TC Energy

450 – 1 Street SW
Calgary, Alberta T2P 5H1

Tel: (403) 920-2174
Fax: (403) 920-2347
Email: roselyn_chou@tcenergy.com

February 28, 2020

Filed Electronically

Canada Energy Regulator
Suite 210, 517 Tenth Avenue SW
Calgary, AB T2R 0A8

Attention: Ms. L. George, Secretary of the Commission

Dear Ms. George:

Re: NOVA Gas Transmission Ltd. (NGTL)
Northwest Mainline Expansion Project (NWML), Leismer-Kettle River Crossover Project (LKXO), and Chinchaga Lateral Loop No. 3 (Chinchaga) Project (collectively, the Projects)
Certificates GC-119, GC-120 and GC- 121
Year Three Caribou Monitoring Report

Enclosed, please see the Year Three Caribou Monitoring Report for the Projects in accordance Condition 24 of NWML Certificate GC-119, Condition 19 of LKXO Certificate GC-120 and Condition 21 of Chinchaga Certificate GC-121.

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

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Roselyn Chou
Regulatory Project Manager
Regulatory Facilities, Canadian Natural Gas Pipelines

Enclosure

cc: Heather Dodds, Canada Energy Regulator
Paul Gregoire, Environment and Climate Change Canada
Joann Skilnick, Alberta Environment and Parks
James Grier, Alberta Environment and Parks
Christa MacNevin, Alberta Environment and Parks

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada Pipelines Limited (TCPL) and affiliate of TC Energy Corporation, applied under applicable sections (i.e., Section 52) of the *National Energy Board Act* (NEB Act) to construct and operate the following projects:

- Leismer-Kettle River Crossover Project (LKXO)
- Chinchaga Lateral Loop No. 3 Pipeline Project (Chinchaga)
- Northwest Mainline Expansion Project (NWML)

Approval for LKXO was granted in September 2012 by the National Energy Board (NEB), predecessor to the Canada Energy Regulator (CER), pursuant to Section 52 of the NEB Act Certificate GC-120.[1] Approval for the construction of Chinchaga was granted in May 2013 by the NEB pursuant to Section 52 of the NEB Act Certificate GC-121and Board Order XG-N081-009-2013.[2,3] Approval for NWML was granted in May 2012 by the NEB pursuant to Section 52 of the NEB Act Certificate GC-119.[4]

1.1 MONITORING PROGRAM

Portions of the above-mentioned Projects occur within the provincially mapped Caribou Range (Figure 2-1) and approval for the construction and operation of these Projects were subject to conditions outlined for the respective NEB Act Certificate (i.e., GC-119, GC-120, GC-121). The Projects include a condition outlining requirements for the filing of a Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP or Monitoring Program).[5] NGTL developed the Monitoring Program to monitor and verify the effectiveness of caribou habitat restoration and offset measures[6] implemented as part of the Projects' Caribou Habitat Restoration Plan (CHRP).[7] Pursuant to the previously mentioned conditions of the Projects' respective certificates, NGTL committed to filing monitoring reports to the CER.

Details of the Monitoring Program are consistent with the primary principles and conditions used to guide NGTL caribou habitat restoration and offset monitoring

[1] NEB Filing ID: A47708.
[2] NEB Filing ID: A51745-3.
[3] A51745-4. NEB Filing ID: A51745-4.
[4] NEB Filing ID: A41744.
[5] NEB Filing ID: A89738-1.
[6] Final Offset Measures Plan (OMP) filed on February 1, 2019 (NEB Filing ID: A97781-1).
[7] Project's CHRP as well as subsequent errata filings to the CHRP (NEB Filing IDs: A87455, A88198, A89273).

programs,[8] and reflect continual improvements based on lessons learned and the adaptive management approach utilized by NGTL. The Monitoring Program was also prepared with consideration for Operational Policy Statement and Follow-Up Monitoring Programs under the *Canadian Environmental Assessment Act* (CEAA) (CEA Agency, 2011).

The CHROMMP was conducted in accordance with Condition 24 of Northwest Mainline Expansion Project (NWML) Certificate GC-119, Condition 19 of LKXO Certificate GC-120 and Condition 21 of Chinchaga Lateral Loop No. 3 (Chinchaga) Project Certificate GC-121 filed with the National Energy Board (NEB) for the Projects on August 4, 2015.[9] The CHROMMP was approved by the NEB in October 2015.[10]

This document reports the third-year results (Year 3) of the Monitoring Program. As committed to in the monitoring and reporting schedule, on February 1, 2017, NGTL submitted the results for the direct project footprints and associated offset areas (Year 1 CHROMMP Report). Collectively:

- LKXO[11]
- Chinchaga
- NWML (including Cranberry and Timberwolf sections)[12]
- Associated offsets for Timberwolf located on the Sloat section
- Offsets for Chinchaga and LKXO located in the Dillon River Wildland Provincial Park (Dillon Offset)[13]

The sections above are referred in this report as the Projects, whereas Project Area refers to their collective locations, unless noted differently.

1.1.1 Recent Updates

In response to feedback from a letter issued by the NEB on January 22, 2018,[14] NGTL filed an update to the Year 1 Report Update (Updated Report) on

[8] NEB Filing ID: A71613 filed with the NEB on August 4, 2015 to comply with Condition 24 (Certificate GC-119) for the Northwest Mainline Expansion Project, Condition 19 (Certificate GC-121) for the Chinchaga Lateral Loop No. 3 Project, and Condition 21 (Certificate GC-120) for the Leismer to Kettle River Crossover Project.
[9] NEB Filing ID: A71613.
[10] NEB Filing IDs: NWML (A72982) and LKXO (A72983) approval received October 1, 2015 and Chinchaga (A73055) approval received October 6, 2015.
[11] NEB Filing ID: A61262.
[12] NEB Filing ID: A61246.
[13] NEB Filing ID: A75414.
[14] NEB Filing ID: A89441-1.

October 31, 2017, and a further revised report on March 5, 2018.[15,16] In addition, the NEB met with NGTL on May 30, 2019, to discuss technical issues about the caribou habitat offsets implemented in Dillon and to discuss caribou habitat restoration calculations. This subsequent filing contains the results of the Year 3 monitoring of caribou habitat restoration (Year 3 CHROMMP Report) for the Projects as defined above and has also integrated feedback from the letters dated January 22, 2018, and March 09, 2019,[17] and the discussions held at the May 30, 2019, meeting.

1.2 ORGANIZATION

This Monitoring Program reflects a cycle of continual improvements based on lessons learned and the adaptive management approach utilized by NGTL. The Year 3 Monitoring Report is divided into the following sections:

- Section 2: Monitoring Program Background and Goals
- Section 3: Ground-based Monitoring
- Section 4: Remote Camera Monitoring
- Section 5: Summary of Results
- Section 6: Residual Effects, Restoration Trajectory and Offsets
- Section 7: Lessons Learned and Adaptive Management
- Section 8: References

[15] NEB Filing ID: A81600.
[16] NEB Filing ID: A6A9A1.
[17] NEB Filing ID: A98227-1.

2.0 MONITORING PROGRAM OBJECTIVES

NGTL's habitat restoraton efforts aim to achieve self-sustaining forests capable of supporting boreal caribou. This Monitoring Program employs a methodology based on a framework of adaptive management informed by ground-based and remote camera surveys. NGTL completed Year 1 of the Monitoring Program in 2016-2017 and Year 3 in 2018-2019 for all locations. The specific objectives of this report are to:

- summarize Year 3 findings from the monitoring Programs, and
- evaluate the habitat restoration performance against the evaluation criteria and measurable targets, where feasible.

Appendix A shows the evaluation criteria and measurable targets (performance indicators) from the CHROMMP (NGTL, 2015).

This Monitoring Program is concurrent to Post Construction Reclamation Monitoring (PCRM). A primary objective of PCRM is to evaluate the success of mitigation measures implemented during construction. In PCRM, NGTL assesses environmental issues and as required, implements corrective measures to address issues. While distinct, the Monitoring Program and PCRM inform each other's activities and provide opportunities for joint procedural learnings and improvements.

2.1 PROJECT AREA

The locations considered by this report include vast tracts of forested land in two distinct geographic areas: the NWML and Chinchaga ROWs in northwestern Alberta, and the LKXO ROW and the Dillon River Wildland Provincial Park (Dillon) offsets in northeastern Alberta.

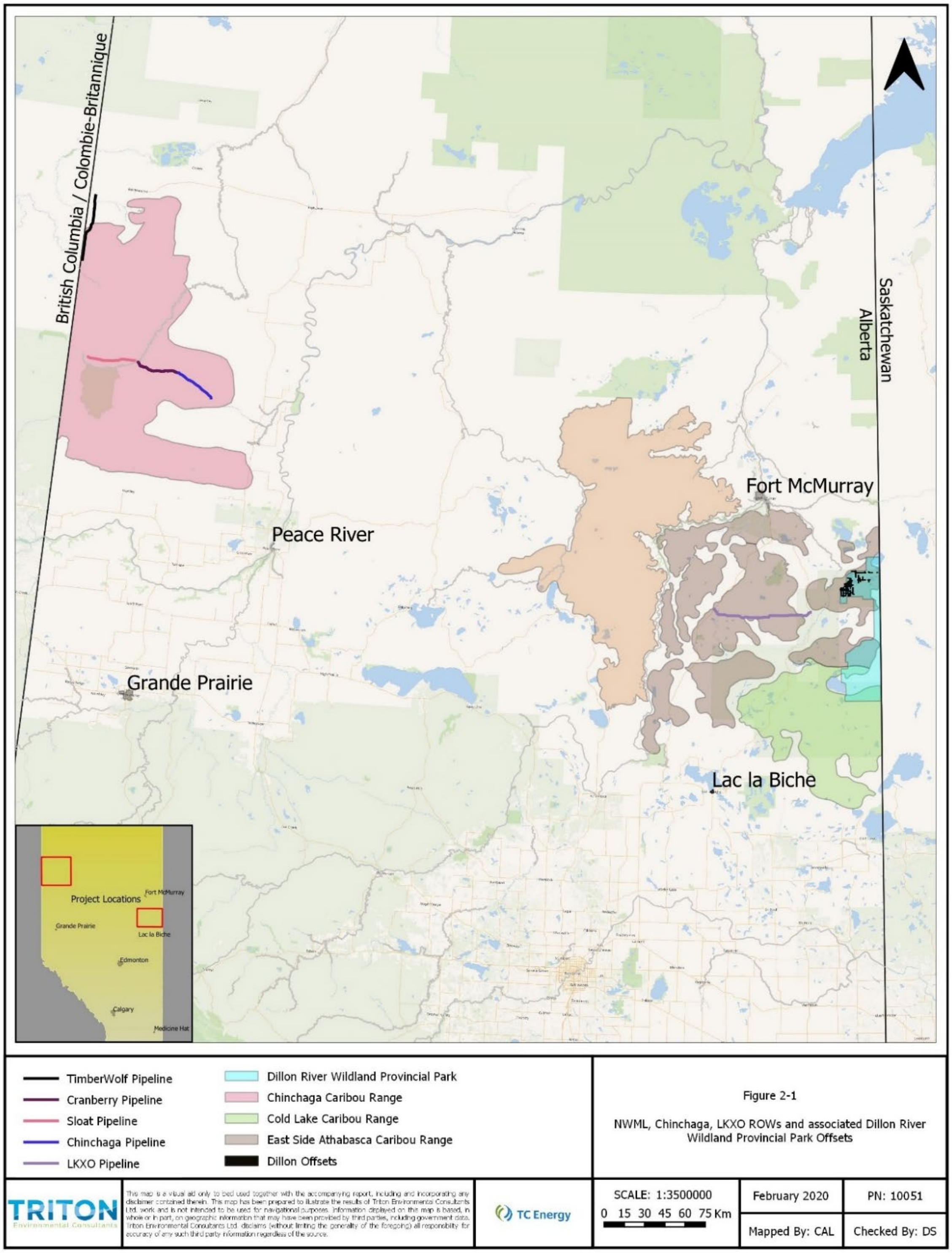


Figure 2-1: Project Area and Associated Caribou Ranges

2.2 PROJECT AREA ENVIRONMENTAL SETTINGS

2.2.1 Northwest Alberta: Chinchaga, NWML

Chinchaga and NWML (Sloat and Cranberry sections) are situated approximately 44 km northwest of Manning, AB while NWML (Timberwolf) is situated approximately 30 km southwest of Rainbow Lake, AB.

Chinchaga, Sloat and Timberwolf are located within the Lower Boreal Highlands Natural Subregion (Natural Regions Committee, 2006). Cranberry crosses both the Lower Boreal Highlands and Upper Boreal Highlands Natural Subregions. Landscapes in the Lower Boreal Highlands Natural Subregion are characterized by diverse mixedwood forests on moist lower slopes of northern hill systems and extensive wetlands at slope bases and on adjacent lowlands. Forests are a mix of aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), white birch (*Betula papyrifera*), with hybrids of lodgepole pine (*Pinus contorta*) and jack pine (*Pinus banksiana*) occurring specifically on slopes. Treed, shrubby and graminoid fens occur in depressions, seepage zones or level areas. This subregion has slightly colder winters and warmer summers than the higher elevation Upper Boreal Highlands Natural Subregion and is moister and cooler than the adjacent Central Mixedwood and Dry Mixedwood Natural Subregions. Common soils are Gray Luvisols (often gleyed) with organic soils and Gleysols in the wetlands (NRC, 2006).

The Upper Boreal Highlands subregion is surrounded by the Lower Boreal Highland subregion and changes in species composition generally reflect changes in elevation. Forests are mainly coniferous and feature lodgepole pine-jack pine hybrids co-occurring with black spruce. Open black spruce stands are prevalent on wetlands. Understory species diversity generally decreases with elevation with bearberry, lichen, common Labrador tea (*Rhododendron groenlandicum*) and common blueberry (*Vaccinium myrtilloides*) occurring on drier sites and mixed stands with aspen, white birch, green alder (*Alnus crispa*), willow (*Salix spp.*), Labrador tea (*Rhododendron groenlandicum*), common blueberry and bog cranberry (*Vaccinium vitis-idaea)* occurring on well drained Brunisols. Soils in the Upper Boreal Highlands Subregion are weakly developed due to the cold, moist environment characteristic of this subregion. Orthic Gray Luvisols are the dominant soils with significant occurrences of Gleyed Gray Luvisols (NRC, 2006).

2.2.2 Northeast Alberta: LKXO, Dillon

LKXO and the Dillon Offsets are within the Regional Municipality of Wood Buffalo; the nearest city is the City is Fort McMurray to the north, and Cold lake to the south. The entire development is located within the Central Mixedwood Natural Subregion and the Lower Boreal Highlands Natural Subregion of the Boreal Forest Natural Region of Alberta (Natural Regions Committee 2006). Soils in these areas are predominantly Gray Luvisols and Dystric Brunisols; organic soils dominate poorly drained locations and wetlands. Typical vegetation communities in the Monitoring Program area consist of mixed forest with white spruce, black spruce, aspen, balsam poplar, white birch, and balsam fir (*Abies balsamea*) or wetlands dominated by black spruce fens and bogs. Dry and sandy sites tend to be dominated by lodgepole pine and jack pine. Understory vegetation consists in an assortment of shrubs, forbs, and grass-like species. Fens and bogs are dominated by sedges, shrubs and mosses. Common occurrences include but are not limited to sedges (*Carex spp.*), dogwood (*Cornus stolonifera*), buffalo-berry (*Sheperdia canadensis*), dwarf birch (*Betula pumice*), willow species, Labrador tea, beaked hazelnut (*Corylus cornuta*), prickly rose (*Rosa acicularis*), low bush cranberry (*Viburnum edule*), green alder (*Alnus crispa*) as well as bunchberry (*Cornus canadensis*) and common horsetail (*Equisetum arvense*).

2.3 PROJECT AREA FOOTPRINT

Summary information about the Project Area is provided below (Table 2-1):

Table 2-1: Summary of Project information and associated caribou habitat information

Project Area	Caribou Range	Herd Range	Constructio n Date	Final Cleanup Date	% Disturbance	
					Existing	Greenfield
Chinchaga[1]	Chinchaga	Chinchaga	Jul 2014	Feb 2015	94	6
NWML[2] Timberwolf	Chinchaga	Chinchaga	Nov 2012	Mar 2014	100	0
NWML[2] Cranberry/Sloat					69	31
LKXO[3]	ESAR	Egg-Pony	Apr 2013	Mar 2014	73	27

Note:
1. NEB Filing ID: A33664.
2. NEB Filing ID: A29090.
3. NEB Filing ID: A30357.

2.3.1 Chinchaga

Cranberry extends 33 km from the adjacent NGTL Chinchaga Meter Station at NE 13-96-05 W6M to the Meikle River Compressor Station at NE 26-94-02 W6M. The Project parallels existing linear disturbances (e.g., pipelines and roads) for 30.4 km (94%) of this loop (Table 2-1). The Chinchaga section is in the Chinchaga caribou range for 97% its entire length. Construction activities for the Project first started in 2013; final cleanup operations were completed by February 2015. Year 1 ground-based monitoring was completed in July and August 2016 and Year 1 camera monitoring was completed in August 2017.

2.3.2 NWML

The NWML sections (portions of Cranberry, Timberwolf) are in the Chinchaga caribou range for 97% its entire length. Construction activities for these sections began in 2012; final cleanup operations were completed by March 2014. The Cranberry section extends from a tie-in point immediately adjacent to the exiting NGTL Chinchaga Meter Station at NE 13-96-5-W6M to a tie-in point at SW 31-96-7 W6M. Cranberry and the chosen offset, Sloat, parallel existing linear disturbances (e.g., pipelines and roads) for 30.4 km (94%) of this loop. The Timberwolf pipeline extends from NGTL's existing Moody Creek Compressor Station at NW 03-109-12 W6M to a tie-in point immediately adjacent to NGTL's existing Snowfall Creek Meter Station at NW 06-104-12 W6M. Timberwolf parallels existing linear disturbances (e.g., pipelines and roads) for 49.4 km (99%) of its length.

2.3.3 LKXO

LKXO extends from the Leismer Compressor Station at SW 03-04-81-13 W4M to the Kettle River Lateral Loop at NW 14-26-80-06 W4M. This Project parallels existing linear disturbances, including pipeline rights-of-way, railway lines, seismic lines and roads for approximately 55 km. (71%) of its length. LKXO is located within the East Side Athabasca River (ESAR) caribou range for 88% its entire length. Construction activities began in 2013; final cleanup operations were completed by March 2014.

2.3.4 Offset Area

The offsetting strategy for constructed portions of the Projects involved identifying suitable offset areas across a vast geographic region. Offsets were ultimately planned for ROWs within the Bohn herd (ESAR) caribou area (Dillon) and Chinchaga caribou range (portions of Cranberry and Sloat Creek sections) and within the Dillon River Wildland Provincial Park (Dillon) in northeastern Alberta. Offsets on the Cranberry and Sloat sections provide direct benefit for the Chinchaga caribou range, while Dillon was chosen due to its importance as reservoir of integral habitat for boreal caribou and where offsets could be protected in perpetuity. Depending on the nature of the offset area (i.e., seismic lines, abandoned forestry roads, log-deck sites or existing NGTL easements) offset restoration measures included planting to accelerate reforestation, planting for line-of-sight blocking, seeding and shrub staking for augmentation of natural revegetation, and barrier segments (rollback, mounding).

2.3.5 Dillon Offset

The Government of Alberta announced the creation of the Dillon River Wildland Provincial Park in 2012. Dillon is located 75 km southeast of Fort McMurray within ESAR (Bohn herd) caribou range. Previously the lands within the park were managed under the Forest Management Agreement by Alberta Pacific Forest Industry Inc. (Al-Pac) but were returned to the Government of Alberta and are not administered by

Alberta Environment and Parks (AEP) to secure and protect a large tract of important woodland caribou habitat. Existing disturbance from historical seismic activity including cut lines and access roads provided an opportunity to invest in caribou habitat restoration that is assured protection from future industrial development.

NGTL conducted a comprehensive desktop review in consultation with AEP and Al-Pac to identify suitable locations for offsetting within the park in 2014 (Figure 2-2). In 2017, NGTL and Al-Pac initiated field visits to determine offset site suitability. Ground-truthing resulted in the discovery that some of the chosen recipient locations within the park were not appropriate for offsetting due to already well-established vegetation communities along seismic lines. As such, NGTL identified alternative sites, tracking changes in locations and treatment areas, to ensure that the offset footprint remained equivalent (Figures 2-3 and 2-4). Offsetting was not conducted in areas where ground-truthing indicated the sites were not appropriate. A summary of the final offset locations and offset value for each Project Area is provided in Table 2-2. Detailed information on offsets and offset value calculation is available in the Final Offset Measures Plan (Final OMP).[18]

Table 2-2: Offset Locations and Final Offset Value for Each Project Area

Project Area	Caribou Range	Offset Location (s)	Final Offset Value Implemented
Chinchaga	Chinchaga	Dillon	54.5 ha
NWML	Chinchaga	NWML ROWs, Dillon	Cranberry 61 ha, Sloat 29 ha, Dillon: 22 ha
LKXO	ESAR	Dillon	68.4 ha

[18] NEB Filing ID: A97781-1.

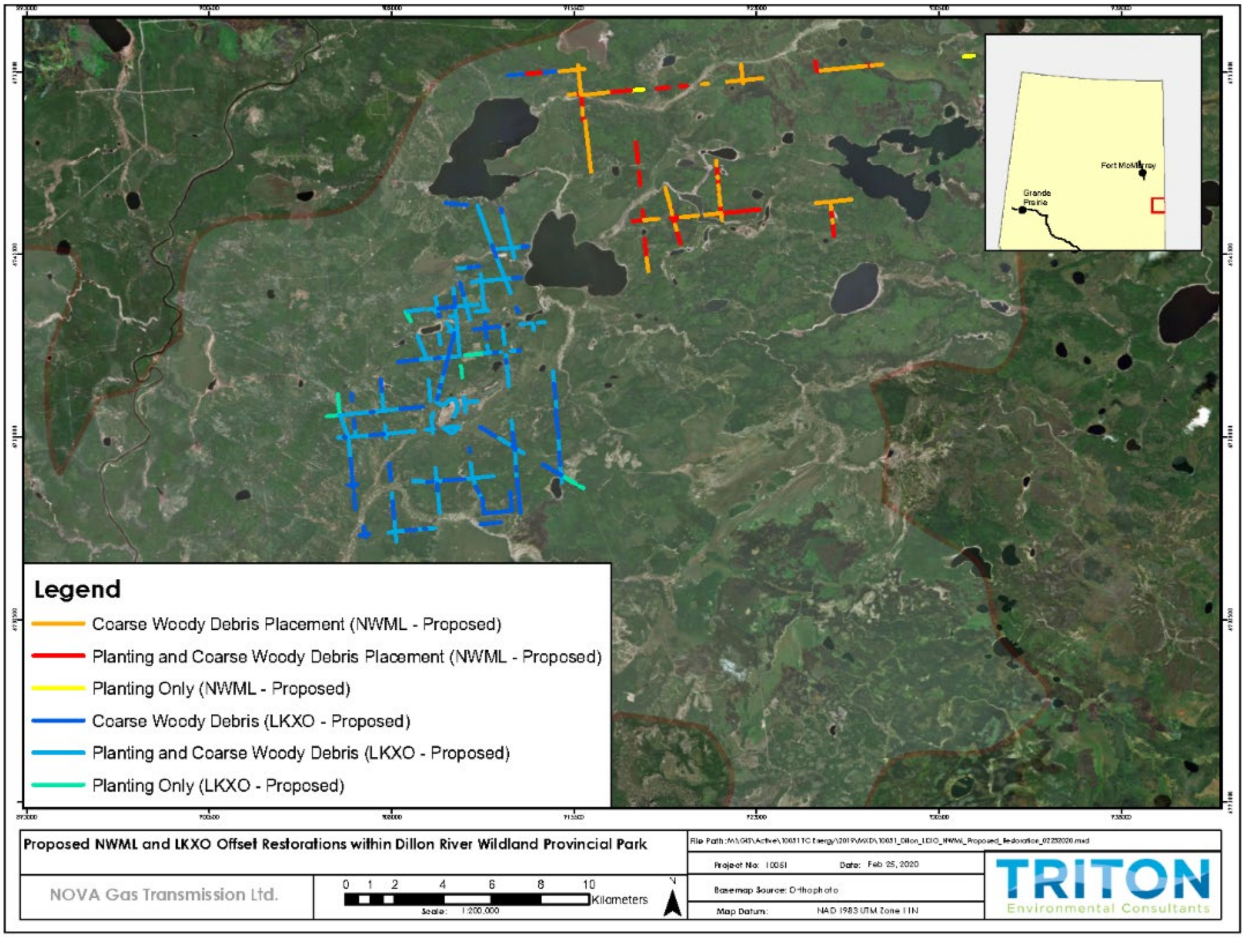


Figure 2-2: Proposed Projects offset in Dillon as identified during the initial desktop assessment in 2014

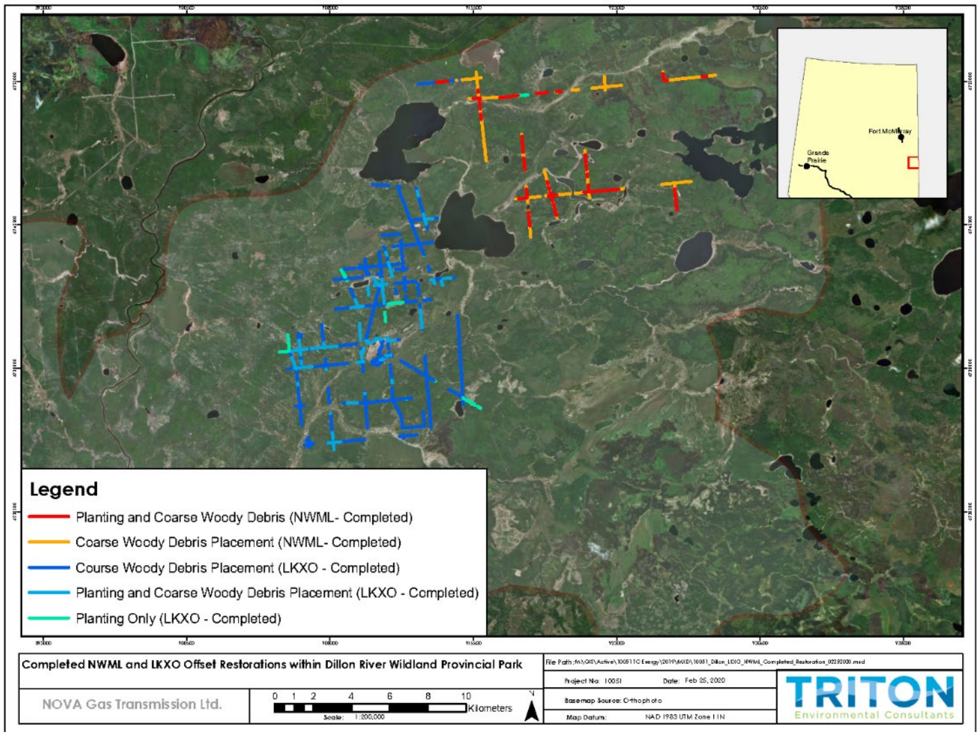


Figure 2-3: Constructed Projects offsets in Dillon implemented following field verification in 2017

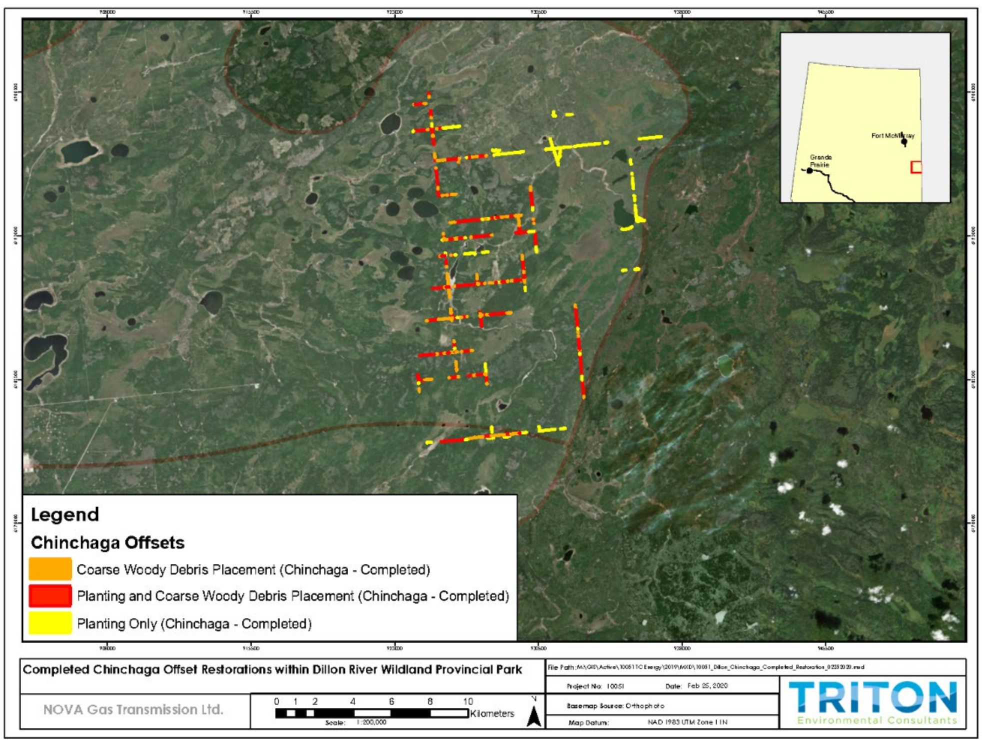


Figure 2-4: Completed Chinchaga offsets, located in another portion within the Dillon area

2.4 BOREAL CARIBOU

Boreal caribou (*Rangifer tarandus caribou*) are a distinct ecotype of woodland caribou inhabiting the boreal forests of Canada. In Alberta, there are 12 populations distributed over the northern half of the province. Boreal caribou are assessed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed as a threatened species under the federal Species at Risk Act (SARA). All herds in Alberta are deemed non-sustaining and require action to return 65% or more of their range to undisturbed conditions for the population to become viable once again (SARA, 2012).[19]

Boreal caribou are mostly sedentary and show high fidelity to home ranges. Lichens typically associated with old growth coniferous forests form an important part of their winter diet. In snow-free months caribou choice of forage is more varied, allowing herds to move across different habitats. The presence of old growth forests is, however, only one of the constraints influencing northern Alberta's caribou populations. Individuals or small herds find refuge from their main predators, wolves and bears, in mature coniferous stands with high canopy cover or in vast wetland complexes. Human disturbances affecting caribou habitat such as clearing and the construction of linear features (e.g., cutlines, roads, pipelines, etc.) result in cumulative effects to caribou through primary and secondary predation, return of the landscape to an earlier seral stage, loss of suitable habitat, and range fragmentation. These threats are compounded by natural fire cycles, insect harassment, disease, and climate change.

The direct correlation between habitat disturbance and sustaining woodland caribou populations underlines the importance of habitat restoration initiatives targeted to boreal caribou recovery. Restoration of disturbed habitat has become one of the key components for caribou conservation identified through the proposed amended federal Recovery Strategy (ECCC, 2019). Preventing off-road and vehicular access, ensuring vegetation regrowth to a reclaimed and self-sustaining state, and blocking line-of-sight along the linear corridor are priority actions undertaken by this Monitoring Program in alignment with provincial and federal policies, management plans and priorities (Alberta Woodland Caribou Recovery Team, 2005; Environment Canada, 2012; ENR, 2019).

2.4.1 Pipeline Vs Offset Restoration Strategy

While subject to the same monitoring methodology, the restoration of pipeline corridors and of the seismic lines within Dillon are inherently different in terms of approach and of recovery performance. The restoration of pipeline corridors needs to account for longer operational needs, a single larger footprint, and for the presence of

[19] Retrieved on December 16, 2019 from: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/woodland-caribou-boreal-population-2012.html

contiguous developments, often time for much of their length. Conversely, the restoration of past seismic footprint in Dillon (and elsewhere) is intended to provide a shorter timeframe for habitat rehabilitation within the ESAR and Cold Lake ranges and within Dillon, which due to its provincially designated status that protects the Dillon against future developments. The reader is encouraged to account for the different footprints of the NWML (Cranberry, Sloat and Timberwolf), Chinchaga, LKXO and Dillon offsets in the analysis of Program's results.

2.4.2 Monitoring Program Timeline

This Monitoring Program was launched in Q3 of 2016 following the completion of final cleanup in February 2015. Year 1 of the Monitoring Program occurred in 2016/2017 and the final revised results were filed with the CER in 2018.[20] In Q3 of 2018 resource specialists revisited vegetation plots (established in 2016) and installed remote cameras to monitor access controls and wildlife movements on the ROW. In Q3 of 2019, after a year of recording, remote camera and ground based data was analyzed and compiled into this Year 3 CHROMMP report. The process of data analysis and reporting for the Year 3 report started in 2019, and was completed in Q1 of 2020.

2.4.3 Monitoring Program Methodology

For a full description of the Monitoring Program methodology, including timeline, surveys, and next steps please refer to the Year 1 CHROMMP (2017) and the report Appendices. Abbreviated descriptions of ground-based and remote camera surveys are also presented in less detail in Sections 3 and 4 of this report.

[20] NEB Filing ID: A90419.

3.0 GROUND BASED MONITORING

Ground-based monitoring involves physical access to a site to monitor the effectiveness of implemented habitat restoration and offset measures. Specifically, the objectives of ground-based monitoring are to:

- evaluate vegetation communities' performance by collecting data on seedling density, vegetation height, percent cover and species composition;
- assess first-hand the effectiveness of access controls;
- evaluate the growth and effectiveness of line-of-sight breaks; and
- gather information on the use of restored areas by wildlife through incidental observations.

The underlying approach to data analysis over time is repeated measures experimental design, where measurements of restoration performance are repeated at each sample plot for each monitoring year. Each year of ground-based monitoring followed the Ground-Based Monitoring Field Protocol outlined in Appendix B.

3.1 METHODS

3.1.1 Timeline

The first year of any restoration program is a key phase for the establishment of functional forests. During this time, seedlings transition between survival and establishment and can be affected by adverse effects from wind and water erosion, frost, colonization from non-native species or from undesirable species from contiguous dispositions, and wildlife forage. Year 1 of this Monitoring Program was a benchmark period as it provided crucial baseline information on restoration following cleanup. Year 1 monitoring methods and results are found in the Year 1 report.[21]

Year 3 of the Program began in early 2018 with planning and mapping activities; fieldwork was completed in Q3 of 2018 during the vegetation growing season, but field crews revisited the Program Area in Q3 of 2019 to retrieve camera data for the remote camera monitoring component (see Section 4).

3.1.2 Treatment Site Types

Treatment unit and plot type selection were chosen in Year 1 utilizing scientific data available for the Program Area and the Geographic Information System (GIS) ArcMap spatial analysis function. The strategy adopted by NGTL first involved exhaustive delineation of treatment sites sharing similar characteristics (Table 3-1),

[21] NEB Filing ID: A6A9A1.

followed by the creation of treatment units and plot types: restoration, natural regeneration, access control, and line of sight.

Table 3-1: General definitions of treatment units, corresponding vegetation, and type of plots employed in the ground-based program

<table>
<tr><th>Plot Type</th><th>Treatment Unit Type</th><th>Description</th></tr>
<tr><td rowspan="3">Restoration Plots
Plots selected in treatment units within the Project's ROW to evaluate vegetation growth and restoration after planting.

Natural Regeneration (Control) Plots
Plots placed on sites disturbed by construction that are currently going through the process of natural regeneration (i.e., sites left to regenerate from the soil seed bank and natural ingress).</td><td>Treed Upland</td><td>Treed uplands (mixed wood, coniferous) are tracts of forest located in non-wetland areas on dry to moist soils. Typical upland vegetation include species such as white spruce, aspen, balsam poplar, jack and lodgepole pine, and balsam fir.</td></tr>
<tr><td>Treed Lowland</td><td>Treed lowlands are tracts of forest typically located in soils with moist to wet regimes and within or adjacent to wetland complexes such as bogs, fens or waterbodies. Typical treed lowland species may include black spruce, tamarack, white birch, and cottonwood.</td></tr>
<tr><td>Shrub Graminoid</td><td>Shrub Graminoid refers to areas characterized by the absence of trees and the prevalence of shrubs such as willows, dogwood and dwarf birch, forbs, and species that have grass-like morphology. These plots may occupy wetlands or naturally disturbed areas (e.g., burned bogs). Seedlings were not planted in these areas as coniferous trees were not dominant within the adjacent landscape.</td></tr>
<tr><td>Access Control Plots</td><td colspan="2">Access management treatment locations monitored to determine ROW usage and effectiveness of controls.</td></tr>
<tr><td>Line-of-Sight Plots</td><td colspan="2">Monitoring locations used to determine the effectiveness of line-of-sight blockages installed to deter visual spotting of caribou by predators.</td></tr>
</table>

3.1.3 Restoration Plots

Restoration plots placed within treatment areas measure the success of restoration activities based upon established metrics.[22] The treatment unit type for each was defined by similar ecological communities and bio-geoclimatic influences (e.g., landscape, moisture, and nutrient regimes and corresponding uplands, lowlands, and shrubland habitat). Monitoring plots were chosen within the treatment polygons using a stratified random site selection method. The number of plots (representation) for each habitat was accounted for to avoid bias.

3.1.4 Natural Revegetation Plots

Natural regeneration plots were selected using the same sampling methodology described above and in Appendix B.

[22] Appendix A.

3.1.5 Access Control Plots

Access controls utilized by NGTL on the Program Area include:

- Extended trenchless crossings
- Vegetation screens
- Rollback
- Fencing and signs (around facilities)
- Vegetation planting
- Mounding

The location of access management controls was first identified during the planning activities preceding pipeline construction using the Projects' construction alignment sheets. Proposed access management treatment locations were adjusted during the construction phase to consider site-specific conditions and to adapt to construction needs, where required. Criteria utilized for their initial appointment included: location within Caribou range, intersecting perpendicular access configuration, as well as evidence of existing human access. Access controls adjacent to other dispositions, including pipeline ROWs, roads, and facilities, access management measures rendered ineffective by accessible parallel dispositions were not considered.

Access controls were not defined for the Dillon Offsets due to the different nature of the area, which is characterized by extensive regenerating seismic development and limited access due to its remoteness. However, felled trees (coarse woody debris) were combined or interspersed with planting treatments, where appropriate, to limit access and secondarily, to slow predators.

3.1.6 Line-of-Sight Plots

NGTL line-of-sight measures implemented in the Program Area include individual or combinations of vegetation screening, tree planting, rollback and mounding created during construction and final cleanup according to the Environmental Protection Plan (EPP). Line-of-sight measures included minimal disturbance to favor regeneration or preserve vegetation, conifer seedling plantings, snow ramping, bore extensions, and shrub staking. While no longer practiced in subsequent NGTL CHROMMPs due to knowledge gained about their effectiveness, this project also has the legacy of a handful of fabricated screens and earth berm line-of-sights. The maximum line-of-sight mitigation that was applied within caribou range was deemed 500 m or less. Suitable locations for line-of-sight plots were identified using a random selection strategy using the Project's environmental alignment sheets and GIS data.

3.1.7 Restoration and Control Plot Establishment

A total of 216 plots were established within the restoration areas (Table 3-4). Circular plots (50 m^2, i.e., 3.99 m radius) were created on operational dispositions 24 m wide or greater. Smaller plots (10 m^2, i.e., 1.79 m radius) were utilized for non-operational Dillon Offset project areas on seismic lines less than 24 m wide.

Ground disturbance is restricted within a certain distance of operating gas pipelines, therefore plots in these locations were not permanently staked. To facilitate finding the exact locations in consecutive years, long-term features in line with the plot center were marked with flagging tape in the adjacent treeline or directly within the plot, if possible. GPS coordinates at plot center were taken using waypoint averaging to increase confidence in plot center coordinates.

3.1.8 Field Program

Field work was conducted outside of the Restricted Activity Period for Caribou (i.e., after July 15) and within the vegetation growing season, by two teams of two qualified vegetation specialists. Monitoring sites were accessed via helicopter, Argo, or on foot. To maintain consistency in data collection, the field program was completed at approximately the same time each monitoring year (Year 1: July 16 – August 19, 2016; Year 3: July 16 – August 15, 2018). Access control and line-of-sight monitoring plot data were collected simultaneously with the habitat restoration monitoring data. Where practical, restoration monitoring plots were selected in proximity to access control and line-of-sight plots.

