Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta

May 2017

Alberta

Executive Summary

Overview

Restoration of legacy features, particularly seismic lines, is a key tool in range planning for woodland caribou in Alberta. This Provincial Restoration and Establishment Framework ("the framework") outlines requirements for government-led programs and recommendations for voluntary industry-led programs to move towards a common restoration objective.

Objective and indicators

The overarching goal of the framework is caribou population recovery, the objective is the successful restoration of legacy seismic lines, and a series of core indicators of success have been established to determine whether habitat is on a trajectory to become effective habitat. These indicators include:

- Restoration programs and locations have been selected based on relevance to woodland caribou and contribute to efforts to restore large tracts of woodland caribou habitat.
- Where advanced regeneration is not evident, treatments have addressed site limiting factors and have established appropriate trees based on the adjacent habitat.
- Where advanced regeneration is already present and to the degree feasible, this advanced regeneration has been protected.
- The treatments limit human and predator movement on the landscape.

To achieve these four indicators of success, the framework includes four key steps that will guide planning of government-led restoration programs in Alberta (Table i).

Table i. Restoration planning in Alberta will follow four major indicators from the planning stage to monitoring for success.

Planning	Treatment delivery and quality control	Survival Assessment (years 2–5)	Establishment Survey (years 8–10)
A site is selected based on benefit to caribou, site limiting factors are identified and an efficient and effective plan is developed for the restoration area.	Treatments are applied, quality is evaluated and corresponding contractor payments are determined.	Seedling survival is evaluated after one full growing season and early warning signs can be used to adjust future treatments or retreat problem areas.	Line coverage and tree recovery and human use are surveyed to assess restoration success.

Planning

The framework outlines necessary steps in planning a restoration program. It is intended to provide a clear roadmap and outline restoration planning expectations to ensure that treatments have the best opportunity to achieve success.

Consistent with the overarching goals of the framework, project plans must clearly demonstrate how the four core indicators of success will be achieved by specifying:

- A clear understanding of the restoration goal
- The location of programs and rationale
- A description of proposed treatments by line and site conditions
- Documentation of access management considerations
- A commitment to adaptive management

Evaluating treatment quality

Quality control efforts will be a requirement of all government-led restoration programs and are encouraged for voluntary restoration programs. Quality control programs will be designed to confirm that:

- Site preparation treatments have been delivered to a high standard of quality and have been applied in a way that addresses the limiting factors of each site.
- Planting or seeding treatments have implemented a robust chain of custody, have been planted to a high standard of quality, and have been applied at a density that matches the approved operational plan.
- Line deactivation treatments have been applied in a way that blocks predator movement patterns and at densities that match the approved operational plan.

Establishment monitoring

Surveys conducted as part of the Establishment Monitoring represent the core metric by which restoration success will be evaluated.

The Establishment Monitoring will consider the survival of tree species at years 2–5 and overall tree stocking, coverage, tree height and absence of human access trails at years 8–10. Specifically, projects will be evaluated against the targets identified in the table below.

Sites that have existing advanced regeneration at the time of restoration are assessed using a different target in the Establishment Monitoring because in some cases a specific objective (e.g., conifer stocking) would be impractical without removing existing regeneration, which may not be desirable. However, advanced regeneration sites must have the ability to reach a minimum vegetation height.

The Establishment Monitoring targets will be a required component of Government led restoration programs and are encouraged for use in voluntary restoration programs.

Site Type	Survival Target	Establishment Target
Upland and transitional; Lowland treed		
Treated Areas	▪ 75% survival of winter-planted trees ▪ 80% survival of summer-planted trees ▪ 4,000–5,000 stems/ha of seeded or naturally regenerated trees	▪ >70% stocking of acceptable tree species with a minimum density of 1000 stems/ha, with no less than 50% stocking on each side of line. ▪ Tree species suitable based on adjacent stand type. ▪ <10% of sites have human access.
Advanced Regeneration Site	N/A	▪ >70% coverage of species that are capable of reaching a height of 5.0 metres[4] with no less than 50% coverage on either side of the line. ▪ <10% of sites have human access.
Upland dry (e.g., xeric); Lowland low density treed		
Treated Areas	▪ 75% survival of winter-planted trees ▪ 80% survival of summer-planted trees ▪ 2,500–4,000 stems/ha of seeded or naturally regenerated trees	▪ >50% stocking of acceptable tree species with a minimum density of 800 stems/ha, with no less than 40% stocking on each side of line. ▪ Tree species suitable based on adjacent stand type. ▪ <10% of sites have human access.
Advanced Regeneration Site	N/A	▪ >70% coverage of species that are capable of reaching a height of 5.0 metres with no less than 50% coverage on either side of the line. ▪ <10% of sites have human access.

Regenerating trees must also have reached a minimum height target by years 8–10 to count toward the stocking objective (Table ii).

Table ii. Coniferous and deciduous minimum height targets for achieving successful stocking.

Site Type	Coniferous Height Target for Stocking	Deciduous Height Target for Stocking
Upland dry	60 cm	120 cm
Upland and transitional	80 cm	120 cm
Lowland treed	65 cm	120 cm
Lowland low density treed	60 cm	120 cm

Monitoring approaches

The provincial restoration framework has been designed to accommodate ground-based Survival Assessments and both ground-based and aerial Establishment Surveys. Aerial assessments provide opportunities to use innovative techniques and maximize the efficiency of monitoring efforts. Ground-based plots are required on a limited number of restoration sites at both the Survival Assessment and Establishment Survey phases to ensure sufficient resolution of vegetation responses across all restored areas, and to verify the quality of aerial assessments. These ground-based surveys will be designed in such a way that they capitalize on existing access points and will not require travel over restored areas.

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Definitions of Terms Used in this Document

Aboriginal	Defined by Section 35 (2) of the *Constitution Act* to be an Indian, Inuit or Métis person in Canada
Acceptable tree	A tree that meets the following criteria: • The tree is alive • It is an acceptable tree species (Table 6) • It has been on the site for a minimum of two growing years These additional criteria must also be met at the Survival Assessment stage: • Deciduous trees shall be a minimum of 30 cm tall. • Coniferous trees shall have a well-defined stem and be a minimum of 15 cm tall.
Advanced regeneration	Areas that are successfully regenerating naturally and therefore do not require treatment. (Note: tree-felling may still be used to limit wildlife movement and human access in advanced regeneration areas.)
Audit	An official review of records which may or may not also involve a field inspection to ensure standards are being met.
Belt plot	A 30 m long rectangular plot that is the width of the seismic line. The plot is used during the Survival Assessment and the ground-based Establishment Survey to estimate stocking, presence of a game trail, human access, browse availability and signs of browsing.
Circular survey plot	A sample plot with a 1.78 m radius, covering a 10 m^2 area.
Coarse woody debris (CWD)	Deadwood found in the adjacent forest or in windrows along seismic lines from original line clearing. Many wildlife species depend on CWD for survival and uses included nesting, denning, roosting, foraging and cover. Decomposed woody fibres are ultimately turned into organic matter utilized by growing forests.
Coniferous tree	Needle-leafed trees that produce cones (includes larch species, e.g. *Larix laricina*).

Consultation	A formal process conducted by the Government of Alberta intended to help parties understand and consider potential adverse impacts of project decisions, and substantially address them through constructive negotiation, accommodation and reconciliation. The duty to consult cannot be delegated to third parties; however, procedural aspects of consultation may be delegated.
Coverage	The extent to which a variable of interest covers or spans a seismic line segment, expressed as a percentage of the segment's surface area. During quality control, coverage refers to operational treatments. This criterion is used to determine operational success and can assist in determining contractor payment. During Establishment Surveys, coverage refers to tree vegetation. This criterion is used as a measure of restoration success.
CSR (Segment passes with conditions)	The line segment passes the general stocking criteria but secondary criteria are not met.
Deciduous tree	Broadleaved tree species that lose their leaves in the autumn.
Disposition	The authority granted by the Alberta Government or the Alberta Energy Regulator pursuant to the *Public Lands Act* to use public land for specific purposes, activities and duration.
Effective habitat	As defined in the draft range plan for the Little Smoky and A La Peche Ranges, habitat with characteristics that provide caribou with all of their ecological needs (that is, food, shelter, ability to travel and disperse, ability to reproduce, and ability to avoid excessive levels of predation).
Engagement	Discussions, meetings, and otherwise sharing information between a third-party project contractor and potentially impacted rights holders (Aboriginal or Indigenous communities) or stakeholders. Potential project impacts, and project option considerations to improve and strengthen the project plans and implementation, are discussed and documented based on feedback.
Establishment Survey	A survey of seeded, planted and advanced regeneration sites conducted 8–10 years after reforestation treatments to evaluate establishment (i.e., whether stands are on a trajectory to close the forest canopy).

Ground-based Establishment Survey	A ground-based survey completed following a reconnaissance Establishment Survey (i.e., 8–10 years after restoration treatments) by a qualified surveyor to confirm the accuracy of reconnaissance survey results and to determine if a site has achieved the establishment targets. Data collected during this survey will be used in quality control evaluations of the reconnaissance Establishment Survey and provide data to determine the rate at which trees are returning to the canopy.
Habitat restoration	The practice, process or result of active human intervention and treatments to renew and restore degraded, damaged or destroyed ecosystems and habitats. Habitat restoration aims to protect and restore critical "services" that the environment provides.
Hydric	The moisture regime of an environment or habitat containing an abundance of moisture; very wet. Hydric soils are permanently or seasonally saturated by water resulting in anaerobic conditions.
Indigenous peoples	Canada's three constitutionally-recognized and diverse aboriginal peoples including First Nation, Inuit and Métis (see Aboriginal).
Indigenous traditional knowledge	An Aboriginal community's understanding about the natural world within a particular area or region based on long-term occupancy and cultural knowledge transmission and practice. (Also traditional ecological knowledge, Aboriginal traditional knowledge or traditional knowledge.)
Legacy seismic lines	Linear features that are seismic in origin and greater than 5 m wide. These lines are also referred to as conventional seismic lines.
LiRA (Linear Restoration Application)	A provincial data management system used by contractors to report all restoration activities performed at the site level, including site reconnaissance information, site imagery, silvicultural treatments, reforestation efforts, and quality control and monitoring information.
Low-impact seismic	Linear features that are seismic in origin and less than 5 m wide. Low-impact seismic lines may also require treatment and should be incorporated into the restoration plan when appropriate.
Mesic	The moisture regime of an environment or habitat containing a moderate amount of moisture; somewhat wet. Mesic soils retain adequate soil moisture year-round; water is removed somewhat slowly in relation to supply.
Microsite	The specific spot occupied by the tree and defined by the environmental attributes that contribute to the tree's growth and survival.

Natural disturbance	A disturbance such as fire, insect, disease or windthrow that impacts the vegetation or environment in an area and may alter the successional trajectory of a forest ecosystem.
Natural regeneration	Sites that have been treated but not seeded or planted and rely on natural recruitment of seeds into the site.
Non-tenured linear features	Linear features that are not tenured or seismic in origin BUT are incorporated into the development of the restoration plan. Examples include trails and cut lines of unknown origin.
NSR (Segment failure)	The line segment does not pass the general stocking criteria or the line segment is less than 60% visible on aerial imagery.
Program	A group of linear restoration projects being implemented by one or more proponents within a single caribou range.
Project	A contiguous area that is being managed by an individual contractor to deliver a subset of an overall restoration program.
Project exclusions	Areas that are not treed or are considered outside the framework including riparian areas, outwash plains, grassy montane areas, open fens, etc.
Proponent	The company or organization overseeing the implementation of a restoration program and corresponding projects.
Qualified	Ground and aerial surveyors meeting the training and certification requirements to conduct Survival and Establishment Surveys (Section 7.5). Interpreters holding valid AVI Level 1 certification to interpret aerial photography or video as part of reconnaissance Establishment Surveys. Government of Alberta agents having authority to review and approve restoration treatment plans and final submissions.
Reconnaissance Establishment Survey	An efficient, visual evaluation of all linear features in a restoration program by a qualified surveyor 8–10 years following restoration to determine whether establishment targets have been achieved. The visual assessment can be conducted by walking or flying over the line. The aerial assessment can be done by a surveyor during the flight or by capturing imagery and conducting a desktop review.
Reforestation	Successful renewal of a forest by planting, direct seeding or natural regeneration.

Regulated Professional	A member in good standing in any of the four acceptable Albertan professional regulatory organizations: Alberta Institute of Agrologist (AIA), Alberta Society of Professional Biologists (ASPB), College of Alberta Professional Foresters (CAPF), or College of Alberta Professional Forest Technologists (CAPFT).
Restoration	The process of repairing damage to ecosystems and habitats to achieve conditions that emulate natural, self-regulating systems integrated ecologically with the local landscape. A holistic approach to renewing native ecosystems.
Root collar	The base of a seedling where the root ends and the stem begins.
Seismic exploration	Industrial activity used to delineate oil and gas reserves. Historically, in forested areas these activities create a linear network of cleared ground.
Site limiting factor	An environmental condition that limits the growth, abundance or distribution of vegetation.
Site preparation	A mechanical, chemical or hand treatment that modifies the site to improve the growing conditions for natural or artificial regeneration.
SR (Segment passes)	A line segment that passes both the general stocking criteria and secondary criteria.
Stand type	A community of trees that is distinguishable from other tree communities based on its composition, structure and density.
Stocked	Sites in which growing spaces across the seismic lines are effectively occupied by tree seedlings that are alive and have achieved a minimum height and there is adequate room for continued development; the target for stocking has been achieved.
Stocking	A measure of the area occupied by trees. In the context of this framework, stocking refers to a combination of density, survival and a minimum height target, along with the presence of trees across the entire line.
Stratum (strata)	A category of linear segments that have received the same treatment and are in the same moisture class (e.g., xeric-screefed, mesic-mounded, etc.).
Successional trajectory	The changes in plant species composition and functional traits as a forest stand ages following disturbance. For this framework, successional trajectory refers to returning linear features from non-treed systems to forested ecosystems matching the adjacent stand.
Survival Assessment	An interim assessment of seedling survival on treated sites, 2–5 years after reforestation.

Traditional land use	Past and present use of the land for traditional or cultural purposes important to Indigenous peoples including but not limited to hunting, fishing, trapping, ceremonial pursuits and the gathering of plants for food and medicinal purposes. (Also Aboriginal traditional land use, Indigenous traditional land use.)
Treatment type	A category of linear segments that have received the same treatment (e.g., mounded, mounded+CWD, screefed, etc.).
Tree height	Measured from the base of the tree at the average ground level. The height of coniferous trees measured prior to July 15 shall be measured to the base of the current year's growth. After July 15, height is measured to the top of the terminal bud or the furthest reaching living bud. For deciduous trees, the current season's growth is to be measured regardless of survey date.
Tree leader	The vertical stem at the top of the tree representing the current year's growth in conifers.
Xeric	Describes the moisture regime of an environment or habitat that is dry and prone to drought; little moisture retention. Water within xeric soils is removed very rapidly in relation to supply.

Disclaimer

The Provincial Restoration and Establishment Framework is not intended to serve as a detailed review of, or justification for, restoration in woodland caribou habitat. Rather, its intent is to provide a clear framework for efficient and effective implementation of restoration programs. For information on the rationale for restoration, factors limiting the recovery of legacy features, and other relevant synthesis please refer to the suggested reading, and references therein, at the end of this document.

This restoration framework *does not* supersede existing regulations nor does it replace existing reclamation obligations for active operations.

Acknowledgements

This framework was prepared for Alberta Environment and Parks and the Forest Resource Improvement Association of Alberta (FRIAA) through the Caribou Landscape Restoration program. The project was managed by Cynthia Chand and George Duffy of Alberta Environment and Parks.

The framework was prepared by Woodlands North Inc., Fuse Consulting Ltd., Burgess Environmental Planning, and ACM Ventures. The report was authored by: Matthew Pyper (Fuse), Geoff Sherman (Woodlands), Terri Perron (Woodlands), Javed Iqbal (Woodlands), Sonya Odsen (Fuse), Bruce Nielsen (Woodlands), Caroline Burgess (Burgess Planning), and Alex McGillivray (ACM Ventures).

The framework benefited significantly from discussions with members of the Canadian Association of Petroleum Producers, representatives of the Alberta forestry industry and engagement with Indigenous communities in west-central Alberta.

Suggested citation

Government of Alberta. 2017. Restoration and Establishment Framework. Prepared for Alberta Environment and Parks, Land and Environment Planning Branch, Edmonton, Alberta. xii + 70 pp.

1. Overview

1.1 Why this framework?

Restoration of legacy features, particularly seismic lines, is a key tool in range planning for woodland caribou in Alberta. For example, in the recent draft range plan for the Little Smoky and A La Peche ranges, restoration will be one of 12 tools used for caribou conservation (Alberta Environment and Parks, 2016). Restoration will also be a management tool used in future range plans throughout Alberta and numerous voluntary industry programs have been initiated in support of this goal. Restoration is also listed in the Federal Recovery Strategy for Woodland Caribou – Boreal population (Environment Canada, 2012) as a key tool for re-establishing vegetation on a trajectory towards effective habitat.

