Strategic Environmental Assessment

Alaska - Canada Rail Link
Biophysical Assessment - Canada

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June 2006;
Up-dated July 2006.

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1.1.1 Purpose, Objectives and Scope

The Alaska – Canada Rail Link (ACRL) traversing the environments of Yukon and northern British Columbia will cause significant social and biophysical changes. In concert with the economic viability of its performance, sustainability of the railway will largely be dictated by the degree to which the ACRL manages these changes. Since much of the Project concept remains to be developed, the following is an initial appraisal of the sustainability of the ACRL concept primarily from the perspective of what must be considered at this early strategic planning stage.

By its nature, sustainability assessment involves input from a wide range of disciplines addressing an equally wide array of issues. Sustainability of a project may be made evident by its comparative advantages compared to other options for achieving the desired societal goal. This entails a review of alternatives, including the “No Project” alternative. Such comprehensiveness is beyond the resources of the current Strategic Environmental Assessment (SEA). This reconnaissance level SEA of the biophysical components of the ACRL concept is the first step in an overall sustainability assessment.

The purpose of sustainability assessment is to identify how the Project must be developed to offer an enduring, integrated balance between its environmental/ecological, social, economic, cultural and human health benefits, opportunities and impacts. Its objective is to anticipate adverse effects of implementing the Project, with particular regard to uncertainties that, on reasonable and well-informed grounds, appear to pose significant adverse potential.

In a nearby jurisdiction, sustainable development has been defined as involving economic vitality, environmental integrity, social and cultural well-being, equity, and control over natural resources (Mackenzie Valley Environmental Impact Review Board). Since this section of the SEA analyses only the biophysical aspects of the ACRL, the following text addresses only the “environmental integrity” aspects, having placed these in the context of what would be necessary for full sustainability assessment.

Overall, the assessment process offers a foundation for a Project development policy, and the first opportunity to commence the process of enhancing potentially positive effects and preventing or mitigating negative effects. Sustainability assessment provides the foundation for sustainability reporting, wherein, as the project progresses, a set of criteria and measurable indicators of success are adopted and reported on in accordance with “best practice” verification tools, such as the Global Reporting Initiative’s Sustainability Reporting Guidelines.

1.1.2 Principles and Criteria for Assessment

In terms of its full scope, sustainability assessment analyzes a project “from cradle to grave”. The objective is to develop integrated project planning, design and implementation that minimizes or eliminates trade offs. The following are selected criteria with potential implications for the protection or management of the biophysical environment:

- Application of environmental, conservation and related land use policies designed to make the Project compatible with the existing landscape of Yukon and northern British Columbia to the extent possible.

- Integrated Decision Making and Planning, encouraging and facilitating decision making and planning processes that are efficient, timely, accountable and cross-sectored, and which incorporate an inter-generational perspective of future needs and consequences, and recognizing how the Project may lead to a forfeiting or retaining of certain identified opportunities.

- Waste Minimization and Substitution, wherein the Project:
  - encourages and promotes the development and use of substitutes for scarce resources where such substitutes are both environmentally sound and economically viable; and
  - reduces, re-uses, recycles and recovers its products.

- Efficient Use of Resources, wherein the Project:
  - encourages and facilitates development and application of systems for proper resource pricing, demand management and resource allocation together with incentives to encourage efficient use of resources;
  - employs full-cost accounting to provide better information for decision makers; and
  - has guidelines for environmentally-responsible purchasing, consisting of product and supplier attributes that should be considered in purchasing decisions, emphasizing the life cycle aspects of products and the four “Rs” of reduce, re-use, recycle and recover. Cost analysis is required to ensure the products and services are competitively priced and that the environmental benefits provided maintain overall performance expected.

- Research and Innovation, wherein the Project
  - encourages and assists the researching, development, application and sharing of knowledge and technologies which further biophysical integrity.

In addition, success in meeting the above criteria will depend on success in meeting the following procedural criteria:

- Public Participation, wherein the Project:
  - establishes forums which encourage and provide opportunity for consultation and meaningful participation in decision making processes;
  - endeavours to provide due process, prior notification and appropriate and timely redress for those adversely affected by decisions and actions; and
  - strives to achieve consensus amongst citizens with regard to decisions affecting them, and represents the conclusion of wide participation and shared vision.

- Access to Information, wherein the project:
  - provides accurate and current information at appropriate scales for planning and decision making;
  - encourages and facilitates the improvement and refinement of biophysical information; and

- promotes transparency and the opportunity for equal and timely access to information by all stakeholders.

At the time of writing the SEA, many aspects of the ACRL are unknown and remain to be developed, even at a conceptual level, and public consultation has not begun. It is therefore not possible, on the basis of the information available, to conclude on the sustainability of the project in the present document. However, it is possible, in the ecological context of Yukon and northern British Columbia, to identify and scope out some of the principal issues that will need to be addressed to contribute to the sustainability of this railway project.

For sustainability to be achieved the ACRL must manage the biophysical issues related to the phases of its development with a long term view to the future. This SEA assumes a 40 year operational life to the year 2055. Although abandonment of the Project would appear to be far into the future, sustainability assessment requires a view to the time when this may be the case, projecting a scenario for the time when the ACRL has outlived its economic life. The rationale for this view can take as a precedent the fate and current biophysical condition of the former BC Rail's Dease Lake Extension, now under consideration as part of this SEA, and abandoned in the early 1980's for a variety of mostly economic reasons.

Biophysically, the Project is viewed from the perspective of its influence on:

- maintenance of the ecological processes, biological diversity and life-support systems of the environment;
- harvesting of renewable resources on a sustainable yield basis;
- making wise and efficient use of renewable and non-renewable resources; and
- enhancing the long-term productive capability, quality and capacity of natural ecosystems.

1.2 Comparative Assessment of Sub-Corridors

1.2.1 Definition and Map of Sub-Corridors

The sub-corridors used in this comparative analysis connect significant settlements or political features (e.g., the Alaska Border), providing combinations of distinct alternative segments that the ACRL could follow. They are as follows, as illustrated in Figure 1:

- North of Beaver Creek to Carmacks via Ladue River
- Beaver Creek to Carmacks via Nisling River
- Beaver Creek to Whitehorse via the Alaska Highway
- Carmacks to Whitehorse
- Carmacks to Watson Lake
- Whitehorse to Skagway via Carcross
- Whitehorse to Watson Lake Via the Alaska Highway
- Watson Lake to Minaret via BCR Extension Rail Bed
- Eaglenest Creek to Hazelton
- Watson Lake to Mackenzie
- Watson Lake to Fort Nelson

As discussed internally in the first step of this study, the breadth of investigation by sub-corridor is 40 Km (20 km on either side of the currently proposed railway alignment), this being considered and agreed by the study team to be of reasonable magnitude to meet the strategic objectives of this study.

This biophysical section of the SEA takes two approaches for its comparative analysis:

a. Quantitative, using GIS and data supplied through the ACRL portal to determine comparable measurements that allow an objective distinction between sub-corridors; and

b. Qualitative, where the biophysical elements are not quantifiable, or where no data could be obtained within the time and resources available for the SEA.

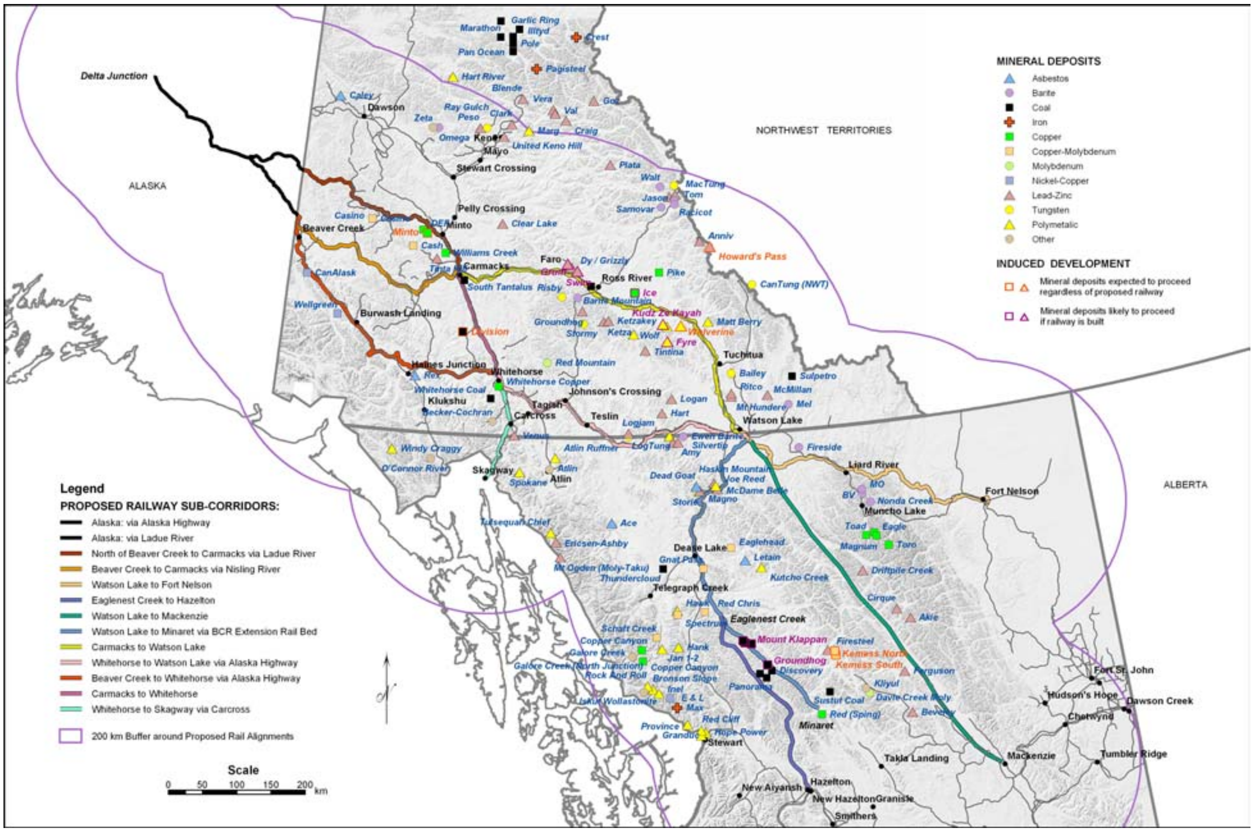

Figure 1. Proposed railway sub-corridors examined in this study.

1.2.2 Criteria for Use in Comparative Assessment

The criteria used for comparative assessment are deemed to represent a reasonable cross-section of the biophysical issues likely in need of management by the ACRL for which information exists and can be utilized for the purposes of SEA. They are as follows:

- Designated Ecologically Sensitive and/or Biodiverse Areas
- SARA-listed Species Involved
- Known Wildlife Ranges or Movement Corridors
- Land Use and Land Take
- Stream/River Crossings & Fisheries
- Lakeshores and Watercourses Paralleled
- Surface Disturbance
- Spill/ Derailment Potential Hazard
- Induced Development (Cumulative Effects) (potential rail-dependent projects facilitated within 200 km)

1.2.3 Data Used in Comparative Assessment

The first source of data utilised in the comparative assessment is that available from the Gartner Lee (GL) Portal. This data, preliminary engineering and construction estimates contained in spreadsheets, was used in assessing stream and river crossings, surface disturbance, and spill/derailment potential hazards. Of the eleven sub-corridors identified, however, this data was not available for four. No digitised mapping data could be downloaded from the Portal; on request, however, GL directly provided route alignment data. An image of a map of potential mining opportunities was also taken from the Portal. Neither the Portal nor GL could provide data dealing with other biophysical criteria, such as designated ecologically sensitive and/or biodiverse areas, SARA-listed species, forestry, fisheries, known wildlife ranges or movement corridors. Other public domain data sources were identified and proved useful for assessment purposes by these criteria. This process was constrained by the time frame of this study and resources available for data acquisition. In addition, qualitative inputs were drawn from team members' knowledge of the study area and are used to supplement the analysis.

2.0 RESULTS AND ANALYSIS

2.1 Biophysical Sustainability Assessment

2.1.1 A Railway Line Compared to Alternative Modes of Transportation

An Alaska-Canada Rail Link would create a new means of transporting goods between Yukon and central Alaska, the lower 48 U.S. states and the rest of Canada. Freight traffic into the region from the south currently arrives in the region via the Alaska Highway, via containers and trailers on vessels through the ports of Anchorage, Skagway, and Haines, and via rail barge service to the port of Whittier. Some of this existing traffic would almost certainly be captured by the ACRL, particularly the current rail barge traffic and a substantial fraction of any long-distance truck traffic utilizing the Alaska Highway. In addition, intermodal rail service might well displace vessels for the movement of some container and trailer traffic into interior Alaska destinations. Rail transportation is likely to be utilized as a substitute for other currently used modes only when it offers lower costs or superior service (Charles River Associates 2005).

Therefore, in terms of biophysical sustainability, the ACRL as the rail mode is comparable to the alternative modes of marine and trucking freight transportation. We use land and space use, greenhouse gas emissions, energy efficiency and fuel consumption as indicators of sustainability, where less of each is the desirable target.

2.1.1.1 Land (Space) Use

While marine transport by and large does not compete for land and space use, its shipping routes are often confined, especially in fjord coastline of British Columbia and Alaska. For large bulk carriers, this confinement can pose elevated risk of accidents, as evidenced by the Exxon Valdez. Marine transport requires extensive land-based port infrastructure. Roads are large consumers of land and space. Compared to marine and rail transport, accident risk is relatively high, but involves significantly less material. Railways occupy relatively narrow ribbons, with physical constraints linked to the types of locomotives used, the gradient, curvature, and load capacity. The biophysical effects are less pervasive than a road in terms of pollution, congestion, land use and infrastructure.

2.1.1.2 Climate Change Implications

In terms of the ways in which the Project could affect climate change through greenhouse gas (GHG) emissions, it is estimated that transportation activities account for 27 percent of Canada's GHG emissions and that, in a business-as-usual scenario, this will increase 50 percent by 2020. The additional length of railway added to the Canadian system will increase GHG emissions from rail proportionally. The net contribution will be determined by the amount of GHG reduction effected by taking trucks off the road, or taken from marine transport, added to the increased traffic generated by the economic activity.

Typically, 89 percent of GHG Emissions from railways originate from locomotives, with minor contributions from refrigeration, fire systems and power (Canadian Pacific Railway 2005). From a 13,800-mile rail network, CPR generated between 2,500,000 and 2,700,000 tonnes of CO_2 equivalent, and averaged between 15 and 20 CO_2 equivalent kg/1000 GTM. Although rail currently carries approximately 60 percent of surface goods by volume in Canada, its contribution to total GHG emissions is low at 4 percent. In its Options Paper, the Transportation Climate Change Task Force notes that GHG emissions associated with rail are less than 20 grams per tonne-kilometre, while that for trucking was more than 100 grams. Transport Canada (1999) compared them as follows:

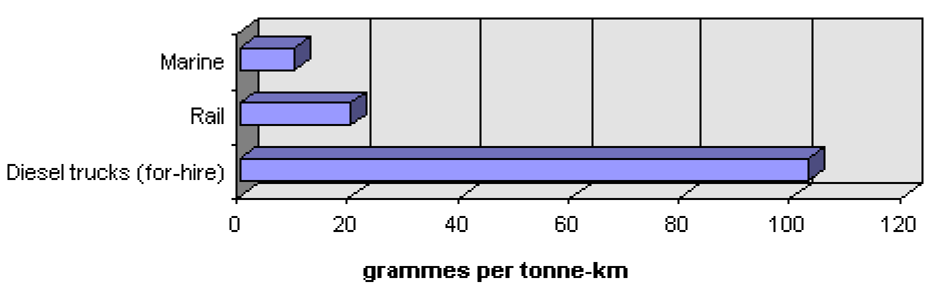

Figure 2. GHG freight emissions per tonne-kilometre by mode, 1997 (Transport Canada (1999).

Rail emissions are affected by a variety of factors: the age of the train, the type of fuel used, load capacity, maintenance of the engine and driving technique. Emission of smog-causing nitrogen oxides (NOX) are also a concern. Canadian railways have signed a memorandum of understanding with Environment Canada that provides for a maximum NOX emission of 115 kilotonnes per year. If railway traffic grows due to diversion from other more emission-intensive modes, such as road transport, the permissible emission limits might be increased.

In terms of the way in which climate change could affect the Project, the most prominent in current thinking is the deterioration of permafrost as temperatures increase with global warming, with resultant effects on rail bed integrity, the increase in number and extent of forest fires in Yukon and northern British Columbia and, related to the latter, changes in precipitation patterns that could affect slope slippage and vegetation patterns. An increase in forest fires and changes in vegetation patters could also alter wildlife corridors and ranges; moreover, these could have an effect on watersheds with a consequent effect on fisheries. These effects are discussed elsewhere in this SEA.

2.1.1.3 Energy Efficiency and Fuel Consumption

Marine transport is the most energy efficient; while, on average, large trucks (more than 14970 Kg) use 9.2 times as much energy as rail per tonne-kilometre. Intercity tractor-trailer trucks use five times as much energy per tonne-kilometre as rail (Railway Association of Canada 2001):

Mode	Fuel Consumption
Rail	455 ton-miles per gallon
Trucking	105 ton-miles per gallon

Source: Brown and Hatch (2002)

2.1.2 The ACRL In Its Overall Corridor

Infrastructure such as rail will provide opportunities for resource development that would otherwise not take place in Yukon, the key consideration being access to markets from remote northern sites. A major infrastructure project such as the ACRL therefore has the potential to influence an extended landscape beyond the immediate vicinity of its route (see below). Analysis of the overall corridor within which the ACRL would lie is therefore relevant to the SEA.

