Caribou Habitat Restoration and Offset Measures Monitoring Program

High Pine Expansion Project
Wyndwood Expansion Project
Pine River Aerial Crossing Project
2BL Crossover Assemblies Replacement Project
Spruce Ridge Program

January 28, 2021

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Abbreviations

BC	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
BWBS	Boreal White and Black Spruce
CER	Canada Energy Regulator
CHROMMP	Caribou Habitat Restoration and Offset Measures Monitoring Program
CHRP	Caribou Habitat Restoration Plan
CS	Compressor Station
CWD	coarse woody debris
ECCC	Environment and Climate Change Canada
ESSF	Engelmann Spruce Subalpine Fir
FOV	Final Offset Value
ha	hectare
IOV	Initial Offset Value
KP	kilometre post
LiDAR	Light Detection and Ranging
LOS	line-of-sight
LPU	Local Population Unit
MFLNRO	Ministry of Forests, Lands and Natural Resource Operations
MFLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
NDVI	Normalized Difference Vegetation Index

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NEB	National Energy Board
OMP	Offset Measures Plan
ROW	right-of-way
SBS	Sub-Boreal Spruce

Glossary

Chlorosis	Abnormal reduction or loss of the normal green coloration of leaves of plants, typically caused by iron deficiency in lime-rich soils, or by disease or lack of light.
Disturbed habitat	As defined in a federal recovery strategy for woodland caribou, that is: within caribou habitat, temporary disturbances that can reasonably recover in 40 years or less (e.g., cut blocks, seismic lines, areas burned by forest fires), permanent disturbances (e.g., transmission lines, roads, urban and rural development, railways, agriculture, mines, well sites), and a 500-m buffer around footprints of disturbances except for forest fires. (i.e., Boreal Population; Southern Mountain Population).
Microsite	A small area within an ecosystem that is defined by unique environmental attributes (e.g. temperature, moisture retention, soil characteristics, sunlight). Used to describe the specific spot occupied by a tree or shrub.
Offset	A means for compensating for Residual Project Effects (i.e., residual direct and indirect effects) that cannot be restored on-site (e.g., the unrestored portions of the Project footprint) with the goal of no net loss of caribou habitat.
Offset Measure	The mechanism through which the Offset is achieved, such as habitat restoration.
Performance Measure	A quality of an objective to be measured and reported.
Restoration	The process of assisting the recovery of an ecosystem that has been disturbed, degraded, damaged, or destroyed.
Site preparation	The modification of ground conditions using mechanical treatment to create favorable microsite conditions that improve the growing conditions for planted and natural vegetation regrowth.
Target	The desired value of a performance measure
Tree (seedling) leader	The vertical stem at the top of the tree that represents the current year's growth in conifers.

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Undisturbed habitat	As defined in a federal recovery strategy for woodland caribou, that is: within caribou habitat, areas not showing evidence of human-caused disturbance within 500 m of a human-caused disturbance, and areas not disturbed by fire in the past 40 years (i.e., Boreal Population; Southern Mountain Population).

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1.0 INTRODUCTION

Westcoast Energy Inc. (Westcoast) has prepared this Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) to satisfy Canada Energy Regulator (CER; formerly the National Energy Board [NEB]) conditions that were issued as part of the orders for the five projects listed below:

1. High Pine Expansion Project (High Pine Project) — Order XG-W102-024-2016
2. Wyndwood Expansion Project (Wyndwood Project) — Order XG-W102-014-2017
3. Pine River Aerial Crossing Project (Pine River Project) — Order XG-W102-030-2016
4. 2BL Crossover Assemblies Replacement Project (2BL Crossover Project) — Order XG-W102-009-2017
5. Spruce Ridge Program (Spruce Ridge Project)—Order XG-W102-032-2018

The purpose of this CHROMMP is to describe the monitoring activities that are planned to verify the effectiveness of habitat restoration and offset measures implemented as described respectively in each project-specific Final Caribou Habitat Restoration Plan (CHRP) and Final Offset Measures Plan (OMP). CER conditions vary slightly among the five projects covered by this CHROMMP (see Section 1.2), however, the broad objectives of this CHROMMP are to describe the:

- scientific methods for short-term and long-term monitoring of the restoration and offset measures;
- protocols for assessing the effectiveness of restoration and offset measures based on monitoring results;
- frequency, timing, and locations of monitoring and corresponding rationale;
- protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results; and
- schedule for filing reports on monitoring results and adaptive management actions to the CER, Environment and Climate Change Canada (ECCC) and the British Columbia (BC) Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD[1]).

This CHROMMP describes monitoring for both on-site (on-project footprint) habitat restoration measures, and off-site (off-project footprint) habitat restoration measures implemented as an offset. Westcoast has combined the offset requirements for the five projects listed above into a single offset implementation program, as described in each project-specific Final OMP.

[1] Referred to as MFLNRO in NEB project conditions.

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The CHROMMP is linked to the project-specific CHRPs and OMPs and is the program through which the effectiveness and accountability of habitat restoration and offset measures are monitored for performance with respect to specific targets and overall goals of the CHRPs and OMPs. Results from monitoring activities described in this CHROMMP are to be used to guide subsequent management activities according to one of these two potential outcomes:

1. Monitoring results based on performance measures meet or exceed targets — no further action is required.
2. Monitoring results based on performance measures do not meet targets — an adaptive management framework is used to investigate the cause of underperformance and to identify corrective actions and potential risks or challenges associated with implementing corrective actions.

The following sections provide a description of the projects' interactions with caribou habitat; details of the relevant conditions; and an outline of the structure of this CHROMMP.

1.1 PROJECT INTERACTION WITH CARIBOU HABITAT

The projects covered by this CHROMMP interact partially or completely with Local Population Units (LPUs) of the Southern Mountain Caribou population of woodland caribou, namely the Pine River LPU and the Graham LPU. Adverse direct effects of the projects on caribou habitat are loss of security and forage habitat, and an increase in early seral forage habitat for moose, elk, and deer which can lead to an increase in mortality risk by attracting predators into, and facilitating predator movement along linear developments within, caribou ranges. For each project, the area affected by indirect disturbance (i.e., up to 500 m from the projects' footprints) is manifested within the context of existing disturbance from pipelines, roads, and forestry cutblocks. The project-specific Final CHRPs and Final OMPs provide additional information on project interactions with caribou habitat and existing disturbance.

Table 1.1 summarizes the residual project effects for each project, which includes accounting for existing disturbance, the area of the project footprint that was restored (i.e., on-site restoration), and the delivery and risk multipliers associated with each on-site restoration measure. There was no opportunity for on-site restoration for either the 2BL Crossover or Spruce Ridge projects, as indicated in Table 1.1 and thus direct project effects were carried forward in full as residual project effects. Table 1.2 summarizes the Final Offset Value (FOV) for each project, which is the area to be restored off-site after accounting for residual project effects, the offset restoration measure and location selected, and the delivery, temporal, and spatial risk multipliers associated with the offset measure and location. Additional information on the calculation of FOVs is provided in the project-specific Final OMPs.

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Table 1.1 Summary of Residual Project Effects

Project[1]	Spatial Boundary	Area (ha)[3]				
		Direct Project Effect	Implemented Restored Footprint	Residual Direct Project Effect	Residual Indirect Project Effect	Residual Project Effect
High Pine	Within project footprint	~~175.2~~173.8	~~119.5~~121.9	~~55.7~~51.9	n/a	~~55.7~~51.9
	Within 500 m buffer	n/a	n/a	n/a	76.7	76.7
Wyndwood	Within project footprint	44.0	23.~~2~~6	20.~~8~~4	n/a	20.~~8~~4
	Within 500 m buffer	n/a	n/a	n/a	9.2	9.2
Pine River	Within project footprint	5.24	3.~~96~~90	1.~~28~~34	n/a	1.~~28~~34
	Within 500 m buffer	n/a	n/a	n/a	0.0	0.0
2BL Crossover	Within project footprint	1.17	0.0	1.17	n/a	1.17
	Within 500 m buffer	n/a	n/a	n/a	0.0	0.0
Spruce Ridge (CS2)[1]	Within project footprint	3.49	0.00	3.49	n/a	3.49
	Within 500 m buffer	n/a	n/a	n/a	0.00	0.0
Spruce Ridge (CSN5)[2]	Within project footprint	2.48	0.00	2.48	n/a	2.48
	Within 500 m buffer	n/a	n/a	n/a	0.00	0.0

NOTES:

n/a = not applicable

1 Compressor Station (CS) 2 is located within the Pine River LPU

2 CSN5 is located within the Graham LPU

3 High Pine and Wyndwood values are rounded to one decimal place. Other projects are rounded to two decimal places because of their comparatively small footprints and restoration units. Details are provided in the Final OMP for each project.