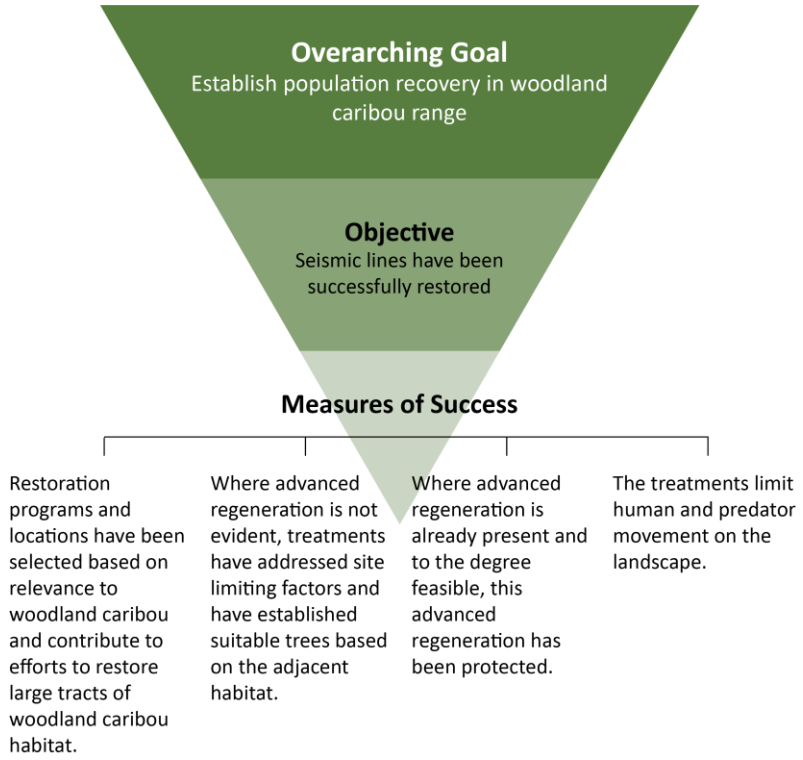
This Provincial Restoration and Establishment Framework ("the framework") identifies: a common approach to planning, restoration objectives and targets, and clear approaches to monitoring and data management controls. These approaches will be required for all government-led restoration programs and are encouraged for voluntary industry-led programs.

This framework has been developed with a specific focus on the implementation of government-led restoration projects within the Little Smoky and A La Peche caribou ranges. However, the framework has been developed to be applicable to all ranges in the province, subject to adjustments based on key learnings as part of an adaptive management approach (Figure 2).

1.2 What is the restoration goal?

The goal for the Provincial Restoration and Establishment Framework is best framed in the context of a criteria and indicators framework. The overarching goal of this framework – consistent with the draft range plan for the Little Smoky and A La Peche ranges – is caribou population recovery, the objective is the successful restoration of legacy seismic lines, and a series of core indicators of success have been established to determine whether habitat is on a trajectory to become effective habitat (Figure 1). In addition to these indicators of success, a series of specific restoration targets have been developed to guide restoration programs. These targets are further explained in Section 5.4.

Figure 1. Criteria and indicator framework showing how core indicators in the framework are linked to broader caribou conservation goals and objectives.



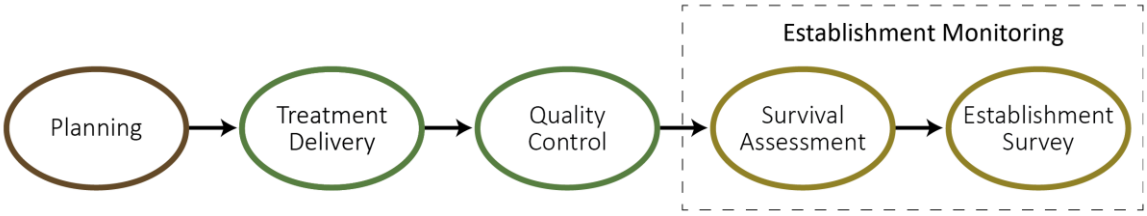
1.3 Integration with wildlife monitoring efforts

This restoration framework focuses on ensuring that treatments have established trees on a natural successional trajectory and that predator and human movement efficiencies on the landscape have been reduced. This framework is consequently focused at the site scale. However, ultimate measures of whether restoration treatments have achieved effective habitat for caribou or have had a positive impact on caribou populations will also require larger-scale studies, including wildlife monitoring at population and landscape scales. This restoration framework has been developed such that it can be nested within broader provincial wildlife monitoring programs and academic research to assess whether habitat restoration programs have resulted in effective habitat for caribou.

1.4 How will the framework be applied?

This framework is intended to apply only to legacy disturbances, with a focus on legacy seismic lines. This restoration framework *does not* supersede existing regulations nor does it replace existing reclamation obligations for active operations (e.g., existing Licences of Occupation (LOCs).

1.5 Organization of this framework



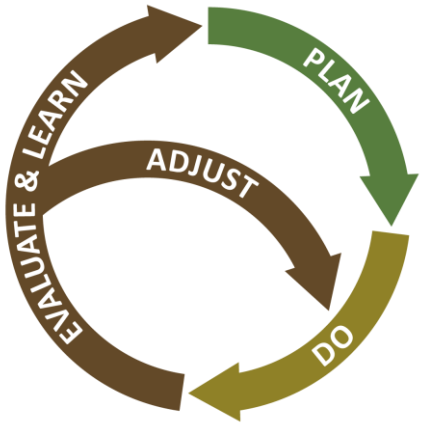
It is widely accepted that planning, treatment application, quality control and monitoring are critical steps in delivering efficient and effective restoration programs. After introducing the overall structure of the restoration framework, this document outlines key criteria and expectations at each stage of a program. The intention is to encourage efficient application and approval processes, while outlining clear performance targets for evaluating establishment success of restoration programs.

Sections 3 (planning), 6 (quality control implementation) and 7 (establishment monitoring implementation) outline data management and submission requirements for all stages of government-led restoration programs.

1.6 Adaptive management

This framework is intended to be adapted over time based on key learnings from program implementation and subsequent monitoring (Figure 2). This continual learning and adaptation will be critical to ensure the long-term success of restoration programs in Alberta. The Province commits to reviewing the implementation of the principles outlined in this framework, their efficiency, and their effectiveness every 1–2 years. This will occur through discussions with program contractors and industrial operators implementing voluntary restoration efforts. Based on these feedback discussions, decisions will be made about whether adjustments to the framework are required.

Figure 2. Future revisions to this framework will be informed by an adaptive management process.



2. Overview of the Provincial Restoration and Establishment Framework

2.1 Core components

The overall intent of the framework is to ensure that site limiting factors on legacy seismic lines are identified and addressed. The framework includes four key steps that will guide government-led programs and which are encouraged for voluntary industry led restoration planning in Alberta (Table 1). These steps are described in detail in subsequent sections of the framework.

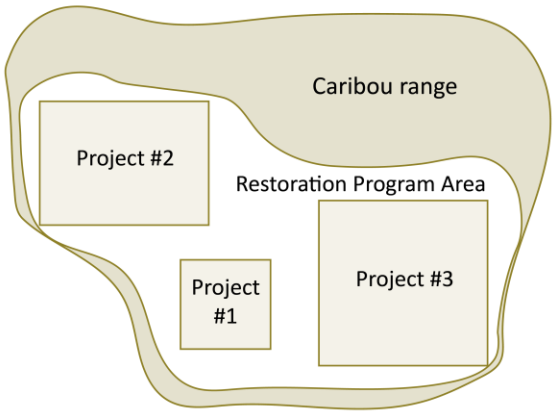
Table 1. Restoration planning in Alberta will follow four major indicators from the planning stage to monitoring for success.

Planning	Treatment delivery and quality control	Survival Assessment (years 2–5)	Establishment Survey (years 8–10)
A site is selected based on benefit to caribou, site limiting factors are identified, and an efficient and effective plan is developed for the restoration area.	Treatments are applied, quality is evaluated and corresponding contractor payments are determined.	Seedling survival is evaluated after one full growing season and early warning signs can be used to adjust future treatments or retreat problem areas.	Line coverage, tree recovery and human use are surveyed to assess restoration success.

2.2 Clarifying programs versus projects

This framework considers restoration at the scale of both the program and the project (Figure 3). A program is defined as a group of linear restoration projects within the same caribou range, and could reflect an entire range. Programs are managed by a proponent (which could be government, or in the case of voluntary programs a company or group of companies), generally span multiple years and include multiple contractors. A project is a sub-set of the overall restoration program (Figure 3). Projects span a single year, are typically overseen by a single contractor, and contribute to achieving the goals of the broader restoration program.

Figure 3. A restoration program is managed by one or more proponents and consists of multiple restoration projects with separate operational plans.



This distinction between programs and projects is important when it comes to planning and evaluating the success of a restoration program. For government-led programs, operational plans will be developed and approved for each project and will be linked to the goals of the overarching program. Establishment Surveys will be performed at the scale of the program (Table 2).

Table 2. Summary of project and program definitions and rationale.

Component	Definition/Rationale
Program	Large restoration area within a caribou range, comprising multiple projects. Used to set an overall restoration objective for a large area that will be restored over multiple years or using multiple contractors and operational plans. Evaluations against the survival and establishment targets will be performed at the program level.
Project	Subset of a restoration program. Used to develop operational plans that contribute to the overarching program-level objectives. Projects are delivered in a single year. Quality control evaluations will be performed at the scale of the project.

2.3 Professional judgement

Linear restoration projects are challenged by difficult ecological conditions and site limiting factors that can quickly change along the length of a seismic line. As a result, the restoration framework relies on the professional judgement of regulated professionals to assign treatments and determine appropriate treatment densities for linear restoration projects. This framework outlines the establishment targets and evaluation metrics, and regulated professionals are responsible for using professional judgement to propose the best ways to achieve that success through their plans. This information will then be reviewed by a qualified expert in the Government of Alberta, or through a third party, during the review of restoration plans to ensure that treatments have a clear ecological rationale and have the greatest potential to achieve the establishment targets.

2.4 Data management and the LIRA system

The development of the Provincial Restoration and Establishment Framework presents an opportunity to employ a fully digital, spatially-referenced data management system for restoration programs in Alberta. The system introduced in this framework will be critical in overcoming this challenge. This centralized data management system will ensure consistent information is documented at each site, permitting meta-analyses and adjustments to practices over time based on new learnings.

To facilitate data collection and management, the Province has developed an application and data management system called LiRA (Linear Restoration Application). For government-led programs, contractors will use LiRA to spatially record all activities performed at the site level including site reconnaissance information, site imagery, silvicultural treatments, reforestation efforts, and quality control and monitoring information. The system permits both desktop entry and field recording of data through an Android-based application (Figure 4). The LiRA system is also available to voluntary industry-led programs.

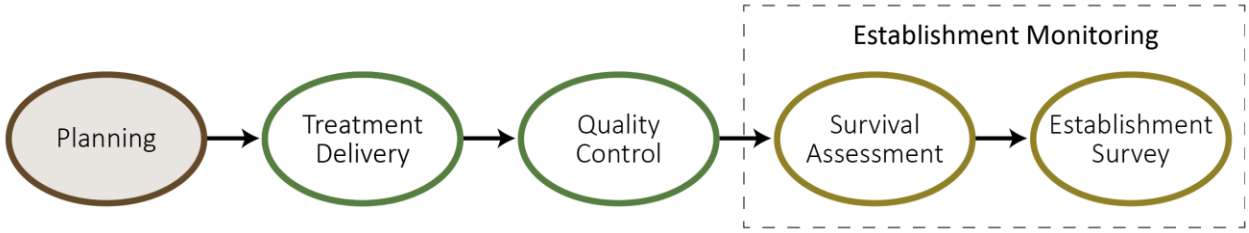
Figure 4. Data accessibility enabled by the LiRA data management system and mobile application.

The centralized LiRA data management system will be critical in helping the Province document and evaluate restoration programs. As such, the framework includes check points at which contractors will be required to submit information to the LiRA data management system. For government-led programs, contractor payment will be conditional on successful submission of this data. A summary of data management expectations and approaches is included in Appendix 1.

2.5 Engagement

Restoration planning will be conducted over both large areas and long timeframes, with potential for affecting how regional peoples use the landscape. Therefore, engagement with people located within the area identified for restoration is a critical component of restoration planning. Restoration project proponents should consult with the Government of Alberta about current required approaches for consultation during restoration planning, and to understand consultation processes already underway through woodland caribou range planning efforts.

3. Developing an Operational Plan



3.1 The role of planning

Planning is an essential step in delivering efficient and effective linear restoration programs. This is because restoration is a complicated process that involves identifying site limiting factors, working with existing tenure holders, operating in challenging field conditions and mitigating sometimes significant operational safety risks.

This section of the framework outlines necessary check points in planning a restoration program. It is intended to provide a clear roadmap and outline restoration planning requirements for government-led programs to ensure that treatments have the best opportunity to achieve success. The steps outlined here will be required for government-led project-level operational plans. These same steps are encouraged for voluntary industry efforts.

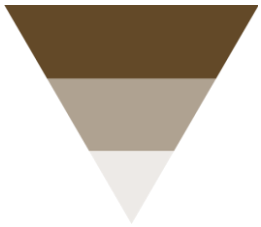
For government-led restoration programs, it is possible that a restoration plan will be developed by one contractor and implemented by another. Therefore, there is an implied expectation that the restoration plan will be implemented as approved by the Government of Alberta. Small scale changes during implementation are permitted but justification should be documented in the LiRA mobile application. Large scale changes during implementation must be verified and approved by the Government of Alberta.

3.2 Planning foundations

Consistent with the measures of success for the framework, projects must clearly demonstrate how the following four core indicators of success will be achieved.

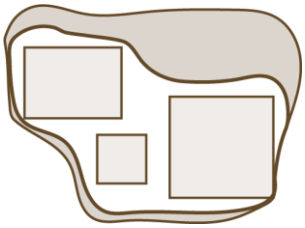
1. Restoration programs and locations have been selected based on relevance to woodland caribou and contribute to efforts to restore large tracts of woodland caribou habitat.
2. Where recovery of vegetation is not already evident, treatments have addressed site limiting factors and have established suitable tree species based on the adjacent habitat.
3. Where existing advanced regeneration is present and to the degree feasible, this advanced regeneration has been protected.
4. The treatments limit human and predator movement on the landscape.

To demonstrate how these indicators of success will be achieved, a restoration plan must include the following elements:



A clear understanding of the restoration goal

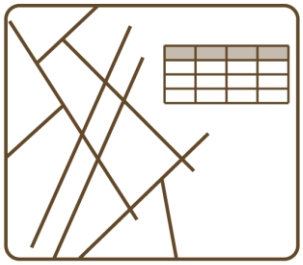
The proponent must clearly articulate that they understand the overarching goal and objective of the framework, and use the indicators of success to provide a summary of how their plan maximizes the probability of achieving the objective (see Section 1.2).



Location of programs and rationale

The proponent must identify how program locations and the scale of the restoration program fit into broader caribou objectives and opportunities. Small-scale, isolated restoration programs should be avoided unless clear justification is provided.

In the case of restoration programs that have locations prescribed by the Government of Alberta, such as in the Little Smoky and A La Peche ranges, this section is not required in the operational plan.



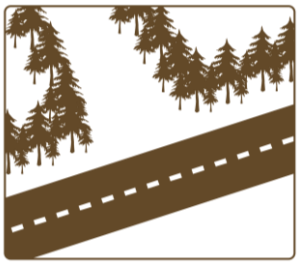
Description of proposed treatments by line and site conditions

Treatments must be planned prior to field delivery and will be reviewed by Government of Alberta staff to ensure treatment prescriptions are likely to achieve the restoration objective.

Treatments must be assigned based on the site conditions (e.g., moisture regime) along legacy seismic lines and must address site limiting factors to the best degree possible. See Appendix 2 for a restoration toolbox that summarizes some of the tools available and their relevant applications.

Specific data submission requirements for project plans that make use of the LiRA data management system are listed in Appendix 1, but an example treatment table is provided here for reference.

Line ID	UTM (Line Location)	Length	Moisture regime	Site limiting factor	Proposed treatment



Documentation of access management considerations

The plan must provide a map of areas where access management measures (e.g., higher volumes of woody materials) will be used to limit human use of lines, thereby protecting the restoration investment. The plan must also discuss how reduction of predator use of lines has been considered in the plan.

The plan must outline how the contractor has considered the broader landscape in their access management plan. For example, a line may not currently be used for access and may show natural vegetation recovery, but may see increased human use if nearby lines are closed with woody materials. The plan will need to outline how treatments have been planned to limit this outcome.

Commitment to adaptive management

The plan must demonstrate a clear commitment to adaptive management. This includes summarizing key learnings from past restoration activities within the project area and identifying specific measures to address those learnings in the proposed restoration work.

3.3 Defining treated areas, advanced regeneration and project exclusions

For the purposes of operational planning and evaluating establishment success, it is important that contractors define areas that will be treated, areas where advanced regeneration will be protected (using tree felling, coarse woody debris, or similar access management measures), and areas that are excluded from the project. Table 3 summarizes the definitions used in the framework and how each category will be evaluated against the establishment targets. For government-led programs, these definitions must be followed by all contractors when developing an operational plan. For voluntary programs, these definitions are encouraged.

Table 3. Definitions of treated, advanced regeneration and project exclusions as used in the framework.