In Yukon and northern British Columbia, sub-corridor options exist for the ACRL to be introduced to a number of areas devoid of infrastructure and essentially all sustained human activity. Even where such infrastructure exists, many will hold that such areas would be considered “wilderness”. At the time writing, it is unknown whether the state of the environment in the overall corridor has been subject to any landscape monitoring to determine whether “wilderness values” are being maintained. Evidence is accumulating of the trend in northern Canada towards a changing landscape as the effects of climate change are felt. The rate of change is unknown, but is generally projected to be appreciable over the next four or five decades, within the life of an operating ACRL. It is beyond the resources of the current review to analyze the potential implications; however, a reasonable scenario for Yukon and northern British Columbia involves increased risk of forest fire, a reduction in permafrost layer, and alterations in precipitation and vegetation patterns, all with significant implications for a railway line.

A key consideration for the Project will be whether it selects a corridor with an existing road, thus mitigating the effects of creating access into an otherwise "wilderness" area. Even though such a choice is consistent with established environmental management practice for minimizing the biophysical impacts of linear developments, science-based risk analysis may reveal that the impacts of using a corridor without existing access are less than those with existing access. An example may be an ACRL option paralleling the Alaska Highway through Kluane National Park where, despite the presence of the Highway, the railway may place at risk a number of ecologically sensitive areas, thus suggesting a "wilderness" alternative as being preferable. This potential situation underscores the need for detailed biophysical information collection and analysis during the planning and design stage such that the comparative trade-offs can be appreciated in decision-making.

In terms of landscape permanence, common to all parts of the ACRL overall corridor is the risk of forest fire due to climate change. Presence of the operating ACRL will, due to increased access, exacerbate this risk. Permafrost will be commonly encountered by the ACRL, particularly in Yukon. Owing to the possibility of thawing and terrain movement, permafrost presents a potential railway integrity issue underscored by biophysical risk due to derailment. Therefore, special attention to rail bed structure design to maintain insulation of the permafrost layer will be necessary, coupled with assiduous inspection and maintenance during the operations phase. Further, alterations to precipitation patterns and vegetation patterns over the life of the rail line due to climate change, and consequent potential effects on fisheries, wildlife corridors and ranges, strongly suggest that final design parameters need to be sensitive to these effects, with the establishment of strong baseline data and information as management and mitigation measures during the construction and operation of the rail line should include significant resources to monitor and adjust to such changes. The relative reduction in emissions inherent in rail line transport goes to the cause of climate change. However, climate change is occurring at an accelerated rate in the project area; it is issues of climate change adaptation that the rail line will need to manage during its duration. Further, the rail line offers a focus for ongoing research and applied research activities on climate change adaptation.

Sustainability assessment requires that the life of the Project be considered along with the prospect of decommissioning and abandonment. Given the volumes of earth moving and positioning involved in its construction, the grade for a railway through mountainous areas such as those in Yukon and northern British Columbia will become a permanent, prominent feature of the landscape. Restoration of the landscape following the ACRL, if this were to be a desired objective of reclamation for abandonment, would be likely to cause as much disturbance as its original construction, and may negate any ecological adaptation that may have taken place. The grade is therefore likely to remain into the foreseeable future. However, the integrity of the grade in relation to maintenance and protection of biophysical environmental quality will be a continuing impact management task.

2.1.3 Relationship to Land Use Policy

To be sustainable, the ACRL will have to be developed in accordance with land use and other related policies and settlements guiding and supporting environmental integrity in Yukon and Northern British Columbia. While much discussion over land use in Yukon has taken place, and a regulatory system under the Territorial Lands Act exists, outside the national parks, adopted policies relating to environmental protection and major industrial and infrastructure development are embryonic, mostly arising from land claims settlement negotiations. Inside the national parks, which will affect a sub-corridor passing along the southwest shore of Kluane Lake through Kluane National park, National Parks Policy is relevant and will be applied.

Yukon First Nation Final Agreements have created Special Management Areas in order to "maintain important features of the Yukon's natural or cultural environment for the benefit of Yukon residents and all Canadians" (from Chapter 10 - Special Management Areas). SMAs include, among other things:

- National wildlife areas
- Territorial parks
- National parks and park reserves
- National historic sites
- Special Wildlife or Fish management areas
- Migratory bird sanctuaries or wildlife sanctuaries
- Designated heritage sites
- Watershed protection areas

The Umbrella Final Agreement also provides a process for the preparation of regional plans in Chapter 11 and for development assessment in Chapter 12. Only one regional land use plan has been completed in the Kluane area. The Yukon Environmental and Socio-economic Assessment Act and associated Regulations are also now in force. This SEA considers which issues will require more detailed examination to meet environmental assessment requirements.

Several "resource management plans" exist in northern British Columbia. These are primarily focussed on forestry operations, not transportation or other forms of land use In general. However, it is reasonable to expect that the values inherent in the plans will be applied to other sectors, such as a major transportation project like the ACRL. The plans state values and objectives, but do not prescribe specifics of how these should be met. In the areas through which current sub-corridors pass in northern British Columbia, the relevant plans providing guidance to biophysical protection and management are:

- Fort Nelson Land and Resource Management Plan
- Cassiar-Iskut-Stikine Resource Management Plan
- Mackenzie Resource Management Plan
- Fort St. James Resource Management Plan
- Kispiox Resource Management Plan
- Dease-Liard Sustainable Resource Management Plan

Resource management plans for Atlin-Taku and Nass are planned for the future.

The resource management plans address any one or several different resource values in a plan area: forestry, biodiversity, water, recreation, and others. In most cases, a plan addresses the highest priority issues, and other "chapters" will be integrated into the plan in the future. Management direction in a plan area is driven by the values of the area. These include: wildlife (particularly caribou, grizzly bear, moose, fur-bearers and mountain ungulates), biodiversity, visual quality, cultural heritage, timber, water quality, tourism and recreation. The plans explain the condition of the resource values (such as wildlife, cultural, etc.), and describe some of the strategies that can be used to meet the plan objectives.

In some plans, such as the Fort Nelson Land and Resource Management Plan, transportation and utility corridors are identified, specifying that the maintenance and utilization of existing corridors and sites is desired whenever possible for future developments, and explicitly referring to scenarios for deactivation (or, abandonment):

> "Any corridor infrastructure or expansion needs will be coordinated with other users through a coordinated access management planning or other appropriate referral process. All maintenance and upgrading of corridors and sites will take place with sensitivity to the other values identified for the area. Planning for transportation and utility corridors will include deactivation, where it is appropriate (e.g. corridor or site no longer required). The deactivation plans will require that all affected agencies and stakeholders be contacted." (FNLRMP)

2.1.4 Potential for Induced Activities and Cumulative Effects

While the ACRL may induce a number of development activities, mining is considered the most likely activity to be stimulated, probably involving spur lines to the ACRL. This brief review of the potential for cumulative effects emphasizes mining potential. Much of the following text uses Charles River Associates Incorporated (2005) as its information source.

Over the next several decades, 34 mining projects, including hard rock and coal, have significant potential to come into existence in Yukon. Twenty-seven of these lie within a 100 km-wide corridor centred on one of the potential sub-corridors through Yukon. Twenty of the most promising are listed in Table 1.

Table 1. Potential Mining Projects in Yukon Stimulated by the Presence of the ACRL

Mining Property	Location	Mineral Resource
Crest	350 kilometres northeast of Elsa	Iron ore
Casino	300 km northwest of Whitehorse	Copper-Lead-Zinc-Gold-Silver
Clear lake	70 km east of Pelly Crossing	Copper-Lead-Zinc-Gold-Silver
Dublin Gulch	North of Mayo	Copper-Lead-Zinc-Gold-Silver
Fyre Lake	160 km northwest of Watson Lake	Copper-Lead-Zinc-Gold-Silver
Ice	60 km east of the Ross River	Copper-Lead-Zinc-Gold-Silver
Wolverine	130 air kilometres southeast of the Ross River	Copper-Lead-Zinc-Gold-Silver
Howard's Pass	55 km northwest of CanTung	Copper-Lead-Zinc-Gold-Silver
Jason	13 km from the MacMillan Pass	Copper-Lead-Zinc-Gold-Silver
Kudz Ze Kayah	110 air km southeast of Ross River	Copper-Lead-Zinc-Gold-Silver
Logan	110 kilometres northwest of Watson Lake	Copper-Lead-Zinc-Gold-Silver
Marg	42 km northeast of Keno City.	Copper-Lead-Zinc-Gold-Silver
Tom	13 km southeast of Macmillan Pass.	Copper-Lead-Zinc-Gold-Silver
Wellgreen	125 km northwest of Haines Junction	Copper-Lead-Zinc-Gold-Silver
Mount Skukum/ Skukum Creek/Goddell	80 kilometres southwest of Whitehorse	Gold/silver
Bonnet Plume	North-east of Dawson City, north-central Yukon.	Coal
Division Mountain	90 km south of Carmacks	Coal
Whitehorse/Rock River	25 km southwest of Whitehorse	Coal
MacTung	250 km northeast of the Ross River	Tungsten
Red Mountain	80 km northeast of Whitehorse.	Molybdenum

Source: Charles River Associates Incorporated (2005)

Others in Yukon and northern British Columbia include:

- Carmacks Copper project, located 28 kilometres northwest of Carmacks and 193 kilometres north of Whitehorse
- The Ketza gold property, situated 50 kilometres south of the Ross River
- Minto copper-silver-gold project 240 kilometres northwest of Whitehorse
- Yukon Zinc Corporation has applied for licenses and are currently pursuing opportunities to develop properties in the Finlayson District in south-eastern Yukon, an area of fairly intensive activity over the last few years
- Tulsequah Chief copper-lead-zinc-gold-silver project, lying 100 kilometres south of Atlin, British Columbia

Development of new mines encouraged by the completed ACRL will place a strain on existing power infrastructure. Besides mining, the Division Mountain coal prospect, with its close proximity to the Alaska Highway, may be an ideal site for a “mine-mouth” coal plant with production potential of 200 megawatts per day. The close proximity of the Crest deposit to the extensive Bonnet Plume coal prospect is an illustration of the potential for synergy in the co-development of energy and mineral resources in the Yukon. Related to energy generation, the Yukon’s current transmission system can only support limited mineral development. Large mining operations in the Tintina Trench region will likely require the upgrading of both the 69 KV transmission line from Mayo to Dawson as well as the Whitehorse grid system. The ACRL right-of-way is described by Charles River Associates Incorporated (2005) as being “a natural corridor for potential shared use by both pipelines and electrical transmission lines”, and “improved infrastructure will encourage development of the Yukon’s petroleum resources”.

More recent work by Yukon Economic Development, and further detailed in ACRL SEA economic studies, has identified specific mineral developments that would go forward with or without a rail link (but likely would use the link to transport product, replacing currently planned trucking) and mineral developments most likely to proceed if a rail link were constructed. These are listed in Table 2.

Table 2. Current and Projected Mineral Development, Rail Assisted or Dependent

Mining Property, Rail Assisted	**Location**	**Mineral Resource**
Division Mountain	Yukon, 90 km (55 miles) south of Carmacks	Coal
Minto	Yukon, 80 km (50 miles) west of Carmacks	Copper
Wolverine	Yukon, 200km (125 miles) northwest of Watson Lake	Copper-Zinc-Lead
Howard’s Pass	Yukon, on Yukon/NWT border between Cantung and Mactung	Lead-Zinc
Kerness North and Kerness South	B.C., currently in operation between Hazelton and Dease Lake, 430 km (250 miles) northwest of Prince George	Copper-Gold
Mining Property, Rail Dependent		
Fyre	Yukon, between Frances Lake and Ross River	Copper

Kudz Ze Kaya	Yukon, 200km (125 miles) northwest of Watson Lake	Lead-Zinc-Copper
Grum	Yukon, near Faro	Lead-Zinc
Ice	Yukon, 65 km (40 miles) east of Ross River	Copper
Swim	Yukon, close to Faro	Lead-Zinc
Lost Fox, Hobbit Boatch, Summit	B.C., Klappen fields	Coal
Ground Hog Coalfield	B.C., south of Klappen fields	Coal

The biophysical impacts of the rail dependent developments, should they be realized, will extend the influence of the ACRL well beyond the rail line right-of-way, and should be considered in detail as part of later stages of environmental impact assessment. Further, the impacts of rail assisted mines, to the extent of assistance, should also be considered in detail. Note that rail assisted mines, should they shift from planned trucking of materials in and product out on a spur line arrangement with the ACRL, would suggest a net environmental benefit to the ACRL due to the reduced ecological footprint, a function of reduced emissions and a narrower bed. Rail dependent developments add their bio-physical effects in a cumulative manner to the ACRL.

2.1.5 The ACRL as A Sustainable Railway

To be sustainable in biophysical environmental terms, the ACRL will need to consider a variety of issues, design criteria and actions that seek to attain the goal. Since it will be introduced to a landscape largely devoid of equivalent infrastructure, and, by virtue of its presence, may induce significant other activity, the full extent of the development potential and its impacts must be envisaged. As the Project moves from concept to realization it will involve a series of decision stages, corresponding to standard Project development. It is important to note that resolution of issues relating to biophysical impacts is critically dependent on acceptance of preferred alternatives, reasonably presented, through public consultation and negotiation.

At the Project Concept stage, sustainability features are best considered as part of the pre-feasibility and feasibility study. Typically, these might be concerned with the fundamental operating concept, in the same way that economic and social considerations affect the method of taking the concept to a blueprint. Much remains to be developed in terms of an ACRL design and operational strategy. In relation to Planning and Design, Construction, Operation and Abandonment stages, Table 3 lists actions to be considered in developing the strategy towards the biophysical sustainability of the ACRL. For this SEA, in the text below we list examples that are most relevant during analysis of the Project Concept, and best considered at the Pre-Feasibility and Feasibility Stages:

- Selection of single or double track options in relation to minimizing the overall land use footprint of the Project.
- Width of the right-of-way in relation to minimization of clearing and grading and related effects on habitat.
- Length of trains in relation to stopping capability in mountainous terrain, and potential for derailment and spillage.
- Evaluation of alternative scenarios for train frequency, length and weight in relation to the need for deeper ballast and borrow pits, thus causing greater terrain disturbance.

- Size of locomotives and cars and their weight in relation to the need for different bridge and culvert structures affecting hydrology and fisheries.
- Design grade, wherein the lower the grade, the greater the need for cut and fill to achieve it, thus increasing the terrain footprint of the railway, and potentially lengthening culverts with attendant impacts on fish passage.
- Operating (design) speed, wherein faster speed requires less curvature, in turn requiring greater potential topographical conflict and surface disturbance in areas of high relief, and raising the potential for wildlife collisions.
- Maximum curvature (radius), wherein the lower the maximum radius, the more likely the terrain impact, but the lower the risk of derailment and risk of spillage.
- Deciding whether access for construction will be along the right-of-way, or whether subsidiary access will be necessary, proceeding on the principle that minimizing access requirements will reduce impacts, particularly on fish and wildlife populations and their habitat.
- Readiness to implement a “no net loss” policy with regard to fish and wildlife habitat, and compensate in kind for residual impacts, particularly at watercourse crossings for fish habitat, and for wildlife habitat in valley bottom situations where rail grade is achieved most easily, and where habitats may be fragmented and habitat effectiveness may be compromised.
- Readiness to incorporate climate change adaptation considerations in final design, construction and operation phases of the project.

Table 3. Actions To Be Considered In Developing a Strategy Towards the Biophysical Sustainability of the ACRL

STAGES AND COMPONENTS OF PROJECT DEVELOPMENT	PRIMARY BIOPHYSICAL ELEMENTS AT RISK IN YUKON AND NORTHERN BRITISH COLUMBIA AND SUSTAINABILITY ACTIONS			
	Air	Water & Fish	Land	Terrestrial Biota
PLANNING AND DESIGN STAGE				
Projected time frame for completion of the Phase, including licenses and permits	Accommodate full public consultation and reasonable adaptation	Accommodate full public consultation and reasonable adaptation	Accommodate full public consultation and reasonable adaptation	Accommodate full public consultation and reasonable adaptation
Selection of siding (double track) locations			Minimizing the overall land use footprint	
Emergency response capability and time necessary in the event of an emergency caused by remote spillage or fire		Minimize effects on aquatic ecosystems	Reduce effects of forest fires, vegetation and soil remediation plan	Spill clean-up and contingency plan
Recognition of wetland values and related surface and sub-surface drainage maintenance, aquatic and wildlife habitat		Avoid wetlands to the extent possible. Adaptation to climate change	Adaptation to climate change	Avoid wetlands to the extent possible; adaptation to climate change
Permafrost, and its potential effects on the rail grade, and the effects of the rail grade on permafrost		Avoidance of permafrost, or use of special construction techniques to reduce the risk of subsidence and rail bed failure resulting in derailment, especially in light of probable climate change effects on permafrost	Avoidance of permafrost to reduce the potential for sub-surface temperature change, and/or use of insulating rock structure in rail bed construction, completion of adequate geotechnical testing.	
Sub-grade depth and width, and side-slope angle			Set side slope angles according to the local climate, soil depth, and vegetation. Adaptation to climate change	Design to accommodate wildlife crossing and minimize risk of collisions. adaptation to climate change
Seismic activity and the rail bed		Select a route that minimizes potential exposure to seismic activity affecting rail bed integrity and related risk of derailment and spillage	Apply seismic zone best practices	
Geotechnical stability		Avoid areas of potential slope and landscape instability where terrain disturbance could increase erosion, create potential for slumping and rail bed failure, and risk of spills	Avoid areas of potential slope and landscape instability where terrain disturbance could increase erosion and create potential for slumping	
Terminal (port) facilities	Recognition of the need to upgrade or expand, with attendant need for biophysical planning and management	Recognition of the need to upgrade or expand, with attendant need for biophysical planning and management	Recognition of the need to upgrade or expand, with attendant need for biophysical planning and management	Recognition of the need to upgrade or expand, with attendant need for biophysical planning and management

STAGES AND COMPONENTS OF PROJECT DEVELOPMENT	PRIMARY BIOPHYSICAL ELEMENTS AT RISK IN YUKON AND NORTHERN BRITISH COLUMBIA AND SUSTAINABILITY ACTIONS			
	Air	**Water & Fish**	**Land**	**Terrestrial Biota**
Avalanches, slides, slumping, rock falls, and stream debris accumulation		Design measures not only to minimize effects on the railway, but also to minimize the biophysical risks posed by these events. Adaptation to climate change.	Analyse during aerial reconnaissance surveys and geotechnical investigations. Adaptation to climate change.	Adaptation to climate change.
Soil		Establish construction guidelines for work near water	Avoid areas of erodible soils, and recognize the need for conservation and use in reclamation	
Sand, ballast, and rip rap		Ensure that acid generating rock is not used for ballast or rip rap	Avoid sandy areas, and find a suitable ballast and construction substitute	Avoid sandy areas which in northern areas may harbour rare or unusual ecosystems in the overall corridor, requiring special attention to biodiversity protection
Locations and Number of Borrow Sites, Work Camps, Storage and Equipment Sites		Locate away from water bodies where practical, select sites and adopt technologies to minimize footprint, direct and indirect impacts	Select sites and adopt technologies to minimize footprint, direct and indirect impacts	Select sites and adopt technologies to minimize footprint, direct and indirect impacts
Access roads		Minimise number of water body crossings	Minimize width, and therefore footprint, by providing turnouts	Select routes to minimize habitat fragmentation and access to wildlife range
Watercourse crossing structures		Commitment to high design standards, allowing for at least 1:100 year flood based on hydrological data review, maintenance and facilitation of fish passage, and "no net loss" of habitat		
Cross-drainage and parallel ditches		Design rail bed to minimize potential impediment of surface and sub-surface water movement, and evaluate potential effects of ditches		
Wildlife				Assess the potential barrier and habitat fragmentation effects of the railway (including fencing need) on populations and habitat use, and adopt special route selection, design and operational measures to avoid or minimize collisions and other impacts, and "no net loss" of habitat. Adaptation to climate change (corridor and range alterations. .