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Table 1.2 Quantification of the Final Offset Value

Restoration Unit			Multipliers for Offset Measures[3] FOV = *Updated IOV x delivery risk x temporal risk x spatial risk x inherent effect*				FOV (ha)
Project	**Habitat Restoration Measure**	**Updated Initial Offset Value (IOV) (ha)**	**Delivery Risk Multiplier**	**Temporal Risk Multiplier**	**Spatial Risk Multiplier**	**Inherent Effect Multiplier**	
High Pine	Road restoration (road ripping; surface prep plus tree planting with or without mounding; tree bending, hinging, or felling)	~~137.00~~136.1	1.5	1.2	2.0	1.0	~~493.20~~489.96
Wyndwood		~~24.70~~19.3	1.5	1.2	2.0	1.0	~~88.92~~69.48
Pine River	Barrier segments (tree-bending, tree-hinging, or tree-felling, minimum 200-m segments; natural regeneration within and or between segments)	3.~~29~~30	2.0	1.2	2.0	n/a	15.~~79~~84
2BL Crossover		1.17	2.0	1.2	2.0	n/a	5.62
Spruce Ridge[1]	Road restoration (road ripping; surface prep plus tree planting with or without mounding; tree-bending, hinging, or felling)	3.49	1.5	1.2	2.0	n/a	12.56
Spruce Ridge[2]		2.48	1.5	1.2	2.5	n/a	11.16
Total Updated IOV (ha)		~~172.13~~165.84				**Total FOV (ha)**	~~627.25~~604.62

NOTES:

1 Amount of Updated IOV in Pine River LPU for CS2

2 Amount of Updated IOV in the Graham LPU for CSN5

3 When implementing an offset for a linear project effect on a linear feature, a 5x multiplier is used if that offset does not span the full width of the linear feature (i.e., the functional attributes of the linear feature for human and predator travel are assumed to persist through time). This "penalty" is similar to the "credit" applied to new linear features that are contiguously aligned with an existing linear feature (i.e., there is no additive or multiplicative functional effect of contiguous alignment).

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1.2 CONDITIONS FOR CARIBOU HABITAT RESTORATION AND OFFSET MEASURES MONITORING PROGRAM

The scope of this CHROMMP is defined by conditions provided in the project-specific CER orders (Table 1.3). The conditions are provided verbatim in the following sections.

Table 1.3 Westcoast Projects, Orders, and CHROMMP Conditions

Project	CER Order	CHROMMP Condition
High Pine	XG-W102-024-2016	8
Wyndwood	XG-W102-014-2017	30
Pine River	XG-W102-030-2016	7
2BL Crossover	XG-W102-009-2017	7
Spruce Ridge	XG-W102-032-2018	see Section 1.2.5

1.2.1 High Pine Project CHROMMP Condition

Table 1.4 provides the CHROMMP condition for the High Pine Project and a concordance of elements of the condition with sections of this CHROMMP.

Table 1.4 Concordance between Condition 8 of the High Pine Order and CHROMMP

NEB Order XG-W102-024-2016		Location in this CHROMMP
8.	Westcoast shall file with the Board, for approval, on or before 1 February after the first complete growing season following the commencement of operation of the South Loop, a program for monitoring and verifying the effectiveness of the caribou habitat restoration and offset measures implemented as part of the final CHRP and final OMP. The Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) shall include, but not be limited to:	
8.a)	the scientific methodology or protocol for short-term and long-term monitoring of the restoration and offset measures, and their actual effectiveness based on monitoring results;	Section 2.0, Section 2.1, Section 2.2; Section 2.3.1, Section 2.4.1, Section 2.5, Appendix A
8.b)	frequency, timing and locations of monitoring and the rationale for each choice;	Section 1.1, Section 2.1, Section 2.3.1, Section 2.4.1, Section 2.5, Table 4.1, Appendix B, Appendix E
8.c)	protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from the implementation of either this Project or other Projects; and	Section 3.0
8.d)	a schedule for filing reports of monitoring results and adaptive management responses to the NEB, ECCC and MFLNRO. This schedule shall be contained in the CHROMMP as well as in the reports required under Condition 9.	Section 4.0

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1.2.2 Wyndwood Project CHROMMP Condition

Table 1.5 provides the CHROMMP condition for the Wyndwood Project and a concordance of elements of the condition with sections of this CHROMMP.

Table 1.5 Concordance between Condition 30 of the Wyndwood Order and CHROMMP

NEB Order XG-W102-014-2017		Location in this CHROMMP
30.	***Caribou Habitat Restoration and Offset Measures Monitoring Program*** Westcoast must file with the Board, for approval, and notify Aboriginal groups who have expressed to Westcoast an interest in this filing, **on or before 1 February after the second complete growing season after commencing operation of the Project**, a program for monitoring and verifying the effectiveness of the caribou habitat restoration and offset measures implemented as part of the final CHRP and final OMP. The Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) must include, but not be limited to:	
30.a)	the scientific methodology or protocol for short-term and long-term monitoring of the restoration and offset measures, and their actual effectiveness based on monitoring results	Section 2.0, Section 2.1, Section 2.2, Section 2.3.2, Section 2.4.2, Section 2.5, Appendix A
30.b)	frequency, timing and locations of monitoring and the rationale for each choice	Section 1.1, Section 2.1, Section 2.3.2, Section 2.4.2, Section 2.5, Table 4.1, Appendix C, Appendix E
30.c)	protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from the implementation of either this Project or other Projects; and	Section 3.0
30.d)	a schedule for filing reports of monitoring results and adaptive management responses to the Board, ECCC and MFLNRO. This schedule must be contained in the CHROMMP as well as in the reports required under Condition 30.	Section 4.0

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1.2.3 Pine River Project CHROMMP Condition

Table 1.6 provides the CHROMMP condition for the Pine River Project and a concordance of elements of the condition with sections of this CHROMMP.

Table 1.6 Concordance between Condition 7 of the Pine River Order and CHROMMP

NEB Order XG-W102-030-2016		Location in this CHROMMP
7.	Westcoast shall file with the Board, for approval, on or before 1 February after the first complete growing season following the commencement of operation of the Project, a program for monitoring and verifying the effectiveness of the CHRP and offset measures implemented as part of the final CHRP and final OMP. The Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) shall include, but not be limited to:	
7.a)	the scientific methodology or protocol for short-term and long-term monitoring of the restoration and offset measures, and their actual effectiveness based on monitoring results;	Section 2.0, Section 2.1, Section 2.3.3, and Section 2.5, Appendix A
7.b)	frequency, timing and locations of monitoring and the rationale for each choice;	Section 1.1, Section 2.1, Section 2.3.3, Section 2.5, Table 4.1, Appendix D, Appendix E
7.c)	protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from the implementation of either this Project or other Projects; and	Section 3.0
7.d)	a schedule for filing reports of monitoring results and adaptive management responses to the Board, ECCC and MFLNRO. This schedule shall be contained in the CHROMMP as well as in the reports required under Condition 8.	Section 4.0

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1.2.4 2BL Crossover Project CHROMMP Condition

Table 1.7 provides the CHROMMP condition for the 2BL Crossover Project and a concordance of elements of the condition with sections of this CHROMMP.

Table 1.7 Concordance between Condition 7 of the 2BL Crossover Order and CHROMMP

NEB Order XG-W102-009-2017		Location in this CHROMMP
7.	Westcoast shall file with the Board, for approval, on or before 1 February after the first complete growing season following the commencement of operation of the Project, a program for monitoring and verifying the effectiveness of the caribou habitat restoration and offset measures implemented as part of the final CHRP and final OMP. Westcoast may submit a Project-specific Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP) or may integrate the CHROMMP in with a CHROMMP for one or more Board-regulated Westcoast Project(s). The CHROMMP shall include, but not be limited to:	
7.a.	the scientific methodology or protocol for short-term and long-term monitoring of the restoration and offset measures, and their actual effectiveness based on monitoring results;	Section 2.0, Section 2.1, Section 2.5, Appendix A
7.b.	frequency, timing and locations of monitoring and the rationale for each choice;	Section 1.1, Section 2.5, Table 4.1, Appendix E
7.c.	a detailed adaptive management plan for how restoration and offset measures will be adapted, based on the monitoring results, in order to ensure the effectiveness of both on-site restoration measures and offset measures in addressing all residual effects; and	Section 3.0
7.d.	a schedule for filing reports of monitoring results and adaptive management responses to the Board, with a copy to be sent at the time of filing to ECCC and MFLNRO. This schedule shall be contained in the CHROMMP as well as in the reports required under Condition 8.	Section 4.0

1.2.5 Spruce Ridge Project CHROMMP Condition

The Spruce Ridge Project order did not contain a specific condition requiring the filing of a CHROMMP. In its letter decision, the NEB stated that it decided against imposing a CHROMMP condition as offsets would be relied on to compensate for habitat restoration. The NEB therefore imposed, in addition to Condition 17 requiring filing of an OMP, Condition 18 requiring filing of reports on the results of the CHROMMP developed by Westcoast. Westcoast has decided to use a single CHROMMP for the five projects and therefore has included the Spruce Ridge Project within the scope of this CHROMMP.

1.3 DOCUMENT STRUCTURE

This CHROMMP includes the following components:

- Introduction (Section 1.0)
- Monitoring Methods (Section 2.0)
- Adaptive Management (Section 3.0)
- Monitoring and Reporting Schedule (Section 4.0)
- References (Section 5.0)
- Example Datasheets (Appendix A)[2]
- Planned Caribou Habitat Restoration Monitoring Locations for the High Pine Expansion Project South Loop (Appendix B)
- Planned Caribou Habitat Restoration Monitoring Locations for the Wyndwood Expansion Project (Appendix C)
- Planned Caribou Habitat Restoration Monitoring Locations for the Pine River Aerial Crossing Project (Appendix D)
- Planned Restoration Treatments and Monitoring Locations for the Bearhole Offset in Bearhole Lake Protected Area (Appendix E)

2.0 MONITORING METHODS

The goal of Westcoast's CHRPs and OMPs is no net loss of caribou habitat. Westcoast's approach to achieving this goal is to implement on-site and off-site (offset) habitat restoration measures that:

- change 'disturbed habitat' to 'undisturbed habitat';
- limit or reduce habitat suitability for caribou predators and other ungulates in disturbed habitats;
- limit or reduce predator and human access within disturbed habitats; and
- provide ecological and functional value for caribou recovery.