Action taken	Definition	Establishment Monitoring Criteria
Treated areas	Areas that did not show existing advanced regeneration and were treated using acceptable restoration methods. Includes areas that were not accessible with equipment because of safety or accessibility concerns and were treated with other means (e.g., tree hinging).	Treated areas will be evaluated against the specific targets identified in the Establishment Monitoring (Table 4).
Advanced regeneration	Areas that are successfully regenerating and therefore do not require treatment. Note: treatments such as tree felling or coarse woody debris may still be used in advanced regeneration areas to limit predator movement and human access.	Advanced regeneration areas will be evaluated against the specific targets identified in the Establishment Monitoring (Table 4).
Project exclusions	Areas that are not treed and/or are considered outside the framework including riparian areas, outwash plains, grassy montane areas, etc. Includes areas that could not be treated due to safety concerns (e.g., steep slopes).	Project exclusions will be identified in the operational plan and will not be evaluated against the Establishment Monitoring (Table 4).

For all areas designated as advanced regeneration, the contractor is required to document the rationale for this designation in the operational plan and to calculate the total area of a project designated as advanced regeneration. Projects which have advanced regeneration areas totalling more than 15% must document the existing species composition for proposed advanced regeneration areas, and the percentage (based on length) of these areas that contain merchantable tree species, in their operational plan. This is to ensure that programs with high levels of advanced regeneration exhibit the potential to achieve the overarching goal of this framework, which is to establish acceptable tree species that can reach the forest canopy over time. Programs with high levels of species that will not reach the canopy (e.g., alder) may compromise this objective.

3.4 Additional steps required for submission of an operational plan

Restoration project planning also requires a significant amount of pre-planning for other key items such as acquisition of regulatory permits, engagement with existing tenure holders, and project safety. To support the successful development, submission, and review of operational plans, Appendix 3 provides a checklist of supplementary items that must be included in an operational plan when submitted to the Government of Alberta for approval. Program proponents are also expected to work with the Government of Alberta to determine appropriate processes for engaging with local Indigenous communities and trappers.

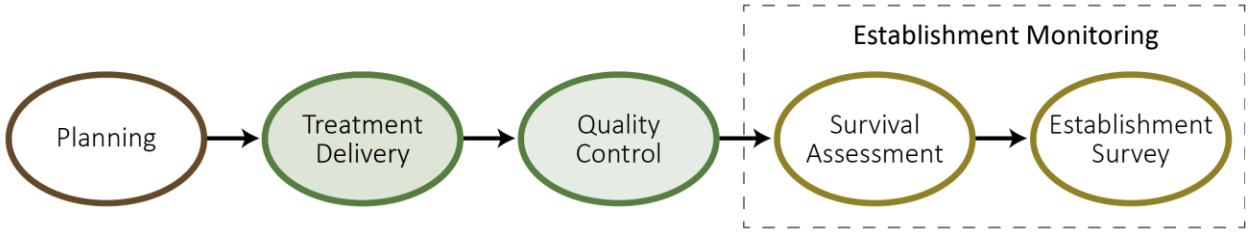
3.5 Data submission requirements

For government-led programs, all planning files including reconnaissance information, documentation of site limiting factors, treatment descriptions and any shapefiles associated with the operational plan will be submitted to the LiRA data management system and mobile application. Treatment data must be entered using standardized data tables, and operational plans must be uploaded in pdf format and linked to all lines associated with the project plan. A pdf document of the complete operational plan should also be included in the LiRA data submissions.

If visual information was captured during site reconnaissance (e.g., LiDAR, aerial video, aerial photo, and ground-based photo), this information must be spatially referenced and submitted to the LiRA data management system. This information will aid in assessing before-and-after treatment effects.

Data submitted to LiRA must comply with the Government of Alberta Open Information and Open Data Policy. Voluntary programs are also encouraged to use these steps to improve program transparency, and to aid in evaluations of establishment success.

4. Treatment Quality Control



4.1 Purpose

The quality control program described herein is intended to ensure that treatments have achieved a high standard of quality during field delivery. High-quality treatments are the first step towards a successful restoration program. Additional details on the implementation of quality control programs are located in Section 6.0 of this framework. Quality control evaluations are required for all government-led programs and are encouraged for voluntary programs to improve the integrity and transparency of restoration work.

4.2 Objectives

Quality control efforts will confirm that:

- Site preparation treatments have been delivered to a high standard of quality and have been applied in a way that addresses the unique limiting factors of a site.
- Planting or seeding treatments have been implemented using a robust chain of custody, planted to a high standard of quality, and applied at a density that matches the approved operational plan.
- Line deactivation treatments have been applied in a way that blocks human access predator movement patterns and at densities that match the approved operational plan.

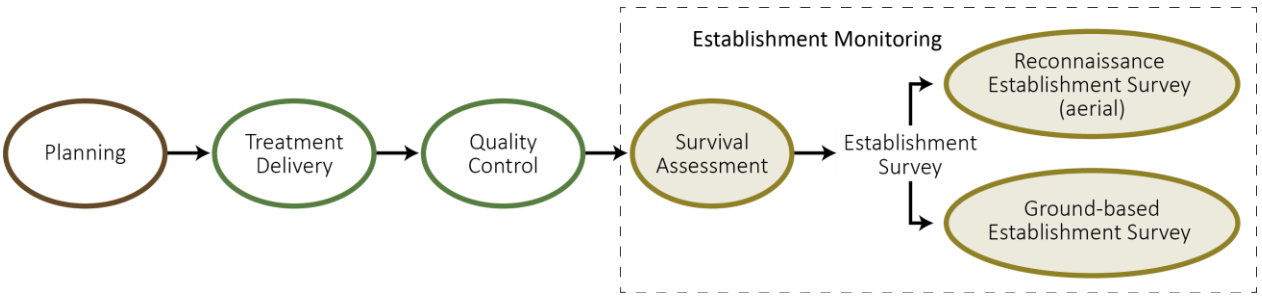
4.3 Survey timing

Quality control surveys must be conducted during field implementation of restoration treatments to ensure that any remedial actions or adjustments to treatment quality can be immediately made by the contractors responsible for applying treatments or planting. This will also facilitate efficient resolution of payment with contractors.

4.4 Survey implementation

Specific guidelines for quality control efforts for government-led restoration projects are included in Section 6.0 of this document. These procedures will be required for government-led restoration projects and are encouraged for voluntary restoration programs to improve program integrity and transparency, and provide consistency in reporting and restoration evaluation.

5. Establishment Monitoring



5.1 Purpose

Surveys conducted as part of the Establishment Monitoring will evaluate the early success of restoration efforts based on tree survival, and will assess whether trees have successfully established on the restored lines at a sufficient density and height by 8-10 years following restoration. Additional measures will be used to determine whether humans are using the restored features. **These targets will be required for all government-led restoration programs and are encouraged for all voluntary restoration programs.**

5.2 Objectives

The Establishment Monitoring has been developed with the following objectives:

- Confirm tree seedlings are establishing on a line and are on a trajectory to close the canopy.
- Identify whether tree seedlings are present across the restored line.
- Identify early areas where tree regeneration success is low and target remedial actions.
- Minimize survey time and effort through the use of aerial and/or digital techniques.
- Provide a sufficiently robust dataset that can be used to direct future restoration efforts and be useful for other monitoring programs related to caribou.

Monitoring information will be collected for each individual project and these data will be pooled at the program level to achieve sufficient statistical power. In other words, no individual project is expected to have sufficient statistical power to assess overall success, but will instead contribute to pooled analyses at the scale of the full restoration program.

5.3 Components of the establishment monitoring

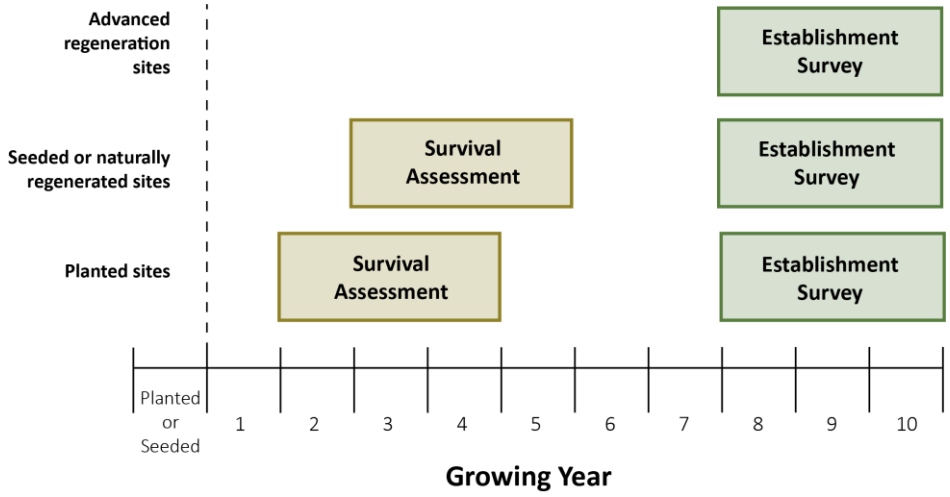
The monitoring program will consist of two sampling windows: Survival Assessment and Establishment Surveys. Advanced regeneration sites will only be evaluated as part of the Establishment Survey. Project exclusions will not be evaluated against either the Survival Assessment or Establishment Survey.

Survival Assessments will be performed 2–4 growing years after planting and 3–5 growing years after seeding or natural regeneration (Figure 5). Survival Assessments will be conducted using a limited number of ground-based sampling plots and a stratified sampling design. Stratification will consider a site's moisture regime and the treatment that was applied. This stratified sampling approach ensures an

appropriate number of plots without requiring a visit to every site, improving monitoring efficiency. For more information on Survival Assessments, please see Section 7.0.

Establishment Surveys will be performed 8–10 growing years after planting or seeding; advanced regeneration segments will likewise be surveyed 8–10 years after the project area was treated (Figure 5). Aerial surveys using modern technologies will facilitate the surveying of large program areas quickly and efficiently. The objective of this survey is to broadly characterise the establishment success of all treated and advanced regeneration line segments in a program area and determine whether each segment has successfully achieved the establishment targets. A limited number of ground-based surveys are also conducted after the aerial surveys to provide more detailed data and provide ground verification of the aerial reconnaissance surveys. For more information on monitoring details, please see Section 7.0.

Figure 5. Acceptable survey windows for Survival Assessments and Establishment Surveys based on seedling origin on a restored site.



A minimum of two complete growing years must occur between a Survival Assessment and an Establishment Survey. Each growing year begins on May 1 following planting, which may fall within the same calendar year (some winter planting) or the subsequent calendar year (spring and summer planting).

In most cases, sampling will only be conducted between June 1 and September 31; however, the optimal sampling window falls between July 31 and September 15. During this optimal sampling window, vegetation in most areas will be completely greened up and most conifer growth will be finished, facilitating accurate field measurements. Surveys conducted in the second year for planted seedlings or the third year for seeded/naturally regenerating sites cannot commence prior to August 1; this is to ensure at least two full growing seasons have taken place. Alternate survey windows may be proposed to accommodate new survey technologies, however sufficient justification must be provided to ensure the integrity of the monitoring program is maintained.

5.4 Restoration targets

The Establishment Monitoring will consider the survival of tree species at years 2–5 and overall stocking, coverage, tree height and absence of human access trails at years 8–10. Specifically, projects will be evaluated against the targets identified in Table 4. Note that the standards are adapted to site conditions

such that restored areas resemble the adjacent stand and are evaluated according to site capabilities (as defined by moisture regime).

Similarly, advanced regeneration sites are assessed using a different target in the Establishment Monitoring because in some cases a specific objective (e.g., conifer stocking) would be impractical without removing existing regeneration, which may not be desirable. However, advanced regeneration sites must have the ability to reach a minimum vegetation height.

Why use stocking as the target?

Stocking is an efficient metric because it captures both density, height and survival into a single value. For example, for a stand to achieve 70% stocking, it requires a certain density, height and survival rate of trees. While this metric is also used in commercial forestry, in this case it represents an efficient way to determine whether vegetation is coming back onto a restored line at a sufficient level to achieve the habitat restoration objectives.

The figure below illustrates an example stocking calculation and its utility in linear restoration. These line segments have the same number of acceptable trees but different coverage, leading to a different stocking estimate for each treatment segment.

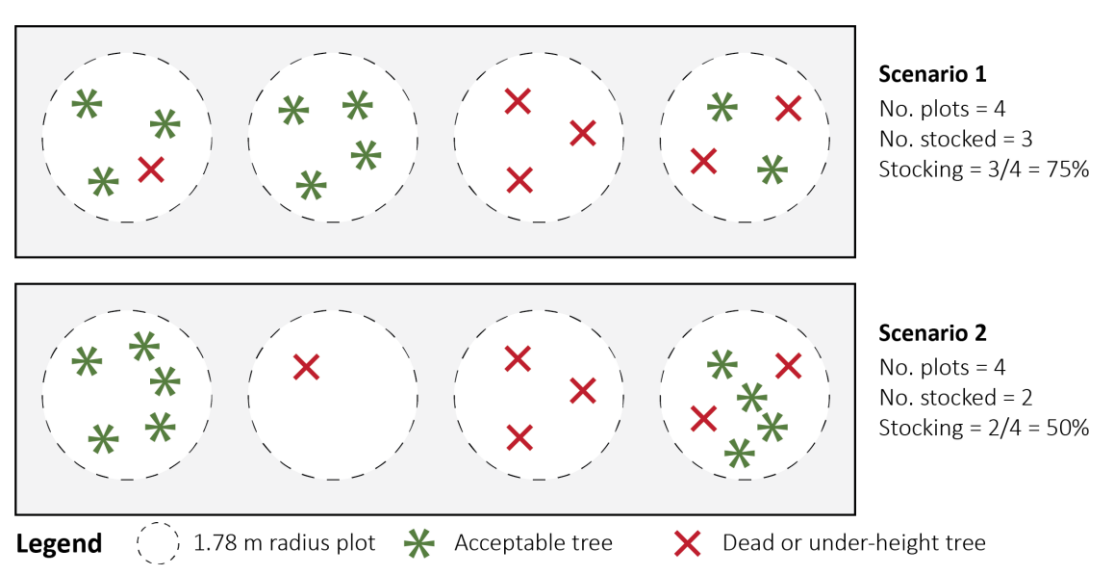


Table 4. Targets used for evaluating whether sites pass the survival and establishment phases of a restoration project.

Site Type	Survival Target	Establishment Target
Upland and transitional; Lowland treed		
Treated Areas	▪ 75% survival of winter-planted trees ▪ 80% survival of summer-planted trees ▪ 4,000–5,000 stems/ha of seeded or naturally regenerated trees	▪ >70%[3] stocking of acceptable tree species with a minimum density of 1000 stems/ha, with no less than 50% stocking on each side of line. ▪ Tree species suitable based on adjacent stand type. ▪ <10% of sites have human access.
Advanced Regeneration Site	N/A	▪ >70%[3] coverage of species that are capable of reaching a height of 5.0 metres[4] with no less than 50% coverage on either side of the line. ▪ <10% of sites have human access.
Upland dry (e.g., xeric); Lowland low density treed		
Treated Areas	▪ 75% survival of winter-planted trees ▪ 80% survival of summer-planted trees ▪ 2,500–4,000 stems/ha of seeded or naturally regenerated trees	▪ >50%[1] stocking of acceptable tree species with a minimum density of 800 stems/ha, with no less than 40% stocking on each side of line. ▪ Tree species suitable based on adjacent stand type. ▪ <10% of sites have human access.
Advanced Regeneration Site	N/A	▪ >70%[3] coverage of species that are capable of reaching a height of 5.0 metres[2] with no less than 50% coverage on either side of the line. ▪ <10% of sites have human access.

For the purposes of this framework, acceptable trees (see Section 5.5 for definition) that meet a minimum height (Table 5) count toward the stocking target. Use of the coniferous or deciduous stocking criteria will depend on the adjacent stand type (per Table 4).

Table 5. Coniferous and deciduous minimum height targets for achieving successful stocking.

Site Type	Coniferous Height Target for Stocking	Deciduous Height Target for Stocking
Upland dry	60 cm	120 cm
Upland and transitional	80 cm	120 cm
Lowland treed	65 cm	120 cm
Lowland low density treed	60 cm	120 cm

[1] Based on the Reforestation Standard of Alberta and adjusted for unique site conditions on seismic lines and differing objectives between habitat restoration and stocking of commercial forests.

[2] (Dickie, 2015; Pigeon et al., 2016; Tigner et al., 2015)

5.5 Acceptable trees

Restoration status will be determined by the presence of acceptable trees during both the Survival Assessment and Establishment Survey. An acceptable tree is an individual seedling, sucker, or advanced regeneration that meets the following criteria:

- The tree is alive
- It is an acceptable tree species (Table 6)
- It has been on the site for a minimum of two growing years (i.e., it is not a germinant)

The following additional criteria must also be met at the Survival Assessment stage:

- Deciduous trees shall be a minimum of 30 cm tall.
- Coniferous trees shall have a well-defined stem and be a minimum of 15 cm tall.

Table 6. Acceptable tree species and species codes.