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STAGES AND COMPONENTS OF PROJECT DEVELOPMENT	PRIMARY BIOPHYSICAL ELEMENTS AT RISK IN YUKON AND NORTHERN BRITISH COLUMBIA AND SUSTAINABILITY ACTIONS			
	Air	**Water & Fish**	**Land**	**Terrestrial Biota**
Bedrock blasting	Minimize noise and dust effects	Take special measures or avoid instream or in-lake blasting and effects on fish		Take special measures or avoid blasting in areas or seasons where sensitive wildlife is present
CONSTRUCTION STAGE				
Parallel water bodies		Adopt setback standards from the ordinary high water mark of water bodies to the extent possible, and minimize stream channelization to protect existing fish habitat	Adopt setback standards from water bodies to the extent possible, and minimize stream channelization to minimize erosion	
Culverts		Positioning to assure high water run-off volume will not prevent upstream fish passage	Positioning to assure high water run-off volume will not scour the downstream end, causing erosion	
Access roads		Minimise instream construction	Removal and restoration on completion	Removal and restoration on completion
Construction - general			Use renewable or recycled materials where feasible. Minimize waste materials generation	
OPERATION AND MAINTENANCE STAGE				
Increased fire hazard resulting from ACRL operation			Emergency response capability. Adaptation to climate change.	
Inspection and surveillance		Although in wilderness areas, commitment to standards equivalent to those adopted in populated areas	Although in wilderness areas, commitment to standards equivalent to those adopted in populated areas	
Gaseous and Particulate Emissions	Set caps according to locomotive emissions monitoring program for NO_{x}, CO, particulates, SO_{2}. Maintain locomotive fleet, reduce idling times, review and upgrade operations and infrastructure to address reductions in emissions			
Fugitive dust at the loading points, along the track, and at the unloading terminals	Adopt reduction techniques depending on the nature of commodities carried	Adopt reduction techniques depending on the nature of commodities carried		
Fuelling stations		Select sites to minimize potential contact with water bodies and risks of ecological effects of spills	Spill contingency plan	
Water and wastewater use, production and drainage		Reduce volumes necessary for use, re-use and recycle wastes.		

STAGES AND COMPONENTS OF PROJECT DEVELOPMENT	PRIMARY BIOPHYSICAL ELEMENTS AT RISK IN YUKON AND NORTHERN BRITISH COLUMBIA AND SUSTAINABILITY ACTIONS			
	Air	Water & Fish	Land	Terrestrial Biota
		Implement storm water management plans and devices		
Chemical and Waste Management (including hazardous liquid and solid wastes)		Develop management and emergency response plans		
Vibration			Implement vibration reduction measures in sensitive areas	
Noise			Select routes and noise attenuating devices and technologies, and adopt operating regimes so as to avoid conflict with land users and to maintain value of land and property	
Cleaning rail cars at terminals		Ensure adequate water quantity, avoid sensitive draw-down locations, contain and recycle run-off		
Reclamation of disturbed sites			Selection of appropriate seed mixes for wilderness areas	Selection of appropriate seed mixes for wilderness areas
Right-of-way management		Appropriate, permitted mechanical and chemical control of vegetation. Combine brush cutting, mowing, herbicides, biological control and computerized "weedseeker" technology, targeting noxious weeds growing on the ballast section of the track, sparing the need to spray the entire track. Identify sensitive areas, including domestic wells and pesticide-free zones, along the right-of- way, where restrictions in the use of herbicides are used.		Appropriate, permitted mechanical and chemical control of vegetation. Combine brush cutting, mowing, herbicides, biological control and computerized "weedseeker" technology, targeting noxious weeds growing on the ballast section of the track, sparing the need to spray the entire track. Identify sensitive areas, including domestic wells and pesticide-free zones, along the right-of- way, where restrictions in the use of herbicides are used.
Surveillance and monitoring	Monitoring programs to measure changes in indicators of quality, and take appropriate action.	Monitoring programs to measure changes in indicators of quality, including adaptation to climate change, and take appropriate action. Ensure that failures are detected in advance of accidents that could threaten aquatic resources	Monitoring programs to measure changes in indicators of quality, including adaptation to climate change, and take appropriate action. Ensure that failures are detected in advance of accidents that could threaten terrestrial resources. Avalanche control program.	Monitoring programs to measure changes in indicators of quality, including adaptation to climate change, and take appropriate action, especially relating to wildlife collisions
Access along the right-of-way (track and				Restrict and control to prevent

STAGES AND COMPONENTS OF PROJECT DEVELOPMENT	PRIMARY BIOPHYSICAL ELEMENTS AT RISK IN YUKON AND NORTHERN BRITISH COLUMBIA AND SUSTAINABILITY ACTIONS			
	Air	Water & Fish	Land	Terrestrial Biota
service road)				potential access to wildlife populations and habitat
Culverts		Blockage by beaver activity, leading to blockage of fish passage	Blockage by beaver activity, leading to washouts and track-bed failure	
ABANDONMENT STAGE				
	Conceptualization of abandonment scenarios and commitment to long-term biophysical impact management	Conceptualization of abandonment scenarios and commitment to long-term biophysical impact management	Conceptualization of abandonment scenarios and commitment to long-term biophysical impact management	Conceptualization of abandonment scenarios and commitment to long-term biophysical impact management

2.2 Preliminary Qualitative Description of Biophysical Risks

The following is an overview of the issues and potential areas of concern from a biophysical perspective of each possible rail line segment in the Yukon and British Columbia. At a SEA level, this includes a scoping component and an initial risk assessment of the types of impacts that might occur and the factors that should be considered at the detailed assessment stage. Biophysical impacts of linear corridors have both a temporal and spatial context. They may also be direct, indirect and induced and/or cumulative such as habitat fragmentation.

A linear project of this scale and length will have multiple biophysical consequences. Some can be anticipated and planned for while others especially induced and cumulative impacts may emerge over time and require changes in operational thinking and approach. For example, moose mortality on the Alaska Railroad during the winter emerged as a significant concern and in recent years resulted in changes in operational snow clearing practices to ensure moose were not trapped between high snow banks with no escape options. Companies such as the Canadian Pacific Railway (CPR) have developed new right-of-way ROWmaintenance practices and equipment to deal with grain spillage that was attracting wildlife to the tracks.

The scope of this analysis is limited by the time and budget available and relies heavily on the information collected by Gartner Lee Ltd and conceptual engineering work completed by UMA Group Ltd. (UMA) in regard to route alignment and construction parameters. Public domain biophysical data was also obtained. In a number of instances, the biophysical information needed for a comprehensive assessment may already exist but was not accessible to the study team within the timeframe available. This includes information within government and company files from previous studies such as the extensive work done for the Alaska Highway Foothills Pipeline in the 1970's.

A word of caution is also in order. At the SEA level, the focus is on potential biophysical effects within a 40 km wide corridor (20 km each side of the track centre line) rather than just the immediate 30-50m of ROW likely to be directly occupied by the rail bed as shown on the maps provided. UMA identified the rail routing on NTS 1:50,000 scale maps while the information sources available for this overview are in many cases at a substantially broader scale. Similarly, the alignments proposed by UMA focus on the core engineering concerns of grade, curvature cut and fill balance, etc. and do not necessarily consider the other biophysical values that may effect the final construction or operating cost.

The objective then of this qualitative assessment is to flag those biophysical values and related concerns that will need to be addressed in the detailed planning and environmental assessment as this project moves forward to the next stage of development.

Rail lines by nature tend to follow valley floors wherever possible. As such the likelihood of biophysical conflicts arising is an inevitable consequence since these lands are generally more productive both for wildlife and humans. Similarly, multiple stream and river crossings can be anticipated and the rail line will inevitably parallel watercourses over considerable distances because the grades in these areas are notably lower and topography more consistent.

2.2.1 North of Beaver Creek to Carmacks Via Ladue River

This alignment at 359 km (223 miles) meets the Alaska rail system at the Ladue River (Figure 3). Identified qualitative biophysical risks are summarised in Table 3. The most northern route, it would pass by two advanced mining projects (Minto and Casino) located on the west side of the Yukon River. From Carmacks the proposed alignment follows the east bank of the Yukon River parallel to the existing Klondike River before crossing the Yukon River just south of Minto Landing. A combined road/rail bridge at this point would benefit both proposed mine projects.

The most notable concerns with UMA's proposed east side alignment between Carmacks and Minto Landing would be the proximity of the alignment to the Yukon River and the terrain in the vicinity of Tatchun Creek/Five Finger Rapids. Both the Yukon River and Tatchun Creek are important salmon habitat while the Frenchmen Lakes corridor is an identified large mammal wildlife movement corridor.

There are likely to be a number of public concerns because the Yukon River and Klondike Highway are key tourism travel corridors and large segments of the rail line will be visible from both the highway and the river. Similarly, any significant cuts and fills will stand out.

The Five Fingers Rapids area includes a territorial recreation site overlooking this prominent landmark and a campground at the mouth of Tatchun Creek, a traditional First Nation fishing and camping spot.

Depending on the routing south from Carmacks, a Tintina Trench routing bypassing Carmacks using the Frenchmen Lakes road could bypass the Five Finger Rapids/Tatchun Creek area of concern.

A west bank routing along the Yukon River paralleling the access road to the Minto mining property, would still involve a Yukon River crossing in the vicinity of Carmacks, but would allow the rail line to be set back further from the river in most instances.

Yukon Environment biologists suggest that there is anecdotal evidence that suggests wildlife populations along the Yukon River have not recovered from over-hunting during the Gold Rush. There are no particular terrain or wildlife habitat issues along this section of the Yukon River north from Minto until the alignment crosses the White River and proceeds up the Ladue River to the Alaska border. In this area the rail line begins to encroach on the southern edge of the Forty Mile caribou herd. Biologists have been concerned with natural mortality rates in this herd for a number of years and are currently completing the third season of an innovative herd management intervention plan that focuses on reducing mortality during calving.

General biological knowledge of this corridor is greater along the Yukon River rather than the significantly smaller Ladue River. That said, the quality, currency and adequacy of available information (and scale of mapped data) for detailed alignment routing and environmental assessment purposes is suspect.

The preliminary route analysis by UMA suggests the seismic and natural disaster hazard risks are both moderate for this segment of the rail corridor.

Yukon Energy (YEC) is currently considering extending the electrical grid north from Carmacks to Stewart Crossing. The extension would also service the Minto and Casino mine properties.

This line would follow the Klondike Highway and eventually be extended to Pelly Crossing and Stewart Crossing.

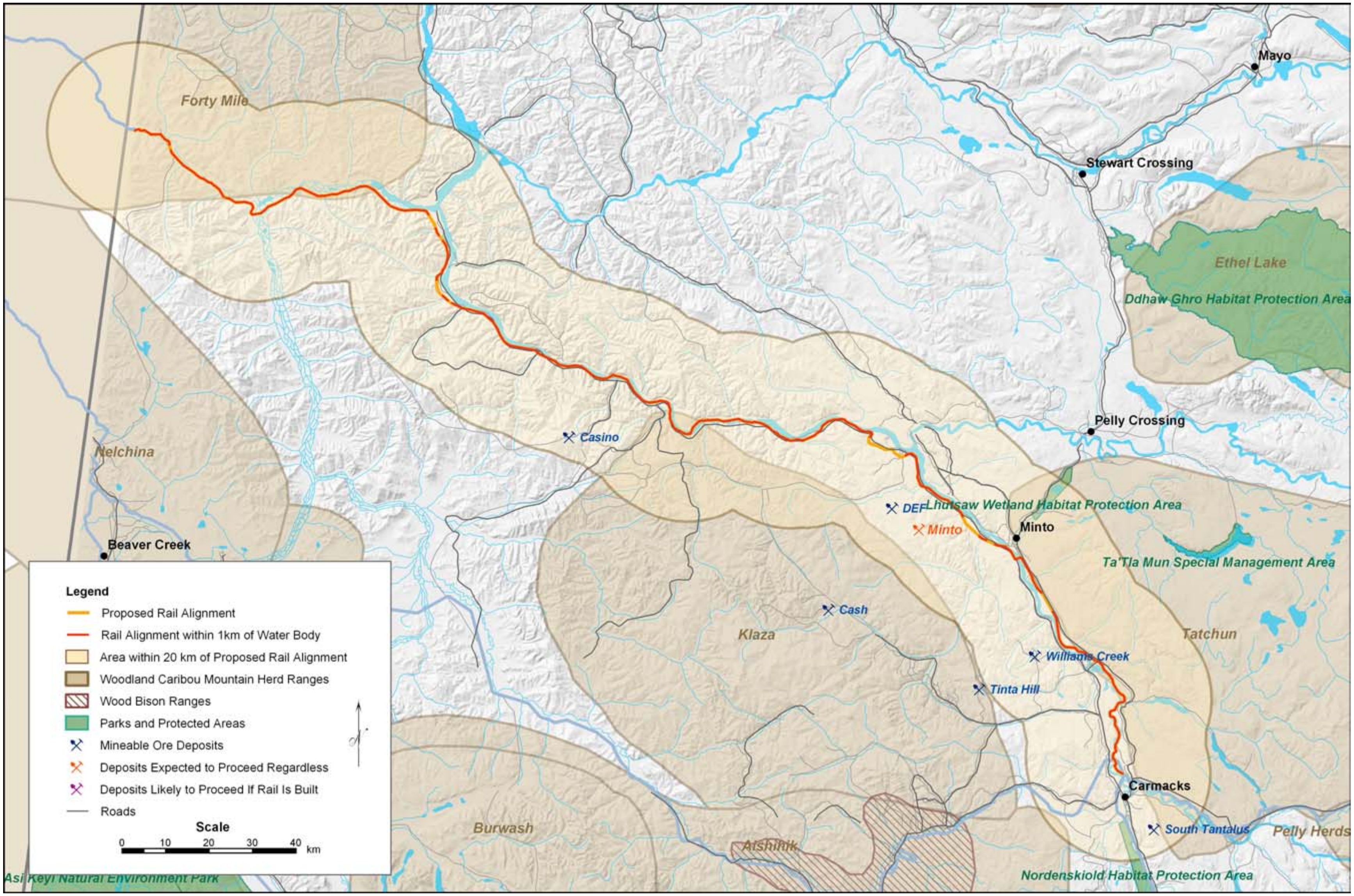

Figure 3. Map of the North of Beaver Creek to Carmacks via Ladue River sub-corridor.

Table 4. Summary of Qualitative Biophysical Risks for North of Beaver Creek to Carmacks via Ladue River.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Nordenskiold Habitat Protection Area, Lhutsaw Wetland Habitat Protection Area	Peregrine Falcon (*anatum* subspecies), Woodland Caribou (northern mountain population	Lower White River, Frenchman Lakes, and Yukon River corridors	Recreation site at Five Finger Rapids, territorial campground at Tatchun Creek, Ft. Selkirk historic site, Yukon River and Klondike Highway are key tourism routes, potential conflict with proposed transmission line from Carmacks to Stewart Crossing	Crossings of Tatchun, Yukon, Selwyn, and White Rivers, crossings of 15 creeks and 119 tributaries, known salmon habitat	No Data	Approximately half of the route requires heavy or very heavy construction, construction on organics required and erosion protection	Approximately 1/3 of the route is curves, average gradient low, seismic and natural disaster risk ranking moderate	Mining, limited agriculture in Yukon River corridor

2.2.2 Beaver Creek to Carmacks Via Nisling River

This route is 16 km longer than the Ladue River route at 375 km (233 miles)(Figure 4). Identified qualitative biophysical risks are summarised in Table 5. Whether the line runs north from Whitehorse or comes from the east along the Campbell Highway there are multiple terrain conflicts in the Carmacks area. The routing around Carmacks for the Watson Lake to Carmacks (Tintina Trench route) follows the north shore of the Yukon River adjacent to the Campbell Highway crossing the Klondike Highway and Yukon River near the foot of Tantalus Butte. Aside from private and First Nation land encroachments and the highway intersection conflict, Tantalus Butte is the site of a former coalmine, which has known subsidence problems partly due to still smouldering underground coal fires. Active riverbank erosion will require substantial riprap protection on all Yukon River meanders. It will also be difficult to achieve a suitable road grade to a height that will eliminate the road conflicts and not encroach on private property.