Table 3-2: **Distributions of monitoring plots established within each restoration treatment unit by Project Area**

Location	Habitat Restoration Treatment Units (Planted)			Natural Regeneration Treatment Unit (Control)		
	Treed Upland	Treed Lowland	Lowland Shrub	Treed Upland	Treed Lowland	Lowland Shrub
Chinchaga	10	7	1	3	5	1
Cranberry	9	11	4	0	2	4
Sloat	13	5	3	1	5	3
Timberwolf	10	8	2	7	4	4
LKXO	17	16	0	7	5	0
Dillon	23	13	0	7	6	0
Totals	82	60	10	25	27	12

3.1.9 Sampling Protocol

Information collected at each plot location was defined in a protocol to ensure consistency and comprised the following:

- vegetation height, density, vigour and health 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, indicator species and non-native, invasive or weed species);
- evidence of access (e.g., vehicle tracks, access type and level) and, where access-control measures are implemented, verification of their ongoing functionality as an adequate barrier or deterrent;
- line-of-sight measurements including functionality and seedling height, density, vigour and health (for vegetation line-of-sights);
- incidental wildlife signs (e.g., animal tracks, scat, browsing);
- cursorial soil information (e.g., percent cover of each surface substrate type to determine the percent covers of vegetated vs. non-vegetated ground, slope and aspect, drainage, moisture and nutrient regime, surface organic matter thickness; and
- any observed plot characteristics that might impact vegetation survival, establishment and/or growth (e.g., competition, vegetation damage).

3.1.10 Data Collection and Analysis

Habitat restoration, access control and line-of-sight data were collected by survey crews using a GPS-enabled field tablet. All field data was reviewed for accuracy and completeness following in-field and post-field quality assurance/quality control (QA/QC) protocols. Data processing and QA/QC was completed immediately after returning from the field and data was uploaded into a secured geodatabase.

Statistical testing was completed using R 3.5.3 software (R Core Team, 2018) and t-test inferential statistics. A t-test determines if there is a significant difference between two groups of data. In this program t-tests were used to measure a range of different parameters such as differences in growth within a treatment between years, or the difference between native vegetation percent cover, or seedling density and desired target values.

In restoration and control plots one-sided t-tests were used to evaluate vegetation performance against habitat restoration thresholds and paired t-tests assessed differences between the two monitoring years or treatment units. Each individual habitat restoration unit was evaluated separately because of the inherent differences associated with their biophysical characteristics. Beginning in Year 5 an analysis of variance (ANOVA), which can detect differences between three or more groups (i.e., years), will be used in the statistical analysis.

3.2 RESULTS

3.2.1 Native Vegetation Cover Re-establishment

3.2.2 Chinchaga

Native vegetation cover is approaching targets and is similar between restored (HR) and naturally regenerating (NR) treatments for each habitat type (Figure 3-1). Mean native percent cover in lowland treatment (LT) units increased by 39.7% (control) to 92.2% (planted) from 2016 to 2018. Mean native percent cover in shrub/graminoid (SG) plots declined by 12.0% (planted) to 24.3% (control).

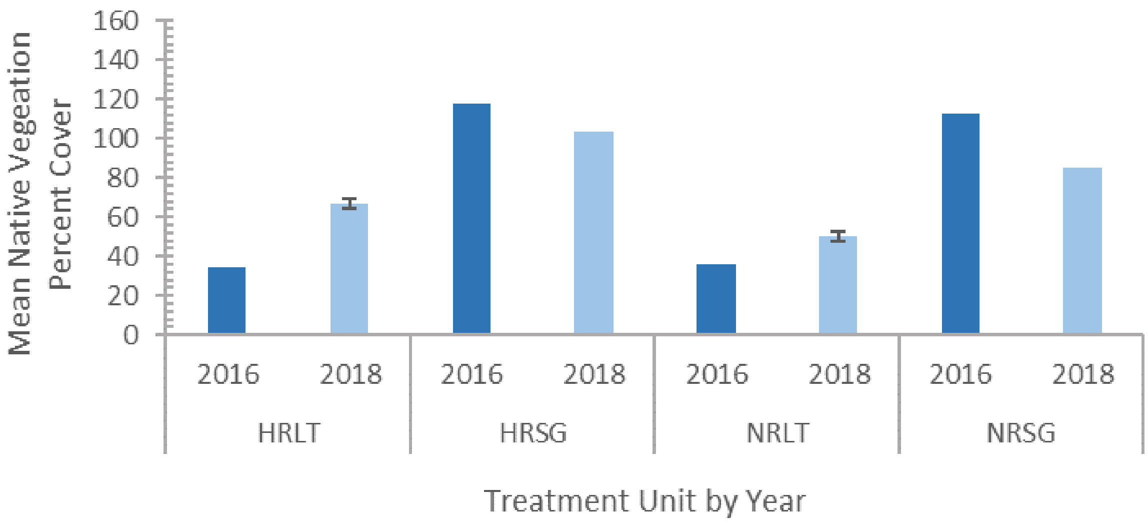


Figure 3-1: Mean percent of native vegetation cover by treatment and year in Chinchaga

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed, SG = shrub/graminoid. Standard error values were not available for 2016.

3.2.3 Cranberry

Native vegetation cover is approaching targets and is similar between restored and naturally regenerating treatments for each habitat type (Figure 3-2). Mean native percent cover in lowland treatment units decreased by 33.1% (control) but increased by 8.4% in planted sites from 2016 to 2018. Mean native percent cover in shrub/graminoid plots declined by 49.6% (planted) and 24.2% (control).

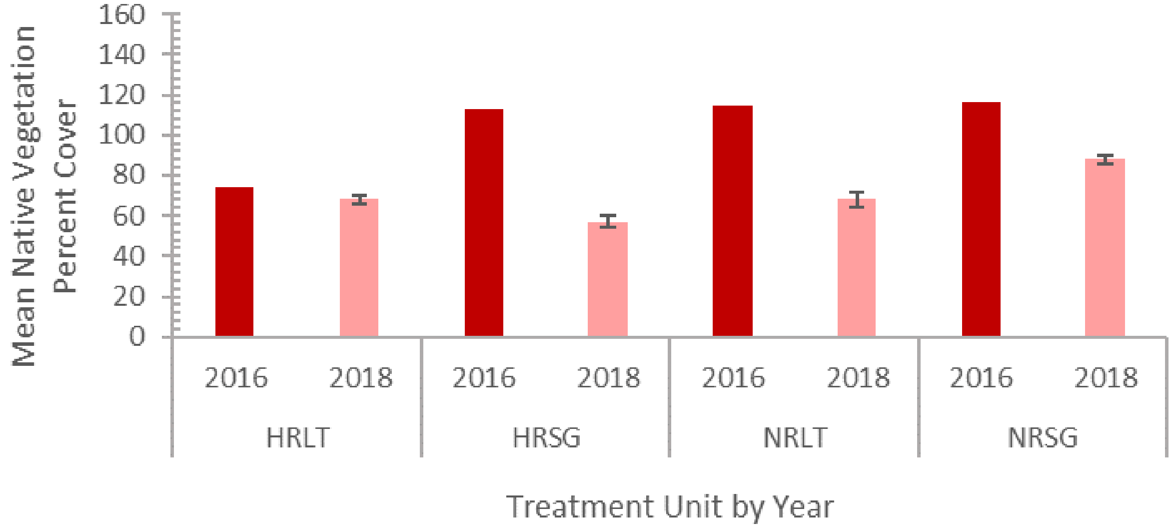


Figure 3-2: Mean percent of native vegetation cover by treatment and year in Cranberry

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed, SG = shrub/graminoid. Standard error values were not available for 2016

3.2.4 Sloat

Native vegetation cover is approaching targets and is similar between restored and naturally regenerating treatments for each habitat type (Figure 3-3). Mean native percent cover in lowland treatment units increased by 16.4% (control) and 5.1% (planted) from 2016 to 2018. Mean native percent cover in shrub/graminoid plots declined by 18.6% (planted) and 8.9% (control).

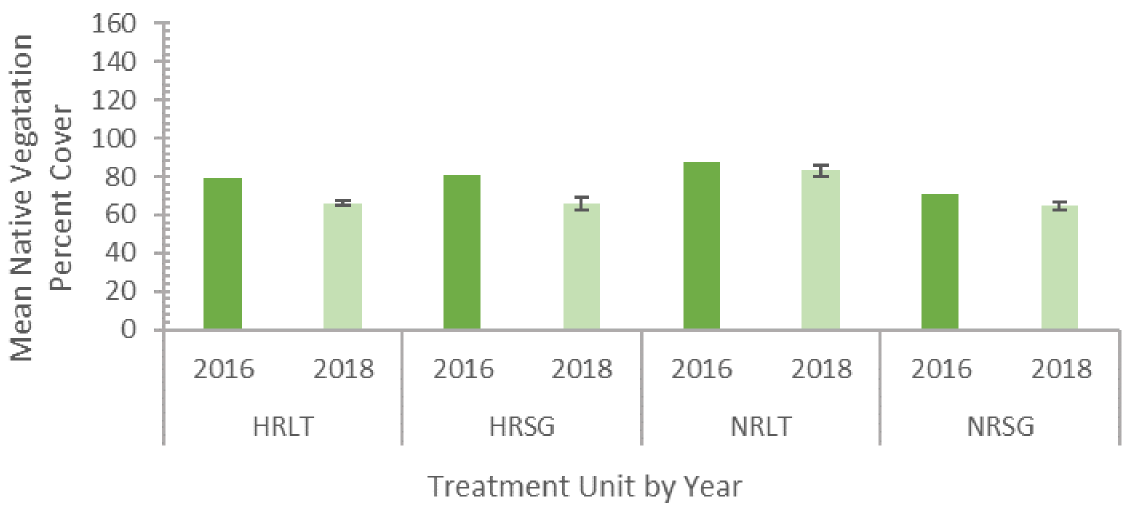


Figure 3-3: Mean percent of native vegetation cover by treatment and year in Sloat

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed, SG = shrub/graminoid. Standard error values were not available for 2016.

3.2.5 Timberwolf

Native vegetation cover exceeds targets in planted lowland treed units and is approaching targets in other treatment units. Native cover is similar between restored and naturally regenerating treatments for each habitat type (Figure 3-4). Mean native percent cover in lowland treatment units increased by 14.5% (control) to 11.3% (planted) from 2016 to 2018. Mean native percent cover in shrub/graminoid plots decreased 19.3% in control plots but increased by 3.5% in planted plots.

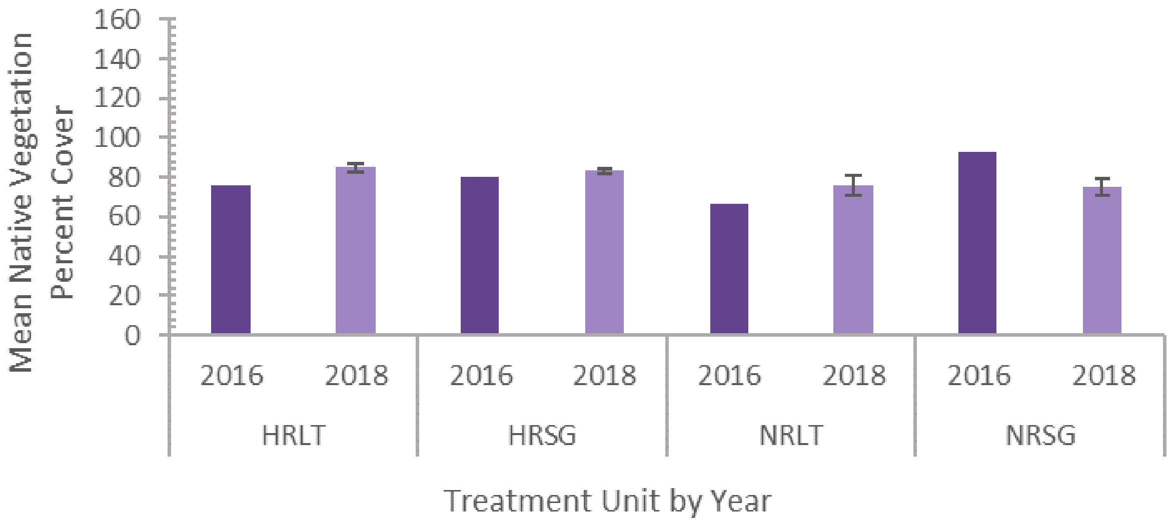


Figure 3-4: Mean percent of native vegetation cover by treatment and year in Timberwolf

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed, SG = shrub/graminoid. Standard error values were not available for 2016.

3.2.6 LKXO

Native vegetation cover is approaching targets in planted lowland treatment units (71.2% increase from 2016) and exceeded targets in control lowland treatment units (50.2% increase from 2016) (Figure 3-5). There are no shrub-graminoid plots within LKXO.

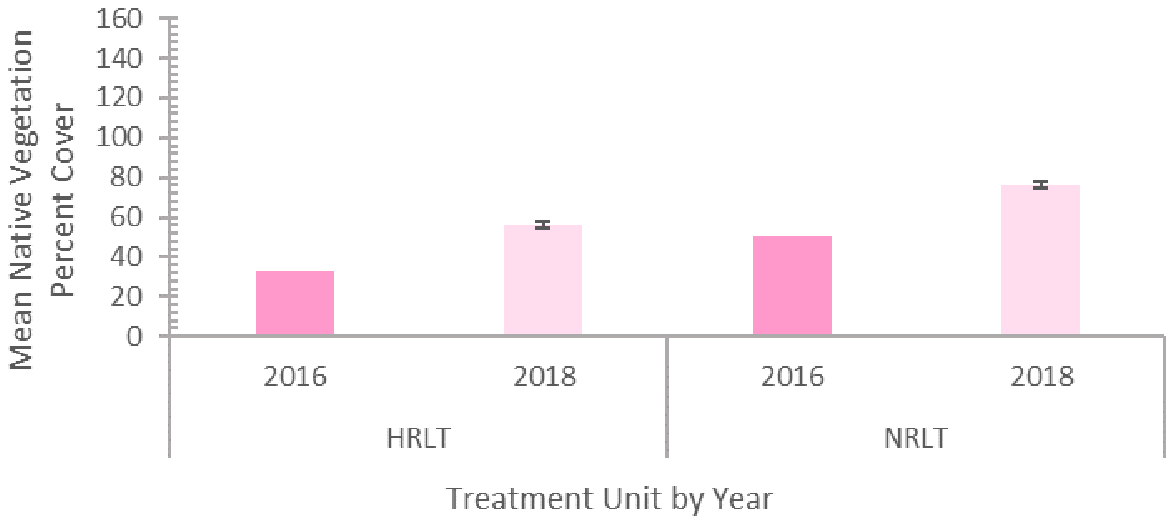


Figure 3-5: Mean percent of native vegetation cover by treatment and year in LKXO

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed. Standard error values were not available for 2016.

3.2.7 Dillon

Native vegetation cover is approaching targets in planted lowland treatment units (71.2% increase from 2016) and exceeded targets in control lowland treatment units (50.2% increase from 2016) (Figure 3-6). There are no shrub-graminoid plots within Dillon.

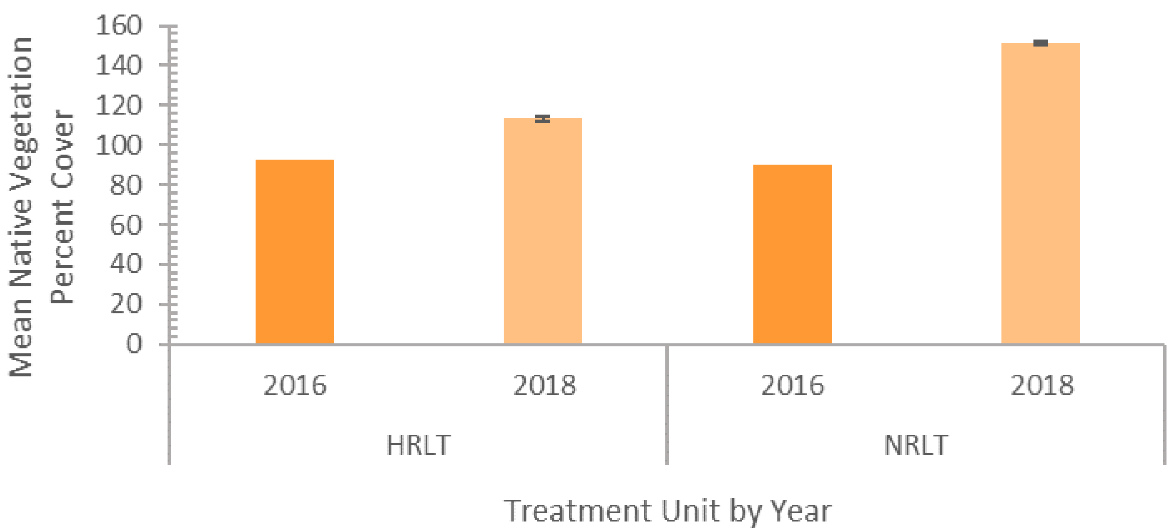


Figure 3-6: Mean percent of native vegetation cover by treatment and year in Dillon

Note: HR = habitat restoration, NR = naturally regenerating, LT = lowland treed. Standard error values were not available for 2016

3.3 SPECIES RICHNESS

Species richness is defined as the diversity of species occupying a given area (Brown et al., 2016). The species richness of native vegetation observed within each restoration treatment unit for each year is presented in Figure 3-7.

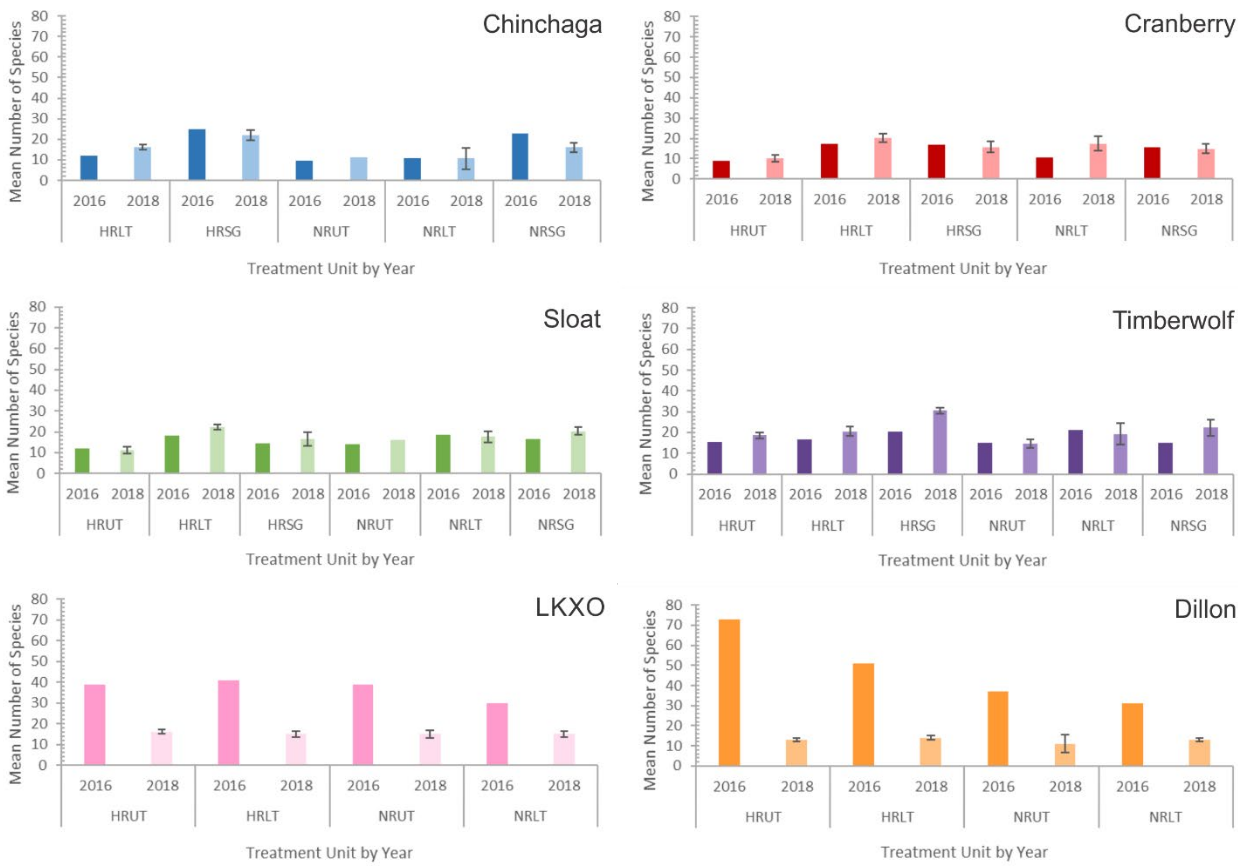


Figure 3-7: Species richness (mean number of species) by year, treatment and Project Area

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

Species richness was similar across most treatments between years within Chinchaga, Cranberry, Sloat and Timberwolf. Species richness was lower across treatments within LKXO and Dillon. For Year 3, species richness was similar within lowland and shrub/graminoid with no obvious difference between restoration sites and natural regeneration plots (Figure 3-7). Upland plots were generally dominated by forbs, graminoids and shrubs under 2.0 m tall, while lowland plots were dominated by mosses and small shrubs. Shrub-graminoid plots, which had the highest species richness values, were dominated by a diversity of sedges, small shrubs and mosses. In general, species richness was higher in the shrub-graminoid and lowland restoration units compared to upland treatments.

3.3.1 Seedling Density

Table 3-3 illustrates the mean tree seedling densities (total of naturally occurring and planted seedlings) by location and restoration treatment unit.

Table 3-3: Mean seedling density (stems per hectare) ±SE by treatment, restoration unit and Project area in 2018

	Habitat Restoration Treatment Units (Planted)		Natural Regeneration Treatment Unit (Control)	
Location	**Upland (stems /ha)**	**Lowland (stems /ha)**	**Upland (stems /ha)**	**Lowland (stems /ha)**
Chinchaga	4628.0 ± 1891.2	4170.3 ± 1595.3	1780.0 ± 1780.0	640.8 ± 261.6
Cranberry	2610.7 ± 575.3	7799.6 ± 1727.1	N/A	0.0
Sloat	1834.8 ± 764.6	6906.4 ± 1865.5	0.0	569.6 ± 569.6
Timberwolf	2848.0 ± 654.3	4138.5 ± 1660.1	1017.1 ± 593.8	25364.9 ± 18926.8
LKXO	3352 ± 689.5	3137.5 ± 897.0	2000 ± 987.0	4160.0 ± 2125.5
Dillon	8850 ± 1629.1	11076.9 ± 3083.2	666.7 ± 666.7	15833.3 ± 4253.8
Note: bold values indicate the probability of the mean being less than the measurable target is less than 0.05, indicating the measurable target (i.e. 1600-2000 stems/ha for Upland, 400-1000 stems/ha for lowland) was exceeded. N/A indicates not applicable as there were not plots within that treatment unit.				

The high standard errors on these values suggest that the number of stems/hectares is highly variable within the Project Areas. More time is needed for natural ingress of seedlings to reach target densities in naturally regenerating locations, which is consistent with expectations prior to Year 5 of the Monitoring Program. The density of seedlings within restored plots relative to naturally regenerating plots indicates that survival of planted seedlings is high to very high.

Results of individual Project Areas are described below:

3.3.2 Chinchaga

The average measured seedling stem density when planted and natural regeneration plots were combined exceeded the measurable target thresholds on all habitat restoration plots ($p < 0.05$). Based on CHROMMP targets (Appendix A) the stems per hectare targets for lowland and upland treatments appear to have been achieved for planted sites (Figure 3-8). Seedling density was comparable for habitat restoration treatments between Year 1 and Year 3.

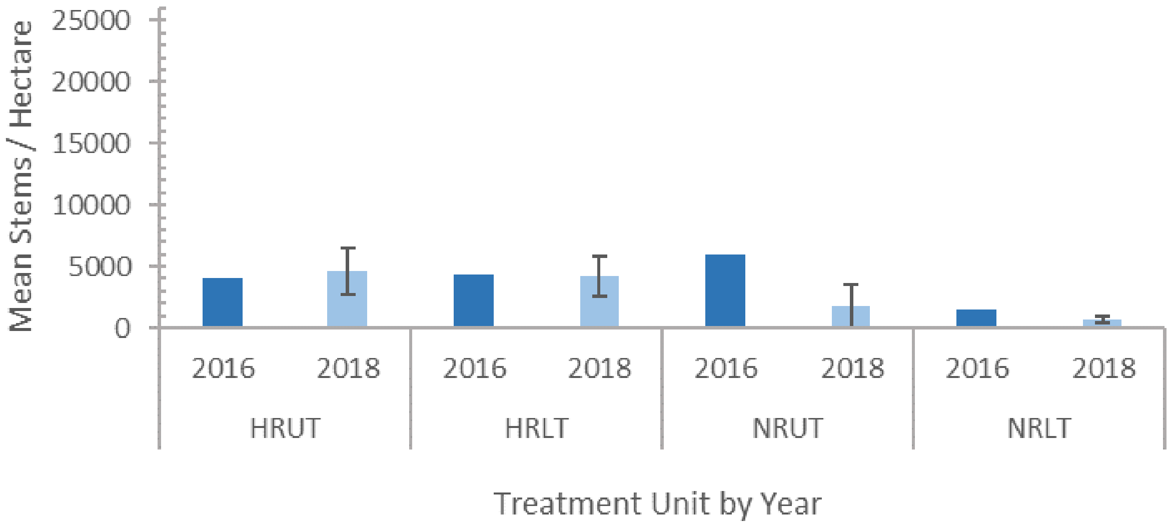


Figure 3-8: Seedling density (mean stems per hectare) by treatment and year in Chinchaga.

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.3 Cranberry

The average measured seedling stem density when planted and natural regeneration plots were combined and exceeds the measurable target thresholds on all habitat restoration plots ($p < 0.05$). Based on CHROMMP targets (Appendix A) the stems per hectare targets for lowland and upland treatments appear to have been achieved for planted sites (Figure 3-9). The natural regeneration treed lowland plots had no seedling stems present in the sampled plots. Seedling density was comparable or increased within habitat restoration treatments in Year 3 compared to Year 1.

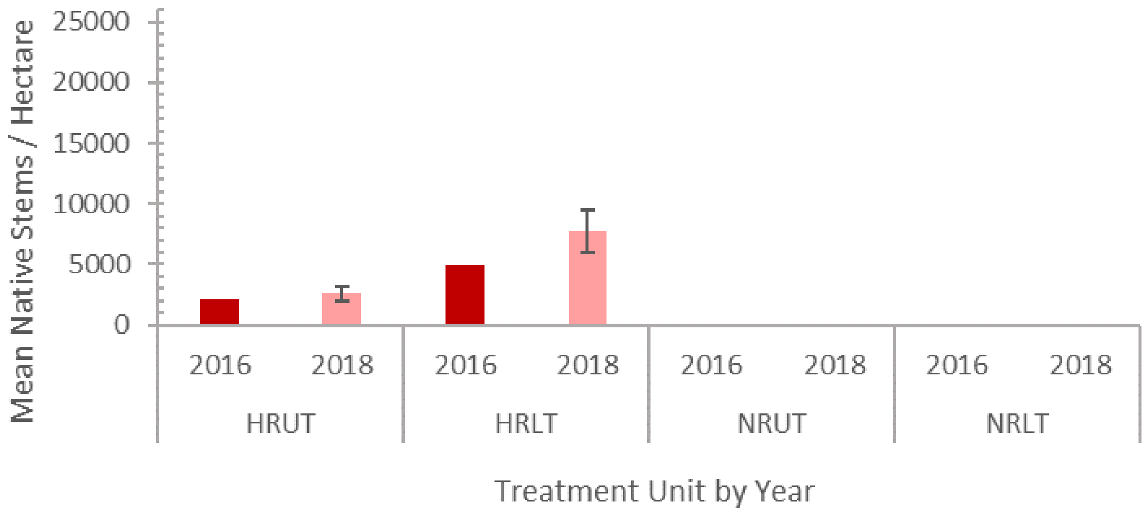


Figure 3-9: Seedling density (mean stems per hectare) by treatment and year in Cranberry

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.4 Sloat

The average measured seedling stem density when planted and natural regeneration plots were combined exceeds the measurable target thresholds on all habitat restoration plots ($p < 0.05$). Based on CHROMMP targets (Appendix A) the stems per hectare targets appear to have been achieved for lowland, but not upland planted sites (Figure 3-10). The natural regeneration treed upland plots had no seedling stems present in the sampled plots. Seedling density was comparable in planted upland plots, increased in planted lowland plots and decreased in naturally regenerating plots between Year 1 and Year 3.

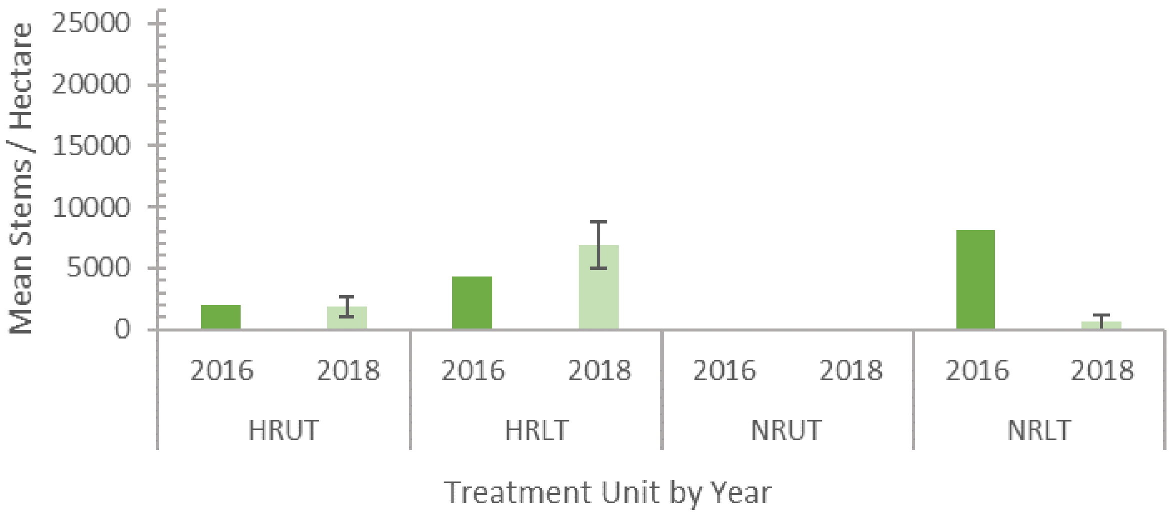


Figure 3-10: Seedling density (mean stems per hectare) by treatment and year in Sloat

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.5 Timberwolf

The average measured seedling stem density when planted and natural regeneration plots were combined exceeds the measurable target thresholds on all habitat restoration plots ($p < 0.05$). Based on CHROMMP targets (Appendix A), the stems per hectare targets for lowland and upland treatments appear to have been achieved for planted sites (Figure 3-11). Seedling density was comparable in planted upland, planted lowland and naturally regenerating plots, and increased naturally regenerating lowland plots between Year 1 and Year 3.

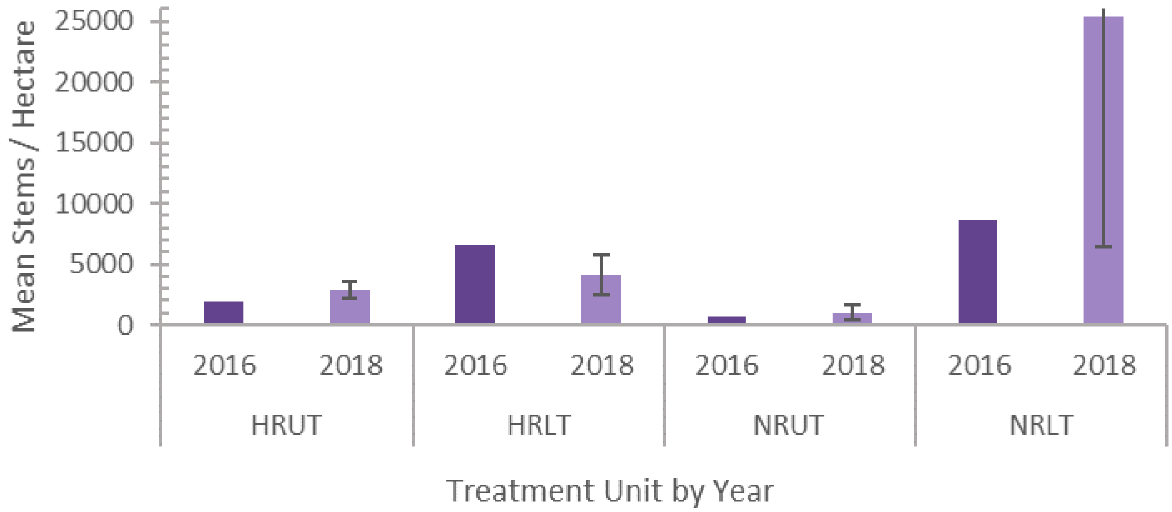


Figure 3-11: Seedling density (mean stems per hectare) by treatment and year in Timberwolf

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.6 LKXO

The average measured seedling stem density when planted and natural regeneration plots when combined exceeds the measurable target thresholds on all habitat restoration plots ($p < 0.05$). Based on CHROMMP targets (Appendix A) the stems per hectare targets for lowland and upland treatments appear to have been achieved for planted sites (Figure 3-12). Seedling density increased in habitat restoration plots between Year 1 and Year 3.

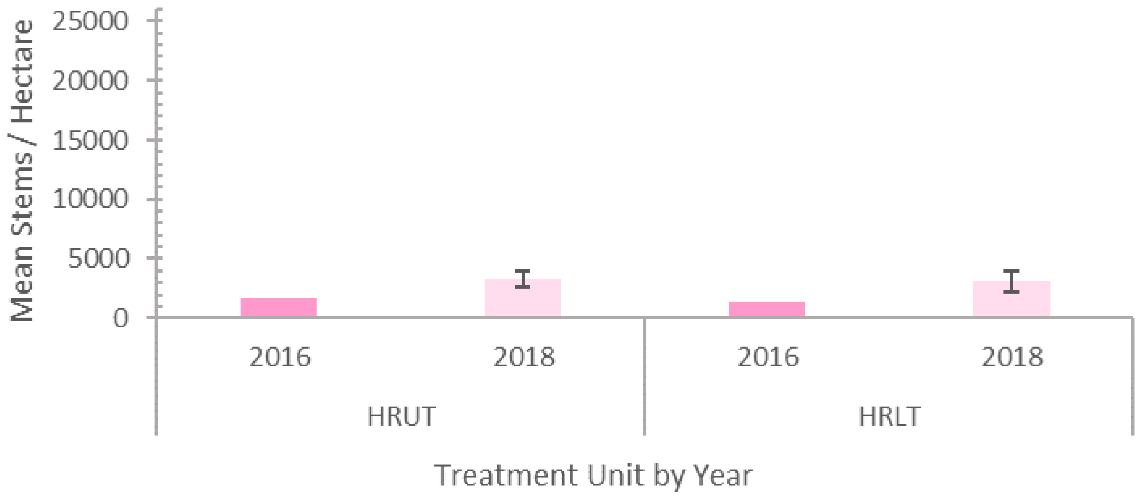


Figure 3-12: Seedling density (mean stems per hectare) by treatment and year in LKXO

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.7 Dillon

Average seedling stem density significantly exceeded ($p < 0.05$) the stems/hectare targets for all restoration plots (Figure 3-13). As anticipated, average stems per hectare were lower in naturally regenerating plots and highly variable in naturally regenerating lowland plots. It is expected that naturally regenerating plots will approach target densities with the continued natural ingress of seedlings over a longer time frame. This process is expected to be even more accelerated within the Dillon Offsets relative to the other Project Areas due to the smaller footprint width and the considerations expressed in previous sections. Seedling density was comparable in habitat restoration plots between Year 1 and Year 3.

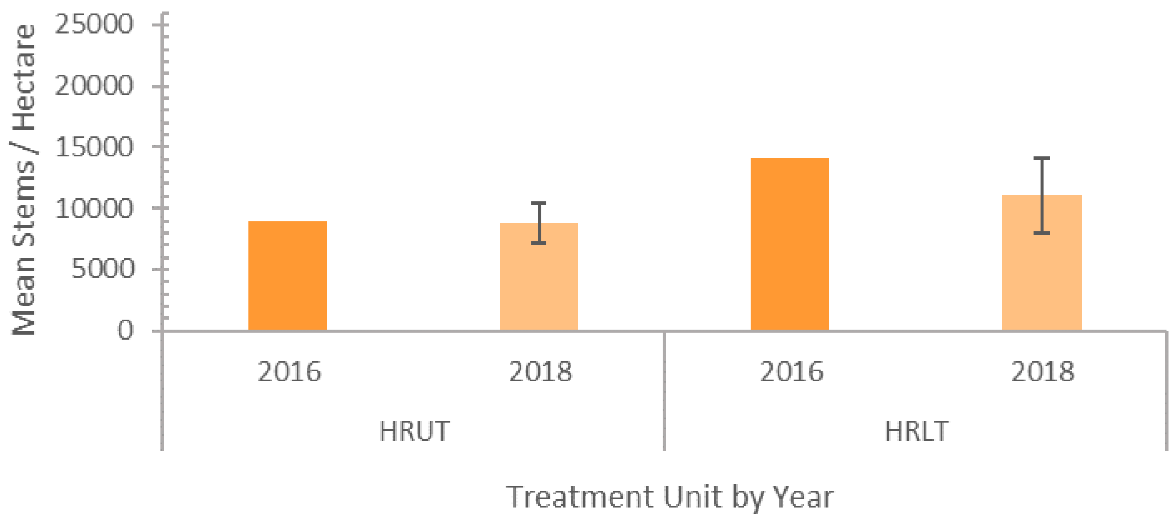


Figure 3-13: Seedling density (mean stems per hectare) by treatment and year in Dillon

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed. Standard error values were not available for 2016.

3.3.8 Seedling Height and Sustained Growth

Achievement of measurable targets for sustained growth is determined from increases or decreases in average height and/or percent cover over time. In 2018, the mean percent cover of measured planted and naturally regenerating tree seedlings (tree species only) ranged from 0.3% to 9.2% and the heights of most tree seedlings fell within the S2 (50 cm to 200 cm tall) or S3 (0 to 50 cm tall) shrub layers.

According to the target criteria, 70% of lowland seedlings and 80% of upland seedlings must demonstrate sustained growth. Figure 3-14 depicts the mean seedling height of each treatment unit in Year 1 and Year 3. Mean seedling height was comparable or higher in Year 3 compared to Year 1, which indicates sustained growth was achieved for all treatment areas.

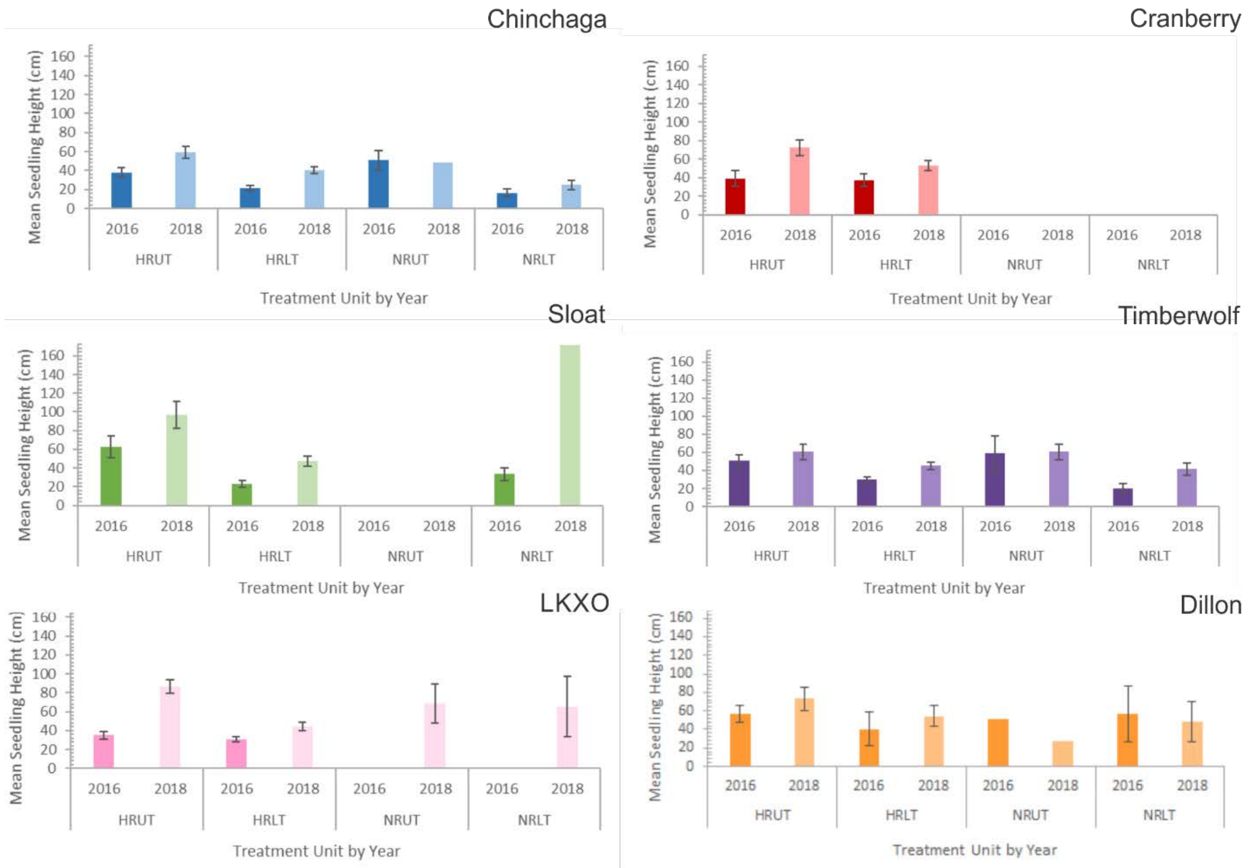


Figure 3-14: Mean seedling height (cm) by treatment, year, and project area

Note: HR = habitat restoration, NR = naturally regenerating, UT = upland treed, LT = lowland treed.

