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PARKER CARIBOU RANGE

Boreal Caribou Restoration Pilot Program Plan

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REPORT

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Distribution:

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Executive Summary

The loss and fragmentation of boreal caribou (*Rangifer tarandus caribou*) habitat resulting from anthropogenic disturbances, and the subsequent increase in predator and primary prey populations in early seral habitats, has been identified as the main limiting factor to caribou populations by both the British Columbia (BC) provincial government and the federal government. Restoration of linear corridors is a management lever to help create larger contiguous patches of preferred caribou habitat than currently exist within fragmented ranges.

This Parker Range Pilot Restoration Program Plan (the Program Plan) is the first plan to propose application of habitat restoration techniques over an entire boreal caribou range in Canada. Oil and gas and forestry activities within the Parker Range are expected to be low over the coming decade, providing the opportunity to apply and monitor, with minimal expectation of human disturbance, the effectiveness of habitat restoration techniques over a caribou-range scale in relation to caribou population metrics. The overall objective of the Program Plan is to transition low quality boreal caribou habitat into higher quality habitat by reducing the benefits predators and their primary prey gain through linear corridor use, and establish a vegetation trajectory on these corridors that will in the long term increase boreal caribou habitat intactness. This Program Plan has been designed to be implemented over a multi-year period, completing desktop disturbance mapping and implementation planning (2015-2016), implementing restoration treatments (2017-2021), and conducting post-treatment monitoring.

Contained within this Program Plan are the details from the linear disturbance mapping, an outline of the authorization process and assessments required to conduct restoration activities within the Parker Range, a tactical multi-year restoration implementation plan as well as a summary of restoration and wildlife monitoring.

Linear disturbance inventory mapping was completed for the Parker Range to determine the extent of linear disturbances that may require implementation of habitat restoration techniques to restore caribou habitat. The mapping was gathered through public government sources, available public reference aerial imagery, and Ladybug®5 360 imagery collected by air in June 2015. A total of 1,040 km (2,473 line segments) of linear disturbances were captured within Ladybug®5 360 imagery. The linear disturbance inventory imagery was interpreted for the attributes of site type, dominant tree species, vegetation height, vegetation cover, line width, presence or absence of a game trail and spatially mapped and then verified in the field for quality control. Linear disturbance segments were then classified as no-treatment, leave for natural revegetation or restoration treatment candidate.

No-Treatment linear disturbances constitute any linear disturbance that may have an active disposition or protective notation, such as a pipeline, lease road, designated recreational trail, or ecological reserve. Where the locations of these access corridors were certain, they were excluded from the linear disturbance inventory treatment options summary. In total, 76 km (7%) of the mapped and classified linear disturbances within the Parker Range are considered No-Treatment disturbances. Leave for natural revegetation was recommended when percent cover and height classification of vegetation along a linear disturbance are above the threshold for recommending tree seedling planting, and there is no game trail. A recommendation of leave for natural was determined if a wetland had > 10% vegetation cover, consistently equal to or over 50 cm in height, and no game trail was present, or an upland site with over 30% vegetation cover, consistently equal to or over 50 cm in height with no game trail present. A total of 394 km (38%) of linear disturbances within the Parker Range are considered Leave for Natural Revegetation and will not be treated due to the current height and consistent cover

of vegetation. A total of 569 km (55%) of linear disturbances within the Parker Range will be considered for treatment. However, ground-truthing before treatment is necessary to verify site specific treatment recommendations.

A tactical plan is outlined to apply restoration treatments over a multi-year period, using ecological, logistical, and economic considerations. Given the multi-year nature of the Program Plan, the tactical plan developed provides guidance for priority of restoration each implementation year within four zones delineated within the Parker Range. An annual implementation plan will be prepared during each year of the Program Plan, as part of the authorization, costing and treatment implementation planning process.

Acknowledgements

This project was recommended by the Research and Effectiveness Monitoring Board (REMB) of the British Columbia Government's Boreal Caribou Implementation Plan (BCIP) initiative. Funding for the project was provided by the BC Oil and Gas Research and Innovation Society (BC OGRIS).

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1.0 BACKGROUND

In British Columbia (BC), boreal woodland caribou (*Rangifer tarandus caribou*) is listed as S2 ('Imperiled') by the BC Conservation Data Centre (CDC) and is on the provincial Red list (BC CDC 2015).The loss and fragmentation of boreal caribou habitat resulting from anthropogenic disturbances, and the subsequent increase in predator and primary prey populations in early seral habitats, has been identified as the main limiting factor to caribou populations by both the BC provincial government and the federal government (BC MoE 2011, EC 2012). The Boreal Caribou Implementation Plan (BCIP) relies partially upon aggressively restoring habitat to improve caribou population projections (BC MoE 2011). Restoration of linear corridors, implemented using methods that reduce wildlife and human use and promote late seral stage vegetation establishment, will create larger contiguous patches of preferred caribou habitat than currently exist.

In recent years there have been ongoing discussions within various jurisdictions in regards to what and where habitat restoration activities should be undertaken, how to sequence restoration plans and who should ultimately be responsible for delivering and covering the costs of landscape level restoration. To date, caribou habitat restoration field programs have been limited in scope primarily to a project scale level (e.g., a pipeline). During a one day workshop held in December 2014, 85 representatives from federal and provincial government regulatory agencies, oil and gas, oil sands, pipeline, power, transportation and mining sectors from western Canada participated in breakout sessions to identify the key steps and actions required for implementation of landscape level restoration plans that achieve 'net positive habitat gain' in boreal caribou ranges. Ultimately, each breakout group came to the conclusion that collaboration between government and industry is essential, potentially through a third party integrator, to strategically restore large tracts of caribou habitat in priority areas (Golder 2015).

The Boreal Caribou (Parker Range) Habitat Restoration Pilot Program Plan (the Program Plan) was initiated in April 2015 by the Research and Effectiveness Monitoring Board (REMB) of the BCIP initiative, with funding for the Program Plan provided by the BC Oil and Gas Research and Innovation Society (BC OGRIS). Science provides guidance regarding the need for landscape level restoration (S. Boutin pers. comm. 2014). Although analysis has indicated that habitat restoration is linked to improving caribou population projections, the feasibility and predicted outcomes of restoration activities are highly uncertain (Wilson et al. 2010). The Program Plan is the first plan to propose application of restoration techniques over an entire boreal caribou range in Canada. The Program Plan has been designed to identify potential barriers, solutions, and costs that will help guide future landscape level habitat restoration programs in priority areas for boreal caribou in NE BC. Forestry activities within the Parker Range are expected to be low over the coming decade (D. Regimbald, pers. comm. 2015), providing the opportunity to apply and monitor, with expected reduced levels of human disturbance, the effectiveness of habitat restoration techniques over a landscape caribou range scale in relation to caribou population metrics.The Program Plan is designed to incorporate lessons learned from this and other jurisdictions, to help guide restoration efforts in each implementation year, and in other ranges and jurisdictions.

Caribou habitat restoration implementation comes at a relatively high cost economically. Current caribou population modeling exercises predict that habitat restoration will lead to an increase in caribou population numbers (e.g., ALT 2009). The Program Plan, a multi-year program to spread out costs over multiple years, provides an opportunity to assess the mitigation efficacy of implementing restoration strategies on a defined caribou population. This will provide an opportunity to assess value of restoration treatments to a caribou population, identify challenges to implementation (e.g., seasonal conditions, terrain, regulatory procedures) and thereby inform considerations and costs of habitat restoration within other boreal caribou ranges in BC and elsewhere.

2.0 PROGRAM PLAN APPROACH

The overall objective of the Program Plan is to transition low quality boreal caribou habitat into higher quality habitat by reducing the benefits predators and their primary prey gain through linear corridor use, and establish a vegetation trajectory on these corridors that will in the long term increase boreal caribou habitat intactness. This Program Plan is designed to be implemented over a multi-year period, completing desktop disturbance mapping and implementation planning (2015 to 2016), implementing restoration treatments (2017 to 2021), and conducting post-treatment vegetation and wildlife monitoring.

The approach for developing the Program Plan includes:

- compiling landscape data and completing a detailed linear disturbance inventory;
- manually interpreting through desktop means vegetation regrowth in order to map the current vegetation status of disturbed areas to identify potential treatable sites;
- ground-truthing potential treatment sites and obtaining site level data required to select restoration treatment, as well as data regarding field equipment accessibility and other field considerations for treatment implementation;
- identifying regulatory requirements and obtaining appropriate authorizations to access and implement habitat restoration measures;
- developing a tactical plan to treat the identified treatable sites within the Parker range over a mulit-year time period beginning in January 2017; and
- implementation of a vegetation and wildlife monitoring program to determine restoration effectiveness.

2.1 Linear Disturbance Mapping

Linear disturbance inventory mapping was completed for the Parker Range to determine the extent of linear disturbances that may require implementation of habitat restoration techniques to restore caribou habitat. The mapping was gathered through public government sources, available public reference aerial imagery, and Ladybug®5 360 imagery contracted from an aerial imagery collection company called Vieworx, flown on the 9th and 10th of June 2015. The mapping was interpreted by Golder and then verified in the field for quality control. Details of the mapping quality assurance processes, as well as lessons learned including cost options, are summarized in Appendix A.

2.1.1 Imagery and Spatial Feature Acquisition

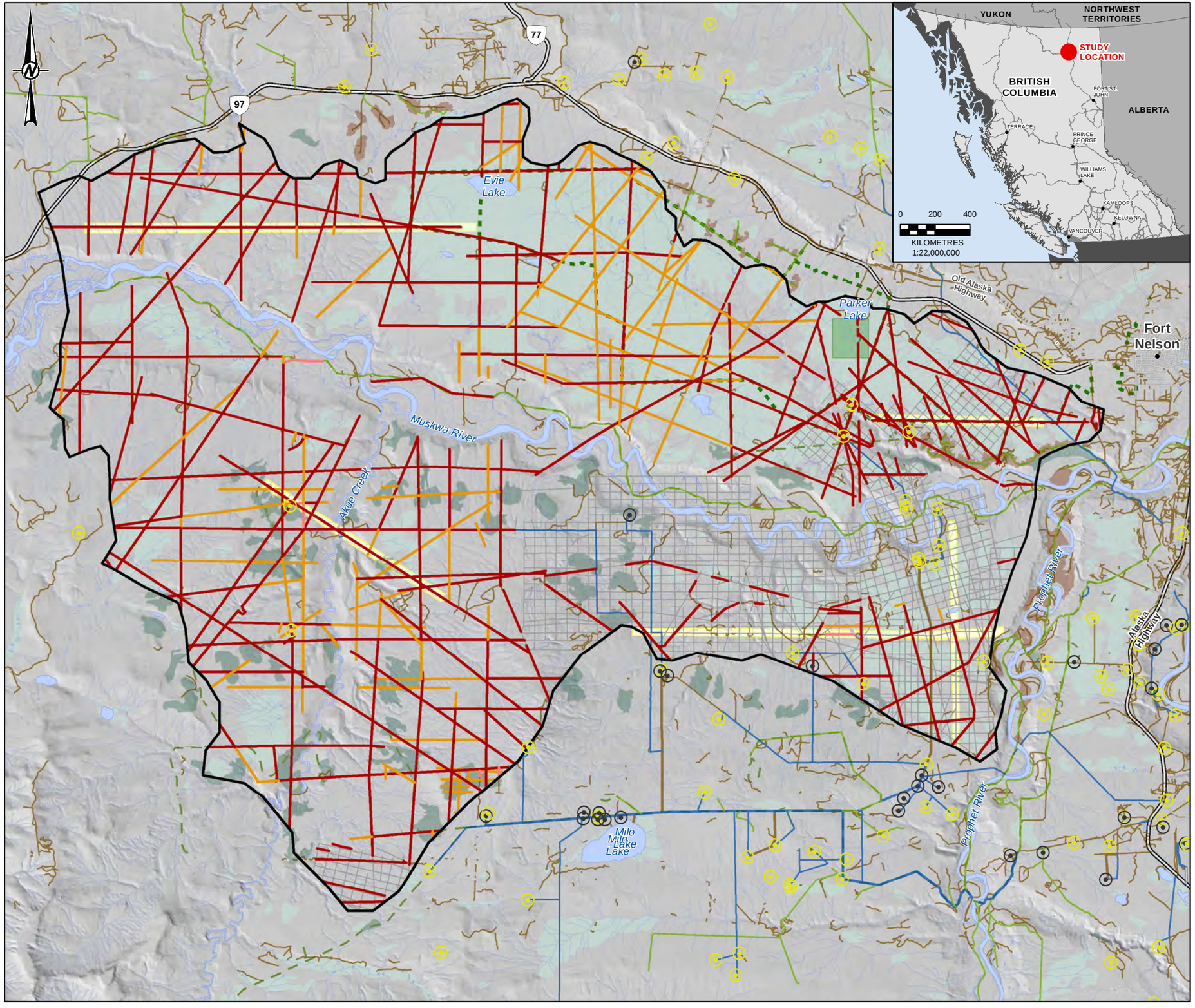
Existing linear disturbance information for the Parker Range was obtained from government sources, with documented metadata. These included:

- confirmed 2D and 3D seismic survey corridors, sourced from the BC Oil and Gas Commission (1996 to 28 May 2015) (BC OGC);
- confirmed 2D seismic survey corridors from CANVEC datasets (2013), sourced from Natural Resources Canada;

- possible or probable 2D and 3D corridors from CANVEC (2013) datasets and the Digital Road Atlas (2015), sourced from GeoBC; and
- other unclassified linear disturbance corridors (e.g winter road access) obtained from the BC OGC (2015) and Digital Road Atlas (2015) (GeoBC).

Aerial imagery for the Parker Range was used to digitise any additional linear disturbances absent from the available government data sources. Imagery used included BING (May 2011) and ESRI (April and July 2010) web imagery services for ArcGIS. Roads and pipeline access roads, other than those defined as winter access only, were excluded from the linear disturbance dataset. Roads and pipelines are considered active dispositions and therefore are not candidate areas for restoration treatments. Confirmed and probable 3D Low Impact Seismic (LIS) disturbances were also not included in the linear disturbance inventory because LIS were considered to be of low priority for restoration treatments given predator research results of Dickie (2015) suggest that wolves, the main predator of caribou, are not utilizing LIS lines during the summer months more than on random, compared to the surrounding forest. Caribou mortality is greatest during the summer. Therefore, it is probable that wolves are deriving less benefit for travel and hunting efficiency from LIS as compared to other linear disturbances such as conventional seismic lines, particularly during the critical caribou calving period.

Following an internal review of the digitised linear disturbances, the combined dataset of confirmed and possible/probable 2D seismic survey corridors and the unclassified linear corridors was provided to Vieworx to capture the Ladybug®5 360 imagery. A total of 1,040 km of linear disturbances were captured within Ladybug®5 360 imagery (Figure 1).



LEGEND

- PARKER CARIBOU RANGE
- LIDAR IMAGERY EXTENT

CLASSIFIED LINEAR DISTURBANCES

- 2D SEISMIC CUTLINE
- WINTER ROAD / ACCESS
- UNKNOWN DISTURBANCE

EXCLUDED LINEAR DISTURBANCES

- LOW IMPACT SEISMIC CUTLINE

CANFOR DETAILED FOREST MANAGEMENT PLAN

- CUTBLOCK
- PROPOSED CUTBLOCK
- PROPOSED CANFOR FORESTRY ROAD

OTHER

- PARKER LAKE ECOLOGICAL RESERVE
- WETLAND
- WATERBODY
- WATERCOURSE
- SURFACE WELL (ACTIVE)
- SURFACE WELL (INACTIVE)
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- RESOURCE ROAD
- UNCLASSIFIED ROAD
- BC OGC PETROLEUM DEVELOPMENT ROAD
- BC OGC PETROLEUM ACCESS ROAD
- FORESTRY SERVICE ROAD / ROAD PERMIT
- RECREATIONAL TRAIL

0 3 6
1:150,000 KILOMETRES

REFERENCES

1. 2D SEISMIC CUTLINES, WATERCOURSE, WATERBODY, POPULATED AREA, WOODED AREA, ROADS, TOWN AND PROVINCIAL BOUNDARY OBTAINED FROM FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. 2D AND LIS SEISMIC CUTLINES, SURFACE WELL AND BC OGC PETROLEUM ACCESS ROAD OBTAINED FROM BC OIL AND GAS COMMISSION.
3. ROAD/ACCESS OBTAINED FROM DIGITAL ROAD ATLAS.
4. CANFOR DETAILED FOREST MANAGEMENT PLAN DATA OBTAINED FROM CANFOR (DEC 2015).
5. PARKER CARIBOU RANGE, RECREATIONAL TRAIL, ECOLOGICAL RESERVE AND HILLSHADE OBTAINED FROM B.C. GOV. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

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CLIENT
BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT
PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE
STUDY AREA AND LINEAR DISTURBANCES OVERVIEW

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-01-29
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
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2.1.2 Mapping Interpretation Process

The Vieworx 360 imagery files were visualised in LadybugCapPro viewer, the software developed by Point Grey Research to display the proprietary Ladybug® .pgr imagery files. The viewer enabled the users to interact with each photo sphere location, with photo sphere locations spaced at approximately 30 m intervals along each linear disturbance. A point file containing the approximate location of each photo sphere assisted the mapping team in the orientation of the imagery with respect to the collated linear disturbance dataset in ArcGIS. A database was created for capturing vegetation classification attributes for intervals along each linear disturbance. The vegetation classification was largely comprised of data fields with an associated list of attributes, available in drop-down menus. The mapping team navigated all linear disturbances visualizing the landscape using the 360 imagery and splitting the linear disturbance features in ArcGIS where it was determined to be a change in the landscape classification (e.g., a linear disturbance was split when the surrounding site series changed, or when the natural vegetation coverage changed along the linear disturbance). The database was then populated with the classification for each segment (Table 1).

Table 1: Linear disturbance database fields for vegetation classification.

Field Name	Description	Data Type
Site Type	Classify corridor segment by type of site	List: Upland Wetland - Mineral Wetland - Organic Other - water / road Natural Non - Forested No Linear Disturbance
Dominant Species	Identify the dominant tree species	List: Alder Balsam poplar Black spruce Lodgepole pine Subalpine fir Tamarack Trembling aspen White birch White spruce Willow Unknown Deciduous Unknown Conifer
Vegetation Cover (%)	Estimate the percentage vegetation cover	List: 0-5 6-10 11-15 16-20 21-25 26-30 30+ N/A

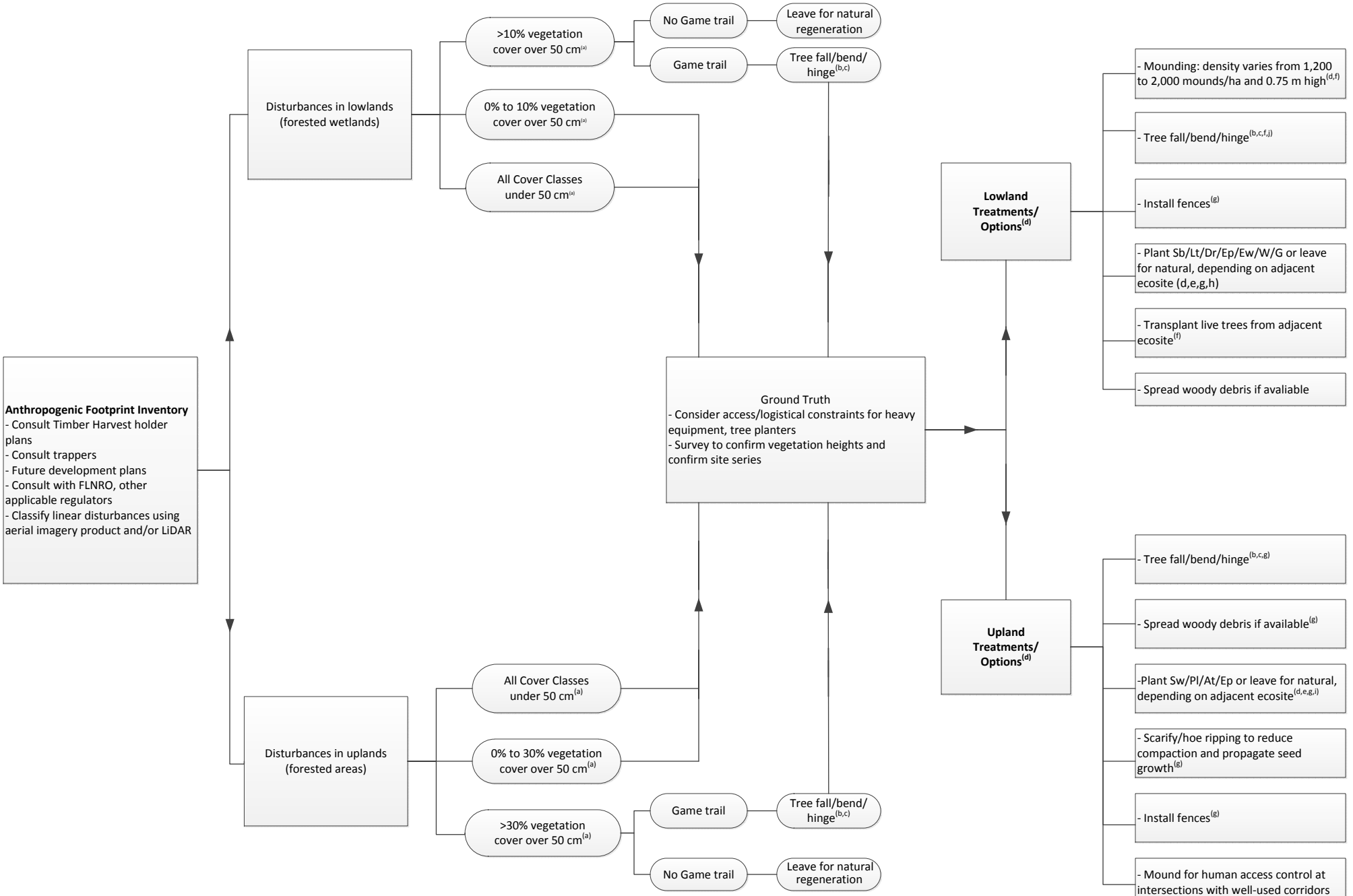
Table 1: Linear disturbance database fields for vegetation classification.

Field Name	Description	Data Type
Height Class (cm)	Estimate the average height of vegetation	List: 0-50 cm 50-100 cm 100 cm + N/A
Game Trail	Determine if a game trail or ATV trail is present along any part of the segment	List: No trail Game Trail Game / ATV Trail
Line width (m)	Average measured width of corridor segment, nearest metre	Free entry – integer
Flag	Flag segment for second opinion	Yes / No
Comment	Any additional comments	Free entry – string

2.2 Restoration Candidacy Decision Support Process

To determine habitat restoration treatment candidate line segments, a decision support flow chart (Figure 2) was developed and applied to the linear disturbance inventory. The decision support flow chart considers site type, naturally re-established vegetation height and cover, and the presence/absence of a game trail.