The degree to which some of the terrain issues can be moderated depends on whether the track heads south to Whitehorse or east along the Campbell Highway. The challenge is maintaining grade up Rowlinson Creek and the Mt. Nansen Road across the height of land to the upper Nisling River drainage. Large cuts and fills as well as a requirement for a 13.5 km (8.4 mile) tunnel illustrate the difficulties to be encountered. There are also permafrost and wildlife concerns in this area.

The Stevens Lake/Upper Nisling River valley is part of the range of a re-introduced wood bison herd while the central and lower portions of the Nisling River to the confluence of the Donjek River are considered important moose habitat. The Nisling River was identified in 1994 as a potential candidate area for special management because it connects two key areas of interest, the Wellesley Lake basin and Aishihik Uplands. It is a relatively inaccessible river valley and the ecosystem is less disturbed. As a result has received minimal scientific study.

The Nisling River is also the transitional point between the glaciated Ruby Range to the west and un-glaciated Dawson Range to the north. In similar situations, when these types of areas are systematically scientifically studied, flora and avifauna range extensions are often found along with other unique landscape features consistent with a relatively undisturbed ecosystem.

The alignment through the Wellesley basin and around the lake itself is also of concern. The lake itself is known for its trophy fishing and the basin is part of the Chisana and Nelchina caribou herd ranges. Migratory waterfowl make extensive use of the numerous wetlands and pothole lakes in the basin and up Scottie Creek.

Permafrost will be extensive throughout this area from the Donjek River north to the border given the route currently identified. While route adjustments are possible to reduce the total amount of permafrost and organic soils to be expected, it will still be significant especially as such ice rich areas contain other values such as ideal migratory waterfowl habitat.

The Donjek and White river outwash plains are subject to extensive seasonal flooding with the Donjek and lower Nisling being important fish habitat whereas the White has limited productivity because of the greater silt loading.

While crossing these rivers will require channel modification, they are also a good source of aggregate for rail bed construction. The Government of Yukon has had some success in exploiting these gravel source opportunities during reconstruction of the Alaska Highway while restoring and upgrading fish habitat after construction completion.

Extreme winter temperatures are common in the Wellesley Basin to Beaver Creek area with the coldest temperature recorded in the Yukon at Snag.

The biophysical information for significant sections of this alignment is poor especially in the Nisling River valley. Information relative to the construction conditions likely to be encountered by a railway improves north of White River to the Alaska border particularly along the alignment of the Alaska Highway and Foothills Pipeline corridor. This section of the Alaska Highway was rebuilt over the past decade and despite best efforts permafrost degradation remains a significant problem limiting roadbed life. It logically follows that this area will also be more susceptible to impacts associated with climate change and this is relevant both to initial construction planning and subsequent rail operation.

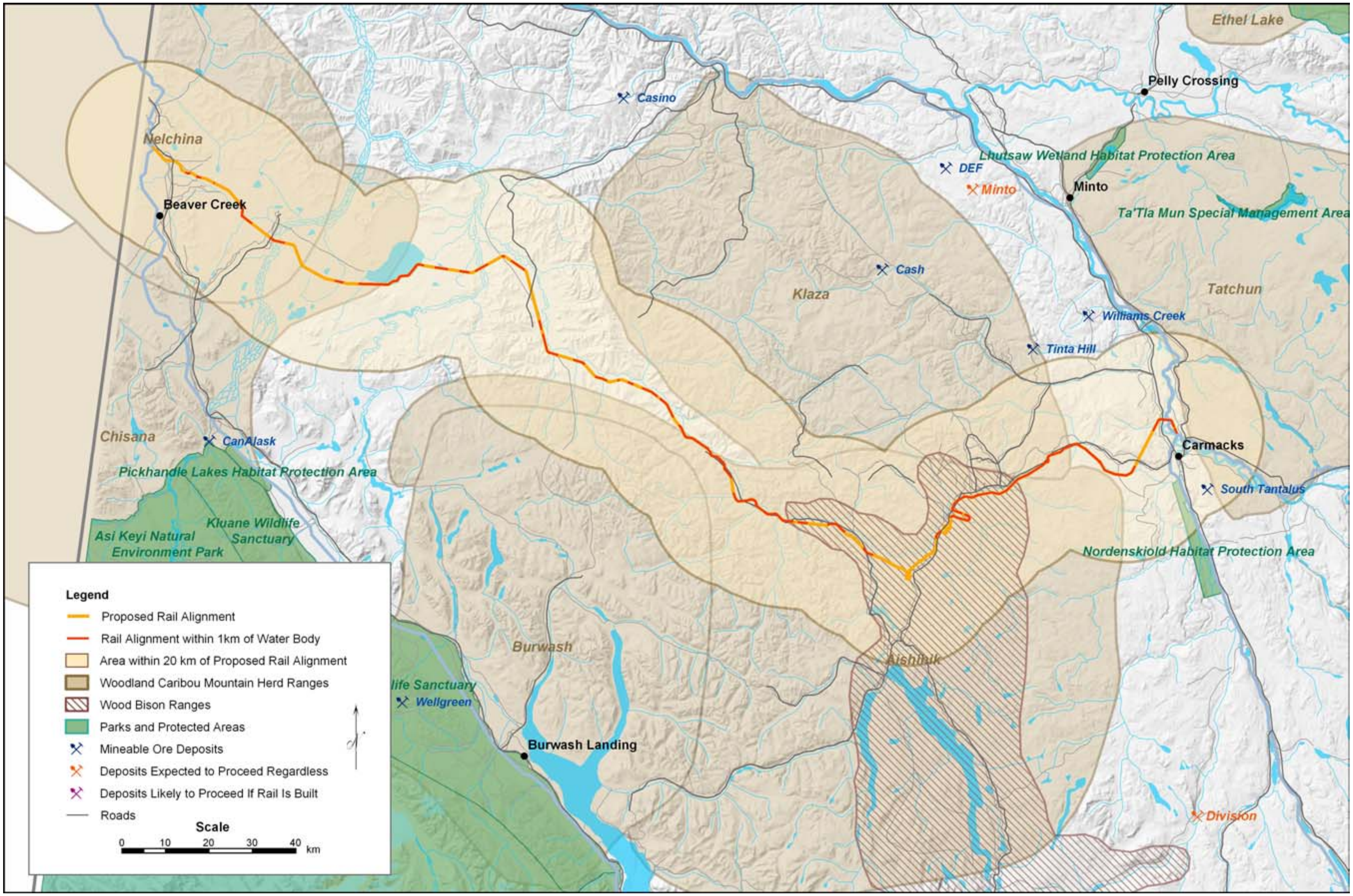

Figure 4. Map of Beaver Creek to Carmacks via Nisling River sub-corridor.

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Table 5. Summary of Qualitative Biophysical Risks for Beaver Creek to Carmacks via Nisling River.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Nordenskiold Habitat Protection Area	Peregrine Falcon (*anatum* subspecies) , Woodland Caribou (northern mountain population, Wood Bison	Nisling River Corridor between Wellesley Lake Basin and Aishihik uplands, migratory waterfowl in Wellesley basin	Private and First Nation lands, Campbell Highway corridor, crosses historic James Trail	Crossings of the Yukon, Nisling, Donjek, and White Rivers, crossings of 18 creeks and 92 tributaries, known salmon habitat	Wellesley Lake (trophy fishing)	Approximately 1/3 requires heavy or vary heavy construction, construction on organics and permafrost also required	Approximately 1/5 of the route is curves, average gradient steep, seismic and natural disaster risk ranking moderate	Mining

2.2.3 Beaver Creek to Whitehorse Via the Alaska Highway

This alignment is 528 km (328 miles) long (Figure 5). Identified qualitative biophysical risks are summarised in Table 5. Much more biophysical information is available for significant sections of this alignment because it parallels the Alaska Highway and the original Foothills Pipelines work. Conoco Phillips reevaluated this route several years ago but the extent of the studies completed and new information collected is unknown and proprietary. Most of this section of highway has now been rebuilt and as such, local conditions within a half-kilometer of the road are well documented.

Heading south down the Shakwak Trench towards Haines Junction there is a number of biophysical concerns. The Pickhandle lakes area is a designated habitat protection area. It has the second highest concentration of muskrats in Yukon, contains critical waterfowl habitat, and is an example of thermokarst topography. The Kluane River and Kloo Lake in particular have also been identified as potential special management areas because of their biodiversity. The Kluane River corridor contains important salmon and raptor habitat while the Chisana and Burwash caribou ranges extend from north of Burwash Landing to the Alaska border. The Shakwak trench is also a very important migratory bird flyway.

A number of rare plants have also been found along the Alaska Highway in this area and a number of the river fans (e.g. Donjek) are important gopher and sharp-tailed grouse habitat.

The Shakwak trench is a fault line and a seismic sensitive zone. All the rivers and streams exiting the Kluane front ranges have a history of seasonal flash flooding with debris flows across outwash fans necessitating stream channel management interventions especially between Burwash Landing and Silver City. The probability of track washouts and the risk of derailments in this area are high.

The potential for such incidents to result in spills into Kluane Lake is also subsequently high because any alignment would likely have to be within 30m of the shore.

The Slims River delta crossing presents a significant challenge. The rail line would have to follow the edge of Kluane Lake from Cogdon Creek south to Silver City across the Slims River delta. As shown the alignment intrudes into the Kluane Game Sanctuary and Kluane National Park. The highway already encroaches on important sheep habitat in the Soldiers summit area. This is a particularly important wildlife viewing location and the presence of a rail line would only exacerbate the frequency of wildlife mortality in this area.

A number of highway alignment options have been examined in this area and the routing about to be built generally follows the present highway leaving no room for a rail corridor. The proposed rail routing intrudes further up the Slims valley itself into the park conflicting with two main hiking trails and grizzly bear habitat. The complexity of the biophysical and engineering issues at the Slims River delta is not insurmountable, but this is the most significant bottleneck point on this alignment option.

Wildlife movement into and out of the park from the Burwash Uplands to the Alsek river valley near Haines Junction is well documented.

A number of highly visible cuts and fills will be required to make grade crossing Boutillier Summit. From this point south and east of Haines Junction, a major spruce beetle infestation poses a significant wildfire risk. High winds are also common in the Paint Mountain area where the alignment calls for a tunnel. A cursory examination of the local terrain suggests other routings may be possible in this area eliminating the need for a tunnel. The tunnel option on the other hand would minimize conflicts with wildlife movement between the Alsek and Dezadeash river valleys around Haines Junction.

The principal challenges east of Canyon to Whitehorse relate more to land use conflicts than biophysical concerns. Much of the Takhini Valley was burnt in a major forest fire in the 1950's. Both bison and elk have been re-introduced in this area while mule and white tailed deer are becoming more common as they extend their range further north. The Takhini Valley is also gradually being converted to farmland. Just east of the Takhini River Bridge, botanists have discovered an unusual area of salt flats containing a number of rare plants.

Routing through and around Whitehorse poses significant challenges. One routing could follow the Whitehorse Copper haul road to connect to the White Pass & Yukon Route near McRae. The other routing would need to skirt Whitehorse to the east requiring a crossing of the Yukon River.

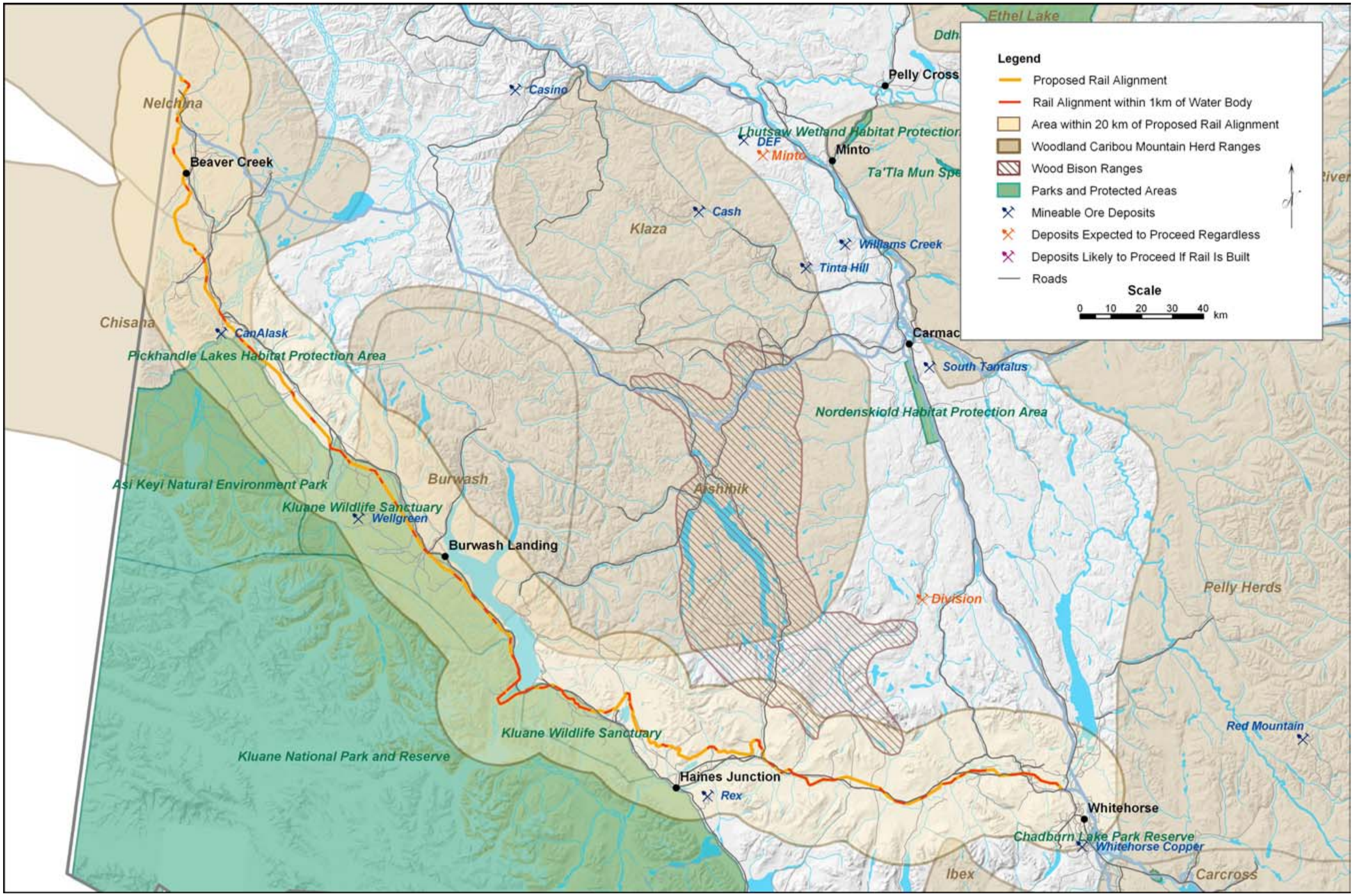

Figure 5. Map of the Beaver Creek to Whitehorse via the Alaska Highway sub-corridor.

Table 6. Summary of Qualitative Biophysical Risks for Beaver Creek to Whitehorse via the Alaska Highway.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Pickhandle Lkaes Habitat Protection Area, Kluane Wildlife Sanctuary, Kluane National Park	Peregrine Falcon (*anatum* subspecies), Woodland Caribou (northern mountain population, Wood Bison	Kluane National Park to Burwash Uplands to Alsek River valley, Shakwak trench migratory bird flyway	Agricultural land in the Takhini Valley, Kluane National Park, Kluane Game Santuary, Pickhandle Lakes, Pine Lake Recreation Area	Crossings of the Yukon, Takhini, Mendenhall, Aishihik, Jarvis, Slims, Duke, Donjek, Koidern, and White Rivers, crossings of 34 creeks and 178 tributaries, known salmon habitat	Kluane Lake, Kloo Lake, Pickhandle Lakes, Pine Lake	>2/3 requires heavy or very heavy construction, construction on organics and permafrost also required	Approximately 1/5 of the route is curves, average gradient low, seismic risk ranking low and natural disaster risk ranking moderate	Mining

2.2.4 Whitehorse to Watson Lake Via the Alaska Highway

This segment is 505 km (314 miles) long (Figure 6). Identified qualitative biophysical risks are summarised in Table 6. The alignment as proposed involves a 4 km (2.5 mile) rock tunnel and a number of long bridge lengths over major rivers such as at Johnson Crossing and the Liard River. There are numerous land use conflicts both with existing development, the present Alaska Highway and the Alaska Highway pipeline corridor.

South of Whitehorse this alignment may affect the Chadburn Park Reserve, which was established to protect the current water supply (Schwatka Lake) for the City of Whitehorse. Further south the alignment crosses the Yukon River and must skirt the Lewes River Habitat Protection Area, Yukon River Bridge and the Yukon Energy water flow structure as well as private lands. The rail corridor would also traverse across the range of the Southern Lakes caribou herd that has also been in decline.