Latin Name	Common Name	Species Code
Picea glauca	White spruce	Sw
Picea mariana	Black spruce	Sb
Picea engelmannii	Engelmann spruce	Se
Pinus contorta	Lodgepole pine	Pl
Pinus banksiana	Jack pine	Pj
Pinus contorta x banksiana	Pine hybrid	Px
Larix laricina	Tamarack	Lt
Abies balsamea	Balsam fir	Fb
Abies lasiocarpa	Subalpine fir	Fa
Pseudotsuga menziesii	Douglas fir	Fd
Populus balsamifera	Balsam poplar	Pb
Populus tremuloides	Trembling aspen	Aw
Betula papyrifera	White birch	Bw

5.6 Aerial and ground based assessments

The provincial restoration framework has been designed to accommodate ground-based Survival Assessments and both ground-based and reconnaissance Establishment Surveys (see Section 7.0). Ground plots are required on a limited number of restoration sites (see Appendix 5) at both the Survival Assessment and Establishment Survey phases. This is to ensure sufficient resolution of vegetation responses across all restored areas. These ground-based surveys should be designed in such a way that they capitalize on access points that are anticipated to be left open following consultation with local trappers and indigenous communities. Traveling over restoration treatments is not desired during monitoring efforts.

Aerial surveys will be used to survey overall restoration program performance and to detect sufficient line coverage and presence or absence of human access trails. Aerial assessments afford opportunities for use of various innovative technologies as described in Section 7.0.

5.7 Survey implementation

Specific guidelines for Survival Assessment and Establishment Surveys for government-led restoration projects are included in Section 7.0 of this document. These procedures will be required for government-led restoration projects and are encouraged for voluntary restoration programs to improve reporting consistency and restoration evaluation.

6. Implementation of Quality Control Programs

The following descriptions of plot requirements and quality control program implementation are specifically designed to guide government-led restoration programs. Voluntary industry-led restoration programs are encouraged to use these methods to provide consistency in restoration reporting across the province.

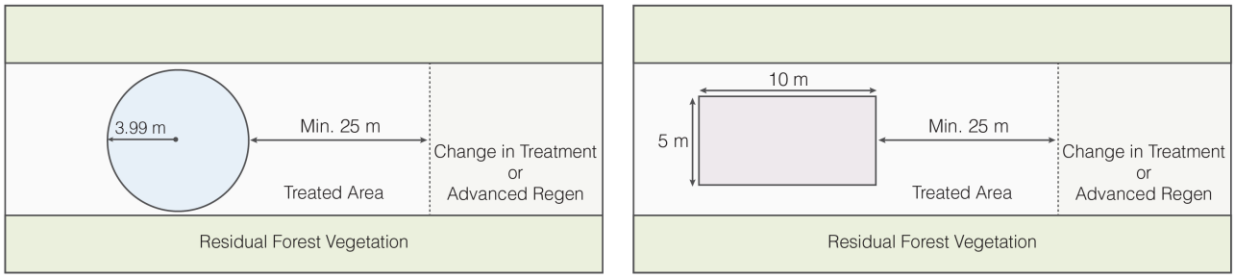
6.1 The role of the auditor

Quality control criteria will be evaluated by third-party auditors who will conduct random quality checks during the field implementation of restoration treatments. Auditors will walk on foot along treated areas documenting and taking spatially-referenced photos (minimum 2 per plot) of their findings. Either project proponents or else contractors delivering operational plans must provide their own third-party auditors as part of their project delivery. Contractor payment will be evaluated based on successfully achieving quality control criteria during restoration application.

6.2 Quality control plot design

Quality must be assessed along the length of a line using a standard 50 m^2 sampling plot. This plot may either be a circular plot with a 3.99 m radius, or it may be a rectangular 5 m × 10 m plot (Figure 6). A minimum of one plot per treatment segment is required. If a treatment segment is longer than 1 km, a minimum of 1 plot/km must be used.

Figure 6. Quality control plot layout for either a 3.99 m radius circular plot or a 5 m x 10 m plot.



6.3 Measures of success

Treatment application success will be evaluated during the quality control process using the following criteria for site preparation, planting/seeding, and line deactivation. Note field level changes to prescriptions may occur for a range of reasons (e.g., safety, site specific information etc.) and should be documented in the LiRA application for government-led programs. Large variances from approved project plans must be approved by the government for government led programs.

6.3.1 Site preparation

Treatment	Measures of Success				
	Density	Quality	Coverage	Pattern	Payment terms
Mounding	Matches operational plan (Y/N)	Hydric: Average mound height 0.7–1 m (Y/N) Mesic: Average mound height 30–50 cm (Y/N)	Across entire line (Y/N)	Matches operational plan (Y/N)	See Appendix 4
Screefing	Matches operational plan (Y/N)	Microsites created (Y/N)	Across entire line (Y/N)	Matches operational plan (Y/N)	See Appendix 4
Inversion	Matches operational plan (Y/N)	Organic layers intact (Y/N)	Across entire line (Y/N)	Matches operational plan (Y/N)	See Appendix 4
Other	Matches operational plan (Y/N)	As defined in operational plan	Across entire line (Y/N)	Matches operational plan (Y/N)	See Appendix 4
None	N/A	N/A	N/A	N/A	Ecological or operational rationale provided

6.3.2 Planting/seeding

Treatment	Measures of Success				
	Chain of Custody	Density	Depth	Quality	Payment terms
Planting	Seedling chain of custody/nursery and field handling documented and followed	Matches operational plan (Y/N)	Root collar up to 3–5 cm beneath surface (Y/N)	Assessed based on protocol provided in operational plan. (%)[3]	See Appendix 4
Seeding	Signs of mold, pathogens, etc (Y/N) Seed chain of custody documented and followed	Matches operational plan (Y/N)	N/A	Seeds present on available microsites and well dispersed (Y/N)	See Appendix 4

[3] Planting quality must be assessed using a proven quality control system such as provided in the BC Ministry of Forests Planting Quality Inspection Guide to Completing the FS 704 (April 2012).

6.3.4 Line deactivation

Treatment	Measures of Success			
	Density	Line of travel blocked?	Access management	Payment terms
Coarse woody debris	Matches operational plan (Y/N)	N/A	Higher densities at intersections (Y/N)	See Appendix 4
Stem bending/tree felling/tree hinging	Matches operational plan (Y/N)	Ocular assessment of whether clear line of travel exists (Y/N)	Higher densities at intersections (Y/N)	See Appendix 4
Other	Matches operational plan (Y/N)	Per operational plan	Per operational plan	See Appendix 4
None	N/A	N/A	N/A	Ecological rationale provided

6.4 Data submission requirements

All quality control evaluations will be completed using the standardized templates within the LiRA mobile application. Contractor payment will be conditional on successful submission of quality control information. Data submission must follow the protocol outlined in Appendix 1. Data submissions are due no later than two months after the assessment/survey is completed.

The accuracy of all submitted data will need to be verified using the following process prior to submission:

1. The LiRA mobile application has logic functions that will not allow unreasonable data entries and prevent incomplete data collection.
2. Field crew and supervisors will be given access on the LiRA web portal to quality check the data that they have collected.
3. Data will be checked by the data manager commissioned by the Government of Alberta before it is available on the web portal to the government and other proponents.

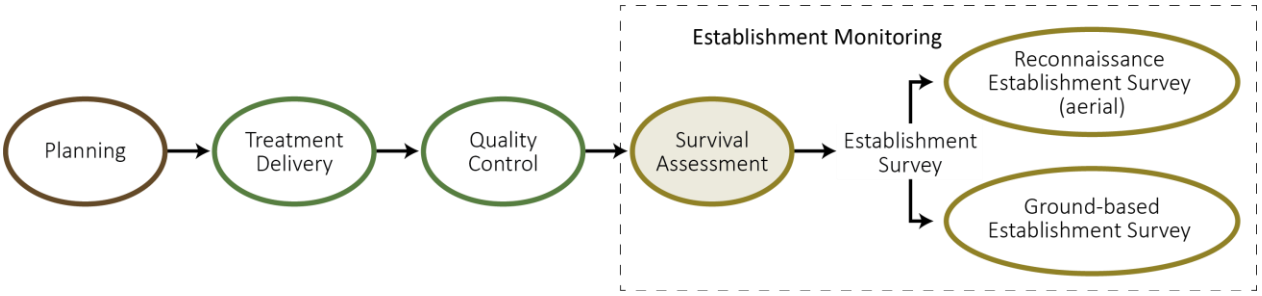
Contractors are also required to submit documentation of seedling handling and chain of custody to relevant government officials and to the LiRA data management system. This documentation must outline the handling of seedlings from the nursery, through transportation, to successful planting in the field.

Contractors will also be required to document any changes to treatment delivery using the LiRA mobile application. Any changes in treatment delivery from what was outlined in the operational plan must be logged into the data management system in order to accurately reflect treatments applied in the field.

7. Implementation of Establishment Monitoring

The following descriptions of plot requirements and implementation parameters for Survival Assessment and Establishment Surveys are specifically designed to guide government-led restoration programs. Voluntary industry-led restoration programs are encouraged to use these methods to provide consistency in restoration reporting across the province.

7.1 Survival Assessment Survey



7.1.1 Purpose

The Survival Assessment is a critical interim check to ensure that seedlings are surviving and seeding has produced sufficient densities on treated sites. This section explains the steps required to deliver Survival Assessments.

7.1.2 Survey method and determining sampling intensity

Survival Assessments will be conducted using ground-based sampling plots and a stratified sampling design. Stratification will consider a site's moisture regime and the treatment that was applied. This stratified sampling approach ensures a sufficient number of plots for analyses without requiring a visit to every site, improving monitoring efficiency. For specific details on calculating the minimum number of plots required and clarification on the stratification approach, please see Appendix 5. Information on determining sample plot locations is included in Appendix 6.

7.1.3 Plot design and methodologies

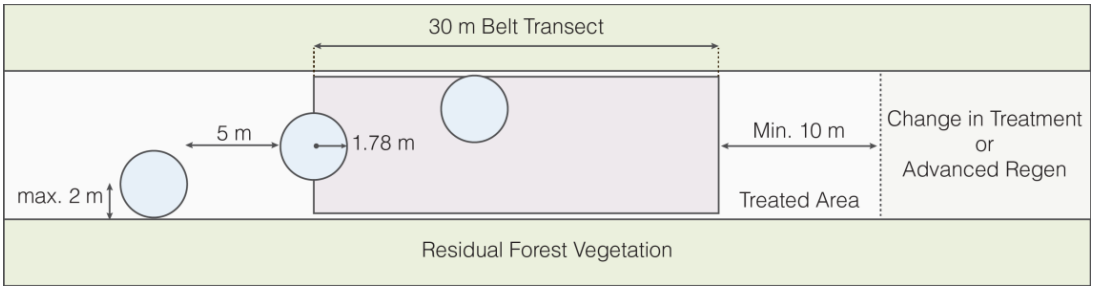
The Survival Assessment will use plots consisting of three evenly-spaced circular subplots spread systematically across the line to account for light and temperature differences, plus a single belt transect (Figure 7).

Each circular subplot will have a 1.78 m radius. The centres of the outermost circular subplots must be within 2 m of the edge of the line, and the three circular subplots must be 5 m apart (Figure 7). On sites that received mounding or other site preparation treatments, subplots can be moved to encircle the nearest treatment microsite (e.g., mound).

In addition to the three circular subplots, a 30 m belt transect extending the width of the seismic line will be used to further assess survival of acceptable species following treatment. This transect will extend 30 m from the middle of the centre circular subplot and the end of each transect will be a minimum of 10 m from the edge of a treatment (Figure 7). **The belt transect is intended to be an efficient assessment of key metrics and will help reduce the variation in project- and program-level data sets, while maintaining an efficient number of sites to be visited.**

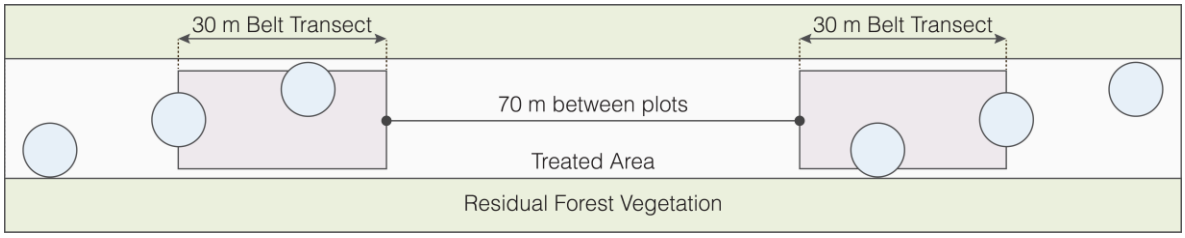
The middle of the centre circular plot should be marked in the field with a metal post and its GPS coordinates recorded using appropriate standards (e.g. UTM NAD83).

Figure 7. Sample subplot layout within a single Survival Assessment plot.



In situations where multiple plots are located within a single location (Appendix 5, 6), plots must be located a minimum of 70 m apart (Figure 8).

Figure 8. Minimum distance between plots when multiple plots are established at a single location.



7.1.4 Data collection requirements

Surveyors will collect the following information during the Survival Assessment.

Component	Variables to be recorded
General information	Line ID Segment ID Plot ID Plot Location (UTM NAD83) Treatment type
Circular subplots	Plot photos Number of germinants and multi-year trees Competition levels Detailed measurements: seedling heights, leader lengths, microsite, and condition codes (Appendix 10)

Belt transect	Survival (planted sites only) Overall stocking Intensity of use CWD cover

Basic Plot Information

The following steps will be followed by a surveyor standing in the middle of the centre circular subplot:

- Project ID, Line ID, Segment ID and Plot ID fields are determined prior to starting the field work and must be filled upon arrival at the plot location.
- Record the treatment that was applied.
- Plot location (UTM NAD83) will have been determined during operational planning; however, movement of plots may need to occur due to errors in treatment locations or GPS coordinates. Any changes to plot locations must be immediately noted in the LiRA application.
- Measure line width to the nearest half-metre and measure orientation to the nearest 5° at the centre circular subplot.
- Determine stand composition from the centre circular subplot. Canopy structure must be documented as tree species and their estimated composition to the nearest 10%; for example, Sw7Aw3 signifies 70% white spruce and 30% trembling aspen. Canopy height will also be estimated to the nearest metre.
- Standing in the middle of the centre circular subplot, capture four plot photos using the LiRA mobile application: two photos down the length of the line (one in either direction) and two photos of the forest on either side of the line.

Beyond this basic plot information, the information collected during the survey will depend on whether the treated segment was planted or seeded for regeneration.

Circular Subplots

The following steps will be followed by the surveyor within each of the circular subplots:

Planted line segments

- Record the total number and individual totals of germinants and multi-year trees.
- Record the overall survival (percentage) of planted seedlings to the nearest 10%.
- Competition levels within the circular subplots will be assessed in two parts. First, perform an ocular estimate of percent non-tree cover within the circular subplot to the nearest 10%. Second, indicate if the competing vegetation overtops (O) the seedlings, is at the same level (L), or is below (B) the seedlings.
- Detailed measurements (see below) will be completed for all planted seedlings and up to five seedlings from natural ingress.

Seeded line segments

- Record the total number and individual totals of germinants and multi-year trees (note: only multi-year trees may be used to estimate density).
- Competition levels within the circular subplots will be assessed in two parts. First, perform an ocular estimate of percent non-tree cover within the circular plot to the nearest 10%. Second, indicate if the competing vegetation overtops (O) the seedlings, is at the same level (L) or is below (B) the seedlings.
- Detailed measurements (see below) will only be completed for a maximum of five trees with multiple years of growth. The surveyor will select the five seedlings by starting at North (0^{o}), moving in a clockwise direction, and selecting the first five trees encountered in the subplot.

Detailed measurements

- For all measured seedlings note the origin (planted or seed origin)
- Measure seedling heights to the tip of the leader to the nearest 1 cm. Conifer heights measured prior to August 1 must not include the current year's growth. On August 1 and later, surveyors must include the current year's growth. For deciduous trees, the current season's growth is to be measured regardless of survey date.
- Measure leader heights to the nearest 1 cm. Prior to August 1, measure only the past year's growth; on or after August 1, measure the current year's growth.
- Record whether the tree is rooted in a treated (T) or untreated (U) microsite. The treatment itself need not be recorded—it is obtainable from the operational plan.
- Assign a condition code to each seedling assessed using the codes found in Appendix 10. Surveyors must assign multiple codes where appropriate.
- Mortality rate within plots will be determined by summing trees that received the dead tree code.

Belt Transect

The 30 m belt transect will be walked by the surveyor and assessed for the following criteria:

- On planted sites only: estimate overall survival to the closest 10% for planted sites within the belt transect.
- On planted sites only: if survival of planted stock is below 75% on winter-planted sites or 80% on summer-planted sites, a minimum of three dead seedlings must be extracted and photos taken to show root growth patterns. These photos will inform subsequent analyses to determine whether survival has been impacted by site conditions or treatment quality.
- On seeded sites only: estimate the overall density of acceptable trees (stems/ha).

The following steps will be followed during belt transect surveys on all sites (planted and seeded).

- Estimate overall stocking to the closest 10% within the belt transect for all sites. In seeded or naturally regenerating areas, only seedlings with multi-year growth will be counted

towards this estimate. If stocking is below 70%, note poorly stocked areas and indicate possible causes.

- Estimate and record intensity of human and/or wildlife use of the seismic line as one of the four categories listed in Table 7. Examples are provided in the *Visual Manual* to help categorize use. If signs of use are present the surveyor will photograph them.
- Estimate coarse woody debris (CWD) cover and record it as one of the five categories found in Table 8. Examples are provided in the *Visual Manual* to help categorize CWD cover.

Table 7. Intensity of use (wildlife/human) of the seismic line as observed within the belt transect.