Three measurable objectives were identified for on-site restoration in the CHRPs:

1. Restore caribou habitat.
2. Control access within caribou habitat.
3. Manage line-of-sight (LOS) within caribou habitat.

[2] The example datasheets are considered draft and may be modified.

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Three measurable objectives were identified for offset restoration in the OMPs:

1. Offset measures, in combination with on-site habitat restoration measures, result in no net loss of caribou habitat.
2. Offset measures are 'like-for-like or better'.
3. Offset measures are in the form of on-the-ground physical habitat restoration measures.

This section describes the methods for monitoring on-site and off-site restoration measures. Monitoring methods are described for the following five program components:

1. Vegetation (Section 2.1)
2. Rollback (Coarse Woody Debris) (Section 2.2)
3. Access Management (Section 2.3)
4. Line-of-Sight Management (Section 2.4)
5. Offset Restoration (Section 2.5)

This CHROMMP includes short-term (i.e., Years 1–5) and long-term (i.e., Years 10–20) monitoring. The proposed monitoring schedule for each project and program component is provided in Section 4.0.

This monitoring program uses a combination of quantitative and qualitative methods, some of which are ground-based, whereas others rely on aerial assessment or remote sensing data. Examples of quantitative methods include vegetation sample plots, rollback sampling transects, the use of motion-sensitive cameras to monitor access activity, and analysis of remote sensing data (e.g., Light Detection and Ranging [LiDAR] with 3D imagery; multispectral high-resolution satellite imagery). Examples of qualitative methods include visual assessments of access management measures, LOS assessments, and review of photo documentation. Collectively, these methods are based on scientific methods, protocols from established literature and previous projects pertaining to monitoring of caribou habitat restoration, and Indigenous knowledge received during the engagement and participation process. By necessity, monitoring methods vary based on the type, frequency (e.g., number of instances of access control locations), and scale (e.g., area seeded/planted among different treatments) of the restoration measures implemented.

The monitoring methods included in this CHROMMP are linked to the restoration goals stated in the Final CHRPs and Final OMPs, the related performance measures for each restoration treatment, and issues of importance to Indigenous groups identified through engagement. The corresponding rationale for the frequency, timing, and location of each component of the monitoring program is provided in the description of methods for each component and project, where relevant.

Adaptive management is a key part of this CHROMMP as it allows for corrective measures to be implemented and for lessons learned to be reviewed and adjusted for future projects. The adaptive management framework for this CHROMMP is described in Section 3.0.

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2.1 VEGETATION

Monitoring vegetation during the first five years following planting will provide an initial indication of habitat recovery and whether vegetation regrowth is on a trajectory to meet the restoration targets and performance measures (Machmer and Steeger 2002; Golder 2015). Vegetation recovery is planned to be monitored during the growing season from the ground and using remote sensing data following implementation of restoration measures. The benefits of monitoring early (i.e., in Years 1, 3, and 5) are early detection of vegetation establishment, seedling survival, and trends pertaining to natural recruitment, plant health, competition with undesired species (i.e., non-native, noxious weeds), and community composition (Rowland and Vojta 2013; Golder 2015). Results of monitoring in Years 1, 3, and 5 will allow for adjustments to be made to the restoration measures in a timely manner that improves habitat restoration outcomes (Machmer and Steeger 2002; Clewell et al. 2005). Short-term monitoring is also useful for testing the efficacy of the monitoring methods for meeting the monitoring objectives (i.e., whether monitoring results provide the desired degree of precision [Rowland and Vojta 2013]).

The development of vegetation communities and forest stands occurs on decadal time scales; therefore, long-term vegetation monitoring is anticipated to occur in Year 10, and in one year between Years 15–20. Vegetation monitoring will cease once restoration has been determined to have achieved a free-to-grow state, that is, an established vegetation community on a trajectory of natural succession that will meet the restoration targets. This is described in detail in Section 2.1.3.

Details of the vegetation monitoring approach are described in the following sections.

2.1.1 Study Design

The study design for vegetation monitoring is intended to provide a confident estimate of habitat restoration performance measures, such as tree or shrub height, tree seedling leader growth, and tree or shrub density. Quantitative and qualitative performance measures are intended to provide a complete picture of restoration performance, such as the tree and shrub species growing in each plot, the percent cover of shrub and herb layers, evidence of chlorosis on tree seedlings, soil type and depth, and presence and percent cover of grasses and other herbaceous plants.

Guidelines for boreal caribou habitat monitoring in northeast BC (Golder 2015) were used to inform the study design. To summarize, these guidelines are:

- Number of sample plots should consider the size of the project/offset area, the number and area of restoration units (e.g., biogeoclimatic zones), and the number and area of restoration treatments (e.g., tree-planted workspaces; seeded workspaces; rollback areas).
- Number of sample plots should be distributed approximately proportionally to the area of each restoration unit x restoration treatment combination.

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- Use sample plots with a radius of 3.99 m (50 m^2) for linear restoration areas where the width of the linear feature being restored is 8 m or wider (Figure 2.2). Sample plots should be placed in restoration unit x restoration treatment combinations that are at least 25 m long (50 m if overlapping with rollback; Section 2.2), approximately every 1 km, and generally no closer than 500 m from another sample plot of the same restoration unit x restoration treatment combination.
- Use three sample plots each with a radius of 1.78 m (10 m^2) for linear restoration areas where the width of the linear feature being restored is less than 8 m wide (Figure 2.2). This trio of sample plots should be placed in restoration unit x restoration treatment combinations that are at least 25 m long (50 m if overlapping with rollback; Section 2.2). Spacing of each trio of sample plots can vary from 1 trio/km to 10 trios/km, depending on the length of narrow segments.
- Sample plots with a radius of 3.99 m should include six mounds and sample plots with a radius of 1.78 m should include two mounds, for linear restoration areas that have been prepped at the recommended mounding density (Figure 2.2).
- Establish at least five sample plots with a radius of 3.99 m per hectare for each restoration unit x restoration treatment combination for non-linear restoration areas. New sample plots may be added at a lower rate (e.g., two to three sample plots for each additional hectare) if more than 20 sample plots can be established in each restoration unit x restoration treatment combination. Place the sample plots strategically such that the distance between sample plots is as large as possible when establishing sample plots in non-linear restoration areas.
- Avoid sampling restoration unit x restoration treatment combinations that are so small that five sample plots (i.e., five 3.99 m radius plots or fifteen 1.78 m radius plots) cannot fit (i.e., less than or equal to 1.0 ha). Consider grouping with another similar restoration area when this occurs but be aware of potential trade-offs in doing so (e.g., vegetation monitoring parameters that may be affected by restoration unit or restoration treatment may be less noticeable when grouped together; variance may be higher in measured parameters when restoration units or treatments are grouped together).

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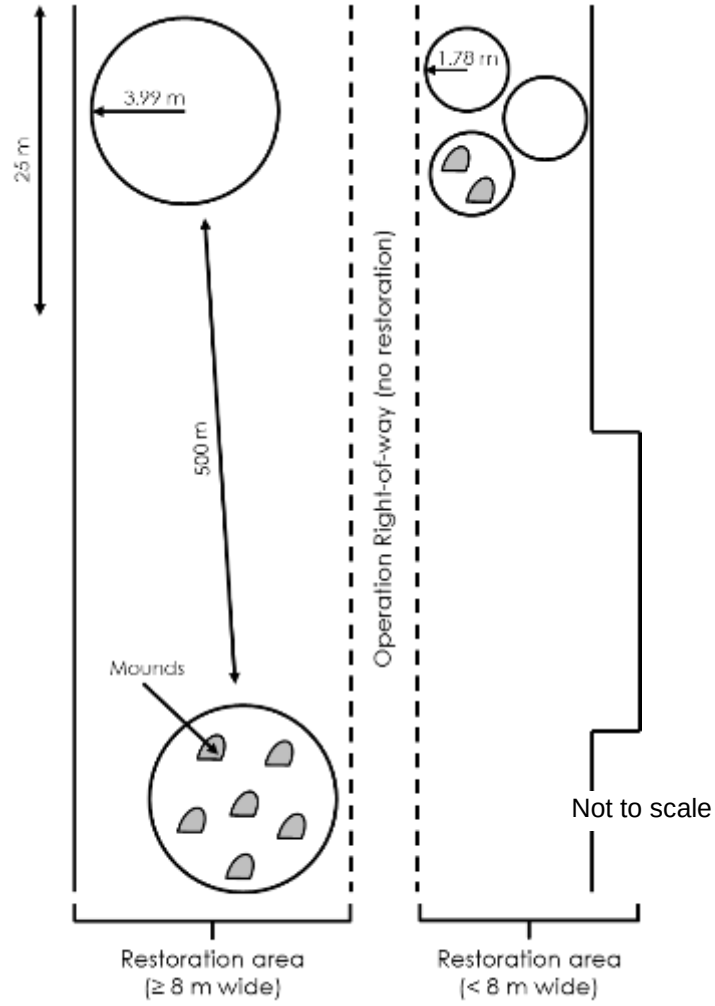
Figure 2.1 Generalized Design Elements for Establishing Vegetation Sample Plots



2.1.2 Sampling Objective and Sample Size

The sampling objective is to quantitatively estimate whether vegetation performance measures are meeting, exceeding, or missing the restoration targets. These targets are provided in the Final CHRPs for projects having on-site restoration, and in Table 2.2 for offsets. A power analysis was used to estimate how many sample plots would be needed to provide a confident estimate of vegetation performance measures for each restoration unit x restoration treatment combination, in consideration of five repeated measures (i.e., monitoring at Years 1, 3, 5, 10, and one year between Years 15–20). The power analysis followed the methods used in a CHROMMP prepared by Northern Resource Analysts (2015). The power analysis was dependent on three parameters, which were defined *a priori*: effect size, Type 2 error value, and Type 1 error value. The power analysis parameters used for each project and offset area were: effect size of 0.4 based on a recommendation from Faul et al. (2009) for one-way repeated measures designs; Type 2 error value of 0.8 based on a general rule for this type of analysis using normally distributed data (Montgomery 2001); and Type 1 error value of 0.1 used on the basis that a 95% (i.e., Type 1 = 0.05) confidence interval is likely overly restrictive for this type of monitoring (e.g., Environment Canada 2010, 2012). From these parameters, the power analysis determines the minimum number of samples that will provide an estimate of the mean that is within 40% of the true mean 90% of the time.