Between Jakes Corners through Squanga Lake to Johnson Crossing, the rail line must pass through a narrow valley corridor. Agay Mene Natural Environment Park is a special management area that includes White Mountain and extends up to the Alaska Highway. It has not yet been withdrawn from disposition. Mountain goats have been re-introduced to the White Mountain area.

Three small lakes in the Squanga Lake area contain the rare Squanga whitefish. Caribou, moose and bear move through this corridor between the southern lakes and the Teslin River corridor. A major challenge will be the height of the bridge required to maintain grade and cross the Teslin River at Johnson Crossing. The outflow from Teslin Lake is an important stopover point for geese and swans during their seasonal migration because the waters freeze here last and open earlier than other sites.

The Teslin River is also on a fault line and significant funds have been expended in recent years to bring the existing bridge up to current standards. As the rail line continues south towards Teslin following the east bank of the lake, the main biophysical issues relate to soil conditions.

The Nisutlin River delta and bay at Teslin is also a special management area and designated a national wildlife area for waterfowl. The rail line will face challenges either in trying to skirt the bay or cross it directly as there is a substantial climb required over the height of land and conflicts with private property, soil conditions and the length of bridge structure required. Extensive and visible cut and fill will be required.

In the Rancheria area the railway will be forced to closely parallel the Alaska Highway and river. The railway will also cross the continental divide. Substantial cuts and fills can be anticipated and they will be visible from the adjacent highway undermining the scenic quality of this road section. This area is also known as a productive trapping area.

South of Swift River there are terrain constraints and potential conflicts with moose and the local caribou herd. The Rancheria River drains into the Liard River and bull trout have penetrated the upper reaches of the river as far as Daughney Lake.

This alignment avoids crossing the Liard River at Upper Liard by following the south bank of the river and avoiding Watson Lake.

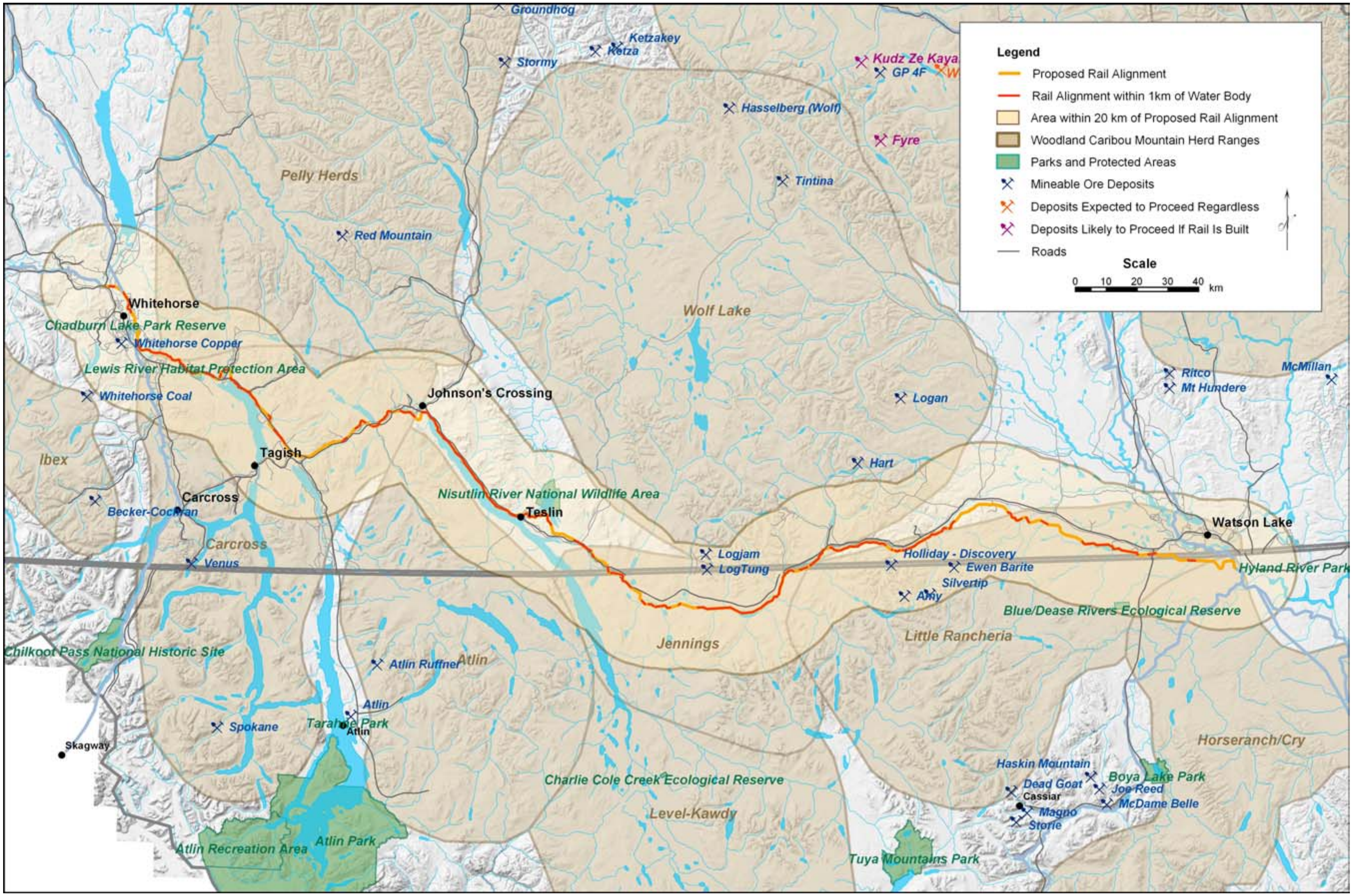

Figure 6. Map of the Whitehorse to Watson Lake via the Alaska Highway sub-corridor.

Table 7. Summary of Qualitative Biophysical Risks for Whitehorse to Watson Lake via the Alaska Highway.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Chadburn Lake Park Reserve, Lewes River Habitat Protection Area, Blue/Dease Rivers Ecological Reserve, Nasutlin River National Wildlife Area	Woodland Caribou (northern mountain population)	Squanga Lake to Teslin River corridor, Teslin Lake outflow for migratory waterfowl	Alaska Highway corridor, Alaska gas pipeline corridor, private property, First Nations land	Crossings of the Little Rancheria, Tootsie, Swift, Morley, Teslin, and Yukon Rivers, crossings of 29 creeks and 105 tributaries, bull trout habitat in the Rancheria River	Nisutlin Bay, Swan Lake, Teslin Lake, Little Teslin Lake	More than 3/4 requires heavy or very heavy construction, construction on organics and some permafrost also required	Approximately 1/3 of the route is curves, average gradient low, seismic risk ranking low and natural disaster risk ranking moderate	Mining.

2.2.5 Carmacks to Whitehorse

This 180 km (112 mile) alignment parallels the Klondike Highway (Figure 7). Identified qualitative biophysical risks are summarised in Table 8. There are terrain conflicts and a crossing of the Nordenskiold River required bypassing Carmacks to the west. A habitat protection area encompassing the wetlands south of Carmacks along the Nordenskiold River is in place and the alignment will face terrain issues as it tries to squeeze a route between the river, existing highway and rising terrain.

There are few biophysical issues that would affect construction and operation along this entire route. The principal conflicts occur at Fox Lake south of Braeburn where the railroad must cross the height of land. It is not clear whether the route follows the east or west side of Fox Lake. A major forest fire in the late 1990's has burnt a significant portion of land and there is evidence of the effects of such hot fires on pockets of underlying permafrost.

While the east side of the lake is more desirable from a construction point of view, substantial cuts and fills will be required as the existing highway has already been carved out of the steep slopes. The west side of the lake and former Dawson Wagon Road also faces challenges in this area with greater amounts of organic soils and permafrost.

Elk first introduced west of Whitehorse in the Takhini Valley have now extended their range north into the Braeburn area.

Past Fox Lake to Whitehorse, the principal constraints relate mainly to conflicts with private lands abutting the highway right-of-way. Finding a crossing point on the Yukon River above the confluence of the Takhini River will also be a challenge as this railway routing envisions bypassing Whitehorse by following the bench-lands south along the Yukon River. This 180 km (112 mile) alignment parallels the Klondike Highway. There are terrain conflicts and a crossing of the Nordenskiold River required bypassing Carmacks to the west. A habitat protection area encompassing the wetlands south of Carmacks along the Nordenskiold River is in place and the alignment will face terrain issues as it tries to squeeze a route between the river, existing highway and rising terrain.

There are few biophysical issues that would affect construction and operation along this entire route. The principal conflicts occur at Fox Lake south of Braeburn where the railroad must cross the height of land. It is not clear whether the route follows the east or west side of Fox Lake. A major forest fire in the late 1990's has burnt a significant portion of land and there is evidence of the effects of such hot fires on pockets of underlying permafrost. While the east side of the lake is more desirable from a construction point of view, substantial cuts and fills will be required as the existing highway has already been carved out of the steep slopes. The west side of the lake and former Dawson Wagon Road also faces challenges in this area with greater amounts of organic soils and permafrost.

Elk first introduced west of Whitehorse in the Takhini Valley have now extended their range north into the Braeburn area.

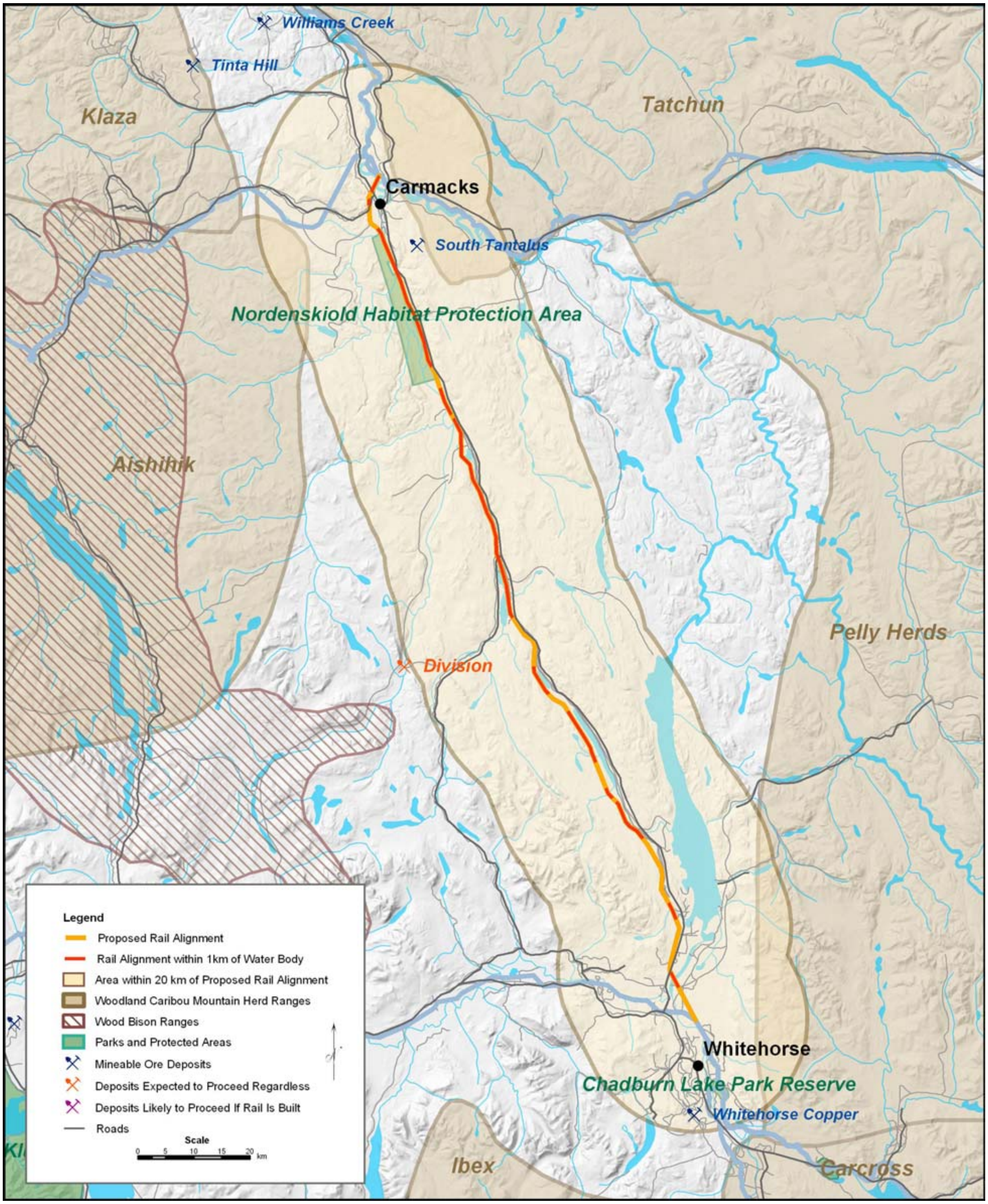

Figure 7. Map of the Carmacks to Whitehorse sub-corridor.

Table 8. Summary of Qualitative Biophysical Risks for Carmacks to Whitehorse.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Nordenskiold Habitat Protection Area	Peregrine Falcon (*anatum* subspecies) , Woodland Caribou (northern mountain population	No Data	Private lands along Klondike Highway corridor	Nordenskiold River	Fox Lake	Potential for construction on permafrost and organics	No Data	Mining

2.2.6 Carmacks to Watson Lake

This routing is 648 km (403 miles)(Figure 8). Identified qualitative biophysical risks are summarised in Table 8. As discussed earlier there are multiple terrain and biophysical concerns in the Carmacks area. Solutions to these issues are dependent on whether the preferred route north would follow the Yukon or Nisling rivers. If the Yukon River routing were preferred, a Frenchman Lakes bypass would resolve some of the immediate conflicts with trying to follow the east bank north past Five Finger Rapids and the conflicts with the Robert Campbell/Klondike Highway intersection. However, this is also an important wildlife travel corridor. The western Nisling River route would require a second crossing of the Yukon River.

Heading east towards Little Salmon Lake the alignment hugs the north bank of the Yukon River before crossing over the Little Salmon River to follow the north shore of Little Salmon Lake to the Magundy River and on towards Faro and the Tintina Trench. On the north shore of Little Salmon Lake the alignment may conflict with private property, First Nations land and two territorial campgrounds. Alternative routing along the south shore of the lake has fewer direct land use conflicts although theer is a greater potential to encounter permafrost.

The Big Salmon and Yukon rivers are the most popular canoe routes in the Yukon and the track would be very visible. Substantial cuts and fills and riprap protection would be needed and the area around Eagles Nest Bluff (km 556) is important raptor habitat.

The Tintina Trench is an important migratory bird flyway with the numerous lakes, ponds and wetlands used as staging areas. The Pelly River contains important salmon habitat. Fannin Sheep are found north of the Pelly River near Faro. A new recreation trail between Faro and Ross River has also been completed.

The alignment crosses the range of both the Finlayson and Rancheria caribou herds but there are no substantive terrain issues over much of the remainder of the alignment past Tutichua and the Nahanni Range Road. South of Simpson Lake soils and permafrost are more prevalent. The alignment then follows the north side of the Liard River before crossing over near Upper Liard to skirt Watson Lake.

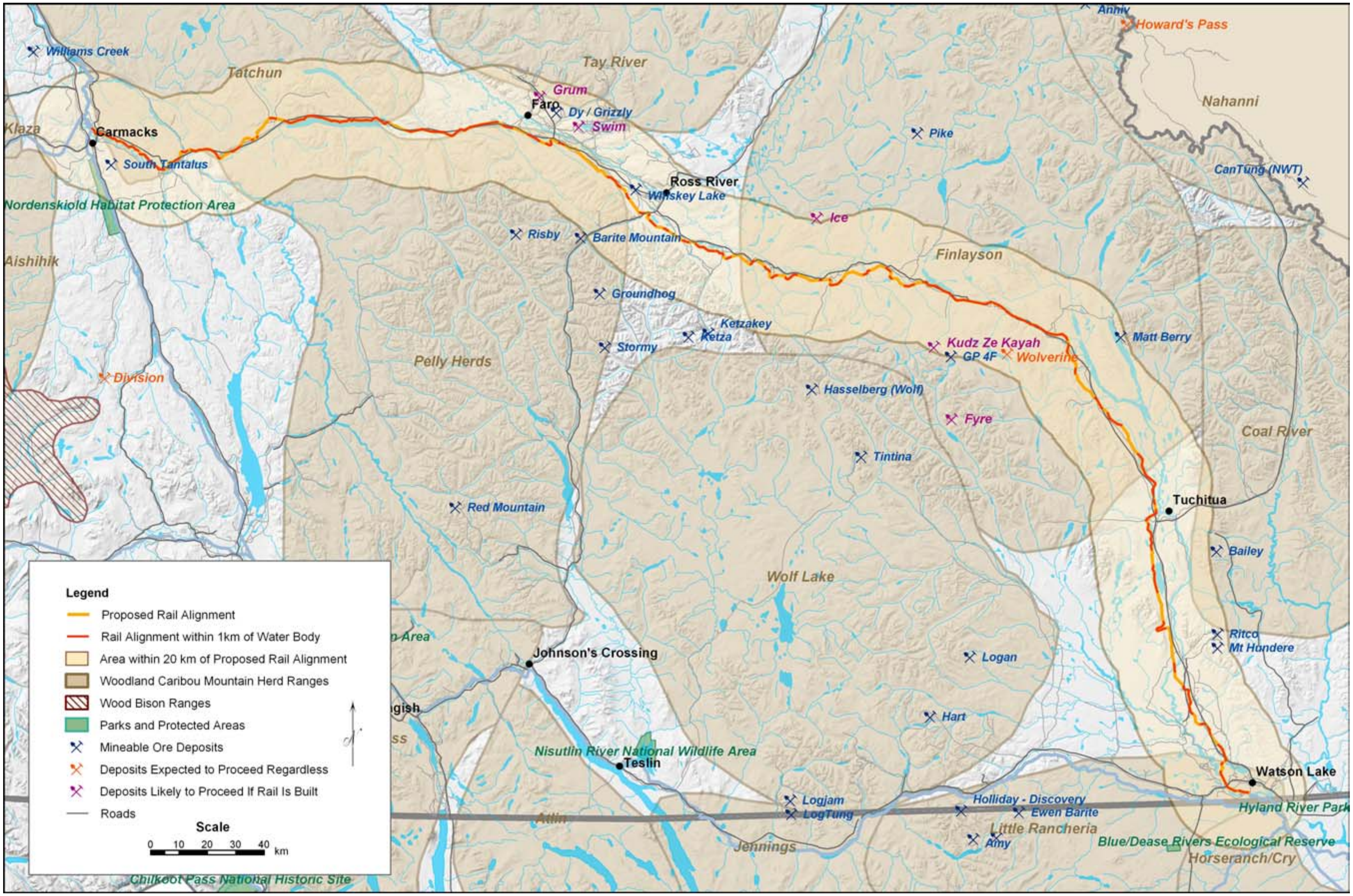

Figure 8. Map of the Carmacks to Watson Lake sub-corridor.