3.3.9 Characteristic Lowland Species

All shrub/graminoid plots (planted and natural regeneration) and at least 80% of the treed lowland plots (Table 3-4) contained two or more characteristic species as described in the Alberta Wetland Classification System (AEP, 2015; observed species list provided in Appendix C).

Table 3-4: Percentage of plots containing at least two indicator species by restoration unit and Project area in 2018

Location	Habitat Restoration Treatment Units (Planted)		Natural Regeneration Treatment Unit (Control)	
	Lowland (%)	Shrub/ Graminoid (%)	Lowland (%)	Shrub/ Graminoid (%)
Chinchaga	100.0	100.0	80.0	100.0
Cranberry	90.9	100.0	100.0	100.0
Sloat	100.0	100.0	80.0	100.0
Timberwolf	87.5	100.0	100.0	100.0
LKXO	100.0	N/A	100.0	N/A
Dillon	100.0	N/A	100.0	N/A
Note: N/A indicates not applicable as there were not plots within that treatment unit.				

3.4 NOXIOUS WEEDS AND UNDESIRABLE SPECIES

The presence of the various non-native species observed within ground-based monitoring plots are summarised by location in Table 3-5. Non-native species were observed within all treatment units; however, these species were observed in highest abundance in treed upland habitats. Total mean percent covers of all live plants, non-native plants as a function of total live plant cover are presented in Appendix D.

3.4.1 Chinchaga

No prohibited noxious or noxious weeds were observed along Chinchaga. Cicer milk-vetch (*Astragalus cicer*), red and alsike clover (*Trifolium* species) and white sweet-clover (*Melilotus alba*) were observed in extensive patches of up to 80% cover.

3.4.2 Cranberry

No prohibited noxious or noxious weeds were observed along Cranberry. Bird's-foot trefoil (*Lotus corniculatus*), cicer milk-vetch (*Astragalus cicer*), and red and alsike clover (*Trifolium* species) were observed in extensive patches of up to 60% cover.

3.4.3 Sloat

No prohibited noxious or noxious weeds were observed along Sloat. Bird's-foot trefoil (*Lotus corniculatus*), cicer milk-vetch (*Astragalus cicer*), and red and alsike clover (*Trifolium* species) were observed in extensive patches of up to 70% cover.

3.4.4 Timberwolf

No prohibited noxious weeds were observed on Timberwolf. Trace amounts of noxious weed perennial sow thistle (*Sonchus arvensis*) was detected within a single plot on Timberwolf. Cicer milk-vetch (*Astragalus cicer*), alsike clover (*Trifolium* species) and white sweet-clover (*Melilotus alba*) were observed in extensive patches of up to 76% cover.

3.4.5 LKXO

No prohibited noxious weeds were observed on LKXO. Trace amounts of noxious weeds scentless chamomile (*Tripleurospermum inodorum*) and common tansy (*Tanacetum vulgare*) were detected within a single plot and in trace to low amounts (0.1 – 5%) on two plots, respectively. Large (up to 40% cover), but in isolated patches, occurrences of timothy (Phleum pretense) and red and alsike clover (*Trifolium* species) were recorded on LKXO.

3.4.6 Dillon

No prohibited noxious weeds or noxious weeds were observed within the Dillon Project Area. A single patch (10% cover) of wheatgrass (*Agropyron sp.*) was observed at one plot.

Table 3-5: Number of plots and range of plot percent cover of noxious weeds and undesirable (non-native) species found within habitat restoration plots

Species Name	Common Name	Chinchaga		Cranberry		Sloat		Timberwolf		LKXO		Dillon	
		# of Plots	% Cover	# of Plots	% Cover	# of Plots	% Cover	# of Plots	% Cover	# of Plots	% Cover	# of Plots	% Cover
Noxious													
Sonchus arvensis	perennial sow thistle	0	0	0	0	0	0	1	0.1	0	0	0	0
Tanacetum vulgare	common tansy	0	0	0	0	0	0	0	0	2	0.1 – 5.0	0	0
Tripleurospermum inodorum	scentless chamomile	0	0	0	0	0	0	0	0	1	0.1	0	0
Non-native													
Astragalus cicer	cicer milk vetch	14	0.5 – 80.0	2	1.0 – 5.0	16	0.1 – 70.0	1	1.0	0	0	0	0
Agropyron sp.	wheatgrass	0	0	0	0	0	0	0	0	1	1.0	1	10.0
Bromus inermis	smooth brome	4	2.0 – 4.0	1	1.0	1	50.0	3	2.0 – 30.0	0	0	0	0
Crepis tectorum	annual hawk's-beard	0	0	0	0	0	0	0	0	2	0.1	0	0
Lotus corniculatus	bird's-foot trefoil	0	0	10	1.0 – 60.0	15	0.1 – 37.0	0	0	2	0.1 – 1.0	0	0
Matricaria discoidea	pineappleweed	0	0	0	0	0	0	0	0	1	0.1	0	0
Medicago sativa	alfalfa	0	0	0	0	1	30.0	0	0	0	0	0	0
Medicago lupulina	black medick	0	0	0	0	0	0	0	0	1	0.1	0	0
Melilotus alba	white sweet-clover	2	1.0	0	0	0	0	3	1.0 – 76.0	2	1.0 – 2.0	0	0
Melilotus officinalis	yellow sweet-clover	3	0.1 – 1.0	0	0	0	0	5	0.1 - 0.5	2	0.1	0	0
Phleum pratense	timothy	11	0.1 – 52.0	1	17.0	6	0.1 – 50.0	5	0.1 – 3.0	6	0.1 – 40.0	0	0
Plantago major	common plantain	3	0.5 – 1.0	0	0	1	10.0	2	0.5 – 1.0	0	0	0	0

Table 3-5: Number of plots and range of plot percent cover of noxious weeds and undesirable (non-native) species found within habitat restoration plots (cont'd)

Species Name	Common Name	Chinchaga		Cranberry		Sloat		Timberwolf		LKXO		Dillon	
Taraxacum officinale	common dandelion	13	0.5 – 25.0	4	0.1 – 2.0	12	0.1 – 10.0	7	0.1 – 10.0	1	0.1	0	0
Tragopogon dubius	common goat's beard	0	0	0	0	0	0	1	0.5	0	0	0	0
Trifolium hybridum	asike clover	20	0.1 – 60.0	11	0.1 – 25.0	19	0.1 – 12.0	8	0.1 – 1.0	2	2.0 – 10.0	0	0
Trifolium pratense	red clover	9	2.0 – 50.0	2	2.0 – 5.0	3	0.5 – 1.0	0	0	4	1.0 – 30.0	0	0
Trifolium sp.	clover	0	0	0	0	0	0	0	0	23	0.1 – 35.0	0	0

3.4.7 Access Control

ROW access control measures consisted of timber rollback and earth mounding. The effectiveness of access control structures was determined by the observed presence/absence of access or magnitude (Table 3-6). If prior access was evident, the level of access was categorized based on a range from low to high. Human access level for each Project Area are reported in Table 3-7.

Table 3-6: Qualitative and quantitative definitions of access

Qualitative Rank	Description	Assigned Numerical Rank
Absent	No evidence of human access	0
Low	Tracks/trail evident but difficult to discern or appear infrequently used.	1
Moderate	Relatively easily discernible, vegetation may be slightly tramped, but no bare ground is visible.	2
High	Tracks and trails appear to be well used, vegetation is trampled around, bare ground may be visible from frequent use.	3

Table 3-7: Summary of human access level observed at access controls by Project area

Location	Range of access level observed	Plots with decrease in access	Plots with increase in access	Plots with equal access	Plots with High Level of Access %(*n*)
Chinchaga	Low – High	6	2	14	5.0 (1)
Cranberry	Absent – High	2	0	13	17.6 (3)
Sloat	Absent – High	1	0	3	25.0 (1)
Timberwolf	Low - High	2	0	8	10.0 (1)
LKXO	Absent – Moderate	4	28	9	0 (0)
Note: change in access is between 2016 and 2018 observations; (*n*) indicates the number of access controls with high level of access					

3.4.8 Chinchaga

Visible trails circumventing many access control structures, including trails/tracks, trampled vegetation and small patches of bare soil where the access control was being bypassed were noted. Access control measures remained intact; however, users were able to access the ROW using parallel dispositions and roads outside the operational control of NGTL. It was also noted that the technique of mounding was ineffective when there were no mounds on the pipeline roach, which left a clear passage through the centre of the ROW. In 2018, access decreased from 2016 baseline levels on 27.3% of plots.

3.4.9 Cranberry

Visible trails circumventing many access control structures, including trails/tracks, trampled vegetation and small patches of bare soil where the access control was being bypassed were noted. Access control measures remained intact; however, users were able to access the ROW using parallel dispositions and roads outside the operational control of NGTL. It was also noted that the technique of mounding was ineffective when there were no mounds on the pipeline roach, which left a clear passage through the centre of the ROW. In 2018, access decreased from 2016 baseline levels on 13.3% of plots.

3.4.10 Sloat

Visible trails circumventing many access control structures, including trails/tracks, trampled vegetation and small patches of bare soil where the access control was being bypassed were noted. Access control measures remained intact; however, users were able to access the ROW using parallel dispositions and roads outside the operational control of NGTL. It was also noted that the technique of mounding was ineffective when there were no mounds on the pipeline roach, which left a clear passage through the centre of the ROW. In 2018, access decreased from 2016 baseline levels on 25% of plots.

3.4.11 Timberwolf

A low level of human access was observed, which was likely aided by the remoteness of the area. Overall, the level of access observed at access controls in 2018 was similar or less than access levels observed in 2016 and access decreased from 2016 baseline levels on 20% of plots.

3.4.12 LKXO

Low to moderate levels of access by Argo and ATV were observed circumventing access control measures at eight non-paralleled locations along LKXO where mounding and rollback were used. This represents a net increase in access within 58.5% of access control plots on LKXO, which resulted in the sites failing to meet the target threshold of less than or equal to 20% change in access from the baseline level.

3.4.13 Dillon

No evidence of human access was observed in the Dillon Offset areas. Access controls were not defined for the Dillon Offsets due to the different nature of the area, which is characterized by extensive regenerating seismic development and limited access due to its remoteness. However, felled trees (coarse woody debris) were combined or interspersed with planting treatments where required to limit access and, secondarily, to slow down or discourage potential predators’ movements along seismic lines. Special attention was paid to existing signs of traffic along lines.

3.5 LINE-OF-SIGHT ASSESSMENTS

Forty-seven line-of-sight breaks were assessed along the Chinchaga section: 24 were located along the Cranberry section, 27 along the Sloat section, 14 across the Timberwolf section, 59 along LKXO, and 29 along Dillon. Vegetation screens were assessed for survival and number of woody stems per hectare.

Mean seedling density and sustained growth targets for line-of-sight blocks are equal to those of habitat restoration plots. Mean seedling density of line-of-sight blocks on lowland or upland Sloat, lowland Timberwolf and lowland Cranberry do not yet meet the measurable targets for seedling density but are consistent with the findings for habitat restoration plots (Figure 3-15).

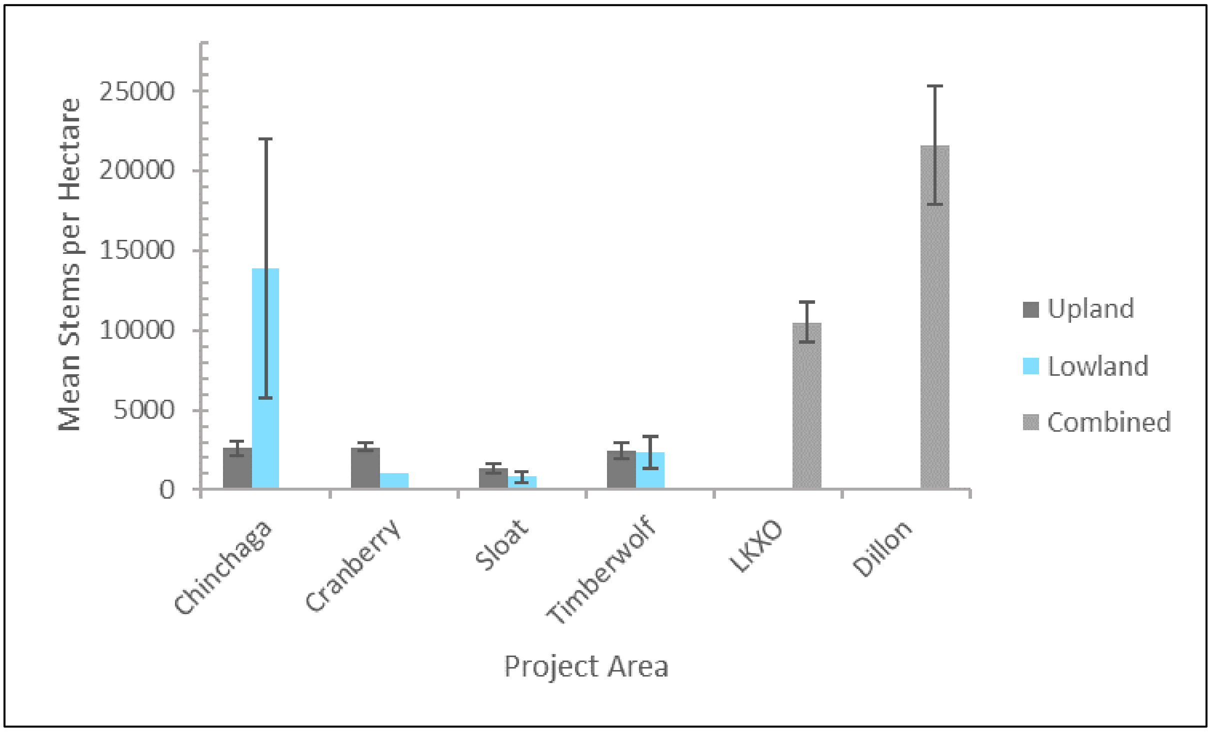


Figure 3-15: Seedling density (mean stems per hectare) for upland, lowland or combined LOS plots for all Project areas in Year 3 (2018)

Mean change in height (i.e., growth) of line-of-sight blocks exceeded targets for upland plots on Chinchaga, Cranberry and Sloat; however, height was not significantly different between years for lowland plots in these areas, nor for lowland and upland Timberwolf plots (Figure 3-16). On the other hand, combined heights for lowland and upland plots were significantly higher in 2018 than in 2016 ($p > 0.05$) for Chinchaga, Cranberry and Sloat, LKXO and Dillon. Together, these results indicate the planted areas are performing as expected. While their height is not yet enough to provide effective line of sight blockage along the ROW, this capacity will increase over the course of the Monitoring Program and will continue to be assessed.

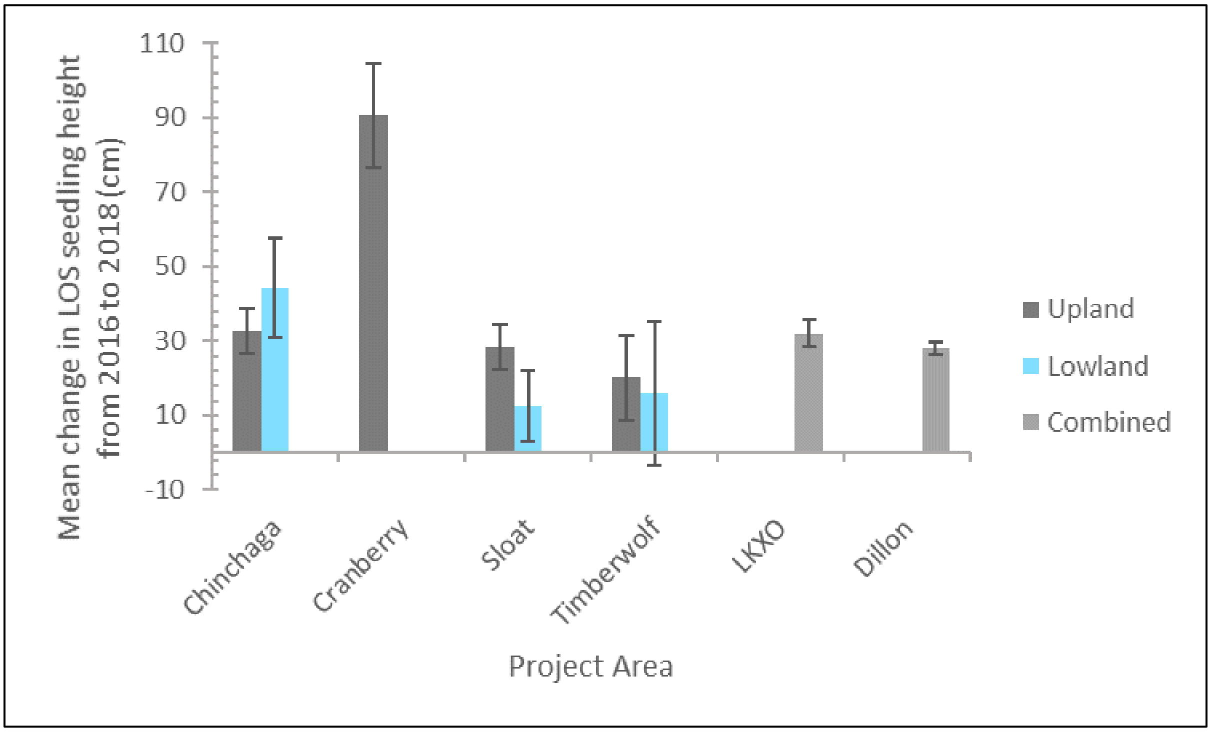


Figure 3-16: Change in height (cm) between Year 1 and Year 3 for upland, lowland or combined LOS plots for all Project areas

4.0 REMOTE CAMERA MONITORING

NGTL implemented the remote camera monitoring program within the Project Areas. The goals of the program are to:

1. verify the effectiveness of access controls along linear corridors; and
2. detect wildlife use through incidental observations.

The target of the Monitoring Program is to decrease access by 20% at access control locations within five years following the completion of restoration activities (Appendix E). Comparisons between years allow an assessment of whether specified targets are met.

The remote camera surveys will also include aerial photographic surveys in future monitoring years. As stated in the Final Caribou Habitat Restoration and Offset Measures Monitoring Program (August 2015),[23] LiDAR High-resolution light detection and ranging (LiDAR) will be conducted in Q3 and Q4 of Years 1, 5, 10 and 15 of monitoring. NGTL decided to defer these surveys from Year 3 to Year 5 since previous studies conducted on other projects, found challenges in measuring and classifying small tree seedlings and distinguishing trees from grasses until a certain level of growth has been achieved.

4.1 METHODS

Access control measures implemented for the Project ROW include mounding, planting within rollback and/or on mounds, layering of coarse woody debris, and physical barriers. These measures were built in areas of new alignment or where the ROW intersects other linear features to prevent or deter human access to portions of the ROW within Caribou range.

Remote motion-triggered cameras installed at or near access controls are a non-invasive monitoring method to capture seasonal variation in human and wildlife occurrence, and an excellent tool to study their effectiveness in preventing access. Time-stamped digital photographs taken when outside movement triggers the sensor record over a continuous timeframe and create permanent records (O’Connell et al., 2010).

4.1.1 Site Selection

Cameras were deployed at the same access control locations in all monitoring years. Using a repeated measures experimental design, the camera Monitoring Program utilizes the same locations and techniques for the duration of the Monitoring Program. Camera locations were selected based on the following criteria:

[23] NEB Filing ID: A71613 (CHROMMP).

- located within a designated caribou range boundary;
- located on a section of new alignment created by the proposed or constructed project;
- located near an active intersection with the proposed or constructed ROW and another linear feature (i.e., roads, pipelines, transmission lines); and
- located within a treed area with trees of adequate size to mount a camera.

An element of flexibility was retained in camera deployment at the ground level to allow for optimum placement in consideration of adjacent vegetation type and structure and deviations in site characteristics (e.g., height of vegetation, or position of suitable trees to mount the camera).

4.1.2 Equipment

Forty (40) Reconyx cameras labelled with unique numerical identifiers were deployed: twelve on the NWML (Sloat, Cranberry and Timberwolf sections), seven on the LKXO line, and 10 within corresponding offsets within the Dillon River Wildlands. Prior to deployment, cameras were pre-set to take five rapid pictures followed by a 60-minute rest period, and to use nighttime shutter speed, and high resolution. Cameras were equipped with twelve AA lithium batteries, a labelled 32 GB SD card, and were tested to ensure correct functioning prior to deployment.

Field crews accessed Monitoring Program Area locations via helicopter, Argo or on foot. Helicopter landings within the Dillon River Wildlands were reported to the AEP as required by the AEP permitting procedures. A tablet/laptop was used for documenting site information, navigation and photographic data collection. After inserting a desiccant packet into each camera case, the camera was mounted and locked to a tree using a cable lock and a Reconyx Hyperfire security enclosure.

4.1.3 Camera Deployment

Cameras were generally deployed between 0 m to 50 m of the pre-selected site and 20 m to 75 m away from the access control measure to allow for suitable trees for camera mounting and to account for topographical restrictions. The units were deployed in a manner that would effectively capture the point of interest; to test this, and a walk test of the camera was conducted immediately after deployment to ensure the camera was operational.

4.1.4 Camera Checks and Maintenance

Remote camera work is inherently limited by prolonged cold weather events, which impair battery life (O’Connell et al. 2010). To ensure cameras were still functioning and to prepare for the winter season, crews revisited camera locations between October and December 2018. At this time cameras were inspected, and SD memory cards, desiccant packs, and AA lithium batteries were replaced. Vegetation management (clearing of obstructing grasses and shrubs) and camera repositioning was completed as required (and permitted according to AEP permits) to minimize the number of photographs triggered by vegetation or the sun's movements across the sky. Data from the cameras was downloaded by the field crews and subsequently backed up onto portable hard drives. To ensure that no data was lost, crews conducted checks at the end of each day; prior to upload to the main database in Calgary, a post-field quality check was conducted.

4.2 DATA COLLECTION

Camera data collection included:

- unique identifier number and site name;
- SD memory card unique identifier;
- dates and times of deployment, maintenance and retrieval;
- field crew name(s);
- UTM (NAD 83);
- ecosite/wetland type;
- description of the camera location (e.g. pipeline ROW, seismic line);
- description of access control treatment type (e.g. coarse woody debris, mounding);
- linear feature width (estimate);
- binary variable indicating evidence of human access (yes/no);
- human access type (off-highway vehicle [OHV], truck, 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/trails well used, vegetation trampled, bare ground may be visible [NGTL, 2015]);
- classification of wildlife access level (low/ high as defined above);
- photographs of camera placement on the tree, and a photograph of the view from the camera.; and
- date/time stamped photographs taken by each remote camera.

4.2.1 Data Management and Analysis

Data analysis of visual data such as photographs poses unique challenges. In wildlife research, distinguishing individual animals of the same species or tracking populations over a prolonged timeframe has proven difficult and effort intensive, with the potential to over-estimate wildlife abundance and density (Rowcliffe et al., 2008;

Tigner et al., 2014). As the primary goal of the camera Monitoring Program is to determine the effectiveness of access controls, and no wildlife count or population survey is required, the methodology adopted by NGTL focused on human access and on recording incidental wildlife occurrence only. While incidental recording cannot be used to collect accurate population counts, it is a valid tool to provide inferences about local species movements, habitat use and the presence/absence of individual species.

Each camera was set to take five pictures in rapid succession upon triggering; therefore, each animal may have been documented multiple times. Counting each wildlife photo as a separate observation decreases the likelihood of missing an individual animal but the final number of observations for each group is, however, most likely overestimated.

The approach to analyse human occurrence was different than for wildlife: images containing humans photo frames were analyzed and individuals (easily distinguishable from one another) were accurately counted and accounted for each monitoring year. Replicate images of human individuals in the same firing sequence were removed. In contrast, since wildlife is more difficult to identify when the subject is blurred or partially obscured and some wildlife species travel in groups, each wildlife photo was considered a separate observation.

Due to operational constraints (e.g., camera malfunctions and/or deployment and retrieval logistics) the number of days each camera was fully functional (i.e., camera effort) was not the same for every camera. Therefore, differences in count data (i.e., the number of observations of a given species) between cameras might reflect differences in camera effort rather than differences in subject counts (O'Connell et al., 2010). To account for this issue, the daily access rate for each group of interest was calculated for each camera location using the following formula:

Daily access rate=observations/effort

Where observations equal the number of observations for a given species and effort equals the number of days a given camera was fully operational (NGTL, 2017).

Human access was further categorized as non-motorized, truck, or other off-highway vehicles (OHVs: i.e., UTVs, ATVs, Argos, Sherpas, snowmobiles), and divided between recreational users or workers.[24] Human visitors were classified as workers if they were observed carrying equipment (e.g., tools, clipboards, measuring devices) and/or if they were using personal protective equipment (i.e., hard hats, high-vis vests, fire-retardant coveralls, etc.). Individuals wearing camouflage clothing and/or carrying hunting gear were assumed to be recreational users.

[24] Workers are in this context authorized NGTL personnel and subcontractors using the ROW for pipeline maintenance or monitoring purposes.

4.3 ACCESS CONTROL EVALUATION CRITERIA AND MEASURABLE TARGETS

Evaluation criteria used to verify the effectiveness of access controls were developed by NGTL for the Project following provincial recommendations and guidelines (Pyper and Vinge, 2012). Table 4-1, below presents the evaluation criteria used to verify the effectiveness of access controls outlined in the CHROMMP (NGTL, 2017).[25] Year 1 data was compared with Year 3 data to assess current progress toward Year 5 access reduction targets.

Table 4-1: Access control evaluation criteria and measurable targets

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management
Access Control	Remote Camera Monitoring	Evidence and level of vehicular use along the Project ROW and at offset locations will be measured using the following criteria: 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) 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 along sections of new alignment of the Project ROW, except for 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 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.

Note:
Abbreviations: equal to or less than (≤); right-of-way (ROW).
Baseline, for the purpose of this Monitoring Program, means 'the first monitoring year' as pre-construction access data is not available.

4.4 RESULTS

Camera data and ground-based data were ultimately combined to study the success of access controls. A discussion of collective results is presented in Section 5 of this

[25] NEB Filing ID: A71613.

document. This section focuses, therefore, solely on the results of camera data and on the analysis of ancillary wildlife information. While not yet sufficient to draw inferences about the long-term success of access controls or not gathered for survey or counting purposes, understanding the type of access and knowing the general number and type of wildlife species frequenting the ROW and its adjacent restored habitat can help decision-makers understand the response of humans and wildlife to disturbance and to restoration efforts; this, in turn, will allow procedural leaning to occur through the adaptive management process.

4.4.1 Results of Camera Deployment, Maintenance and Retrieval

The figures and the table in Appendix F and Appendix G provide the geographic and temporal information for each camera. Field maintenance of the cameras and download of data occurred between October 12 and 20, 2018, for Chinchaga, Cranberry, Sloat, LKXO and the Dillon Offsets and on December 9, 2018, for the three remaining Timberwolf cameras. NWML and Chinchaga cameras were retrieved between July 24 and 27, 2019, while LKXO cameras were retrieved on August 23, 2019.

4.4.2 Human Access

Due to the remoteness of the areas (and particularly of the Dillon offsets), NGTL anticipated low to no human access along the monitored ROW sites. This assumption was reflected in the data collected, which has shown low evidence of human access throughout the year, especially in winter. On the Dillon offsets, camera data and ground-based data indicate no evidence of human access for the entire year. Winter observations were rare, occurring on only two days (less than 0.13% of all human observations) on Sloat and LKXO, by recreational users on snowmobiles. Human access consisted mainly of workers and recreational users operating OHVs (Off-highway Vehicles; Photo 4-21). Overall, recreational access was low (the equivalent to less than 24 observations per year) on all lines and absent on Timberwolf. Most recreational users (89.7%) were observed during the fall hunting season. No trucks or large vehicles were observed directly on the ROW.

Observations of photos and tracks in the field indicated that some OHVs circumvented access controls by driving over the centre line or bypassed them by travelling along adjacent ROWs (i.e., power lines or adjacent pipelines), which remain outside of NGTL control.

Photo 4-1: Example of a worker (left; wearing PPE) and a recreational user access (right; wearing camouflage and hunter high visible orange hat) by OHV.

Human access is summarized in Table 4 2 and in Photo 4-1. Overall, the data suggests a 20% decrease in access was achieved for five out of six Project Areas. This positive trend may be further reinforced by increasing revegetation in upcoming years.

Table 4-2: Mean OHV access by Project Area during each camera monitoring period

Project Area	2016 Camera Effort (Days)	2018 Camera Effort (Days)	2016 OHV Access (Total Obs./Effort)	2018 OHV Access (Total Obs./Effort)
Chinchaga	347 ± 0	353.5 ± 6.6	0.014 ± 0.003	0.008 ± 0.002
Cranberry	347 ± 0	348.3 ± 7.0	0.007 ± 0.003	0.001 ± 0.001
Sloat	347 ± 0	357.5 ± 0.4	0.003 ± 0.002	0.002 ± 0.001
Timberwolf	342 ± 0	338.3 ± 11.2	0	0
LKXO	342 ± 0	342.8 ± 12.2	0.001 ± 0.001	0.011 ± 0.003
Dillon Offset	N/A*	309.5 ± 27.5	N/A*	0

Note: 2016 camera data from Northern Resource Analysts (2017). *Data for the Dillon line was collected by AEP in 2016 as part of a larger Monitoring Program. AEP reported 2 OHV (snowmobile) sightings for this area but camera effort is not available to calculate the Total Obs/Effort.

OHV activity ranged from 0 to 0.024 OHV observations per day on a single camera. Mean OHV activity was highest on LKXO with an average of 0.011 OHV observations per day per camera. Mean OHV activity on the remaining ROWs was below 0.008 observations per camera per day and no OHV activity was observed on Timberwolf or within the Dillon offsets. These results are consistent with the low evidence of human activity in 2016 (Northern Resource Analysts, 2017).

Mean OHV access did not change significantly for most project areas between 2016 and 2018. Mean OHV access increased by 66.7% on LKXO but decreased by 42.9%

on Chinchaga, 85.7% on Cranberry and 33.3% on Sloat. On LKXO 76% of the OHV observations were of workers travelling along the ROW.

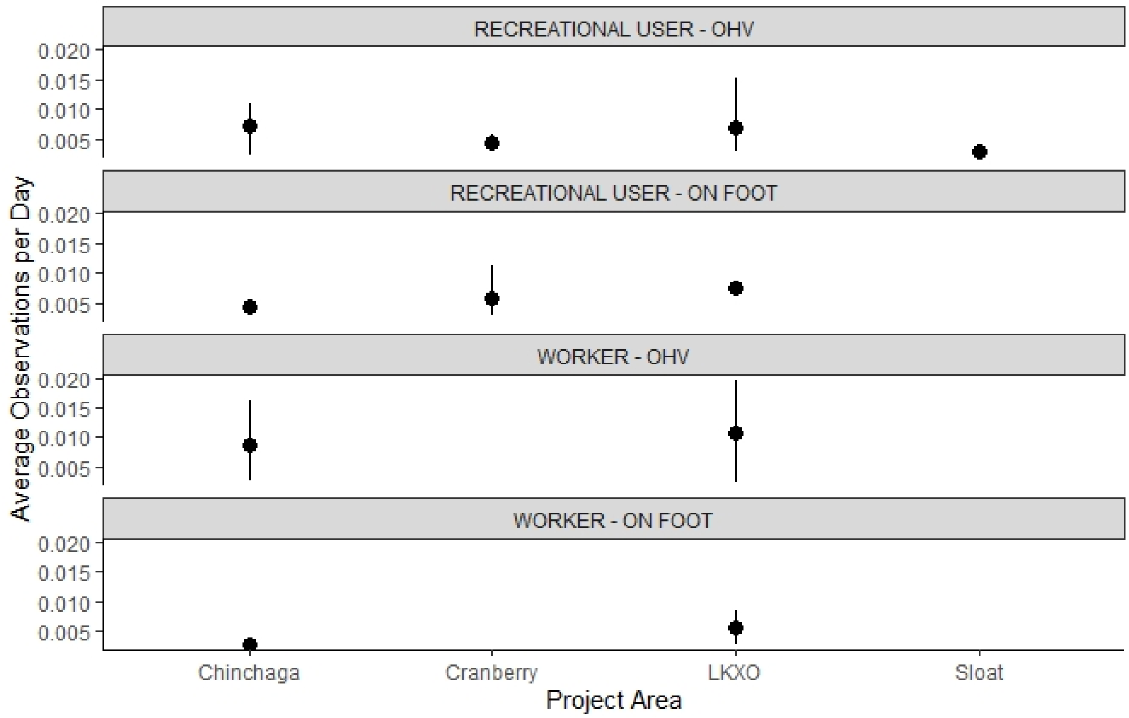


Figure 4-1: Average worker and recreational user observations (± SE) per day at access controls during the 2018/2019 observation period

4.5 WILDLIFE OCCURRENCE

The average wildlife observations per day are presented by species are detailed in Figure 4-2. A detailed summary by species is provided in Appendix C. With one exception (C-04 on Cranberry), wildlife was observed at all camera locations. No obvious trend is apparent between the frequency of wildlife occurrence and the type of access control; total wildlife varied by camera for all Project areas. While the exact cause of variability is unknown, habitat characteristics are the most likely cause of species variation.

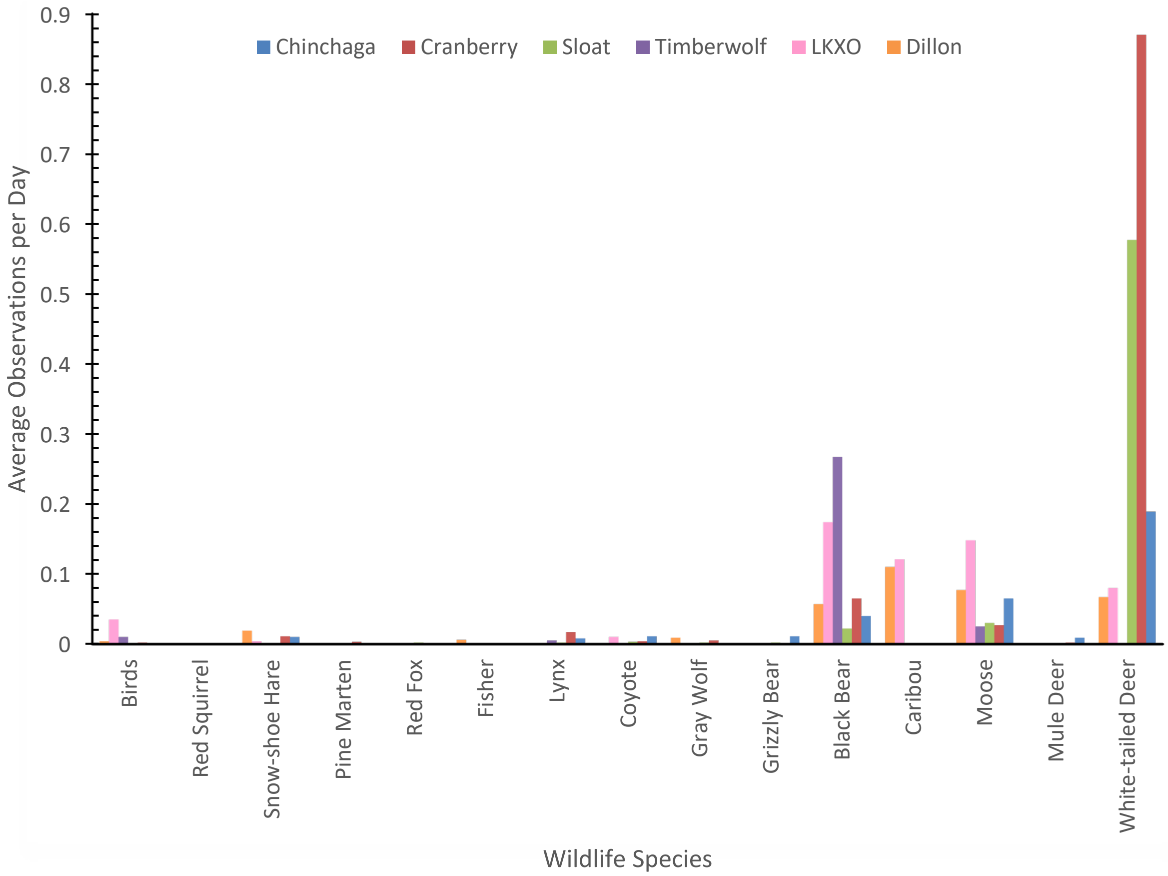


Figure 4-2: Average wildlife observations by species per day for each Project Area.

Note the predominance of ungulates and black bears.

Of all the species observed, white-tailed deer was the most abundant (*Odocoileus virginianus*: 0.067 to 0.870 observations per day; Photo 4-2), followed by moose (*Alces alces*: 0.025 to 0.148 observations per day; Photo 4-3), and black bears (*Ursus americanus*: 0.022 to 0.174 observations per day; Photo 4-4) No deer were observed on Timberwolf, while mule deer (*Odocoileus hemionus*) were observed infrequently on Chinchaga and Cranberry (0.002 to 0.009 observations per day).

A single woodland caribou was observed on the Cranberry ROW (0.0004 observations per day). Woodland caribou were observed more frequently and in greater numbers on the LKXO ROW and within the Dillon offsets, where suitable caribou habitat is widespread (Photo 4-5; 0.121 observations per day and 0.110 observations per day respectively).

Predators observations were dominated by black bear (see above), but grizzly bear (*Ursus arctos*), coyote (*Canis latrans*), gray wolf (*Canis lupis*), lynx (*Lynx* *canadensis*), fisher (*Martes pennanti*), red fox (*Vulpes vulpes*) and pine marten (*Martes martes*) were also observed with varying low frequencies. Grizzly bears were only observed on Chinchaga, Cranberry and Sloat sections in low numbers (0.002 to 0.011 observations per day), but were not expected within LKXO and Dillon, which are located outside of grizzly bear range. Wolves (Photo 4-6), coyotes, and lynx (Photo 4-7) were also infrequent (wolves: 0 to 0.009 observations per day, coyotes: 0 to 0.011 observations per day, lynx: 0 to 0.017 observations per day) but were widespread overall (wolves and lynx were absent on LKXO and coyotes were absent on Timberwolf). Fishers were documented rarely at two Chinchaga and two Dillon cameras, red fox at a Chinchaga and a Sloat camera and pine marten (Photo 4-8) on a Chinchaga and a Cranberry camera.

Snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*) and various bird species were also documented during the monitoring period. Snowshoe hare were observed on Chinchaga, Cranberry, LKXO and Dillon cameras (0 to 0.019 observations per day). A single red squirrel was photographed on Chinchaga and various bird species were observed on all lines except Sloat. On LKXO and Dillon, birds were represented mainly by sandhill cranes (Photo 4-9; 48 observations or 0.135 observations per day on LKXO and 11 or 0.035 observations per day on Dillon). A single sandhill crane was also observed on Timberwolf.

4.6 WILDLIFE PHOTOGRAPHS

The photographs below are a sample of the wildlife species encountered during the Year 3 Wildlife Camera Monitoring Program.

Photo 4-2: White-tailed deer buck photographed on Chinchaga (Chin-05)

Photo 4-3: Moose cow and calf photographed on LKXO (LKXO-03).

Note the advanced revegetation stage of the ROW, with tall species transitioning to coniferous edge habitat in the background.

Photo 4-4: Black bear photographed on Cranberry (C-05).

Photo 4-5: Caribou on LKXO (LKXO-01). Following calving, caribou move between different habitats; herds are typically joined in the fall for the rut.

Photo 4-6: Gray wolf on Cranberry (C-02)

Photo 4-7: Lynx photographed on Cranberry (C-06).

Photo 4-8: Pine marten photographed on Chinchaga (Chin-07)

Photo 4-9: Sandhill crane pair photographed on LKXO (LKXO-05)

5.0 SUMMARY OF RESULT

Year 3 is a mid-point phase of the Monitoring Program, a time when survival surveys offer a second snapshot of site conditions over the lifetime of the Monitoring Program. Planted areas transition from taking root to becoming adapted to local conditions, and in most cases, plants have reached or are shortly expected to achieve adequate height to be measured using LIDAR. This information allows NGTL to draw inferences on preliminary restoration trajectories and flag locations for which corrective actions may be undertaken at Year 5 of the Monitoring Program, when a comprehensive review of all sites' establishment is scheduled. The following subsections summarizes the results of ground-based surveys for each area and discusses correlations between plots and treatment units.

5.1 NATIVE VEGETATION SURVIVAL

Survey results indicated that native vegetation cover is approaching or exceeding targets in all restoration and natural regeneration plots except for shrub graminoid treatment types, which declined in all locations except for LKXO and Dillon (where there are no shrub graminoid plots). NGTL is awaiting the next set of survey data at Year 5 to examine species composition and successional patterns to determine possible correlations for this trend.