Intensity of use	Description
None	No established path, no recent signs of access, any broken or cut vegetation is old.
Low	Trampled/broken vegetation, path can be followed but vegetation still present.
Medium	Clear path on some of line but vegetation is still present in areas, bare earth in most areas, some removal/cutting of CWD.
High	Completely open line, soil eroded, rutting, woody debris cut and moved off path, access improvements (corduroy road, bridges) may exist.

Table 8. Levels of coarse woody debris as represented by percent ground cover (adapted from Vinge and Pyper, 2012).

Coarse woody debris level	Cover
None	0%
Low	1-15%
Moderate	16-30%
High	>30%

A detailed data sheet for Survival Assessments is included in Appendix 7 and within the LiRA mobile application.

7.1.5 Reporting and data submission requirements

For government-led programs and programs using the LiRA application, Survival Assessments for individual sampling plots must be submitted to the LiRA data management system using the standardized data collection form in the LiRA mobile application and shown in Appendix 7. Data must be directly entered in the field using the mobile application or entered immediately at the end of the field day. Contractor payment will be subject to confirmation of successful data submission. Data submitted to LiRA must comply with the Government of Alberta Open Information and Open Data Policy. Data submissions are due no later than two months after the assessment/survey is completed.

The accuracy of all submitted data will need to be verified using the following process prior to submission:

1. The LiRA mobile application has logic functions that will not allow unreasonable data entries and prevent incomplete data collection.
2. Field crew and supervisor will be given access on the LiRA web portal to quality check the data that they have collected.
3. Data will be checked by the data manager before it is available on the web portal to the government and other proponents.

After the project's Survival Assessment is completed, the contractor will provide a summary report to the program proponent outlining the project-level results of the Survival Assessment. The report will provide a summary of any line segments that did not meet the Survival Assessment criteria. The report will include a summary table that outlines the ID, length and stratum (moisture regime plus treatment, e.g., xeric+screefed) of each failed segment. Because only a subset of lines will be surveyed during the Survival Assessment (Appendix 5), a project-level map of all surveyed line segments must also be provided. The lines will be colour-coded: green for segments that were surveyed and passed the Survival Assessment, and red for segments that were surveyed and did not pass the Survival Assessment.

Report submissions must include the Survival Assessment cover sheet including the Registered Professional's signature stating that the Establishment Survey information is complete and accurate (Appendix 11).

7.1.6 Outcome and next course of action

Because the ground-based Survival Assessment surveys are stratified (i.e., they do not cover the entire program area), **subsequent program-level assessments must be completed by the program proponent** based on pooled Survival Assessment information from individual project-level surveys. Program-level assessments will use the ground-based sampling information to model predicted survival across the program and will use this information to determine whether subsequent ground-based assessments or management actions are required.

Why is modelling of survival required in addition to ground-based plots?

A core goal of the Establishment Monitoring is to conduct monitoring as efficiently as possible. By surveying a subset of the treated plots, programs can efficiently capture information about survival and then use this information to predict survival rates across the rest of the program area. This ensures maximum efficiency in the monitoring approach, while affording opportunities to predict survival status across the entire program area.

As part of this summary report, the program proponent is required to identify whether re-treatment of lines is necessary based on the re-treatment assessment protocol (Table 9). Sites that are predicted to not achieve the Survival Assessment target based on modelling results, or that are known to have not achieved the Survival Assessment target based on ground plots, must be evaluated using this protocol.

Where segments and strata (moisture regime plus treatment) show high levels of failure, the decision to re-treat will ultimately depend on the anticipated impact of the failed site on caribou populations. The factors to be considered in the decision are summarized in Table 9. Sites that did not achieve the survival target, measure less than 100 m and are surrounded by a high proportion of successful segments will not be re-treated.

The program proponent must submit a detailed summary report documenting the modelled survival status on all lines and the recommended approach for retreatment of lines that have not achieved the Survival Assessment target.

Table 9. Decision criteria for re-treating a segment that failed the Survival Assessment.

Decision Criteria	Rationale
Length of the failed segment	Longer segments are more likely to facilitate predator movement and caribou encounters, and will be prioritized over short segments for re-treatment.
Presence of a wildlife trail or human access trail	Lines with wildlife or human access trails are at higher risk of use by alternate prey or predators, and will be prioritized over little-used lines for re-treatment.
Distance from other failed segments	Clusters of failed segments are likely to have a larger negative impact on caribou than isolated segments, and will be prioritized for re-treatment.
Reasons for the failure	Failures because of poor treatments will be prioritized for re-treatment over sites with local site conditions that limit recovery potential.
How close the segment came to meeting the target	Treatments that almost met the criteria are likely to benefit caribou more than sites that were not close to meeting the target. Those that were far from reaching the target will be prioritized for re-treatment.
Accessibility	Remote sites may require travel over existing regeneration during re-treatment which may not be desirable from a caribou and cost efficiency perspective, and are a low priority for re-treatment.

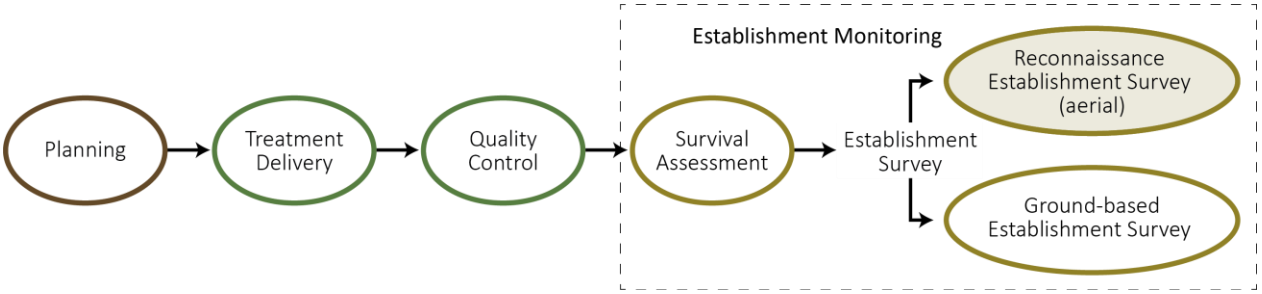
7.2 Establishment Survey methods

Establishment Surveys are the main tool to assess whether a site is on track to recovering to desirable vegetation and whether wildlife movement and human access concerns have been addressed at 8-10 years following treatment. **Establishment Surveys will be conducted primarily using aerial assessment, with a limited number of ground plots to verify the accuracy of aerial assessment protocols.**

Reconnaissance Establishment Surveys are aerial evaluations by qualified surveyors to determine whether sufficient stocking levels have been achieved on a line following restoration treatments. Aerial assessments will be completed for all advanced regeneration and treated sites within the program area.

Ground-based Establishment Surveys will be conducted using the same plot locations as the Survival Assessment, meaning the plots will be stratified according to a site's moisture regime and the treatment that was applied. For specific details on calculating the minimum number of plots required and clarification on the stratification approach, please see Appendix 5.

7.3 Reconnaissance Establishment Survey



7.3.1 Purpose

The Reconnaissance Establishment Survey focuses on surveying large program areas quickly and efficiently using aerial survey methods or remote sensing. The objective of this survey is to broadly characterise the establishment success of all treated and advanced regeneration line segments in a program area and determine whether each segment has successfully achieved the establishment targets. Ground-based surveys are conducted after the reconnaissance surveys to provide more detailed data and ground verification of the aerial reconnaissance surveys.

7.3.2 Procedures

Aerial assessments will be completed for all advanced regeneration and treated sites within the program area. The Reconnaissance Establishment Survey will be completed in one of the following four ways:

Approach	Method	Requirements
Visual	Flying the treated and advanced regeneration areas of the program and visually assessing them.	A minimum of 50% of the program should be filmed for auditing purposes, including a complete recording of major lines
	Walking through the treated and advanced regeneration areas of the program and visually assessing them.	Appropriate for smaller programs
Digital	Flying the treated and advanced regeneration areas of the program and recording high-resolution photography or video (e.g., Forward Looking Infrared (FLIR) and true color imagery) and performing a desktop analysis.	Minimum spatial resolution of 15 cm or better[4]
	Capturing LiDAR or other remote sensing information and performing a desktop analysis.	

Based on the data provided to the interpreter and the conditions encountered in the field or viewed in the aerial dataset, the interpreter shall complete the following steps:

[4] (Pitt et al., 1997; Pouliot et al., 2002; Wulder and Franklin, 2003)

- Prior to commencing the survey, complete the summary section on the electronic data form.
- Using data provided from visual assessments and the LiRA data management system, delineate each line into segments based on the strata (moisture regime and treatment), including advanced regeneration.
- For each line segment, determine the stocking density (upland dry, upland and transitional, lowland treed, and lowland low density treed sites) or percent coverage of species capable of reaching a height of 5.0 m (advanced regeneration sites), and the presence or absence of human access trails (Table 4).
- Determine if there is at least 50% stocking on both sides of the line (upland and transitional, lowland treed, and advanced regeneration sites) or at least 40% stocking on either side of the line (upland dry and lowland low density treed sites).
- Document whether shadows limit the assessment of part of the line.

The following additional considerations apply to each survey:

- An individual segment will be at least 50 m in length.
- If small patches of a treatment (<50 m) are mixed in with large stretches of another treatment, stocking of the segment will be judged as a whole and presence of the secondary treatment will be noted in the treatment codes.
- Any adjustments to segment names or start and end points must be adjusted in the LiRA application and data management system.

7.3.3 Evaluating Success

The reconnaissance Establishment Survey determines success using several pass/fail criteria which are based on the establishment targets presented in Table 4.

Criteria	Stand Type		
	Upland dry; Lowland low density treed	Upland and transitional; Lowland treed	Advanced regeneration sites
Stocking	>50% stocked **or** stocking falls below this level but is appropriate for the adjacent stand conditions*	>70% stocked**	>70% coverage with species capable of reaching a height of 5.0 m
Coverage	>40% stocked on both sides of line	>50% stocked on both sides of line	>50% coverage on both sides of line
Line Use	There is no visible human access trail on the line segment		
Shadow	No more than 20% of the line cannot be seen because of shadow		

* Note: Stands must achieve a density of 800 stems/ha. ** Note: Stands must achieve a density of 1000 stems/ha.

Each line segment either passes, passes with conditions, or fails based on how many of the above criteria it meets:

Segment passes stocking criteria (SR): the segment passes all the criteria (stocking, coverage, line use, and shadow).

Segment passes with conditions (CSR): the segment passes the stocking criteria but fails on coverage or line use, or it passes these criteria but 20–40% of the line cannot be seen due to shadow.

Failure (NSR): the segment does not meet stocking criteria for the site type or more than 40% of the line cannot be seen because of shadow.

7.3.4 Aerial survey qualifications

Contractors must meet the following requirements in order to conduct aerial reconnaissance Establishment Surveys:

- Is a qualified surveyor or is under the direct supervision of a qualified surveyor.
- Has been specifically trained in the distinct differences between forestry and restoration establishment targets (see establishment targets in Table 4 and acceptable tree species in Table 6).
- Has been provided with a digital map set that shows treatments, advanced regeneration areas and project exclusions (areas that could not be treated).

Contractors must meet the following requirements in order to conduct reconnaissance Establishment Surveys using photo and video interpretation:

- Is a certified Level 1 Photo Interpreter or under the direct supervision of a certified Level 1 Photo Interpreter.
- Has been specifically trained in the distinct differences between forestry and restoration establishment targets (see establishment targets in Table 4 and acceptable tree species in Table 6).
- Has been provided with a digital map set that shows treatments, advanced regeneration areas and project exclusions (areas that could not be treated).

7.3.5 Reporting and data submission requirements

For government-led programs, reconnaissance Establishment Surveys must be submitted to the LiRA data management system using the standardized data collection form in the LiRA mobile application and shown in Appendix 8. Data must be entered either directly into the LiRA mobile application during the survey or immediately following survey completion. Contractor payment will be subject to confirmation of successful data submission. Data submitted to LiRA must comply with the Government of Alberta Open Information and Open Data Policy. Data submissions are due no later than two months after the assessment/survey is completed.

The accuracy of all submitted data will need to be verified using the following process prior to submission:

1. The LiRA mobile application has logic functions that will not allow unreasonable data entries and prevent incomplete data collection.
2. Field crew and supervisor will be given access on the LiRA web portal to quality check the data that they have collected.
3. Data will be checked by the Government's data manager before it is available on the web portal to the government and other proponents.

After a program's reconnaissance Establishment Survey is completed, the contractor will provide a summary report to the program proponent outlining the results of the program-level Establishment Survey. The report will provide a summary of any line segments that received either a CSR or a NSR (Section 7.3.3). The report will include a summary table with a row for each CSR or NSR segment outlining the segment's ID, length, status, strata (treatment and moisture regime, e.g, xeric+screefed), percent stocking level, stocking levels on either side of the line, and presence of a human access trail (Table 10). This information can be easily exported from the LiRA data management system. A program-level map of all surveyed lines will also be provided. The lines will be colour-coded: green for segments that are SR, yellow for segments that are CSR and red for segments that are NSR (as defined in Section 7.3.3).

Table 10. Required data summary table summarizing CSR and NSR segments in a program.

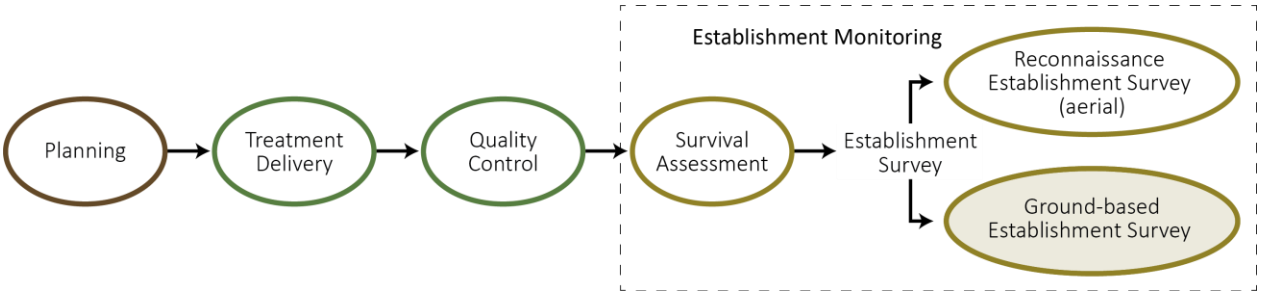
Segment ID	Segment length	Status	Strata	Stocking (%)	Both sides stocked (Y/N)	Wildlife trail (Y/N)	Human access trail (Y/N)

Report submissions must include the Establishment Survey cover sheet including the Registered Professional's signature stating that the Establishment Survey information is complete and accurate (Appendix 11).

7.3.6 Outcome and next course of action

Following the reconnaissance Establishment Survey, a summary report will be developed as outlined in Section 7.3.5. Ground-based surveys will be conducted following the steps outlined in the next section and together this information should be presented in a final establishment report to the program proponent.

7.4 Ground-based Establishment Survey



7.4.1 Purpose

Ground-based Establishment Surveys are intended to meet the following objectives:

- Serve as quality control for aerial reconnaissance surveys.
- Identify the causes of high variability in a stratum (treatment and moisture regime, e.g., xeric+screefed) observed during aerial surveys.

- Inform long-term monitoring and line trajectory calculations.

7.4.2 Determining sampling intensity

Sampling will occur at all the locations surveyed during the Survival Assessment survey. In situations where the locations of Survival Assessment plots are unknown, not available, or where additional plots are deemed necessary, ground-based Establishment Survey plot locations and intensity will be determined using the methodology described in Appendix 5.

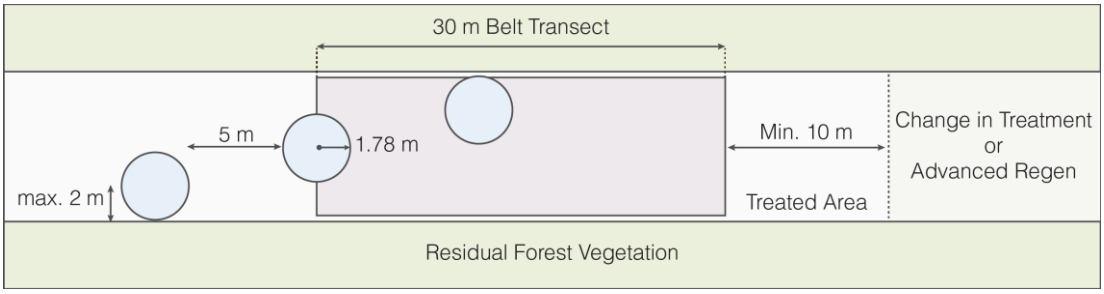
7.4.3 Plot design methodologies

The ground-based Establishment Survey will use the same plot layout and stratification as in the Survival Assessment: plots consisting of three evenly-spaced circular subplots spread systematically across the line to account for light and temperature differences, plus a single belt transect (Figure 9).

Each circular subplot will have a 1.78 m radius. The centres of the outermost circular subplots must be within 2 m of the edge of the line and each circular subplot must be 5 m apart (Figure 9). On sites that received mounding or other site preparation treatments, subplots can be moved to encircle the nearest treatment microsite (e.g., mound).