Figure 2: Treatment Decision Making Flow Chart



Notes:
(a) 50 cm is used as a cut-off since it is difficult to accurately determine vegetation heights to a smaller variance. If a site has consistent vegetation over 50 cm it won't require additional vegetation treatment. If a site has less than 50 cm cover it should be ground-truthed for greater accuracy.
(b) For sites with less than 3 m vegetation heights use an excavator. For sites over 3 m vegetation heights use a hand faller.
(c) Tree felling/bending/hinging is only successful if trees used are sufficient size to alter line of sight or prevent access control
(d) Refer to Treatment matrix from Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia (Golder 2015b) regarding treatment type and planting recommendations.
(e) Planting densities will vary depending on species present in adjacent ecosite. Refer to the Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia (Golder 2015b) regarding treatment type and planting recommendations
(f) Winter operation
(g) Summer or winter operation
(h) Sb = black spruce; Lt = tamarack, Dr = red alder; Ep = paper birch; Ew = water birch; W = willow; G = dogwood
(i) Sb = black spruce; Sw = white spruce; Pl = lodge pole; At = trembling aspen; Ep = paper birch
(j) Will require a permit from FLNRO

The decision to recommend a restoration treatment, or to leave a segment to naturally re-vegetate based on current vegetation height and cover, considers both van Rensen's research (van Rensen 2014, van Rensen et al. 2015) on attributes of linear disturbances that display natural vegetation recovery, as well as recent research results on predator movements in relation to linear disturbance vegetation heights and type of disturbance (Dickie 2015; Finnegan et al. 2014). Dickie (2015) and Finnegan et al. (2014) report that once vegetation reaches certain heights, the vegetation either slows down predators and/or acts as a deterrent to both human and predator use. Finnegan et al. (2014) summarized that at vegetation heights greater than 1.4m, movement rates of both wolves and adult grizzly bears decreased by 70%, and that a change point in human use occurs at vegetation heights of approximately 2 m after which human use decreases dramatically. Finnegan et al. (2014) classified seismic lines with vegetation heights less than 1.4 m as high human/predator use, vegetation heights between 1.4 m and 2 m as moderate human/predator use, and seismic lines with vegetation height greater than 2 m as low human/predator use. Dickie (2015) compared wolf travel speed on linear features with vegetation heights less than 1 m, and reported that wolves moved 24% and 13% slower when vegetation reached 1 - 2 m and 2 - 5 m, respectively, in summer; with a potential breakpoint of 1 m. When on linear features, wolves selected and moved faster on linear features with shorter vegetation (Dickie 2015).

Based on Dickie (2015) and Finnegan et al. (2014) research results on predator movements, habitat restoration treatment of linear disturbances is suggested to target sites that have less than 1 m height of consistent vegetation cover, after which treatment is no longer recommended given the natural re-establishment of vegetation. This would be contingent upon a consistent >10% cover class in wetlands, and >30% cover class in uplands (MacKenzie and Moran, 2004; ESRD 2013). Although the research on predator movements indicates reduced travel speed at greater than 1 m heights of vegetation, the decision to recommend a restoration treatment also takes into account the presence of a well-worn game trail on linear disturbances. Where a linear disturbance segment has > 1 m and up to 3 m vegetation height of consistent cover, but also has a game trail, these segments are recommended for the application of an access control treatment. Treatment application to a linear disturbance after 3 m vegetation height is not recommended, is to avoid potential damage to the existing, naturally re-established, vegetation (Dave Larsen, pers. comm.). At 3 m heights or greater, a segment is also considered to have reached a minimal green-up standard for forest regeneration (van Rensen et al. 2015).

Within the decision support flowchart, site type is classified as either lowland (including forested wetlands) or uplands (forested) (Figure 2). Only lowlands that are characterized by woody vegetation were considered for linear restoration. Graminoid or herbaceous wetlands were not considered for habitat restoration treatments. Organic wetlands (peatlands) with woody vegetation are common across northeastern BC and include wooded fens and bogs. However, wooded fens and bogs generally have a much lower percent vegetation cover of woody species than a forested upland site due to relatively poor growing conditions which limits tree or shrub establishment. The Wetlands of British Columbia: A Guide to Identification (MacKenzie and Moran, 2004) was used to develop thresholds for determining regeneration status of linear disturbances in lowland areas. Undisturbed wooded fens and bogs are considered 'wooded' when woody vegetation is equal to, or greater than, 6% cover. Overall, three categories were developed for linear disturbances in lowlands dependent on the percent cover of woody vegetation, outlined in Table 2. This use of percent cover is consistent with the 'Boreal Caribou Habitat Restoration Toolkit' (Appendix B in Golder 2015a). All upland sites were considered for linear restoration since upland sites in northeastern BC are not considered to have any natural limiting factors that would prevent tree establishment.

Table 2: Lowland/Wetland Regeneration Status and Habitat Restoration Treatment Potential.

Cover of Woody Vegetation (%)	Regeneration Status	Vegetation Treatment Candidacy
0 to 5	Not regenerating – require ground-truthing	High potential
5 to 10	Possibly regenerating – require ground-truthing	Moderate potential
>10	Naturally regenerating	N/A

The 2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (ESRD 2013) was used to determine thresholds for assessing vegetation regeneration on linear disturbances on upland sites. The reclamation criteria outline that a recovering site must have a minimum of 25% canopy cover of herbaceous species; and a minimum 25% canopy cover of woody species or a minimum stem/plant count of 5 (ESRD 2013). With these criteria, three categories and thresholds were developed for upland linear disturbances (Table 3).

Table 3: Upland Regeneration Status and Habitat Restoration Treatment Potential

Cover of Woody Vegetation (%)	Regeneration Status	Vegetation Treatment Candidacy
0 to 20	Not regenerating – require ground-truthing	High potential
20 to 30	Possibly regenerating – require ground-truthing	Moderate potential
>30	Naturally regenerating	N/A

If a line segment was classified as < 10% vegetation cover in a lowland site type, and < 30% vegetation cover in an upland site type, regardless of height classification, then the segment was recommended as a treatment candidate in need of ground-truthing (Figure 2).

If a line segment was classified as > 10% vegetation cover in wetlands, and > 30% in uplands, the segment was only considered a treatment candidate if:

- height classification was less than 50 cm, therefore ground-truthing is required; or
- height classification was between 50 cm and 300 cm with a game trail present (Appendix B).

Due to accuracy limitations of assessing vegetation heights to 50 cm during the remote sensing process of using aerial imagery, all sites with less than 50 cm height classification were classified as requiring ground-truthing. Sites with greater than 50 cm height classification that met the criteria of > 10% vegetation cover in wetlands and > 30% vegetation cover in uplands were considered on a trajectory to naturally re-vegetate to 3 m heights within 30 years without implementing restoration vegetation treatments. This is the same height criteria and time period used by van Rensen (2015) when considering whether a site requires vegetation treatment or can be left for natural processes.

During ground-truthing, no treatments were recommended for sites over 300 cm, regardless of the presence or absence of a game trail, due to the damage to the existing vegetation that heavy equipment or access to the area would cause.

Line segments that were less than 100 m in length were ignored for the purposes of maintaining a manageable number of linear segments. Adjustments will be made at the time of treatment, as required, if there are noticeable differences in the linear disturbance within these sections.

Appendix C provides a summary of vegetation characteristics and extents for both lowland and upland linear disturbance segments occurring within the Parker Range based on the results of the linear disturbance mapping. Metrics include total length and number of segments by site type, total corridor length (km) and number segments with game and/or ATV trail, total corridor length and number of segments by vegetation type and site type.

2.2.1 Restoration Candidacy Results

There were three types of recommendations noted once mapping of the Parker range was complete (see Appendix B for aerial photos of each classification type):

- No-treatment;
- Leave for Natural Revegetation; and
- Treatment Candidate.

No-Treatment

No-Treatment linear disturbances constitute any linear disturbance that may have an active disposition or protective notation, such as a pipeline, lease road, recreational trail, or ecological reserve. Where the locations of these access corridors were certain, they were excluded from the linear disturbance inventory treatment options summary. For example, Parker Ecological Reserve is located in the Parker Range and contains approximately 2 km of trails, which are also used as snowmobile trails in the winter. These trails can contain low vegetation height and cover, but cannot be treated due to their current provincial land use status. The Parker Lake and Evie Lake recreational trails account for an additional 58 km of identified protected corridors. In total, 76 km (7%) of the mapped and classified linear disturbances within the Parker Range are considered No-Treatment disturbances (Figure 3).

Leave for Natural Revegetation

Vegetation recovery in the medium and long-term following the creation of linear disturbances has not been extensively documented (with some exceptions; e.g., Lee and Boutin 2006). However, the attributes of naturally revegetated linear disturbances have been documented by the Caribou Range Restoration Project (CRRP 2007), the Foothills Research Institute (FRI 2014), and van Rensen et al. (2015). Natural vegetation regeneration does occur, with linear disturbances in mesic sites the most likely to regenerate naturally without restoration treatments implemented (all things being equal), whereas a linear disturbance in a bog or fen is least likely to regenerate naturally (van Rensen et al. 2015). Natural regeneration to 3 m vegetation height within 30 years is inversely related to terrain wetness, line width, proximity to roads as a proxy for human use of lines, and lowland ecosites such as fens and bogs (van Rensen et al. 2015). Areas adjacent to major rivers illustrate high probability of regeneration. Overall, terrain wetness and the presence of fens have the strongest negative effect on natural regeneration (van Rensen et al., 2015). Passive restoration can be defined as leaving a treatment candidate site to vegetate naturally to 3 m vegetation height within 30 years without implementing revegetation techniques such as planting seedlings or using a seed product (van Rensen et al 2015).

Leave for Natural Revegetation is recommended when percent cover and height classification of vegetation along a linear disturbance are above the threshold for recommending vegetation introduction or access control, and there is no game trail. A recommendation of Leave for Natural Revegetation was determined if:

- a wetland had > 10% vegetation cover, consistently equal to or over 50 cm in height, and no game trail is present; and
- an upland had over 30% vegetation cover, consistently equal to or over 50 cm in height and no game trail present.

A total of 394 km (38%) of linear disturbances within the Parker Range are considered Leave for Natural Revegetation and will not be treated due to current naturally established vegetation height and cover classification (Figure 3).

Treatment Candidate

Treatment candidate segments are sites that require, based on the decision support flow chart (Figure 2), one or a combination of the following treatments:

- Excavator Mounding;
- Slash Rollback (use of coarse woody debris present along the line);
- Seedling Planting or Seeding; or
- Tree-felling / Bending.

A linear disturbance segment was considered a Treatment Candidate when the following attributes occurred:

Wetland:

- < 10% vegetation cover, all vegetation heights;
- > 10% vegetation cover, but < 50 cm in height; and/or
- a game trail exists when < 3 m in height.

Upland:

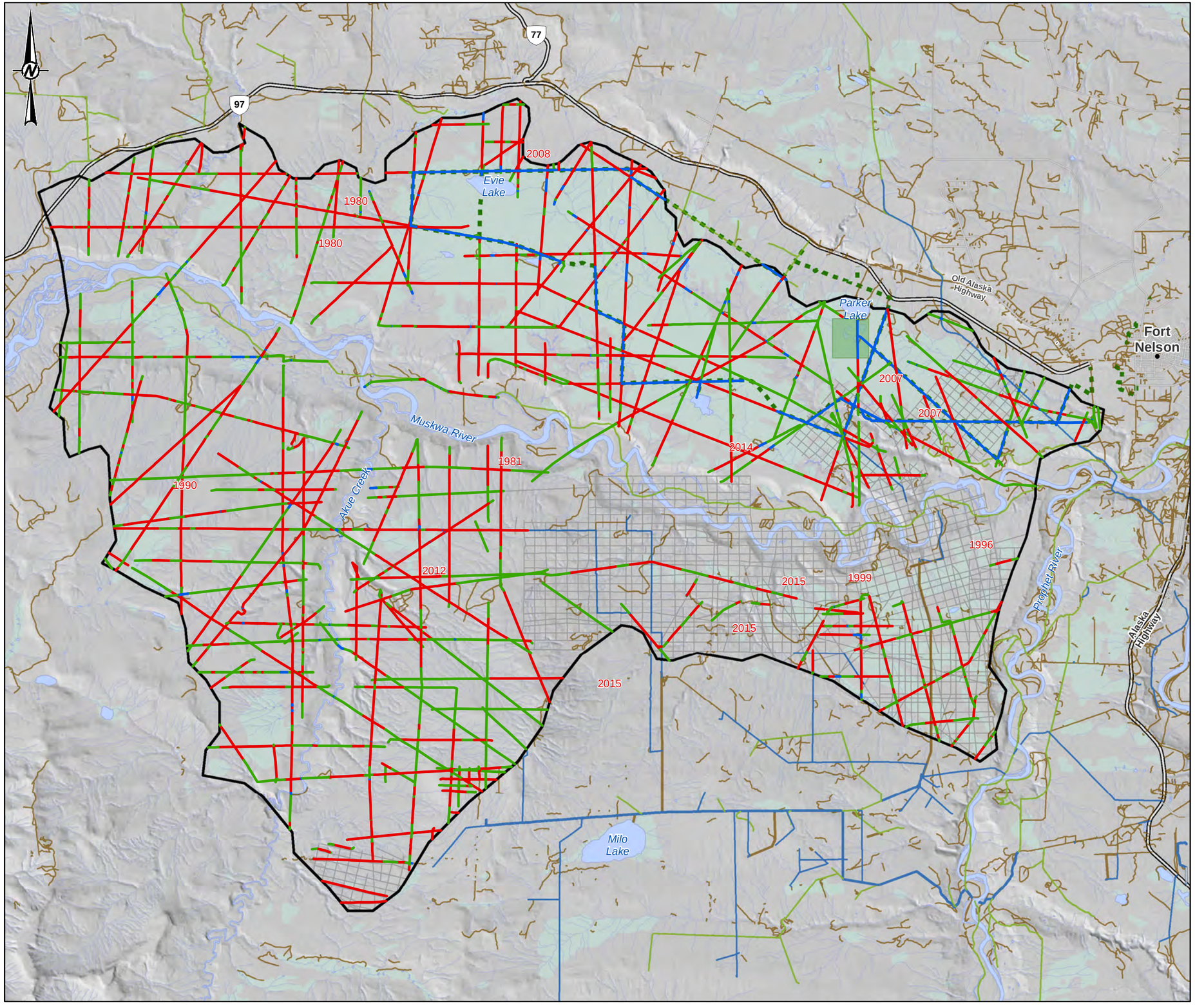
- < 30% vegetation cover and < 100 cm in height;
- > 30% vegetation cover, but < 50 cm in height; and/or
- a game trail exists when < 3 m in height.

Candidate treatment sites classified as Leave For Natural Revegetation may still be treated if (Figure 2):

- the existing vegetation is less than 50 cm in height; and/or
- there is less than 30% vegetation cover; or
- there is a game trail on sites with less than 300 cm in vegetation height, despite having greater than 30% cover over 50 cm heights.

In the case of a game trail on sites with 50 cm to greater than 300 cm vegetation heights, the treatment method would be focused on access control rather than establishing vegetation through tree planting or seeding. The focus would be protecting the site from human disturbance and wildlife use by implementing access control techniques such as mounding, spreading of coarse woody debris, and/or tree-felling (Golder 2015a).

A total of 569 km (55%) of linear disturbance segments within the Parker Range will be considered for treatment. However, ground-truthing before specific treatment selection is necessary to verify site specific treatment recommendations (Figure 3).



LEGEND

- PARKER CARIBOU RANGE

PRELIMINARY RESTORATION RECOMMENDATION

- TREATMENT CANDIDATE
- NO TREATMENT - LEAVE FOR NATURAL REGENERATION
- NO TREATMENT - NON TREATABLE

OTHER

- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)
- PARKER LAKE ECOLOGICAL RESERVE
- WETLAND
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- RESOURCE ROAD
- UNCLASSIFIED ROAD
- BC OGC PETROLEUM DEVELOPMENT ROAD
- BC OGC PETROLEUM ACCESS ROAD
- FORESTRY SERVICE ROAD / ROAD PERMIT
- RECREATIONAL TRAIL

0 3 6

1:150,000 KILOMETRES

REFERENCES

1. 2D SEISMIC CUTLINES, WATERCOURSE, WATERBODY, POPULATED AREA, WOODED AREA, ROADS, TOWN AND PROVINCIAL BOUNDARY OBTAINED FROM FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. 2D AND LIS SEISMIC CUTLINES AND BC OGC PETROLEUM ACCESS ROAD OBTAINED FROM BC OIL AND GAS COMMISSION.
3. ROAD/ACCESS OBTAINED FROM DIGITAL ROAD ATLAS.
4. PARKER CARIBOU RANGE, RECREATIONAL TRAIL, ECOLOGICAL RESERVE AND HILLSHADE OBTAINED FROM B.C. GOV. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

ALL LINEAR DISTURBANCES AND RESTORATION POTENTIAL

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-14
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	3

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3.0 DATA MANAGEMENT

The Program Plan has been set up on Golder Orientis, a web mapping viewer. The Golder Orientis web mapping viewer is designed to allow users to view, explore and examine project data on an interactive map. Manageable data is submitted to the Golder Orientis Team as it becomes available and is loaded into the web mapping viewer. Specific functions and features of the mapping viewer include:

- secured access;
- ability to turn layers on and off, and create customized maps;
- ability to zoom in and out and pan around the area of interest;
- ability to zoom to layers and features, hide labelling, hide and show legends;
- ability to view metadata for each layer;
- customized and user defined spatial bookmarks;
- measuring tools (length and area) in multiple units of measurement;
- ability to zoom to coordinates by different projection;
- ability to view, select, sort, output tabular information associated with features in the map;
- ability to print cartographic maps on standard Golder mapping templates;
- add mark-up drawings, Shapefiles and tabular data to the map;
- ability to share mark-up, current view, layer state, etc. with other users of the system; and
- searching based on queries of data within the map (e.g. Parcel search).

Project specific layers which are available for visualisation in the viewer include the Parker Caribou Range study area, identified linear corridors (including 3D seismic survey corridors), the Ladybug® 360 photo locations and URL links to the photosphere imagery, available LiDAR coverage and additional reference layers for project use.

The base data (not project specific) that is available in the BC OGRIS map viewer includes BC general mapping data managed (Forestry, Grid, Hydrology, Oil and Gas, Social Boundaries, Transportation, Wildlife and Geology data) and Canada general mapping data (Contours, Facilities, Parks, Hydrology, NTS, Topography, Transportation and Wildlife data). Additionally there are project specific base data layers in the viewer, which includes Boundaries, Landcover Occurrences and Classifications, Land Use, Water, Wildlife, and Ducks Unlimited Canada datasets.

Over the multi-year period of the Program, additional project data will be added to the viewer as it becomes available and updated as milestone decisions are made, such as the linear disturbance restoration recommendations and areas of implementation completion.

4.0 AUTHORIZATION PROCESS

4.1 Review of Regulatory Authorization Process

The regulatory process for implementing habitat restoration treatments in identified boreal caribou habitat involves meeting the requirements of the Interim Operating Practices for Oil and Gas Activities in Identified Boreal Caribou Habitat in British Columbia (IOPs). In addition, Section 19 of the Environmental Protection and Management Regulation (EPMR) contains an Operator Requirement (legal requirement for all Oil and Gas Activities Act [OGAA] permit holders) "Areas to be Restored" whereby oil and gas operators must restore operating areas as soon as practicable.

The IOPs were transmitted to the Oil and Gas Commission (OGC) by the provincial Ministry of Environment (MOE) as operational policy that must be followed for all oil and gas activities within identified boreal caribou habitat. For activity in identified boreal caribou habitat, the OGC considers adherence with the IOPs as a satisfactory requirement for mitigation planning. If a proposed activity does not adhere to the IOPs, the OGC requires a separate mitigation plan, developed by a qualified professional, which outlines how the material adverse effect criteria under Section 6 of the EPMR will be met. The mitigation plan is required to contain restoration commitments when there will be residual effects to identified values, including wildlife habitat. Those restoration commitments become legally binding as an enforceable condition under an authorized OGC permit.

The Certificate of Reclamation (CoR) process is solely used for well operations, and the reclamation of well pads post-abandonment. CoR's are not mandatory, but are a voluntary process under which companies can absolve themselves of future commitments by completing the two-part CoR process. The CoR process does not reflect habitat requisites, and often requires regeneration to a vegetative stage that might differ from wildlife habitat forest types.

For oil and gas activities occurring within boreal caribou habitat where restoration is a requirement of a permit, or where a company volunteers to complete the CoR process, no additional regulatory authorization is required to conduct caribou habitat restoration activities.

4.1.1 Restoration on Legacy Linear Disturbance Footprints

Requirements from applicable regulatory agencies regarding what authorizations are required prior to conducting restoration activities on legacy disturbance footprints are still preliminary. Outlined below is the expected authorization process for the Program Plan, given that the linear disturbance mapping inventory is comprised of legacy linear disturbance footprints, which do not fall under the IOP or EPMR regulatory process outlined in Section 4.1.

For legacy disturbance features, such as legacy seismic lines, there are no active permits or dispositions issued through the OGC to authorize or require restoration activities. Authorization will not be required under the *Oil and Gas Activities Act* (OGAA) given the focus on treating legacy disturbance footprints, which do not fall under an existing oil and gas permit or disposition (L. Helmer, pers. comm., August 11, 2015). Authorization may be granted by the OGC through the *Petroleum and Natural Gas Act* (Part 16) (L. Helmer, pers. comm., November 30, 2015), however, this requires further discussion between the OGC and MFLNRO regarding whether authorization is required from both government agencies.

Through a review of legislation, as well as through discussions with staff from the OGC, the MOE and the Ministry of Forest and Natural Resource Operations (MFLNRO), restoration treatments on legacy disturbance

footprint within the Parker Range not under an existing permit of another Ministry or the OGC; may obtain authorization by the MFLNRO under the *Forest and Range Practices Act* (M. Viszlai-Beale, pers. comm., September 11 and November 19, 2015). The restoration treatments, and associated obligation to the treatment activities, will be identified and tracked by FLNRO as a silvicultural opening. Identification of a 'licensee' who will be carrying out the on the ground activities must be provided. Authorization will be on a yearly basis during the multi-year Program Plan, specific to the area of restoration treatment.

To assist with the FLNRO authorization, FLNRO provided authorization staff to work with the Program Plan steering team during the development of this Program Plan and the associated Zone 1 Implementation Plan. Authorization application projected submission date of the Zone 1 Implementation Plan is January 30, 2016. Authorization timeline will account for First Nations consultation led by FLNRO. The First Nations consultation and referral process will be led by FLRNO and completed according to the respective consultation process agreements (e.g., Crown Land Management Agreement, Treaty 8 Economic Benefits Agreement, etc…) (J. Hudson, pers. comm. November 16, 2015). Feedback received during the consultation phase and from the FLNRO will be incorporated into future implementation plans developed as part of this multi-year Program Plan. Authorization is not required under the *Land Act* to conduct the restoration treatment work, however, if there is a desire to place a level of protection on the restored footprints, then the REMB could pursue a Special Use Permit under the *Land Act* through FLNRO once the work is completed (L. D'Aloia, pers. comm., August 12, 2015).