5.2 SPECIES RICHNESS

Species richness indicate positive relative trends between restoration and natural regeneration plots from Year 1 to Year 3. Vegetation in upland plots is typically dominated by forbs, graminoids, and shrubs while lowlands appear to have further developed shrub cover and moss growth. Lowlands sites are typically more productive than upland sites, in alignment with scientific research of understory succession (Mallon et al., 2016).

5.3 SEEDLING DENSITY

Seedling density in restored Cranberry (treed upland and lowland), Timberwolf (treed upland and lowland), Chinchaga (treed lowland), Sloat (treed lowland), LKXO and Dillon Offset areas have been achieved. Seedling density in restored upland plots on Chinchaga, Cranberry and Sloat fell below the target of 1600 stems/ha on non-mounded sites. The high variance in mean stems/ha suggest seedling survival was particularly patchy in upland areas or on lines near with contiguous dispositions.

5.4 SEEDLING HEIGHT AND SUSTAINED GROWTH

Targets have been achieved for all restored treatment units across all plots. Growth targets for naturally regenerating plots are steadily harmonizing with restored plots as natural ingress of seedlings continues. While naturally regenerating plots in Cranberry, Sloat and Dillon did not achieve targets, this deviation maybe a function of insufficient length of period, as most sites appear to be on a positive trajectory.

5.4.1 Noxious Weeds and Undesirable Species

Prohibited noxious or noxious weeds as defined by the Alberta Weed Act and associated Regulation (2017) are a key monitoring criterion for this Monitoring Program. No prohibited noxious weeds (Alberta Weed Control Regulation, 2016) were noted on the Monitoring Program Area. Noxious weeds as defined in the Regulation were remarked on a single plot in Timberwolf (Perennial sow thistle) and scentless chamomile and common tansy were discovered in trace to low amounts (0.1 – 5%) on two plots on LKXO.

In Chinchaga, extensive patches of alsike and white sweet clover were observed in patches of up to 80% ground cover. In Cranberry, bird's-foot trefoil, cicer milk-vetch, and red and alsike clover were noticed in extensive patches with up to 60% cover. In Sloat, patches of the same species were detected with up to 70% cover. Cicer milk-vetch alsike and white sweet-clover were also found in broad swaths of up to 76% cover.

The spread of invasive species from baseline is an indicator of ingress from continuous dispositions. Previous reclamation practices, which focused on rapid revegetation to prevent erosion and seeding with agronomic or other non-native species,[26] create modern challenges for successful invasive species management on multiple adjacent dispositions. These challenges are currently being examined by NGTL through this Monitoring Program and PCRM; however, in many cases options are limited due to operational and tenure considerations.

Additional monitoring years and the progression to Year 5 will be critical in targeting suitable corrective actions. In this transition period, native species with a slower growth cycle are expected to further establish and reduce or eliminate the competition threat from invasive species. Competition from other native species to the area may also offer a new angle to consider invasive species. For example, the ingress of outcompeting native species such as bluejoint reedgrass (*Calamgrostis canadensis*) has been noted to influence stem density and survival; this species can be a nuisance on sites of forest restoration due to its ability to outcompete conifer seedlings.

[26] Often, seed bags were contaminated by small amounts of noxious weeds, resulting in the wide dispersal of common problem species across much of western Canada.

5.4.2 Wetland Species

All shrub/graminoid plots across the Project Area and restored lowland treed plots on Chinchaga, Sloat, LKXO and Dillon contain a minimum of two characteristic wetland species. Areas that do not have indicator species in 100% of lowland treed plots have indicator species in at least 80% of plots surveyed.

5.4.3 Access Control

The 20% reduction in access has largely been achieved and human access is not deemed a threat to restoration efforts. No evidence of human access was observed within Timberwolf section or in the Dillon Offset areas, and seedling damage attributable to trampling was less than 1%.

The only location to have exceeded set targets is LKXO; however, the exceedance of targets in this area reflects the small parameters adopted rather than statistical significance. Access to the lines was mainly conducted by NGTL workers performing maintenance activities. Qualitative descriptors employed in this Monitoring Program are based on very low access levels; consequently, access levels are overestimated.[27] It is also important to note that access restrictions are only effective when no contiguous dispositions are present, as adjacent developments allow users to circumvent barriers beyond NGTL's ability to keep under control.

5.4.4 Line-of-sight-breaks

Consistent with habitat restoration plots, seedling density within the vegetation screens is meeting growth targets for line-of-sight breaks; however, seedlings are currently too small to provide effective predator line-of-sight breaks along the ROW. Along the LKXO ROW, line-of-sight measures are limited to "zipper" plantings which are not expected to be effective immediately but will become more effective over time as trees mature.

One fabricated screen along Chinchaga, one fabricated screen on Sloat and three log berms no longer met the minimum height requirement of 1.5 m due to natural deterioration. The condition of the fabricated blocks, log berms and earth berms has been recorded; corrective actions are currently being evaluated by NGTL. Fabricated line of sight blockages was installed as legacy of previous recommendations for work in caribou habitat. Current scientific research and ground monitoring has determined fabricated solutions to be largely ineffective; a replacement approach is currently under discussion and will be addressed by NGTL on Year 5 of this Monitoring Program.

[27] As the Monitoring Program progresses, the descriptors may be revisited as part of the adaptive management process described in Section 7 of this document.

5.4.5 Human access

Based on measurable targets, a reduction in access from baseline level is expected to be achieved within five years of the completion of restoration activities. The camera monitoring data suggest measurable targets have already been achieved for five out of six Project Areas (Chinchaga, Cranberry, Sloat, Timberwolf and the Dillon offsets). Subsequent monitoring years will provide further data on LKXO. Access to the lines was mainly conducted by NGTL workers performing maintenance activities. Access by recreational users appears to be limited to hunters during the fall travelling on foot or by OHV.

5.4.6 Wildlife Occurrence

Caribou sightings during the 2018/2019 monitoring period were limited to the LKXO and Dillon Project Areas in the east (ESAR or Cold Lake) and a single observation within the Chinchaga Caribou range in the west. Although anecdotal, observations by field crew during remote camera work frequently documented tracks (deer, moose, wolf, coyote, lynx and bear), scat (moose, caribou, deer, wolf, coyote and bear) and browse sign within and around the access controls. It was observed that tracks were especially frequent at mounding access controls, possibly indicating animals are using the pools as a source of water or dissolved minerals.

5.5 YEAR 3 STATUS OF MEASURABLE TARGETS

Table 5-1 provides a summary of the status of measurable final targets. Where targets are not met, Year 3 monitoring results generally indicate restoration measures are performing as expected and subsequent monitoring events will determine if the targets have been met (see Section 6). Measures will continue to be assessed in subsequent monitoring years, and adaptive management measures will be applied as required to achieve the goals of the CHROMMP.

Table 5-1: Status summary of Measurable Targets for Each Pipeline Section after Year 3 Monitoring

Habitat Unit	Measurable Target	Pipeline Section					
		Chinchaga	Cranberry	Sloat	Timberwolf	LKXO	Dillon Offset
Upland	Seedling density 1600-2000 stems/ha on non-mounded sites	Performing as Expected	Yes[1]	Performing as Expected	Yes[1]	Yes[1]	Yes[1]
	Seedling density 800-1400 stems/ha on mounded sites	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]
	Spatial distribution of seedlings ≥ 80% of restoration unit[5]	N/A	N/A	N/A	N/A	N/A	N/A
	≥ 80% of tree seedlings demonstrate sustained growth trends	Yes[1]	Yes[1]	Yes[1]	Performing as Expected	Yes[1]	Performing as Expected
Treed Lowlands	Natural regeneration includes at least two characteristic species	Yes[1]	Performing as Expected	Yes[1]	Performing as Expected	Yes[1]	Yes[1]
	No restricted weeds or invasive species	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected
	≥ 80% cover of native vegetation species in footprint	Yes[1]	Yes[1]	Yes[1]	Performing as Expected	Yes[1]	Yes[1]
	Seedling density 400-1000 stems/ha on mounded sites	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]
	Spatial distribution of seedlings ≥ 80% of restoration unit[5]	N/A	N/A	N/A	N/A	N/A	N/A
	≥ 70% of tree seedlings demonstrate sustained growth trends	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Performing as Expected	Performing as Expected
Shrub/Graminoid Lowlands	Natural regeneration includes at least two characteristic species	Yes[1]	Yes[1]	Yes[1]	Yes[1]	N/A[3]	N/A[3]
	No noxious weeds or invasive species	Yes[1]	Yes[1]	Yes[1]	Yes[1]	N/A[3]	N/A[3]
	≥ 80% cover of native vegetation species in footprint	Yes[1]	Performing as Expected	Performing as Expected	Yes[1]	N/A[3]	N/A[3]

Table 5-1: Status summary of Measurable Targets for Each Pipeline Section after Year 3 Monitoring (cont'd)

Habitat Unit	Measurable Target	Pipeline Section					
All	≤ 20% increase in access against baseline	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Performing as Expected	Yes[1]
	Success of sustained growth trends	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes[1]
Upland	Line-of-sight is limited to ≤ 500 m	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected
All	Berms are in good condition and effectively block line-of-sight	No	No	Yes	N/A[4]	N/A[4]	N/A[4]
	Vegetation screen seedling densities meet restoration targets	Performing as Expected	Yes	Performing as Expected	Performing as Expected	Yes	N/A[6]
	Vegetation screen sustained growth trends meet restoration targets	Yes	Yes	Yes	Yes	Yes	N/A[6]
	Vegetation screen line-of-sight breaks are in good condition and effectively block line-of-sight	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected	Performing as Expected

Note:

Target range exceeded.

Upland sites were not mounded.

Not applicable due to absence; for example, there were no shrub/graminoid lowlands present on LKXO or Dillon

There are no berms installed on Timberwolf, LKXO or Dillon. Lessons learned have shown berms to be ineffective and are no longer part of the restoration Monitoring Program.

Spatial distribution was not measured in 2016 or 2018. This was due to limitation of LIDAR to differentiate seedlings from surrounding herbaceous vegetation during an early growth stage.

These measures were not used in the Dillon River Wildlands.

6.0 RESIDUAL EFFECTS, RESTORATION TRAJECTORY AND OFFSETS

6.1 INTRODUCTION

The restoration of large caribou home ranges characterized by a diverse and complex habitat is challenging to implement because these ranges are not limited to discrete areas (Arkle et al., 2014), and because of the long timelines required to rehabilitate plant communities critical to this species, such as lichens. In the context of this CHROMMP, restoration targets focus on minimizing the adverse effects from the Project to caribou habitat during and after the life of the Project, as well as continuing to offset residual effects. These targets feed into the main goal of NGTL, which consists of the establishment of a firm trajectory towards normal ecosystem-level functioning for impacted areas (SER, 2004).

Regular measurements of the restoration trajectory are critical to achieve full rehabilitation in the long term. Yet, as for other forms of prediction, restoration trajectories must be informed by multiple data points. The limited timeframe of this Year 3 Monitoring Program does not yet allow NGTL's ability to make predictions on trajectories. As restoration of the ROW progresses, NGTL will continue to chart and present trajectories through monitoring data and the adaptive management process. Year 5 of the Monitoring Program has been chosen as a suitable time frame for a more accurate characterization of the restoration trajectory and associated corrective decisions, if required.

6.2 RESIDUAL EFFECTS

The mitigation of Project effects on the environment included an analysis of residual effects on caribou habitat conducted as part of the Environment and Socioeconomic Assessment(s) (ESA).[28] The degree that residual effects contribute to cumulative effects at the regional scale varies with time and changing environmental conditions. NGTL's offset strategy including advanced tools such as the use of temporal and spatial multipliers to ensure that the spatial-temporal relevance of the offset measures relative to the Project being offset is maintained. Scientific literature and past research suggest a multiplier range from 1.0 through 5.0 is required (DEFRA, 2011; Northern Resources, 2014; Northern Resources, 2017). NGTL adopted this multiplier range within their restoration and offset plans. The proposed timing of re-calculation is discussed below (Section 6.2.1), and further detail can be found in the OMPs.[29]

6.2.1 Timelines for Re-calculating Offset Requirements

Industry standards (Alberta Agriculture and Forestry, 2018; Table 6-1) recommends survival surveys in Year 1 to 3 of Monitoring; establishment surveys are completed

[28] NEB Filing IDs: A29090, A30357, A33664.
[29] NEB Filing IDs: A61246, A75414.

no earlier than four years after disturbance and no later than eight years after disturbance, and performance surveys to be completed between Years 11 and 14. NGTL has committed to re-evaluating the Projects' offset requirements following the gathering of Year 5 monitoring results. This approach is markedly more conservative than standard forestry practices. By starting re-evaluations at Year 5 and including a last survey at Year 15, the cycles of monitoring and adaptive management are extended.

Table 6-1: Overview of monitoring years for the Project

Monitoring Years 1, 3, 5, 10 and 15														
Survival Survey			**Establishment Survey**							**Performance Survey**				
2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

Year 1, 3, and 5 will evaluate habitat restoration and vegetation establishment efforts, allowing NGTL to implement site-specific adaptive management actions as needed. Years 10 and 15 will enable NGTL to assess ongoing habitat restoration performance and the success of adaptive management actions taken in previous years.

7.0 ADAPTIVE MANAGEMENT AND LESSION LEARNED

Adaptive management emerged as a structured decision-making approach in habitat restoration science from the need to respond to rapidly changing environmental conditions and a wide variety of stakeholders. The term adaptive connotates flexibility and responsiveness to changing conditions; the primary principle underlying this approach is simple, and yet effective: "learning by doing".[30] While this notion seems straightforward, the practical application of adaptive management involves a clear decision-making framework and unambiguous delineation of roles and responsibilities to make informed adjustments in policies, and long-term thinking (Figure 7-32).

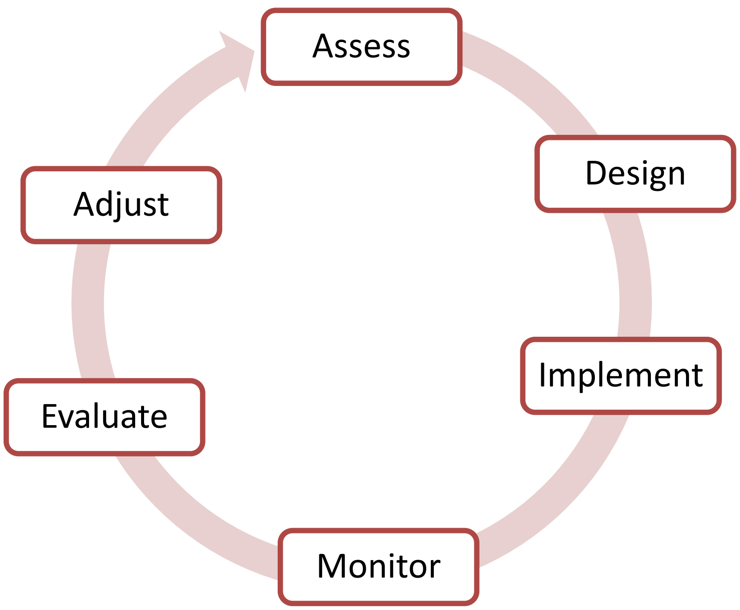


Figure 7-1: Traditional adaptive management wheel

Note: Continuous monitoring throughout the cycle is required to inform decision making and adjust policies and design.

NGTL's adaptive management framework has been under development since the start of the NWML. This approach has also been enhanced from knowledge, experiences and lessons learned during the development of numerous linear corridors across western Canada. In this Monitoring Program, data are collected via aerial and ground-based Monitoring Programs (including remote camera monitoring). This informs decision makers at various points of the restoration timeline, allowing adjustments that are often site-specific. The process of monitoring is, in the NGTL process, also

[30] John F. Organ, Daniel J. Decker, Shawn J. Riley, John E. McDonald, Jr., and Shane P. Mahoney (2012). Adaptive Management in Wildlife Conservation. 7th Edition, Vol. 2, John Hopkins University Press. Baltimore, US.

highlighted as a key component of the adaptive management process and remains ongoing throughout the 15-year Monitoring Program.

The habitat restoration and offset measures are considered successful when monitoring results indicate restoration has been achieved, or is on trajectory to achieve, the monitoring plan targets. No additional measures or monitoring will be considered necessary at that point. If performance measures indicate that targets have not been achieved, or are not on trajectory to be achieved, the reasons for not achieving the targets will be evaluated and an appropriate course of action will be taken and monitoring will continue until the targets are met.

8.0 REFERENCES

Alberta Agriculture and Forestry. 2018. Reforestation Standard of Alberta. Department of Agriculture and Forestry, Forestry Division, Forest Management Branch, Edmonton, Alberta. 376 pp.

[AEP] Alberta Environment and Parks. 2015. Alberta Wetland Classification System. Water Policy Branch, Policy and Planning Division, Edmonton, AB.

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

Arkle, R. S., D. S. Pilliod, S. E. Hanser, M. L. Brooks, J. C. Chambers, J. B. Grace, K. C. Knutson, D. A. Pyke, J. L. Welty, and T. A. Wirth. 2014. Quantifying restoration effectiveness using multi-scale habitat models: implications for sage-grouse in the Great Basin. Ecosphere 5(3):31.

Bayne, Dr. E., H. Lankau and J. Tigner. 2011. Ecologically-based criteria to assess the impact and recovery of seismic lines: The importance of width, regeneration, and seismic density. Report No. 192. Edmonton, AB. 98 pp.

Blanco. J.A., Welham, C., Kimmins, J.P., Seely, B., Mailly, D. 2009. Guidelines for modelling natural regeneration in boreal forests. The Forestry Chronicle 85. 427-439.

Brown, R. L., Reily, L. J., & Peet, R. K., 2016. Species Richness: Small Scale. eLS: 1-9.

[DEFRA] Department for Environment, Food and Rural Affairs. 2011. Biodiversity Offsetting. Technical Paper: Summary of the Options Impact Assessment for Biodiversity Offsetting. London, UK. 9 pp.

[ECCC] Environment and Climate Change Canada. 2019. Action Plan for the Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada 2019 - Federal Actions. Species at Risk Act Action Plan Series. Environment and Climate Change Canada, Ottawa, ON.

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

Environment Canada. 2020. Operational Framework for Use of Conservation Allowances. Government of Canada. Ottawa, ON. 17 pp

Mallon E., Merritt R. Turetsky, Ian D. Thompson, John M. Fryxell, Philip A. Wiebe. 2016.

Effects of disturbance on understory succession in upland and lowland boreal forests and implications for woodland caribou (Rangifer tarandus caribou). Forest Ecology and Management.Volume 364. 17-26.

[NRC] Natural Regions Committee. 2006. Natural Regions and Subregions of Alberta. Compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852.

[NGTL] Nova Gas Transmission Limited. 2015. Nova Gas Transmission Ltd. Caribou Habitat Restoration and Offset Measures Monitoring Program. Leismer to Kettle Crossover Project, Northwest Mainline Expansion Project, Chinchaga Lateral Loop No. 3. Prepared by Northern Resource Analysts Ltd. Submitted to the National Energy Board.

[NGTL] Nova Gas Transmission Limited. 2017. Year One Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) – Revised Year One Report (Revised Report). Report prepared for Nova Gas Transmission Ltd. Calgary, Alberta. December 2017. Submitted to the National Energy Board. 77 pp.

[NGTL] NOVA Gas Transmission Ltd. 2020. Northwest Mainline Loop (Boundary Lake North Section). Final Caribou Habitat Restoration & Offset Measures Plan. Report prepared for Nova Gas Transmission Ltd. Calgary, Alberta. January 2020. Submitted to the National Energy Board. 157 pp.

[Northern Resources] Northern Resource Analysts Ltd. 2014. Northwest Mainline Expansion Project: Final Offset Measures Plan for Residual Effects on Caribou Habitat. Prepared for NOVA Gas Transmission Ltd. Calgary, AB.

[Northern Resources] Northern Resource Analysts Ltd. 2017. Caribou Habitat Restoration and Offset Measures Monitoring Program, Leismer to Kettle River Crossover Project, Northwest Mainline Expansion Project, Chinchaga Lateral Loop No. 3. Camera Monitoring Report August 2016 to July 2017. Prepared for Nova Gas Transmission Ltd. Calgary, Alberta. August 2017. 54 pp.

Lee, P., Boutin, S., 2006. Persistence and developmental transition of wide seismic lines in the western Boreal Plains of Canada. J. Environ. Manage. 78, 240–250

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

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

R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Rowcliffe, M., J. Field, S. T. Turvey, and C. Carbone. 2008. Estimating animal density using camera traps without the need for individual recognition. Journal of Applied Ecology, 45: 1228 – 1236.

[SER] Society for Ecological Restoration International Science & Policy Working Group. 2004. The SER International Primer on Ecological Restoration. www.ser.org &Tucson: Society for Ecological Restoration International.

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.

Van Rensen, C.K., S.E. Nielsen, B. White, T. Vinge, and V.J. Leiffers. 2015. Natural regeneration of forest vegetation on legacy seismic lines in boreal habitats in Alberta's oil sands region. Biological Conservation 184:127-135.

APPENDIX A

CHROMMP TARGETS

Table 4a Habitat Restoration Evaluation Criteria and Measureable Targets On Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Habitat Restoration	• Aerial Monitoring – LiDAR Imagery – 360 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 – palatable shrub – non-palatable 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. • 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 Halsey et al. 2004). • As indicators of healthy vegetation community, no restricted weeds or invasive species such as cattails or reed grass. • ≥80% cover of native vegetation species in the footprint. • 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 (as per Halsey et al. 2004). • No restricted weeds. • ≥80% cover of native vegetation species in the footprint.	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.

Notes: The ratio of palatable to non-palatable species will be measured using ground-based monitoring. Where naturally regenerating palatable species are observed restricting seedling growth for planted areas, adaptive management actions in the form of either mechanical or chemical control will be implemented, with special consideration for the need to minimize access at CHRP and OMP locations. ha = hectare; sp. = species; ROW = right-of-way; m = metre; ≥ = equal to or greater than; ≤ = equal to or less than.

Table 4b Habitat Restoration Evaluation Criteria and Measureable Targets On Non-Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Habitat Restoration	• Aerial Monitoring – LiDAR Imagery – 360 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). 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).	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.

Notes:ha = hectare; sp. = species; ROW = right-of-way; m = metre; ≥ = equal to or greater than; ≤ = equal to or less than.

Table 5a Access Control/Line-of-Sight Evaluation Criteria and Measureable Targets On Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Access Control	• Aerial Monitoring – LiDAR Imagery – 360 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) – 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 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 : • <u><</u>20% increase in access against baseline[1] 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 – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Performance Surveys • Remote Camera Monitoring	• 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	Line-of-sight breaks are designed to block sight lines 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. • Line-of-sight is limited to ≤500 m along the linear feature in upland forested areas. • Where log/earth berms are installed to break the line-of-sight, berms are in good condition and functional (in terms of blocking line-of-sight). • 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–site measures and include: • Where log/earth berms are installed, repairing berms to maintain height and length requirements (i.e., revegetating berm to prevent erosion). • 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.

Notes: ha = hectare; sp. = species; ROW = right-of-way; m = metre; <u>></u> = equal to or greater than; <u><</u> = equal to or less than.

[1] Baseline for the purpose of this CHROMMP means ‘the first monitoring year’ as pre-construction access data is not available; future projects will established preconstruction.

Table 5b Access Control/Line-of-Sight Evaluation Criteria and Measureable Targets On Non-Operational Lines

Objective	Monitoring Method	Evaluation Criteria	Measureable Targets	Adaptive Management
Access Control	• Aerial Monitoring – LiDAR Imagery – 360 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: • <u><</u>20% increase in access against baseline[2] 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 – 360 Photography – EI Aerial Inspection • Ground-Based Monitoring – Establishment Surveys – Sample Plots • Remote Camera Monitoring	• Coarse woody debris: – 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	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 log berms are installed to break the line-of-sight, berms are in good condition and functional (in terms of blocking the line-of-sight). • 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 (Cody 2013; Golder 2014), across the ROW where there is suitable thick, adjacent forest cover of either non-merchantable or merchantable coniferous trees.

Notes: ha = hectare; sp. = species; ROW = right-of-way; m = metre; <u>></u> = equal to or greater than; <u><</u> = equal to or less than.

[2] Baseline for the purpose of this CHROMMP means 'the first monitoring year' as pre-construction access data is not available future projects will established preconstruction.

APPENDIX B

GROUND-BASED MONITORING FIELD PROTOCOL

Table of Contents

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Table 1 Revisions Log

Date	Section	Description
June 26, 2018	**1.2**	**Update Objectives to reflect the revised description of objectives of ground-based monitoring as per the current revision of the CHROMMP**
	2.1.1	**Update experimental design to reflect description contained within the current revision of the CHROMMP**
June 26, 2018	3.3.3 Staking of Permanent Monitoring Plots	In 2016 ground disturbance activity was not permitted by NGTL, preventing the permanent marking of plot locations. Provided a ground disturbance variance is issued, the 2018 program will utilize metal pin flags pushed into the ground by hand to a depth not exceeding 30 cm
June 26, 2018	3.3.5 Plot Maintenance	Updated wording to match changes in section 3.3.3.
June 26, 2018	Table 4. Plot Description	Updated soil descriptors: Soil drainage and soil type have been removed as there will be no ground disturbance activity during the 2018 program.
June 26, 2018	Table 5. Vegetation Community Field Data	Updated to reflect full inventory of vegetation species in each plot. Average vigour for weedy or invasive species will no longer be recorded.
June 26, 2018	3.4.3.3 Photographs	Due to the low seedling height observed in 2016, the photographic records of access controls or line-of-sight breaks will be captured at a distance of 25m from the structure instead of 50 m in cases where seedling height is insufficient to capture at a distance of 50 m.
June 26, 2018	1.2 Ground-Based Monitoring Objectives	Updated ground-based monitoring objectives and protocols to provide more detail.
June 26, 2018	2.1.1 Experimental Design	Removed paragraph referencing Table 1 and sampling frequency.
June 26, 2018	2.1.4 Preliminary Monitoring Plot Locations	Updated Plot Locations: 13 plot locations and 4 contingency plot locations will be selected 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 control 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 control plots would be distributed such

		that 10 plots are in treed upland and 3 plots are in treed lowland habitat units.
June 26, 2018	3.3.3 Staking of Permanent Monitoring Plots	Updated intro paragraph: In addition, GPS waypoints, plot sketches, and photographs will aid in locating sampling plot locations, particularly in the event that a plot flag becomes removed. Removed paragraph explaining permanent sign protocols.
June 26, 2018	3.3.5 Plot Maintenance	Removed sentence explaining differential replacement ID data.
June 26, 2018	3.4.3.2 Line-of-sight Breaks	Updated line-of-sight description: In early stages of regrowth (ie Years 1 and 3), regrowth may not have attained sufficient height relative to surrounding vegetation for useful measurement.
June 27, 2018	References	Reference additions: Montgomery (2001), Kuehl (2000), and Faul et al. (2009).

1 INTRODUCTION

1.1 Background

The following document contains the field protocols for ground-based monitoring of caribou habitat restoration (the Protocols) for TCPL. The ground-based monitoring program described in this document has been developed to verify the effectiveness of measures provided in the Caribou Habitat Restoration Plans (CHRPs) and Offset Measures Plans (OMPs) using evaluation criteria and measurable targets (Northern Resources 2015). The intent of TransCanada's CHRPs and OMPs is to reduce and offset residual direct and indirect project effects on caribou habitat through habitat restoration, access control, and line-of-sight breaks (Northern Resources 2015). The field protocols are designed to evaluate the effectiveness of TCPL's caribou habitat restoration methods (physical restoration measures implemented) over a span of 15 years. All of the data and information collected from the ground-based monitoring will be reviewed to inform TCPL's future caribou habitat restoration (habitat restoration follow-up program).

Objectives of the ground-based monitoring programs align with those of the Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP; Northern Resources 2015) and include:

- verification that CHRPs and OMPs 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 .

This document outlines the processes and procedures required to implement a successful field program to meet the objectives of the ground-based monitoring components of the caribou habitat restoration follow-up program. There are different parts to the field program. Office based pre-field activities (Section 2) are described in terms of planning, personnel, H&S, literature review, and equipment (Appendix A). The field work component (Section 3) details plot establishment and data collection (Appendices B and C). And finally, post-field data management is then described in Section 4. This document will be reviewed after implementation of the Protocols in 2016 and revised as needed to meet the overarching objectives of the caribou habitat restoration follow-up program.

1.2 Ground-Based Monitoring Objectives

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.

1.3 Guidance Documents

The Protocols were developed using the following guidance documents. Although less intensive and with varying objectives, these Protocols align with other monitoring protocols such as those used by the Alberta Biodiversity Monitoring Institute for terrestrial surveys (ABMI 2014), and the Alberta Regeneration Standards (ASRD 2000; ESRD 2013a). The ultimate objective of the ground-based monitoring protocols is to evaluate restoration performance as it relates to caribou habitat. Data is meant to be collected in a manner that allows it to be shared with industry partners.

- *Alberta Regeneration Standards for the Mineable Oil Sands* (ESRD 2013a)
- *Alberta Regeneration Survey Manual: Field Edition* (ASRD 2000)
- *Alberta Wetland Policy* (ESRD 2013b)
- CHROMMP (NGTL 2015; 2018))
- *Ecological Land Survey Site Description Manual* (Second Edition) (ASRD 2003)
- *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases (2nd edition)* (AENV 2008)
- *Reclamation Criteria for Wellsites and Associated Facilities for Peatlands* (AEP 2015a)
- "Reclamation Assessment Criteria for Pipelines" (AENV 2001)
- *Terrestrial Field Data Collection Protocols (Abridged Version) 2015-02-19* (ABMI 2014)
- *2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* (ESRD 2013c)

2 PRE-FIELD PLANNING

This section includes background information, sampling design rationale, pre-field planning and health and safety (H&S) considerations, preliminary plot location planning, and field map preparation requirements.

2.1 Sampling Protocol

Experimental design and sampling protocol are presented in this section. These are scientifically based and were developed based on the recommendations from Northern Resources (2015), and recognized monitoring and vegetation survey methods (ABMI 2014; ASRD 2003). The design and sampling protocol align with reclamation and revegetation assessment practices in the province (ESRD 2013a, 2013b; ASRD 2000; AEP 2015a).

2.1.1 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. 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.

2.1.2 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. 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.

2.1.3 Restoration Units

Restoration units, as developed for the CHRP and OMP, relate to ecosite phases in the footprints. These were further grouped for monitoring purposes; vegetation community types (e.g., ecosite phases) have been reduced to four main restoration units (including natural regeneration units; Table 1) to facilitate the development of evaluation criteria and measurable targets (Northern Resources 2015). These four units are ecologically based, and correspond to different types of caribou habitat.

Natural regeneration plots will be established to evaluate natural regeneration in disturbed areas (operational and non-operational dispositions and/or lines) where no restoration measures were applied. Natural Regeneration plot locations will be randomly selected in naturally regenerating areas on project footprints and offset locations where no restoration measures (e.g., tree planting, mounding, seeding) have been applied. The age of regeneration in naturally regenerating plots should be comparable to the age of regeneration in plots where restoration measures were implemented. Natural Regeneration plots should be established equally in uplands and lowlands where no restoration measures have been implemented (Section 3.3).

Table 2 Description of Restoration Units

Restoration Unit	Description
1. Treed upland/transitional	• mineral soil or transitional soil • ≥5% tree cover
2. Treed lowland (wetland)	• organic soil • ≥5% tree cover
3. Shrub-graminoid lowland (wetland)	• organic soil • <5% tree cover • dominant vegetation cover is shrubs and/or graminoids
4. Natural regeneration control	• equally distributed between upland and lowland

2.1.4 Preliminary Monitoring Plot Locations

Existing information (e.g., aerial photographs, vegetation mapping, alignment sheets) will be used to select the monitoring plot locations. Pre-field maps will be developed with the following attributes (in addition to standard GIS attributes) to aid in plot site selection:

- vegetation community polygon boundaries
- aerial photography (highest resolution available)
- locations, types, and planting rates of implemented restoration measures
- locations and types of implemented access control measures and line-of sight breaks
- access layers (e.g., roads, cutlines, seismic lines)
- other disturbance layers as available (e.g., fire, seismic)

Using the pre-field map, 13 plot locations and 4 contingency plot locations will be selected 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 control 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 control plots would be distributed such that 10 plots are in treed upland and 3 plots are in treed lowland habitat units. Preliminary plot locations will be randomly selected (i.e., avoiding bias placing preliminary locations), while incorporating the following selection criteria:

- restoration/habitat unit
- geographical distribution of plots provides coverage throughout study area
- plot accessibility

- avoidance of transitional areas unless they are extensive in the study area and are determined to be important monitoring areas; if required in the monitoring program, they should be included in the treed upland restoration unit

The types and planting rates of implemented restoration measures will also inform selection of monitoring plot locations. The four contingency plot locations in each restoration unit may be used in situations where a preliminary plot location is found to not meet the criteria, once assessed in the field (i.e., the pre-field vegetation community mapping was incorrect and the actual vegetation community is not representative of the restoration unit, or what looked like an accessible location is discovered not to be once on the ground).

2.1.5 Pre-Field Access Planning

Access to monitoring plot locations will vary depending on local conditions, and could include the use of helicopters, trucks and/or offhighway vehicles. Access methods, as well as access and egress plans, must be developed during pre-field planning. Contact the regional TCPL office and consult line lists or other available sources of existing access information to guide planning decisions. Shapefiles and/or alignment sheets will be provided by TCPL to help field personnel avoid damaging existing seedlings or other restoration measures.

2.1.6 Selection of Qualified Personnel

At least one surveyor per survey crew will have the following skills:

- be experienced in applying field vegetation survey protocols and procedures
- have and understanding of and familiarity with the local plant communities and soils in the study area
- be able to classify local plant communities using appropriate regional classification system (i.e., to ecosite phase level in northern Alberta)
- have expertise in plant ecology, including the ability to measure health and vigour of vegetation
- be competent in plant taxonomy and able to identify most plant species, to the species level, while in the field
- be familiar with soil and landscape classification systems
- have the ability to interpret aerial photographs
- be familiar with GIS*
- be competent in the operation of GPS equipment

* While field personnel may not be required to use GIS tools directly (depending on whether GIS-based digital field data collection tools are used or not), they should have a basic understanding of how GIS applications work. However, **the consulting company must have a GIS expert** to process and export the data in spatial geo-databases.

2.2 Health and Safety

Field personnel must comply with TCPL H&S standards. Safety planning considerations include but are not limited to:

- required personal protective equipment (PPE)

- required H&S training, including Standard First Aid and TCPL Contractor Orientation
- required field equipment
- all ground disturbance requirements, including buried facility locates (if applicable)
- General Work Permit
- field communication
- job safety analysis
- Site-specific Safety Plan (SSSP)

All H&S documentation must be reviewed by a TCPL representative in advance of the ground-based monitoring program.

2.3 Review of Background Information

Background information to be reviewed before field work includes but is not limited to:

- these Protocols, and any information provided by the TCPL coordinator for the applicable area
- project-specific caribou habitat monitoring program, including local certificate conditions, for site-specific requirements (i.e., additional data parameters to collect)
- project-specific caribou habitat restoration plan and associated caribou offset measures plan
- provincial Weed Act and Weed Control Regulations
- field maps (in hard copy or digital format; Section 2.5), including location of implemented restoration measures
- any other relevant environmental information (e.g., local vegetation communities and species)

2.4 Field Equipment

Refer to Appendix A for a checklist of recommended field and safety equipment. A laptop computer (preferably with internet connection) will be required to download data from digital cameras, GPS units and field tablets (if used) each evening while in the field.

2.5 Field Maps

Field maps (digital and/or hard copy) will be produced with standard GIS attributes, as well as the following:

- vegetation community polygon boundaries (e.g., Alberta Vegetation Inventory)
- vegetation community classification labels (and wetland classes where applicable)
- aerial photography (highest resolution available)
- locations, types, and planting rates of implemented restoration measures
- locations and types of implemented access control measures and line-of-sight breaks
- preliminary monitoring plot locations
- contingency monitoring plot locations

- access layers (e.g., roads, cutlines, and seismic lines)
- other disturbance layers as available (e.g., fire, seismic, and buried facilities)

If field tablets* are used, all of the above data layers can be uploaded into the units as digital field maps, including shapefiles of restoration measures, etc. (provided by TCPL). However, a hard copy of the field maps should still be taken in the field as backup (in case of equipment failure), along with a handheld GPS unit and compass.

At minimum, preliminary and contingency monitoring plot locations and locations of restoration measures, access control measure, and line-of-sight breaks must be uploaded into handheld GPS units for accurate navigation and avoidance of damage to existing seedlings or other restoration measures. The other data layers can be taken to the field in hard copy (i.e., on paper maps).

* Some field tablets such as iPads may require additional external GPS receivers to improve spatial accuracy.

2.6 Data Management Preparation

A spatial geo-database (or several) must be set up before field data collection. The geo-database attributes must contain all data fields included on the different datasheets (Appendix C), which will be linked to a geo-referenced plot location (so location can be accurately displayed on a figure). If GIS-based field data collection tools (e.g., GPS-enabled field tablets) are available, data may be collected directly into a digital data sheet (must contain all fields from data sheets in Appendix C). Otherwise, field data may be collected on hard copy data sheets (using a handheld GPS unit to obtain location data) and the data subsequently entered into the geo-database upon completion of the field work. The spatial geo-database files will be submitted to TCPL upon completion of the ground-based fieldwork.

3 FIELD PROCEDURES

This section presents timing and access considerations, procedures for establishing, marking and maintaining monitoring plots, and data collection protocols. The field data collected in ground-based monitoring will allow assessment of vegetation performance against criteria and measurable targets (e.g., species composition, seedling survival, percent cover; Northern Resources 2015). The end goal of monitoring vegetation is to assess the effectiveness of caribou habitat restoration methods.

3.1 Timing of Field Surveys

The surveys must be completed in Q3 after July 15 of each monitoring year (Years 1, 3, 5, 10 and 15), outside of the Restricted Activity Period for caribou (February 15 to July 15). For consistency in data collection, it is preferable to complete field surveys at the same time each monitoring year, and must be done during the growing season. This allows more precise and consistent data to be collected (e.g., percent cover, vigour, line-of-sight measurements). Year 1 will be defined as the first growing season 1 year after planting tree seedlings, to allow a growing season following implementation of restoration measures and planting.

3.2 Site Access

Access to monitoring plot locations could include the use of helicopters, trucks, and/or offroad vehicles, and will be determined during pre-field planning. Care must be taken to not disturb potential monitoring plot locations or established plots; a shapefile (or layer displayed on hard copy field maps) must be on hand to guide crews around planted areas to avoid damage to seedlings when accessing the line. Activities are expected to take place in areas where access has not been controlled and access is gained without disrupting access control measures.

3.3 Monitoring Plot Establishment

Monitoring plots will be established in Year 1 (unless a permanent plot becomes unsuitable for use in the monitoring program in future years and needs to be replaced). An example plot diagram is shown on Figure 1 (Section 3.3.4).

3.3.1 Plot Location

Permanent monitoring plots will be established on operational and non-operational lines where CHRP or OMP measures have been implemented, as well as on natural regeneration control sites (i.e., on operational and non-operational lines where no mitigation measures have been implemented).

Preliminary plot locations selected in the pre-field activities will be displayed on field maps and will be used as starting points. Each plot location will be assessed once onsite to determine if it is characteristic of that restoration unit before a plot is established. If a preliminary plot location is not representative of that restoration unit, a more characteristic location must be selected from the four contingency locations selected for that restoration unit.

3.3.2 Plot Size

Size of plots will differ depending on if the plot is on operational or non-operational lines or dispositions (Table 2). Plot sizes and disturbance definitions are consistent with those presented in the CHROMMP (Northern Resources 2015). Operational lines or dispositions are the portions of the footprint which are still in use (e.g., right-of-way [ROW] of active pipeline, temporary workspaces still in use). Non-operational lines are parts of the project footprint that are not in active use (e.g., seismic lines, inactive winter roads, decommissioned/abandoned pipelines).

Table 3 Size of Monitoring Plots

Disturbance Type	Circular Plot Size
Operational TCPL dispositions (e.g., pipelines and temporary workspace 24 m wide or greater)	3.99 m radius (50 m^2)
Non-operational lines (e.g., seismic lines approximately 8 m wide, other lines less than 24 m wide)	1.79 m radius (10 m^2)
Natural regeneration (consistent with disturbance type)	3.99 m radius (50 m^2) or 1.79 m radius (10 m^2)

Plot size on wider disturbances may be reduced to the smaller 1.79 m radius if ground disturbance constraints limit the placement of the plot (Section 3.3.3).

3.3.3 Staking of Permanent Monitoring Plots

Provided a Ground-Disturbance variance is issued prior to field montoring, plots should be staked and labeled to aid in locating plots in subsequent monitoring years and also to ensure they are not removed during operational and maintenance activities of active pipeline RoWs. In addition, GPS waypoints, plot sketches, and photographs will aid in locating sampling plot locations, particularly in the event that a plot flag becomes removed.

1. Ensuring all TCPL ground disturbance protocols are followed, mark plot centre using a metal pin flag inserted by hand approximately 15cm into the ground..

    - Plot centre must be located greater than 5 m from a pipeline that has been line-located. Clearly mark the setback and the azimuth from pipeline centre on the plot diagram (offset must be sufficient to allow for integrity digs to occur if required).