The power analysis was completed using G*power 3.1, a free online software program developed by Faul et al. (2009). The power analysis determined that at least 10 sample plots per restoration unit x restoration treatment combination would be needed to provide a confident estimate of vegetation performance measures (Figure 2.2).

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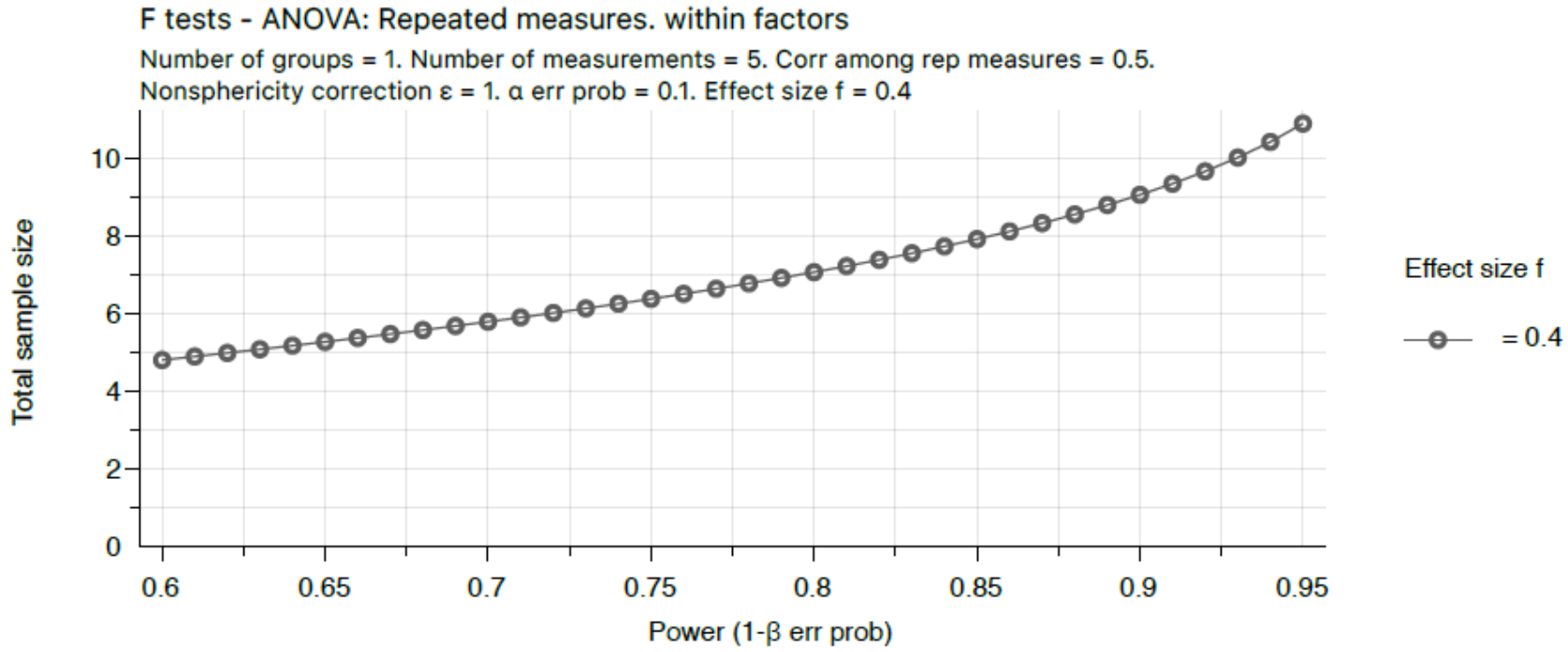
Figure 2.2 Power Analysis Results for Estimating Sample Size for Vegetation Monitoring



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2.1.3 Sample Plots

Sample plots were stratified and distributed among restoration unit x restoration treatment combinations based on general guidance (see Section 2.1.1) and the results of the power analysis (see Section 2.1.2). Table 2.1 summarizes the number of sample plots assigned to each project, restoration unit, and restoration treatment. Planned sample plot locations for High Pine, Wyndwood, and Pine River are shown in Appendix B, Appendix C, and Appendix D, respectively. Several restoration unit x restoration treatment combinations could not accommodate the minimum number (n = 10) of sample plots because the areas were too small and/or too patchy to accommodate more sample plots. Potential limitations resulting from these smaller sample sizes will be discussed in subsequent monitoring reports but may be managed analytically by grouping some plots together (e.g., High Pine—Access Control: Barrier Segments (rollback and tree planting) across different biogeoclimatic zones (e.g. Boreal White and Black Spruce [BWBS], Sub-Boreal Spruce [SBS], and Engelmann Spruce Subalpine Fir [ESSF]).

Attributes of vegetation to be measured in each plot are derived from the restoration targets and performance measures associated with each project and habitat type, as well as issues identified during engagement with Indigenous groups. Within each vegetation sample plot, a common set of plot data is planned to be collected at each monitoring interval (i.e., Year 1, 3, 5, 10, and one year between Years 15–20); the following vegetation performance measures will be observed and recorded (where relevant):

- tree species and abundance;
- coniferous and deciduous tree density (trees/ha; determined by summing the number of trees and dividing by the area sampled);
- tree seedling leaders appear healthy and are growing at expected rates for the species and ecosystem in which they were planted;
- percent cover of dominant and codominant trees, shrubs, and herbaceous plants (where dominant is greater than 25% cover and is visually estimated);
- percent cover and/or density of noxious and restricted weed species;
- mean coniferous and deciduous tree height (determined by taking the mean of trees measured); and
- percent rating of tree seedling health based on amount of observed chlorosis of each tree seedling.

The performance measure 'free-to-grow', which will generally be determined after Year 10, is based on the British Columbia Ministry of Forests guidebook (BC MOF 2000) and is defined as follows:

- Greater than or equal to 80% of live tree seedlings (from planting or natural ingress) demonstrate sustained growth trends and reach a height where they can no longer be outcompeted by undesired plants.
- Greater than or equal to 80% of tree seedlings (from planting and natural ingress) are considered well-spaced (e.g., maximum distance between stems relative to stocking density, such as 2 m at 2,500 stems/ha).

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Appendix A includes example datasheets for the collection of sample plot data[3]. These datasheets are considered draft and may be modified. The quantitative sample plot data will be supported by photo documentation of each sample plot at each monitoring interval.

Table 2.1 Number of Sample Plots Among Projects and Restoration Treatments and Units

Project	Restoration Treatment	Restoration Unit (Biogeoclimatic Ecosystem Classification [BEC] Zone)	Area (ha)	Sample Plots
High Pine	Tree planting (with and without rollback)	BWBS	37.3	20
		ESSF	5.6	5
		SBS	64.2	20
	Shrub Planting and Left for Natural Revegetation (Riparian Reserve Zone)	BWBS	0.2	2
		SBS	0.1	2
	Access Control: Barrier Segments (rollback with and without tree planting)	BWBS	6.0	4
		ESSF	1.0	3
		SBS	4.2	5
	Minimal Surface Disturbance and Left for Natural Revegetation	BWBS	1.1	3
	Unrestored (Rollback, Seeded)	BWBS	8.9	5
	Unrestored (Horizontal Directional Drill)	BWBS	0.6	2
		Project Total	**129.2**	**71**
Wyndwood	Tree planting (with and without rollback)	BWBS	20.9	27
	Shrub Planting and Left for Natural Revegetation (Riparian Reserve Zones)	BWBS	1.2	5
	Access Control: Barrier Segments (rollback with and without tree planting)	BWBS	1.0	7
	Unrestored (rollback)	BWBS	0.6	1
	Unrestored (left for natural revegetation)	BWBS	13.4	10
		Project Total	**37.1**	**50**
Pine River	Tree planting (with and without mounding)	BWBS	1.72	10
	Shrub planting	BWBS	1.17	9
	Unrestored (left for natural revegetation)	BWBS	0.16	1
		Project Total	**3.05**	**20**

[3] Information may be collected digitally.