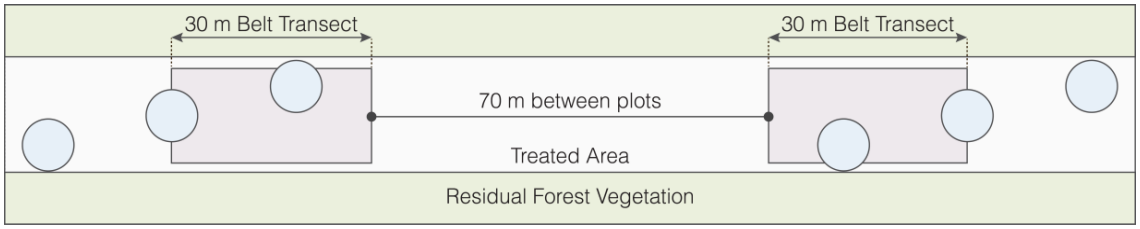
In addition to the three circular subplots, a 30 m belt transect extending the width of the seismic line will be used to further assess survival and stocking levels of acceptable species (Figure 9). This transect will extend 30 m from the middle of the centre circular subplot and the end of each transect will be a minimum of 10 m from the edge of a treatment (Figure 9). The belt transect is intended to be an efficient assessment of key metrics and will help reduce the variation in project- and program-level data sets, while maintaining an efficient number of sites to be visited.

Figure 9. Sample subplot layout for ground-based Establishment Surveys.



In situations where multiple plots are located within a single location (Appendix 5, 6), plots must be located a minimum of 70 m apart (Figure 10).

Figure 10. Minimum distance between plots when multiple plots are established at a single location.



7.4.4 Data collection requirements

Surveyors will collect the following information during the ground-based Establishment Survey.

Component	Variables to be recorded
General information	Line ID Segment ID Plot ID Plot Location (UTM NAD83)
Circular subplots	Plot photos Number of acceptable trees in subplot Heights of acceptable trees Leader lengths of acceptable trees Conditions of acceptable trees (based on condition codes in Appendix 10)
Belt transect	Overall stocking Intensity of use Coarse woody debris cover Presence of palatable shrubs and signs of browsing

Basic Plot Information

The following steps will be followed by a surveyor standing in the middle of the centre circular subplot:

- Project ID, Line ID, Segment ID and Plot ID fields are determined prior to starting the field work and must be filled upon arriving at the plot location.
- Plot location (UTM NAD83) will have been determined during operational planning; however, plots may need to be relocated due to errors in treatment locations or GPS coordinates. Any changes to plot locations must be immediately noted in the LiRA application.
- Adjacent stand composition and stand height are not recorded unless a natural disturbance or harvesting event has occurred since the time of the Survival Assessment.
- Standing in the middle of the centre circular subplot, capture four plot photos using the LiRA mobile application: two photos down the length of the line (one in either direction) and two photos of the forest on either side of the line.

Circular Subplots

The following steps will be followed by the surveyor within each of the circular subplots:

- Record the total number of germinants and multi-year seedlings.
- Competition levels within the circular subplots will be assessed in two parts. First, perform an ocular estimate of percent non-tree cover within the circular plot to the nearest 10%. Second, indicate if the competing vegetation overtops (O) the seedlings, is at the same level (L) or is below (B) the seedlings.

Conduct detailed measurements of up to five of the tallest acceptable tree species in each subplot that have multiple years of growth (i.e., are not germinants).

- Measure seedling heights to the tip of the leader to the nearest 1 cm. Conifer heights measured prior to August 1 must not include the current year's growth. On August 1 and later, surveyors will include current year's growth. For deciduous trees, the current season's growth is to be measured regardless of survey date.
- Record leader heights for all seedlings being measured to the nearest one cm. Prior to August 1, measure only the past year's growth; on or after August 1, measure the current year's growth.
- Identify the measured tree was rooted in a treated (T) or untreated (U) microsite. The treatment itself need not be recorded—it is obtainable from the operational plan.
- Assign one or more condition codes to each of the measured seedlings using the codes found in Appendix 10. Surveyors should assign multiple codes where appropriate.

Belt Transect:

The 30 m belt transect will be walked by the surveyor and assessed for the following criteria:

- Estimate overall stocking of acceptable tree species to the closest 10% within the belt transect for all sites. Only seedlings with multi-year growth will be counted towards this estimate. If stocking is below 70%, note poorly stocked areas and indicate possible causes.
- Estimate and record intensity of use as one of the four categories listed in Table 11. Examples are provided in the *Visual Manual* associated with this framework to help categorize intensity of use. If signs of wildlife use or human use exist the surveyor will photograph them using the LiRA mobile application.
- Estimate shrub cover and browsing by first walking the transect and estimating total shrub cover to the nearest 20%. The surveyor will then estimate the percentage of palatable shrub cover to the nearest 10%. Table 12 lists the species that are considered palatable to ungulates for the purpose of this framework. While other species may be palatable, these species represent the major species encountered in forested areas of Alberta.
- The surveyor will then look for signs of new browsing on the shrubs and record browsing intensity as one of the four categories listed in Table 13.
- Estimate coarse woody debris (CWD) cover and record it as one of the four categories found in Table 14. Examples are provided in the *Visual Manual* associated with this framework to help categorize CWD cover.

Table 11. Intensity of use (human or wildlife) of the seismic line as observed within the belt transect.

Intensity of Use	Description
None	No established path, no recent signs of access, any broken or cut vegetation is old.
Low	Trampled/broken vegetation, path can be followed but vegetation still present.
Medium	Clear path on some of line, bare earth in most areas, some removal/cutting of CWD.
High	Completely open line, soil eroded, rutting, woody debris cut and moved off path, access improvements (corduroy road, bridges) may exist.

Table 12. Shrub species considered palatable by ungulates in the framework (adapted from Strong and Gates, 2006).

Common name	Latin name
Willow	*Salix spp.*
Trembling aspen	*Populus tremuloides*
Balsam poplar	*Populus balsamifera*
Wild prickly rose	*Rosa acicularis*
Saskatoon berry	*Amelanchier alnifolia*
Red-osier dogwood	*Cornus sericea*
Choke cherry	*Prunus virginiana*
Highbush cranberry	*Viburnum edule*
Bracted honeysuckle	*Lonicera involucrata*

Table 13. Levels of browsing intensity.

Browsing intensity	Description
None	No signs of recent browsing.
Low	Occasional signs of new browsing, most areas show no signs of browsing.
Moderate	Browsing occurring through much of the belt plot, majority of palatable shrubs show some signs of browsing.
High	Almost all shrubs show some signs of browsing, many shrubs have had almost all leaders browsed.

Table 14. Levels of coarse woody debris as represented by percent ground cover (adapted from Vinge and Pyper, 2012).

Coarse woody debris level	Cover
None	0%
Low	1-15%
Moderate	16-30%
High	>30%

A detailed data sheet for the ground-based Establishment Survey is included in Appendix 9 and within the LiRA mobile application.

7.4.5 Reporting and data submission requirements

Ground-based Establishment Surveys for all sampling plots must be submitted to the LiRA data management system using the standardized data collection form in the LiRA mobile application and shown in Appendix 9. Data must be directly entered in the field using the mobile application or entered

immediately at the end of each field day. Contractor payment will be subject to confirmation of successful data submission, including quality checks.

Data submitted to LiRA must comply with the Government of Alberta Open Information and Open Data Policy.

After the ground-based Establishment Survey is completed, the contractor will provide a summary report to the program proponent outlining the results of the ground-based Establishment Survey. The report will include the following items:

- A summary of establishment results (SR, CSR, NSR) by strata (treatment and moisture regime, e.g., xeric+screefed) based on ground-based sampling.
- A summary of how the results by strata compare to the results of the reconnaissance Establishment Survey.
- An assessment of the accuracy of the reconnaissance survey compared against the ground-based sampling plots.
- A summary of key factors that may be contributing to any variability observed within the strata during the reconnaissance Establishment Survey.

In addition to this summary, the information from both the reconnaissance Establishment Survey and the ground-based Establishment Survey will be used to make a recommendation about the re-treatment of NSR areas. In conjunction with a restoration specialist, the report will document recommendations regarding re-treatment for each NSR segment and associated rationales.

The decision whether to re-treat will ultimately be based on the anticipated impact of the NSR segment on caribou populations. The factors to be considered are the same as following Survival Assessments, as summarized in Table 9. Failed (NSR) segments that are less than 100 m and which are surrounded by a high proportion of SR or CSR segments will not be re-treated.

Report submissions must include the Establishment Survey cover sheet including the Registered Professional's signature stating that the Establishment Survey information is complete and accurate (Appendix 11).

7.4.6 LiRA data management submissions

For the Survival Assessment, reconnaissance Establishment Survey and ground-based Establishment Survey, the Regulated Professional in charge of the monitoring program shall ensure that all required data is submitted to the Government of Alberta through the LiRA system. Submissions must use the standardized data forms and follow the data submission protocol as outlined in Appendix 1 to ensure robust data analysis capabilities. Data submissions are due no later than two months after the assessment/survey is completed.

The accuracy of all submitted data will need to be verified using the following process prior to submission:

1. The LiRA mobile application has logic functions that will not allow unreasonable data entries and prevent incomplete data collection.
2. Field crew and supervisor will be given access on the LiRA web portal to quality check the data that they have collected.

3. Data will be checked by the data manager before it is available on the web portal to the government and other proponents.

Recorded data and any video or aerial photographs taken as part of the assessment or auditing process will be submitted to the Government of Alberta and kept by the contractor for a minimum of 20 years after the flight.

7.5 Surveyor qualifications

The Government of Alberta has established surveyor certification requirements for Survival Assessments and Establishment Surveys.

Field Surveyors must meet the following criteria:

- Regulated Professional from an acceptable Professional Regulatory Organization[5] or under the direct supervision of a Regulated Professional.
- Successfully completed Survival and Establishment survey training. Both the development of training requirements and the provision of adequate training are the responsibility of each proponent.

When a surveyor is operating under the direct supervision of an Regulated Professional, the following conditions must be met:

- The Regulated Professional is overseeing the surveys as they occur.
- The Regulated Professional is overseeing (i.e., has direct authority over) and will be held responsible for the performance of surveyors.
- The Regulated Professional is providing direction and feedback to surveyors in a timely manner.
- The Regulated Professional is ensuring surveys conducted under their direct supervision are complete and accurate.

Interpreters must meet the following criteria in order to interpret regenerating openings by aerial photography or video for the reconnaissance Establishment Survey:

- Alberta AVI Level 1 interpreter or under the direct supervision of a Level 1 interpreter
- Has successfully completed interpretation training

When an interpreter is operating under the direct supervision of an AVI Level 1 Interpreter, the following conditions must be met:

- The supervising interpreter is overseeing the interpretation as it occurs.
- The supervising interpreter is overseeing (i.e., has direct authority over) and will be held responsible for the performance of interpreters.
- The supervising interpreter is providing direction and feedback to interpreters in a timely manner.

[5] Regulated Professionals are members in good standing of any of the following professional organizations: Alberta Institute of Agrologist (AIA), Alberta Society of Professional Biologists (ASPB), College of Alberta Professional Foresters (CAPF), or College of Alberta Professional Forest Technologists (CAPFT).

- The supervising interpreter is ensuring stratification and interpretation being conducted under their direct supervision are complete and accurate.

7.6 Survey quality

For all Survival Assessments, reconnaissance Establishment Surveys and ground-based Establishment Surveys, the Government of Alberta requires the following quality assurances:

- The Regulated Professional in charge of the assessment/survey is responsible for ensuring data is complete, accurate and consistent with the LiRA data submission protocols by having in place sufficient quality control systems.
- These systems must include surveyor training, field auditing, and data validation.

The quality control system must be detailed in writing and made available to the Government of Alberta.

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Suggested reading

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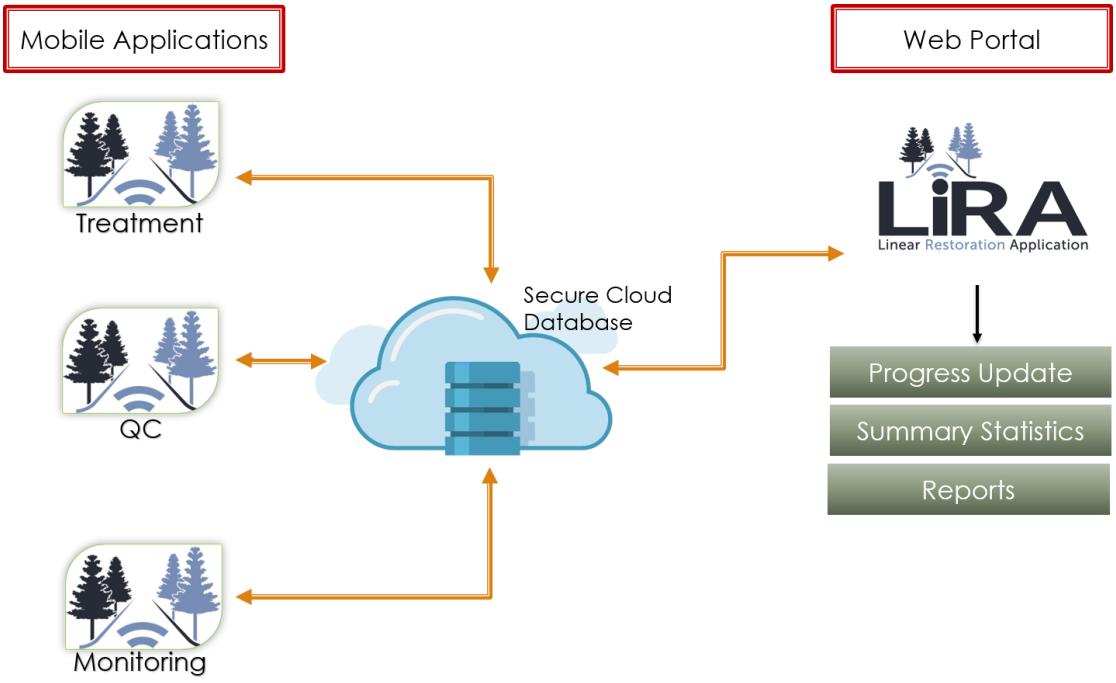
Appendix 1. Data Management Protocol

For all government-led programs, data collection will be completed in the field using three LiRA mobile applications which can be downloaded onto mobile devices. Collected data will be submitted to secure servers and will be available for editing and quality control from the wed-based LiRA portal. This protocol and application is also available to voluntary programs.



Flow of Information

Approved project treatment plans will be uploaded into the mobile application. These spatial plans will provide baseline information for on-the-ground treatments. The mobile applications, downloaded on standard tablets with GPS hardware, will provide 1.5 m positional accuracy. These can be used in both online and offline environments. Data can be collected and treatment plans can be viewed in an offline mode; however, data can only be submitted when mobile devices have internet access (either through Wi-Fi or data plans). Within the applications, dropdown menus are provided along with logic functions to avoid incorrect data collection. Similarly, error messages are provided when a user has not collected a complete data set; data cannot be saved or submitted without first collecting the complete required data.

1: Treatments:

Prescribed treatments for both site preparation and revegetation will be uploaded by contractors to the LiRA web application and can be viewed in the LiRA Treatment mobile application. An operator will sign in to this app at the start of each day and immediately know their location relative to the project area and treatments already applied on the ground. New treatment data coordinates will be

automatically recorded with the press of a start/stop button. Any change in applied treatment from the prescription can also be recorded with functions to collect the modified treatment and rationale. The operator has the ability of take photos to support the rationale. A similar approach has been taken for revegetation data management such that the planting/seeding plans will be available on the mobile devices with respective species and target densities. The revegetation supervisor is required to submit any changes to the treatments applied on the ground to the secure cloud server through the mobile application.

2: Quality Control:

The Quality Control (QC) mobile application will be used by a contractor assigned the task of treatment QC. Each QC inspector will have the prescribed treatments available on their device. The QC inspector can verify the treatments applied vs. what was initially prescribed and document supporting comments and pictures. QC plot locations will be spatially recorded on the app and provide visual aid to determine if QC plots are well-distributed across the project area. This app also allows the quality control inspector to record information to verify whether applied treatments support the overall goal of hindering line trafficability for wildlife and humans.

3: Monitoring:

The LiRA Monitoring mobile application will be used to collect data at the time of plot establishment as well as collecting data in circular subplots and belt transects across both short and long term monitoring. The forms will dynamically change based on what stage of the establishment monitoring is being conducted (i.e., Survival Assessments, Establishment Surveys, etc.). Similar to other forms, photos can be taken with added descriptions to emphasise particular field observations.

4: Backup to the LiRA Application:

LiRA applications have already been field tested in different conditions. If for some reason the application is not properly functioning, paper forms are included in this framework for data collection. If paper forms are used, field supervisors will then be required to submit the information collected on the paper forms into the LiRA web portal. For locational accuracies, a handheld GPS unit must be referenced when documenting coordinates of treatment start and stop locations, QC plot locations and vegetation monitoring stations.

5: Backup Data Submission using LiRA Web Portal:

The LiRA web portal has a specific interface to submit field data manually (without using mobile applications). This interface is used to submit data collected on the backup paper forms. Pictures can also be uploaded that were taken using a phone or digital camera. Field supervisors are required to ensure all data is submitted on a daily basis.

6: Data QC on LiRA Web Portal:

A data quality control interface is provided on the LiRA web portal for checking data submitted on the server. The interface has intuitive tools to view the data on a map, check the details, edit the details or delete a specific form. Field supervisors are responsible to QC the submitted data using the LiRA web portal on a weekly basis.