Requirements of the application for authorization under the *Forest and Range Practices Act* include (M. Viszlai-Beale, pers. comm., September 11 and November 19, 2015):

- identification of a land base;
- identification of an area;
- boundary for activities on the ground, and details of those activities;
- identifying who the 'licensee' is that will be carrying out the activities; and
- providing both hard copy documents and shapefiles for area and activity identification for FLNRO tracking.

Additional authorization of a Heritage Inspection Permit under the *Heritage Conservation Act* may be deemed necessary following an Archaeological Overview Assessment (AOA). Relevant First Nations will be contacted and First Nations' Permits obtained if required. Lastly, where disturbance to a watercourse or riparian area during crossing is anticipated, watercourse crossing assessments will be conducted.

4.2 Archeological Desktop Review

An archaeological desktop review of the Program Plan was conducted. The objectives of the review were to:

- determine whether any recorded archaeological sites are located within the Parker Range, and if they may be impacted by the Program Plan; and
- outline the archaeological process to be followed during the planning and implementation of the Program Plan.

4.2.1 Methods

The archaeological desktop review consisted of a review of readily available archaeological data relevant to the Parker Range. The following resources were accessed in the Provincial Heritage Register (PHR) via the Remote Access to Archaeological Data (RAAD) application maintained by the MFLNRO:

- archaeological site polygon shapefiles;
- British Columbia Archaeological Site Inventory Forms; and
- Archaeological Overview Assessment (AOA) metadata.

A summary of recorded archaeological sites identified during the desktop review is provided in Appendix D, and includes the Borden number, site type, dimensions, general site information, and relation to the Year 1 Implementation Plan area of the Program Plan. A summary of expected site types within the Parker Range is also provided.

The AOA metadata outlined in Figure 4 is for information purposes only, as the archaeological desktop review did not include an assessment of archaeological potential for the Parker Range. The archaeological desktop review also did not include communication with First Nations whose traditional territories overlap with the Parker Range. As such, this review does not constitute an AOA, as defined by the Archaeology Branch "Archaeological Overview Assessments as General Land Use Planning Tools – Provincial Standards and Guidelines" (Archaeology Branch 2009).

Field Visit

A Golder archaeologist accompanied an environmental field crew to the Parker Range in September 2015 on an observational basis only and no archaeological data was collected during the field visit. Archaeological data could not be collected because the First Nations whose traditional territories overlap with the Parker Range had not yet been contacted regarding archaeology in relation to the Program Plan. Therefore, observations from the field visit were not relied upon for this archaeological desktop review.

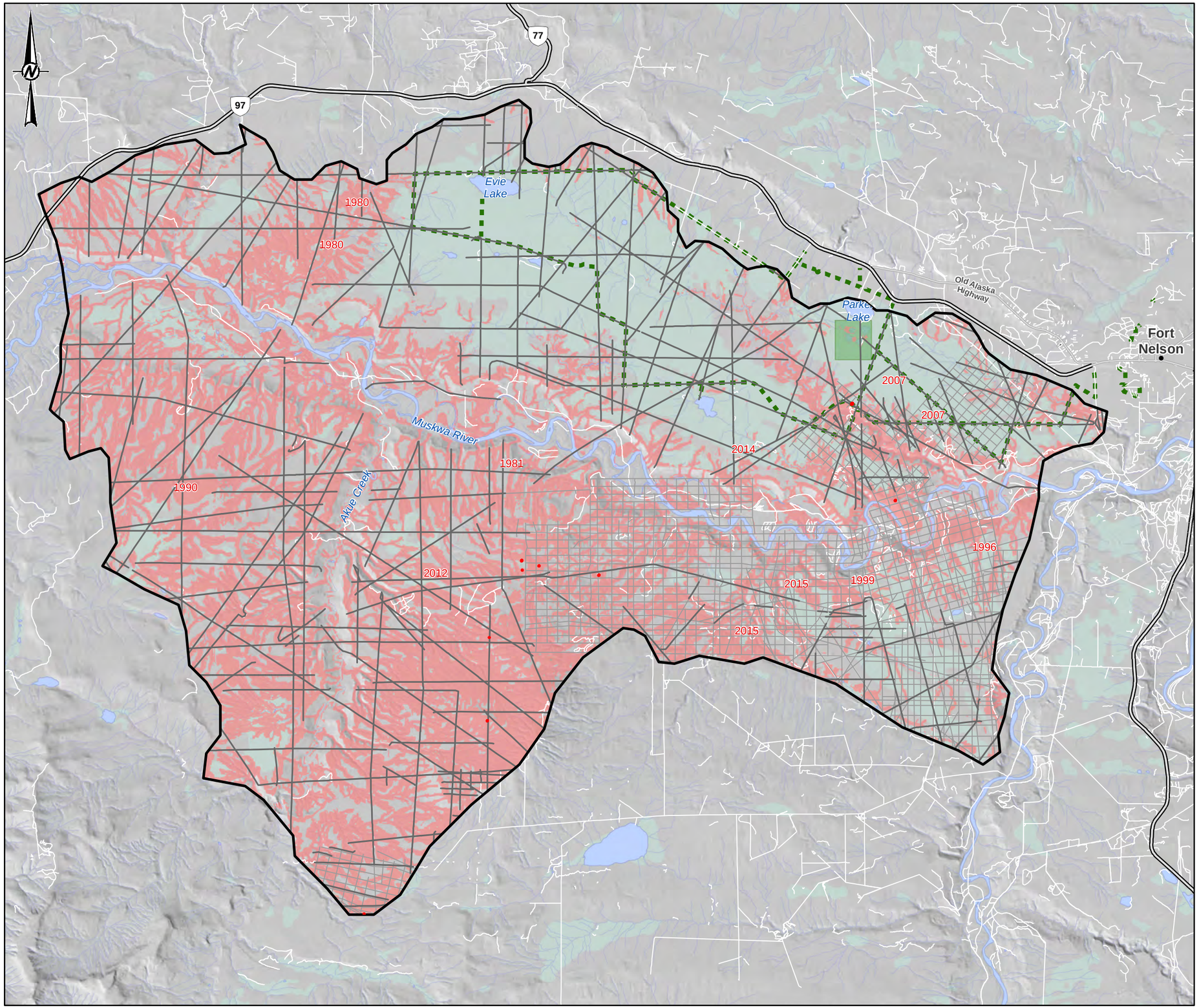
4.2.2 Results

Recorded Archaeological Sites

A total of nine recorded archaeological sites are located within the Parker Range (Figure 4). Details of these sites are discussed in Appendix D.

Expected Site Types

Based on the archaeological desktop review in Section 4.2.1 and Appendix D, if additional archaeological sites are present within the Program Plan area, pre-contact temporary habitation or subsistence sites types are expected. Within the Parker Range, these sites generally consist of lithic scatters, either on the surface, or in a buried (subsurface) context. Little to no organic cultural materials remain, and the surface expression of the sites is minimal (in the case of sites discovered on ground surface exposures) to non-existent.



LEGEND

- PARKER CARIBOU RANGE
- ARCHAEOLOGICAL SITE
- AOA METADATA
- CLASSIFIED LINEAR DISTURBANCE

OTHER

- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)
- PARKER LAKE ECOLOGICAL RESERVE
- WETLAND
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- ACCESS ROAD / TRAIL
- RECREATIONAL TRAIL

0 3 6

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REFERENCES

1. 2D SEISMIC CUTLINES, WATERCOURSE, WATERBODY, POPULATED AREA, WOODED AREA, ROADS AND TOWN OBTAINED FROM FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. 2D SEISMIC CUTLINES AND LIS BC OGC PETROLEUM ACCESS ROAD OBTAINED FROM BC OIL AND GAS COMMISSION.
3. ROAD/ACCESS OBTAINED FROM DIGITAL ROAD ATLAS.
4. ARCHAEOLOGICAL SITES OBTAINED FROM B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS ON 2015-03-31.
5. AOA METADATA DEVELOPED BY MILLENNIA RESEARCH LTD.
6. PARKER CARIBOU RANGE, RECREATIONAL TRAIL, ECOLOGICAL RESERVE AND HILLSHADE OBTAINED FROM B.C. GOV. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

ARCHAEOLOGICAL DESKTOP REVIEW

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-01-15
DESIGNED	HC
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
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4.2.3 Recommendations

According to the BC Archaeological Impact Assessment Guidelines (Archaeology Branch 1998), an archaeological study is initiated when a proposed development or activity will possibly disturb or alter the landscape, thereby endangering archaeological sites. Although the activities associated with the Program Plan are anticipated to be carried out during the winter months, under frozen ground conditions, with flexibility to move treatments to avoid areas of high potential for archaeological sites; some of the proposed treatment methods for the Program Plan may be considered land-altering, specifically microsite preparation using mounding techniques or tree-felling, and as such, further archaeological assessment may be required. In order to meet the specific objectives and needs of each stage of the Program Plan, a customised archaeology plan is recommended. This plan may include any of the following, to be undertaken following discussion with the Archaeology Branch:

- Archaeological Overview Assessment;
- Archaeological Impact Assessment;
- Site Alteration Permit;
- Archaeological Monitoring; and/or
- Chance Find Procedure.

Details of each of these components of the Archaeology Plan are outlined in Appendix D.

4.3 Watercourse Crossing Requirements

During the implementation of the restoration treatments, access will be required into the Parker Range during the winter in areas without high grade roads or bridges. Main access routes required for each implementation year will need to be frozen-in prior to bringing heavy machinery into the area. For these main access routes, when watercourses are present, crossings will need to be established in the form of either temporary bridges or ice bridges/snow fills. Once machinery has been transported into a treatment zone, watercourse crossings will also need to be established where heavy machinery needs to cross a watercourse to access treatment areas, again in the form of either temporary bridges or ice bridges/snow fills. The type of crossing structure required will depend on the size of the watercourse and presence/absence of flowing water.

At least four months prior to mobilizing heavy machinery required for the field implementation component for each field implementation year, access routes will be assessed using the Vieworx 360 Imagery to determine the presence and number of potential watercourse crossings, and a watercourse crossing plan will be developed as part of the yearly implementation plan. The watercourse crossing plan will indicate where there are watercourses and wetlands that may require crossing structures, and what type of structure will be used to cross each watercourse. During the ground-truthing component required as part of each yearly implementation plan, the access routes will be visited to field verify the watercourse crossing plan and any watercourses identified in the field that were not identified during the review of the Vieworx 360 Imagery will be added to the watercourse crossing plan.

The watercourse crossing plan will form the basis for a notification package that must be sent to FrontCounterBC at least 45 days prior to the establishment of any required crossing structures, as required under the BC *Water Act*. Field watercourse crossing assessments are not anticipated to be required prior to establishing a crossing structure if there will be no disturbance to the watercourse or the riparian area. Due to the nature of establishing

crossing structures in the winter using temporary bridges or ice bridges/snow-fills, it is not anticipated there will be disturbance to any of the watercourses or riparian areas.

4.4 Aboriginal Inclusion Plan

An Aboriginal Inclusion Plan (AIP) will be developed to facilitate opportunities to integrate the involvement of Aboriginal Peoples and Businesses as a core function in the execution of the multi-year Program Plan. In 2016, an experienced Aboriginal Inclusion Lead will work with the leadership and community members of the Fort Nelson First Nation and the Prophet River First Nation to identify training, employment, and contracting opportunities within the Parker Range to assist in the execution of the Program Plan.

Potential services and roles may include, but are not limited to, wildlife monitors, medics, general contractors, equipment operators, surveyors, safety supervisors, field technicians, data collectors, researcher assistants, archaeologist assistants, tree fallers, and danger tree assessors. The AIP will outline the necessary administrative, contractual, and logistical arrangements required to facilitate Aboriginal participation in the Program Plan as much as practical. The AIP will outline our strategy to facilitate the participation of qualified local Aboriginal resources, where appropriate and available, and in accordance with health and safety policies and protocols. The AIP will seek to support three main streams of Aboriginal involvement, including providing on-the-job and other training support (e.g., wildlife survey) to Aboriginal individuals, where needed and feasible; identifying opportunities to augment Golder's existing workforce through direct hires; and retaining Aboriginal businesses as service suppliers under this contract (e.g., transportation, field technicians, wildlife (bear) monitors, and heavy equipment operators), where feasible.

Golder will meet with the BC OGRIS REMB advisory team to the Program Plan to review commitments made to the Aboriginal groups and overall expectations as expressed by Aboriginal leadership or the REMB. The Aboriginal Inclusion Lead and a senior restoration specialist will conduct two face-to-face meetings, one with the Fort Nelson First Nation and one with the Prophet River First Nation in their home community. A draft and final AIP will be prepared, and will outline the contracting strategy, potential subcontracting and training opportunities, estimated spend, reporting procedures, communication protocols and how the manage public inquiries.

Through the multi-year Program Plan, Golder will endeavour to facilitate opportunities for long-term benefits by providing training opportunities and hands-on experience to local Aboriginal Peoples and Businesses. Golder has extensive experience in providing training as part of capacity building for project involvement. A key to successful capacity building is to provide relevant educational programs aimed at training individuals in areas that will lead to future employment and career development opportunities. Training opportunities will be identified during discussions with Aboriginal leadership. Once identified, the specific training approach will be outlined in the AIP. In an effort to establish a consistent and clear understanding of expectations and resources required to successfully execute the AIP, Golder will develop and deliver an orientation to personnel and select contractors (e.g., foreman) who undertake the implementation restoration work (anticipated start date of December 2016). The objective of this orientation will be to review responsibilities expected of field crews and supervisors. In addition, the communication protocols between field crews and interactions with the public and Aboriginal Peoples will be reviewed during the orientation. Currently the AIP development does not include the cost to develop or to train Aboriginal individuals, apart from on-the-job training opportunities. Managing Aboriginal subcontractors, and budget required to coordinate, train and facilitate participation of Aboriginal Peoples and Businesses during the multi-year program will be built into each year's implementation plan.

5.0 IMPLEMENTATION TACTICAL PLAN

The Program Plan is designed to guide the implementation of habitat restoration treatments along ground-truthed candidate treatment areas identified during the desktop linear classification exercise, throughout the entire Parker Range. Currently the Program Plan outlines plans for habitat restoration to be completed over 5 field implementation periods, beginning in January 2017, although this may be modified based on the amount of restoration completed each field implementation period and available funding. See the schedule in Appendix E for more detail.

This tactical plan has been developed to focus on treating specific areas throughout the range, in four designated treatment zones. Zone boundaries were drawn in consideration of major rivers and amount of restoration potential. A treatment zone hierarchy was developed based on a number of ecological, logistical, and economic criteria, including, but not limited to:

- Treatment Priority Class Optimization calculated by ranking treatment segment sites based on a combination of weighted variables including:
  - Probability of Regeneration (POR) ranking based on ecological criteria including:
    - vegetation cover percentage;
    - vegetation height;
    - soil moisture (wetness);
  - presence/absence of game trail;
  - presence/absence of atv trail;
  - distance to high grade road;
  - caribou calving areas;
  - wolf usage;
  - caribou usage; and
  - percentage change of habitat intactness expected following restoration treatments.
- specific implementation period treatment area/amount or budget objectives; and
- access into the zone area(s), which will reflect overall economic and logistical considerations.

5.1 Treatment Priority Class Optimization Process

To determine treatment priority areas, each line segment that is designated for treatment for Zone 1 (following field truthing) and designated as a treatment candidate for Zones 2 to 4 (following the linear disturbance mapping) was subject to a treatment priority class optimization process. The treatment priority class optimization process involved assigning a relative treatment priority value to each line segment based on the criteria outlined in Section 5.0. An equation was developed in consultation with habitat restoration experts in prioritizing habitat

selection (Cassidy van Rensen and Tim Vinge, Alberta Environment and Parks, pers. comm. 2015), with additional feedback from the REMB Parker Pilot project steering committee.

Line segments that had already been classified through the field truthing and/or linear disturbance mapping process identified as 'Leave for Natural Revegetation' or 'No Treatment' (Section 2.0) were eliminated from the restoration optimization process. All other line segments were given a treatment priority value based on the equation:

Treatment Priority Value = POR_Final * UF1 * UF2 * UF3 * UF4 * UF5 * UF6 * INT where:

- POR = Probability of Regeneration
- UF1 = Game Trail
- UF2 = ATV Trail
- UF3 = Distance to Road Value
- UF4 = Caribou Calving
- UF5 = Wolf Usage
- UF6 = Caribou Usage
- INT = Predicted Percent Change to Intactness After Treatment

5.1.1 Probability of Regeneration

Segments were given a relative ranking depending on the three criteria of vegetation cover, vegetation height, and soil moisture (wetness) (Table 4). Vegetation cover and vegetation height were values collected during the field truthing and/or desktop mapping classification outlined in Section 2. Each segment started with a ranking of one, indicating all three of these biophysical factors were sufficient to promote natural growth without additional vegetation enhancement treatment required.

Table 4: Probability of Vegetation Regeneration Weighting

Probability of Regeneration	YES	NO
If vegetation cover is > 10% in wetland	0.3	0.15
If veg cover is > 30% in upland	0.3	0.15
If veg height is > 50 cm	0.3	0.15
If soil moisture is within parameters*	0.4	0.2

*Soil moisture is considered sufficient for promoting natural regeneration if it is not hydric, sub-hydric, hygric (with poor soil nutrients), or xeric (van Rensen *et al*. 2015). Soil moisture data was derived from DUC Enhanced Wetland Classification (Feb 2014) supplied by BC OGRIS REMB.

The three biophysical factors add up to '1' if they are all met, indicating the line segment is not a candidate for treatment based only on the vegetation criteria. Each "No" value brings down the POR score.

Usage Factors UF1 through UF6

The remaining Usage Factor criteria were scored based on the numbers provided in Tables 5 to 8. Each Usage Factor was given a relative weight in the equation, with ATV trail considered the most important factor, and the level of intactness following restoration treatment the least. A higher percentage knockdown value will lower the treatment class value, contributing to a higher ranking in the Treatment Priority Class table (Table 11), indicating it is ranked higher on the priority list for treatment.

UF1 – Game Trail

The presence or absence of a game trail is considered one of the more important criteria for assessing the relative treatment priority of a line segment and is therefore given a relatively higher ranking of 0.8 out of 1 if present. A ranking of 0.8 out of 1indicates UF1 was entered as 20% knockdown in the treatment priority class equation. The presence of a trail indicates the feature is being used by wildlife regardless of the level of vegetation regeneration. The relative level of usage as scored from high to low was not collected during the ground truthing and/or desk top analysis and is therefore not applicable to the equation.

UF2 – ATV Trail

The presence or absence of an ATV trail is also considered one of the more important criteria for assessing the relative treatment priority of a line segment with a ranking of 0.75 out of 1 or scored as 25% knockdown in the treatment priority class equation if present. The presence of an ATV trail indicates the site is being used by people regardless of the level of vegetation regeneration and may inhibit natural regeneration of vegetation. The relative level of usage as scored from high to low was not collected during the ground truthing and/or desk top analysis and is therefore not applicable to the equation.

Table 5: Usage Factors UF1 and UF2

UF	Relative Value or Percentage Knockdown	
	Presence	Absence
1 - Game Trail	.8 or 20%	N/A
2 - ATV Trail	.75 or 25%	N/A

UF3 – Distance to Road Value

The distance to high grade road is considered an important variable that will impact the natural regeneration of a line segment (van Rensen 2014). It is assumed that the closer a segment is to a high grade road, the greater the probability human usage of the feature will be higher. The rankings were scored with a higher percentage knockdown score within a kilometer of a high grade road, slightly less between 1 and 2, and then 2 and 3 km away, with no percentage weight given to distances greater than 3 km.

Table 6: Usage Factor UF3

UF	Relative Value or Percentage Knockdown		
	Nearest	Medium	Far
3 - Distance to Road Value	0 - 1 km = .85 or 15%	1 - 2 km = .9 or 10%	2 - 3 km = .95 or 5%

UF4 to UF6 – Caribou and Wolf Usage Areas

Caribou and predator range use have been taken into consideration in determining the treatment priority optimization. The critical habitat requirements (e.g. for calving) of the declining population in the Parker range is considered an important variable in prioritizing sections of the range for restoration. General caribou usage and calving areas have been identified through recruitments surveys completed in 2013 and 2015 and on-going Global Positioning System (GPS) radiocollar monitoring since 2011 through the University of Alberta (DeMars 2015) and BC OGRIS (Culling and Culling 2013). Regional wolf packs were also radiocollared and monitored by the University of Alberta (DeMars and Boutin 2014; DeMars 2015).

DeMars' research of boreal caribou in NE BC identified patterns of use by caribou in the Parker range; in the winter, they were primarily located north of the Muskwa river around Parker and Evie lakes, and in the spring and summer they dispersed throughout the range, including south of the Muskwa river. Predicted calving habitat was identified in three locations in the range, two areas north of the Muskwa river and one area in the SW corner (DeMars and Boutin 2014) (Figure 5). Wolves and bears were located throughout the range. Wolves collared were located on the western side of the range, but tracks and kill sites were also found on the eastern side of the range as well (C. DeMars, pers. comm., Sept. 28, 2015).

By analysing the data provided by the University of Alberta and BC OGRIS, percentage knockdown numbers were estimated for moderate, low-moderate, and low predicted caribou calving areas (UF4). A higher percentage knockdown of 20 was given for line segments occurring within predicted moderate, 10 for low-moderate, and 5 for low.