    - The rest of the plot can overlap the 5 m distance from pipeline centre, but stakes or posts marking the outer edges of a plot must not be within 5 m of a pipeline. Ground disturbance within 5 m of a pipeline requires hand exposure of the pipe and must be avoided.

    - If the minimum 5 m offset of a plot centre on operational lines causes the 3.99 m radius plot to cover a transitional area (between disturbance and surrounding undisturbed vegetation), a smaller plot (1.79 m radius) may be used instead, to be more representative of the area.

2. Write the plot name (e.g., U002) on the pin flag, using permanent/waterproof black marker.
3. Take and record GPS coordinates at the centre stake.

4. Create plot diagram (Appendix C1 and Section 3.3.4).

In the event a plot stake has been removed, re-establish the plot as close as possible to the original location using the original coordinates and plot diagram as references.

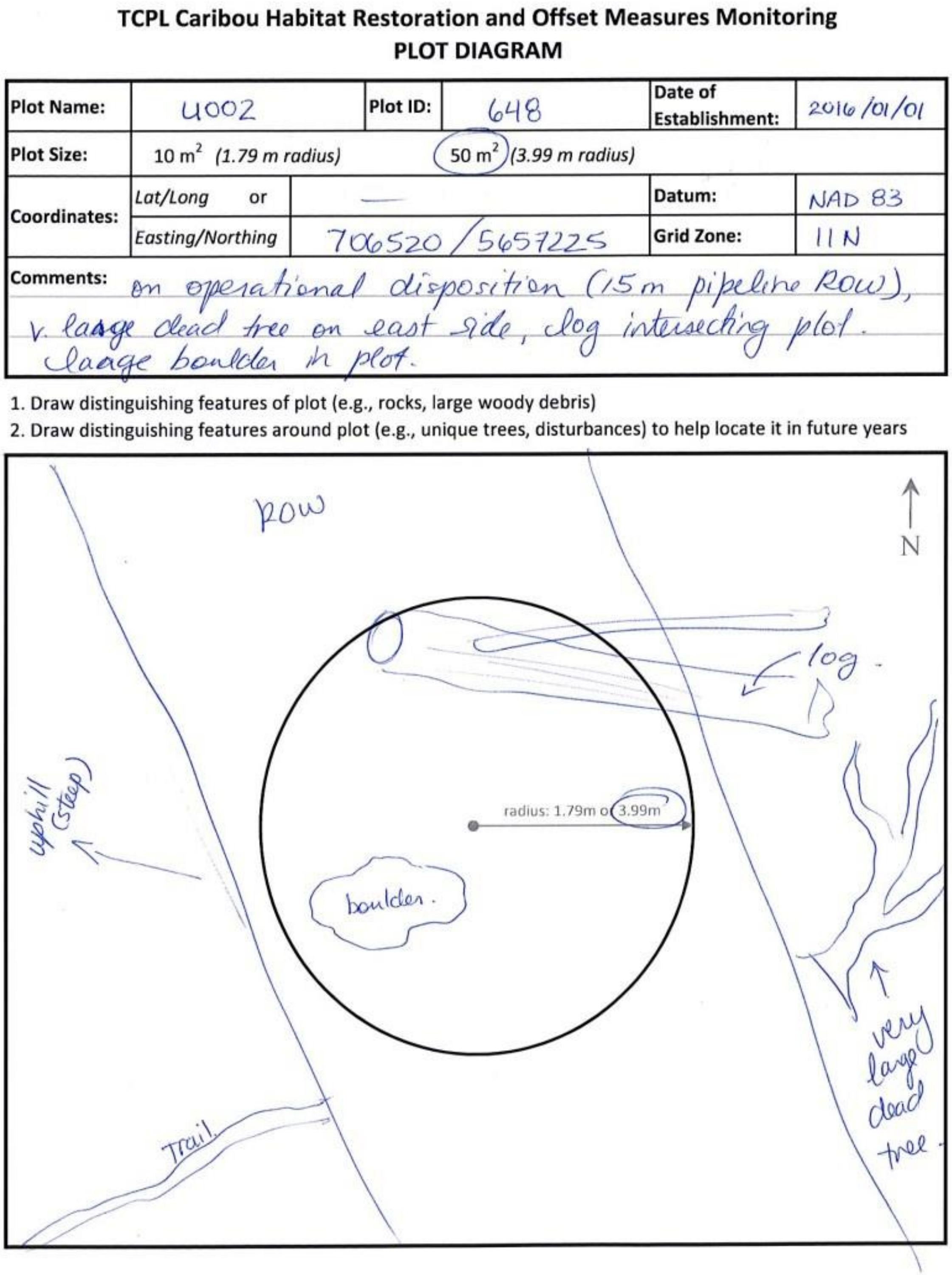
3.3.4 Plot Diagram

Plot diagrams must be created immediately after plot establishment so that the plot can be re-established if damaged or if the marker is lost. Plot diagrams must be detailed enough that people other than the original establishers can locate the site. Complete diagrams using the plot diagram template (Appendix C1) and include the following:

- name of plot (refer to Table 3 for naming convention) and plot ID (metal tag)
- date of establishment
- size of plot
- GPS coordinates (e.g., Universal Transverse Mercators [UTM]) of plot centre
- distinguishing features of plot (e.g., rocks, large woody debris)
- distinguishing features around plots (e.g., unique trees, disturbances)

As per Figure 1, the data reported in the top portion of the template (i.e., everything except the drawing) will be entered and stored in a spatial database (geo-database) once the field program is completed (Section 4). Any features drawn on the plot diagram that were not included as text in the Comments field should be described and added to the geo-database data.

Figure 1 Example Plot Diagram



TCPL Caribou Habitat Restoration and Offset Measures Monitoring
PLOT DIAGRAM

Plot Name:	U002	Plot ID:	648	Date of Establishment:	2016/01/01
Plot Size:	10 m² (1.79 m radius)	50 m² (3.99 m radius)			
Coordinates:	Lat/Long or	—		Datum:	NAD 83
	Easting/Northing	706520 / 5657225		Grid Zone:	11 N
Comments:	on operational disposition (15m pipeline ROW), v. large dead tree on east side, log intersecting plot. large boulder in plot.				

1. Draw distinguishing features of plot (e.g., rocks, large woody debris)
2. Draw distinguishing features around plot (e.g., unique trees, disturbances) to help locate it in future years

3.3.5 Plot Maintenance

In subsequent monitoring years, visually inspect plot identification markers (e.g., pin flagging, flagging tape) to ensure they remain in place, and are intact and legible. If the markers or signs are in poor or deteriorating condition, they must be replaced. Replace any faded, worn, or missing flagging tape to ensure visibility of plot centre. Review the plot diagram (hardcopy/digital) and make any related to maintenance changes.

3.4 Field Data Collection

Field data will be collected using the Appendices C2 (Habitat Restoration) and C3 (Access Control and Line-of-sight Breaks) field data sheet templates. Data collection at each habitat restoration plot is anticipated to take (on average) approximately 1.5 hours, not including plot establishment. All data from the field data sheets must be entered and stored in a geo-database once the field program is completed (Section 4).

Data collection is divided into two main types: Habitat Restoration (Section 3.4.1; Appendix C2) and Access Control and Line-of-sight Breaks (Section 3.4.2; Appendix C3). The latter does not require permanent plot establishment; however, temporary plots will be used for vegetation screen assessment. Although the detailed descriptions for data fields common to each type of survey (e.g., coordinates, surrounding vegetation community) have not been repeated in each section, all data fields on the data sheets must be filled out, except where not applicable (i.e., access control measures and line-of-sight breaks have been included on a single data sheet template, but only the applicable section on the lower portion of the page would be used for any one site).

3.4.1 Habitat Restoration

The following section presents detailed data collection methods for habitat restoration monitoring. These data include evaluation criteria such as seedling density, percent cover and vigour that will be used to assess whether habitat restoration measures meet or are on trajectory to the measurable targets set out in the CHROMMP (NGTL 2015, 2018). The goal of restoration is to achieve growth that is similar to natural yields found in Alberta forests. Habitat restoration data will also be used to verify aerial monitoring data and to inform adaptive management actions to be implemented in areas where measurable targets have not been met.

3.4.1.1 Monitoring Plot Identification & Geographical Information

Collect plot information (Table 3) using the Habitat Restoration Field Data Sheet (Appendix C2). Ensure all fields have been filled out.

Table 4 Plot Identification and Location

Field	Description	Example
Project Identification	• Project name or geographical location of study area	Northwest Mainline Expansion Project
Surveyors	• Names of people collecting the field data (list field lead or primary surveyor first)	Aspen Anderson/Willow Wilson

Plot Name	• Mandatory unique identifiers, which will identify the plot throughout the monitoring program • Use this naming convention: ✦ Treed upland plot 001 = U001 ✦ Treed lowland plot 001 = L001 ✦ Shrub/graminoid lowland plot 001 = S001 ✦ Natural regeneration control plot 001 = C001 • Use three-digit numbering for database sorting purposes (i.e., U001, not U1)	U001, U002...U013 L001, L002....L013 S001, S002...S013 C001, C002...C013
Plot Identification Number	• Unique number on metal tag used to permanently mark plot	648
Date	• Date of survey as YYYY/MM/DD	2016/08/21
Natural Subregion or Ecozone	• Natural subregion where plot is located	Central Mixedwood
Restoration Unit	• Treed upland, treed lowland, shrub/graminoid wetland or control	Treed upland
Plot Size	• Size of plot area to the nearest m^2	10 m^2 or 50 m^2
Waypoint Number	• Take waypoint at centre stake on handheld GPS unit • Record waypoint name/number	012
GPS Location Information (Coordinates)	• GPS location information is collected using a handheld GPS device (minimum ±10 m accuracy) • Record coordinates of centre stake waypoint • Format: UTMs or latitude and longitude (lat/long)	UTMs:6516048/474594 or Latitude/Longitude: 49°00’00.00” /110°00’00.00”
Grid Zone	• GPS Grid Zone (only if using UTM format)	12U
Datum	• North American Datum 83	NAD83
Elevation	• Elevation in metres (using GPS unit)	1,100 m
Surrounding Vegetation Community/Wetland Class	• Determine the surrounding (i.e., non-disturbed) vegetation community and wetland class (if applicable) using the local classification system (e.g., ecosite phase [Canada Forest Service field guides], or Alberta Wetland Classification System for wetlands [ESRD 2015])	i1 treed bog/BWcfa

3.4.1.2 Monitoring Plot Description

Collect plot information in Table 4 using the Habitat Restoration Field Data Sheet (Appendix C2).

Table 5 Plot Description

Factor	Description	Example
Slope	• Slope is the amount of incline where the plot is located • Measure slope with a clinometer and record to the nearest 1% (level ground has a slope of 0%)	4%

Aspect	• Aspect is the orientation of the slope where the plot is located (1° to 360°) • Measure aspect using a compass (facing downhill) • Level ground has no aspect (record as -1)	270°
Meso Site Position	• Meso site position is the position of the plot along a slope segment • Reference Table B1 for descriptions of meso site position	Upper slope
Moisture Regime	• Classify the soil moisture regime at the plot • Reference Table B2 and Figure B1 for moisture regime categories and characteristics	Mesic
Nutrient Regime	• Classify the soil nutrient regime at the plot based on the plot ecosite • Reference Table B3 for nutrient regime categories and characteristics	Medium
	Classify surficial soil within the plot as mineral or organic	Organic or mineral
Surface Substrate	• Classify the ground surface within the whole plot into various types • Assign % cover to: water, cobbles and stones, mineral soil, organic soil, organic matter, coarse woody debris, live plant material • The total should be around 100%, but may not be exactly that due to some overlap (e.g., live plant material may overlap coarse woody debris to some degree) • Reference Table B5 for surface substrate definitions	Water = 5% Cobbles and Stones = 0% Mineral Soil = 0% Organic Soil = 0% Organic Matter = 20% Coarse Woody Debris =5% Live Plant Material = 70%

3.4.1.3 Vegetation Community Composition

Collect and record data listed in Table 5 at each plot on the Habitat Restoration Field Data Sheet (Appendix C2).

Table 6 Vegetation Community Field Data

Field	Description	Example
Vegetation Structure		
Vegetation Strata Percent Covers	• Record the total percent estimate of cover of each stratum within the plot (ASRD 2003) • The total percent cover for a stratum does not necessarily equate to the sum of all plant covers for a particular stratum as foliage overlap may occur • Reference Table B6 and Figure B2 for stratum categories and definitions	T1 – 0% T2 – 0% S1 – 0% S2 – 4% S3 – 20% G – 5% H – 3% M – 50% L – 2%
Vegetation Strata Heights	• Record average height of each stratum within the plot (exclude M and L strata) to the nearest 5 cm • Reference Table B6 and Figure B2 for stratum categories and definitions	T1 – 0 cm T2 – 0 cm S1 – 0 cm S2 – 165 cm S3 – 30 cm G – 35 cm H – 20 cm
Vegetation Species Composition		
Vegetation Species Code and Stratum	• Identify all species for each stratum, to species level where possible • Identification to genus level is sufficient for vegetation that cannot be identified in the field (e.g. *Sphagnum* sp., *Salix* sp., *Carex* sp.) • Use scientific botanical nomenclature following provincial standards (e.g., ACIMS nomenclature; AEP 2015b or most current) • A 7-letter code (in upper case) will be used to identify specific species, composed of two parts reflecting the scientific name of the plant; the first four letters of the code represents the genus, and are extracted from the first four letters of the scientific genus name and the last the three the species (ASRD 2003).	black spruce = *Picea mariana* = PICE MAR willow species = *Salix* sp. = SALI SP.
Vegetation Percent Cover	• Percent cover is the percent of the ground area covered by a vertical projection of the foliage onto the ground surface • Determine the percent cover for each species within the plot • Cover values must all be numeric, and no ranges of values are allowed • Reference Figure B3 for examples of percent cover	S2 – PICE MAR = 2% S3 – PICE MAR = 15%
Plant Vigour	• Vigour is a measure of the relative health of a plant • Determine average vigour for each non-invasives species within the plot • Reference Table B7 for vigour categories	PICE MAR – 4 - Excellent
Plant Health Observations	• Note insect infestations, changes in colour or any other plant health observations • Take photos of any specific plant health concerns	Leaves on *Salix* sp. have brown spots

3.4.1.4 Tree Seedling/Tree Data

Collect data in Table 6 at each plot and record on the Habitat Restoration Field Data Sheet (Appendix C2). These data will be used in assessing the success of habitat restoration measures and include criteria such as seedling density, percent cover, and seedling damage (Northern Resources 2015). Vigour and percent cover for tree species will have already been collected in the Vegetation Community Composition portion of the habitat restoration data sheet (Table 5) and do not need to be recorded again for this portion.

Table 7 Tree Seedling Field Data

Field	Description	Example
Damage (Plot)	• Assess and record damage to seedlings/tree species for the entire plot • Use a maximum of two codes per plot • Select class code, severity code and causal code (only if reasonably certain) • Reference Table B8 for damage categories	FO-2-ID, PD-1-UK
Species Code	• Record the 7-letter code (Table 5) for each dominant tree species (i.e., those species that have the potential to grow into trees, including those in seedling and shrub stages/strata)	PICE MAR; POPU TRE; PINU BAN
Density (Count)	• Count the number of seedlings in each plot (for each species) • When possible, differentiate between planted or natural regeneration (do not guess); if both are present, use a separate row for each one (i.e., one row for planted stems and one row for natural stems of the same species)	PICE MAR – 4 – P PICE MAR – 5 – N
Density Distribution	• Determine density distribution class Reference Table B9 for plant distribution class categories	7
Spatial Distribution	• Qualitatively assess the distribution of seedlings over the entire plot • This is not a canopy cover measurement, but distribution throughout the entire plot	seedlings are distributed over 80% of the plot
Height	• Measure and record the height of five representative seedlings of each species in the plot to the nearest cm • The height of the seedling/tree is measured from the base of the seedling/tree, at the average ground level, to the tallest reaching point of the live matter of the seedling/tree (Figure B4) • In older trees, measure the height to the nearest cm for trees <100 cm and to the nearest 10 cm for trees >100 cm	PICE MAR 12 cm 15 cm 14 cm 15 cm 12 cm
Age Estimate	• Determine and record the estimated age of each of the five stems selected for height measurements • To determine age, count the number of branch whorls on coniferous trees, and number of bark scars (breaks in bark consistency) on deciduous trees • Start at present year's growth (terminal shoot/leader) and work down to base (root collar node; ASRD 2000; ESRD 2013a)	

3.4.1.5 *Noxious and Restricted Weeds/Invasive and Agronomic Species*

Record any observations of noxious and prohibited noxious weeds, as well as invasive and agronomic species (Table 7) on the Habitat Restoration Field Data Sheet (Appendix C2).

Table 8 Noxious and Restricted Weeds/Invasive and Agronomic Species

Field	Description	Example
Noxious or Restricted Weeds	• Identify and record noxious or restricted weeds to species level	Canada thistle *Cirsium arvense* = CIRV ARV
Invasive and Agronomic Species	• Identify invasive or agronomic plants to species level	alsike clover *Trifolium hybridum* = TRIF HYB
Growth Stage	• Record average growth stage – seedling, bolt, bud, flower, seed set or mature	Flower
Percent Cover Code	• Determine percent cover, and record code ✦ trace = <1% cover ✦ low = ≥1% and <5% cover ✦ moderate = ≥5% and <25% cover ✦ high = ≥25% cover	Low
Density Distribution	• Determine density distribution class • Reference Table B9 for plant distribution class categories	2
Photographs	• Take photographs of the general infestation and a representative individual of each species	-

3.4.2 Photographs

A minimum of seven photographs will be taken at each survey plot. Record the photograph file number and description on the Habitat Restoration Field Data Sheet (Appendix C2).

1. north from centre of plot (capture plot by angling toward edge of plot)
2. east from centre of plot (capture plot by angling toward edge of plot)
3. south from centre of plot (capture plot by angling toward edge of plot)
4. west from centre of plot (capture plot by angling toward edge of plot)
5. ground cover (looking down)
6. from outside edge of plot, parallel to linear disturbance (to capture entire plot), facing opposite side of plot
7. from opposite outside edge of plot, facing other direction (parallel to linear disturbance; to capture entire plot)

3.4.3 Access Control and Line-of-sight Breaks

Access control and line-of-sight break monitoring will be conducted in combination with habitat restoration monitoring. Collect information for access control measures and line-of-sight breaks. Data in the top portion of the data sheet (location and identification information) is similar to fields described in Table 3. Fields specific to access control and breaks are explained below.

3.4.3.1 Access Control

Inspect all access control measure locations (Table 8) and record data on the Access Control and Line-ofsight Breaks field data sheet (Appendix C3). Complete all data fields on the data sheet (e.g., date, GPS coordinates), even though they are not described again in Table 8.

Table 9 Field Data Collection for Access Control Evaluation Criteria

Evaluation Criteria	Description	Example
Physical Materials	• Visually inspect and comment on condition of physical materials used for access control • Record condition and average height of planted trees (where applicable)	Access control in good physical condition; trees healthy, average height 2 m
Evidence of Access	• Look for evidence of access (e.g., trampled vegetation, bare ground, rutting, trails)	Yes – trail observed
Evidence of U-turns at Access Barriers	• Look for evidence of U-turns at access barriers (e.g.,trampled vegetation, bare ground)	Yes – bare ground observed
Access Type	• Determine type of access ✦ non-motorized ✦ all-terrain vehicle ✦ truck ✦ other (details to be noted)	All-terrain vehicle
Access Level Metrics	• Determine level of access ✦ absent ✦ low (tracks/trail evident but difficult to discern or appear to be infrequently used) ✦ moderate (relatively easily discernable; vegetation may be slightly trampled, but no bare ground is visible) ✦ high (tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use)	High
Adjacent Habitat Disturbance	• Visually inspect adjacent habitat for signs of disturbance	No signs of disturbance in habitat adjacent to control measure

3.4.3.2 Line-of-sight Breaks

Inspect all line-of-sight breaks (Table 9) and record data on the Access Control and Line-of-sight Breaks field data sheet (Appendix C3). Record all data fields on the data sheet even if not listed below (e.g., date, GPS coordinates).

Table 10 Field Data Collection for Line-of-sight Break Evaluation

Line-of-sight Break Type	Evaluation Criteria	Description	Example
Berms	Footprint Width	• Measure footprint width using tape measure	32 m
	Length of Berm	• Measure length of berm (perpendicular to RoW) using tape measure	50 m
	Length of Berm with Height ≥1.5 m	• Measure length of berm (perpendicular to RoW) ≥1.5 m using tape measure	20 m
	Berm Composition	• Record what the berm is made of (e.g., fabricated, earthen)	Fabricated
	Condition of Berm	• Record any observations regarding the condition of the berm	Berm looks to be in good condition
Fabricated Screens	Screen Composition	• Record materials the screen is made from (e.g., burlap, snow fencing)	Burlap
	Screen Condition	• Comment on condition of fabricated screen (including sagging issues)	Burlap in poor condition, needs replacing
Vegetation Screens ***(select a representative 10 m² circular plot within vegetation)***	Spatial Distribution	• Measure/calculate the spatial distribution (distance between) 10 of live woody stems to the nearest cm (within a representative 10 m² circular plot)	10 cm, 12 cm, 25 cm, 9 cm, 15 cm, 40 cm, 17 cm, 20 cm, 33 cm, 46 cm
	Density of Woody Stems	• Count woody stems within the 10 m² circular plot	37
	Height of Live Woody Stems	• Measure the average height of live woody stems within the 10 m² circular plot	60 cm
	Percent Cover of Live Woody Stems	• Measure the percent cover of live woody stems within the 10 m² circular plot	25%
	Line-of-sight Measurements	• Use a cover/Robel pole for line-of-sight measurements (see below for more detailed methods)	-

3.4.3.3 Vegetation Screen Line-of-sight Measurements

Line-of-sight measurements are only to be completed for vegetation screens. Vegetation obstruction (line-of-sight) is measured using procedures adapted from Herrick et al. (2009); these are similar to the Robel Pole Method (BLM 1996). Where feasible based on seedling height, a cover pole (Appendix A, Figure A1), divided into increments or “bands” of alternating colour, is used to measure the degree to which the vegetation is obstructing visibility to the other side of the screen. Ensure your cover pole has 0.5 m segments and 10 cm bands for consistency across monitoring years. In early stages of regrowth (ie Years 1 and 3), regrowth may not have attained sufficient height relative to surrounding vegetation for useful measurement.

1. Select three to five representative positions at regular intervals along the length of the vegetation screen (number of positions and interval distance will depend on width of the disturbance).

2. Record interval distance (to the nearest metre) on the Access Control and Line-of-sight Breaks field data sheet.

3. Start at one end of the vegetation screen (note Position name/number on the datasheet).

    a) One surveyor holds the cover pole at the location of first position (take GPS coordinates).

    b) A second surveyor walks perpendicular to the vegetation screen (parallel to the linear disturbance), holding the sighting pole, until the 5-metre cord is pulled taut. This will be the “Observation A” location.

    c) Crouching down, the second surveyor looks just over the top of the sighting pole to the cover pole, and calls out which bands (10-cm intervals) are obstructed.

    d) First surveyor can note the observations on the datasheet:
        - band is obstructed if ≥25% visually covered by vegetation (alive or dead);,write “1” on the datasheet
        - if band is not obstructed (<25% covered), write “0” on the datasheet

    e) Repeat steps b) to d) on the other side of the vegetation screen (i.e., second surveyor walks across the screen and pulls the cord taut to 5 m on the opposite side of the screen, parallel to the linear disturbance). This will be the “Observation B” location.

4. Both surveyors move to the next position along the vegetation screen.

    f) Repeat steps a) to e) at each position (GPS coordinates are only taken at first position).

5. When both sides of the 3 to 5 positions have been completed, calculate the totals on the datasheet.

3.4.3.4 Photographs

Take a minimum of six photographs from different angles to document the condition of the access control measure or line-of-sight break:

- one on each side of the break/access control, from centre of RoW: 25 m from structure or far enough to capture entire structure (Figures 2 and 3, star symbols)

- wider disturbances (e.g., operational lines): one photograph from each edge of the RoW at about 50 m from structure, on both sides of the structure, to show different perspective (Figure 2, dot symbols)

- narrower disturbances (e.g., non-operational lines): reduce distance to about 20 m, one photograph from each edge of the RoW (Figure 3, dot symbols)

Record the photograph file number (GPS coordinates for each photograph will be recorded automatically using GPS-enabled camera; ensure GPS function is enabled). Take photographs from the same locations in subsequent monitoring years. Also take photographs of any signs of natural or anthropogenic disturbance, damage to structure, or anything else of note.

Figure 2 Access Control and Line-of-sight Breaks Photograph Locations (Wider Lines)

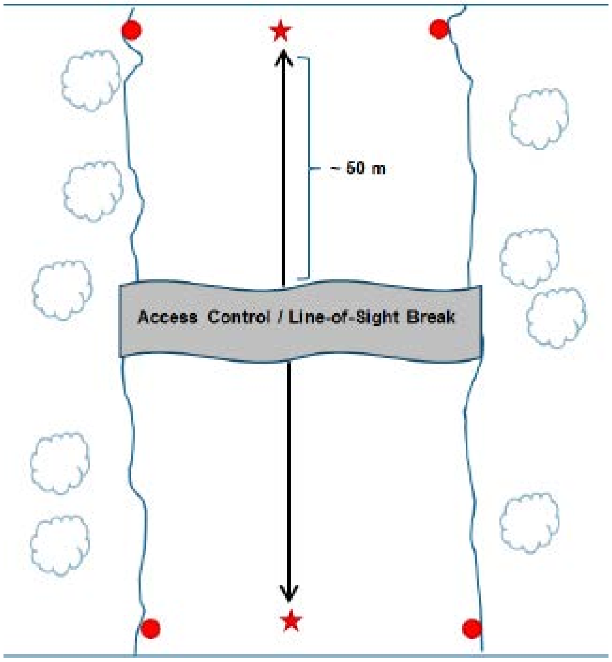
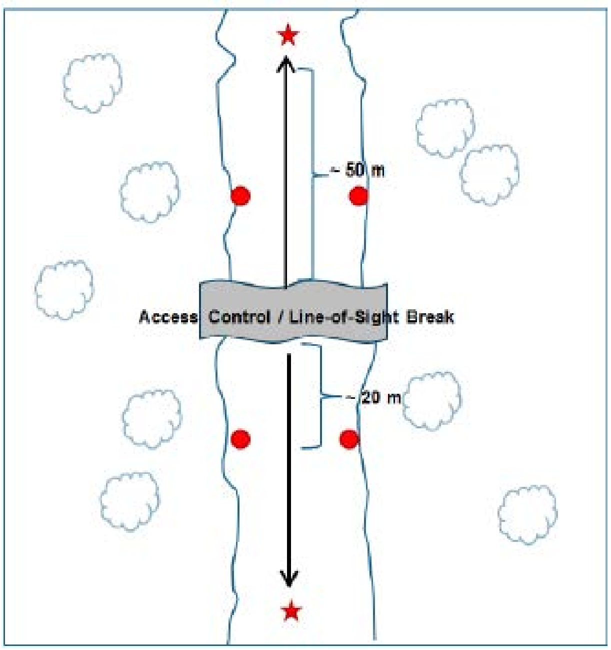


Figure 3 Access Control and Line-of-sight Breaks Photograph Locations (Narrower Lines)



3.4.4 Incidental Wildlife Observations

While completing surveys, document and photograph (when possible) any incidental wildlife observations onto the field data sheets. If photographs are taken, record photograph file number. Incidental wildlife observations include the following:

- wildlife sightings
- wildlife tracks or other signs of habitat use (e.g., dens, sleeping areas)
- signs of browsing or predation (e.g., kill sites, bones)
- scat

3.4.5 Field Data Management

Post-field (end of field day) debriefing and data processing will be an ongoing process from the end of the first day of the field survey. If possible, data will be reviewed nightly by the field lead to ensure blanks are complete and errors noted and corrected while the day's survey is still fresh in the memory.

The following steps will also be taken:

- If using digital field tablets, nightly data backups are required to ensure an offsite backup of field data exists in case the field tablet is lost, stolen or damaged.
- If using hard copy datasheets, photographs will be taken of the datasheets in the field after each site (plot or access control/break) is complete, to ensure a backup exists in case the datasheets are lost or damaged.
- Photographs and GPS handheld units will be backed up nightly and uploaded offsite if local internet can accommodate this, in case cameras/GPS units are lost, stolen or damaged.
- Failure to properly complete these procedures increases the risk of lost data.

4 POST-FIELD DATA MANAGEMENT

Data processing, data entry and quality assurance/quality control (QA/QC) should be completed as soon as possible upon returning from the field. Steps include but are not limited to:

- Scanning hard copy data sheets immediately upon returning from the field and saving resulting digital files in a secure location (e.g., server with regular backup routine) accessible to multiple people (i.e., not on an individual's desktop).
- Backing up all final digital files (e.g., photographs, field data entry files, data downloaded from GPS unit) in a secure location (as above).
- Entering all data from hard copy data sheets into a spatial geo-database (refer to Appendix E for format requirements).
- Completing a QA/QC process on the final digital data and ensuring any edits are incorporated into the geo-database. Examples of items to verify include but are not limited to:
    - looking for spatial outliers, or any plots that seem not to be where they should be (e.g., not on an operational or non-operational disposition, or outside of the project area)
    - verifying that species lists make sense with habitat where plot was located and vegetation communities reflect the restoration unit type
    - checking for outlier data (e.g., nonsensical date, percent cover, or height values) or duplicate or incorrect plot names
    - cross-checking that recorded photograph numbers match digital file names of downloaded photos

Data (including digital files) must be formatted to meet TCPL requirements (Appendix D). All field data collected on data sheets (hard copy or digital version) will be stored in a spatial geo-database and subsequently submitted to TCPL, along with any other digital field files (e.g., photographs).

5 REFERENCES

Alberta Biodiversity Monitoring Institute (ABMI). 2014. *Terrestrial Field Data Collection Protocols (Abridged Version) 2015-02-19*. Alberta Biodiversity Monitoring Institute. ftp://ftp.public.abmi.ca/Publication/home/publications/documents/366_ABMI_TerrestrialFieldProtocolAbridged_ABMI.pdf

Alberta Environment (AENV). 2008. *Guideline for Wetland Establishment on Reclaimed Oil Sands Lease (2nd edition)*. Prepared by M.L. Harris of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, Alberta. December 2007.

Alberta Environment (AENV). 2001. "Reclamation Assessment Criteria for Pipelines." Draft. http://environment.gov.ab.ca/info/library/6883.pdf

Alberta Environment and Parks (AEP). 2015a. *Reclamation Criteria for Wellsites and Associated Facilities for Peatlands.* Edmonton, Alberta. October 2015. http://aep.alberta.ca/lands-forests/land-industrial/programs-and-services/reclamation-and-remediation/upstream-oil-and-gas-reclamation-and-remediation-program/documents/ReclamationCriteriaPeatlands-Oct2015.pdf

Alberta Environment and Parks (AEP). 2015b. *Element Occurrence Data*. Alberta Conservation Information Management System (ACIMS). Edmonton, Alberta. Updated in July and October 2015. http://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-inform ation-management-system-(acims)/download-data.aspx

Alberta Environment and Sustainable Resource Development (ESRD). 2015. *Alberta Wetland Classification System.* Water Policy Branch, Policy and Planning Division. Edmonton, Alberta. Effective June 1, 2015.

Alberta Environment and Sustainable Resource Development (ESRD). 2013a. *Alberta Regeneration Standards for the Mineable Oil Sands.* Government of Alberta, Department of Environment and Sustainable Resource Development. Edmonton, Alberta. Effective May 1, 2013.

Alberta Environment and Sustainable Resource Development (ESRD). 2013b. *Alberta Wetland Policy*. September 2013. 25 pp. ISBN: 978-1-4601-1287-8. http://aep.alberta.ca/water/programs-and-services/wetlands/documents/AlbertaWetlandPolicy-Sep2013.pdf

Alberta Environment and Sustainable Resource Development (ESRD). 2013c. *2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands*. Edmonton, Alberta. Updated July 2013. http://www.environment.gov.ab.ca/info/library/8364.pdf

Alberta Sustainable Resource Development (ASRD). 2003. *Ecological Land Survey Site Description Manual (Second Edition)*. Resource Data Research, Strategic Corporate Services Division. Edmonton, Alberta. 112 pp.

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

Bureau of Land Management (BLM). 1996. Sampling Vegetation Attributes. Interagency Technical Reference. Cooperative Extension Service, U.S. Department of Agriculture, Forest Service, Natural Resource Conservation Service, Grazing Land Technology Institute, U.S. Department of the Interior, Bureau of Land Management. Supercedes BLM Technical Reference 4400-4. Denver, Colorado.

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.

Herrick J.E. et al. 2009. *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems. Volume II, Design, supplementary methods and interpretation.* USDA-ARS Jordana Experimental Range. Las Cruces, New Mexico. 200 pp.

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.

Northern Resource Analysts Ltd. (Northern Resources). 2015. Caribou Habitat Restoration and Offset Measures Monitoring Program, Leismer to Kettle River Crossover Project, Northwest Mainline Expansion Project, Chinchaga Lateral Loop No. 3. Report prepared for NOVA Gas Transmission Ltd. Calgary, Alberta. August 2015.

APPENDIX A

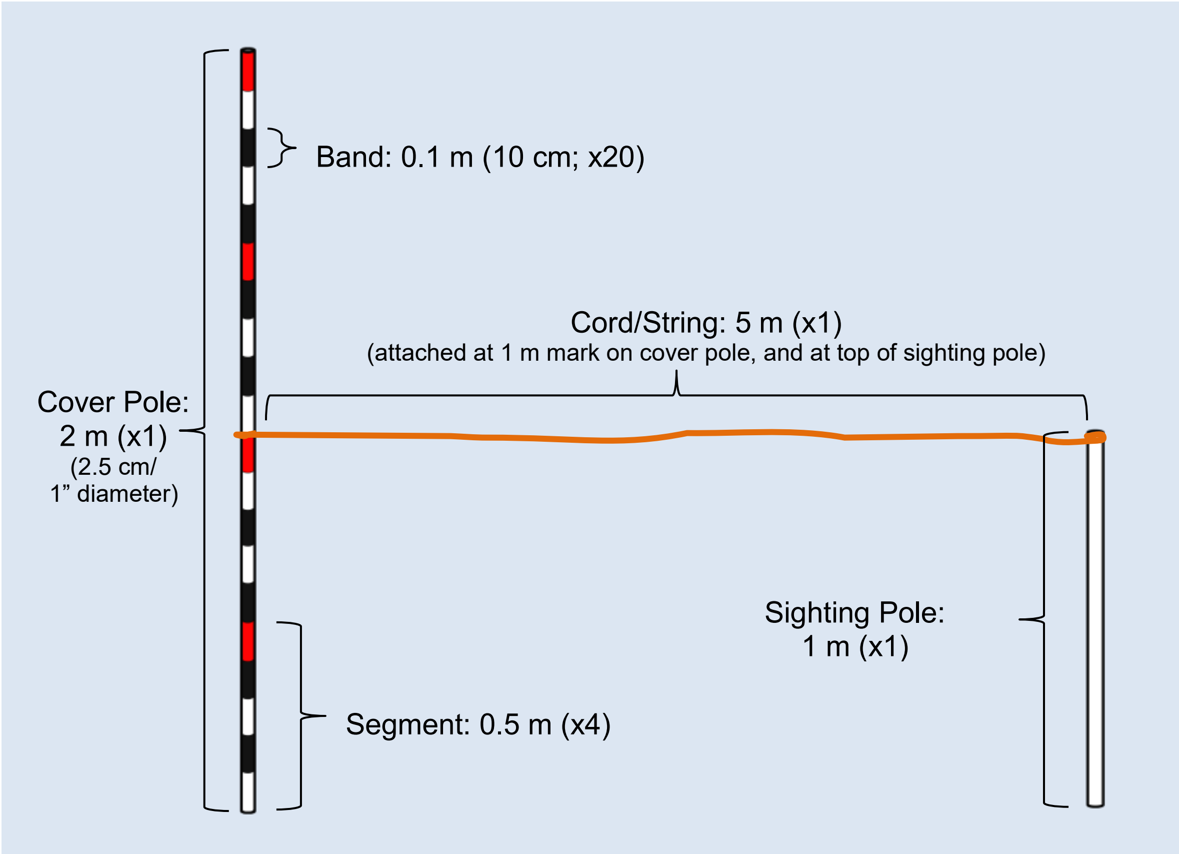
FIELD EQUIPMENT CHECKLIST

Table A1 – Field Equipment Checklist

General
☐ Field maps (to Section 2.6 standards) ☐ Compass ☐ Clinometer ☐ GPS handheld unit ☐ Digital camera – GPS-enabled (ensure GPS function is activated) ☐ Digital field tablet* ☐ Field Data Sheets on all-weather paper (x60: 52 plots + 8 extra) ☐ Spare batteries/chargers (as required) ☐ Hand lens ☐ Field notebook ☐ Pencils ☐ Permanent markers (Sharpies) ☐ Tape measure (pocket-sized) ☐ Clipboard ☐ DBH (diameter at breast height) tape ☐ Cover pole (e.g., Robel pole) with sighting pole (Figure A1)
Plot Establishment
☐ Tape measure (30 m) ☐ Stake with 3.99 m rope (radius for 50 m^2 plot) ☐ Stake with 1.79 m rope (radius for 10 m^2 plots) ☐ Hammer (i.e., mallet) ☐ Post pounder ☐ Flagging tape and plot markers (e.g., metal tree tags) ☐ Permanent/waterproof black markers ☐ Metal posts (e.g., t-posts or other permanent stake) ☐ Metal pins (flagged; for ground-level marking of plot centres) ☐ Permanent signs to alert others at each monitoring plot
Reference Material
☐ These Protocols ☐ Field guides and taxonomic keys (vegetation) ☐ Ground Disturbance Package ☐ CHROMMP ☐ TCPL General Work Permit, Site Specific Safety Plan (SSSP) and all other required H&S documentation (comprehensive H&S requirements are outside the scope of these Protocols)
Health and Safety
☐ Appropriate PPE as per company and TCPL policy – may include but not limited to: o Long sleeves and long pants o Cruise vest (high-visibility) o Safety-toed boots o Safety glasses o Hard hat ☐ Bear spray/bangers, air horns ☐ Survival kit (for remote areas) ☐ First Aid kit

*If using a digital field tablet, it is recommended to take hard copy field data sheets in case of device failure

Figure A1 Cover Pole Specifications (not to scale)



APPENDIX B

FIELD REFERENCE SHEETS

Table B1 Meso Site Position Definitions

Meso Site Position	Definition
Crest	The generally convex uppermost portion of a hill (meso scale); it is usually convex in all directions; no distinct aspect.
Upper Slope	The generally convex upper portion of the slope of a hill (meso scale) immediately below the crest; it has a convex surface profile with a specific aspect.
Middle Slope	The area of the slope of a hill between the upper slope and the lower slope, where the slope profile is not generally concave or convex; rather it has a straight or somewhat sigmoid surface profile with a specific aspect.
Lower Slope	The area toward the base of the slope of the hill. It generally has a concave surface profile with a specific aspect.
Toe	The area below and adjacent to the lower slope. It is apparent by an abrupt decrease in slope. Zone of potential accumulation at the bottom of a slope.
Depression	Any area that is concave in all directions; generally at the foot of a meso scale hill or in a generally level area.
Level	Any level meso scale area not immediately adjacent to a meso scale hill. The surface profile is generally horizontal with no significant aspect.