Data Upload and Storage

Data uploaded to the cloud database will have a secure backup; the backup process will occur daily. All submitted data along with the pictures will have an additional backup at the end of every shift (10 day period) saved onto secure file servers. Access to the cloud database will be secure; access is restricted to personnel approved by the Government of Alberta.

Data Access, Maintenance and Updates

Access to the LiRA web portal will be monitored and maintained based on requirements set by the Government of Alberta. Access will only be provided to relevant data for each contractor (e.g., treatment, QC, and monitoring information for a specific project or area). The contracting supervisor will only have the privileges to edit data relevant to that company's operations.

Data Manager

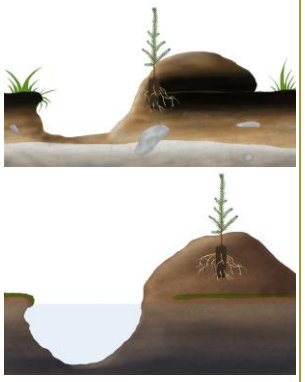
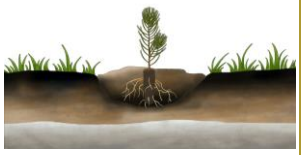
Final quality control and data publishing of any information in the LiRA web portal will be completed by a centralized data manager. The data manager will steward all quality, storage, backup and access to the project data. They will also be responsible for any system maintenance and update requests. The data manager will be a qualified person or company contracted by Government of Alberta, or a staff member of the Government of Alberta.

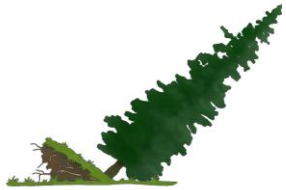
Exporting LiRA Deliverables

The LiRA web portal can be used to provide desired outputs in the form of project summaries and reports. Advanced data query and exporting functions have been created to ensure desired outputs. The interface will be further updated as per reporting requirements of the government.

Appendix 2. The Restoration Toolbox

Adapted with permission from Pyper et al., 2014. Linear Feature Restoration in Caribou Habitat: A summary of current practices and a roadmap for future programs. Canada's Oil Sands Innovation Alliance, Calgary, AB.

Treatment	What is it?	Why would you use it?	Where would you use it?	Key considerations	References
Mounding 	An excavator is used to dig holes and place the soil beside the hole creating an elevated mound.	Mounds create an elevated microsite that increases soil temperature and improves growing conditions for natural regeneration and/or planted seedlings. Mounds can help create an access barrier for human use and may impede predator movement on lines.	Lowlands with high water tables (moisture concerns). Dry stands to improve moisture availability (pooling of water in mound holes). Uplands to address competition concerns (e.g., grasses).	Operator training is essential. While mounds may appear simple, proper construction is critical to ensure moisture wicking for seedling growth, and also to ensure structural stability and integrity through annual freeze-thaw cycles. Treatment patterns should extend beyond the edge of the seismic line into adjacent forest.	Von der Gönna, 1992
Inversion 	An excavator is used to flip the organic layer and mineral soil to create a microsite.	Inversion is typically used to provide a microsite free of competition and a deeper rooting medium of organic material.	Generally used on xeric sites or sites with high competition.	Keeping organic layers intact improves the depth of organic rooting medium.	
Screefing 	An excavator or other implement removes the organic layer, exposing a mineral soil microsite.	Can be used in areas where organic layers would inhibit seed germination. Can also help create pockets of moisture in dry sites. May promote tree suckering.	Generally used on xeric sites with thick duff or litter layers.	Operator care must be taken not to screef too deep or too wide. Leaving some organic material is desirable for nutrient availability.	Von der Gönna, 1992

Treatment	What is it?	Why would you use it?	Where would you use it?	Key considerations	References
Rollback and coarse woody material 	Woody materials from beside the line, or from nearby operations, are placed on the line.	Creates microsites for vegetation establishment and protection of seedlings (natural and planted). Creates a human access barrier when applied at high enough volumes. May impede predator movement.	Anywhere microsites would help regeneration or where access management is required.	Wood availability may be limited and depends on historical exploration practices. Wood may also be transported from active operations. Treatment should extend beyond edge of line.	Vinge and Pyper, 2012; Pyper and Vinge, 2012
Tree felling or tree hinging 	Trees adjacent to the seismic line are felled across it.	Creates microsites for vegetation establishment and protection of seedlings (natural and planted). Creates a human access barrier when applied at high enough volumes. May impede predator movement.	Any sites where microsites would benefit regeneration or where access management is required.	Approvals required to fell trees from adjacent stands. Depends on adjacent stand density and in some areas may require use of merchantable tree species. Prioritizing felling on south sides of lines may improve light availability on lines.	
Tree tipping 	A process by which trees are pulled over using winches or heavy equipment.	Felling trees results in rapid loss of needles. Tree tipping maintains root contact with soils and may extend the life of the tree while still creating a line-of-sight and movement barrier for wolves and humans.	Any sites where microsites would benefit regeneration or where access management is required to reduce human access and predator movement.	The Cenovus LiDea project has experimented with both summer and winter applications.	Michael Cody (Cenovus); Geoff Sherman (Woodlands North)

Treatment	What is it?	Why would you use it?	Where would you use it?	Key considerations	References
Tree transplants 	Established trees adjacent to the treatment lines are excavated and moved onto treatment lines.	Generally used in situations where operators wish to establish immediate tree cover on a line.	Generally restricted to wet areas where the root ball can be excavated with minimal damage to the root structure.	Operators should create a divot prior to transplanting the tree to maximize root contact with surrounding peat or soil. Technique remains unproven and long-term survival of trees has not been tested.	
Summer planting 	Seedlings are planted to encourage regeneration.	Can help ensure desirable species mixes. Puts vegetation on a long-term recovery trajectory to a restored condition.	Any sites where improving regeneration is desirable. Often used in combination with site preparation. Wetlands can be difficult to plant in summer (access challenges).	Species should be selected based on local site conditions. Provides opportunity for planting additional species compared to winter planting.	
Winter planting 	Seedlings are planted to encourage regeneration.	Establishes conifer cover on sites and puts vegetation on a long-term recovery trajectory to a restored condition.	Generally used in treed wetlands where site preparation (mounding) has occurred. Enables planting of wetlands when access is possible (i.e., frozen ground conditions).	Planting occurs alongside site preparation. Currently, winter planting is limited to black spruce. Proper storage and handling of seedlings is critical. Covering seedlings with snow will help protect from desiccation.	Tan and Vinge, 2011

Treatment	What is it?	Why would you use it?	Where would you use it?	Key considerations	References
Seeding 	Seeds are spread on exposed microsites to facilitate tree recruitment.	Can reduce project costs and in some cases may improve tree establishment by allowing trees to establish on the most desirable microsites as opposed to relying on a planted tree plug.	Sites with sufficient exposed microsites to enable seed germination.	Seed must be collected and handled appropriately to ensure germination capabilities. Seeded sites can be delayed by 2–5 years compared to planted sites.	
Natural regeneration 	Exposed microsites are created and rely on seed influx from the adjacent stand.	Can reduce project costs and in some cases may improve tree establishment by allowing trees to establish on the most desirable microsites as opposed to relying on a planted tree plug.	Sites with sufficient exposed microsites to enable seed germination and with sufficient seed sources of desired species (e.g., white spruce) available adjacent to the treated line.	If insufficient seed of desired tree species is present in the first year, competing vegetation may quickly occupy available microsites. Used in tandem with site preparation could prove to be an efficient treatment.	
Ripping 	A bulldozer with either ripping teeth or a specialized plow, used to decompact soil.	Reduces site compaction, improves moisture availability, soil aeration and potential for root development.	Generally used on upland sites with soil compaction issues.	May use ripping teeth on bulldozers but ripping plows (RipPlow) have additional benefits.	McNabb et al., 2012

Appendix 3. Checklist of Supplementary Requirements for Operational Plan Submissions

Key item	Plan consideration	Required detail within the restoration plan
Stakeholder and Indigenous community engagement (e.g., (local forestry, oil and gas, trappers, recreation groups, etc.)	Contractors should consult with the Government of Alberta for consultation requirements.	
Regulatory approvals	Permit, approval, agreement and notification requirements	Contractor's written understanding of relevant regulations and acquisition of approvals based on project activities and verified environmental features (wetlands, stream crossings, etc), local infrastructure (pipeline crossings, LOCs, etc.), sensitive wildlife populations, and so on.
	Mapping and documentation of identified features requiring regulatory review	Map(s) showing distribution of appropriately classified environmental features, seed zones, rare species occurrences, registered land users and dispositions within and adjacent to the restoration project area. Records of database searches and field surveys.
	Mitigation and conservation measures	Contractor's written understanding of relevant standards, guidelines and best practices. Detailed plans for crossing installations and removals, water quality and flow protection, erosion control, weed management, mountain pine beetle, rare species protection, and so on.

Key item	Plan consideration	Required detail within the restoration plan
Safety	Worker safety during restoration operations	Written approach to ensure contractor/subcontractor safety throughout the restoration project. Present a site-specific safety plan with operational plan submission.
Clean-up plans	Project refuse	Written commitment and description of how all wastes generated during the restoration project will be managed.
Professional review	Professional sign-offs	Documented plan review, regulated professional sign-offs of assessment and survey quality.

Appendix 4. Quality Control Payment Criteria

Contractors are responsible for providing their own third-party auditors as part of their project delivery. For government-led programs, contractor payment will be evaluated based on successfully achieving quality control criteria during restoration application.

Quality will be assessed against the criteria outlined in Section 6.3 of the framework. Quality control plots will be pooled and the overall percentage used to evaluate payment percent. An example is provided below for evaluating mounding quality and assessing payment. Note: The quality control auditor is responsible for determining a statistically credible number of quality control plots for proper evaluation of treatments.

Example 1: Determine payment criteria for mounding quality

Step 1: A statistically defensible number of plots are established by the auditor for each treatment type.

Step 2: Data is averaged for each quality control metric

Treatment	Measures of Success				
	Density	Quality	Coverage	Pattern	Payment terms
Mounding	Average = 97%	Average = 85%	Average = 100%	Average = 100%	See Table 15

Step 3: Determine overall quality %

$$\text{Quality \%} = \frac{(97\%+85\%+100\%+100\%)}{4} = 95.5\%$$

Step 4: Determine payment amount by referring to Table 15 (see next page).

Quality % = 95.5%

Payment = 100%

Table 15. Treatment payment reference guide[6].

Quality%	Pay%	Quality%	Pay%	Quality%	Pay%	Quality %	Pay %
100.00-92.60	100.00	90.30	96.76	88.00	91.96	85.70	85.63
92.50	99.90	90.20	96.58	87.90	91.72	85.60	85.32
92.40	99.79	90.10	96.40	87.80	91.48	85.50	85.01
92.30	99.67	90.00	96.22	87.70	91.23	85.40	84.69
92.20	99.55	89.90	96.03	87.60	90.97	85.30	84.37
92.10	99.43	89.80	95.85	87.50	90.72	85.20	84.05
92.00	99.31	89.70	95.66	87.40	90.46	85.10	83.72
91.90	99.18	89.60	95.46	87.30	90.20	85.00	83.40
91.80	99.05	89.50	95.27	87.20	89.94	84.00	79.96
91.70	98.92	89.40	95.07	87.10	89.67	83.00	76.22
91.60	98.78	89.30	94.86	87.00	89.40	82.00	72.20
91.50	98.65	89.20	94.66	86.90	89.13	81.00	67.89
91.40	98.50	89.10	94.45	86.80	88.85	<80.00	0.00
91.30	98.36	89.00	94.24	86.70	88.57		
91.20	98.21	88.90	94.02	86.60	88.29		
91.10	98.06	88.80	93.81	86.50	88.01		
91.00	97.91	88.70	93.59	86.40	87.72		
90.90	97.75	88.60	93.36	86.30	87.43		
90.80	97.60	88.50	93.14	86.20	87.14		
90.70	97.43	88.40	92.91	86.10	86.84		
90.60	97.27	88.30	92.68	86.00	86.54		
90.50	97.10	88.20	92.44	85.90	86.24		
90.40	96.93	88.10	92.21	85.80	85.94		

[6] Based on payment criteria in: BC Ministry of Forests. Planting Quality Inspection Guide to Completing the FS 704. 2012. Effective April 2012.

Appendix 5. Guide to Minimum Plot Density and Plot Stratification

Sampling plot density and plot locations for the Survival Assessment and ground-based Establishment Surveys are scalable based on the size of the restoration project. The approach is intended to achieve the following core objectives:

- Provide a clear indication of overall project-level response to treatments.
- Provide sufficient power for program-scale analyses while maintaining a cost-efficient system for monitoring.
- Enable projects to establish multiple plots within a single general location, increasing monitoring efficiencies.
- Scale the number of plots required based on the total length of treated lines in an individual stratum and total length of the restoration project.
- Sample a small portion of the treated areas only to manage monitoring costs.

A single project may contain many different strata, defined as any combination of site type and treatment method (e.g., xeric+screef, mesic+mound+cwd, mesic+mound, etc.). A minimum number of plots will be required based on the total length of a treatment method, with the plots then distributed according to the establishment categories outlined in Table 4 (i.e., upland dry; upland and transitional; lowland treed; lowland low density treed). These plots may be grouped in "plot locations" (or simply "locations") to reduce the spatial extent of sampling and improve monitoring efficiencies. A location consists of no more than eight plots spaced at least 70 m apart.

It is important to note that the following calculations will provide a *minimum* number of sample plots. If a contractor is unsure of project success or has used innovative treatments on a portion of the project, a higher sample size should be used. Examples are included below to clarify the steps for different scenarios.

Step 1: Total length of each treatment

Determine the total length (km) of each treatment (e.g., screef, mound+cwd, mound, etc.), not including project exclusions or advanced regeneration segments.

Step 2: Sampling parameters for each treatment

Step 2a: Minimum number of plots

The minimum required number of plots is determined for each treatment type using Table 16. The sampling stratification is designed in such a way that the minimum sample plot density is 1 plot per 4 km. In treatments that have a low number of total kilometres, the actual plot density will be higher than this minimum.

Step 2b: Minimum number of locations

The minimum number of locations is based on the total length of each treatment type; the longer the total treatment length, the more locations are required (Table 16).

Step 2c: Maximum number of plots per location

The maximum number of plots per location is based on the total length of each treatment type; the longer the total treatment length, the more plots can be included within a single location (Table 16).

Table 16. The total length of each treatment type is used to calculate the minimum number of plots per treatment, the minimum number of locations that must be sampled per treatment, and the maximum number of plots that can be placed per location per treatment. Note that the minimum number of plots is always rounded up to the next whole number.

Distance in a treatment type	Minimum no. of plots	Minimum no. of locations	Maximum no. plots per treatment per location
>2 km	3 plots	1	3
3–10 km	3 plots + ((treatment length – 2 km)/2)	2	5
11–50 km	7 plots + ((treatment length – 10 km)/4)	3	6
51–100 km	17 plots + ((treatment length – 50 km)/4)	4	7
101–200 km	30 plots + ((treatment length – 100 km)/5)	5	8
>200 km	50 plots + ((treatment length – 200 km)/10)	7	8

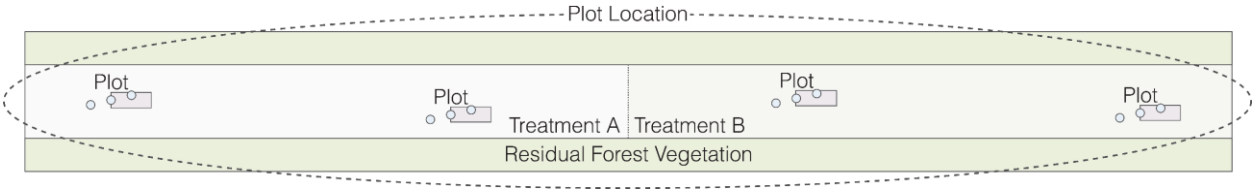
Step 3: Divide treatments into establishment categories to determine final plot allocation

Plot allocations are determined by taking the number of plots assigned to each treatment type and dividing them into each establishment category (i.e., upland dry; upland and transitional; lowland treed; lowland low density treed) found in the project area. The number of plots placed in each establishment category should be representative of the project (e.g., If 50% of the mounded area in a project is lowland treed, 50% of the monitoring plots for mounding should be placed in lowland treed areas). A leeway of ±10% is allowed.

Step 4: Minimum number of plot locations for overall project

The minimum number of locations applies at two different scales. Each treatment requires a minimum number of locations (Step 2b); however, a single location may span across multiple treatment types. When this happens, a single location may contribute to the location totals for two or more treatments (Figure 11). It is therefore necessary to define a minimum number of locations for the overall project area.

Figure 11. Where a location covers multiple treatments, it counts as a single location within the project area, but it counts toward the minimum number of locations for each treatment (i.e., for treatment A it is considered one location, and for treatment B it is considered one location).



The minimum overall number of locations for the entire project is calculated as:

i. The sum of the minimum number of plots for the entire program divided by the maximum number of plots per location as determined by the total treated line length (Table 17).

Table 17. The total treated length of the project is used to determine the maximum number of plots that can be placed per location. This value is used in Step 4 to calculate the minimum number of plot locations over the entire project area.

Total treated length of the project (km)	Max # plots per location
1–100	6
101–200	7
> 200	8

Example 1: Small project size

Step 1: Determine length of treated area.