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Table 9. Summary of Qualitative Biophysical Risks for Carmacks to Watson Lake.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Nordenskiold Habitat Protection Area	Peregrine Falcon (*anatum* subspecies) , Woodland Caribou (northern mountain population)	Raptor habitat at Eagles Nest Bluff, Frenchman Lakes, Finlayson River, and French River corridors	Conflict with Klondike and Robert Campbell Highway intersection, Little Salmon Lake	Crossings of the Frances, Puchitua, Ketza,and Lapie Rivers, crossings of 13 creeks and 212 tributaries, known salmon habitat	Little Salmon, Finlayson, Frances, and Simpson Lakes	Approximately 2/3 requires heavy or very heavy construction, construction on permafrost and some organics also required	Approximately 1/3 of the route is curves, average gradient low, seismic risk ranking moderate and natural disaster risk ranking moderate	Mining, forestry near Watson Lake

2.2.7 Whitehorse to Skagway Via Carcross

The biophysical impacts associated with this corridor are largely known since the routing follows the existing White Pass & Yukon rail corridor (Figure 9). Identified qualitative biophysical risks are summarised in Table 10. This narrow gauge railway historically operated year round between Whitehorse and Skagway on the coast. Today, train service is only offered in the summer months mainly between Skagway and the summit near Fraser, B.C. The rails between Fraser and Carcross are being upgraded but plans to rebuild the tracks between Carcross and Whitehorse remain uncertain.

Between Carcross and Whitehorse the principal biophysical concern is historical in nature. During the initial construction of the line, crews accidentally drained Lewes Lake. In 2005, beavers created a similar problem when a beaver dam was breached and the resulting flood disrupted natural flow and drainage patterns. As this has occurred in the past, this is clearly a sensitive area requiring careful design and execution.

The rail line cuts through the active Carcross sand dunes just before Carcross. At Carcross, the existing rail bridge may need to be rebuilt to carry the heavier and longer trains. The tracks pass through the center of the community and there is currently no secondary access available. Long, slow moving trains would restrict pedestrian and vehicle movement and potentially disrupt access for emergency vehicles.

The rail line then follows the east shore of Bennett Lake within 30m of the edge of the lake itself and approximately 1.8 m above the high water mark of the lake. Work to upgrade the existing narrow gauge railway to a standard gauge has been partially completed on this line and it is expected that this work will continue. The proximity of the line to the lake is a spill risk concern. If a derailment occurred there is a high potential for derailed cars to end up in the lake. From Bennett the line climbs up into the alpine near Fraser. Avalanches and snow drifting are the primary concerns. From the summit south of Fraser, the railway winds its way down the White Pass to Skagway.

The main biophysical concern between Bennet and Carcross is the 43.5 km (27 mile) stretch of railway along the shore of Bennett Lake. The rail bed is directly adjacent to the lake and only elevated 1.8 m (6') above the ordinary high water mark. As a result there is significant potential that a derailed train will end up in the lake, as has occurred in the past.

UMA did not study this routing. However, HDR has examined and confirmed the feasibility of upgrading the alignment to standard gauge track. Much of the work necessary to accomplish this, including addition of ballast and installation of ties has already been completed from Carcross to Skagway with minimal biophysical impacts. As such, overall biophysical impacts are expected to be relatively minor.

As Gartner Lee Ltd is undertaking a separate related assessment of the environmental issues associated with this route as part of the Yukon ports Access Strategy that will subsequently be consolidated with the other rail research projects, no further SEA level assessment analysis has been undertaken.

Depending on the routing around Whitehorse there is potential for a number of land use conflicts.

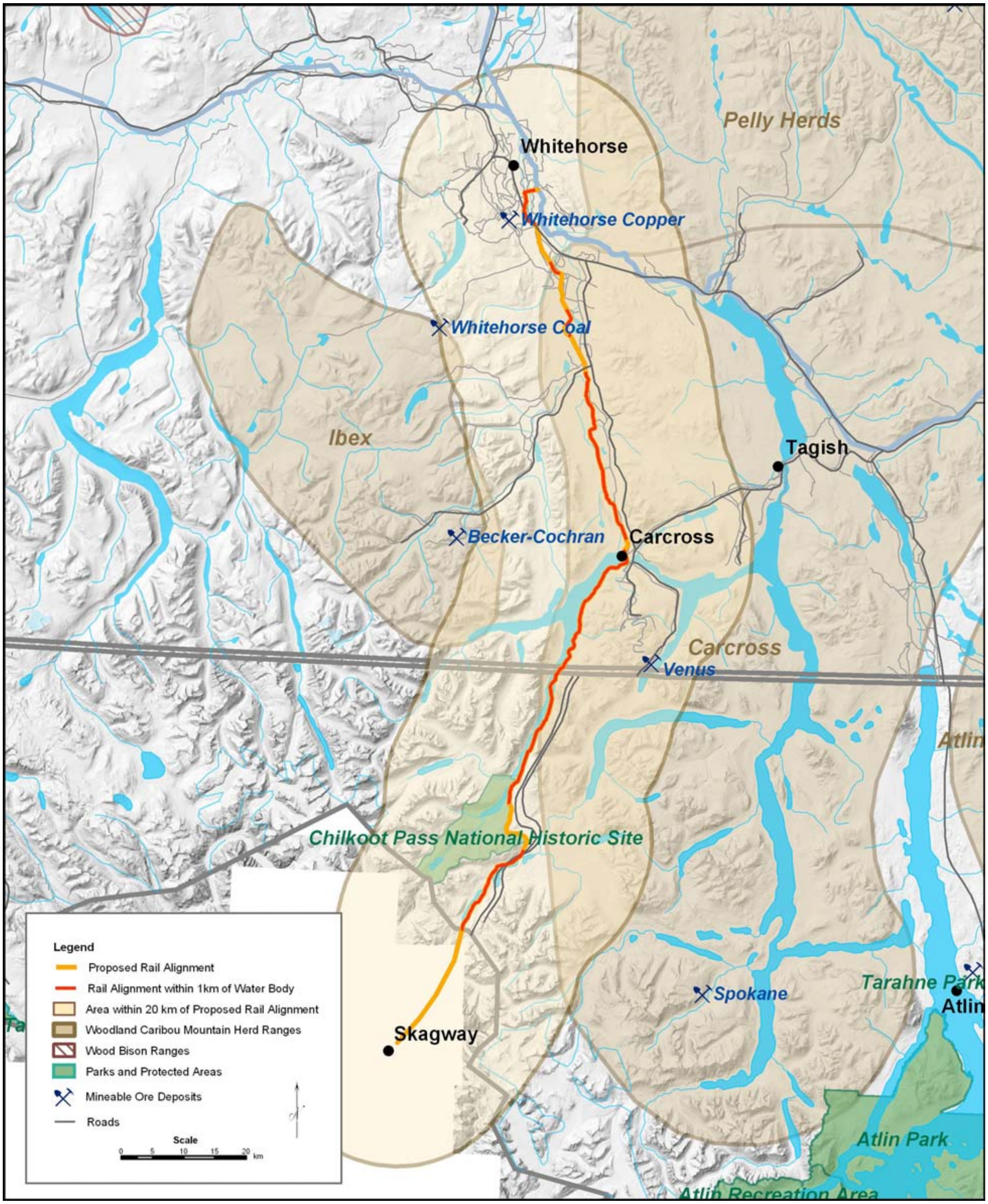

Figure 9. Map of the Whitehorse to Skagway via Carcross sub-corridor.

Table 10. Summary of Qualitative Biophysical Risks for Whitehorse to Skagway via Carcross.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Chilkoot Pass National Historic Site	Peregrine Falcon (*anatum* subspecies), Woodland Caribou (northern mountain population)	Lewes and Watson River valleys	Follows existing rail corridor with summer use (runs down the main street of Carcross)	No Data	Lewes Lake, Bennett Lake	Likely minimal if existing corridor is followed	Bennett Lake an area of concern	Mining

2.2.8 Watson Lake to Minaret via BCR Extension Rail Bed

This segment is approximately 631 km (393 miles) long and follows the original planned alignment (Figure 10). Identified qualitative biophysical risks are summarised in Table 11. UMA notes that this is the most expensive segment to construct with multi-summits, heavy grading and rock cuts requiring rock sheds and five tunnels totaling 26.6 km (16.5 miles). With the average cost per mile for all rail segments in the $9.5M range, this alignment at $14.14M per mile is 49% more expensive than the average mileage cost so a Mackenzie or Hazelton alignment would save from 53-56% in construction cost alone. It is also the most expensive segment to maintain and operate with the highest risk ranking for natural disasters.

The present BCR routing follows the west boundary of the Spatsizi Wilderness Park to cross the Stikine River Canyon before following Highway 37 north past Dease Lake and the Cassiar cut-off before turning north and following the Dease River to its confluence with the Liard River at Lower Post.

Following the Cassiar Highway north from the Stikine River reduces the overall footprint and moderates the cumulative impacts by keeping the rail line and highway in the same corridor. However the cuts and fills required to maintain grade would also be very visible and take away from the scenic quality of this highway. The rail line follows the east side of Dease Lake for approximately 40 km (25 miles) and may conflict with private land (recreation cabins). The distance of the rail line from the ordinary high water mark of the lake will also need to be considered to reduce potential spill risk from a derailment.

South of the Stikine River, the alignment parallels the western boundary of Spatsizi Wilderness Park before following the Duti and Skeena Rivers to Bear Lake. This alignment also accesses a number of large, potential coal deposits. Much of the area along this alignment contains significant wildlife and fisheries values while the canyon of the Stikine River is high value mountain goat and raptor habitat.

The 2000 Cassiar Iskut-Stikine Local Resource Management Plan provides clear direction on the importance of conservation values in the Upper Stikine River. Specific concerns include protection of the canyon goat populations, moose, grizzly bear and woodland caribou.

The unfinished sub-grade south of the Stikine River is currently used as an access to the Mount Klappan coal deposits. It is generally assumed that if the rail line is not constructed the sub grade may be upgraded further and used as a resource road. A rail line may also reduce uncontrolled access and in this respect would be preferable to a road. As much of the railroad subgrade has already been constructed between the end of steel at Minaret to Highway 37 it is expected that some environmental impacts have already occurred. Biophysical information collected during the permitting process for the Mt. Klappan coal deposits is expected to be relevant to an environmental of the railway if this route is selected.

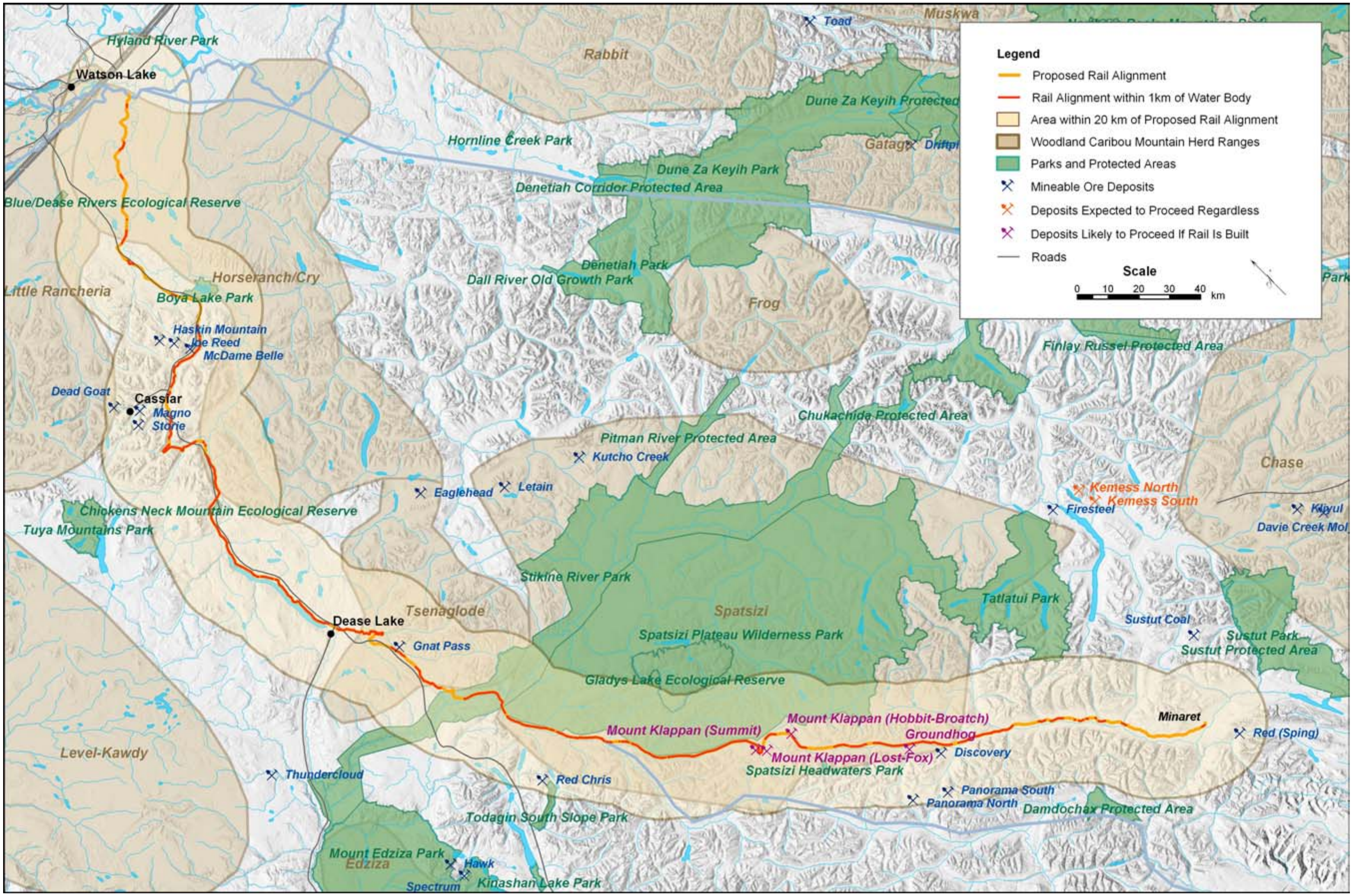

Figure 10. Map of the Watson Lake to Minaret via BCR Extension Rail Bed sub-corridor.

Table 11. Summary of Qualitative Biophysical Risks for Watson Lake to Minaret via BCR Extension Rail Bed.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Tatlatui Provincial Park, Spatsizi Headwaters Provincial Park, Todagin South Slope Provincial Park, Spatsizi Plateau/ Stikine River PP/ Gladys Lake Ecological Reserve, Chickens Neck Mountain Ecological Reserve, Boya Lake Provincial Park, Blue/ Dease Rivers Ecological Reserve	Woodland Caribou (northern mountain population)	Dease, Stikine, and Klappan River valleys	Interaction with multiple protected areas, private land on Dease Lake	Crossings of the Mosque, Duti, Kluatan, Spatsizi, Stikine, Tansilla, Dease, Cottonwood, French, and Blue Rivers, crossings of 24 creeks and 183 tributaries, known salmon habitat, construction along the Skeena River	Dease Lake	Approximately 2/3 requires heavy or very heavy construction, some construction on permafrost expected	> 1/3 of the route is curves, average gradient very steep, seismic risk ranking low and natural disaster risk ranking high	Mining, forestry

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2.2.9 Eaglenest Creek to Hazelton

This route option shares the original BC Rail extension alignment from the Klappan River north by Dease Lake and on to Watson Lake (Figure 11). Identified qualitative biophysical risks are summarised in Table 12. The total distance is 795 km (494 miles). This routing was also identified in the 1969 federal government study. No information is provided in the UMA analysis to suggest what the advantages or disadvantages of this option are over the original BCR alignment. Both involve substantial cuts and pass through relatively undeveloped and remote areas. Both are intended to allow BC mineral and forest products to be exported either by rail east to the central United States via Prince George or by sea through the port of Prince Rupert. The Mount Klappan coal deposits include Canada's largest known resources of high quality anthracite coal and Fortune Minerals is currently proceeding with permitting for a 1.5 million tonne open pit mine. The deposit straddles a section of the BCR sub grade.

The Cassiar Iskut-Stikine LRMP includes references for the need to improve baseline information on wildlife populations and other features of terrestrial and aquatic ecosystems in the Klappan drainage. Some of this work has been underway since 2004 by the consultants working on the Mount Klappan coal project. Specifically habitat use by key species of the Spatsizi predator-prey system (moose caribou, grizzly) and furbearer populations are identified with an emphasis on fishers. Concern with arctic grayling populations in the Upper Stikine and bull trout are also noted as species of research interest. If compared further, it would also make sense to examine a connection between the two routes following the upper Skeena River if the cumulative impact and economic benefits of one alignment are more favourable than the other.