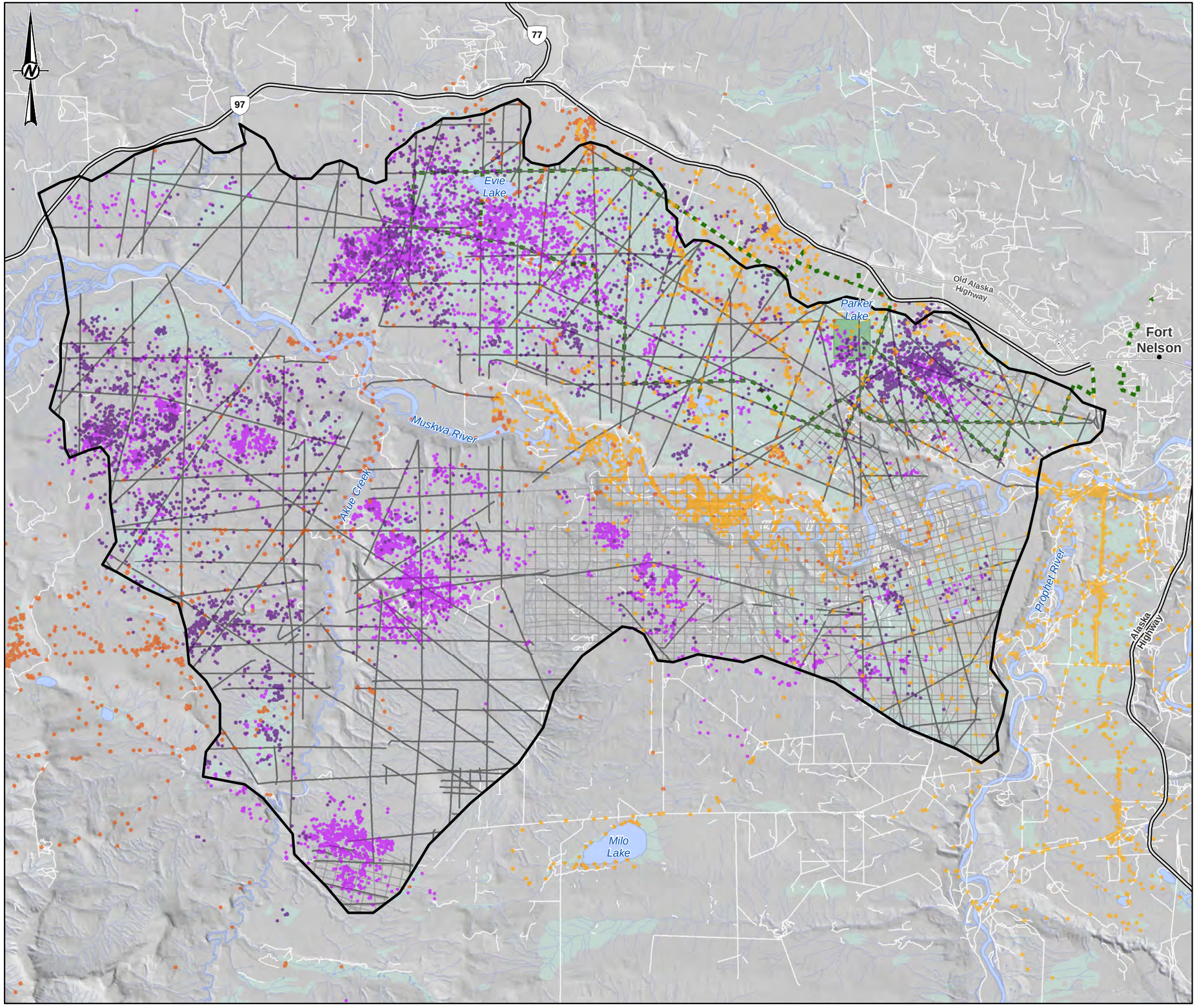
Table 7: Usage Factor UF4 Predicted Caribou Calving Areas

UF	Relative Value or Percentage Knockdown		
	Predicted Moderate Calving Area	Predicted Low-Moderate Calving Area	Predicted Low Calving Area
4 - Caribou Calving	.8 or 20%	.9 or 10%	.95 or 5%

General caribou usage and wolf usage scores were determined by assigning a percentage knockdown to line segments that were within a buffered distance from a radiocollar caribou or wolf location, beginning with 0 to 5 m, and then 5 to 45 m. A 5 percentage knockdown was given for wolf usage for line segments within 5 m, and 2 percentage knockdown if between 5 and 45 m. No score was given if greater than 45 m. A 10 percentage knockdown was given for general caribou usage for line segments within 5 m, and 5 percentage knockdown if between 5 and 45 m. The percentage knockdown is relatively lower for wolf usage since there are a limited number of wolves collared in the Parker range, and therefore, the absence of a wolf point does not necessarily indicate the absence of wolves in the area, only that there is a possible data gap.

Table 8: Usage Factor UF5 and UF6 Wolf and Caribou Usage

UF	Percentage Knockdown	
	Within 5 m Buffer	Between 5 m and 45 m Buffer
5 - Wolf Usage (Buffer intersecting line)	.95 or 5%	.98 or 2%
6 - Caribou Usage (Buffer intersecting line)	.9 or 10%	.95 or 5%



LEGEND

- PARKER CARIBOU RANGE
- CLASSIFIED LINEAR DISTURBANCE

RADIO-COLLAR DATA

- CARIBOU GPS RADIO-COLLAR LOCATION (2011 - 2012) [1]
- CARIBOU GPS RADIO-COLLAR LOCATION (2013 - 2015) [2]
- WOLF GPS RADIO-COLLAR LOCATION (2012 - 2013) [1]
- WOLF GPS RADIO-COLLAR LOCATION (2013 - 2014) [3]

OTHER

- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)
- PARKER LAKE ECOLOGICAL RESERVE
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- ROAD / TRAIL ACCESS
- RECREATIONAL TRAIL

0 3 6

1:150,000 KILOMETRES

REFERENCES

1. CARIBOU (2011-2012) AND WOLF (2012-2013) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM C.DEMARS, UNIVERSITY OF ALBERTA (2015).
2. CARIBOU (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM BC OGRIS REMB BOREAL CARIBOU RADIO-COLLARING PROGRAM, AVAILABLE ONLINE AT HTTP://WWW.BCOGRIS.CA/BOREAL-CARIBOU/PROJECTS/ACTIVE (13 OCTOBER 2015)
3. WOLF (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS.
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7. PARKER CARIBOU RANGE, RECREATIONAL TRAIL, ECOLOGICAL RESERVE AND HILLSHADE OBTAINED FROM B.C. GOV. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

LINEAR DISTURBANCES AND GPS RADIO-COLLAR LOCATIONS FOR CARIBOU (2011 - 2015) AND WOLF (2012 - 2014)

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-01-15
DESIGNED	MB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	5

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INT - Predicted Percentage Change to Intactness After Treatment

The final criteria to determining the Treatment Priority Value for a line segment is the predicted percentage change of intactness to the Zone if all line segements scheduled for treatment are completed (Table 9).The Tactical Plan has placed the ecological importance of certain areas, or zones, and the increased intactness that would result from restoring those areas, as one of the considerations in the selection and timing of sections of the range to restore. The federal Recovery Plan calculated 58% of the Parker range as disturbed (1% from fires that were less than 40 years old, and 57% from anthropogenic disturbances, including a 500 m buffer on linear features) (EC 2012). For the tactical plan, the same method of calculating disturbed habitat was completed, but with more finely detailed disturbance footprint layers, which resulted in 85% of the range disturbed by fire or anthropogenic disturbances (Table 9, Figure 6). Environment Canada's recovery plan includes a goal that all ranges should achieve 65% undisturbed habitat to support a self-sustaining population of caribou (EC 2012). Given that goal, and the provincial objective to manage the size and mitigate the effects of the industrial footprint by managing and protecting habitat (BC MoE 2011), the tactical plan has considered the objective of increasing intactness in determining restoration zone treatment priority.

Table 9: Disturbed and Intact Habitat in Tactical Plan Zones

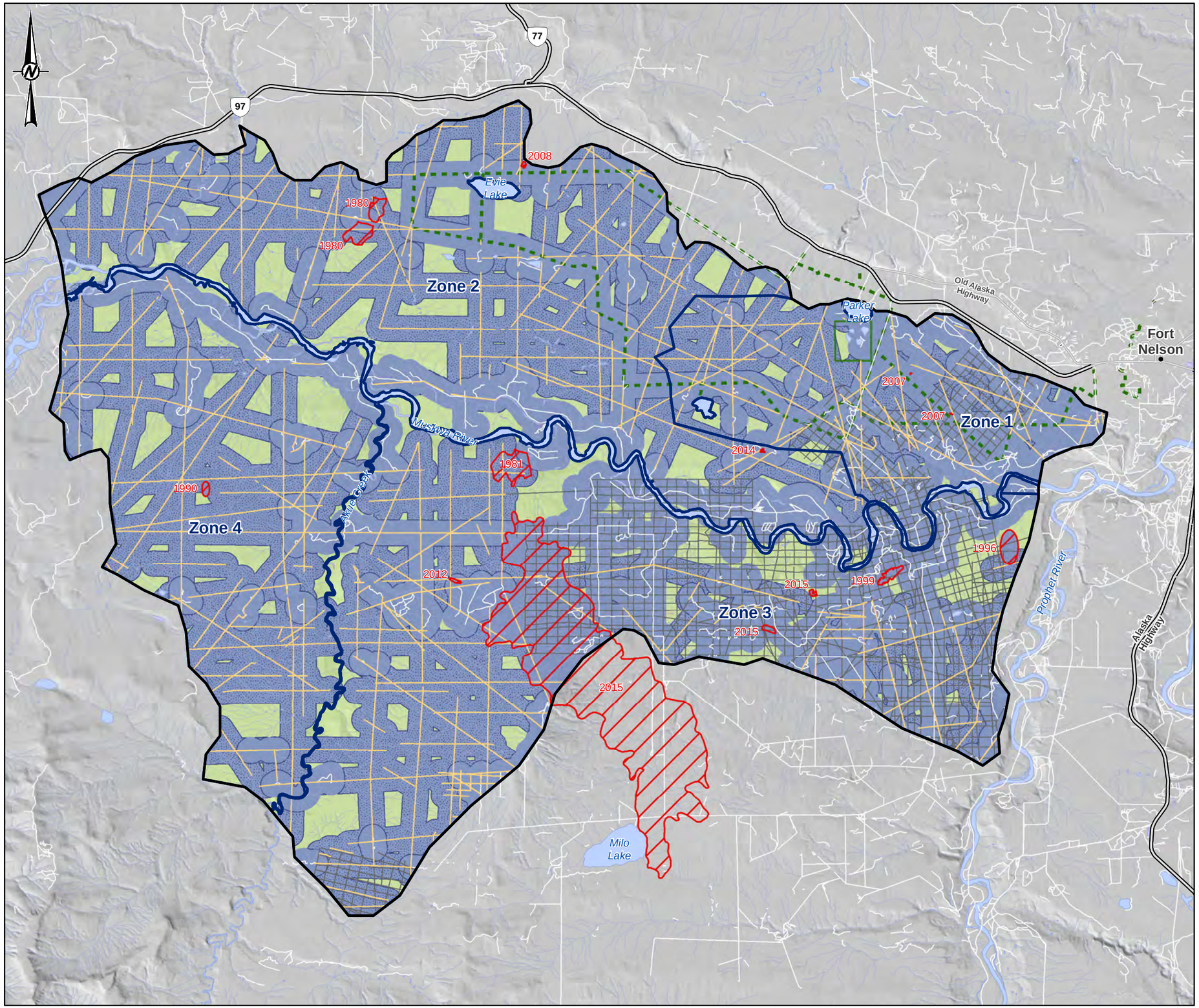
Zone	Zone Size (ha)	Current Disturbed and Intact (ha)[1, 2, 3]		Current Disturbed and Intact (%)		Disturbed and Intact (ha) of Zone after restoration treatments [1, 3, 4]		Disturbed and Intact (%) of Zone after restoration treatments [4]		Predicted % Change of intact – Current to Post-Treatment
		Disturbed	Intact	Disturbed	Intact	Disturbed	Intact	Disturbed	Intact	
Zone 1	9,215	8,836	379	96%	4%	6,439	2,776	70%	30%	26%
Zone 2	22,986	19,593	3,393	85%	15%	8,668	14,318	38%	62%	48%
Zone 3	25,972	22,626	3,345	87%	13%	13,704	12,267	53%	47%	34%
Zone 4	15,532	13,133	2,399	85%	15%	4,054	11,478	26%	74%	58%
TOTAL PARKER RANGE	**75,162.5**	**64,189**	**9,516**	**85%[2]**	**13%**	**32,866**	**40,839**	**44%**	**54%**	**42%**

1 Disturbed habitat was calculated using Environment Canada methods of adding linear disturbances plus a 500 m buffer, and fires < 40 years old (i.e fires from 1975 to October 2015 inclusively) (EC 2012).

2 Note that EC 2012 calculated 58% disturbance across the entire Parker range. Golder calculations were done using more detailed layers of linear footprint, thus the increased percentage of disturbances.

3 Note that disturbed and intact calculations do not include LIS, as per EC 2012 calculations.

4 Change in intactness value includes both treated areas as well as areas identified as "leave for natural recovery" based on current height and cover of vegetation. Fires which occurred between 1975 to 1982 were excluded as they would be >40 years old at the time of the programs completion. Predicted area assuming no new fires will occur within the Range and there will be no change to existing road/trail access



LEGEND

- PARKER CARIBOU RANGE
- TACTICAL PLAN ZONE

INTACTNESS

- CURRENT DISTURBED HABITAT
- PREDICTED HABITAT IMPROVEMENT AREA - POST-RESTORATION TREATMENT
- INTACT HABITAT

DISTURBANCE

- RECENT AND HISTORICAL FIRE (<40 YEARS)
- CLASSIFIED LINEAR DISTURBANCE
- EXCLUDED LINEAR DISTURBANCE (LOW IMAPACT SEISMIC)

OTHER

- PARKER LAKE ECOLOGICAL RESERVE
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- ACCESS ROAD / TRAIL
- RECREATIONAL TRAIL

0 3 6

1:150,000 KILOMETRES

REFERENCES

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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT
BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT
PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE
DISTURBED AND INTACT HABITAT IN PARKER RANGE ZONES

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-01-15
DESIGNED	MB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	6

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Table 10: Usage Factor UF5 and UF6 Intactness after Treatment

Criteria	High Intact % Change	Medium Intact % Change	Low Intact % Change
INT - Predicted % Change to Intactness	66% - 100% = 0.85 or 15%	33% - 66% = 0.9 or 10%	% 0 - 33% = 0.95 or 5%

To determine the relative weighting of the effect of change to intactness after treatment, the percentage change was broken into thirds, with an intactness change percentage over 66% receiving a higher percentage knockdown of 15%, 33 to 66% receiving a 10% knockdown, and 0 to 33% change receiving a 5% knockdown.

5.2 Treatment Priority Class Summary

By applying the criteria in Section 5.1 and inserting into the Treatment Priority Value equation "POR_Final * UF1 * UF2 * UF3 * UF4 * UF5 * UF6 * INT", each line segment was given a final score between 0 and 1, with lower scores considered higher priority for treatment. To simplify the process into manageable scores, Treatment Priority Classes were then assigned with values between 1 and 3 (Table 11).

Table 11: Treatment Priority Classes Assigned by Treatment Priority Values

Treatment Priority Class	Treatment Priority Value Range
1	0 - 0.333
2	0.333 - 0.666
3	0.666 - 1

The sum of the line segments by Treatment Priority Class was then calculated for the entire range and by Zone (Tables 12 through 16) (Figure 7):

Table 12: Treatment Priority Class Summary for the Parker Range

All Zones TREATMENT PRIORITY CLASS	Length (km)	% of TOTAL
1	135.08	23.82%
2	430.40	75.90%
3	1.58	0.28%
TOTAL	**567.07**	100.00%

Table 13: Treatment Priority Class Summary for Zone 1

TREATMENT PRIORITY CLASS	Length (km)	% of TOTAL
1	27.86	38.91%
2	25.43	61.09%
3	0.00	0.00%
TOTAL	**53.29**	**100.00%**

Table 14: Treatment Priority Class Summary for Zone 2

TREATMENT PRIORITY CLASS	Length (km)	% of TOTAL
1	53.80	23.87%
2	171.58	76.13%
3	0.00	0.00%
TOTAL	**225.38**	**100.00%**

Table 15: Treatment Priority Class Summary for Zone 3

TREATMENT PRIORITY CLASS	Length (km)	% of TOTAL
1	34.81	21.65%
2	125.33	77.95%
3	0.65	0.40%
TOTAL	**160.79**	**100.00%**

Table 16: Treatment Priority Class Summary for Zone 4

TREATMENT PRIORITY CLASS	Length (km)	% of TOTAL
1	18.61	14.59%
2	108.07	84.68%
3	0.93	0.73%
TOTAL	**127.62**	**100.00%**

ZONE 2		
PRIORITY CLASS	Length (km)	% of TOTAL
1	53.80	23.87%
2	171.58	76.13%
3	0.00	0.00%
TOTAL	**225.38**	100.00%

ZONE 1		
PRIORITY CLASS	Length (km)	% of TOTAL
1	20.73	38.91%
2	32.55	61.09%
3	0.00	0.00%
TOTAL	**53.29**	100.00%

ZONE 4		
PRIORITY CLASS	Length (km)	% of TOTAL
1	18.61	14.59%
2	108.07	84.68%
3	0.93	0.73%
TOTAL	**127.62**	100.00%

ZONE 3		
PRIORITY CLASS	Length (km)	% of TOTAL
1	34.81	21.65%
2	125.33	77.95%
3	0.65	0.40%
TOTAL	**160.79**	100.00%

LEGEND

- PARKER CARIBOU RANGE

TREATMENT PRIORITY CLASS

- HIGH
- MEDIUM
- LOW

TACTICAL PLAN TREATMENT ZONES AND TREATMENT CORRIDORS

TREATMENT SITE

- ZONE 1 (EAST)

TREATMENT CANDIDATE SITE

- ZONE 2 (NORTH)
- ZONE 3 (SOUTH)
- ZONE 4 (WEST)

OTHER

- CLASSIFIED LINEAR DISTURBANCE (NO TREATMENT REQUIRED)
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)
- PARKER LAKE ECOLOGICAL RESERVE
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- RESOURCE ROAD
- UNCLASSIFIED ROAD
- BC OGC PETROLEUM DEVELOPMENT ROAD
- BC OGC PETROLEUM ACCESS ROAD
- FORESTRY SERVICE ROAD / ROAD PERMIT
- RECREATIONAL TRAIL

0 5 10

1:175,000 KILOMETRES

REFERENCES

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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN - TREATMENT PRIORITY CLASSES

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-28
DESIGNED	MB
PREPARED	CH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**7**

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Based on the results of the optimization process, Zone 1 has the highest percentage of line segments (~39%) ranked as Treatment Priority Class 1. Zones 2 and 3 are almost identical in their rankings, with 24 and 22% respectively of the line segments ranked as Class 1, and 76 and 78% respectively ranked as Class 2. Zone 4 has a relatively low Class 1 ranking of ~15%.

Criteria associated with travel time to the worksite, possible requirement for a remote camp, length of winter access, and possible requirement for clear span bridges was not factored into the optimization equation. In the absence of ground truthing in Zones 2 through 4, there isn't enough information available to determine winter access, camp, and bridge requirements. Additionally, further stakeholder consultation is required to determine potential resource collaboration with industrial operators in the area such as sharing bridges and costs of access. However, Zone 4 is currently the most remote and inaccessible restoration zone, whereas Zone 1 and 2 are the most accessible from Fort Nelson and the Alaska Highway.

Costs of treatment applications have also not been factored into the equation. Costs of the treatments have a direct relationship to the Treatment Priority Class, with the higher priority class costing more per kilometer to treat. Line segments with a lower class ranking require less treatment intervention and therefore are less expensive to implement. For example, based on the costs to implement a linear restoration program provided in Table 17, Zone 1 costs can vary between $8,000 and $15,000/km, depending on treatment type, access requirements, frost level, and other variables. These costs assume a full treatment of mounding, tree felling, and seedling planting and are based on existing restoration programs in Alberta (Pyper *et al.* 2014).

Table 17: Treatment Candidate Lines in each Tactical Section of Parker Caribou Range Tactical Zones, and Projected Costs of Treatments

Zone	Zone Size (ha)	Linear disturbance treatment candidate length (km)[1]	Projected cost of treatment at:	
			$8,000/km	$15,000/km
Zone 1	9,215	53.3	426,400	799,500
Zone 2	22,986	225.4	1,803,200	3,381,000
Zone 3	25,972	160.8	1,286,400	2,412,000
Zone 4	15,532	127.6	1,020,800	1,914,000
TOTAL	75,162.5	567.1	4,536,800	8,506,500

[1] Note that LIS is excluded from disturbance calculations as per EC 2012.

Since Zone 1 has been ground truthed and a Year 1 Implementation Plan developed (Golder 2015c), there is a greater confidence in the costs of implementing the program based on treatment type as outlined in Table 18:

Table 18: Estimated Treatment Costs of Zone 1 Determined by Level of Effort by Treatment Type

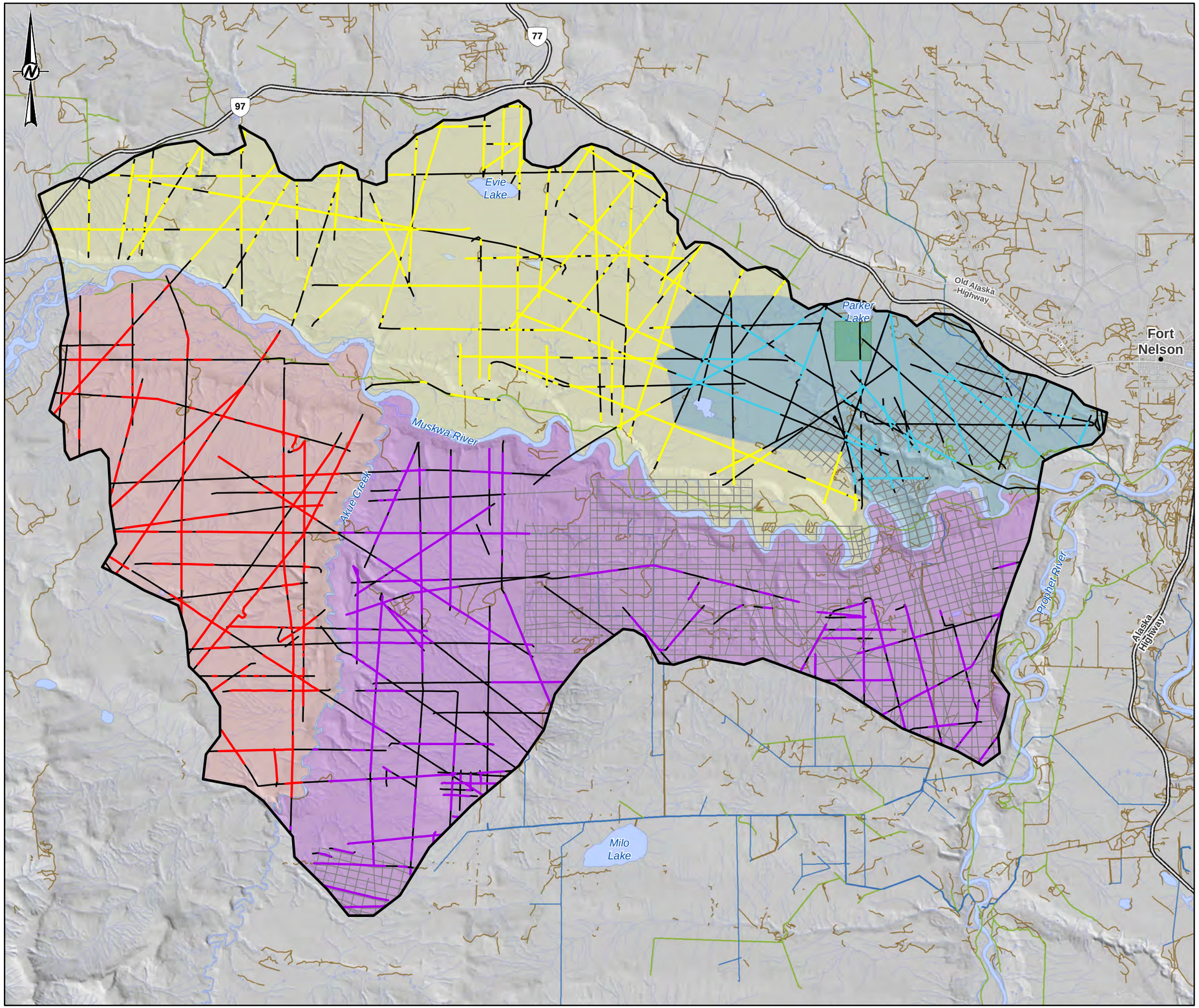
Treatment Priority Class	Treatment Type	Length (km)	% of Total	Cost/km ($)	km/day	Total Cost ($)
1	Mounding / Seedling Planting	9.69	18.19%	8,250	1	79,947
1	Mounding / Tree Felling / Seedling Planting	8.14	15.27%	11,000	0.8	89,524
1	Tree Felling	10.03	18.82%	2,750	2	27,580
2	Mounding / Seedling Planting	9.19	17.24%	8,250	1	75,794
2	Mounding / Tree Felling / Seedling Planting	8.44	15.83%	11,000	0.8	92,797
2	Tree Felling	7.80	14.65%	2,750	2	21,460
3		0.00	0.00%	2,750	2	0
TOTAL		**53.29**	100.00%		**Total Cost**	**387,104**
				Total Extimated Cost/km		**7,265**

Costs are estimated to be approximately $7,265 / km for Zone 1. Note that this cost does not factor in seasonal variables such as extreme cold and warm weather and frost depths.