2.1.4 Remote Sensing Data

Remote sensing technology is widely used to monitor a range of remotely detectable characteristics of vegetation and offers broad scale automated and repeatable methods for monitoring indicators of vegetation condition (Lawley et al. 2016). When combined with detailed ground-based vegetation monitoring methods, remote sensing and ground-based data can improve detectability of changes in vegetation (restoration performance) across a range of spatial and temporal scales (Lawley et al. 2016). In this CHROMMP, data derived from remote sensing technology (e.g., LiDAR integrated with 360° digital photography or high-resolution multispectral satellite imagery) is planned to be collected in Years 3, 5, 10, and one year between Years 15–20 to supplement ground-based vegetation monitoring data. The remotely sensed data will be used to draw inferences about vegetation performance measures for the on-site and off-site areas. In part, this will be done by correlating ground-based data from vegetation sample plots to variables in the remote sensing data that will serve as a proxy for vegetation regeneration within each project footprint.

Remotely sensed data can provide a quantitative estimate of vegetation establishment, growth, and productivity within the on-site and off-site restoration areas. While LiDAR has the advantage of providing a measurement of vegetation height, multispectral satellite imagery can provide a relative index to estimate the density of greenness on the landscape, such as Normalized Difference Vegetation Index (NDVI). Remotely sensed data is planned to be linked to restoration performance measures and targets, and may be derived as one or more of the following indicators: vegetation height, stem density, ground cover, ground roughness, slope, aspect, solar radiation index, and site severity index. If LiDAR is used, it will be sampled at a height above ground to effectively cover each restoration area. Westcoast will determine the appropriate type of remote sensing technology to use in consultation with Westcoast's Qualified Professional biologist and geospatial analyst in consideration of evolving tools, technological constraints, and monitoring objectives.

2.2 ROLLBACK (COARSE WOODY DEBRIS)

Rollback is used for access control in conjunction with other access management measures, and as part of site preparation to provide nutrients and microsite conditions (e.g., shading; moisture retention; wind protection) for vegetation establishment (see Final CHRPs for the High Pine and Wyndwood projects). Locations of rollback are identified in Appendix B for the High Pine Project and Appendix C for the Wyndwood Project. An example datasheet for measuring the volume of coarse woody debris (CWD) is provided in Appendix A. Rollback, where implemented, is planned to be measured in Year 1 to determine whether initial targets are met; that is:

- Volume is 150 m^3/ha or more.
- Spread across width of ROW and extends for at least 100 m, and up to 400 m, along the ROW.

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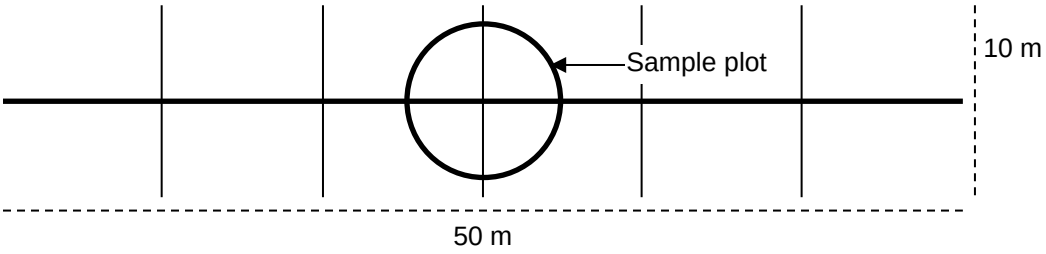
Volume (m^3/ha) of rollback is planned to be estimated by measuring individual pieces of CWD along one transect measuring 50 m in length, and along five perpendicular transects each measuring 10 m in length and spaced equally along the 50-m transect (Figure 2.3). Each 50-m transect will be centered on a vegetation sample plot (see Section 2.1) and oriented such that the full length of the transects are within an area treated with rollback. Pieces of CWD that will be included in the volume estimate will be greater than or equal to 5 cm in diameter and less than 45° to the ground. The volume V will be calculated using the formula from Van Wagner (1968) as:

$$V = \frac{(10{,}000\pi^2)}{8L}\sum_{i=1}^{N} d_i^2$$

where L is the combined length of the transects, d_i is the diameter (m) of the i^{th} piece of CWD, and N is the number of pieces of CWD that intersect the transect.

Figure 2.3 Transect Layout Centered on a Sample Plot for Measuring Volume of Coarse Woody Debris



2.3 ACCESS MANAGEMENT

Access management measures and the approach to monitoring effectiveness were affected by project-specific factors (i.e., number of locations; type of measure) and input from Indigenous groups. Therefore, the approach to monitoring access management is described separately for the High Pine, Wyndwood, and Pine River projects.

2.3.1 High Pine Project

Access monitoring for the High Pine Project is planned to occur annually through qualitative visual assessments of access controls for a period of five years (Years 1 to 5). These assessments will be completed either from the air during routine operations and maintenance inspections year-round, from the ground during ground-based monitoring activities (e.g., vegetation monitoring during the growing season), or from a combination of these. Remote cameras will not be used to monitor access control effectiveness to respect the request of local Indigenous land users. An example datasheet for documenting access control effectiveness is provided in Appendix A.

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Access monitoring targets, per the Final CHRP, are:

- access controls are not breached, damaged, or by-passed;
- human access is limited to low levels; and
- access controls are effective over the long term.

Access monitoring performance measures, per the Final CHRP, are:

- rollback is intact, with little evidence of motorized vehicle trails over or around them; and
- little evidence of damage to vegetation on the ROW by motorized vehicles.

The locations where access control was implemented and where monitoring is planned to be undertaken are provided in Appendix B.

2.3.2 Wyndwood Project

Access monitoring for the Wyndwood Project will use quantitative and qualitative methods comprised of remote cameras and visual assessment of access controls. Collectively, these methods are planned to be used to evaluate access control effectiveness in respect of the access control targets and performance measures.

Access monitoring targets, per the Final CHRP, are:

- access controls are not breached, damaged, or by-passed;
- human access is limited to low levels; and
- access controls are effective over the long term.

Access monitoring performance measures, per the Final CHRP, are:

- rollback is intact, with little evidence of motorized vehicle access over or around; and
- little evidence of damage to vegetation on the ROW by motorized vehicles

2.3.2.1 Remote Cameras

Eight remote cameras were installed along the project ROW (see Appendix C) within caribou range to monitor non-project motorized vehicle access and predator (e.g., wolf) and primary prey (e.g., moose) access. The cameras were installed in December 2019 and the locations are subject to refinement following analysis of Year 1 data. The cameras are planned to be maintained (e.g., replace batteries and memory cards) at six- to eight-month intervals for a period of five years (i.e., Years 1 through 5). Access control effectiveness is planned to be assessed by comparing the number of motorized vehicle, predator, and primary prey detections at access-controlled and reference (no access control) locations along the ROW. An example datasheet for documenting installation and maintenance checks of remote cameras is provided in Appendix A.

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2.3.2.2 Visual Assessments

These assessments will be completed either from the air during routine operations and maintenance inspections, from the ground during ground-based monitoring activities (e.g., vegetation monitoring), or from a combination of these. An example datasheet for measuring access control effectiveness is provided in Appendix A.

The locations where access control was implemented and where monitoring is planned to be undertaken are provided in Appendix C.

2.3.3 Pine River Project

A gate with concrete lock-blocks on both sides was installed across the existing Forest Service Road that leads from the Hart Highway into the existing cutblock that overlaps with the Project footprint (Appendix D).

Access monitoring for the Pine River Project is planned to be completed through visual assessment of access controls for a period of five years (Years 1 to 5). Access monitoring will be qualitative and completed during routine operations and maintenance inspections, and during on-site vegetation monitoring. An example datasheet for recording access control effectiveness is provided in Appendix A.

Access monitoring targets, per the Final CHRP, are:

- access control (i.e., gate) is not breached, damaged, or by-passed;
- human access is limited to low levels; and,
- access control is effective over the long term.

Access monitoring performance measures, per the Final CHRP, are:

- gate is not damaged or by-passed (i.e., no evidence of motorized vehicle trails around gate); and
- little evidence of damage to vegetation on the Project footprint by non-project motorized vehicles.

2.4 LINE-OF-SIGHT MANAGEMENT

LOS management is an objective of the High Pine and Wyndwood projects. The following sections describe how LOS measures are planned to be monitored for each project.

2.4.1 High Pine Project

Staggered pairs of zig-zag fencing were installed at three locations near KP 20+000, KP 22+600, and KP 22+800. Two rows of zig-zag fencing were also installed across the 10-m wide operational ROW near KP 10+000 along with planted trees measuring approximately 1.2 m in height on either side of the zig-zag fence over temporary workspace and the unmaintained ROW. Locations of LOS measures are shown in Appendix B.

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The LOS targets, per the Final CHRP, are:

- LOS is effectively managed at 500 m or less; and
- LOS mitigation is effective over the long term.

The LOS performance measures, per the Final CHRP, are:

- Zig-zag fencing is intact and at least 1.2 m in height;
- LOS is less than 500 m when observer height is 1.5 m and receptor height is the approximate height an adult caribou (i.e., 1.0 m to 1.2 m) such that at a distance of 500 m from an observer, less than 20% of a 'caribou' is visible; and
- Where shrubs or trees were used to manage LOS, height is 1.2 m or greater within five years, shrubs and trees are alive and healthy, and visibility through the trees and or shrubs is less than 50% at Year 2, less than 40% at Year 3, and less than 20% at Year 5.