The Kispiox, Nass, Skeena and Klappan rivers all have high value fisheries and other landscape conservation features that merit a more detailed assessment. The BC government has completed a number of local resource management plans that encompass parts of this alignment but a brief literature search provided little evidence that this potential rail corridor had received much consideration.

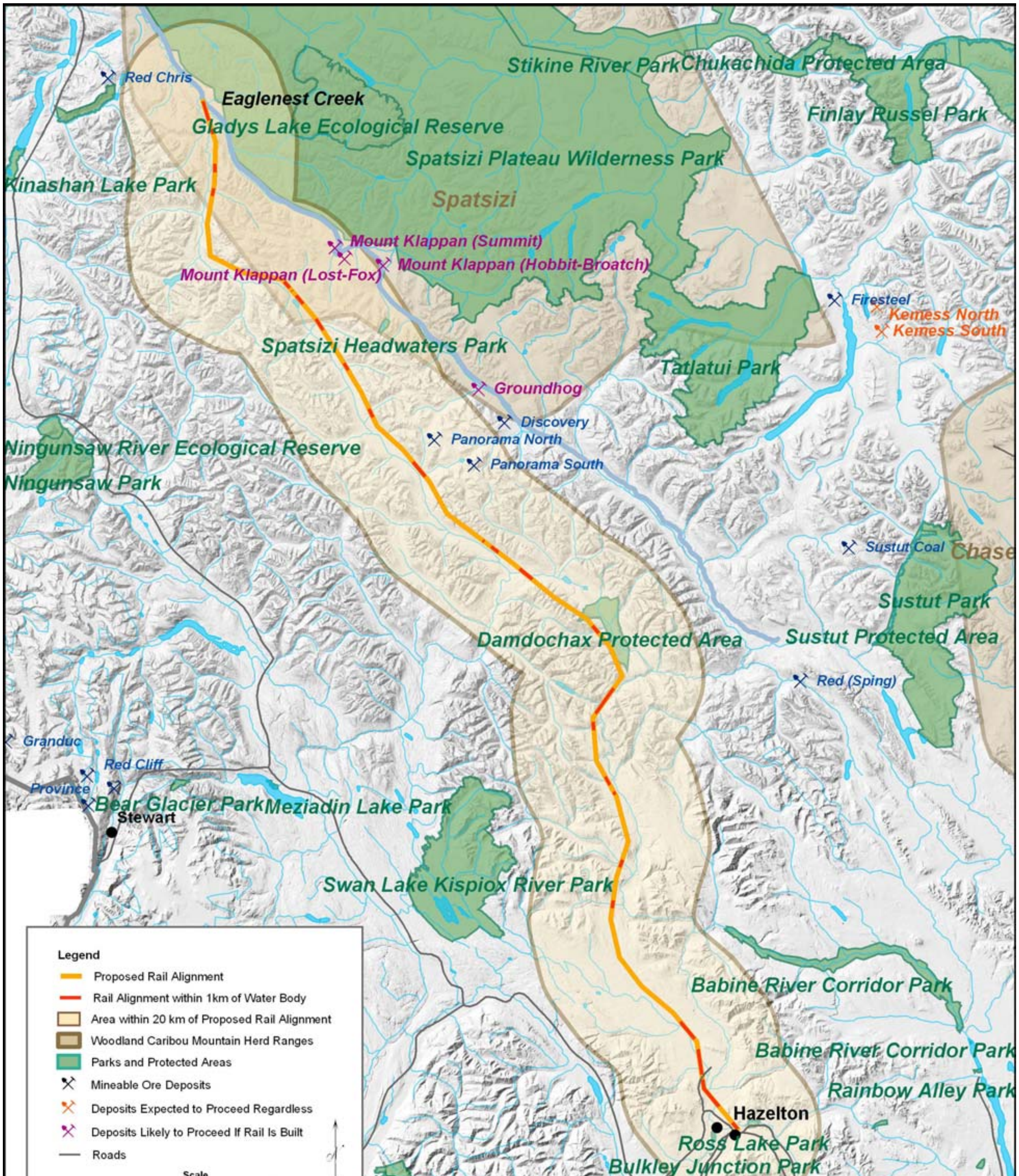

Figure 11. Map of the Eaglenest Creek to Hazelton sub-corridor.

Table 12. Summary of Qualitative Biophysical Risks for Eaglenest Creek to Hazelton.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Boulder Creek Provincial Park, Seeley Lake Provincial Park, Catherine Creek Ecological Reserve, Bulkley Junction Provincial Park, Ross Lake Provincial Park, Damdochax Protected Area, Spatsizi Headwaters Provincial Park, Spatsizi Plateau Wilderness Provincial Park	Woodland caribou (northern mountain population)	Skeena, Klappan, Nass, Kispiox River valleys	Multiple protected areas, transects large areas of wilderness, duplicates an existing right of way	Klappan, Nass, Skeena, and Kispiox Rivers	No Data	No Data	> 1/3 of the route is curves, average gradient moderate, seismic risk ranking low and natural disaster risk ranking moderate	Mining. Forestry.

2.2.10 Watson Lake to Mackenzie

This possible routing was examined in a 1969 reconnaissance study prepared for the federal government. It would be approximately 700 km (435 miles) long and cuts directly southeast over Sifton Pass along the Rocky Mountain Trench following the Kechika and Finlay rivers and the west side of Williston Lake reservoir (Figure 12). Identified qualitative biophysical risks are summarised in Table 13. UMA did not have access to the original alignment study but notes this routing is attractive because it is relatively direct, involves minimal grades and needs to cross only one summit.

The Fort Nelson LRMP acknowledges the importance of the Kechika River corridor and includes a specific management zone in the plan providing management direction. Although no roads currently exist the potential for future transportation development is recognized. The rail line parallels the historic Davie trail that links Fort Ware to Lower Post. The LRMP focuses on the possibility of road development rather than a rail link and expresses the need to carefully control access management. To that end, a rail line would be a better compromise than a road because it provides for more controlled access.

The Kechika river corridor encompasses three ecosections: Liard Plain, Kechika Mountains and Cassiar Ranges. It is mainly part of the Boreal White and Black spruce biogeoclimatic zone and is influenced by rain shadows. Lower snow depths and frequent Chinooks create a unique climatic variant for this latitude.

The area is part of a larger intact predator prey system and is home to Stone's sheep, moose, elk, both bear species, wolves, mountain goats and deer. The floodplains and riparian areas are important staging areas and migration routes for ungulates, and birds such as sandhill cranes and eagles. The dominant fish species in the river include bull trout, whitefish and Arctic grayling.

The proposed route cuts through the middle of the Denetiah Protected Area that has provincially significant wildlife values. Again provision is included in the plan to allow an access corridor through the protected area provided the proposal can, on its merits demonstrate its general compatibility with the conservation management and wildlife protection intent for this area. The resource management plans assumed the demand would be for road access. A rail line would be more compatible with these conservation objectives.

Further south the rail line would follow the Finlay River to Williston Lake and on to Mackenzie. The risk ranking is low for seismic concerns and moderate for natural disasters.

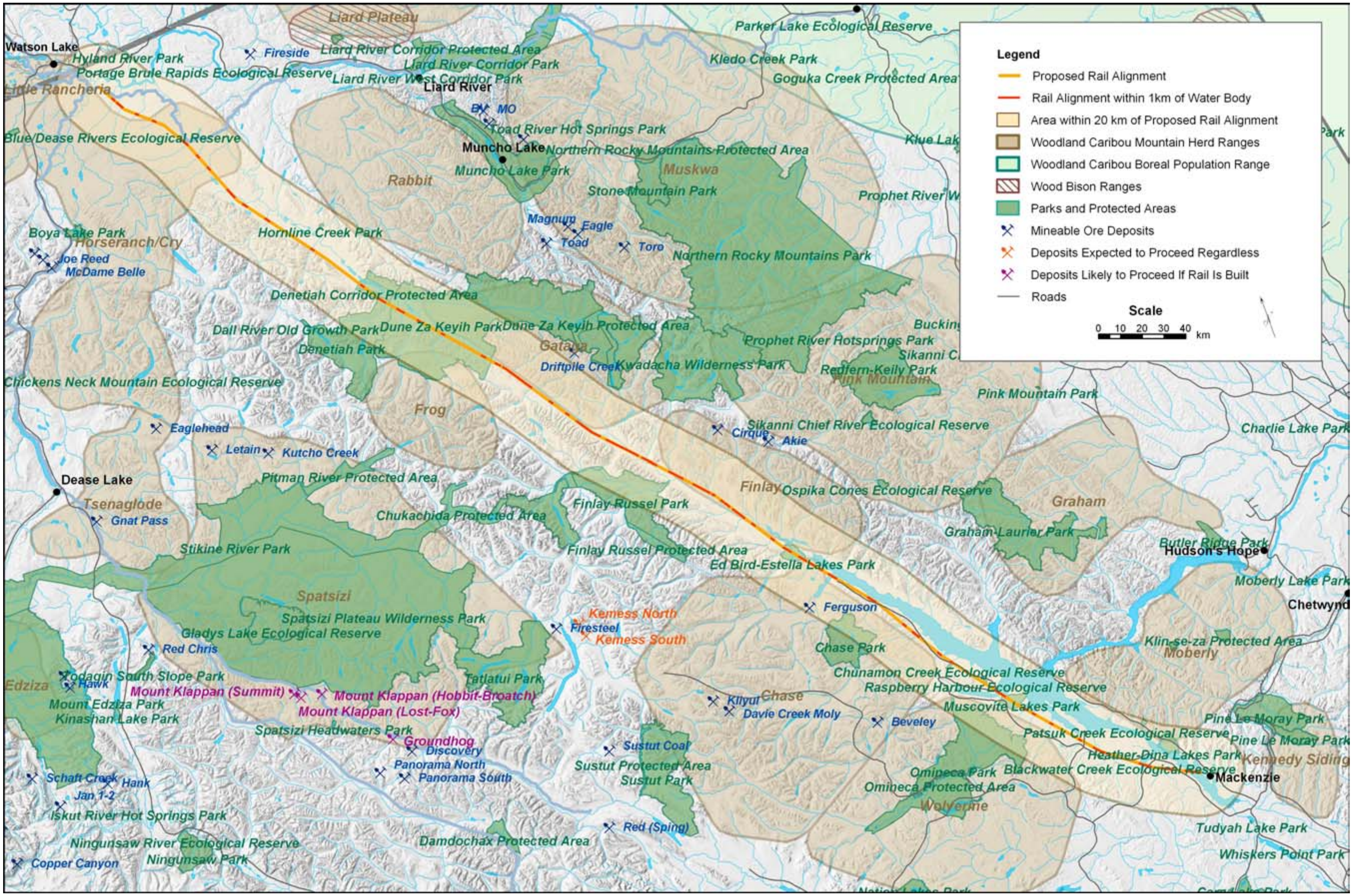

Figure 12. Map of the Watson Lake to Mackenzie sub-corridor.

Table 13. Summary of Qualitative Biophysical Risks for Watson Lake to Mackenzie.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Blackwater Creek Ecological Reserve, Heather – Dina Lakes Provincial Park, Patsuk Creek Ecological Reserve, Muscovite Lakes Provincial Park, Omineca Provincial Park, Raspberry Harbour Ecological Reserve, Chunamon Creek Ecological Reserve, Chase Provincial Park, Ed Bird – Estella Lakes Provincial Park, Finlay Russel Provincial Park & Protected Area, Dune Za Keyih Provincial Park, Denetiah Provincial Park, Denetiah Corridor, Hornline Creek Provincial Park, Hyland River Provincial Park	Woodland Caribou (northern mountain & southern mountain populations)	Kechika and Finlay Rivers, Rocky Mountain Trench	Multiple protected areas	Number of crossings may be higher than other alignments	Williston Lake	No Data	1/4 of the route is curves, average gradient gentle, seismic risk ranking low and natural disaster risk ranking moderate	Mining, forestry

2.2.11 Watson Lake to Fort Nelson

This 541 km (336 miles) segment would link the railhead at Fort Nelson to Watson Lake (Figure 13). Identified qualitative biophysical risks are summarised in Table 14. The proposed routing follows the south shore of the Liard River from Watson Lake south past Lower Post and over the divide into the Kechika River drainage returning to the Liard River and following it by the Liard Hotsprings and through the provincial park. The Fort Nelson LRMP has established the Liard River North Corridor Resource Management Zone. Three ecosections are represented: Eastern Muskwa ranges, Hyland Highland and the Liard Plain. Extensive fires have occurred throughout this corridor.

The river and tributaries contain approximately 20 species of fish that rely on the tributaries for spawning and rearing habitat according to the plan. Bald eagles and raptors are common and a variety of waterfowl nest along the river including passerines and shore birds while bats and boreal toad are found at the hot springs. Wildlife vehicle conflicts are common. Grizzly bear, moose, elk, white tailed deer, caribou and smaller furbearers are common.

The scenic quality of this area results in significant recreational use.

This railway route leaves the Liard River near the confluence of the Toad River crossing the height of land to the Muskwa River where it follows the north shore into Ft. Nelson.

This routing involves a number of major river crossings and potentially one 3.2 km (2 mile) tunnel. The seismic risk is low and the risk of natural disasters rated moderate. Rail wear is anticipated to be high as 24% of the route involves 4-6 degree curves. Considering that substantial sections of this route parallel rivers, setback distances from water will be an important consideration to minimize spill risks. While the Ft Nelson LRMP recognizes that a transportation corridor may be required up the Kechika River, it is silent on whether a rail line would be allowed through Liard Hotsprings Provincial Park.

This alignment is located in a biologically diverse area of the boreal forest and Liard River. With oil and gas exploration in northeast B.C. moving toward the Yukon border, wildlife habitat fragmentation is expected to be a concern on this alignment. The routing to the Liard River Corridor Protected Area is expected to be of particular importance.

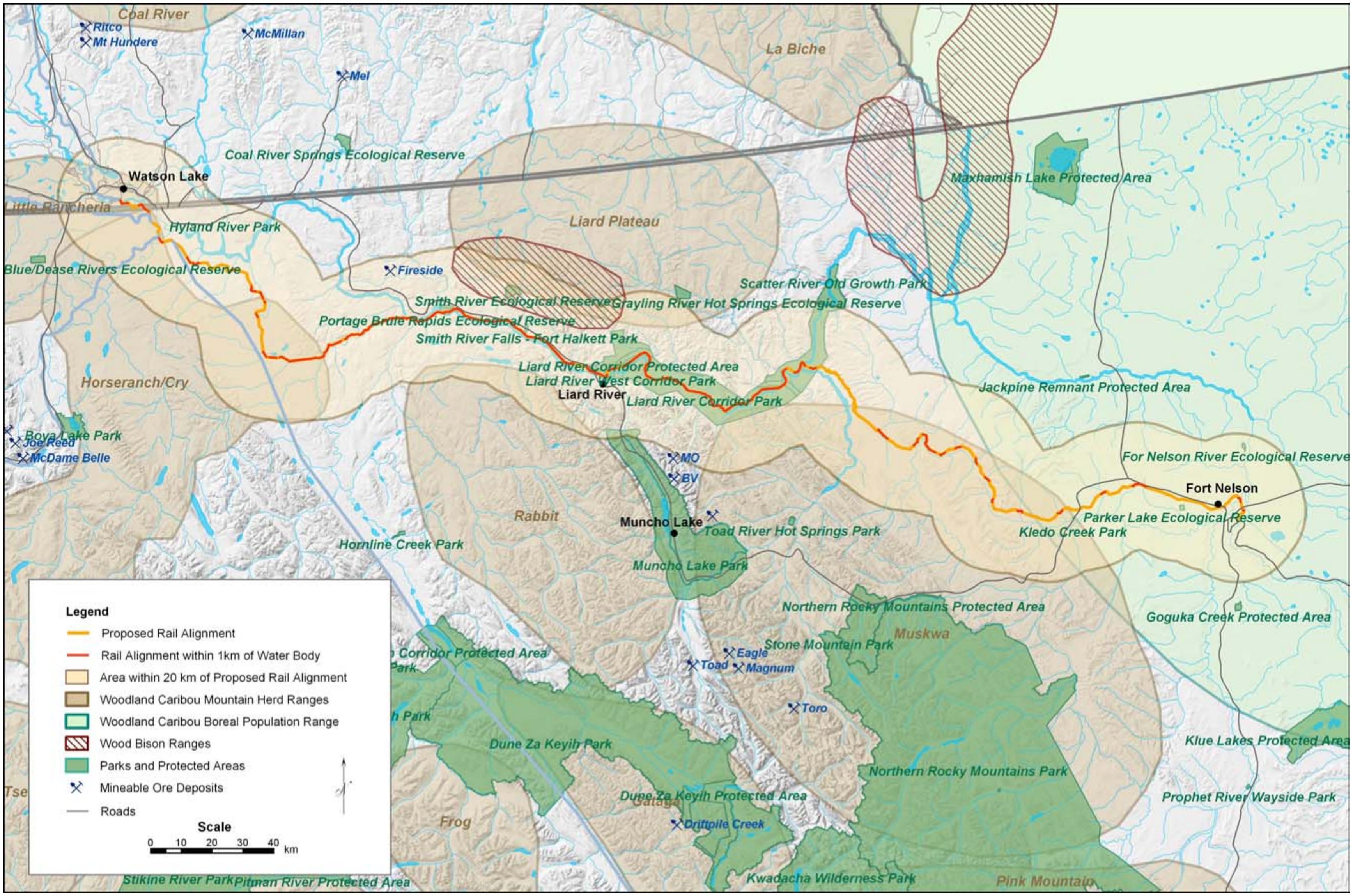

Figure 13. Map of the Watson Lake to Fort Nelson sub-corridor.