5.3 Treatment Zones

In order to reduce the amount of time traveling between treatment areas, treatments for each implementation year will be focused in a specific treatment zone, within a certain geographical area, for logistical implementation efficiency.

Figure 8 illustrates the proposed hierarchy of treatment zones to be treated, by Zone number. Zones are numbered based on the Treatment Class Priority determined by an optimization process outlined in Section 5.2, and given existing access and proximity to Fort Nelson for staging implementation.



LEGEND

- PARKER CARIBOU RANGE

TACTICAL PLAN TREATMENT ZONES AND TREATMENT CORRIDORS

TREATMENT SITE

- ZONE 1 (EAST)

TREATMENT CANDIDATE SITE

- ZONE 2 (NORTH)
- ZONE 3 (SOUTH)
- ZONE 4 (WEST)

OTHER

- CLASSIFIED LINEAR DISTURBANCE (NO TREATMENT REQUIRED)
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)
- PARKER LAKE ECOLOGICAL RESERVE
- WATERBODY
- WATERCOURSE
- TOWN

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- RESOURCE ROAD
- UNCLASSIFIED ROAD
- BC OGC PETROLEUM DEVELOPMENT ROAD
- BC OGC PETROLEUM ACCESS ROAD
- FORESTRY SERVICE ROAD / ROAD PERMIT
- RECREATIONAL TRAIL

0 3 6

1:150,000 KILOMETRES

REFERENCES

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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN - PROPOSED HIERARCHY OF TREATMENT ZONES

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-29
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**8**

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The large zone sizes illustrated in Figure 8 are bounded by the Parker Range boundary and major watercourses, with the exception of Zone 1. Zone 1's boundaries are the caribou range boundary to the north and east, the Muskwa River to the south, and the size is based on an estimated area to treat approximately 64 linear kilometers, to the west. The other zone boundaries have been created based on major watercourses, and will be sub-divided into smaller treatment areas based on the amount of treatment that is proposed for each implementation period and watercourse crossing considerations, among other variables. Any further sub-division of Zones 2 through 4 will be completed as part of future Program Plan annual Implementation Plan development.

Appendix C provides a summary of vegetation characteristics and extents within the Parker Range based on the results of the linear disturbance mapping, including metrics such as total length and number of segments by site type, total corridor length (km) and number segments with game and/or ATV trail, total corridor length and number of segments by vegetation type and site type, among others. The metrics provided in Appendix C however do not differentiate these extents by zone.

Zone 1

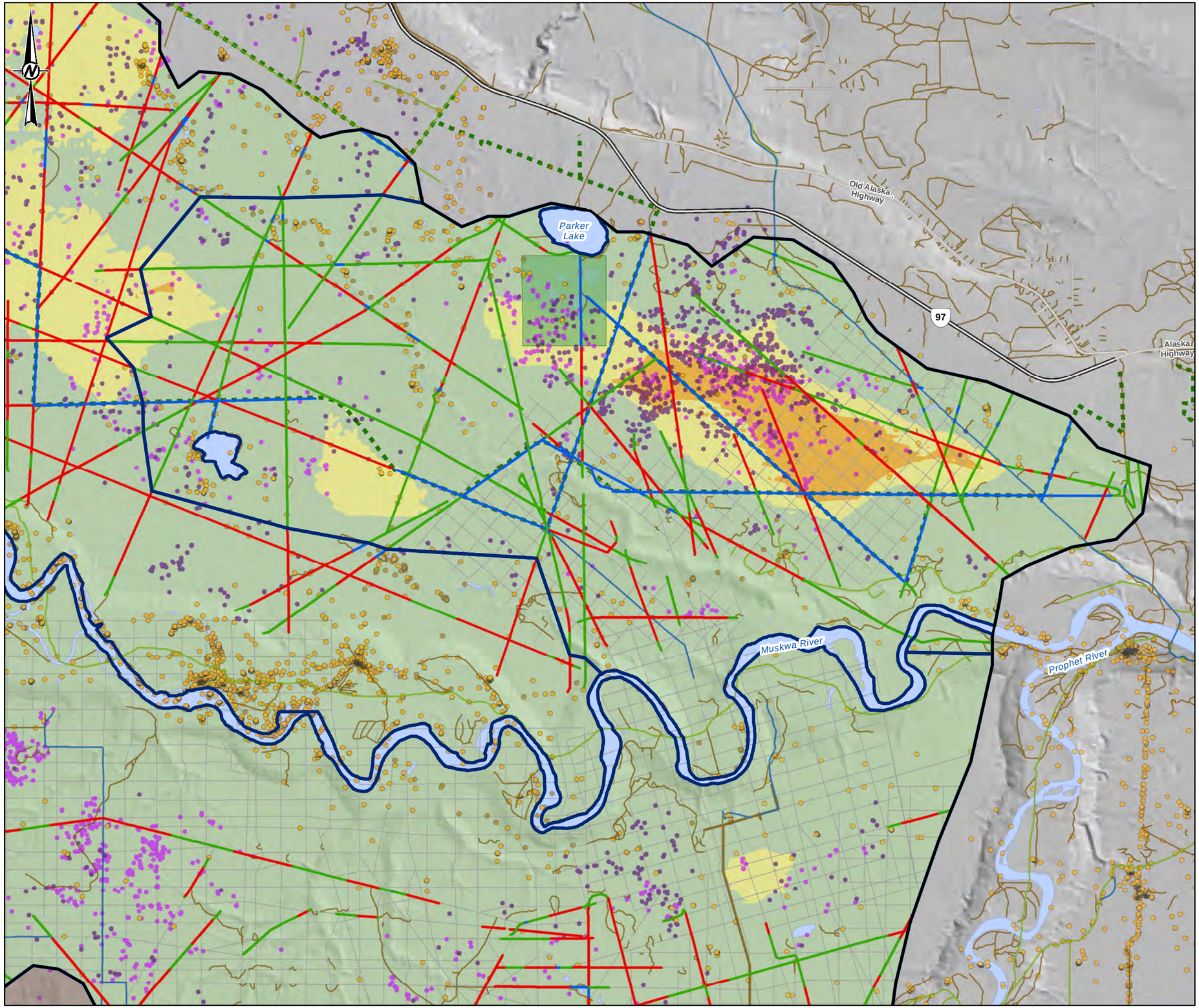
As outlined in Section 5, Zone 1 has been recommended as the first zone for restoration treatment implementation, as this zone met the criteria of:

- restoring corridors in an area that has documented high caribou use;
- restoring corridors in an area that has relatively high caribou use and predicted caribou calving habitat;
- restoring corridors in an area that has known wolf use;
- controlling human access on linear disturbances within the caribou range where human use is known to occur due to the proximity to Fort Nelsen;
- there is a high density of treatment candidate linear disturbances, resulting in logistical and cost efficiencies;
- reducing the impact any planning or field related logistical constraints will have by reducing the variables for the first year of field implementation by:
  - requiring less winter access than other zones;
  - eliminating any requirements for establishing a camp (proximity to Fort Nelson);
  - reducing the number of road use and pipeline crossing agreements; and
  - no major watercourse crossings are required.
- known number and length of treatment sites; and
- Zone has been ground-truthed in September 2015.

Although learnings will be documented during each implementation period of the Program Plan, it is anticipated that the first year of the implementation will provide a number of learnings that will support building in execution efficiencies into the overall Program. Due to uncertainties in cost, availability of qualified contractors, and regulatory requirements to implement a large-scale habitat restoration program in this area, it is easier to implement a program that has the easiest access routes, closest to Fort Nelson. Also, reducing the number of

planning and implementation variables makes it easier to adapt to any planning or field related issues which may arise during the field implementation.

Treatment Zone 1 will result in a length of 53 km within the Parker Range that is restored through active treatments (Table 17, Figure 9).



LEGEND

- PARKER CARIBOU RANGE
- TACTICAL TREATMENT PLAN ZONE

PRELIMINARY RESTORATION RECOMMENDATION

- TREATMENT CANDIDATE
- NO TREATMENT - LEAVE FOR NATURAL REGENERATION
- NO TREATMENT - NON TREATABLE
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)

RADIO-COLLAR DATA

- CARIBOU GPS RADIO-COLLAR LOCATION (2011 - 2012) [1]
- CARIBOU GPS RADIO-COLLAR LOCATION (2013 - 2015) [2]
- WOLF GPS RADIO-COLLAR LOCATION (2012 - 2013) [1]
- WOLF GPS RADIO-COLLAR LOCATION (2013 - 2014) [3]

PREDICTED CARIBOU CALVING HABITAT

- LOW
- LOW - MODERATE
- MODERATE

OTHER

- PARKER LAKE ECOLOGICAL RESERVE
- MUSKWA CARIBOU HERD RANGE
- WATERBODY
- WATERCOURSE

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- RECREATIONAL TRAIL

0 1 2

1:65,000 KILOMETRES

REFERENCES

1. CARIBOU (2011-2012) AND WOLF (2012-2013) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM C.DEMARS, UNIVERSITY OF ALBERTA (2015).
2. CARIBOU (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM BC OGRIS REMB BOREAL CARIBOU RADIO-COLLARING PROGRAM, AVAILABLE ONLINE AT HTTP://WWW.BCOGRIS.CA/BOREAL-CARIBOU/PROJECTS/ACTIVE (13 OCTOBER 2015)
3. 2D SEISMIC CUTLINES, WATERCOURSE, WATERBODY, POPULATED AREA, WOODED AREA, ROADS, TOWN AND PROVINCIAL BOUNDARY OBTAINED FROM FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN TREATMENT ZONES - ZONE 1

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-15
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**9**

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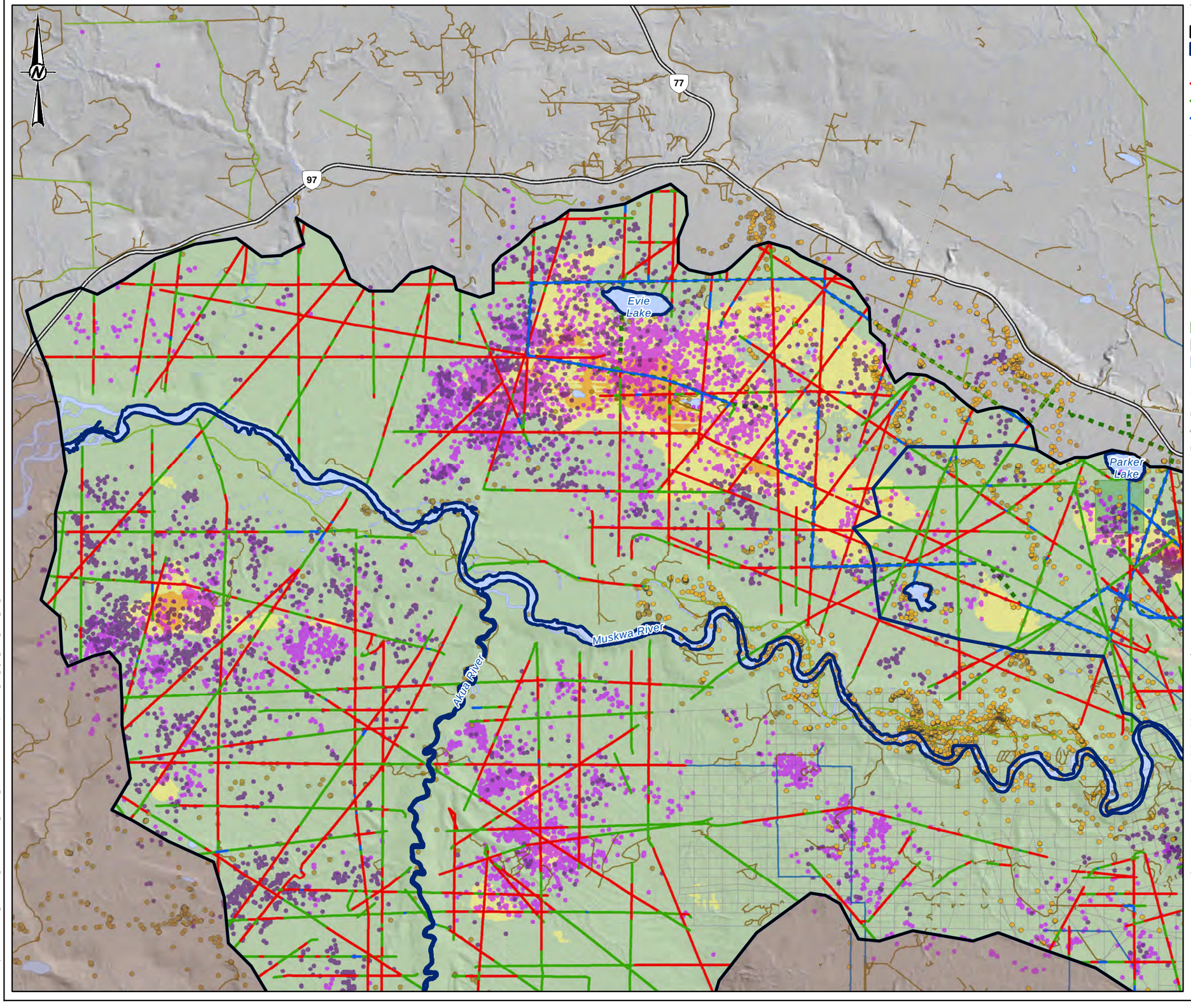
Zone 2

It is recommended that Zone 2 will be treated following Zone 1. The zone is currently ranked second in the treatment hierarchy because of the following variables:

- restoring corridors in an area that has documented high caribou use;
- restoring corridors in an area of predicted caribou calving use;
- restoring corridors in an area that has known wolf use
- Zone is close to the Alaska highway, reducing the impact any planning or field related constraints will have on costs by:
  - requiring less winter access than Zones 3 and 4
  - eliminating any requirements for establishing a camp
  - reducing the number of road use and pipeline crossing agreements, and
- no major watercourse crossings are required.

Zone 2 is the largest zone, at 22,986 ha in size, with 225.1 km of candidate treatment areas (Table 17; Figure 10). Consideration within this zone will be minimizing the disturbance from a treatments to caribou that winter within the large peatland complex which occurs in the middle of this zone (DeMars, pers. comm). Access within the peatland complex will also need to consider depth to water table and weight of equipment.



LEGEND

- PARKER CARIBOU RANGE
- TACTICAL TREATMENT PLAN ZONE

PRELIMINARY RESTORATION RECOMMENDATION

- TREATMENT CANDIDATE
- NO TREATMENT - LEAVE FOR NATURAL REGENERATION
- NO TREATMENT - NON TREATABLE
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)

RADIO-COLLAR DATA

- CARIBOU GPS RADIO-COLLAR LOCATION (2011 - 2012) [1]
- CARIBOU GPS RADIO-COLLAR LOCATION (2013 - 2015) [2]
- WOLF GPS RADIO-COLLAR LOCATION (2012 - 2013) [1]
- WOLF GPS RADIO-COLLAR LOCATION (2013 - 2014) [3]

PREDICTED CARIBOU CALVING HABITAT

- LOW
- LOW - MODERATE
- MODERATE

OTHER

- PARKER LAKE ECOLOGICAL RESERVE
- MUSKWA CARIBOU HERD RANGE
- WATERBODY
- WATERCOURSE

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- RECREATIONAL TRAIL

0 2 4

1:110,000 KILOMETRES

REFERENCES

1. CARIBOU (2011-2012) AND WOLF (2012-2013) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM C.DEMARS, UNIVERSITY OF ALBERTA (2015).
2. CARIBOU (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM BC OGRIS REMB BOREAL CARIBOU RADIO-COLLARING PROGRAM, AVAILABLE ONLINE AT HTTP://WWW.BCOGRIS.CA/BOREAL-CARIBOU/PROJECTS/ACTIVE (13 OCTOBER 2015)
3. 2D SEISMIC CUTLINES, WATERCOURSE, WATERBODY, POPULATED AREA, WOODED AREA, ROADS, TOWN AND PROVINCIAL BOUNDARY OBTAINED FROM FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
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5. ROAD/ACCESS OBTAINED FROM DIGITAL ROAD ATLAS.
6. PARKER AND MUSKWA CARIBOU RANGE, RECREATIONAL TRAIL, ECOLOGICAL RESERVE AND HILLSHADE OBTAINED FROM B.C. GOV. CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN TREATMENT ZONES - ZONE 2

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-15
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**10**

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Zone 3

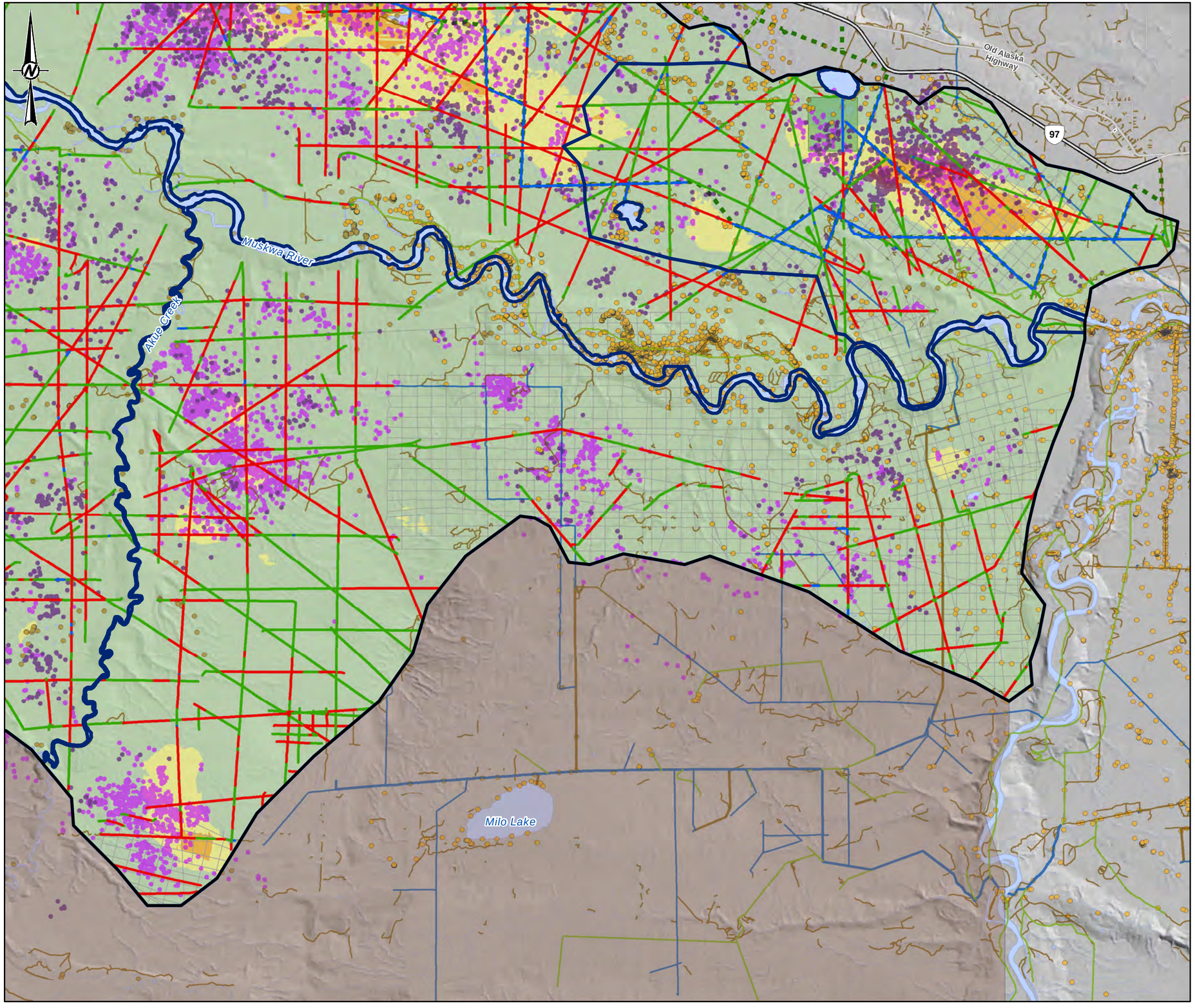
It is recommended that Zone 3 will be treated following Zone 2. The zone is currently ranked third in the treatment hierarchy because of the following variables:

- requires a relatively significant amount of winter access compared to Zones 1 and 2;
- may require the establishment of a camp;
- existing oil and gas dispositions within the zone which will require agreements to use and/or cross;
- major watercourse crossing is required to access the area; and
- has relatively low predicted selection for caribou calving (DeMars and Boutin 2014).

Although it is unknown how much oil and gas activity may occur in this area over the next few years, current projections are for low use, with current OGC dispositions held by SMR Oil and Gas Ltd (with shared winter access), Spoke Resources Ltd. (shared winter access from the southeast), Encana Corporation and Dolomite Energy Inc. (cancelled projects) (Ben Rauscher pers. comm).

There may be an increase in oil and gas activity in this area by the time Zone 3 is scheduled for treatment, which would enable the Program Plan to take advantage of establishing collaborations with companies that will be accessing the area. This would have the potential to result in a significantly amount of cost savings creating access into the area. In addition, restoration treatment areas may shift to avoid areas planned for development (Figure 11).

Zone 3 is the largest zone, at 25,972 ha in size, with 160.8 km of candidate treatment areas (Table 17; Figure 11).