Locations where burlap fencing was implemented as a LOS measure were visually assessed in 2020 (Year 1) as likely to be deficient. These fences were replaced in Q3 2020 with zig-zag fencing and are planned to be monitored in Years 2, 3 and 5 using a life-size cutout of a caribou (shoulder height of 1.2 m above ground). The cutout will be a similar shade, color, and shape to a caribou, and will be stood perpendicular to the ground. Two estimates of LOS effectiveness are planned using techniques adapted from McKay et al. (2014):

1. An observer, standing 25 m from the LOS measure, will estimate the percent visibility of the 'caribou' receptor on the opposite side of the LOS mitigation at 50 m, 100 m, 200 m, 300 m, 400 m, and 475 m from the observer. The measurements will be taken from both up-chainage and down-chainage of the LOS measure; these measurements will be recorded on the Access Management and Line-of-Sight Datasheet (Appendix A).
2. The observer and receptor will maintain a fixed distance apart (i.e., 500 m) and receptor visibility will be measured up-chainage and down-chainage where the receptor is 50 m, 100 m, 200 m, 300 m, 400 m, and 475 m from the LOS mitigation. LOS measurements will be recorded on the Access Management and Line-of-Sight Datasheet (Appendix A).

2.4.2 Wyndwood Project

A staggered pair of zig-zag fencing was installed at one location near KP 11+600 (Appendix C).
The same LOS monitoring approach, targets, and performance measures described for the High Pine Project are applicable to Wynwood.

2.5 OFFSET RESTORATION

The Final OMP for each project covered by this CHROMMP describes the offset measures planned for implementation. Westcoast opted to combine the offset requirements of each project into a single offset restoration program to restore legacy roads in a portion of the Narraway LPU that overlaps with Bearhole Lake Protected Area. Active restoration of the selected site is expected to deter motorized vehicle access, promote and establish vegetation communities so that they can recover on a trajectory of natural succession, and reduce the disturbance footprint on the landscape for caribou. Details describing how the offset location was selected, what offset measure is planned to be implemented, and how much area is expected to be restored directly and indirectly is provided in each of the project-specific Final OMPs.
The habitat restoration targets and performance measures for the Bearhole Offset are provided in Table 2.2.

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Table 2.2 Habitat Restoration Targets and Performance Measures for the Bearhole Offset

Measurable Objectives	Targets	Performance Measures
Restore caribou habitat (transitional and upland forest restoration units)	• Plantings do not include preferred browse (e.g., willow) that can attract other ungulates, unless naturally occurring or ingress occurs. • Evidence of chlorosis is low. • Leader growth of planted or naturally established seedlings. • Percent cover of targeted vegetation. • Density of targeted vegetation (e.g., stems/ha of prescribed species planted).	• At least 2,000 stems/ha planted. • In Year 1, average number of surviving stems/ha is at least 1,800 stems/ha (planted and natural ingress). • Evidence of chlorosis in Year 1 and Year 5 as determined by: – none (0%) – low (1-15%) – moderate (16-50%) – high (>50%) • At each monitoring interval, leaders appear healthy and are growing at expected rates for the species and ecosystem in which they were planted. • In Year 5, live seedling density is at least 2,000 stems/ha (from planting and natural ingress). • Initial plantings do not include preferred browse (e.g., willow) that can attract other ungulates. • In Year 1, Year 5, and Year 10 the percent cover of target vegetation is predominantly native, is not suppressing tree seedling growth, and is indicative of expected successional restoration. • After 10 years (i.e., one year between Years 15–20), ≥ 80% of live tree seedlings (from planting or natural ingress) demonstrate sustained growth trends and reach a height where they can no longer be outcompeted by undesired plants (i.e., free-to-grow conditions). • After 10 years (i.e., one year between Years 15–20), more than 80% of tree seedlings (from planting or natural ingress) are considered well-spaced.
Access control and LOS management (i.e., barrier segments)	• Access controls are not breached, damaged, or by-passed. • Human access is low. • LOS is effectively managed to 500 m or less. • Access controls and LOS are effective over the long term.	• Barrier segments are intact. • Evidence of human use as determined by the following in Year 1 to Year 5: – none – no evidence of human use (e.g., no sign of motorized vehicle tracks; no sign of damaged vegetation). – low – limited evidence of use (e.g., faint motorized vehicle tracks; some damaged vegetation). – medium – evidence of use prevalent (e.g., motorized vehicle tracks obvious; some rutting; vegetation suppressed). – high – evidence of use pervasive (e.g., motorized vehicle tracks well established; soils/organics deeply rutted or churned; vegetation limited). • LOS is less than 500 m when observer height is 1.5 m and receptor height is the approximate shoulder height of an adult caribou (i.e., 1.0 m to 1.2 m) such that at a distance of 500 m from an observer, less than 20% of a ‘caribou' is visible.

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Westcoast is planning to directly restore 7.08 ha (7.4 km) of road within Bearhole Lake Protected Area (Table 2.3;

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Figure 2.4) subject to an approved Park Use Permit. This direct restoration effort is expected to indirectly restore an additional 642.59 ha of disturbed caribou habitat. The restoration measures include road-ripping, rough-and-loose techniques, installation of barrier segments (i.e., tree-bending, tree-hinging, or tree-felling), and tree planting. Details of the offset restoration measures and timing of implementation are provided in the Final OMP for each project.

Table 2.3 Planned Vegetation Sample Plot Effort for Off-site Restoration

Project	Habitat Restoration Method	Final Offset Value (ha)	Habitat Restoration	Monitoring Effort (Number of Sample Plots)
High Pine	Road restoration (road ripping; surface prep plus tree planting with or without mounding; tree-bending, hinging, or felling)	~~493.20~~489.96	Length = 7.2 km Direct = 6.91 ha Indirect = 620.75 ha	36
Wyndwood		~~88.92~~69.48		
Spruce Ridge (CS2)		12.56		
Spruce Ridge (CSN5)		11.16		
Pine River Aerial	Barrier segments (tree-bending, tree-hinging, or tree-felling, minimum 200-m segments; natural regeneration within and or between segments)	15.~~79~~84	Length = 216 m Direct = 0.17 ha Indirect = 21.84 ha	1
2BL Crossover		5.62		
Subtotal		-	Length = 7.4 km Direct = 7.08 ha Indirect = 642.59 ha	-
Total		**~~627.25~~604.62**	**649.67 ha**	**37**

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Figure 2.4 Extent of Direct and Indirect Habitat Restoration of Roads in Bearhole Lake Protected Area (Bearhole Offset)

Monitoring of offset measures is planned to include the following methods:

- Vegetation monitoring: Methods are expected to be the same as those prescribed for on-site restoration treatments (see Section 2.1). Planned vegetation monitoring locations are shown in Appendix E. The quantitative sample plot data will be supported by photo documentation of each sample plot at each monitoring interval.
- Access monitoring: Qualitative methods are expected to be the same as those methods described for on-site access management (e.g., see Section 2.3.1). Quantitative methods will be based on human and wildlife detections collected by remote cameras, whereby the cameras will be placed along the restored roads and in undisturbed forest settings at least 500 m from restored roads and other linear features. Appendix E shows the planned remote camera monitoring locations. Cameras are planned to be installed following the implementation of the offset measures, and in use from Years 1 to 5.
- LOS monitoring: The method will be similar to the High Pine and Wyndwood projects (see Section 2.4.1 and 2.4.2). However, because the barrier segments are relatively long (e.g., 100 m to 200 m rather than a finite point), the 500 m fixed-distance approach used for High Pine and Wyndwood is not needed. Therefore, LOS monitoring for the barrier segments will have an observer, standing 25 m from the barrier segment, estimate the percent visibility of a 'caribou' receptor at 50 m, 100 m, 200 m, 300 m, 400 m, and 475 m from the observer. The measurements will be taken in a single direction along the road, as there is limited topographic relief along the roads that could affect LOS in different directions. Similarly, because of limited topographic relief, LOS will not be measured at distances greater than when a measured receptor value is less than 10% at a specified distance (e.g., 200 m), or where a bend in the road would naturally break LOS. Appendix E illustrates the location of planned barrier segments; LOS monitoring is planned to occur at those barrier segments that have a corresponding vegetation monitoring location.

3.0 ADAPTIVE MANAGEMENT

Adaptive management is a key part of the monitoring program and is the process through which the outcomes of monitoring activities are assessed relative to targets, and restoration or offset measures are adjusted or corrected as necessary in a timely manner, to achieve the goal. Adjustments or corrective measures may be needed if monitoring results indicate that targets are not being met. The adaptive management framework provides a process for investigating the root cause of performance measures that are not meeting their targets. Adjustments or corrective measures that are implemented will be subject to monitoring.

Figure 3.1 illustrates the adaptive management framework for this CHROMMP. The framework comprises six key steps:

1. Plan—the CHRPs and OMPs define the goal and describe the amount and type of on-site and off-site restoration that has been, or is planned to be, implemented to achieve no net loss of caribou habitat; targets and performance measures are also defined.
2. Act—the restoration and offset measures are implemented as prescribed in the CHRPs and OMPs.