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*
Hill also generally refers to mound or ridge

Table B2 Moisture Regime Characteristics

Moisture Regime	Description	Primary Water Source	Slope Position	Soil Properties			
				Texture	Internal Drainage	Surface Humus Depth	Available Water Storage Capacity
Very xeric	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after precipitation	Precipitation	Ridge crests shedding	Very coarse (gravelly-sand); abundant coarse fragments	Very rapid	Very shallow	Extremely low
Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation	Precipitation					
Subxeric	Water removed rapidly in relation to supply; soil is moist for short periods following precipitation	Precipitation	Upper slopes shedding	Coarse to moderately coarse (LS-SL); moderately coarse fragments	Rapid	Shallow	Very low
Submesic	Water removed readily in relation to supply; water available for moderately short periods following precipitation	Precipitation			Rapid to well		Low
Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year; available moisture reflects climatic inputs	Precipitation in moderately to fine-textured soils and limited seepage in coarse textured soils	Mid slope rolling to flat	Moderate to fine (L-SiL); few coarse fragments	Well to moderately well	Moderately deep	Moderate
Subhygric	Water removed slowly enough to keep the soil wet for significant part of the growing season; some temporary seepage and possibly mottling below 20 cm	Precipitation and seepage	Lower slopes receiving	Variable depending on seepage	Moderately well to imperfect	Deep	High
Hygric	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possibly weak gleying	Seepage			Imperfect to poorly		Variable depending on seepage
Subhydric	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral soils or organic soils; permanent seepage less than 30 cm below the surface	Seepage or permanent water table	Depressions and level receiving	Variable depending on seepage	Poor to very poorly	Very deep	Variable depending on seepage
Hydric	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral soils or organic soils	Permanent water table			Very poorly		

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Figure B1 Ecological Moisture Regime in relation to landscape position and geologic material (ASRD 2003)

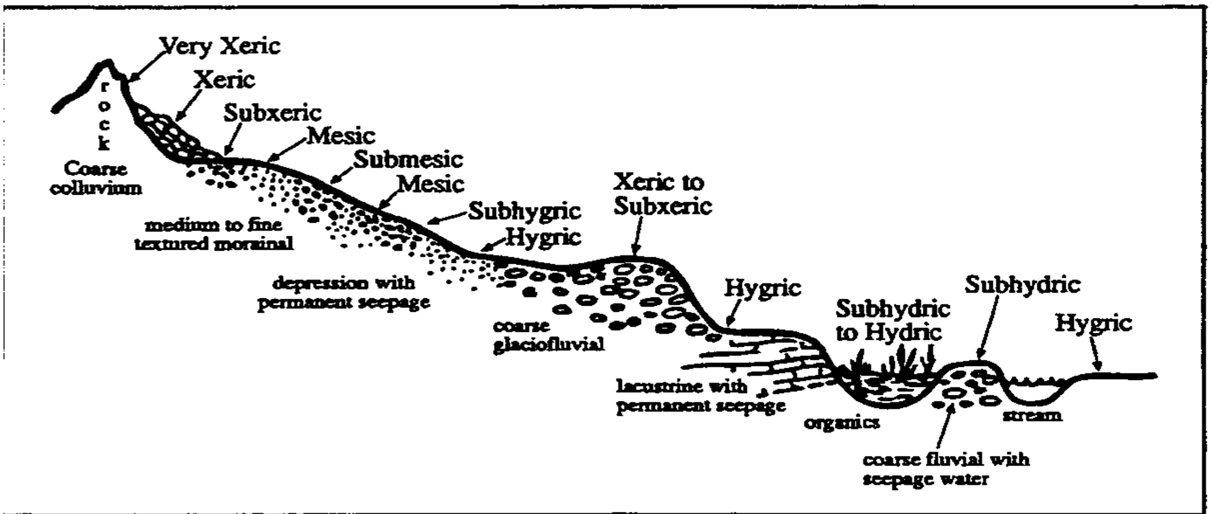


Table B3 Nutrient Regime Characteristics

Characteristic	Very Poor (Oligotrophic)	Poor (Submesotrophic)	Medium (Mesotrophic)	Rich (Permesotrophic)	Very Rich (Eutrophic)
Definition	Very poor nutritional status, very small supply of available nutrients	Poor nutritional status, low supply of available nutrients	Medium nutritional status, medium supply of available nutrients	Rich nutritional status, plentiful supply of available nutrients	Very rich nutritional status, abundant supply of nutrients
Texture	Very coarse	Coarse	Medium	Fine	Very fine
Organic Matter Content	Low	Moderate	Moderate	High	High

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B4 Soil Drainage Definitions

Drainage	Description
Very rapidly drained	**The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.** Water is removed from the soil very rapidly in relation to supply. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Water source is precipitation.
Rapidly drained	**The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.** Soils are free from any evidence of gleying or mottling throughout the profile. Rapidly drained soils often occur on steep slopes.
Well drained	**The soil moisture content seldom exceeds field capacity in any horizon (except possibly the C) for a significant part of the year.** Soils are usually free from mottling in the upper 1m, but may be mottled below this depth.
Moderately well drained	**The soil moisture remains in excess of field capacity for a small but significant period of the year.** Soils are often faintly mottled in the lower B and C horizons or below a depth of 0.7 m. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium textured soils that have a slowly permeable layer below the A and B horizons.
Imperfectly drained	**The soil moisture remains in excess of field capacity in subsurface horizons for moderately long periods during the year.** Soils are often distinctly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. Soils are generally "gleyed" subgroups of mineral soil orders.
Poorly drained	**The soil moisture remains in excess of field capacity in all horizons for a large part of the year.** The soils are usually strongly gleyed. Soils are generally in the Gleysolic or Organic order.
Very poorly drained	**Free water remains at or within 30 cm of the surface most of the year.** The soils are usually strongly gleyed. Soils are generally in the Gleysolic or Organic order; mineral soils are usually a peaty phase.

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B5 Surface Substrate Definitions

Surface Substrate	Definition
Water	Areas of open water
Cobbles and Stones	Exposed unconsolidated rock fragments greater than 7.5 cm in diameter
Mineral Soil	Unconsolidated mineral material of variable texture not covered by organic materials
Organic Soil	Organic soil not covered by organic material
Organic Matter	Organic layers, including living and dead plant materials, which have accumulated on the soil surfaces, ranging from easily recognizable undecomposed vegetation parts to humified organic material (excluding decaying wood as defined below).
Coarse Woody Debris	Fallen trees, large branches on the ground surface or partially buried stumps with an exposed edge, >7.5 cm diameter
Live Plant Material	Any live plant material, not including canopy area (e.g., moss, live stem area)

ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Table B6 Definition of Vegetation Layer Strata

Vegetation Layer Code	Vegetation Layer Name	Definition
T1	Tree (Main Canopy)	This stratum (T1) consists of the **dominant (tallest) tree species in the main canopy**. These are the trees that make up the upper part of the height distribution population and form the general layer of the canopy or foliage. These may include trees of the same age group that are significantly taller than the others in the canopy. Any woody species may meet this requirement as long as they meet a minimum height criterion of greater than 5 m.
T2	Tree (Understory)	This stratum (T2) is composed of trees and/or shrubs (see above) whose **crowns, extend into the bottom of the general level of the canopy or are located below the main canopy**. Trees and/or shrubs in this layer must exceed 5 m in height. Any species meeting these criteria should be identified as part of this stratum (This layer may or may not be present).
S1	Shrub (Tall)	All **woody plants between 2.0 m and 5.0 m tall** are recorded as part of the Tall Shrub (S1) stratum. Shrub and tree regeneration is included in this stratum.
S2	Shrub (Medium)	This stratum (S2) includes **shrubs and regenerating trees that are between 0.5 m and 2.0 m tall**. Shrub and tree regeneration is included in this stratum.
S3	Shrub (Low)	All **woody plants up to 0.5 m tall** are considered part of the Low Shrub stratum (S3). Some plants which have a minimal amount of woody tissue, such as bunchberry *(Cornus canadensis)* strongly resemble herbaceous plants but are actually part of this layer. Shrub and established tree regeneration may be recorded here.
H	Herb (Forb)	Only **forb (generally broad-leafed herbaceous) species** are to be recorded in this stratum (H). Some plants which superficially could be viewed as shrubs because of hard woody stem tissue near the crown are actually forbs. Some plants which may look like grasses or grass-like plants, such as cattail *(Typha latifolia)* are also forbs.
G	Grass/graminoid	Only cover estimates for **graminoid (grasses or grass-like) species** are recorded as part of this stratum (G). For a listing of these species check the Master Species list (Alberta Environmental Protection 1993).
M	Moss	**Bryophytes and hepatics (mosses and liverworts) growing on the dominant substrate** make up this stratum (M).
L	Lichen	**Lichen species growing on the dominant substrate** (usually mineral or organic soil) are considered part of this stratum (L).

Adapted from ASRD 2003 *Ecological Land Survey Site Description Manual (2nd Edition)*

Figure B2 Stratification of Forest Stand, Shrubs and Trees (ASRD 2003)

Figure B3 Examples of Percent Cover (ASRD 2003)

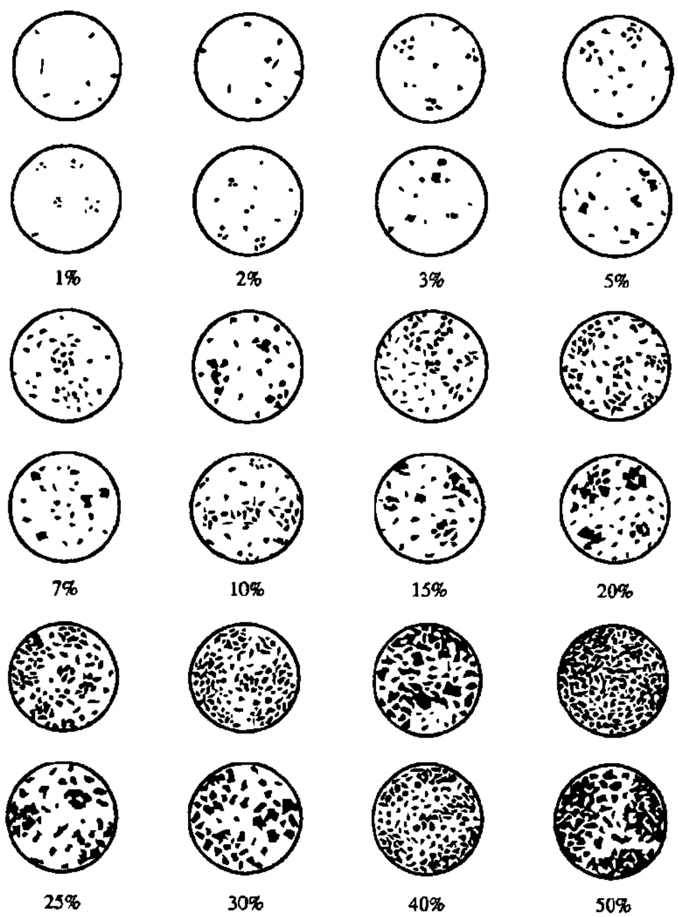


Table B7 Vigour Classes

Vigour Code	Vigour Class
0	Dead
1	Poor
2	Fair (Average)
3	Good
4	Excellent
5	Unknown

Table B8 Tree/Seedling Damage Classes and Severity Codes

Damage Class	Severity	Severity Code	Description
DE (Dead)	Minimal	1	Dead trees/ vegetation (1-25% stems)
	Moderate	2	Dead trees/ vegetation (26-50% stems)
	Significant	3	Dead trees/ vegetation (51-75% stems)
	Severe	4	Dead trees/ vegetation (76-100% stems)
FO (Foliage discolouration/ loss)	Minimal	1	Foliage discolouration/ loss 1-25%
	Moderate	2	Foliage discolouration/ loss 26-50%
	Significant	3	Foliage discolouration/ loss 51-75%
	Severe	4	Foliage discolouration/ loss 76-100%
MI (Missing/ low density)	Minimal	1	Density 1-25% less than expected
	Moderate	2	Density 26-50% less than expected
	Significant	3	Density 51-75% less than expected
	Severe	4	Density 76-100% less than expected
PD (Physical damage)	Minimal	1	Damaged trees/ vegetation 1-25%
	Moderate	2	Damaged trees/ vegetation 26-50%
	Significant	3	Damaged trees/ vegetation 51-75%
	Severe	4	Damaged trees/ vegetation 76-100%
PG (Poor growth/ form)	Minimal	1	Vegetation is expected to recover
	Moderate	2	Growth rate/ form will be reduced by 26-50%
	Significant	3	Growth rate/ form will be significantly reduced
	Severe	4	Vegetation is expected to die

Adapted from AESRD 2013 *Alberta Regeneration Standards from Mineable Oil Sands*

Table B9 Tree/Seedling Damage Causal Codes

Cause of Damage	Causal Code	Cause of Damage	Causal Code
Animal Codes		***Weather Codes***	
Bear damage	AU	Frost damage	WD
Beaver felling/chewing	AC	Hail	WH
Horse/cattle trampling	AH	Snow/ ice	WN
Rodent chewing/damage (porcupine, rabbit or squirrel)	AD	Wind damage/ blowdown	WB
Ungulate browsing	AB	***Human Codes***	
Other animal	AO	Equipment/ machine	HE
Disease Codes		Land clearing/ soil	HL
Dieback	DD	Poor planting	HP
Needle rust	DN	Other human damage	HO
Other disease	DO	***Environment Codes***	
Insect Codes		Aspect/ exposure	EA
Aphid	IA	Drought	ED
Defoliator	ID	Fire	FR
Wood borer	IB	Flooding/ seepage/ water	EF
Other insect	IO	Soil erosion	EE
Unknown Codes		Other climate extremes	EC
Unknown	UK	Other soil factors	ES

Adapted from AESRD 2013 *Alberta Regeneration Standards from Mineable Oil Sands*

Table B10 Description of Plant Distribution Classes and Codes

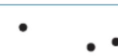
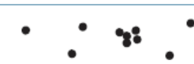
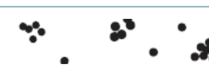
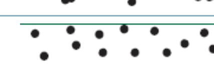
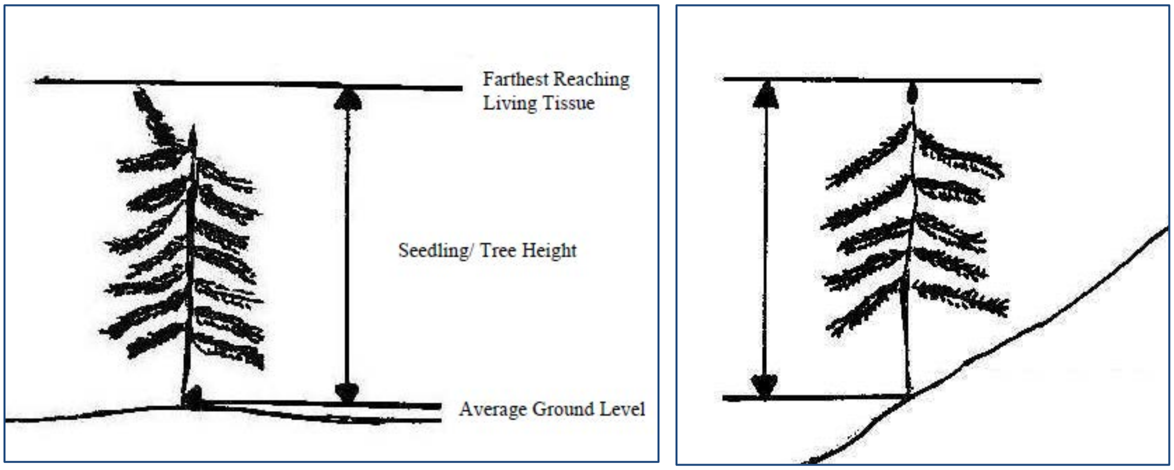
Code	Plant distribution class	
1	Rare individual, a single occurrence	
2	A few sporadically occurring individuals	
3	A single patch or clump of a species	
4	A single patch plus a few sporadically occurring individuals	
5	Several sporadically occurring individuals	
6	A single patch plus several sporadically occurring individuals	
7	A few patches or clumps of a species	
8	A few patches plus several sporadically occurring individuals	
9	Several well-spaced patches or clumps	
10	Continuous uniform occurrence of well-spaced individuals	
11	Continuous occurrence of a species with a few gaps in distribution	
12	Continuous dense occurrence of a species	
13	Continuous occurrence of plants with a distinct linear edge in the polygon	

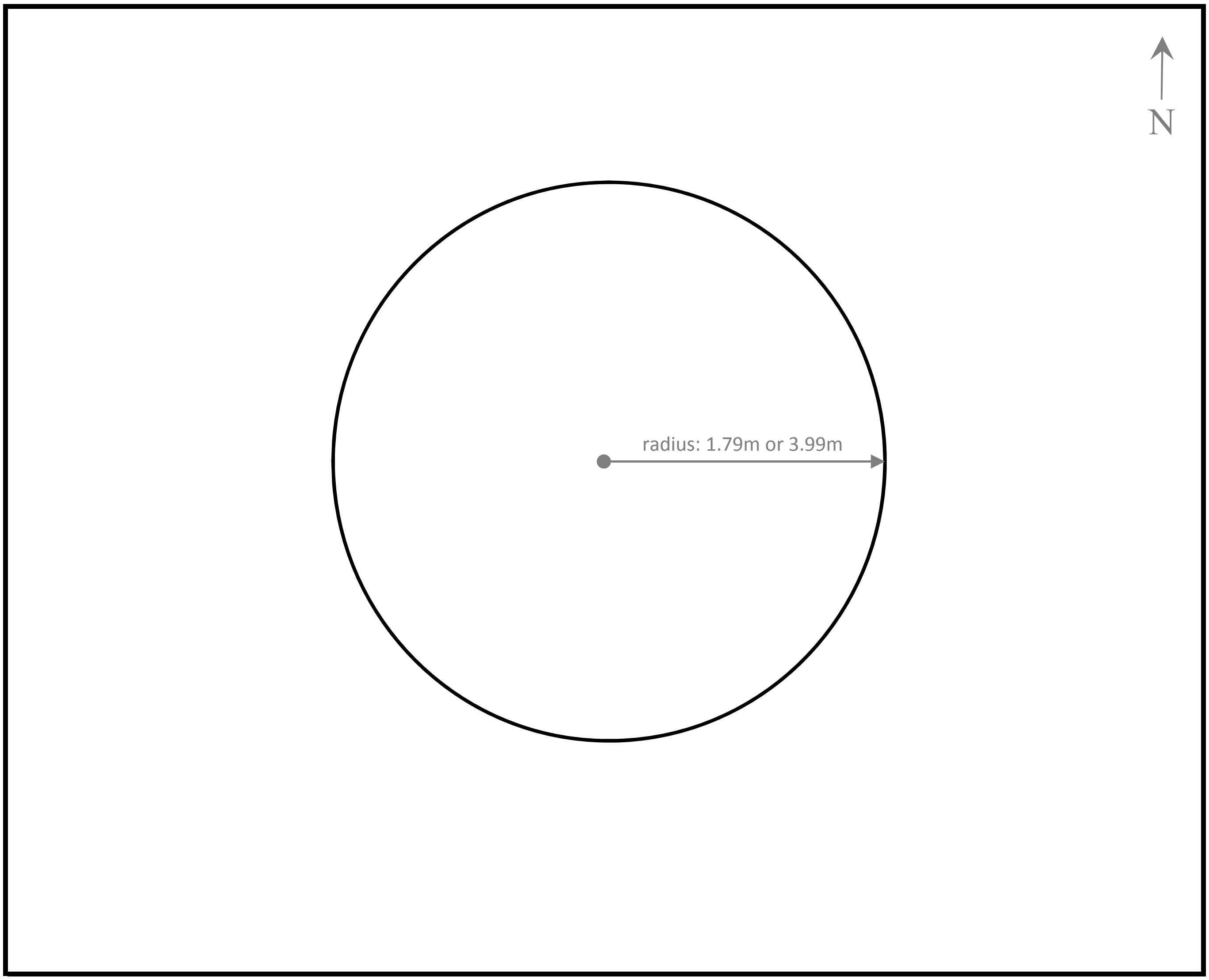
Figure B4 Measurement of Tree Seedling Height on Flat and Sloped Ground (ASRD 2001)



TCPL Caribou Habitat Restoration and Offset Measures Monitoring
PLOT DIAGRAM

Plot Name:		**Plot ID:**		**Date of Establishment:**	YYYY/MM/DD
Plot Size:	10 m^2 *(1.79 m radius)* 50 m^2 *(3.99 m radius)*				
Coordinates:	*Lat/Long* or			**Datum:**	
	Easting/Northing			**Grid Zone:**	
Comments:					

1. Draw distinguishing features of plot (e.g., rocks, large woody debris)
2. Draw distinguishing features around plot (e.g., unique trees, disturbances) to help locate it in future years



TCPL Caribou Habitat Restoration and Offset Measures Monitoring
FIELD DATA SHEET - HABITAT RESTORATION

PLOT IDENTIFICATION / LOCATION

Project Name:		**Plot Name:**		**Plot ID:**	
Surveyors:				**Date:**	YYYY/MM/DD
Plot Type:	habitat restoration measures plot		natural regeneration control plot		
Restoration Unit Type:	treed upland/ transitional		treed lowland		shrub-graminoid lowland
Plot Size:	10 m^2 50 m^2	**Waypoint #:**		**Nat. Subregion/ Ecozone:**	
Coordinates:	*Lat/Long* or		**Datum:**	**Grid Zone:**	
	Easting/Northing		**Elevation (m):**		
Surrounding Vegetation Community:			**Wetland Class:**		

PLOT DESCRIPTION

Slope (%):					**Aspect (degrees):**					
Meso Site Position:	Crest	Upper Slope		Mid-slope		Lower Slope	Toe	Depression		Level
Moisture Regime:	Very Poor	Poor		Medium		Rich	Very Rich			Saline
Nutrient Regime:	Very Xeric	Xeric	Sub-xeric	Sub-mesic	Mesic	Sub-hygric	Hygric	Sub-hydric	Hydric	Aquatic
Soil Drainage:	Very Rapidly	Rapidly	Well	Moderately Well		Imperfect (Gleyed)		Poorly (<50cm)		Very Poorly (Standing)

Soil Type:		**Surface Substrate:**	*Type*	*Cover (%)*	*Type*	*Cover (%)*
	Mineral		Water		Organic Matter	
			Cobbles/Stones		Coarse Woody Debris	
	Organic		Mineral Soil		Live Plant Material	
			Organic Soil			

PLOT PHOTOS

From **Plot Centre** (capture plot by angling down towards edge of plot):		At **edge** of plot, parallel to linear disturbance (to capture entire plot):	
Facing:	*Photo File #*	*Facing:*	*Photo File #*
1. North		6.	
2. East		7.	
3. South			
4. West			
5. Ground (down)			

Plot Comments / Incidental Wildlife Observations (include GPS coordinates):

NOXIOUS AND RESTRICTED WEEDS / INVASIVE AND AGRONOMIC SPECIES

Species Code	Growth Stage	Distribution Class	Cover Class	Photos File Numbers	Nox./ Restr. Weed?	Inv./ Agro. Sp.?

Growth Stages	Cover Classes (%)
SD: seedling	T: Trace <1
BL: bolt	L: Low ≥1 - <5
BD: bud	
FL: flower	M: Moder. ≥5 - <25
SS: seed set	
MA: mature	H: High ≥25

FIELD DATA SHEET - HABITAT RESTORATION

Project Name:		**Plot Name/ID:**		**Date:** YYYY/MM/DD

VEGETATION COMMUNITY COMPOSITION

Vegetation Structure (*to nearest 5 cm)

Stratum	T1	T2	S1	S2	S3	G	H	M	L
Cover (%)									
Avg. Ht (cm*)								---	---

Vegetation Species Composition

Species Code	**Stratum**	**Cover (%)**	**Vigour**	**Species Code**	**Stratum**	**Cover (%)**	**Vigour**

Vegetation Health Notes:

TREE SEEDLING/TREE DATA

Tree/Seedling Damage (Entire Plot)			**Codes 1:**							**Codes 2:**				
Species Code	**Density Distrib. Class**	**Distrib. (% of plot where present)**	**Planted or Natural?**	**Density (Count)**	**Height (cm)**					**Estim. Age (yrs)**				
					1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**

TCPL Caribou Habitat Restoration and Offset Measures Monitoring
FIELD DATA SHEET - ACCESS CONTROL & LINE-OF-SIGHT BREAKS

SITE LOCATION

Project Name:		**Site Name:**		**Waypoint #:**			
Surveyors:				**Date:**	YYYY/MM/DD		
Control Type:	access control *(use Section 1 of this sheet)*		line-of-sight break *(use Section 2 of this sheet)*				
Coordinates:	*Lat/Long* or		**Datum:**	NAD83	**Grid Zone:**		
	Easting/Northing		**Elevation (m):**				
Surrounding Vegetation Community:			**Wetland Class:**				

1 - ACCESS CONTROL

Evaluation Criteria	***Inspection Comments (describe observations)***				
Physical Materials:	Condition:				
	Average Ht (m) *(if vegetation)* :				
Evidence of Access:	yes	no	*Describe:*		
Evidence of U-turns:	yes	no	*Describe:*		
Access Type/ Method:	non-motorized	all-terrain vehicle	truck	other*	**Details:*
Access Level:	absent	low	moderate	high	
Low - tracks/trail evident but difficult to discern or appear to be infrequently used	*Moderate - relatively easily discernable; vegetation may be slightly trampled, but no bare ground is visible*		*High - tracks/trails appear to be well-used; vegetation is trampled down; bare ground might be visible from frequent use*		
Adjacent Habitat Disturbance:	yes	no	*Describe:*		

2 - LINE-OF-SIGHT BREAKS

Break Type	***Evaluation Criteria***										
Berm	Composition (Materials) *(e.g., fabricated, earthen)*	Footprint Width (m)	Berm Length (m) (perpend. to ROW)	Length of Berm ≥1.5m High (m)	Condition of Berm:						
Fabricated Screen	Composition (Materials) *(e.g., burlap, snow-fencing)*	Condition of Fabricated Screen *(including sagging, etc.)* :									
Vegetation Screen *(10 m² circular plot - 1.79 m radius)*	Woody Stem Density (Count):		Cover of Live Woody Stems (%):		Avg. Height of Live Woody Stems (cm):						
	Spatial Distribution (cm) *(measure 10 representative distances between random woody stems)*										Average:
	Dominant Woody Species:										
	Line-of-Sight Measurements: *See page 2 of this datasheet*										

NOTES

Site Comments / Incidental Wildlife Observations (include GPS coordinates and photo file names [if applicable]):

FIELD DATA SHEET - ACCESS CONTROL & LINE-OF-SIGHT BREAKS

Project Name:		**Site Name:**		**Wpt #:**		**Date:**	YYYY/MM/DD

SITE (BERM / BREAK) PHOTOS

Take a minimum of 6 photos from different angles, as per Protocols (including signs of disturbance)

Photo File #:	**Facing:**	**Description** ***(must be clear enough for similar photo to be taken in the next monitoring year)*****:**
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	
	N NE E SE S SW W NW	

LINE-OF-SIGHT (VISUAL OBSTRUCTION) MEASUREMENTS

Pole Segm. (m):	*0.5*	**Pole Band Width (cm):**	*10*	**Position Intervals (m):**	
Coordinates (first position only):					

band is obstructed if ≥25% visually covered by vegetation (alive or dead) = "1"; if band <25% covered = "0"

Segm.	**Band #**	**Position:**		**Position:**		**Position:**		**Position:**		**Position:**				
		Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	Obs. A	Obs. B	*Visual Obstruction = 100% x Segm. Total / # of Obs.*		
1 *(bott.)*	**1**													
	2													
	3													
	4											Segm. Total	# of Obs.	Vis. Obstr.
	5													
Total # Bands														
2	**6**											*Segm. Total = Sum of "1"s observed for segment*		
	7													
	8													
	9											Segm. Total	# of Obs.	Vis. Obstr.
	10													
Total # Bands														
3	**11**											*# of Obs. = 5 bands x (# Positions x 2)*		
	12													
	13													
	14											Segm. Total	# of Obs.	Vis. Obstr.
	15													
Total # Bands														
4 *(top)*	**16**													
	17													
	18													
	19											Segm. Total	# of Obs.	Vis. Obstr.
	20													
Total # Bands														

Notes:

APPENDIX C

LIST OF CHARACTERISTIC SPECIES

LIST OF CHARACTERISTIC SPECIES

Table C-1. List of characteristic lowland species found on one or more pipeline ROW based on species assemblages in the Alberta Wetland Classification System

Species Name	Common Name
Andromeda polifolia	bog rosemary
Aulacomnium palustre	tufted moss
Betula glandulosa	bog birch
Betula pumila	dwarf birch
Calla palustris	water arum
Calliergon richardsonii	calliergon moss
Calliergon stramineum	calliergon moss
Campylium stellatum	yellow starry fen moss
Carex aquatilis	water sedge
Carex aurea	golden sedge
Carex brunnescens	brownish sedge
Carex canescens	hoary sedge
Carex disperma	two-seeded sedge
Carex gynocrates	northern bog sedge
Carex magellanica	bog sedge
Carex prairea	prairie sedge
Carex rostrata	beaked sedge
Carex tenuiflora	thin flowered sedge
Carex trisperma	three-seeded sedge
Carex utriculata	small bottle sedge
Chamaedaphne calyculata	leatherleaf
Cladonia mitis	reindeer lichen
Cladonia stellaris	star-tipped reindeer lichen
Comarum palustre	marsh cinquefoil
Dicranum undulatum	wavy dicranum moss
Drosera rotundifolia	round-leaved sundew
Eriophorum vaginatum	sheathed cotton grass
Hamatocaulis vernicosus	brown moss
Hylocomium splendens	stair-step moss
Kalmia polifolia	northern laurel
Larix laricina	tamarack
Maianthemum trifolium	three-leaved Solomon's-seal
Meesia triquetra	moss
Menyanthes trifoliata	buck-bean
Peltigera aphthosa	studded leather lichen
Peltigera malacea	veinless pelt lichen
Peltigera neopolydactyla	carpet pelt lichen
Picea mariana	black spruce

Platanthera dilatata	tall white bog orchid
Platanthera stricta	slender bog orchid
Polytrichum strictum	slender hair-cap moss
Rhododendron groenlandicum	common Labrador tea
Rubus chamaemorus	Cloudberry
Salix discolor	pussy willow
Salix myrtillifolia	myrtle-leaved willow
Salix pedicellaris	bog willow
Salix planifolia	flat-leaved willow
Salix scouleriana	Scouler's willow
Sanionia uncinata	brown moss
Scorpidium scorpioides	Moss
Sphagnum angustifolium	peat moss
Sphagnum fallax	peat moss
Sphagnum fuscum	rusty peat moss
Sphagnum jensenii	pendant branch peat moss
Sphagnum magellanicum	midway peat moss
Sphagnum majus	peat moss
Sphagnum riparium	shore-growing peat moss
Sphagnum warnstorfii	peat moss
Spiranthes romanzoffiana	hooded ladies'-tresses
Tomentypnum nitens	golden moss
Triglochin maritima	seaside arrow-grass
Vaccinium oxycoccos	small bog cranberry
Vaccinium vitis-idaea	bog cranberry

Table C-2. List of characteristic shrub/graminoid species found on one or more pipeline ROW based on species assemblages in the Alberta Wetland Classification System

Species Name	Common Name
Agrostis scabra	rough hair grass
Alisma trivale	broad-leaved water-plantain
Alnus incana	river alder
Andromeda polifolia	bog rosemary
Aulacomnium palustre	tufted moss
Beckmannia syzigachne	slough grass
Betula glandulosa	bog birch
Betula pumila	dwarf birch
Calamagrostis canadensis	bluejoint
Calla palustris	water arum
Caltha palustris	marsh-marigold
Carex aquatilis	water sedge
Carex bebbii	Bebb's sedge
Carex diandra	two-stamened sedge

Carex interior	Inland sedge
Carex media	Intermediate sedge
Carex utriculata	small bottle sedge
Chamaedaphne calyculata	leatherleaf
Cladonia mitis	reindeer lichen
Cladonia stellaris	star-tipped reindeer lichen
Comarum palustre	marsh cinquefoil
Cornus canadensis	Bunchberry
Dicranum undulatum	wavy dicranum moss
Drosera rotundifolia	round-leaved sundew
Eleocharis palustris	creeping spike-rush
Equisetum fluviatile	swamp horsetail
Equisetum hyemale	common scouring-rush
Epilobium palustre	marsh willowherb
Eriophorum vaginatum	sheathed cotton grass
Galeopsis tetrahit	hemp-nettle
Galium trifidum	small bedstraw
Geum aleppicum	yellow avens
Geum macrophyllum	large-leaved yellow avens
Glyceria borealis	northern manna grass
Glyceria grandis	common tall manna grass
Glyceria striata	fowl manna grass
Hylocomium splendens	stair-step moss
Juncus balticus	wire rush
Kalmia polifolia	northern laurel
Larix laricina	tamarack
Maianthemum trifolium	three-leaved Solomon’s-seal
Menyanthes trifoliata	buck-bean
Peltigera aphthosa	studded leather lichen
Peltigera malacea	veinless pelt lichen
Peltigera neopolydactyla	carpet pelt lichen
Petasites frigidus	coltsfoot
Phalaris arundinacea	reed canary grass
Picea mariana	black spruce
Platanthera dilatata	tall white bog orchid
Platanthera orbiculata	round-leaved bog orchid
Platanthera stricta	slender bog orchid
Pleurozium schreberi	Schreber’s moss
Polytrichum strictum	slender hair-cap moss
Populus balsamifera	balsam poplar
Ranunculus aquatilis	large-leaved white water crowfoot
Ranunculus gmelinii	yellow water crowfoot
Rhododendron groenlandicum	common Labrador tea

Ribes glandulosum	skunk currant
Ribes triste	wild red currant
Rubus chamaemorus	cloudberry
Rubus pubescens	dewberry
Salix arbusculoides	shrubby willow
Salix bebbiana	beaked willow
Salix discolor	pussy willow
Salix exigua	narrow-leaved willow
Salix glauca	smooth willow
Salix lasiandra	shining willow
Salix maccalliana	velvet-fruited willow
Salix pedicellaris	bog willow
Salix planifolia	flat-leaved willow
Salix scouleriana	Scouler’s willow
Salix serissima	autumn willow
Schoenoplectus tabernaemontani	common great bulrush
Scripus atrocinctus	black-girdled bulrush
Scirpus microcarpus	small-fruited bulrush
Scutellaria galericulata	marsh skullcap
Sphagnum angustifolium	peat moss
Sphagnum fallax	peat moss
Sphagnum fuscum	rusty peat moss
Sphagnum jensenii	pendant branch peat moss
Sphagnum magellanicum	midway peat moss
Sphagnum majus	peat moss
Sphagnum riparium	shore-growing peat moss
Stellaria longifolia	long-leaved chickweed
Symphyotrichum boreale	marsh aster
Tomentypnum nitens	golden moss
Trientalis borealis	Northern starflower
Triglochin maritima	seaside arrow-grass
Vaccinium oxycoccos	small bog cranberry
Vaccinium vitis-idaea	bog cranberry
Viola renifolia	Kidney-leaved violet

APPENDIX D

NATIVE SPECIES PERCENT COVERS

Table D-1. Mean percent covers of total live plants (± SE), non-native live plants (± SE) and non-native live plants as a percentage of total live plant cover by restoration unit, and Project area in 2018

Location	Percent Cover	Habitat Restoration Treatment Units (Planted)			Natural Regeneration Treatment Units (Control)		
		Upland	Lowland	Shrub	Upland	Lowland	Shrub
Chinchaga	Total live	86.5 ± 7.2	73.4 ± 11.5	104	104.2 ± 5.7	51.8 ± 14.1	87.5
	Non-native	36.1 ± 7.6	9.6 ± 4.8	0.5	69.3 ± 10.2	3.0 ± 2.3	2.0
	Non-native as % of total	41.8	13.1	0.5	66.5	5.9	2.3
Cranberry	Total live	59.6 ± 6.4	72.0 ± 5.9	72.2 ± 11.2	--	89.9 ± 0.2	87.9 ± 5.6
	Non-native	32.3 ± 8.9	8.7 ± 6.0	30.6 ± 30.4	--	26.0	0
	Non-native as % of total	54.2	12.1	42.4	--	28.9	0
Sloat	Total live	87.6 ± 2.3	76.0 ± 13.3	88.5 ± 3.2	70.1	94.3 ± 4.0	65.3 ± 7.0
	Non-native	42.2 ± 7.6	10.1 ± 4.0	22.6 ± 22.0	1.5	14.1 ± 14.0	0.8 ± 0.3
	Non-native as % of total	55.1	13.2	25.4	2.1	14.9	1.2
Timberwolf	Total live	69.7 ± 5.6	95.8 ± 11.0	83.3 ± 4.3	86.2 ± 5.9	76.1 ± 16.3	75.1 ± 7.8
	Non-native	4.4 ± 2.0	21.7 ± 19.8	0.1	7.0 ± 4.7	0.3 ± 0.2	0
	Non-native as % of total	8.2	22.7	0.1	8.2	0.4	0
LKXO	Total live	50.9 ± 8.0	60.4 ± 9.0	--	76.3 ± 15.5	77.5 ± 9.2	--
	Non-native	5.5 ± 2.5	4.0 ± 1.9	--	10.8 ± 7.2	2.0 ± 1.5	--
	Non-native as % of total	10.8	6.6	--	14.2	2.6	--
Dillon	Total live	92.7 ± 7.8	113.3 ± 9.9	--	105 ± 20.7	151.3 ± 6.0	--
	Non-native	0.5 ± 0.8	0	--	0	0	--
	Non-native as % of total	0.54	0	--	0	0	0

APPENDIX E

CAMERA MONITORING PROTOCOL

Remote Camera Monitoring Protocol

Developed for the Caribou Habitat Restoration and
Offset Measures Monitoring Program

July 2018

Table of Contents

Revisions Log

Date	Section	Description
July 3, 2018	Camera Deployment	Addition of “one desiccant packet for each camera case”
July 3, 2018	Camera Deployment	Addition of pliers or vice grips, and gloves to equipment requirements
July 3, 2018	Camera Deployment	Addition of “one desiccant packet for each camera case”
July 3, 2018	Camera Deployment	Updated wording from “NGTL has solar panel units available for use. The use of these units should be prioritized for sites where access is challenging or remote.” To NGTL has solar panel units available for use. The use of these units may be considered for sites where access is challenging or remote.” Rationale is that due to bear attraction to solar units and associated wiring, NGTL is generally avoiding use of solar panels.
July 3, 2018	Appendix A – Camera Deployment	Addition of “Insert a desiccant packet into the camera box.”
July 3, 2018	Appendix A – Camera Deployment	Addition of “Use pliers or vice grips as necessary to securely fasten the cable.”
July 3, 2018	Appendix A – Remote Camera Settings	Revise from “rapid fire” photo interval to “set for 1 minute photo interval” based on 2016 year 1 lessons learned

Introduction

This protocol is intended to be applied to specific NGTL pipeline projects occurring within caribou ranges while still providing a consistent monitoring approach across NGTL projects. The monitoring protocol is intended to be comparable to other programs where monitoring movement around access control measures is of primary concern. This document presents the protocol for the design and implementation of camera monitoring programs to record baseline and post-construction access levels along a project's pipeline right-of-way (ROW) at access control locations. The monitoring protocol will focus on the effectiveness of access control measures in preventing or deterring human access along the ROW. Wildlife response to access control will also be documented and form a separate analysis focused on wildlife occurrence.

Background

As part of National Energy Board (NEB) authorizations for construction and operations of pipeline projects in woodland caribou range on NGTL projects, the NEB requires a Caribou Habitat Restoration and Offset Measures Management Program (CHROMMP) be prepared pursuant to the conditions of the authorizations. Each CHROMMP is to outline the plan to verify the effectiveness of mitigation measures outlined in Caribou Habitat Restoration Plans (CHRPs) and Offset Measures Plans (OMPs) to avoid impacts, minimize Project effects on caribou, restore caribou habitat, and offset residual impacts. NGTL's approved CHROMMP establishes the founding principles which will guide future monitoring programs for projects requiring caribou habitat restoration or offset measures.

Objective

The primary objective of the camera monitoring protocol is to assess the effectiveness of access control measures by observing:

- baseline human and wildlife access conditions (pre-construction where possible);
- post-construction human access conditions; and
- wildlife occurrence to access control measures.

Study Timeframe

Baseline

Baseline access monitoring should be carried out over a one year period prior to construction when possible. This approach ensures seasonal variation in human and wildlife use is captured. For example human access may peak in the fall, coinciding with the hunting season or in winter when wet areas become accessible under frozen conditions. Baseline access monitoring can be carried out in conjunction with the characterization of baseline wildlife studies in support of the Environmental and Socio-Economic Assessment (ESA).

Should the project alignment change during the baseline monitoring period, the remote camera program should be adjusted accordingly, and as soon as possible. This will ensure cameras are deployed at monitoring sites on the proposed project ROW for as long as possible. Deploying cameras following project kick-off will increase the probability that they will successfully document a full year of baseline access prior to construction. If a full year of data has not been collected at the time of ESA preparation, cameras should remain deployed during the project's application and approval phase to try and achieve a minimum monitoring period of 12 months.

Post-Construction Monitoring

Post-construction short-term monitoring will be conducted at years 1, 3, and 5 to identify any need for adjustments as part of NGTL's adaptive management approach (NGTL 2015a). Long-term monitoring will be conducted at years 10 and 15 to evaluate performance and implement adaptive management actions if required (NGTL 2015a). After 10 to 15 years, planted seedling and naturally regenerating areas are anticipated to have grown to heights where they provide an additional level of access control. Although there are currently no mid-term objectives outlined for the monitoring program, this may change as the program matures. Access control effectiveness monitoring periods will be implemented for 12 months during each monitoring year.

Study Design

Baseline

Baseline surveys will document human access before project construction on a project's pipeline ROW. Remote camera monitoring sites (i.e., monitoring sites) will be placed at proposed access control locations to better represent baseline human access conditions prior to the project being constructed. Proposed access control locations may include areas of new alignment or where the proposed ROW intersects other linear features.

At the baseline study design phase, detailed construction alignment sheets outlining the exact placement of proposed access control measures may not be available to support planning. The site selection approach outlined below is consistent with design elements of access control implementation thereby increasing the likelihood of spatial overlap between baseline monitoring sites and future access control locations.

Baseline monitoring sites will be established along the proposed project ROW where access control measures can be implemented (i.e., areas of new alignment or where there are existing linear crossings). These baseline locations will act as controls and provide pre-construction data on human access and wildlife occurrence along the proposed ROW.