Project overall length: 74 km

Project exclusions: 8 km

Advanced regeneration areas (only assessed in aerial reconnaissance): 15 km

Treated area that is used to determine sample distribution: 74 km – 8 km – 15 km = **51 km**

Step 2: Calculate treatment-level sampling parameters (Table 18).

Table 18. Example treatment-level sampling parameters for a small-sized restoration project. Note that the minimum number of plots is always rounded up to the next whole number.

Treatment	Total treatment length (km)	Minimum Number of Plots	Minimum # of Plot Locations	Max # plots per location	Plots per km
Mounded	6	5	2	5	0.63
Mounded+CWD	8	6	2	5	0.75
Screef+Cwd	29	12	3	6	0.41
Screef	8	6	2	5	0.75
Totals	**51**	**29 plots**			**0.57**

Step 3: Assign plots to establishment categories within each treatment type.

For this example, 20 km of the screef+CWD treatment is on upland dry sites, while 9 km of this treatment is on upland and transitional sites.

i. Calculate the proportion of this treatment within each of the above establishment categories: 69% upland dry and 31% upland and transitional

ii. Each group has a 10% leeway in the number of plots:

   a. Upland dry: 59%–79% of 12 total plots = 7–9 plots

   b. Upland and transitional: 21%–41% of 12 total plots = 3–4 plots

iii. Assign plots to each establishment category such that they add up to the total calculated in Step 2 (12 plots).

Step 4: Calculate project-level minimum number of plot locations.

i. The sum of the minimum number of plots for the entire program divided by the maximum number of plots per location as determined by the total treated line length (Table 17), rounded up:
   29 plots (sum of the min number of plots) / 6 plots per location (From Table 17) = 4.8 = 5 plot locations

There must be a minimum of five plot locations within the treated project area. Locations and their associated plots must be laid out such that the requirements of Table 18 and Step 3 are met.

Example 2: Medium project size

Step 1: Determine length of treated area.

Project overall length: 354 km

Project exclusions: 52 km

Advanced regeneration areas (only assessed in aerial reconnaissance): 97 km

Treated area that is used to determine sample distribution: 354 km – 52 km – 97 km = **205 km**

Step 2: Calculate treatment-level sampling parameters (Table 19).

Table 19. Example treatment-level sampling parameters for a medium-sized restoration project. Note that the minimum number of plots is always rounded up to the next whole number.

Treatment	Total treatment length (km)	Minimum Number of Plots	Minimum # of Plot Locations	Max # plots per location	Plots per km
Mounded	95	29	4	7	0.30
Mounded+CWD	19	10	3	6	0.52
Screef+CWD	47	17	3	6	0.36
Screef	36	14	3	6	0.39
Straight Planted	8	6	2	5	0.75
Totals	**205**	**76 plots**			**0.37**

Step 3: Assign plots to establishment categories within each treatment type.

For this example, 55 km of the mounding treatment is on upland and transitional sites, while 40 km of the mounding is on lowland treed sites.

i. Calculate the proportion of this treatment within each of the above establishment categories: 58% upland and transitional and 42% lowland treed.

ii. Each group has a 10% leeway in the number of plots:

   a. Upland and transitional: 48%–68% of 29 total plots = 14–20 plots

   b. Lowland treed: 32%–52% of 29 total plots = 9–15 plots

iii. Assign plots to each establishment category such that they add up to the total calculated in Step 2 (29 plots).

Step 4: Calculate project-level minimum number of plot locations.

i. The sum of the minimum number of plots for the entire program divided by the maximum number of plots per location as determined by the total treated line length (Table 17), rounded up:

   76 plots (sum of min number of plots) / 8 plots per location (from table 17) = 9.5 = 10 plot locations

There must be a minimum of 10 plot locations within the treated project area. Locations and their associated plots must be laid out such that the requirements of Table 19 and Step 3 are met.

Example 3: Large project size

Step 1: Determine length of treated area.

Project overall length: 864 km

Project exclusions: 92 km

Advanced regeneration areas (only assessed in reconnaissance): 167 km

Treated area that is used to determine sample distribution: 864 km – 92 km – 167 km = **605 km**

Step 2: Calculate treatment-level sampling parameters (Table 20).

Table 20. Example treatment-level sampling parameters for a large-sized restoration project. Note that the minimum number of plots is always rounded up to the next whole number.

Treatment	Total treatment length (km)	Minimum Number of Plots	Minimum # of Plot Locations	Max # plots per location	Plots per km
Mounded	258	56	7	8	0.22
Mounded+CWD	112	33	5	8	0.29
Screef+CWD	107	31	5	8	0.29
Screef	66	21	4	7	0.32
Straight Planted	17	9	3	6	0.53
CWD	45	16	3	6	0.36
Totals	**605**	**166 plots**			**0.27**

Step 3: Assign plots to establishment categories within each treatment type.

For this example, 100 km of the mounding treatment is on upland and transitional sites, while 158 km of this treatment is on lowland low density treed sites.

i. Calculate the proportion of this treatment within each of the above establishment categories: 39% upland and transitional and 61% lowland low density treed.

ii. Each group has a 10% leeway in the number of plots:

   a. Upland and transitional: 29%–49% of 56 total plots = 16–27 plots

   b. Lowland low density treed: 51%–71% of 56 total plots = 29–40 plots

iii. Assign plots to each establishment category such that they add up to the total calculated in Step 2 (56 plots).

Step 4: Calculate project-level minimum number of plot locations.

i. The sum of the minimum number of plots for the entire program divided by the maximum number of plots per location as determined by the total treated line length (Table 17), rounded up:
166 plots (sum of min number of plots) / 8 plots per location (based on table 17) = 20.75 = 21 plot locations

There must be a minimum of 21 plot locations within the treated project area. Locations and their associated plots must be laid out such that the requirements of Table 20 and Step 3 are met.

Appendix 6. Determining Sampling Locations

The following procedure will be used to determine sampling plot locations. Plots will be located during the planning stage, after calculating the required number of plots.

While plots would ideally be randomly placed, limited locations of some strata and access concerns will affect sampling locations.

The deliberate nature of picking sampling locations at the planning stage will introduce limited bias since this is done prior to actual treatments taking place. Deciding locations at the planning stage will also limit future access challenges by guiding helipad placement and determining access routes.

If the developer of the operational plan is also involved in implementing the operational plan, the locations of the monitoring locations must not be conveyed to operators in order to limit bias in treatment quality.

At least 20% more potential monitoring locations than determined by the sampling calculation will be identified during the planning stage. This will provide a buffer as some locations may become inaccessible due to future disturbance or development.

If the project runs multiple years, the contractor must consider how access may change over time.

There are two classes of monitoring locations that will be stratified by access:

- Up to 75% of monitoring locations can be biased for access.
- At least 25% of monitoring locations must be at least 2.5 km from the edge of access.
- In cases of small projects with limited stretches of treated lines that meet this distance requirement, this rule may be relaxed by the reviewing government agent.

Monitoring locations will be subject to the following basic guiding requirements:

- Locations on the same line must be at least 1.5 km apart.
- Locations on different lines must be at least 1 km apart.
- Locations must be at least 200 m from all-season roads.
- Locations must be at least 100 m from the edge of a project area.
- Locations must not be in areas treated to stop access (excessive CWD or fencing) unless these areas constitute separate treatments.
- If the project has less than 100 km of lines receiving treatment or the project has access issues, spacing of the plot locations can be reduced in consultation with the Government of Alberta.

Combining years

- In projects treated over multiple years, up to three treatment years can be combined.
- If the project runs more than three years, the project must be divided into, and plot numbers determined for, phases containing no more than three years each.

Appendix 7. Survival Assessment Data Sheet

Note: These data sheets may not be identical to what is seen within the LiRA application, due to changes with subsequent application updates.

Basic Plot Information: recorded on arrival at the plot.

Project Name	Plot ID	Date	Company	Crew	Latitude	Longitude	Planted?	Planting Species	Seeded?	Seeding Species	Line width	Line orientation	Stand type	Estimated stand height
							Yes	1: White Spruce	Yes	1: White Spruce				
							No	2: Black spruce	No	2: Black spruce				
								3: Englemann spruce		3: Englemann spruce				
								4: Lodgepole pine		4: Lodgepole pine				
								5: Larch		5: Larch				
								6: Willow		6: Willow				

Circular Subplot: recorded within each of the circular subplots (abridged)

Inspector	Overall cover	Seedlings overtopped?	Photos	Yr after Treatment	Germinants	Planted	Advanced Regen	Height	Leader length	Condition codes	Planting location
		Y/N	4 taken		Count	Count	Count	Cm	Cm	Appendix 10	Treated/untreated

Belt Transect: recorded within each of the belt transects (abridged)

Inspector	Evidence of Use	Use Comments	CWD level	Stocking %	Survival %
	0 - None		None		
	1 - Low		Low		
	2 - Moderate		Medium		
	3 - High		High		
			Very High		

Appendix 8. Reconnaissance Establishment Survey Data Sheet

Note: This data sheet may not be identical to what is seen within the LiRA application, due to changes with subsequent application updates.

Line ID	Date	Time	Crew	Flying Conditions	Stocking Density	Evidence of Human Use	Evidence of Wildlife Use	Remarks
					Groups of 10%	0 - None	0 - None	
						1 - Low	1 - Low	
						2 - Moderate	2 - Moderate	
						3 - High	3 - High	

Appendix 9. Ground-based Sampling Establishment Survey Data Sheet

Note: These data sheets may not be identical to what is seen within the LiRA application, due to changes with subsequent application updates.

Basic Plot Information: recorded on arrival at the plot.

Project Name	Plot ID	Date	Company	Crew	Latitude	Longitude	Planted?	Planting Species	Seeded?	Seeding Species	Line width	Line orientation	Stand type	Estimated stand height
							Yes	1: White Spruce	Yes	1: White Spruce				
							No	2: Black spruce	No	2: Black spruce				
								3: Englemann spruce		3: Englemann spruce				
								4: Lodgepole pine		4: Lodgepole pine				
								5: Larch		5: Larch				
								6: Willow		6: Willow				

Circular Subplot: recorded within each of the circular subplots (abridged)

Inspector	Overall cover	Seedlings overtopped?	Photos	Yr after Treatment	Germinants	Planted	Advanced Regen	Height	Leader length	Condition codes	Planting location
		Y/N	4 taken		Count	Count	Count	Cm	Cm	Appendix 10	Treated/untreated

Belt Transect: recorded within each of the belt transects (abridged)

Inspector	Evidence of Use	Use Comments	CWD level	Stocking %	Shrub cover %	% Palatable	Browsing level
	0 - None		None				
	1 - Low		Low				
	2 - Moderate		Medium				
	3 - High		High				
			Very High				

Appendix 10. Condition Codes

Code	Description
0	Healthy
1	Insects
2	Disease
3	Browsing
4	Frost Heaving
5	Multiple Leader
6	Dead Top/Dieback
7	Dead Top/Dieback with new leader
8	Dying
9	Snow Press
10	Missing
11	Flooding
12	Poor Planting
13	Suppression
14	Dead Tree

Appendix 11. Submission Coversheet

Alberta Restoration Framework for Legacy Seismic Lines Submission Coversheet & Professional Declaration			
Company Name and Project:		Reporting Date:	
Name(s) of Company Reps:		Name(s) of Qualified Professionals or Interpreters:	

Instructions:

Submit one coversheet and professional declaration for each assessment report (Survival Assessment Survey, Aerial Reconnaissance Establishment Survey, and Ground-based Establishment Survey). The survey elements listed below must be submitted to the Alberta Government LiRA data management system in order for the submission to be deemed complete. Initial beside each element to verify that the element has been reviewed and submitted at the time of professional declaration.

Survey Level: **Survival Assessment** ☐ **Reconnaissance Establishment** ☐ **Ground-Based Establishment** ☐

Required Survey Reporting Element	Initials	Required Survey Reporting Element	Initials

Reporting Declaration:

I (we) declare the survey was completed to the approved methods of the indicated company's Legacy Seismic Restoration Program. All of the information submitted is, to the best of my knowledge, complete, accurate and consistent with the LiRA data submission protocols. The enclosed report has been prepared in accordance with the agreed upon quality assurance/quality control set by the Province of Alberta.

Print Name	Title	Professional Reg./Member #	Stamp
Signature	Date	I am aware it is an offence under Section 227 of the Environmental Protection and Enhancement Act to provide false, misleading or inaccurate information, and there are significant fines for committing these offences.	

Print Name	Title	Professional Reg./Member #	Stamp
Signature	Date	I am aware it is an offence under Section 227 of the Environmental Protection and Enhancement Act to provide false, misleading or inaccurate information, and there are significant fines for committing these offences.	

For Internal Use Only Reviewer's Declaration

I declare the survey has been reviewed and was completed to the approved methods of the indicated company's Legacy Seismic Restoration Program. All of the reviewed information submitted is, to the best of my knowledge, complete, accurate and consistent with the LiRA data submission protocols. The reviewed report has been prepared in accordance with the agreed upon quality assurance/quality control set by the Province of Alberta.

Reviewer's Name Print	Reviewer's Title	Professional Reg./Member #	Stamp
Reviewer's Signature	Date	Comments	

Appendix 12. Standardized Criteria for use During Reconnaissance

Main	Field	Description
	Date	M/D/Y
	Location	UTM
	Crew	Initials
	Line ID	Unique Line ID
	Line Segment	Unique Line Segment
History/ Current Use	**Field**	**Description**
	Seismic	
	Access road	Winter / summer
	Access trail	Reason
	Markings noted	Signage, traps, ceremonial, burial, other
Site Action	**Field**	**Description**
	Exclude from program	Yes / No
	Include into program	Yes / No
	Access deactivation required	Yes / No
	Access deactivation method	Mound, barrier, cwd, signage
	Site preparation treatment	none, mounding, screefing, ripping, inversion
	CWD available on site	Yes / No
	CWD treatment	Yes / No
	CWD treatment density	High, med, low
	Treatment 1 density	
	Treatment 2 density	
	Treatment 3 density	
	Revegetation species	Sw%, Sb%, Lt%, Pl%, Fb%
	Revegetation density	sph
	Revegetation - Shrub	List Spp
	Revegetation plan	winter plant, summer plant, transplant, seeding, advanced regen
Access	**Field**	**Description**
	Access Type	All weather, Frozen, Dry conditions only, Heli, ATV/UTV/Sled, Foot

Dispositions	Field	Description
	Linear disposition type	DLO, LOC, ROI
	Crossing disposition type	PLA, DLO, LOC, PIL, EZE
	Number	List if known
	LSD	Sec. Twp. Rge. Meridian
	Status	Active, cancelled, reclaimed
	Owner	Text
Timber	**Field**	**Description**
	AVI Description	
	Leading Canopy Spp	Sw%, Sb%, Lt%, Pl%, Fb% Pj...Se, Fa, Fd, Pb, Aw, Bw...
	2nd Canopy Species	Sw%, Sb%, Lt%, Pl%, Fb%
	3rd Canopy Species	Sw%, Sb%, Lt%, Pl%, Fb%
	Understory	
	Height (m)	
	Diameter (cm)	
Site Descriptions	**Field**	**Description**
	Lowland	Hydric, hygric, mesic
	Transitional	Hydric, mesic, xeric
	Upland mesic	Mesic, xeric
Streams	**Field**	**Description**
	Crossing ID	
	Stream Class	LP, SP, TRANS, INT, EPH
	Waterbody Classification	A, B, C, D
	RAP	
	Channel Width	in centimeters
	Channel Depth	in centimeters
	Streambed Composition	% fines, % sands, % Gravels, % Cobbles, % Boulders
	Crossing type	Bridge Temp, Bridge Perm, Culvert Single, Culvert Multiple, Cross Drain, logfill, snowfill
	Riparian vegetation	AVI Code
	Sedimentation	Yes / No
	Sedimentation extent	Low, Med, High
	Erosion	Yes / No
	Erosion	Low, Med, High
	Ditch flow	Yes / No
	Ditch flow	Low, Med, High
	Fish Presence	Yes / No / Unknown
	Fish Habitat	Good / Bad / Poor

Crossings	Field	Description
	Existing crossing type	Bridge Temp, Bridge Perm, Arch, Culvert Single, Culvert Multiple, Cross Drain, logfill, snowfill, ford
	New crossing required	Bridge Temp, Bridge Perm, Arch, Culvert Single, Culvert Multiple, Cross Drain, logfill, snowfill, ford
Wetlands	**Field**	**Description**
	Wetland Class	Bog, Fen, Marsh, Shallow Open Water, Swamp
	Bog	Wooded, Coniferous, Shrubby, Graminoid
	Fen	Wooded, Coniferous, Shrubby, Graminoid
	Marsh	Graminoid
	Shallow Open Water	Submersed and or floating aquatic vegetation, bare
	Swamp	Wooded coniferous, Wooded mixedwood, Wooded deciduous, Shrubby
Site Limiting Factors	**Field**	**Description**
	Anthropogenic use	No, Low, Mod, High, N/A
	Browsing	No, Low, Mod, High, N/A
	Compaction	No, Low, Mod, High, N/A
	Cold / wet soils	No, Low, Mod, High, N/A
	Low soil NR	No, Low, Mod, High, N/A
	Competition	No, Low, Mod, High, N/A
Remarks	**Field**	**Description**
		alpha numeric
Photos	**Field**	**Description**
	looking north	Multiple with description
	looking east	Multiple with description
	looking south	Multiple with description
	looking west	Multiple with description