3. Monitor and Report—the restoration and offset measures are monitored, at specified monitoring intervals (see Section 4.1), to determine if the monitoring targets are met using the performance measures. A monitoring report is prepared and filed with the CER following the reporting schedule (see Section 4.2).
4. Assess/Adjust/Correct—this step allows for an assessment of the root cause of a deficiency if monitoring targets are not being met; results of the assessment can inform the need for adjustments to existing measures, or for the implementation of corrective measures; as needed, engagement with government agencies and/or Indigenous groups may help to understand root causes and identify the need for adjustments or corrective measures.
5. Revise—implement adjustments or corrective measures as needed such that the goal of the CHRPs and OMPs is achieved; these adjustments or corrective measures will be monitored for effectiveness; for new measures not identified in a CHRP or OMP, monitoring targets, performance measures, and monitoring intervals will be provided in applicable monitoring reports.
6. Review/Learn—a comprehensive review of the restoration and offset plans, restoration and offset measures, targets and performance measures, and monitoring outcomes will be provided in the final monitoring report (i.e., one year between Years 15–20); as needed, final adjustments or corrective actions will be identified and implemented such that the goal of the CHRPs and OMPs is achieved; Westcoast plans to engage with government agencies and Indigenous groups as part of the review and lessons learned step.

Table 3.1 provides project-specific adaptive management actions for each restoration and offset measure, and their associated target(s) and performance measure(s). These adaptive management actions are not exhaustive, and the root cause assessment may identify other actions appropriate to addressing a deficiency.

The timing of implementing adjustments or corrective measures will consider sensitive periods for wildlife and other seasonal restrictions. Westcoast will also consider potential adverse effects when planning to implement corrective measures and will use appropriate mitigation to avoid disturbing regenerating vegetation, watercourses and wetlands, wildlife habitat features, and other sensitive resources (e.g., heritage resources). Other potential constraints to be considered by Westcoast include access, equipment needs, material availability, and on-site constraints such as weather and ground conditions.

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Figure 3.1 Adaptive Management Framework

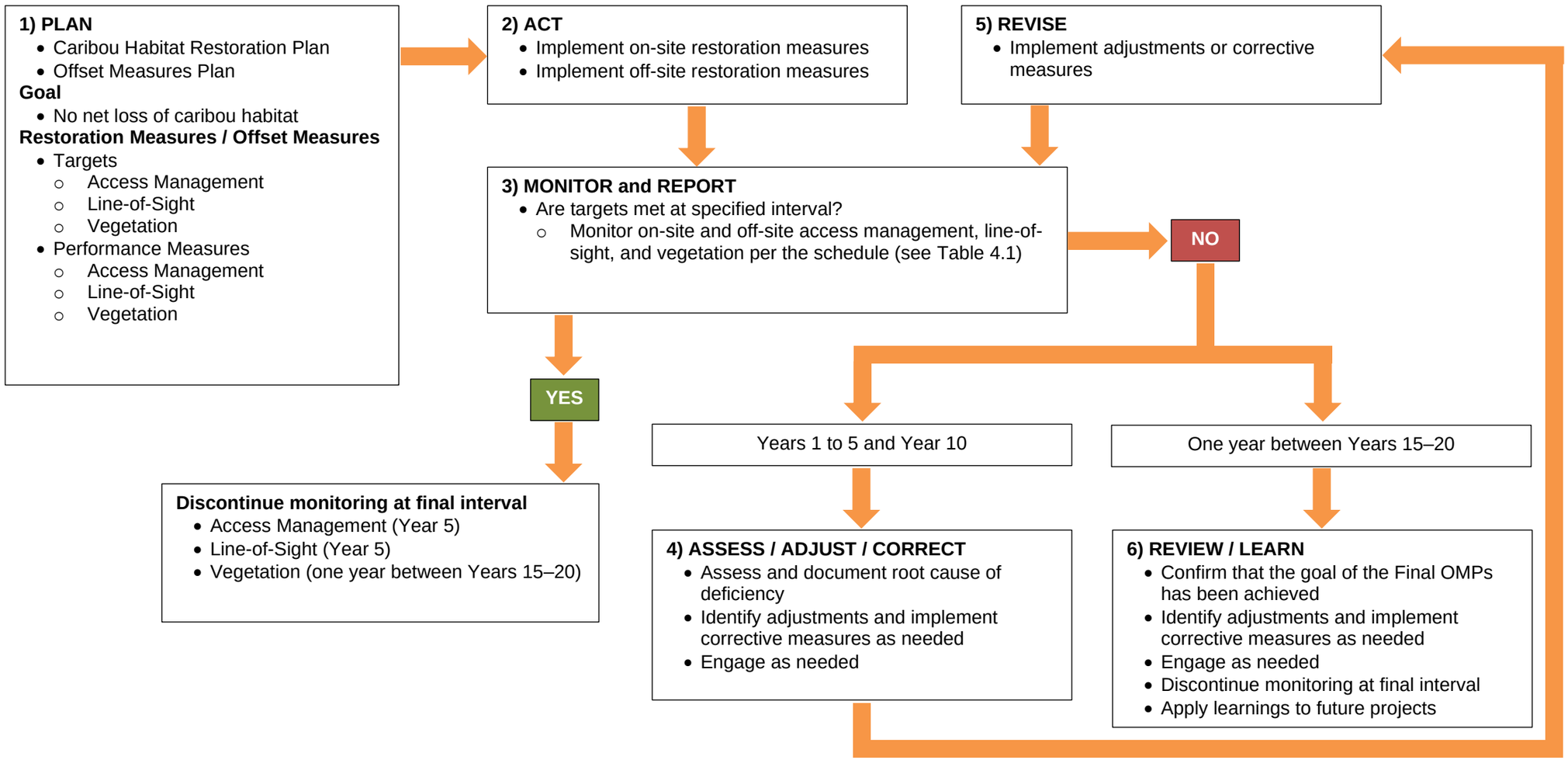

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Table 3.1 Habitat Restoration Targets, Performance Measures, and Adaptive Management Actions

Project	Targets and Performance Measures	Adaptive Management Action
High Pine	**Tree Planting to Accelerate Reforested State:** • See Final CHRP	**Tree Planting to Accelerate Reforested State:** • Mortality or damage of planted seedlings will be investigated, and supplemental planting will occur, as appropriate, to attain seedling density targets for each monitoring interval. This action will account for ingress of natural tree seedlings. • Vegetation management (e.g., herbicide application, mechanical removal) will be implemented to reduce competition if planted seedling growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Damage to planted seedlings caused by human access will be reviewed. If access can be controlled through corrective measures, supplemental planting may be undertaken depending on the scale of damage (e.g., area affected and effect on targets).
	Riparian Reserve Zone: • See Final CHRP	**Riparian Reserve Zone:** • Mortality or damage of planted shrubs will be investigated, and supplemental planting will occur, as appropriate, to attain the desired stem density target. This action will account for ingress of natural tree seedlings. • In riparian reserve zones willow will either be cut high or left to grow to reduce LOS where they are growing naturally if willow exceeds 10% cover. • Manual removal methods will be implemented to reduce competition, if planted shrub growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Corrective measures will be implemented if bank erosion is present, which may include additional planting and bank restructuring or stabilization measures.
	Wetlands [naturally forested]: • See Final CHRP	**Wetlands [naturally forested]:** • See adaptive management actions for Tree Planting to Accelerate Reforested State.
	Access Control: • See Final CHRP	**Access Control:** • Evidence of breach, damage, or bypass will be assessed for root cause, including physical destruction and motorized vehicle access. Corrective or supplemental access control measures may be implemented (e.g., fencing, rollback, large rocks) if materials are available locally. Access management issues will, as appropriate, be discussed with Indigenous groups and MFLNRORD regarding finding an appropriate solution.
	Line-of-Sight Management: • See Final CHRP	**Line-of-Sight Management:** • Zig-zag fencing will be repaired, as needed, to maintain LOS until planted vegetation height meets LOS targets. As appropriate, damage to zig-zag fencing caused by physical destruction will be discussed with Indigenous groups and MFLNRORD. • Mortality or damage to shrubs and trees planted for LOS will be investigated and supplemental planting or alternate treatment may be implemented to achieve LOS targets.

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Table 3.1 Habitat Restoration Targets, Performance Measures, and Adaptive Management Actions