LEGEND

- PARKER CARIBOU RANGE
- TACTICAL TREATMENT PLAN ZONE

PRELIMINARY RESTORATION RECOMMENDATION

- TREATMENT CANDIDATE
- NO TREATMENT - LEAVE FOR NATURAL REGENERATION
- NO TREATMENT - NON TREATABLE
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)

RADIO-COLLAR DATA

- CARIBOU GPS RADIO-COLLAR LOCATION (2011 - 2012) [1]
- CARIBOU GPS RADIO-COLLAR LOCATION (2013 - 2015) [2]
- WOLF GPS RADIO-COLLAR LOCATION (2012 - 2013) [1]
- WOLF GPS RADIO-COLLAR LOCATION (2013 - 2014) [3]

PREDICTED CARIBOU CALVING HABITAT

- LOW
- LOW - MODERATE
- MODERATE

OTHER

- PARKER LAKE ECOLOGICAL RESERVE
- MUSKWA CARIBOU HERD RANGE
- WATERBODY
- WATERCOURSE

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- RECREATIONAL TRAIL

0 2 4

1:110,000 KILOMETRES

REFERENCES

1. CARIBOU (2011-2012) AND WOLF (2012-2013) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM C.DEMARS, UNIVERSITY OF ALBERTA (2015).
2. CARIBOU (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM BC OGRIS REMB BOREAL CARIBOU RADIO-COLLARING PROGRAM, AVAILABLE ONLINE AT HTTP://WWW.BCOGRIS.CA/BOREAL-CARIBOU/PROJECTS/ACTIVE (13 OCTOBER 2015)
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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN TREATMENT ZONES - ZONE 3

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-15
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**11**

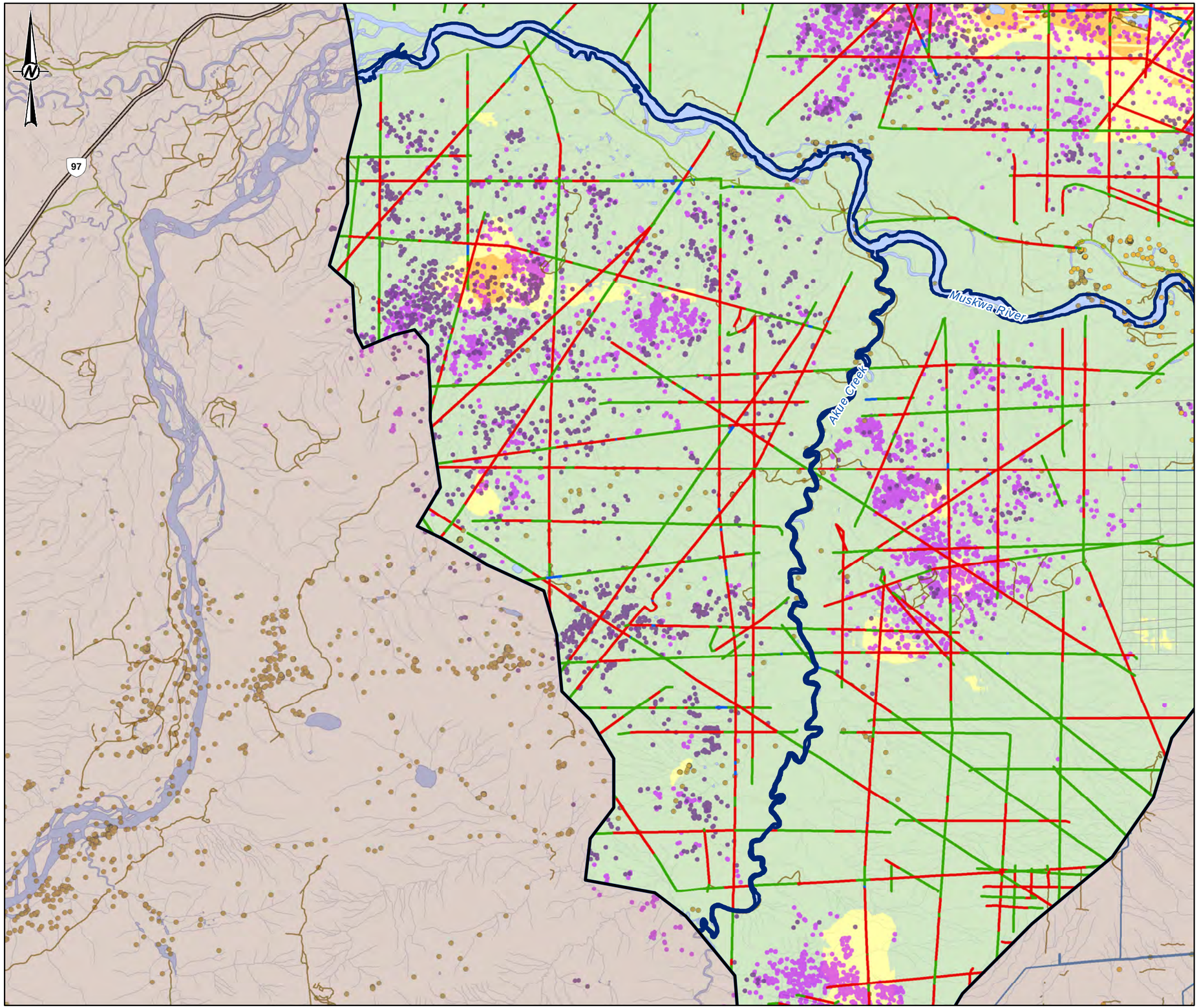
Zone 4

It is recommended that Zone 4 will be treated following Zone 3. The zone is currently ranked fourth in the treatment hierarchy because of the following variables:

- caribou within this Zone are adjacent to the Muskwa northern mountain caribou range and have displayed behaviours of both boreal and mountain ecotypes (M. Watters, pers. comm., October 22 2015), giving some indication that these caribou may be transitional in behaviours;
- Zone 4 is the most remote zone within the Parker Range with no known existing access routes;
- major watercourse crossing would be required to access the area with heavy machinery;
- may require the establishment of a camp;
- may require implementing summer only treatment by flying in contractors;
- has low predicted caribou calving use; and
- restoring corridors in an area that has known wolf use.

Although it is unknown how much oil and gas activity may occur in this area over the next few years, current projections are for low use (Ben Rauscher pers. comm). There may be an increase in oil and gas activity in this area by the time Zone 4 is scheduled for treatment, which would enable the Program Plan to take advantage of establishing collaborations with companies that will be accessing the area. This would have the potential to result in a significantly amount of cost savings creating access into the area (Figure 12).

Zone 4 is 15,532 ha's in size, with 127.6 km of candidate treatment areas (Table 17; Figure 12).



LEGEND

- PARKER CARIBOU RANGE
- TACTICAL TREATMENT PLAN ZONE

PRELIMINARY RESTORATION RECOMMENDATION

- TREATMENT CANDIDATE
- NO TREATMENT - LEAVE FOR NATURAL REGENERATION
- NO TREATMENT - NON TREATABLE
- EXCLUDED LINEAR DISTURBANCE (LOW IMPACT SEISMIC)

RADIO-COLLAR DATA

- CARIBOU GPS RADIO-COLLAR LOCATION (2011 - 2012) [1]
- CARIBOU GPS RADIO-COLLAR LOCATION (2013 - 2015) [2]
- WOLF GPS RADIO-COLLAR LOCATION (2012 - 2013) [1]
- WOLF GPS RADIO-COLLAR LOCATION (2013 - 2014) [3]

PREDICTED CARIBOU CALVING HABITAT

- LOW
- LOW - MODERATE
- MODERATE

OTHER

- MUSKWA CARIBOU HERD RANGE
- WATERBODY
- WATERCOURSE

TRANSPORTATION

- HIGHWAY
- MAJOR ROAD
- RECREATIONAL TRAIL

0 1.5 3

1:90,000 KILOMETRES

REFERENCES

1. CARIBOU (2011-2012) AND WOLF (2012-2013) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM C.DEMARS, UNIVERSITY OF ALBERTA (2015).
2. CARIBOU (2013-2015) GPS RADIO-COLLAR LOCATIONS OBTAINED FROM BC OGRIS REMB BOREAL CARIBOU RADIO-COLLARING PROGRAM, AVAILABLE ONLINE AT HTTP://WWW.BCOGRIS.CA/BOREAL-CARIBOU/PROJECTS/ACTIVE (13 OCTOBER 2015)
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COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

BC OIL AND GAS RESEARCH AND INNOVATION SOCIETY

PROJECT

PARKER CARIBOU RANGE
PILOT RESTORATION PROGRAM PLAN

TITLE

TACTICAL PLAN TREATMENT ZONES - ZONE 4

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-01-15
DESIGNED	PB
PREPARED	RH
REVIEWED	BC
APPROVED	PB

PROJECT NO.	CONTROL	REV.	FIGURE
1529978	5000	0	**12**

5.4 Field Implementation Design Specifications

Due to the lack of research indicating what percentage of a treatment segment is required to be treated to meet the objective of reducing wildlife use to a level equal to the adjacent vegetation community, 100 percent of the segment will be treated with the following exceptions:

- Treatment gaps will be left in areas that do not require treatment such as where the adjacent vegetation community type is a graminoid wetland and less than 100 m in length. Treatment lengths less than 100 m were not identified during desktop classification for logistical and cost efficiency during the planning stage and must be identified immediately prior to treatment.
- Treatment prescription on segments less than 100 m will be adjusted when site specific conditions indicate the full prescription is not required to meet the objective. For example, segments scheduled for mounding and tree-felling may only be mounded if the trees in the adjacent vegetation community are not considered tall enough to create a suitable access control. These areas will also be identified immediately prior to treatment.
- When there are monitoring plots to be established, a 25 m segment will be left untreated adjacent to the treatment plot as part of the paired treatment and reference plot lay-out as illustrated in the Boreal Caribou Habitat Restoration Monitoring Framework (Golder 2015b, Figure 3).

5.5 Implementation Plans

The Program Plan is designed as a multi-year program. Each year of the program will involve the development of an Implementation Year planning document for the particular zone, or area within a zone. The following elements will be captured within each annual implementation plan:

- review linear inventory mapping and treatment candidate sites to plan ground-truthing field program;
- reviewing potential archeological requirements prior to ground-truthing, and incorporating any archeological field work with the ground-truthing;
- reviewing Vieworx 360 Imagery to document accessibility to the area:
  - identify the locations of potential watercourse crossing locations, and determine if disturbance to the watercourse may be required to cross; and
  - if disturbance is a possibility, incorporate a field watercourse crossing assessment into the ground-truthing plan.
- ground-truthing of potential restoration segment sites to confirm treatment recommendation;
- confirmed restoration segment sites will be given a treatment prescription guided by the Boreal Caribou Habitat Restoration Toolkit Treatment Matrix (Appendix B and Table 1 of the toolkit will be used to support treatment type based on objective along the specific restoration segment);
- the following will be noted for each treatment site to guide logistical planning for field implementation:
  - treatment site location;
  - treatment access route or other considerations (ground access vs. aerial support);

- site conditions which may impact treatment options (e.g., terrain, site wetness, pipeline crossings, impact to existing vegetation between restoration segments); and
- update vegetation mapping for the site where a variance occurs from original mapping interpretation (surrounding stand type, height of vegetation per strata, vegetation species composition, % vegetation cover, game trail/ human access presence, width, line orientation).

- seed and seedling requirements will be finalized, and will be sourced, as required.

6.0 MONITORING FRAMEWORK

6.1 Vegetation and Treatment Response

The vegetation response to the Program Plan treatments will be monitored following guidelines in the Boreal Caribou Habitat Restoration Monitoring Framework developed for BC OGRIS (Golder 2015b). Monitoring for compliance, effectiveness, and validation will be incorporated into the study design. Reference plots will be established during treatment periods on untreated gaps of linear features (reference plots- disturbed) and on linear features that are already on a successional vegetation trajectory (reference plots- natural revegetation). These reference plots will be compared to the treatment plots to evaluate the effectiveness of the treatments at achieving the overall objectives of the program, which is to reduce predator and primary prey access and establish a vegetation trajectory that will increase boreal caribou habitat intactness.

Measurable targets and monitoring periods are provided in the Framework as a means of comparison to evaluate whether the restoration treatment is on a trajectory towards effectiveness. The Program Plan will help to validate the prescriptions of the Monitoring Framework.

6.2 Wildlife Response Monitoring[1]

Wildlife monitoring is currently being conducted in the Parker Caribou Range as part of a research program designed to monitor the wildlife and human use of both treated and untreated linear features (Matrix Solutions Inc.; BCIP-2016-17). The wildlife monitoring program consists of two monitoring phases

- Phase 1 consists of developing and implementing a sampling program designed to monitor wildlife and human use in the Parker Caribou Range for one year using motion-sensing cameras. The program is designed to collect habitat use data continuously across seasons on humans and large mammal species that interact in this ecosystem such aswolves, bears, caribou, moose, and deer. Results from this phase facilitate the Habitat Restoration Pilot Program implementation planning by providing wildlife and human use data which may be used as one of the weighted variables to help guide the type and placement fof restoration treatments (i.e., placement and prescription).
- Phase 2 consists of developing and implementing a sampling program designed to monitor wildlife and human use once restoration treatments are implemented, and is designed to answer ‘how well does the treatment mitigate predator use?’ and ‘are predators leaving the treatment area?’ These questions are key to measuring how successful functional restoration is at reducing predator use and predator-caribou overlap.

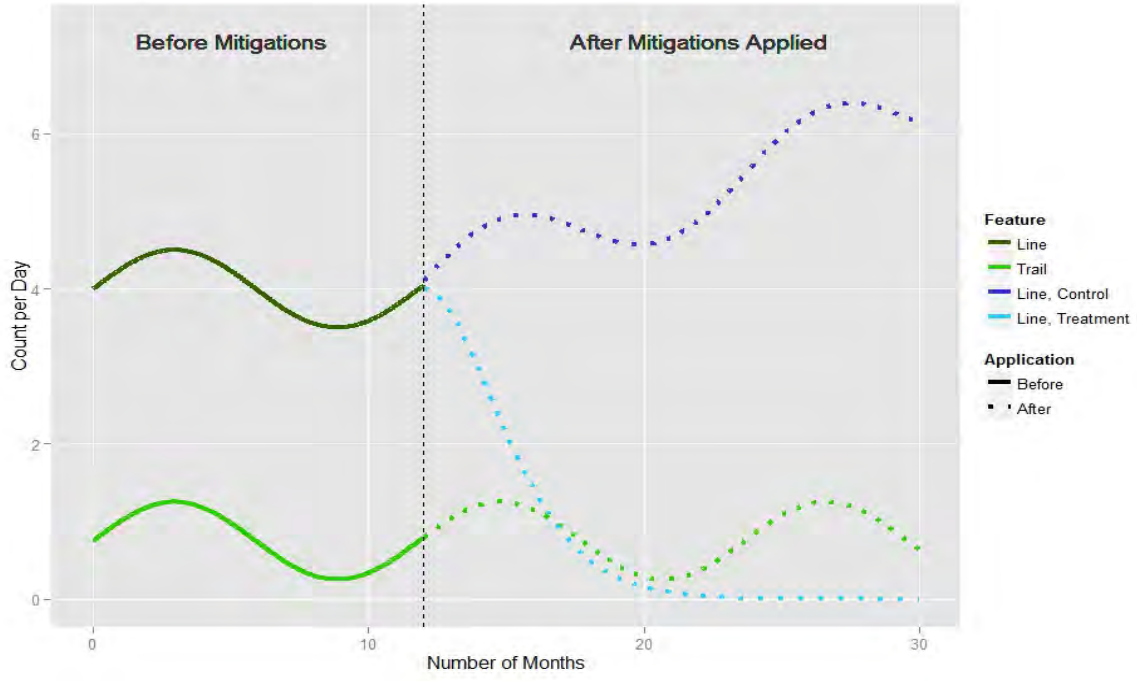
A schematic showing how predator use is hypothesized to change across time, mitigation treatment, and feature type is provided in Figure 12. Predator use will be measured asthe rate of relative use of a feature, with treatment considered successful when:

- predator use on linear features is lower in the treatment area than in similar control areas;
- predator use on linear features in the treatment area approaches the rate of use on game trails; and

[1] Information and figures for this section was received from Matrix Solutions on November 27 2015.

- predator use on game trails within the treatment area remains constant or declines.

Figure 13: Predicted Response of Predator Use Before Mitigations (Phase 1) and After Mitigations (Phase 2) on Linear Features (Line) and Game Trails (Trail). Figure received from Matrix, November 2015



Phase 1 was initiated in Fall 2015. First, a grid of potential monitoring units was placed across caribou range to reduce spatial inter-dependence among stations, ensure that monitoring considered the range of environmental variability across the caribou range, and reduce the sampling frame from continuous space to a finite population framework, which simplified the design while maintaining statistical rigor. The environmental conditions of each unit were characterized using a GIS. A total of 85 monitoring locations were selected from the pool of units using a balanced approach, such that stations were representative of the range of habitat conditions, geography, linear features, and game trails within the caribou range.

Survey crews flew to each location and identified the nearest site that met the predefined criteria identified for that location (i.e., habitat conditions and whether the location was identified as being on a linear feature or game trail). Crews then landed at the site and established a motion-sensing camera monitoring station. Cameras were deployed across linear features (n=56) and game trails (n=29). Camera deployment was completed in mid-November 2015 and will collect animal use data for the Phase 1 portion of the program for one year (Figure 13) (P. DeWitt, pers. comm., 2015).

7.0 SUMMARY

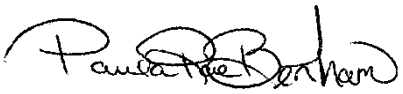
Existing research provides guidance for the need for landscape level habitat restoration for woodland caribou (S. Boutin pers. comm. 2014). The BC government's Boreal Caribou Implementation Plan (BCIP) relies partially upon aggressively restoring habitat to improve caribou population projections. However, although analysis has indicated that habitat restoration is linked to improving caribou population projections, the feasibility and predicted outcomes of restoration activities are highly uncertain (Wilson et al. 2010). This Parker Range pilot restoration program is the first plan to propose application of habitat restoration techniques over an entire boreal caribou range in Canada. With projected low levels of industrial activities within the Parker Range expected over the coming decade, the Program Plan provides the opportunity to apply and monitor, with minimal human disturbance, the effectiveness of habitat restoration techniques over a caribou-range scale in relation to caribou population metrics. The overall objective of the Program Plan is to transition low quality boreal caribou habitat into higher quality habitat by reducing the benefits predators and their primary prey gain through linear corridor use, and to establish a vegetation trajectory on these corridors that will in the long term increase boreal caribou habitat intactness.

This Program Plan has been designed to be implemented over a multi-year period; completing desktop disturbance mapping, tactical planning, implementation planning, development of an aboriginal inclusion plan (2015-2016), implementing restoration treatments (2017-2021), and conducting post-treatment monitoring on both restoration treatments and wildlife response. The linear disturbance inventory mapping resulted in the classification of 1,040 km of linear disturbance, comprising 2,473 line segments with unique attributes. Of the 1,040 km of linear disturbance mapped within the Parker Range, 76 km (7%) were classified as requiring No-Treatment based on permanence (active disposition or protective notation, such as a pipeline, lease road, designated recreational trail, or ecological reserve). Based on the current vegetation status of naturally established vegetation height and cover, a total of 394 km (38%) of linear disturbances within the Parker Range are considered Leave for Natural and will not be treated due to current natural regeneration. The remaining 569 km (55%) of linear disturbances within the Parker Range will be considered for treatment, with ground-truthing before treatment necessary to verify site specific treatment recommendations.

An annual implementation plan will be prepared during each year of the Program Plan, as part of the authorization, costing and treatment implementation planning process. Given the multi-year nature of the Program Plan, the tactical plan developed provides guidance for each implementation year based on ecological, logistical, and economic criteria within four zones delineated within the Parker Range.

Report Signature Page

GOLDER ASSOCIATES LTD.



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Senior Restoration Specialist

Paula Bentham, M.Sc., P.Biol.
Principal, Senior Wildlife Ecologist, Project Director

BC/PB/l

CC: Steve Wilson, Gary Sargent, Mary Viszlai-Beale Shawn Williams, Megan Watters, Lisa Helmers, Ben Rauscher

https://capws.golder.com/sites/1529978bcborealcaribouhabrestpilotprogram/1529978/5000_pilot_restoration_program_plan_final/final restoration program plan/bcip-2016-04 parker range program plan final.docx

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APPENDIX A

Linear Disturbance Mapping and Quality Control: Methods and Lessons Learned

January, 2016
Report No. 1529978/5000

1) LINEAR DISTURBANCE MAPPING: METHODS AND QUALITY CONTROL

Quality Assurance and Quality Control of Mapping Interpretation

Quality assurance (QA) and quality control (QC) are different sets of activities, however, both relate to the development of a reliable, quality product. Quality assurance typically relates to proactive steps and developing documented, systemic processes and procedures to ensure the final product meets the requirements. Quality control, however, is more of a reactive process, focused primarily on the identification and correction of any issues or errors in a product under development. The linear disturbance inventory used a combined QA/QC process, to develop a reliable map product for the Program Plan.

QA Methods

A process guide was developed for team members conducting the linear disturbance classification since the Vieworx 360 imagery is a relatively new technology that has not been tested by Golder, or by others, for the use of developing a linear disturbance inventory with vegetation attributes (Morgan Beaupre, pers. comm.). The process guide outlines the tools required for viewing the Vieworx 360 imagery in the LadyBugCapPro© viewer and, methodologies employed in ArcGIS for viewing, navigating and editing the linear disturbance dataset. The drop-down lists in the database were used to ensure proper codes and classes were attributed to the features, as well as reducing the potential for manual data entry errors. Interpretation guidance for the available reference data such as aerial imagery, Ducks Unlimited Canada (DUC) enhanced wetland classification layer, and a limited extent of Light Detection and Ranging (LiDAR) imagery was also provided. Photographic or other graphic examples of classification attributes, such as upland and wetland site types, dominant species and percent cover of vegetation, were provided to aid in consistency between interpreters. Criteria for the final intended use of the linear feature map (i.e., restoration planning) were also provided to aid consistent decision making when creating and classifying linear corridor segments.

Finally, a specific work instruction (SWI) was developed for the field program associated with collecting ground-based validation data (see QC Methods) for the interpreted segments from throughout the Parker Range. The SWI outlined the criteria to evaluate in the field, namely:

- site type (upland, mineral wetland, organic wetland, water or other);
- vegetation cover %;
- vegetation height class;
- dominant species;
- presence of game trail or ATV use; and
- line width.

An experienced vegetation ecologist, familiar with linear restoration planning and implementation, identified appropriate sampling locations along selected linear segments for ground-based data collection. This, in conjunction with the specific work instructions, provided a documented process for data collection.

QC Methods

While no official standards exist for linear disturbance inventories and classification, existing standards for other mapping products were referenced to guide the level of intensity recommended for field sampling and other QC procedures. Both the Preliminary Land and Vegetation Inventory (PLVI) Standards and Specifications (ESRD 2012) and Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998) were consulted to determine an appropriate range of line segments to field-validate and audit. The PLVI standards do not include a field verification aspect, but provide a sliding scale to audit based on the size of the study area (Table 1) while TEM standards (Table 2) provide a range of survey intensities considering the size of the study area, associated cost for field verification and acceptable reliability of the finished product.

Table 1: PLVI polygons for selection in interpretation audit (ESRD 2012).

Area (ha)	Minimum % of Polygons	Max # of Polygons
< 2,500	25	No maximum
2,500 to 10,000	15	75
10,000 to 20,000	10	100
>20,000	5	150

Table 2: Survey intensity levels for ecosystem mapping (adapted from RIC 1998).