Monitoring is used to determine the effectiveness of access control measures implemented on the project ROW through the course of the monitoring timeframe. It is assumed human access along a proposed project ROW is at its lowest possible level prior to the project being constructed, as clearing of timber and vegetation has not occurred. Where baseline data cannot be collected (i.e., the project ROW was constructed without the opportunity to establish camera monitoring sites), the effectiveness of access control measures may compare future human access to observations and data collected during the first monitoring year.

Site Selection

Site selection for the baseline monitoring sites should be conducted using a Geographic Information System (GIS). Site selection should also consider:

- the proposed project route alignment;
- 360 degree imagery (if available);
- existing anthropogenic linear features which intersect the proposed project ROW alignment;
- the presence of trees of adequate size to facilitate camera mounting, or
- where appropriately sized trees are not available, posts or poles may be needed to mount the remote cameras.

Using GIS, the proposed project route will be overlaid onto recent geo-referenced satellite imagery where existing linear disturbances (i.e., roads, pipelines, transmission lines) can be identified.

Site selection for access control sites should meet the following criteria:

- within a designated caribou range boundary
- located on a section of new alignment 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

Once the proposed sites are selected, the locations are used by field personnel to guide the deployment of cameras in the field. However, there needs to be flexibility to allow for optimum camera placement. Field personnel should select a suitable site within 50 m of the proposed site location when possible. A schematic showing a theoretical site selection is illustrated in Figure 1, where A and B are camera plot locations.

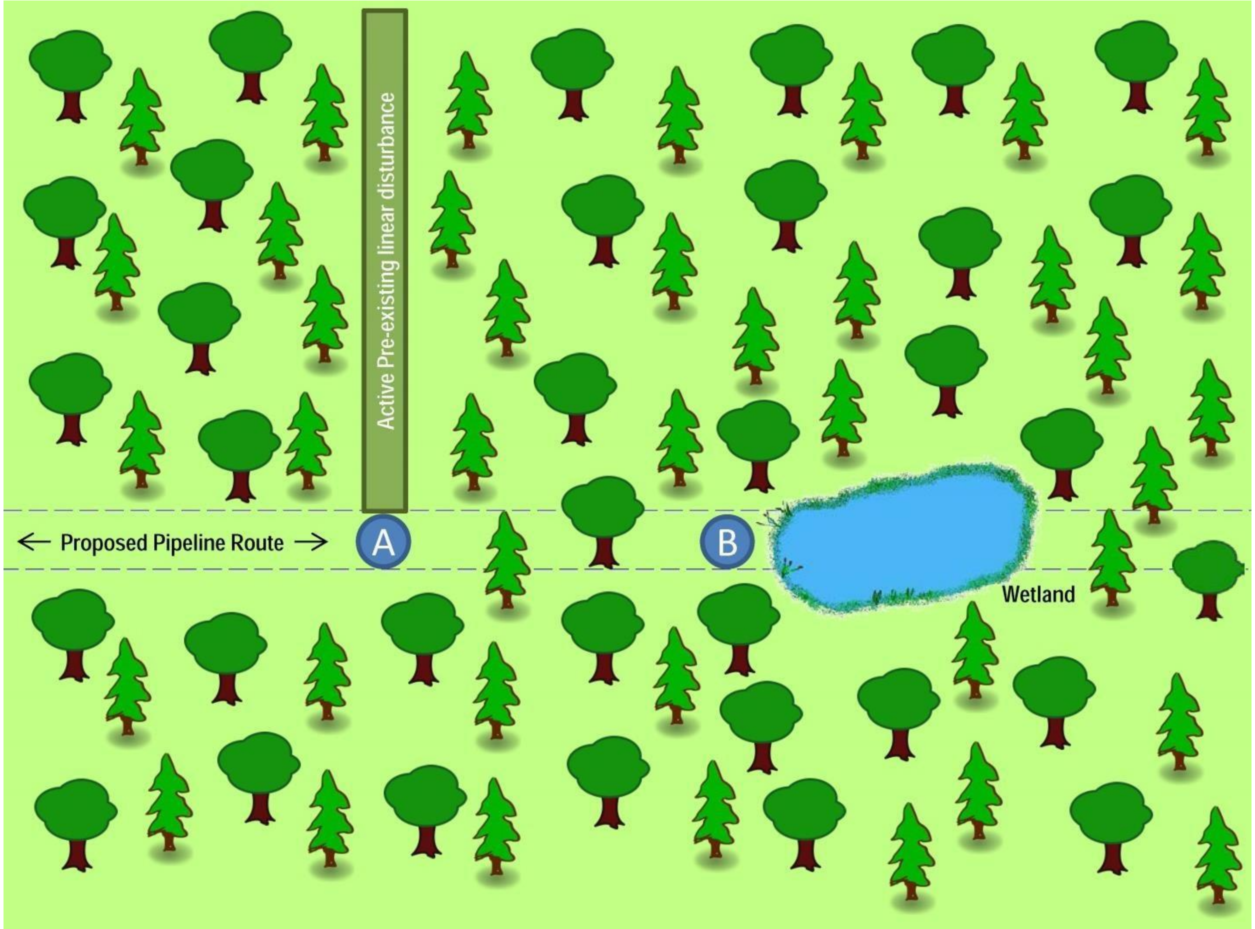


Figure 1: Example Site Diagram Showing Camera Plot Site Selection for Baseline Monitoring

Post Construction Monitoring

The study design implemented during post-construction monitoring will mainly be the same design used to conduct baseline monitoring described above. Additional considerations are as follows:

- remote camera monitoring sites will be located at actual access control mitigation locations (i.e., place cameras on the ROW where access control measures have been implemented);
- target treed areas where possible to ensure cameras can be successfully deployed; or
- posts or poles may be needed to mount cameras and/or solar panels in areas without appropriated sized trees.

Figure 2 shows examples of camera site locations on constructed segments of ROW, identified as A and B. The site selection of plot A is located where an access control measure is implemented. Site selection of plot B outside of the wetland is favored over the site selection of plot B within the wetland due to better accessibility and functionality.

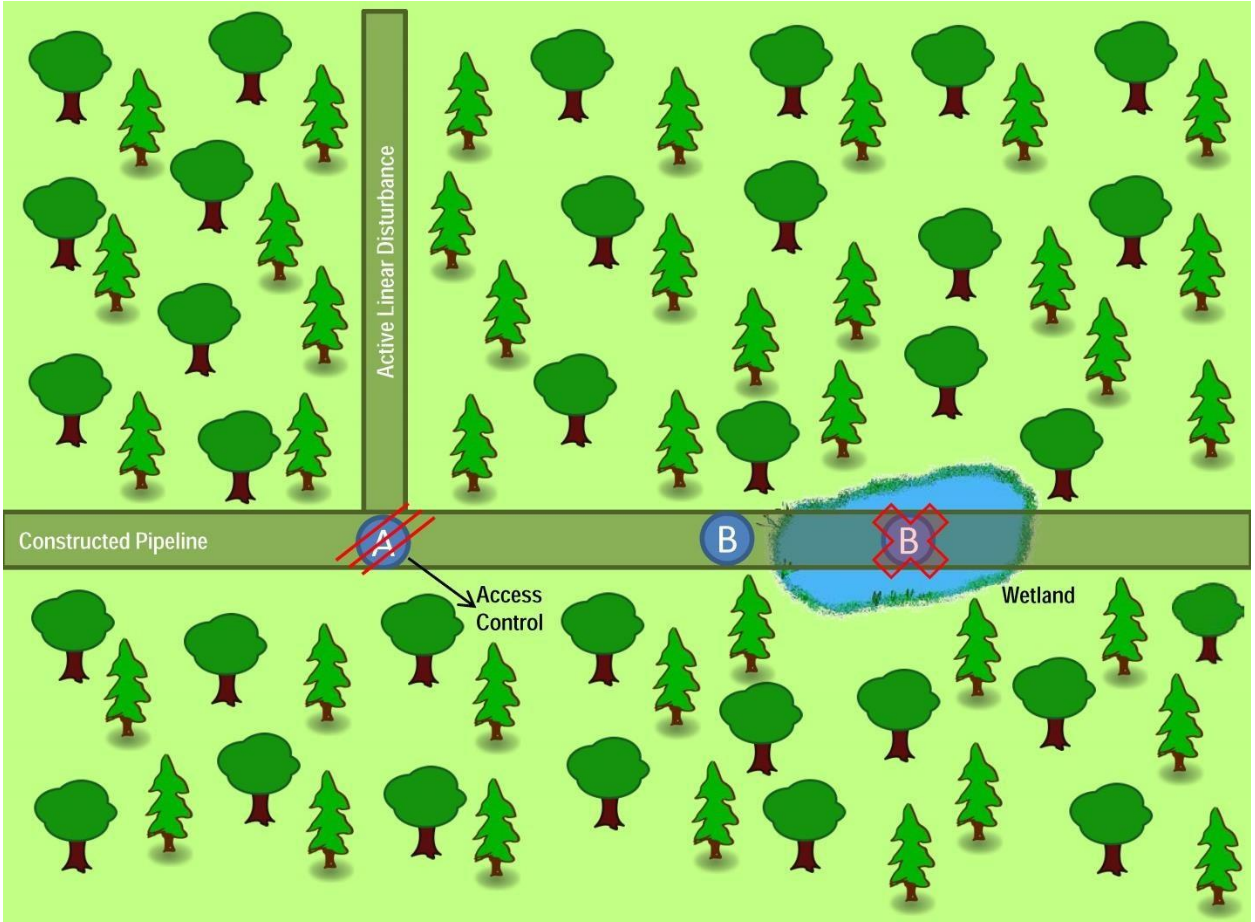


Figure 2: Example Site Diagram Showing Camera Plot Site Selection for Post-construction Monitoring

Statistical Considerations

The focus of the study is to test the effectiveness of access control measures in reducing or eliminating human access along the project ROW. Therefore, the total number of camera monitoring locations is equal to the total number of access control measures implemented along a project ROW, which will vary for different projects. The unit of measurement used to detect a change in human access at an access control location will be calculated as a daily human access rate (i.e., within a 24 hour period). Wildlife response to access control will also be collected and calculated as a daily access rate. The wildlife occurrence will form a separate analysis from the change in human access rate.

Assuming that each access control location will be monitored for approximately 365 days each monitoring year, for 5 monitoring years across the study timeframe, there will be adequate replication for statistical analysis (i.e., a total of 1,825 monitoring days per camera/access control location across the study timeframe). This will ensure statistical robustness of inferences used to assess both daily human access rates and wildlife occurrences between each monitoring year, including pre-construction baseline conditions if available. Upon completion of the 2nd monitoring year, inferences regarding seasonal differences in daily human access rate between monitoring years may also be incorporated into hypothesis tests.

Pre-Field Planning and Preparations

NGTL owns a number of PC900 HyperFire Professional Covert IR with HyperFire Security Enclosures. If additional cameras are required, similar cameras (i.e., PC Hyperfire covert or semi-covert series) may be purchased directly from Reconyx (www.reconyx.com). Cameras and memory cards should be programmed as per instructions included in Appendix A.

Camera Deployment

Cameras should be deployed as per instruction included in Appendix A. For each monitoring plot, the following equipment list will likely be required:

- one Reconyx camera;
- 12 AA lithium or rechargeable batteries and/or external power jack, cable and solar panel power unit;
- if using a solar panel, one wooden post, T-post or fence post for system mounting;
- two 32 GB (minimum size memory) memory cards (i.e., so camera cards can be swapped in the field). The larger sized memory card provides more storage space for cameras fitted with solar panel units;
- one desiccant packet for each camera case;
- locking mechanism (see Reconyx Hyperfire Instruction Manual for option details; http://images.reconyx.com/file/HyperFireManual.pdf):
- Hyperfire security enclosure and padlock;
- Heavy Duty Swivel Mount;
- Pliers or vice grips for pulling locking cable tight;
- Gloves for hand protection when tightening cables;
- Python lock and key; or
- wire cable (small loop on both ends) and small padlock (with key, if applicable).

NGTL has solar panel units available for use. The use of these units may be considered for sites where access is challenging or remote. The solar panels will reduce the need to access the cameras for battery changes. Instructions for setting up the panels are available online from Reconyx at http://images.reconyx.com/file/SolarPanelPowerUnit.pdf and in Appendix A. Data recorded at each plot during deployment is also included in Appendix A. Data should be QA/QC'd daily to ensure all field data is collected.

Camera Checks and Maintenance

With the exception of cameras fitted with solar panels, cameras should be revisited every 4-6 months to change memory cards and check batteries. Battery life is shorter during the winter months, so a 6 month maximum interval is recommended. Cameras fitted with solar panels should be visited a maximum of twice per year. In warmer weather, batteries should last at least 6 months, but this can vary depending on the number of photos taken, hence larger sized memory cards are to be used. Memory cards can fill quickly if moving vegetation triggers the cameras. This typically occurs in spring or summer when tall grass or shrubs grow quickly in front of a camera. Similarly, if a camera is deployed on a small tree (<25 cm), the camera will be triggered under windy conditions when the tree sways. Regular maintenance checks can ensure ongoing camera function and prevent gaps in monitoring data due to dead batteries or full memory cards.

Further instructions for camera checks and associated data collection are included in Appendix A.

References

NGTL (Nova Gas Transmission Limited). 2015a. Nova Gas Transmission Ltd. Caribou Habitat Restoration and Offset Measures Monitoring Program. Leismer to Kettle Rover Project, Northwest Mainline Expansion Project, Chinchaga Lateral Loop No. 3. Prepared by Northern Resource Analysts Ltd. Submitted to the National Energy Board.

NGTL. 2015b. Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station – Preliminary Caribou Habitat Restoration Plan. Submitted to the National Energy Board.

Appendix A

Remote Camera Settings

Before deployment, each camera's memory cards should be preset to desired settings using the Reconyx software provided with camera. The Reconyx Hyperfire Instruction Manual is available online at http://images.reconyx.com/file/HyperFireManual.pdf and can help the user get more familiar with the camera unit and software. Prior to programming the memory card, ensure the card is labelled to match the corresponding camera number. Preferred settings for PC Hyperfire series cameras are as follow:

1) Under the "Triggers" tab (Figure A-1);

- under 'Quickset' – select 'Advanced';
- when triggered, take 5 pictures;
- set for 1 minute photo interval;
- quiet period – ensure this is 0; and
- options – select 'Use the internal motion trigger'.

2) Under the "Images" tab (Figure A-1);

- ensure image setting sliders (brightness, contrast, sharpness, and saturation) are similar to the ones displayed in the screen capture (Figure 1-A);
- For Camera naming under 'Options' – Label each camera – [Project Name-Measure (M) or Control (C) Site – XXX] (ex. For Chinchaga, on an access control site and the first camera, use: CHI-M-001)
- under 'Temperature', select 'Celsius';
- under 'Time', select '24 hr';
- set 'Night Shutter Speed' in the middle;
- set 'Night ISO Sensitivity' in the middle; and
- set 'Resolution' to 'High'.

3) Set date and time on memory cards with the software and immediately insert the card into the corresponding camera.

4) Turn camera on for settings to become active. Settings will now remain active unless the memory card is formatted.

5) Battery life will read 0% until battery type is specified. Use the arrow key to cycle through to "Battery Type". Press OK. Select battery type (Lithium if applicable) and press OK. Press ok again to finish setting battery type.

6) Take a few pictures to ensure camera is functioning properly and delete prior to taking camera to the field.

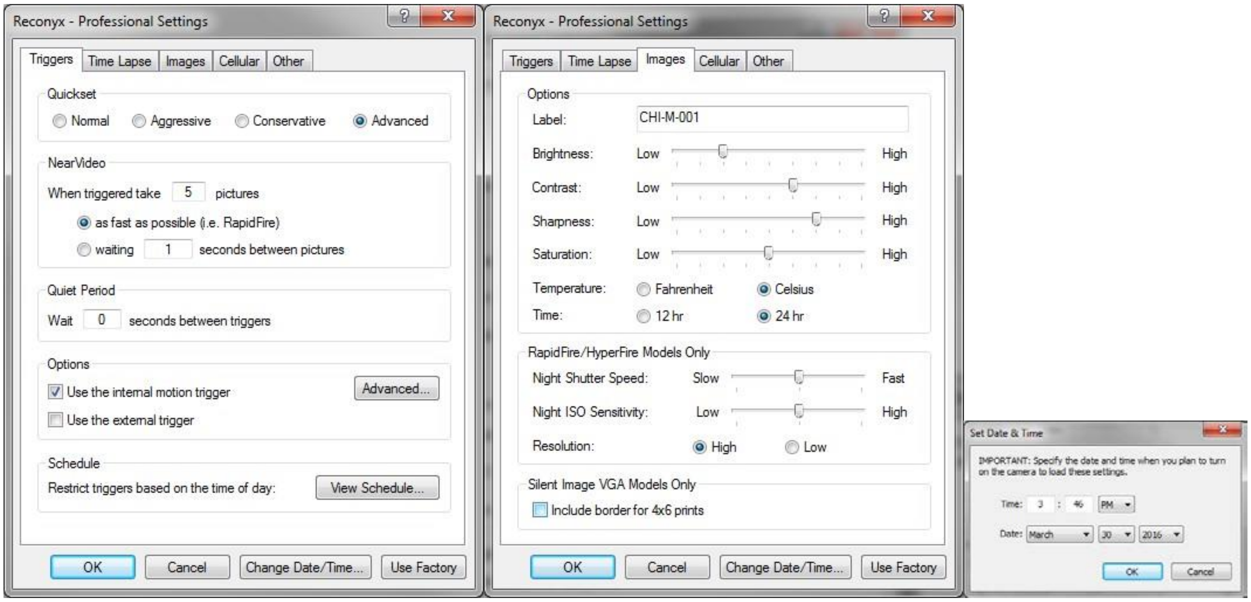


Figure A-1: Reconyx HyperFire Series Memory Card Camera Settings.

Camera Deployment and Retrieval

For each camera, a bungee cord, python lock, or security enclosure bolts will be required to secure the camera.

Deployment

- Insert a desiccant packet into the camera box.
- Place camera about 1 m above the ground.
- Angle camera to capture the point of interest (i.e., access control treatment location along a linear corridor ROW; Figure A-2).
- Camera should be a maximum of 20 to 25 m from the point of interest (Figure A-2) because the detection radius on Reconyx cameras is approximately 30 m.
- If possible, always orient the camera to face north.
- If the camera is placed in area of upward sloping ground, the camera may need to be higher and angled slightly upwards.
- If the camera is placed in an area of downward sloping ground, the camera may need to be lower and angled slightly downwards.
- Ensure there is no debris obscuring the view of the camera by removing any overhanging branches, shrubs or grass to avoid camera triggers from moving vegetation.
- Conduct a walk test.
- Reconyx PC Hyperfire cameras provide activation instruction on the screen once the camera is turned on. Conduct a walk test to confirm that the camera is functioning properly and to verify that the trigger zone covers your area of interest. A walk test is performed by following the steps below:
    1. select the setting ‘Walk Test’,

2. close the camera panel, and

3. walk in front of the camera in your area of interest (along the length of the treatment, i.e. access control).

o The camera will flash red if it is being triggered, but no photos will be recorded. Adjust the camera position as required.

- When ready, turn on the camera and Select 'Arm Camera'.
- Loop the cable lock around the tree or post and lock the camera. Use pliers or vice grips as necessary to securely fasten the cable.

Refer to the Reconyx Hyperfire Instruction Manual to see mounting options available http://images.reconyx.com/file/HyperFireManual.pdf .

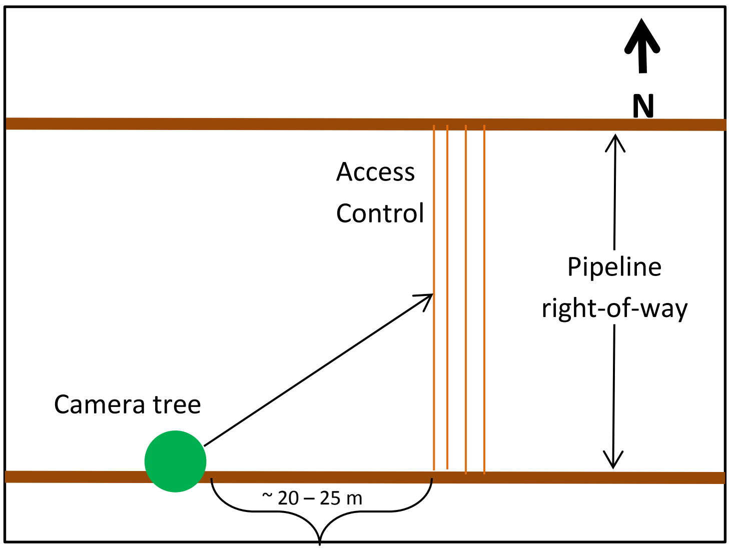


Figure A-1: Schematic of Camera Deployment on Pipeline Right-of-way

If the camera to be deployed is equipped with a solar panel, the following steps should be followed (see Photo 1 for example):

- Attach the solar panel to the mounting bracket using hardware provided.
- Mount the solar panel bracket and battery box on a wooden post, T-post or fence post (note: you will have to pre-drill holes to mount the battery box if using a T-post).
- The solar panel should face south.
- Ensure the connectors on the battery box face down.
- Connect the solar panel wire to the battery box.
- Place lithium or rechargeable batteries in the camera (these will act as a back-up power supply and the camera will automatically use the best power source).
- Plug the camera into the battery box using the power cable. If using a security enclosure, you will need to turn the power switch on before placing the camera in the enclosure. The power cable should be connected to the camera after the camera is installed in the security enclosure

Photo 1: Example Camera and Solar Power Panel Pack Mounted on a T-post (© Reconyx)

Camera Retrieval

When retrieving a camera, always walk in front of it to take a photo. This "take down photo" is used to determine if the camera was functional for the duration of its deployment. It also allows the date and time stamp to be cross-referenced with the datasheet to ensure they are correct. When retrieving a camera complete the following:

- Unlock and open the camera panel.
- Record the following on the datasheet:
    - camera battery level; o

      card capacity; and
    - "take down" date and time.
- If the camera is to remain deployed at its monitoring site, ensure batteries are replaced if below 50%, swap out the memory card for a new one, and repeat the camera deployment instructions (above).

Recording Data

The following information should be recorded at each plot during camera deployment and retrieval.

Camera Deployment

- plot name;
- SD memory card name or number;
- plot photos;
- date and time;
- names of observer(s);
- UTM location;
- ecosite or wetlands type;
- description of plot location (e.g., pipeline right-of-way, seismic line);
- description of access control treatment type, if applicable (e.g., coarse woody debris, roll back, mounding)
- linear feature width (estimate);
- binary variable indicating evidence of human access (yes/no);
- human access type (all-terrain vehicle, truck, equipment);
- 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]); and
- classification of wildlife access level (low/high, as defined above).

Camera Retrieval

- plot name;
- date and time;
- name of observer(s);
- percent (%) battery remaining (will display on camera screen once panel is opened);
- percent (%) memory used (will display on camera screen once panel is opened);
- number of pictures taken (will display on camera screen once panel is opened);
- SD memory card name or number for card being removed (this is important if camera is not being taken down); and
- SD memory card name or number for card being inserted (i.e., if camera is not taken down).

APPENDIX F

CAMERA INFORMATION

Camera Identifier (Year 3/ Year 1)	UTM (NAD 83)	Project (Pipeline)	Deployment/Start Date (DD/MM/YEAR)	Retrieval/End Date (DD/MM/YEAR)
LKXO-01/ TCPL1	480426E 6200199N 12N	LKXO	01/09/2018	23/08/2019
LKXO-02/ TCPL2	480085E 6199995N 12N	LKXO	01/09/2018	23/08/2019
LKXO-03/ TCPL3	486050E 6200253N 12N	LKXO	01/09/2018	23/08/2019
LKXO-04/ TCPL4	488375R 6200240N 12N	LKXO	01/09/2018	23/08/2019
LKXO-05/ TCPL5	487988E 6200236N 12N	LKXO	01/09/2018	23/08/2019
LKXO-06/ TCPL6	499366E 6200401N 12N	LKXO	01/09/2018	23/08/2019
LKXO-07/ TCPL7	498997E 6200436N 12N	LKXO	01/09/2018	23/08/2019
CHIN-01/ TCPL23	402143E 6355576N 11N	Chinchaga	16/07/2018	26/07/2019
CHIN-02/ TCPL22	402846E 6355611N 11N	Chinchaga	17/07/2018	26/07/2019
CHIN-03/ TCPL21	407086E 6352968N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-04/ TCPL20	407533E 6352685N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-05 / TCPL11	409653E 6351227N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-06 / TCPL13	416730E 6347631N 11N	Chinchaga	24/07/2018	26/07/2019
CHIN-07 / TCPL12	417238E 6347582N 11N	Chinchaga	24/07/2018	26/07/2019
CHIN-08 / TCPL14	419524E 6345784N 11N	Chinchaga	23/07/2018	27/07/2019
CHIN-09 / TCPL15	419759E 6345428N 11N	Chinchaga	23/07/2018	26/07/2019
CHIN-10 / TCPL16	427180E 6340306N 11N	Chinchaga	22/07/2018	26/07/2019
CHIN-11 / TCPL17	427476E 6340105N 11N	Chinchaga	21/07/2018	26/07/2019
C-01 / TCPL18	372048E 6360692N 11N	Cranberry	03/08/2018	25/07/2019
C-02 / TCPL19	372556E 6359488N 11N	Cranberry	04/08/2018	25/07/2019
C-03 / TCPL28	374134E 6358170N 11N	Cranberry	03/08/2018	25/07/2019
C-04 / TCPL26	386600E 6356012N 11N	Cranberry	26/07/2018	26/07/2019
C-05 / TCPL27	386852E 6355991N 11N	Cranberry	26/07/2018	26/07/2019
C-06 / TCPL25	391310E 6356026N 11N	Cranberry	25/07/2018	26/07/2019
C-07 / TCPL24	391045E 6355958N 11N	Cranberry	25/07/2018	26/07/2019
SL-01 / TCPL29	362607E 6362178N 11N	Sloat Creek	01/08/2018	25/07/2019
SL-02 / TCPL30	362357E 6362151N 11N	Sloat Creek	02/08/2018	25/07/2019
TW-01 / TCPL9	329399E 6475011N 11N	Timberwolf	06/08/2018	24/07/2019
TW-02 / TCPL10	329248E 6466069N 11N	Timberwolf	06/08/2018	24/07/2019
TW-03 / TCPL8	329244E 6465862N 11N	Timberwolf	06/08/2018	24/07/2019

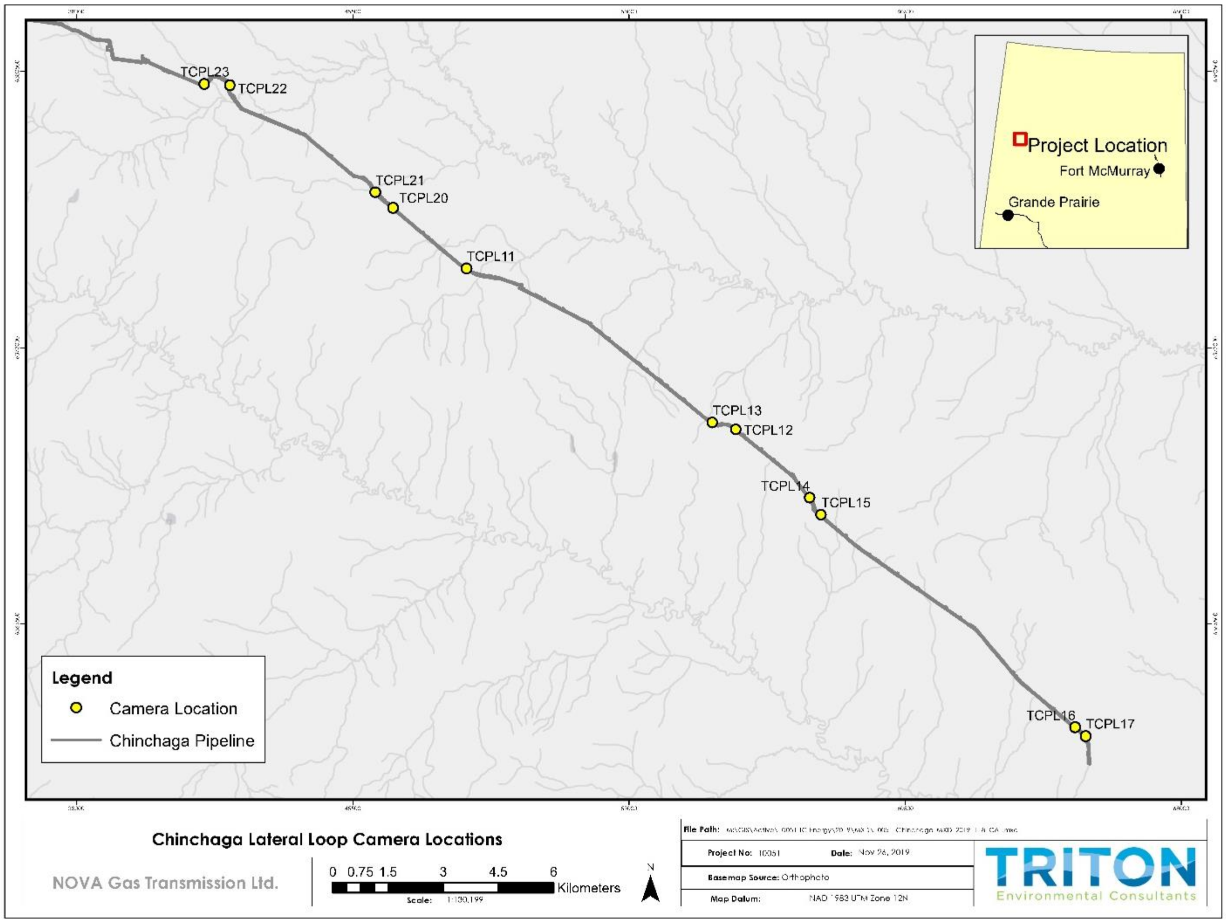


Figure 0-1. Distribution of remote cameras deployed along the Chinchaga Lateral Loop No. 3 ROW from July 16, 2018 to July 27, 2019. All cameras were within Caribou Range.

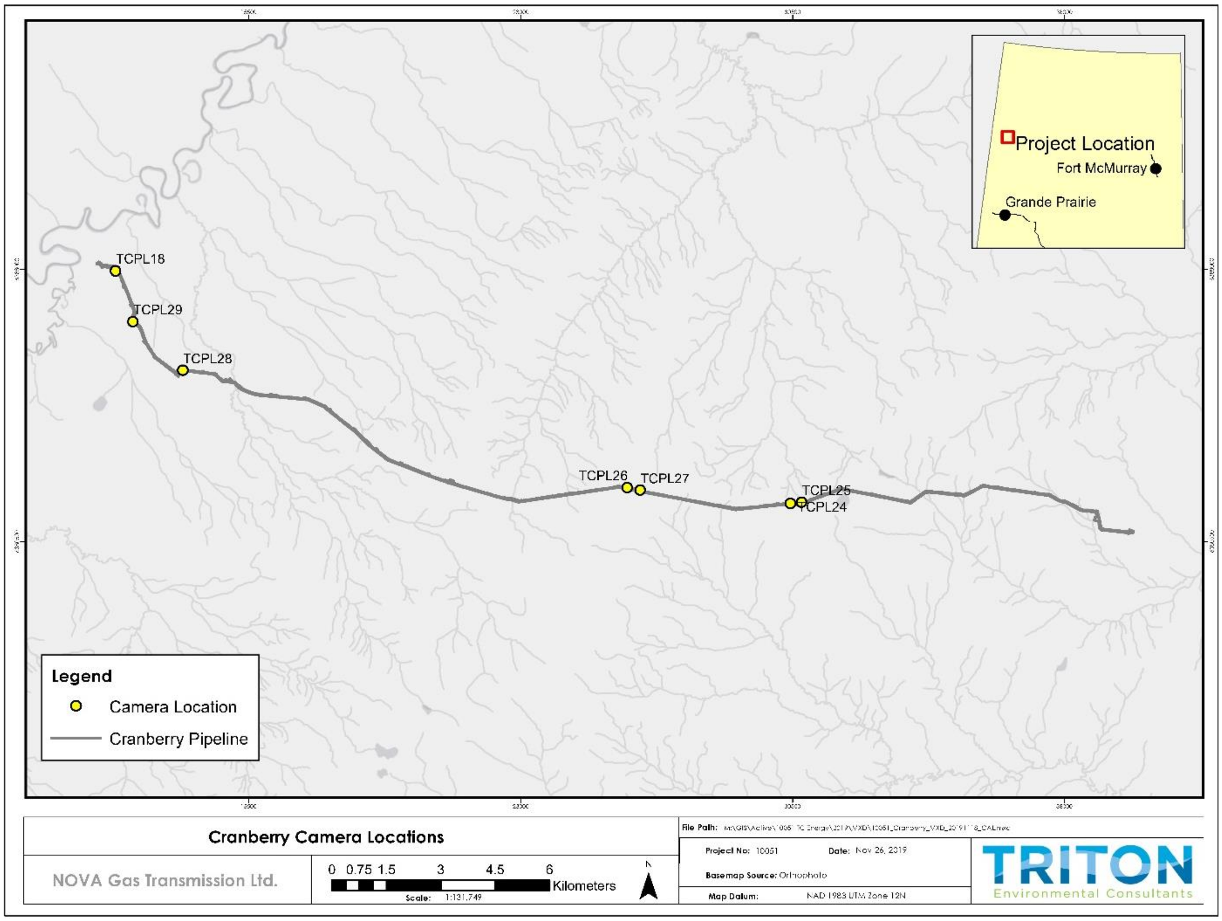


Figure 0-2. Distribution of remote cameras deployed along the NWML Cranberry section ROW from July 25, 2018 to July 26, 2019. All cameras were within Caribou Range.

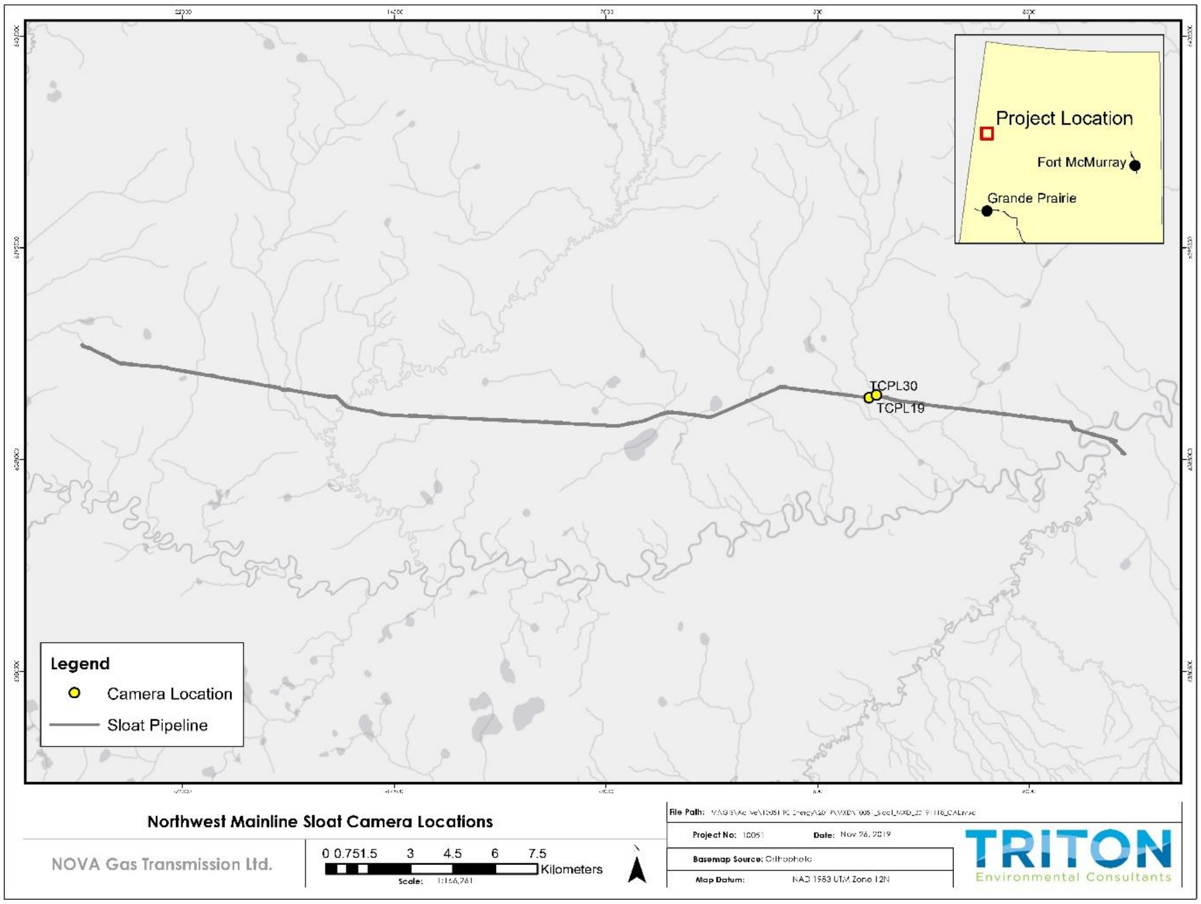


Figure 0-3. Distribution of remote cameras deployed along the NWML Sloat section ROW from August 1, 2018 to July 25, 2019. All cameras were within Caribou range.

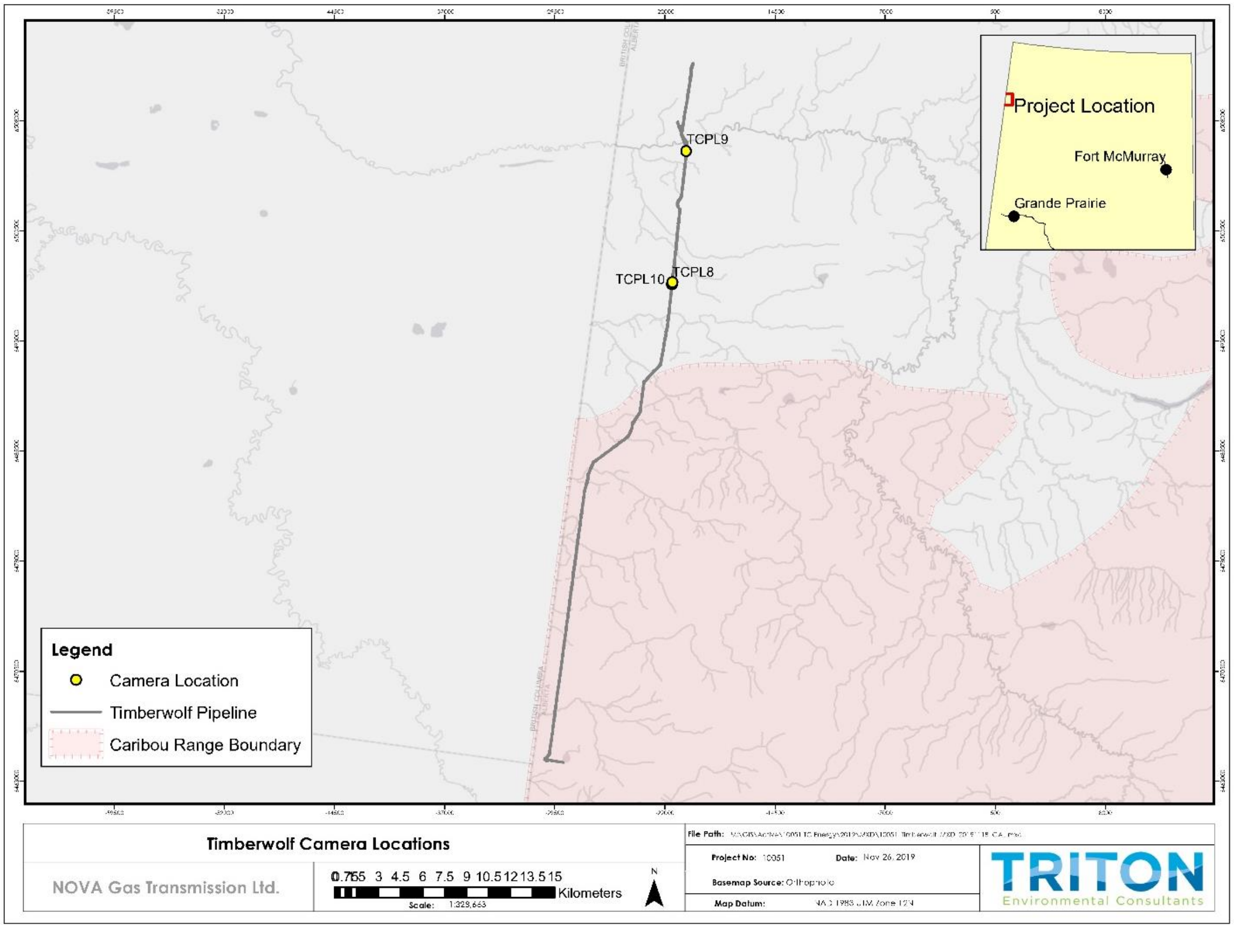


Figure 0-4. Distribution of remote cameras deployed along the Northwest Mainline Timberwolf section ROW from August 6, 2018 to July 24, 2019.