Project	Targets and Performance Measures	Adaptive Management Action
Wyndwood	**Tree Planting to Accelerate Reforested State:** • See Final CHRP	**Tree Planting to Accelerate Reforested State:** • Mortality or damage of planted seedlings will be investigated, and supplemental planting will occur, as appropriate, to attain seedling density targets for each monitoring interval. This action will account for ingress of natural tree seedlings. • Vegetation management (e.g., herbicide application, mechanical removal) will be implemented to reduce competition if planted seedling growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Damage to planted seedlings caused by human access will be reviewed. If access can be controlled through corrective measures, supplemental planting may be undertaken depending on the scale of damage (e.g., area affected and effect on targets).
	Riparian Reserve Zone: • See Final CHRP	**Riparian Reserve Zone:** • Mortality or damage of planted shrubs will be investigated, and supplemental planting will occur, as appropriate, to attain the desired stem density target. This action will account for ingress of natural tree seedlings. • In riparian reserve zones willow will either be cut high or left to grow to reduce LOS where they are growing naturally if willow exceeds 10% cover. • Manual removal methods will be implemented to reduce competition, if planted shrub growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Corrective measures will be implemented if bank erosion is present, which may include additional planting and bank restructuring or stabilization measures.
	Wetlands [naturally forested]: • See Final CHRP	**Wetlands [naturally forested]:** • See adaptive management actions for Lowland and Upland/Transitional units
	• **Access Control and Line-of-Sight Management:** • See Final CHRP	**Access Control and Line-of-Sight Management:** • Evidence of breach, damage, or bypass will be assessed for root cause, including physical destruction and motorized vehicle access. Corrective or supplemental access control measures may be implemented (e.g., fencing, rollback, large rocks) if materials are available locally. Access management issues will, as appropriate, be discussed with Indigenous groups, and MFLNRORD regarding finding an appropriate solution. • Zig-zag fencing will be repaired, as needed, to maintain LOS until planted vegetation height meets LOS targets. Damage to zig-zag fencing caused by physical destruction will be discussed with Indigenous groups and MFLNRORD, as appropriate. • Mortality or damage to shrubs and trees planted for LOS will be investigated and supplemental planting or alternate treatment may be implemented to achieve LOS targets.
Pine River	**Tree Planting to Accelerate Reforested State:** • See Final CHRP	**Tree Planting to Accelerate Reforested State:** • Mortality or damage of planted seedlings will be investigated, and supplemental planting will occur, as appropriate, to attain seedling density targets for each monitoring interval. This action will account for ingress of natural tree seedlings. • Vegetation management (e.g., herbicide application, mechanical removal) will be implemented to reduce competition if planted seedling growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Damage to planted seedlings caused by human access will be reviewed. If access can be controlled through corrective measures, supplemental planting may be undertaken depending on the scale of damage (e.g., area affected and effect on targets).
	Riparian Reserve Zone: • See Final CHRP	**Riparian Reserve Zone:** • Mortality or damage of planted shrubs will be investigated, and supplemental planting will occur, as appropriate, to attain the desired stem density target. This action will account for ingress of natural tree seedlings. • In riparian reserve zones willow will either be cut high or left to grow to reduce LOS where they are growing naturally if willow exceeds 10% cover. • Manual removal methods will be implemented to reduce competition, if planted shrub growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Corrective measures will be implemented if bank erosion is present, which may include additional planting and bank restructuring or stabilization measures.
	Access Control: • See Final CHRP	**Access Control:** • Damage to the gate or lock blocks, evidence of motorized trails, and the level of breach, damage, or bypass will be assessed. The gate or lock blocks will be repaired or replaced to maintain access control as necessary until the planted vegetation height and density naturally limits motorized vehicle access to low levels. • Supplemental access control measures may be implemented (e.g., fencing, supplemental rollback, large rocks), as appropriate, based on availability of local materials and specific to areas where motorized vehicle access is identified.

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Adaptive Management
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Table 3.1 Habitat Restoration Targets, Performance Measures, and Adaptive Management Actions

Project	Targets and Performance Measures	Adaptive Management Action
Offset Bearhole Lake Protected Area	**Road Restoration:** • See Final Table 2.2	**Road Restoration:** • Mortality or damage of planted seedlings will be investigated. However, supplemental planting is not expected to be needed based on initial planting densities being relatively high (i.e., up to 5,000 stems/ha) to account for expected rates of mortality and the limited and challenging access to the restoration units following initial restoration implementation • Vegetation management (e.g., herbicide application, mechanical removal) may be implemented (subject to an approved Park Use Permit) to reduce competition if planted seedling growth is suppressed by undesired vegetation (i.e., non-native species, noxious weeds). • Damage to planted seedlings caused by human access will be reviewed. If access can be controlled through corrective measures, supplemental planting may be undertaken depending on the scale of damage (e.g., area affected and effect on targets). Barrier segments, subject to an approved Park Use Permit, are planned for implementation based on the distribution and availability of suitable materials. There are no adaptive management actions for LOS in Bearhole Lake Protected Area, although the likelihood of not meeting the intended target is predicted to be negligible given the implementation prescription and prohibition of motorized vehicle access within Bearhole Lake Protected Area.

4.0 MONITORING AND REPORTING SCHEDULE

4.1 MONITORING SCHEDULE

To the extent practical, on-site monitoring has been aligned to occur in the same years for the High Pine, Wyndwood, and Pine River projects to take advantage of efficiencies and to provide consistency in data collection. Off-site monitoring years have also been aligned with on-site monitoring years to the extent practical. The planned monitoring schedule for on-site and off-site restoration is provided in Table 4.1. The schedule is subject to change, dependent on unforeseen or unplanned constraints (e.g., weather and ground conditions; permit conditions; access or travel restrictions).

4.1.1 Vegetation and Rollback (Coarse Woody Debris)

Westcoast's monitoring schedule for vegetation and rollback is Years 1, 3, 5, 10, and one year between Years 15–20. On-site vegetation and rollback monitoring for the High Pine, Wyndwood, and Pine River Projects commenced in 2020 (Year 1), and off-site vegetation monitoring is planned to commence in 2022 (Year 1). Monitoring of vegetation restoration treatments that were planted with tree seedlings to accelerate forest regeneration will continue until free-to-grow status is achieved. Free-to-grow status could occur as early as 10 years at some sites but is more likely to be achieved at 15–20 years (BC MOF 2000).

4.1.2 Access Control and Line-of-Sight Management

On-site access control monitoring for the High Pine, Wyndwood, and Pine River projects commenced in 2020, and on-site LOS monitoring for the High Pine and Wyndwood projects is planned to commence in 2021 as LOS measures that were in place initially were replaced in late Q3 2020 (Table 4.1).
Access control monitoring is planned to occur annually in Years 1 to 5 following implementation, and LOS monitoring for the High Pine and Wyndwood projects is planned to occur in Years 2, 3, and 5. An assessment at Year 5 is planned to be completed to determine if additional monitoring is needed as vegetation recovers around the access control and LOS management areas.

Off-site access control monitoring is planned to commence in late 2021 and continue through late 2026 (Table 4.1). Off-site LOS monitoring is planned to commence in late 2022 and continue in 2024 and 2026. An assessment at Year 5 is planned to be completed to determine if additional monitoring is needed as vegetation recovers around the access control and LOS management areas.

4.2 REPORTING SCHEDULE

Westcoast will file monitoring reports with the CER, and provide copies to ECCC, MFLNRORD, and interested Indigenous groups. The reports will include monitoring results, outcomes of adaptive management, and a summary of lessons learned (i.e., in the final monitoring report in one year between Years 15–20). The reporting schedule is illustrated in Table 4.1, which mirrors the monitoring schedule for on-site and off-site monitoring in Years 1, 3, 5, 10, and one year between Years 15–20 following the implementation of restoration measures.

CARIBOU HABITAT RESTORATION AND OFFSET MEASURES MONITORING PROGRAM

Monitoring and Reporting Schedule
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Table 4.1 Monitoring and Reporting Schedule

Project Activity	Timing																																							
	2018				2019				2020				2021				2022				2023				2024				2025				2026				2029				2031				Year 15-20[a]			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Implement High Pine CHRP																																											
Implement Wyndwood CHRP																																											
Implement Pine River CHRP																																											
On-site access monitoring (High Pine, Wyndwood, Pine River)									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5																
On-site LOS monitoring (High Pine and Wyndwood)[b]											1				2				3							5																	
On-site vegetation monitoring (High Pine, Wyndwood, Pine River)											1								3							5									10							
Implement OMP (off-site)																																											
Off-site access monitoring																1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5									
Off-site LOS monitoring																			1								3							5									
Off-site vegetation monitoring																			1								3							5				10					
On-site monitoring reports																1				3								5										10					
Off-site monitoring reports																				1								3							5				10				

LEGEND:
Shaded cells indicate timing of project activity; a number inside the shaded cell indicates the monitoring Year

NOTES:
[a] The final year of on-site and off-site vegetation monitoring will occur in Q3 in one of the years between Years 15-20. This year may be different for on-site and off-site.
[b] Locations where burlap fencing was implemented as a LOS measure were assessed in 2020 as likely to be deficient. These fences were replaced in Q3 2020 with zig-zag fencing and are planned to be monitored in Years 2, 3 and 5.

CARIBOU HABITAT RESTORATION AND OFFSET MEASURES MONITORING PROGRAM

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APPENDIX A

Example Datasheets

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Appendix A Example Datasheets
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Appendix A EXAMPLE DATASHEETS

APPENDIX B

Planned Caribou Habitat Restoration Monitoring Locations for the High Pine Expansion Project South Loop

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Appendix B Planned Caribou Habitat Restoration Monitoring Locations for the High Pine Expansion Project South Loop
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Appendix B PLANNED CARIBOU HABITAT RESTORATION MONITORING LOCATIONS FOR THE HIGH PINE EXPANSION PROJECT SOUTH LOOP

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APPENDIX C

Planned Caribou Habitat Restoration Monitoring Locations for the Wyndwood Expansion Project

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Appendix C Planned Caribou Habitat Restoration Monitoring Locations for the Wyndwood Expansion Project
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Appendix C PLANNED CARIBOU HABITAT RESTORATION MONITORING LOCATIONS FOR THE WYNDWOOD EXPANSION PROJECT

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APPENDIX D

Planned Caribou Habitat Restoration Monitoring Locations for the Pine River Aerial Crossing Project

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Appendix D Planned Caribou Habitat Restoration Monitoring Locations for the Pine River Aerial Crossing Project
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Appendix D PLANNED CARIBOU HABITAT RESTORATION MONITORING LOCATIONS FOR THE PINE RIVER AERIAL CROSSING PROJECT

APPENDIX E

Planned Restoration Treatments and Monitoring Locations for the Bearhole Offset in Bearhole Lake Protected Area

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Appendix E Planned Restoration Treatments and Monitoring Locations for the Bearhole Offset in Bearhole Lake Protected Area
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Appendix E PLANNED RESTORATION TREATMENTS AND MONITORING LOCATIONS FOR THE BEARHOLE OFFSET IN BEARHOLE LAKE PROTECTED AREA