Survey Intensity Level	Percentage of Polygon Inspections	Range of Study Area (hectares)
1	76 to 100%	20 to 500
2	51 to 75%	100 to 10,000
3	26 to 50%	5,000 to 50,000
4	15 to 25%	10,000 to 500,000
5	5 to 14%	10,000 to 1,000,000
Reconnaissance	0 to 4%	50,000 to 1,000,000+

An initial intensity of 15% of combined field survey, LiDAR and audits was selected given that the Parker Range is 75,162 hectares (ha), with 1,040 km of linear disturbances identified, subdivided into 2,473 segments.

Quality control focusing on the linear disturbance inventory mapping and classification included the following:

- field verification of interpreted linear disturbances and associated classification (41 plots or 2.2% of total km);
- a comparison between field plots and interpreted segments for site type, vegetation cover and vegetation height (61% correct);
- use of LiDAR to compare actual height with the interpreted height on 53.6 km, 5.2% of total linear disturbance length (94% correct); and
- a desktop audit process using the most experienced mapper, on an additional 8.2% of interpreted segments (60% correct).

The specific methods and results of these assessments are further detailed in the following section.

1.1.1 Verification of Linear Mapping Interpretation

While general guidance was taken from QC and verification methods associated with the PLVI and TEM mapping standards, a project-specific approach consisting of several comparisons and audit processes was conducted to assess the quality of the linear disturbance inventory and classification for determining restoration treatment selection.

Field Verification

A total of 45 sites were chosen to be visited in the field as part of the linear disturbance inventory mapping and interpretation QA/QC. Twenty-eight of the sites were flagged to be ground-truthed during the desktop mapping of the 360 imagery, and the remaining 17 sites were randomly selected and equally distributed across the entire Parker Range. Sites were QA/QC'd by one crew in the field over a period of three days (September 2nd through 4th, 2015). In total, 41 sites were field visited, with 11 sites that had vegetation cover differences and eight sites that had height differences that would have the potential to affect treatment recommendations. Table 3 summarizes the surveyed sites; any field bolded indicates a change significant enough to change treatment recommendation.

A direct comparison between field plot variables and desktop interpreted segments was conducted to get an understanding of the accuracy of the linear feature classification. The comparison evaluated all classified variables, but ultimately the assessment considered classifications to be incorrect if the difference in interpretation changes a treatment recommendation.

Results of Field Verification of Linear Mapping Interpretation

Twenty five of the 41 sites visited in the field were correctly classified for site type, vegetation cover and height class. Thirty nine percent of the number of line segments sampled during the field program had a different classification applied, compared to what had been assigned during the mapping interpretation process. Therefore, sixty one percent (61%) of the number of line segments sampled during the field program were deemed to be correct and did not have a different classification applied. The field verification of < 80% accuracy level for the linear disturbance mapping and classification, is below the BC Vegetation Resource Inventory mapping standard procedure of > 80%. However, there was a 100% classification for site type into wetland or upland.

It should be noted that the majority of line segments selected for field verification (i.e., 28 of 45), had been flagged during the mapping interpretation process due to an attribute or characteristic that was difficult to determine from the 360 imagery. Thus, it was more likely that these segments would change in classification as a result of the field visit than if more random field plots had been selected for field verification.

Table 3: Comparison of Vieworx mapping and Field Observations, where Bolded indicates a significant change in classification affecting treatment recommendation.

Site Number	Site Type	Site Type	Veg Cover (%)	Veg Cover (%)	Height (cm)	Height (cm)
	Vieworx	Field	Vieworx	Field	Vieworx	Field
1	Wetland-Org	Wetland-Org	0-5	0-5	0-50	0-50
2	Upland	Upland	30+	30+	101+	101+
3	Upland	Upland	**26-30**	**30+**	101+	101+
4	Wetland-Org	Not Visited	0-5	Not Visited	0-50	Not Visited
5	Upland	Upland	11-15	0-5	0-50	0-50
6	Upland	Upland	6-10	16-20	51-100	51-100
7	Wetland-Org	Wetland-Org	16-20	16-20	51-100	51-100
8	Wetland-Org	Wetland-Org	**0-5**	**11-15**	**0-50**	**101+**
9	Upland	Upland	30+	30+	101+	101+
10	Wetland-Org	Wetland-Org	30+	30+	101+	101+
11	Upland	Upland	6-10	16-20	**0-50**	**51-100**
12	Wetland-Org	Wetland-Org	0-5	0-5	0-50	0-50
13	Wetland-Org	Wetland-Org	11-15	11-15	101+	101+
14	Wetland-Org	Wetland-Org	0-5	6-10	101+	101+
15	Upland	Upland	0-5	11-15	**0-50**	**51-100**
16	Wetland-Min	Wetland-Org	30+	30+	51-100	51-100
17	Wetland-Org	Wetland-Org	21-25	21-25	101+	101+
18	Wetland-Org	Wetland-Org	**6-10**	**16-20**	51-100	101+
19	Other-water/road	Other-water/road	N/A	N/A	N/A	N/A
20	Wetland-Org	Wetland-Org	**6-10**	**11-15**	101+	101+
21	Wetland-Org	Wetland-Org	**6-10**	**11-15**	51-100	51-100
22	Wetland-Org	Wetland-Org	**30+**	**6-10**	51-100	51-100
23	Upland	Upland	16-20	16-20	51-100	101+
24	Wetland-Org	Wetland-Org	11-15	11-15	51-100	51-100
25	Upland	Upland	26-30	11-15	**0-50**	**51-100**
26	Upland	Upland	16-20	16-20	**0-50**	**51-100**
27	Upland	Upland	11-15	11-15	101+	101+
28	Upland	Upland	16-20	21-25	51-100	101+
29	Wetland-Org	Not Visited	21-25	Not Visited	101+	Not Visited
30	Upland	Upland	**Unclassified***	**0-5**	**Unclassified***	**0-50**
31	Upland	Upland	**16-20**	**30+**	51-100	101+
32	Upland	Upland	11-15	11-15	51-100	51-100
33	Upland	Upland	16-20	16-20	51-100	51-100
34	Upland	Upland	11-15	16-20	**0-50**	**51-100**
35	Upland	Upland	21-25	21-25	51-100	51-100
36	Wetland-Min	Wetland-Org	**6-10**	**11-15**	101+	101+
37	Upland	Upland	30+	30+	51-100	101+
38	Wetland-Org	Wetland-Org	6-10	6-10	101+	101+
39	Wetland-Org	Wetland-Org	6-10	6-10	51-100	51-100
40	Wetland-Org	Wetland-Org	6-10	6-10	101+	101+
41	Wetland-Org	Wetland-Org	**6-10**	**11-15**	**0-50**	**51-100**
42	Wetland-Org	Wetland-Org	**0-5**	**11-15**	51-100	51-100
43	Wetland-Org	Not Visited	6-10	Not Visited	101+	Not Visited
44	Wetland-Org	Wetland-Org	0-5	0-5	0-50	0-50
45	Wetland-Org	Not Visited	16-20	Not Visited	101+	Not Visited

* One site was unclassified during the interpretation because the canopy interfered with the view of the line and the interpreter assumed the line would not require treatment, but noted it should be field verified. Field verification revealed the site was a treatment candidate.

Internal Review, LiDAR, and Audit

A manual review and audit process was conducted on an additional 8.2% (85.7 km) of the linear disturbances. The review and manual audit process involved selecting linear disturbances in a relatively random manner across the Parker Range, representing a cross-section of all 12 interpreters that conducted the linear disturbance classification. The audit was weighted slightly heavier to those interpreters with lesser experience in linear disturbance attributes. The audit process ensured that audits were not self-conducted (i.e., someone auditing was not reviewing their own classification efforts) but was limited to two individuals to enhance consistency. In the audit process, the reviewers classified site type, height class, and percent vegetation cover for comparison with the original classification. The difference between the initial interpretation and the review classification were then calculated.

LiDAR data collected from 50 km of lines flown during the collection of the 360 imagery was used to compare the actual height of vegetation growing along the linear corridors with the interpreted height. Correct height interpretation is important for determining whether restoration treatment is recommended or not. The difference between the interpreted height and the LiDAR-derived height were then calculated.

Results of Internal Verification of Linear Mapping Interpretation

Forty percent of locations reviewed during the internal audit process had a different classification applied, compared to what had been assigned during the initial mapping process. Therefore, sixty percent of line segments reviewed during the internal audit process were deemed to be correct and did not have a different classification applied. Given the initial attempt at using the 360 spherical imagery and technology, there was a learning curve associated with the linear inventory interpretation. The learnings developed out of this process will be used to inform similar future activities, which are anticipated to result in an overall higher accuracy.

Verification of vegetation heights using LiDAR to compare actual height with the interpreted height on 53.6 km resulted in an accuracy of 94% in height interpretations of line segments by length. The location of one ground-truthing site did overlap with the area covered by the LiDAR data. The results of the initial classification, field QAQC and LiDAR QAQC were identical with respect to estimated vegetation cover (%) and height (101cm+).

2.0 LINEAR DISTURBANCE MAPPING: LESSONS LEARNED

Government Database Information for Linear Corridors

- Over half of the linear segments identified prior to the Vieworx 360 imagery collection were identified by reviewing available imagery. Digitizing linear segments that were not documented within government databases was necessary.
- The field crew noted that there were linear disturbances which were not flown as part of the 360 imagery collection that were candidates for restoration. Upon further investigation it was determined that these lines were mapped within Oil and Gas Commission (OGC) database as 3D seismic lines and therefore were not considered for reclamation during the initial planning because of their assumed smaller widths. It is also possible that these lines did not exist within the OGC databases used to select flight lines prior to 360 imagery acquisition.

Linear Disturbance Mapping Cost

- The mapping and linear disturbance classification team comprised of 4 vegetation / habitat restoration specialists and 8 supporting ecologists and GIS analysts. The linear disturbance classification effort on 1,040 km
- (2,473 line segments) was conducted in approximately 550 hours over a period of 4 weeks. The Vieworx 360 imagery was piloted as an untested product for linear disturbance mapping, given the high cost of purchasing LiDAR imagery which has been used in other restoration planning programs. Use of the Vieworx 360 imagery resulted in added cost for the linear disturbance inventory, though this approach was initiated with the hopes of a cost-effective means for capturing current linear disturbances (Table 4). The estimated hours for mapping the linear disturbance features were estimated at 530 hours to capture time to map, support IM and data processing to support moving photo data to a GIS mapping tool. For the Parker Range inventory, over 900 hours were required for mapping, processing, and interpreting the Vieworx 360 imagery due to the nature of the product.
- The Purview Approach, while initially appearing to have a greater cost (Table 4), may have been a more efficient and cost-effective approach to complete the inventory, though the initial data acquisition cost is higher than Vieworx. This method has been used for other restoration and linear projects and the data products, process and limitations are well understood. Labour hours would have been less given the understood data products and inventory process.
- A LiDAR only-based approach could also be an option, though not presented in Table 4. This approach would use LiDAR data to identity and classify linear features using essentially the same parameters required for restoration planning purposes. While analysis of LiDAR can achieve many of the required attributes (i.e., upland vs. lowlands, vegetation height class and cover, line width) it cannot easily identify important attributes such as the dominant species type, nor verify the presence or absence of game trails, which are important variables to consider when making treatment recommendations.

Table 4: Linear Disturbance Mapping: Options Comparison

Option Description	Benefits/Potential Cons	Data Requirements	Data Available	Data Acquisition Costs	Processing Effort	Projected Processing Costs	Total Costs
360 Video Overflight and Photo Mapping	• Use of 360 video camera technology attached to a helicopter, allows linear features to be flown at a speed of approximately 120 km/hr while capturing still photo images along the entire linear footprint that can be viewed on desktop. • GIS processing and manual mapping of video is required. • Data does not include LiDAR. A Digital Elevation Model cannot be built. As a result, vegetation heights cannot be mapped in a proven method. Vegetation heights become estimates and require increased field verification with unknown accuracy as compared to Purview Option. • Vegetation Resource Inventory (VRI could provide a source of site series classification within the range (dates to 2000, but is "grown" overtime and available through government sources. • Overall benefit is lower cost than PURVIEW Option, given that LiDAR and aerial photo or Spot acquisition and costs need to be added to Option B. However field level verification needs to be increased to determine vegetation height and data processing time was unknown prior to use due to lack of knowledge/use of technology in this type of project. • Benefit for year to year operational plans to minimize field verification time (photos readily available for planners and contractors to understand detailed site conditions).	Data is obtained from 360 video camera and photos are captured in the field. Photos require extensive processing to develop a mapping tool of the entire Parker Range.	VRI (portion)	$41,000 (predicted) $33,274 (actual)	Processing effort was unknown prior to imagery collection. An original estimate of 530 hours was made to capture time to map, support IM, support data processing to support moving photo data to a GIS mapping tool. Actual effort was 903 hours to map, with 300 hours for mapping verification and QC.	$78,000 (predicted) $111,037 (actual)	**$119,000 (predicted)** **$144,311 (actual)**
PURVIEW Mapping	Accurate vegetation mapping / classification for determining treatments (used in past restoration programs) and known ability to ID tree species and heights.	1) stereo image pairs (ideally colored: n= 234) 2) high-resolution DEM (LiDAR ideally) for measuring vegetation heights	Available stereo imagery exists 1:15,000 (1997). Considered not appropriate for mapping the current footprint on the ground. (1998 - 2014 would not be captured).	No cost for available imagery (1997)	Effort determined through review of Geo BC Air Photo viewer and Parker Range boundaries (234 stereo images)	$66,500 Data Processing	**$166,500 (Predicted)**
	Consistent with previous methodology for similar programs (high degree of certainty on data and costs)		LiDAR not available through data sharing agreement	LiDAR: $100,000 (available for purchase)			
	LiDAR is used to classify regeneration heights	1b) OR stereo image pairs can be replaced with Spot 6 or 7 (satellite data with stereo capability) (choose 1 of IKONOS or Spot 6/7)	not available	IKONOS (80 cm product class) approx. $36 USD/km2 (standard tasking, <15% cloud cover, etc.) = $27,000	Golder vegetation mappers to map linear features and attribute type, with expected ~ 495 hours for: • map interpretation • senior mapping review • vegetation QA/QC, • IM support (LiDAR processing for DEM, PURVIEW MXD set up, IM processing) • Post field refinement by vegetation mappers		
	Potential Cons: lack of recent imagery would result in either additional costs to acquire up-to-date imagery (stereo or satellite, prices vary), or field level verification to find data gaps, as well as project schedule shifts to account for imagery acquisition. Lack of LiDAR available through a data sharing agreement adds significant costs to pilot project. Requires two field visits, one to ground-truth mapping, the 2nd visit to build operational plan for Year 1 Implementation Plan			SPOT 6/7 stereo (1.5 m) would be about $18/km^2 = $13,500			

Vieworx 360 Imagery and LadybugCapPro Viewer

- Product worked well for viewing the vegetation status on the lines, and can be used for other purposes which may reduce future field visit costs such as assessing access routes and identifying watercourse crossing locations.
- Product required manual interpretation and the use of two software programs which is time intensive and requires a learning curve to train interpreters to use.
- The built-in GPS used to record the location of each 360 imagery sphere was only able to provide the approximate co-ordinates for each location resulting in referencing approximation during the classification process.
- Multiple users could not utilize the LadybugCapPro Viewer at the same time. This required increased time to split the 360 imagery into sections for interpreters and remerging interpreted data.

Experience of the Interpreters conducting the linear disturbance classification

- Interpreters should be experienced in vegetation types for the area being interpreted. Due to the amount of linear disturbances to be interpreted and the mapping timelines associated with completing the classification, staff with less experience in vegetation interpretation were utilized which led to some inefficiencies in training and additional time spent with quality control by the more experienced interpreters.
- Graminoid or herbaceous wetlands, although encompassing a small percentage of linear segments, were not classified consistently during the classification process, and were often identified as treatment candidates due to their low cover percentage and height class. There are few of these sites since many were less than 100 m in length. Any graminoid or herbaceous sites classified for treatment will be removed as treatment candidates during the ground-truthing and field implementation stage.

APPENDIX B

Linear Inventory Photos

Photo 1: **Leave for Natural: a wetland segment with > 10% vegetation cover, consistently equal to or over 50 cm in height, and no game trail is present (Vieworx June 2015).**

Photo 2: **Ground photo comparison of Leave for Natural: wetland segment with > 10% vegetation cover, consistently equal to or over 50 cm in height, and no game trail is present (Site Number 18; Golder September 2015).**

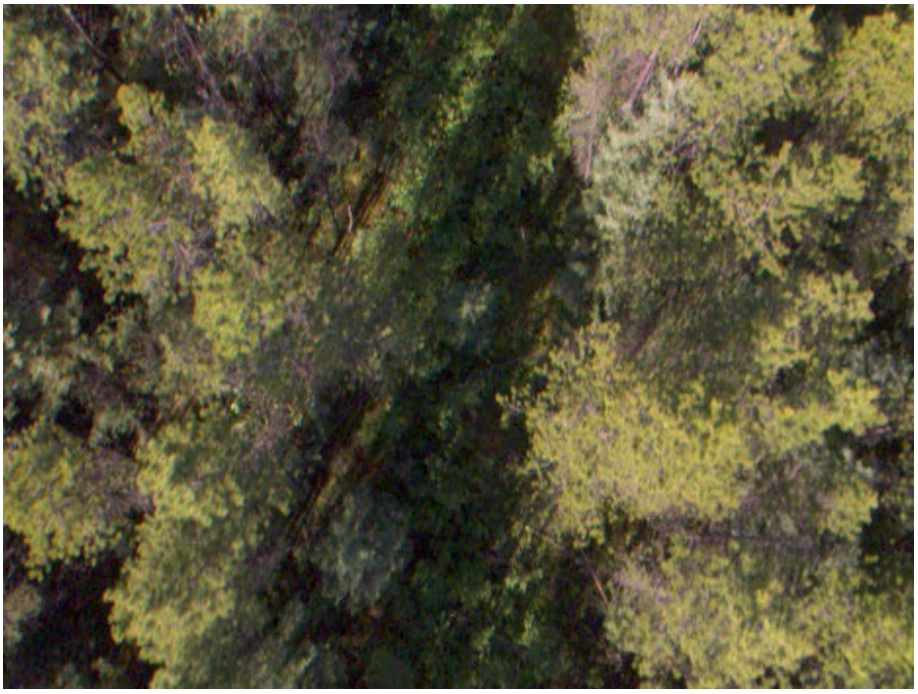


Photo 3: **Leave for Natural: upland segment with over 30% vegetation cover, consistently equal to or over 50 cm in height and no game trail present (Vieworx June 2015).**

Photo 4: **Ground photo comparison of Leave for Natural: upland segment with over 30% vegetation cover, consistently equal to or over 50 cm in height and no game trail present (Site Number 2; Golder September 2015).**

Photo 5: **Treatment Candidate Wetland segment: < 10% vegetation cover, with < 50 cm height (Vieworx June 2015).**

Photo 6: **Ground photo comparison of Treatment Candidate Wetland segment: < 10% vegetation cover with < 50 cm height (Site Number 12; Golder September 2015).**

Photo 7: **Treatment Candidate Upland segment: < 30% vegetation cover and < 50 cm in height (Vieworx June 2015).**

Photo 8: **Hover photo comparison of Treatment Candidate Upland segment: < 30% vegetation cover and < 50 cm in height (Site Number 30; Golder September 2015).**

Photo 9: **Treatment Candidate Wetland segment: < 10% vegetation cover, with > 50 cm height (Vieworx June 2015).**

Photo 10: **Ground photo comparison of Treatment Candidate Wetland segment: < 10% vegetation cover, with > 50 cm height (Site Number 38; Golder September 2015).**

Photo 11: **Treatment Candidate Upland segment: < 30% vegetation cover and > 50 cm in height (Vieworx June 2015).**

Photo 12: **Ground photo comparison of Treatment Candidate Upland segment: < 30% vegetation cover and > 50 cm in height (Site Number 35; Golder September 2015).**

Photo 13: **Treatment Candidate Wetland segment: > 10% vegetation cover, with < 50 cm in height (Vieworx June 2015).**

Photo 14: **Treatment Candidate Upland segment: > 30% vegetation cover and < 50 cm in height (Vieworx June 2015).**

APPENDIX C

Mapping Interpretation Results of Linear Disturbances

January, 2016
Report No. 1529978/5000

SUMMARY OF VEGETATION CHARACTERISTICS

The following tables summarize the vegetation characteristics occurring within the Parker Range based on the results of the linear disturbance mapping. The linear disturbance classification was conducted on 1,040 km or 2, 473 line segments. Please note that values reported have been rounded, or are influenced by line lengths or segments classified as 'no treatment' or other (water/road, natural non-forested) and totals do not add up to exactly 100%.

1.0 SUMMARY OF LINEAR DISTURBANCES BY SITE TYPE

Table 1: Length of Linear Disturbances by Site Type

Classified Site Type	Length (km) linear disturbance	% of total length classified	Number of corridor segments	% of all segments
Upland	332.5	32%	758	31%
Wetland - Mineral	23.2	2%	99	4%
Wetland - Organic	584.9	56%	1,271	51%
Other - water/road	16.2	2%	156	6%
No linear disturbance	72.6	7%	153	6%
Natural non - forested	10.1	1%	38	2%

2.0 SUMMARY OF LINEAR DISTURBANCES BY VEGETATION HEIGHT

Table 2: Length of Linear Disturbances by Vegetation Height

Vegetation Height	Length (km) linear disturbance	% of total length classified	Number of corridor segments	% of all segments
0 - 50 cm	326.0	31%	632	26%
51 - 100 cm	216.6	21%	566	23%
101 cm +	414.0	40%	975	39%
N/A *	82.8	8%	302	12%

* = Segments classified as either Site Type: No linear disturbance, Other water/road, natural non-forested.

Table 3: Length of Linear Disturbances in each Site Type by Vegetation Height

Vegetation Height	Site Type						Grand Total	
	Upland		Wetland- Mineral		Wetland- Organic			
	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified
0 - 50 cm	33.5	3%	9.9	1%	279.3	27%	322.68	31%
51 - 100 cm	53.1	5%	6.0	1%	157.4	15%	216.50	21%
101 cm +	245.8	24%	7.3	1%	148.2	14%	401.34	39%
Total	**332.5**	**32%**	**23.2**	**2%**	**584.9**	**56%**	**940.53**	**90%**

Table 4: Number of Segments of Linear Disturbances in each Site Type by Vegetation Height

Vegetation Height	Site Type						Grand Total	
	Upland		Wetland- Mineral		Wetland-Organic			
	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments
0 - 50 cm	98	4%	36	1%	480	19%	614	25%
51 - 100 cm	172	7%	23	1%	369	15%	564	23%
101 cm +	488	20%	40	2%	422	17%	950	38%
Total	**758**	**31%**	**99**	**4%**	**1271**	**51%**	**2128**	**86%**

3.0 SUMMARY OF LINEAR DISTURBANCES BY PERCENT VEGETATION COVER

Table 5: Length of Linear Disturbances by Percent Vegetation Cover

% Vegetation Cover	Length (km) linear disturbance	% of total length classified	Number of corridor segments	% of all segments
0 - 5	276.2	27%	559	23%
6 - 10	176.6	17%	363	15%
11 - 15	92.4	9%	240	10%
16 - 20	55.4	5%	180	7%
21 - 25	38.6	4%	113	5%
26 - 30	33.9	3%	109	4%
30 +	282.5	27%	611	25%
N/A *	84.0	8%	300	12%

* = Segments classified as either Site Type: No linear disturbance, Other water/road, natural non-forested.