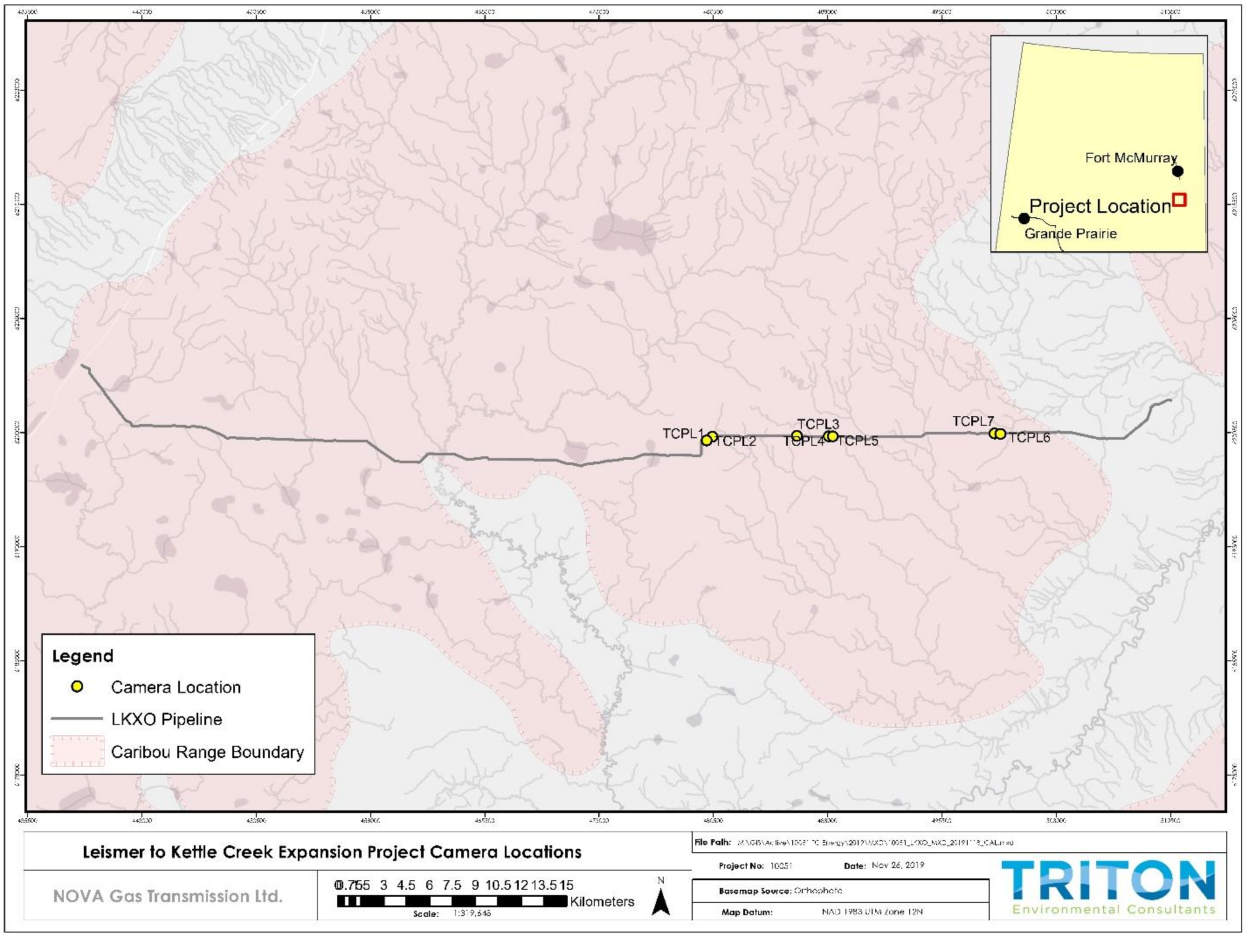


Figure 0-5. Distribution of remote cameras deployed along the Leismer to Kettle Creek Expansion Project ROW from September 1, 2018 to August 23, 2019.

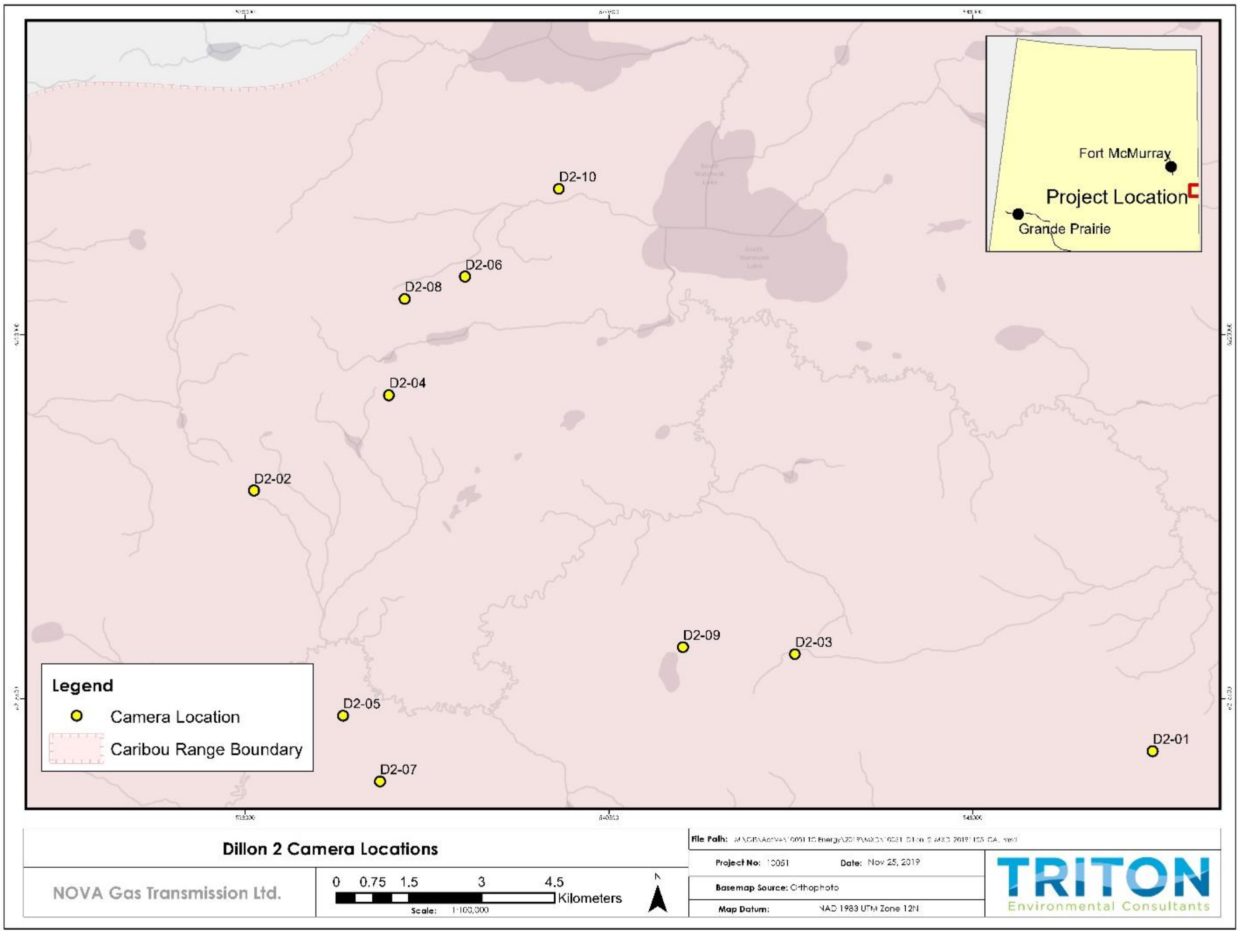


Figure 0-6. Distribution of remote cameras deployed within the Dillon River Wildlands offsets from August 31, 2018 to August 25, 2019.

Table F-1. Summary of wildlife species mean daily occurrence at access controls during each camera monitoring period

Camera	*White-tailed Deer*	*Mule Deer*	*Moose*	*Caribou*	*Black Bear*	*Grizzly Bear*	*Gray Wolf*	*Coyote*	*Lynx*	*Fisher*	*Red Fox*	*Pine Marten*	*Snow-shoe Hare*	*Red Squirrel*	*Birds*
Chinchaga															
CHIN-01	0.075	0	0.344	0	0.048	0.005	0	0.0133	0	0	0	0	0	0	0
CHIN-02	0.0134	0	0.094	0	0.040	0	0.005	0.019	0.003	0	0	0	0.110	0	0
CHIN-03	0.051	0	0.027	0	0.057	0.063	0.003	0.009	0.003	0	0	0	0	0	0
CHIN-04	0.093	0	0.155	0	0.062	0.016	0	0.009	0	0	0	0	0	0	0
CHIN-05	0.208	0.060	0.003	0	0.019	0.025	0	0.019	0	0	0	0	0	0	0
CHIN-06	0.071	0.008	0.003	0	0.003	0	0	0	0	0	0	0	0	0	0
CHIN-07	0.134	0.014	0	0	0.016	0.008	0	0.014	0.033	0	0	0.005	0	0.005	0
CHIN-08	0.073	0.005	0.030	0	0.049	0	0	0.003	0.046	0.005	0	0	0	0	0.003
CHIN-09	0.160	0.010	0.010	0	0.008	0	0	0	0	0	0	0	0	0	0
CHIN-10	0.569	0	0.003	0	0.114	0	0	0.027	0	0.003	0.011	0	0	0	0
CHIN-11	0.632	0	0.049	0	0.021	0	0	0.006	0	0	0	0	0	0	0
Cranberry															
C-01	0.951	0	0.091	0.003	0.039	0	0.003	0	0.006	0	0	0	0	0	0.003
C-02	2.586	0	0.020	0	0.183	0	0.028	0.011	0.020	0	0	0.020	0.017	0	0.006
C-03	2.461	0.006	0.076	0	0.138	0	0	0	0.003	0	0	0	0	0	0
C-04	0	0	0.003	0	0	0	0	0	0	0	0	0	0	0	0
C-05	0.074	0	0	0	0.038	0	0	0.003	0.003	0	0	0	0.005	0	0.008
C-06	0.003	0	0	0	0.033	0	0	0.006	0.086	0	0	0	0.054	0	0
C-07	0.014	0.006	0	0	0.023	0.003	0.006	0.006	0.003	0	0	0	0	0	0
Sloat															
SL-01	1.098	0	0.031	0	0.036	0.003	0.003	0.006	0.003	0	0	0	0	0	0
SL-02	0.056	0	0.028	0	0.008	0	0	0	0	0	0.003	0	0	0	0
Timberwolf															
TW-01	0	0	0.064	0	0	0	0.003	0	0.003	0	0	0	0	0	0.010
TW-02	0	0	0	0	0.80	0	0	0	0	0	0	0	0	0	0.020
TW-03	0	0	0.011	0	0	0	0	0	0.011	0	0	0	0	0	0

Camera	*White-tailed Deer*	*Mule Deer*	*Moose*	*Caribou*	*Black Bear*	*Grizzly Bear*	*Gray Wolf*	*Coyote*	*Lynx*	*Fisher*	*Red Fox*	*Pine Marten*	*Snow-shoe Hare*	*Red Squirrel*	*Birds*
LKXO															
LKXO-01	0	0	0	0.256	0.076	0	0	0	0	0	0	0	0	0	0.096
LKXO-02	0.014	0	0.014	0.079	0.435	0	0	0	0	0	0	0	0.014	0	0.020
LKXO-03	0.017	0	0.963	0.011	0.042	0	0	0	0	0	0	0	0	0	0
LKXO-04	0	0	0.028	0.374	0.028	0	0	0	0	0	0	0	0	0	0
LKXO-05	0	0	0.028	0.129	0.323	0	0	0.065	0	0	0	0	0.003	0	0.129
LKXO-06	0.504	0	0	0	0.019	0	0	0	0	0	0	0	0.008	0	0
LKXO-07	0.028	0	0	0	0.298	0	0	0.008	0	0	0	0	0	0	0
Dillon															
D2-01	0	0	0	0	0	0	0.026	0	0	0	0	0	0	0	0
D2-02	0.022	0	0.006	0	0.028	0	0	0	0	0	0	0	0	0	0
D2-03	0.067	0	0.159	0.006	0.067	0	0.014	0	0	0.003	0	0	0.008	0	0
D2-04	0	0	0.003	0.003	0	0	0	0	0	0	0	0	0.003	0	0.003
D2-05	0	0	0.006	0.039	0.011	0	0	0	0.003	0	0	0	0	0	0
D2-06	0.203	0	0.014	0.014	0	0	0	0	0	0	0	0	0	0	0
D2-07	0	0	0.082	1.033	0.039	0	0.045	0	0	0	0	0	0	0	0
D2-08	0	0	0.264	0	0.157	0	0	0	0	0	0	0	0.013	0	0.033
D2-09	0.374	0	0.240	0	0.196	0	0	0	0.011	0.056	0	0	0.168	0	0
D2-10	0	0	0	0	0.073	0	0	0	0	0	0	0	0	0	0

Camera	*White-tailed Deer*	*Mule Deer*	*Moose*	*Caribou*	*Black Bear*	*Grizzly Bear*	*Gray Wolf*	*Coyote*	*Lynx*	*Fisher*	*Red Fox*	*Pine Marten*	*Snow-shoe Hare*	*Red Squirrel*	*Birds*
LKXO															
LKXO-01	0	0	0	0.256	0.076	0	0	0	0	0	0	0	0	0	0.096
LKXO-02	0.014	0	0.014	0.079	0.435	0	0	0	0	0	0	0	0.014	0	0.020
LKXO-03	0.017	0	0.963	0.011	0.042	0	0	0	0	0	0	0	0	0	0
LKXO-04	0	0	0.028	0.374	0.028	0	0	0	0	0	0	0	0	0	0
LKXO-05	0	0	0.028	0.129	0.323	0	0	0.065	0	0	0	0	0.003	0	0.129
LKXO-06	0.504	0	0	0	0.019	0	0	0	0	0	0	0	0.008	0	0
LKXO-07	0.028	0	0	0	0.298	0	0	0.008	0	0	0	0	0	0	0
Dillon															
D2-01	0	0	0	0	0	0	0.026	0	0	0	0	0	0	0	0
D2-02	0.022	0	0.006	0	0.028	0	0	0	0	0	0	0	0	0	0
D2-03	0.067	0	0.159	0.006	0.067	0	0.014	0	0	0.003	0	0	0.008	0	0
D2-04	0	0	0.003	0.003	0	0	0	0	0	0	0	0	0.003	0	0.003
D2-05	0	0	0.006	0.039	0.011	0	0	0	0.003	0	0	0	0	0	0
D2-06	0.203	0	0.014	0.014	0	0	0	0	0	0	0	0	0	0	0
D2-07	0	0	0.082	1.033	0.039	0	0.045	0	0	0	0	0	0	0	0
D2-08	0	0	0.264	0	0.157	0	0	0	0	0	0	0	0.013	0	0.033
D2-09	0.374	0	0.240	0	0.196	0	0	0	0.011	0.056	0	0	0.168	0	0
D2-10	0	0	0	0	0.073	0	0	0	0	0	0	0	0	0	0

APPENDIX G

REMOTE CAMERA MONITORING SUMMARY DATA

Table G-5. Camera locations and deployment periods

Camera Identifier (Year 3/ Year 1)	UTM (NAD 83)	Project (Pipeline)	Deployment/Start Date (DD/MM/YEAR)	Retrieval/End Date (DD/MM/YEAR)
LKXO-01/ TCPL1	480426E 6200199N 12N	LKXO	01/09/2018	23/08/2019
LKXO-02/ TCPL2	480085E 6199995N 12N	LKXO	01/09/2018	23/08/2019
LKXO-03/ TCPL3	486050E 6200253N 12N	LKXO	01/09/2018	23/08/2019
LKXO-04/ TCPL4	488375R 6200240N 12N	LKXO	01/09/2018	23/08/2019
LKXO-05/ TCPL5	487988E 6200236N 12N	LKXO	01/09/2018	23/08/2019
LKXO-06/ TCPL6	499366E 6200401N 12N	LKXO	01/09/2018	23/08/2019
LKXO-07/ TCPL7	498997E 6200436N 12N	LKXO	01/09/2018	23/08/2019
CHIN-01/ TCPL23	402143E 6355576N 11N	Chinchaga	16/07/2018	26/07/2019
CHIN-02/ TCPL22	402846E 6355611N 11N	Chinchaga	17/07/2018	26/07/2019
CHIN-03/ TCPL21	407086E 6352968N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-04/ TCPL20	407533E 6352685N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-05 / TCPL11	409653E 6351227N 11N	Chinchaga	19/07/2018	26/07/2019
CHIN-06 / TCPL13	416730E 6347631N 11N	Chinchaga	24/07/2018	26/07/2019
CHIN-07 / TCPL12	417238E 6347582N 11N	Chinchaga	24/07/2018	26/07/2019
CHIN-08 / TCPL14	419524E 6345784N 11N	Chinchaga	23/07/2018	27/07/2019
CHIN-09 / TCPL15	419759E 6345428N 11N	Chinchaga	23/07/2018	26/07/2019
CHIN-10 / TCPL16	427180E 6340306N 11N	Chinchaga	22/07/2018	26/07/2019
CHIN-11 / TCPL17	427476E 6340105N 11N	Chinchaga	21/07/2018	26/07/2019
C-01 / TCPL18	372048E 6360692N 11N	Cranberry	03/08/2018	25/07/2019
C-02 / TCPL19	372556E 6359488N 11N	Cranberry	04/08/2018	25/07/2019
C-03 / TCPL28	374134E 6358170N 11N	Cranberry	03/08/2018	25/07/2019
C-04 / TCPL26	386600E 6356012N 11N	Cranberry	26/07/2018	26/07/2019
C-05 / TCPL27	386852E 6355991N 11N	Cranberry	26/07/2018	26/07/2019
C-06 / TCPL25	391310E 6356026N 11N	Cranberry	25/07/2018	26/07/2019
C-07 / TCPL24	391045E 6355958N 11N	Cranberry	25/07/2018	26/07/2019
SL-01 / TCPL29	362607E 6362178N 11N	Sloat Creek	01/08/2018	25/07/2019
SL-02 / TCPL30	362357E 6362151N 11N	Sloat Creek	02/08/2018	25/07/2019
TW-01 / TCPL9	329399E 6475011N 11N	Timberwolf	06/08/2018	24/07/2019

Camera Identifier (Year 3/ Year 1)	UTM (NAD 83)	Project (Pipeline)	Deployment/Start Date (DD/MM/YEAR)	Retrieval/End Date (DD/MM/YEAR)
TW-02 / TCPL10	329248E 6466069N 11N	Timberwolf	06/08/2018	24/07/2019
TW-03 / TCPL8	329244E 6465862N 11N	Timberwolf	06/08/2018	24/07/2019

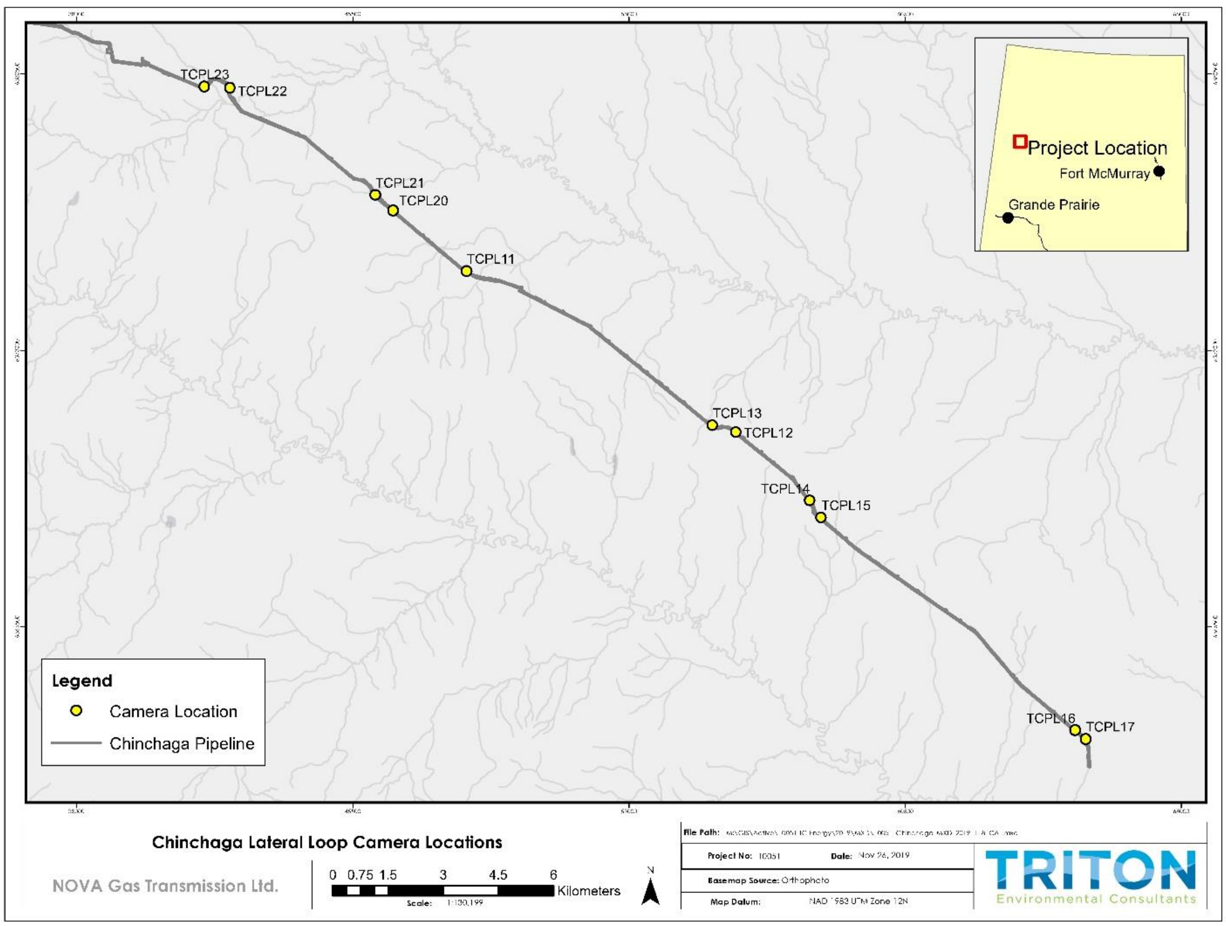


Figure E-1. Distribution of remote cameras deployed along the Chinchaga Lateral Loop No. 3 ROW from July 16, 2018 to July 27, 2019. All cameras were within Caribou Range.

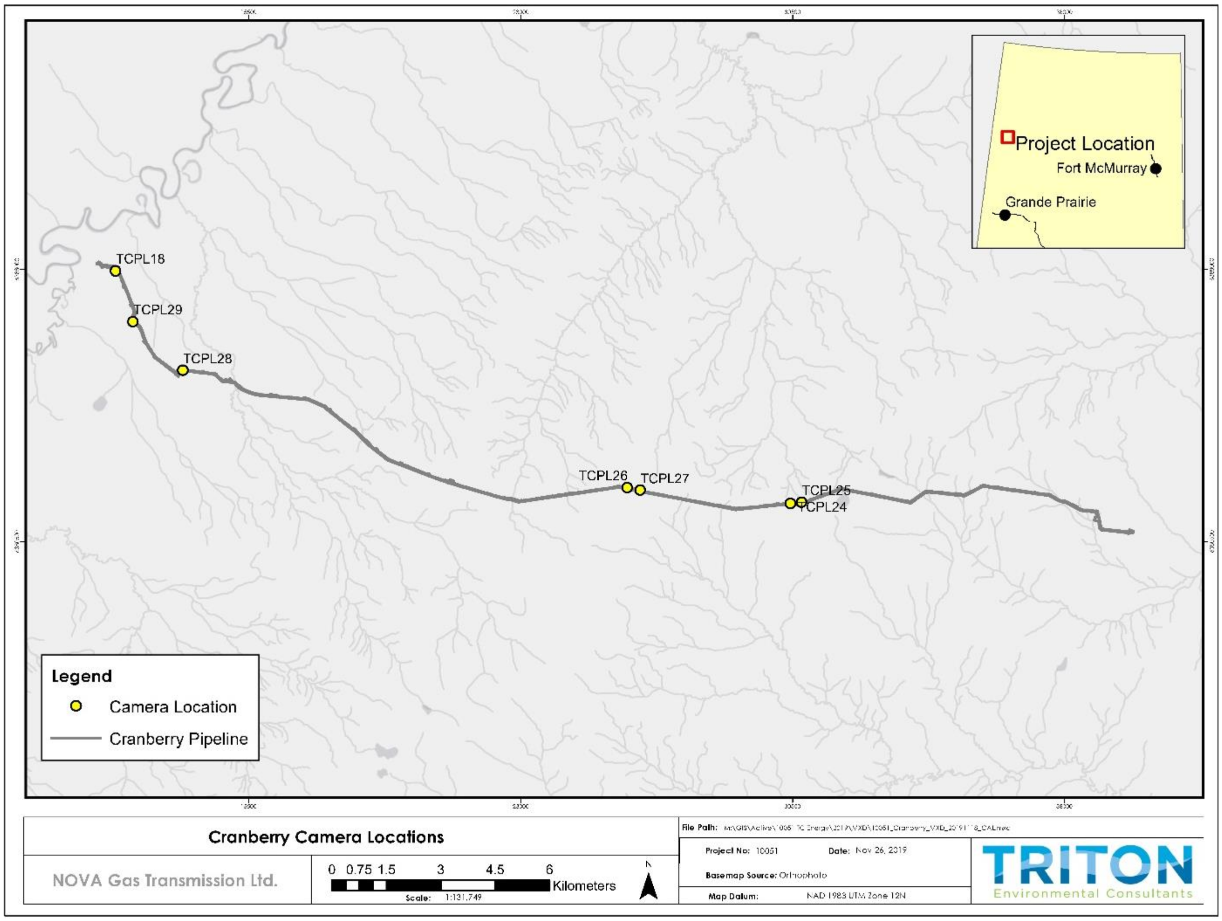


Figure E-2. Distribution of remote cameras deployed along the NWML Cranberry section ROW from July 25, 2018 to July 26, 2019. All cameras were within Caribou Range.

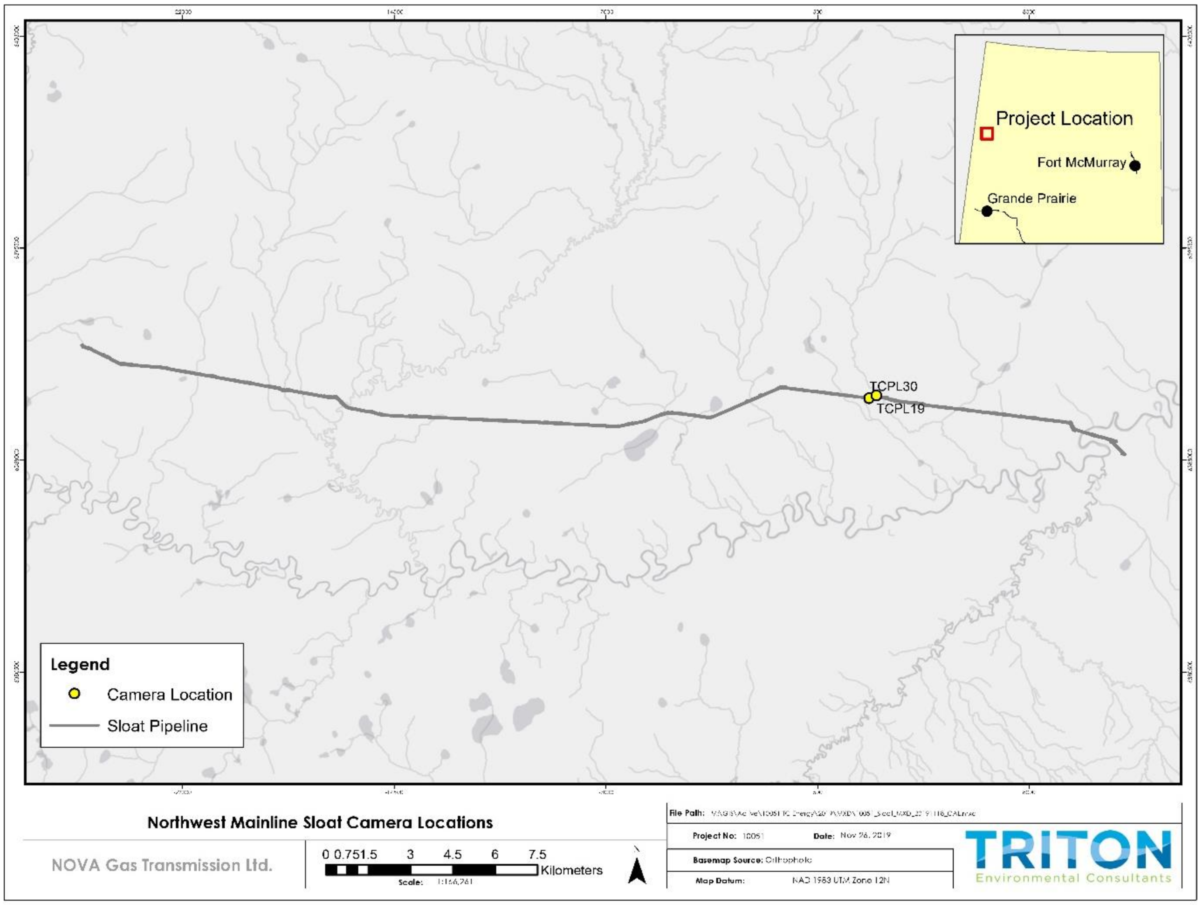


Figure E-3. Distribution of remote cameras deployed along the NWML Sloat section ROW from August 1, 2018 to July 25, 2019. All cameras were within Caribou range.

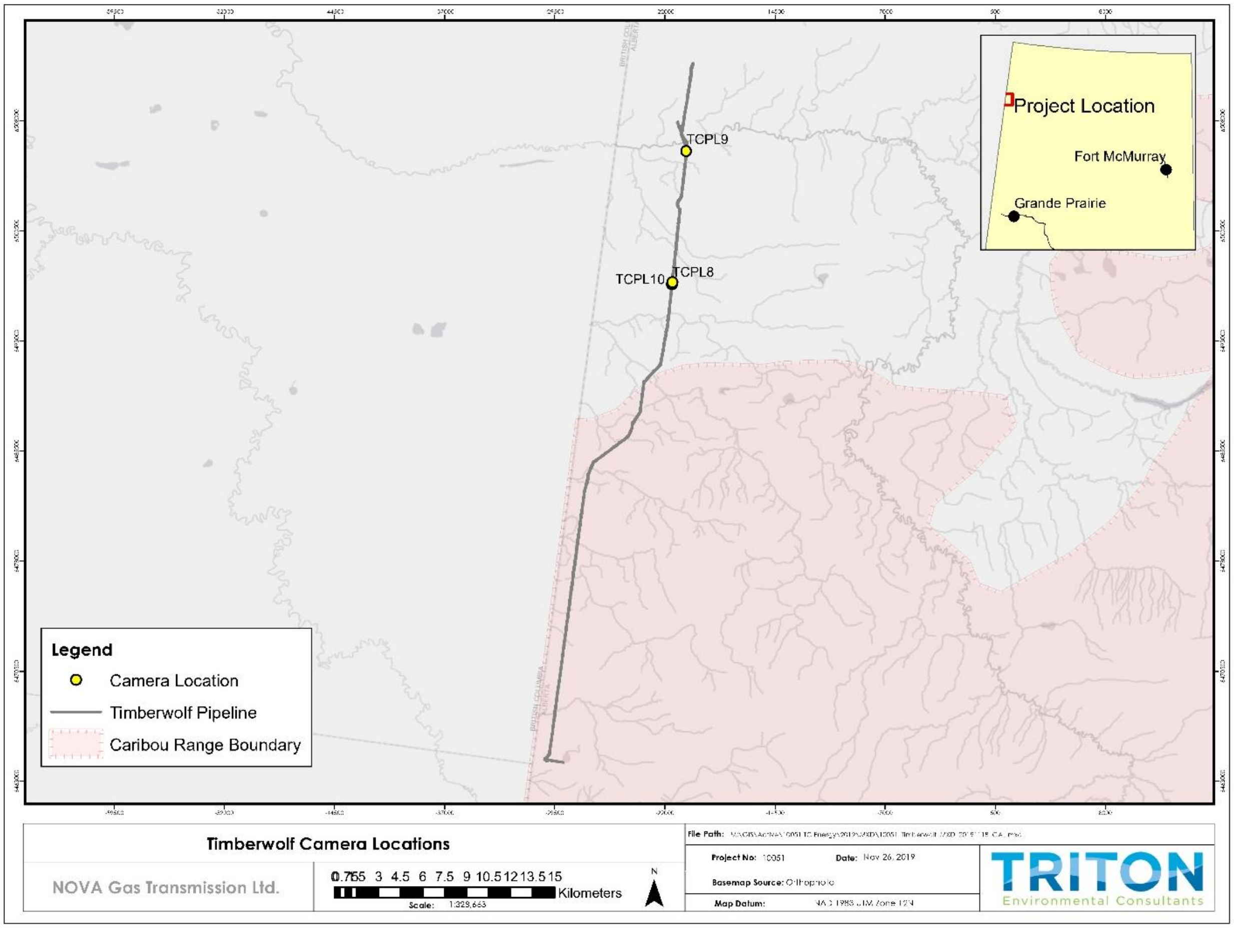


Figure E-4. Distribution of remote cameras deployed along the Northwest Mainline Timberwolf section ROW from August 6, 2018 to July 24, 2019.

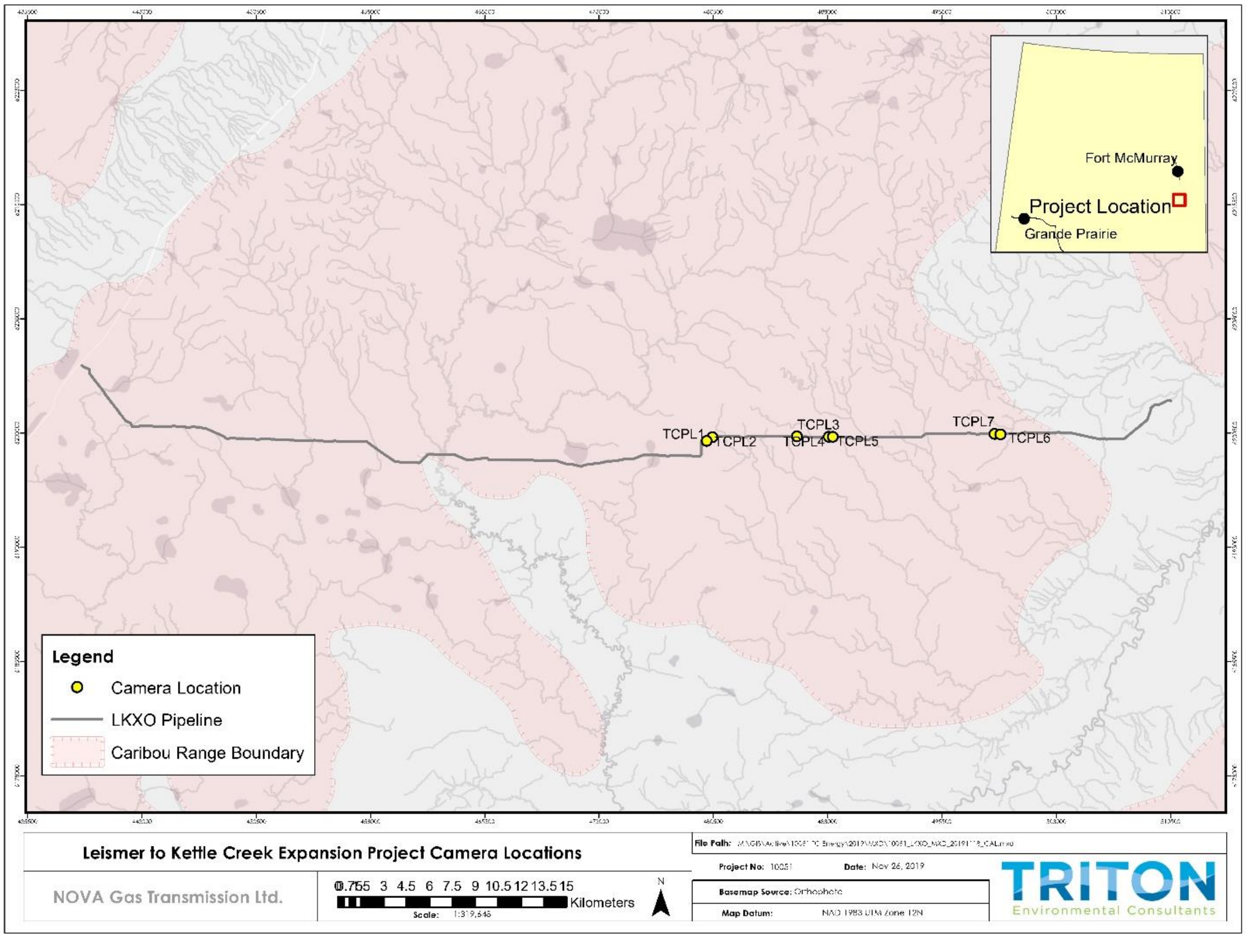


Figure E-5. Distribution of remote cameras deployed along the Leismer to Kettle Creek Expansion Project ROW from September 1, 2018 to August 23, 2019.

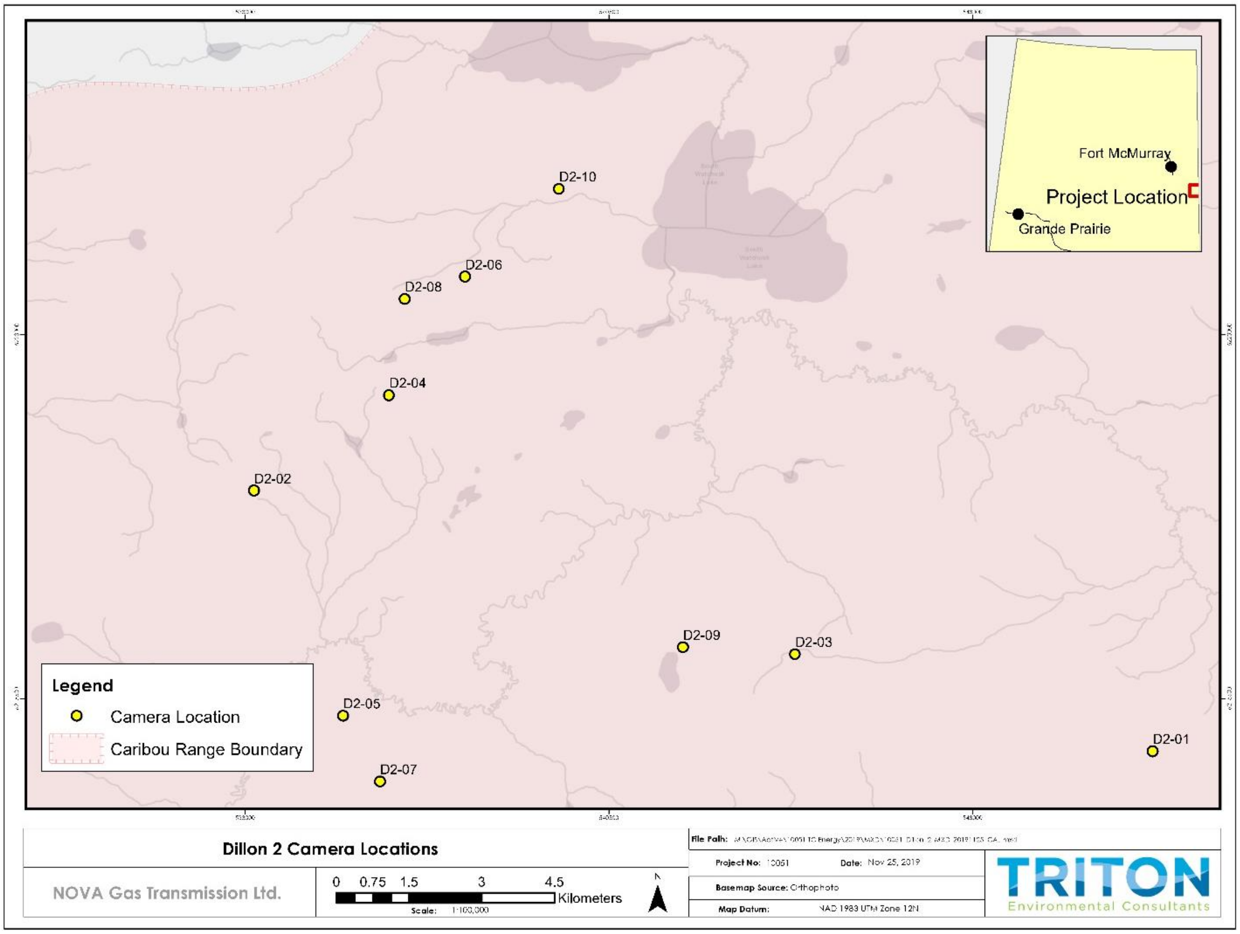


Figure E-6. Distribution of remote cameras deployed within the Dillon River Wildlands offsets from August 31, 2018 to August 25, 2019.