Table 6: Length of Linear Disturbances in each Site Type by Percent Vegetation Cover

% Vegetation Cover	Site Type						Grand Total	
	Upland		Wetland- Mineral		Wetland- Organic			
	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified
0 - 5	15.6	2%	7.2	1%	248.3	24%	271.18	26%
6 - 10	16.4	2%	4.1	0%	155.8	15%	176.19	17%
11 - 15	17.0	2%	1.2	0%	74.1	7%	92.35	9%
16 - 20	16.1	2%	1.9	0%	37.2	4%	55.22	5%
21 - 25	16.0	2%	2.3	0%	20.2	2%	38.60	4%
26 - 30	17.5	2%	1.8	0%	14.1	1%	33.36	3%
30 +	233.8	22%	4.8	0%	35.1	3%	273.62	26%
Total	332.5	32%	23.2	2%	584.9	56%	940.53	90%

Table 7: Number of Segments of Linear Disturbance in each Site Type by Percent Vegetation Cover

% Vegetation Cover	Site Type						Grand Total	
	Upland		Wetland- Mineral		Wetland-Organic			
	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments
0 - 5	55	2%	30	1%	453	18%	538	22%
6 - 10	48	2%	12	0%	301	12%	361	15%
11 - 15	54	2%	7	0%	179	7%	240	10%
16 - 20	55	2%	8	0%	116	5%	179	7%
21 - 25	45	2%	9	0%	59	2%	113	5%
26 - 30	48	2%	6	0%	53	2%	107	4%
30 +	453	18%	27	1%	110	4%	590	24%
Total	**758**	**31%**	**99**	**4%**	**1271**	**51%**	**2128**	**86%**

4.0 SUMMARY OF LINEAR DISTURBANCES WITH GAME/ATV TRAILS

Table 8: Length of Linear Disturbance with Game/ATV Trails

Game/ATV Trail Presence	Length (km) linear disturbance	% of total length classified	Number of corridor segments	% of all segments
Game trail	570.9	55%	1,304	53%
Game / ATV trail	74.4	7%	110	4%
No trail	302.8	29%	754	30%
N/A *	88.7	9%	305	12%
Unclassified ~	2.7	0%	2	0%

* = Segments classified as either Site Type: No linear disturbance, Other water/road, natural non-forested.

~ = 2 segments classified as Site Type 'No Linear Disturbance' site type.

Table 9: Length of Linear Disturbances with Game/ATV Trails in each Vegetation Height Category

Game/ATV Trail Presence	Vegetation Height (cm)						Grand Total	
	0 – 50 cm		51 – 100 cm		101 cm +			
	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified
Game trail	241.5	23%	157.4	15%	168.8	16%	567.7	55%
Game / ATV trail	52.6	5%	16.2	2%	4.9	0%	73.7	7%
No trail	28.6	3%	42.9	4%	227.6	22%	299.2	29%
Grand Total	**322.7**	**31%**	**216.5**	**21%**	**401.3**	**39%**	**940.5**	**90%**

Table 10: Number of Segments of Linear Disturbances with Game/ATV Trails in each Vegetation Height Category

Game/ATV Trail Presence	Site Type						Grand Total	
	0 – 50 cm		51 – 100 cm		101 cm +			
	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments
Game trail	456	18%	400	16%	432	17%	1,288	52%
Game / ATV trail	67	3%	24	1%	14	1%	105	4%
No trail	91	4%	140	6%	504	20%	735	30%
Grand Total	**614**	**25%**	**564**	**23%**	**950**	**38%**	**2,128**	**86%**

Table 11: Length of Linear Disturbances with Game/ATV Trails in each Percent Vegetation Cover Category

Game/ATV Trail Presence	% Vegetation Cover														Grand Total	
	0 – 5%		6 – 10 %		11 – 15%		16 – 20 %		21- 25 %		26 – 30%		31 + %			
	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified	Length (km)	% of total length classified
Game trail	200.0	19%	147.0	14%	80.4	8%	37.0	4%	19.5	2%	17.0	2%	66.8	6%	567.7	55%
Game / ATV trail	51.3	5%	14.7	1%	3.1	0%	2.6	0%	0.3	0%	0.6	0%	1.1	0%	73.7	7%
No trail	19.8	2%	14.4	1%	8.9	1%	15.7	2%	18.8	2%	15.8	2%	205.7	20%	299.2	29%
Grand Total	271.2	26%	176.2	17%	92.4	9%	55.2	5%	38.6	4%	33.4	3%	273.6	26%	940.5	90%

Table 12: Number of Segments of Linear Disturbances with Game/ATV Trails in each Percent Vegetation Cover Category

Game/ATV Trail Presence	% Vegetation Cover														Grand Total	
	0 – 5%		6 – 10 %		11 – 15%		16 – 20 %		21- 25 %		26 – 30%		31 + %			
	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments	Number segments	% of all segments
Game trail	409	17%	296	12%	197	8%	122	5%	60	2%	53	2%	151	6%	1,288	52%
Game / ATV trail	63	3%	19	1%	9	0%	5	0%	1	0%	2	0%	6	0%	105	4%
No trail	66	3%	46	2%	34	1%	52	2%	52	2%	52	2%	433	17%	735	30%
Grand Total	538	22%	361	15%	240	10%	179	7%	113	5%	107	4%	590	24%	2,128	86%

APPENDIX D

Archaeological Sites and Plan

Archaeological Desktop Review

An archaeological desktop review was conducted to identify archaeological sites relevant to the Parker Range as described in Section 4.2. A total of nine sites are located in the Parker Range and summarized in Table 1.

Table 1: Recorded Archaeological Sites within the Parker Range

Borden Number	UTM Coordinates[(a)]	Site Type	Dimensions	Relation to Pilot Restoration Program
IdRt-2	486490E 6496813N	Precontact, temporary habitation or subsistence, surface lithic	3 m x 10 m	Recorded in 2000, the site consists of a concentration of black chert and quartzite lithic artifacts observed on the surface of a knoll during a post completion archaeological inspection of a 2-D seismic program. The site is deemed to be 90% intact. The site is located at the southern extent of the Parker Range, approximately 24 km southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRr-1	507152E 6512902N	Precontact, temporary habitation or subsistence, subsurface lithic	8 m x 16 m	Recorded in 2004, the site consists of 117 chert flakes and one obsidian flake recovered from 33 subsurface tests and four evaluative units excavated during the Archaeological Impact Assessment (AIA) of a proposed oil and gas development. The site is located approximately 530 m south of the nearest portion of the Year 1 Implementation Plan area.
IeRr-2	505470E 6516662N	Precontact, temporary habitation or subsistence, subsurface lithic	30 m x 55 m	Recorded in 2005, the site consists of four pieces of chert debitage collected from three subsurface tests during the AIA of a proposed oil and gas development. The site is deemed to be 90% intact. The site is located within the Year 1 Implementation Plan area.
IeRs-1	495617E 6509989N	Precontact, temporary habitation or subsistence, surface and subsurface lithic	24 m x 30 m	Originally recorded in 2002, the site consisted of three retouched chert flakes and four unmodified chert flakes recovered from the ground surface and within a single shovel test during the AIA of an oil and gas development. The site was revisited in 2010 during the AIA of another oil and gas development, at which time four additional chert flakes were recovered from four subsurface tests. The site is deemed to be 80% intact. The site is located in the central portion of the Parker Range, approximately 8.1 km south-southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRs-2	493288E 6510355N	Precontact, temporary habitation or subsistence, subsurface lithic	14 m x 16 m	Recorded in 2005, the site consists of four retouched chert flakes and four unmodified chert flakes recovered from five subsurface tests during the AIA of a forestry development. The site is deemed to be 95% intact. The site is located in the central portion of the Parker Range, approximately 9.1 km southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRs-3	492639E 6510187N	Precontact, temporary habitation or subsistence, subsurface lithic	6 m x 8 m	Recorded in 2005, the site consists of one utilised piece of black chert shatter and one piece of black chert shatter recovered from a single subsurface test during the AIA of a forestry development. The site is deemed to be 95% intact. The site is located in the central portion of the Parker Range, approximately 9.7 km southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRs-4	492614E 6510557N	Precontact, temporary habitation or subsistence, subsurface lithic	20 m x 35 m	Recorded in 2005, the site consists of four retouched chert flakes recovered from two subsurface tests during the AIA of a forestry development. The site is deemed to be 95% intact. The site is located in the central portion of the Parker Range, approximately 9.5 km southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRs-5	491346E 6507568N	Precontact, temporary habitation or subsistence, subsurface lithic	4 m x 4 m	Recorded in 2005, the site consists of one piece of black chert debitage recovered from a single subsurface test during the AIA of a forestry development. The site is deemed to be 95% intact. The site is located in the south-central portion of the Parker Range, approximately 12 km southwest of the nearest portion of the Year 1 Implementation Plan area.
IeRs-6	491280E 6504325N	Precontact, temporary habitation or subsistence, subsurface lithic	12 m x 20 m	Recorded in 2005, the site consists of one piece of obsidian debitage recovered from a single subsurface test during the AIA of a forestry development. The site is deemed to be 95% intact. The site is located in the south-central portion of the Parker Range, approximately 15 km southwest of the nearest portion of the Year 1 Implementation Plan area.

(a) UTM coordinates provided are Zone 10 NAD 83.

Archaeological Plan

A customized archaeological plan will be developed through consultation with the Archaeology Branch and may include any of the following:

Archaeological Overview Assessment

An AOA, with or without Preliminary Field Reconnaissance (PFR), can normally be conducted without need for a *Heritage Conservation Act* permit issued by the Archaeology Branch and provides the opportunity to gather information useful for project planning purposes, particularly at an early stage in a project lifespan.

An AOA with PFR generally involves:

1) conducting a background desktop review of readily available ethnographic, archaeological and environmental data pertinent to a project area with a focus on identifying overlap with documented archaeological sites and dividing the project area into areas of high and low archaeological potential;

2) conducting a field inspection to confirm and refine areas of archaeological potential arising from the desktop review and to identify surface expressions of archaeological sites, if present;

3) conducting a preliminary assessment of anticipated impacts in light of proposed activities; and,

4) developing recommendations concerning the need for permitted archaeological studies (e.g., AIA), if warranted and in consultation with the client.

Consistent with industry practice and the bylaws of the BC Association of Professional Archaeologists (BCAPA), First Nations who are identified through the Consultative Areas Database (CAD) should be contacted to discuss the nature of the proposed activities and the AOA. Information and concerns that First Nations may have regarding a project area will be solicited. First Nations interest in participation on the PFR would be identified and discussed with the client prior to undertaking a PFR.

Many of BC's First Nations groups have developed their own heritage policies and permitting systems. The archaeological community has largely respected these requirements. Where identified, First Nations permits would be applied for after discussion with the client.

An AOA of the Parker Range was initiated in October 2015 to refine the results of this archaeological desktop review. Specifically, the AOA metadata from RAAD shown on Figure 4 will be reviewed to provide a planning tool for the Program Plan. Depending on feedback from the Archaeology Branch, an AOA may need to be completed for the specific year's Implementation Plan area, each year for the duration of the Program Plan, as it is not known at this stage where specific treatment sites will occur during subsequent years of the Program Plan.

Archaeological Impact Assessment

An AIA is recommended to be undertaken when overlaps between planned disturbance and documented archaeological site(s), or areas of high potential to contain archaeological sites, are identified and cannot be avoided. These areas may be identified through the completion of an AOA or if positive results are identified by a regulatory agency (e.g., local government agency, the Archaeology Branch, Oil and Gas Commission, etc.) or a professional consulting archaeologist during a review of resources such as the PHR and the archaeological potential layer in RAAD.

An AIA is conducted under a Heritage Inspection Permit (HIP), issued by the Archaeology Branch, pursuant to Section 14 of the HCA. It takes approximately 8 to 10 weeks for a Section 14 permit to be issued from the time of application. An AIA must be undertaken in accordance with British Columbia Archaeological Impact Assessment Guidelines. The objectives of an AIA are typically to:

1. identify, record, and assess archaeological sites located within a project area through the implementation of both surface and subsurface inspection procedures;
2. identify and evaluate possible impacts by a proposed project to archaeological sites, if present; and
3. recommend appropriate impact management actions such as archaeological site avoidance through project re-design, implementation of archaeological site protection structures, or systematic data recovery through excavation programs.

Similar to the AOA, an AIA involves notification of relevant First Nations about the proposed activities which generally happens through a combination of the Archaeology Branch providing the HIP application to First Nations for review and comment, and the professional consulting archaeologist contacting First Nations to discuss the nature of the proposed activities and the AIA program. Information and concerns that the First Nations may have regarding the project area would be solicited. If identified during the review, First Nations permits would be applied for after discussion with the client. First Nations interest in participation in the AIA would be identified and discussed with the client prior to undertaking the AIA.

Conducting an AIA requires increased levels of effort, time and resource in comparison to an AOA. As such, it is generally recommended that such a program is initiated once project planning has proceeded to a stage where the extent of land-altering activities is known, but where AIA recommendations can be implemented with minimal project disruption.

At this time, it is not anticipated that an AIA will be required for the Program Plan, as it is expected that treatment locations will avoid disturbance to archaeological sites. However, future circumstances may warrant the undertaking of an AIA, such as if an area of archaeological potential becomes unavoidable or a new site is identified through the Chance Find Procedure (see below), thus this option will remain a recommendation of the customised archaeology plan for the Program Plan. Furthermore, given the timeline required for obtaining a HIP, it is recommended that a permit application be prepared and submitted to the Archaeology Branch, should the need to carry out permitted archaeological activities for the Program Plan arise.

Site Alteration

Should current or future land-altering activities pose a threat of disturbance to recorded archaeological sites, without the possibility of avoidance, application for a Section 12 Site Alteration Permit (S.12 SAP) issued by the Archaeology Branch would be required prior to land-altering activities.

Archaeological sites are protected by Section 13 of the HCA. Alterations to a documented site cannot take place without authorization of a S.12 SAP, at a minimum. Site alteration permits may involve concurrent archaeological work, such as monitoring, sampling, and/or data recovery, the details for which are addressed on a case by case basis. As with the AIA process, a SAP application is provided to the Archaeology Branch for processing and review, as well as First Nations review and comment, prior to issuance within an approximately 8 to 10 week period.

The Archaeology Branch may decide not to issue a SAP until an AIA under a HIP is conducted if the site boundaries are poorly defined or minimal information about the nature of the site is available. Such a decision is made on a case by case basis, taking into consideration the specific nature of the proposed activities and the archaeological site.

At this time, it is not anticipated that a SAP will be required for the Program Plan. However, as with the AIA recommendation, it has been included with the customised archaeology plan in the event that future circumstances may necessitate an application for a SAP.

Archaeological Monitoring

Archaeological monitoring consists of a qualified consulting archaeologist being present during any land-altering activities associated with a project, to provide archaeological direction to the workers carrying out the activities.

For example, for the Program Plan specifically, an archaeological monitor's tasks would be to evaluate the depth of snow cover along machinery travel routes, to double check "No Work Zone" flagging for recorded archaeological sites in the vicinity of Program Plan activities, and to direct machinery away from areas of archaeological potential, among others.

At this time, it is not anticipated that archaeological monitoring will be required for the Program Plan. However, some level of archaeological monitoring may be warranted if the AOA is not able to refine areas of archaeological potential within the Parker Range sufficiently for the objectives of the Program Plan.

Chance Find Procedure

Chance Find Procedures are developed for projects where there is deemed to be a very low likelihood of impacting archaeological sites, whether recorded or as-yet unrecorded. Chance Find Procedures are intended to promote the preservation and proper management of archaeological resources and the respectful handling of human remains, should they be encountered, while at the same time limiting disruption to project activities and schedule.

For the Program Plan, where land-altering activities are anticipated to be carried out during the winter months under frozen ground conditions, and with minimal likelihood of impacting archaeological sites as areas of archaeological potential will be avoided wherever possible, a Chance Find Procedure is recommended. This will be developed through discussion with the REMB and/or the Archaeology Branch, and will be included as a component of the HIP application.

APPENDIX E

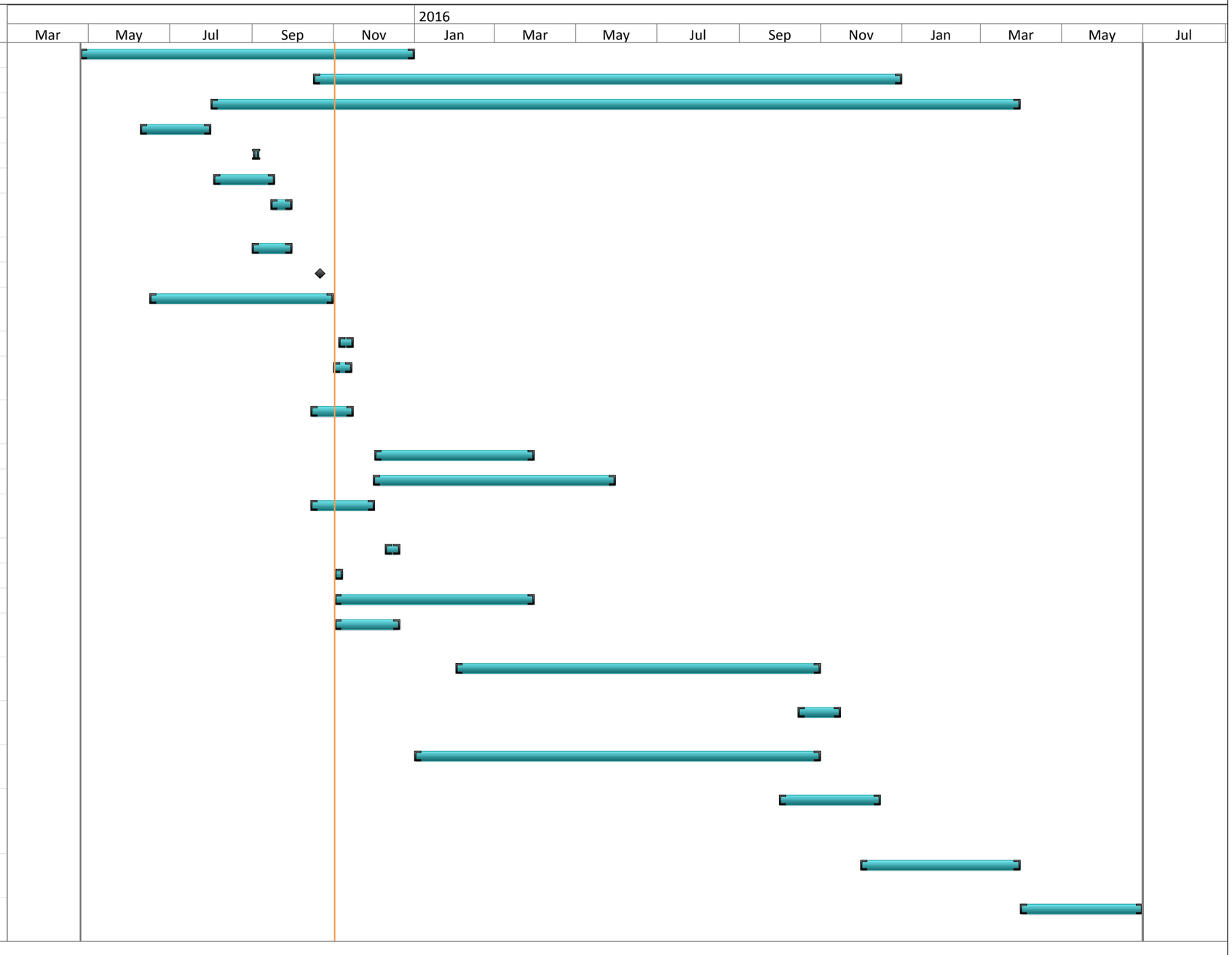
Parker Caribou Range Restoration Pilot Program Plan Schedule 2015-2017

Golder Associates

Parker Range Restoration Program Plan
2015-2017 Schedule

Last Updated: November 2, 2015
Project Number: 1529978

ID	Task Name	Start	Finish
1	BCIP-2016-04 Scope	Apr 25 '15	Dec 31 '15
2	BCIP-2016-16 Scope	Oct 17 '15	Dec 31 '16
3	Data Management (Orientis)	Aug 1 '15	Mar 30 '17
4	360 Vieworx & Data Acquisition	Jun 9 '15	Jul 31 '15
5	Field Reconnaissance	Sep 2 '15	Sep 5 '15
6	Linear Inventory Mapping Desktop	Aug 3 '15	Sep 17 '15
7	Linear Disturbance Inventory Mapping Finalization & Initial Reporting Results	Sep 15 '15	Sep 30 '15
8	Archaeological Desktop	Sep 1 '15	Sep 30 '15
9	Project Team Update Meeting	Oct 22 '15	
10	Development of Draft Habitat Restoration Pilot Program Plan Report	Jun 16 '15	Oct 31 '15
11	Project Team Update Meeting	Nov 5 '15	Nov 15 '15
12	Finalize Habitat Restoration Pilot Program Plan Final Report	Nov 1 '15	Nov 14 '15
13	Year 1: Seed, Seedling & Encapsuled Seed Puck Sourcing	Oct 15 '15	Nov 15 '15
14	FLNRO Authorization	Dec 2 '15	Mar 30 '16
15	Aboriginal Inclusion Plan	Dec 1 '15	May 30 '16
16	Development of Draft Year 1 Implementation Plan	Oct 15 '15	Dec 1 '15
17	Finalize Year 1 Implementation Plan	Dec 10 '15	Dec 20 '15
18	Nofity First Nations	Nov 2 '15	Nov 7 '15
19	Archaeological Overview Assessment	Nov 2 '15	Mar 30 '16
20	Preparation of Heritage Inspection Permit Application	Nov 2 '15	Dec 20 '15
21	Watercourse Crossing Assessments & Road/Pipeline Crossing Agreements	Feb 1 '16	Oct 31 '16
22	Year 2: Seed, Seedling & Encapsuled Seed Puck Sourcing	Oct 15 '16	Nov 15 '16
23	Development of Year 2 Implementation Plan & Securement of 2017 Authorizations	Jan 1 '16	Oct 31 '16
24	Year 1 Field Program Mobilization (Secure Constractors, Field Logistics, HSE Documents, etc)	Oct 1 '16	Dec 15 '16
25	Year 1 Field Program Implementation & Demobilization	Dec 1 '16	Mar 30 '17
26	Year 1 Field Implementation Workplan Reporting	Mar 31 '17	Jun 30 '17



Proposed Task Proposed Milestone ◆

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