Table 14. Summary of Qualitative Biophysical Risks for Watson Lake to Fort Nelson.

Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Stream and River Crossings	Lakes	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development
Kledo Creek Provincial Park, Parker Lake Ecological Reserve, Fort Nelson River Ecological Reserve, Muncho Lake Provincial Park, Liard Hot Springs Provincial Park, Smith River Falls – Fort Halkett Provincial Park, Portage Blue Rapids Provincial Park, Liard River Corridor Provincial Park, Smith River Ecological Reserve, Hyland River Provincial Park	Woodland Caribou (northern mountain & boreal populations), Wood Bison, Hotwater Physa	No Data	Alaska Highway corridor, protected areas	Crossings of the Muskwa, Dunedin, Liard, Grayling, Deer, Smith, Rabbit, Kechika, and Dease Rivers, crossings of 17 creeks and 151 tributaries, known salmon habitat	No Data	> 1/3 requires heavy or very heavy construction, construction on organics also required	Approximately 1/3 of the route is curves, average gradient low/moderate, seismic risk ranking low and natural disaster risk ranking moderate	Mining

2.3 Preliminary Quantitative Assessment of Biophysical Risk

2.3.1 Comparison of Sub-Corridors

Table 15 presents a comparison of sub-corridors according to those criteria for assessment for which data were available for the SEA. Comparative mapping of the sub corridors with respect to protected areas, SARA Schedule 1 species, distance from water bodies, relative terrain disturbance, potential spill/ derailment risk, and identified mineral deposits is shown in Figures 14 to 19.

For the purposes of the SEA all known mineable mineral deposits within the study area are mapped. Further work has identified potential Rail Assisted mineral developments (those that will go forward with or without a rail line but that may utilise the line to transport product if it is built) and potential Rail Dependent mineral developments (those likely to go forward if the rail line is built). It is assumed that completion of the rail corridor increases the possibility of a number of these deposits being developed as a result of improved transportation.

Table 15. First-order quantitative comparison of biophysical risk presented by the ACRL sub-corridors.

SUB-CORRIDOR	Area of Corridor (40 km) Within Parks and Protected Areas (ha)	Proportional Distance of Alignment Within Parks and Protected Areas (%)	SARA Schedule 1 Species Present (number)	Major Water Body Crossings per Alignment	Total Stream and River Crossings Per Km of Alignment	Proportional Distance of the Alignment Paralleling Water Bodies Within One Km (%)	Surface Disturbance as a Function of Construction Difficulty (km of Heavy & Very Heavy Construction as a % of Total Length of Alignment) (%)	Potential Spill/ Derailment Hazard as a Function of Curvature (km of Total Curves as a % of Total Length of Alignment) (%)	Induced Development (mines, rail assisted or dependent)
North of Beaver Creek to Carmacks via Ladue River	4,168	0	2	20	0.49	90.2	55	35	Potential but not near/medium term..
Beaver Creek to Carmacks via Nisling River	2,584	0	3	21	0.3	56.6	31.6	22	Potential but not near/medium term.
Beaver Creek to Whitehorse via the Alaska Highway	462,329	27.15	3	36	0.43	40.0	71.8	21	Potential but not near/medium term.
Carmacks to Whitehorse	7,847	0	2	12	No Data	63.7	No Data	No Data	Division Mountain, Minto; both assisted.
Carmacks to Watson Lake	3,166	0	2	41	0.35	62.6	62.7	28	Wolverine; assisted Fyre, Kudz Ze Kaya, Grum, Ice, Swim; all dependent.
Whitehorse to Skagway via Carcross	12,770	0	1	4	No Data	66.8	No Data	No Data	Potential but not near/medium term.
Whitehorse to Watson Lake Via the Alaska Highway	6,454	0	1	31	0.27	64.8	79.7	34	Howard's Pass; assisted.

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SUB-CORRIDOR	Area of Corridor (40 km) Within Parks and Protected Areas (ha)	Proportional Distance of Alignment Within Parks and Protected Areas (%)	SARA Schedule 1 Species Present (number)	Major Water Body Crossings per Alignment	Total Stream and River Crossings Per Km of Alignment	Proportional Distance of the Alignment Paralleling Water Bodies Within One Km (%)	Surface Disturbance as a Function of Construction Difficulty (km of Heavy & Very Heavy Construction as a % of Total Length of Alignment) (%)	Potential Spill/ Derailment Hazard as a Function of Curvature (km of Total Curves as a % of Total Length of Alignment) (%)	Induced Development (mines, rail assisted or dependent)
Watson Lake to Minaret via BCR Extension Rail Bed	187,675	4.42	1		0.36	38.1	68.6	38	Potential but not near/medium term.
Eaglenest Creek to Hazelton	84,225[a]	1.77	1		No Data	23.9[a]	No Data on	No Data	Kerness North and South; assisted Lost Fox, Hobbit Boatch, Summit, Ground Hog Coalfield; all dependent
Watson Lake to Mackenzie	310,509[a]	15.07	2	53	No Data on GL Portal	38.1[a]	No Data	No Datal	Potential but not near/medium term.
Watson Lake to Fort Nelson	90,575	21.14	4	33	0.33	55.5	36.9	34	Potential but not near/medium term.
INTERPRETATION	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk	Higher Number = Greater Risk

[a] – Appeared to be an approximate alignment when mapped so number is an estimate and may be low.

Figure 14. Proposed sub-corridors in relation to parks and protected areas.

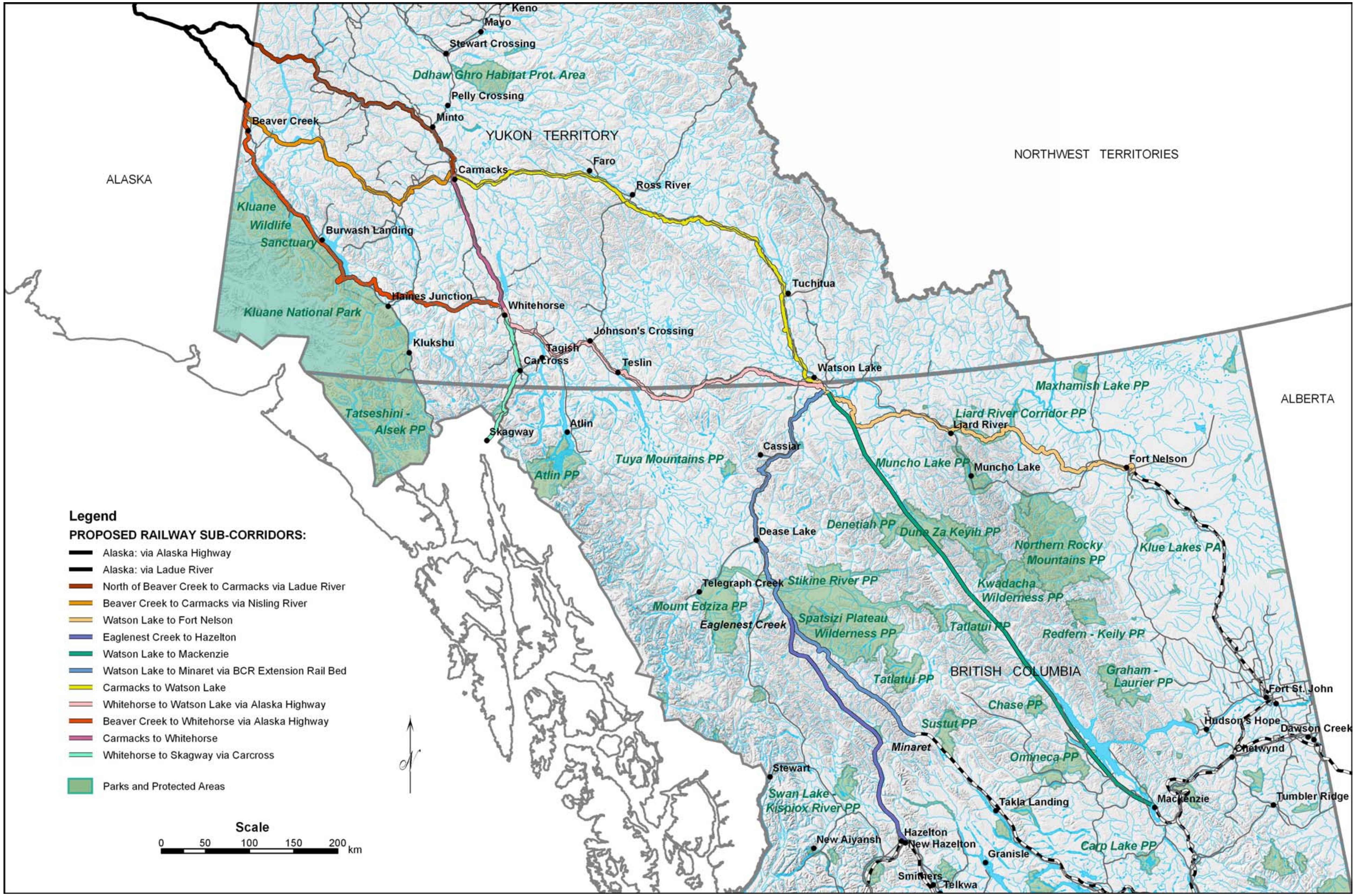


Figure 14. Proposed sub-corridors in relation to parks and protected areas.

Figure 15. Proposed sub-corridors in relation to ranges of SARA Schedule 1 species.

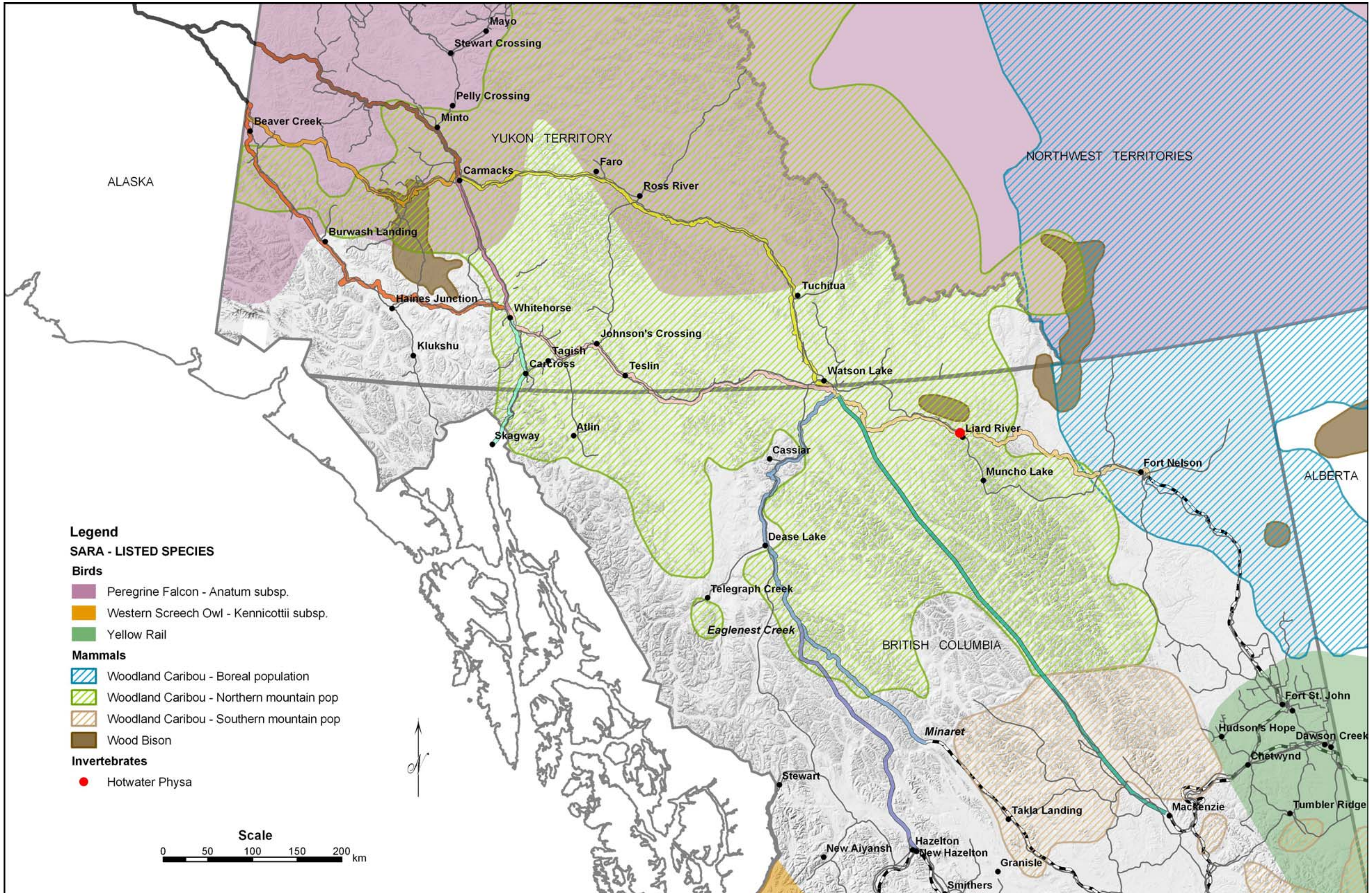
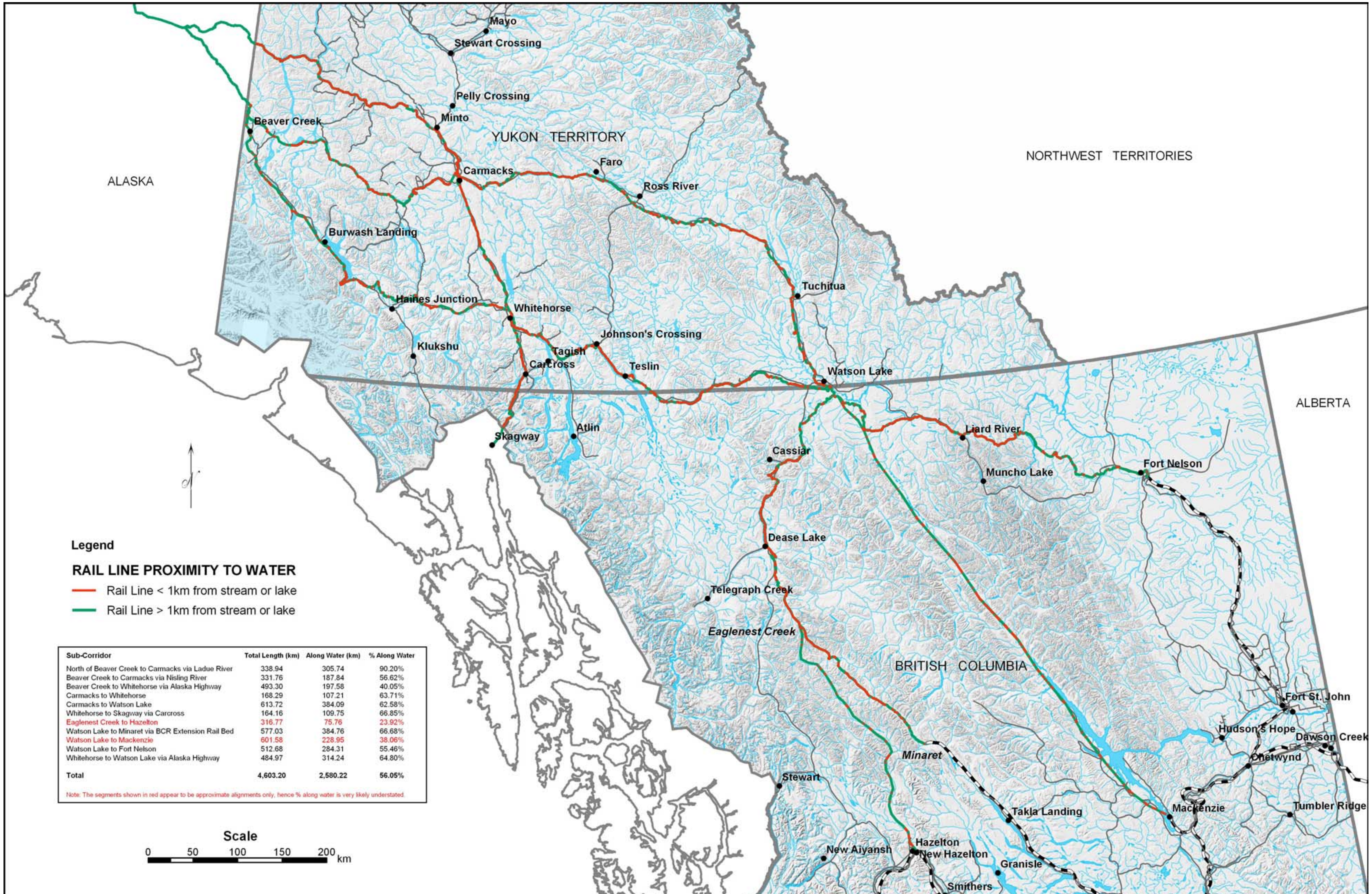


Figure 15. Proposed sub-corridors in relation to ranges of SARA Schedule 1 species.

Figure 16. Proposed sub-corridors and distance from surface water bodies.



Sub-Corridor	Total Length (km)	Along Water (km)	% Along Water
North of Beaver Creek to Carmacks via Ladue River	338.94	305.74	90.20%
Beaver Creek to Carmacks via Nisling River	331.76	187.84	56.62%
Beaver Creek to Whitehorse via Alaska Highway	493.30	197.58	40.05%
Carmacks to Whitehorse	168.29	107.21	63.71%
Carmacks to Watson Lake	613.72	384.09	62.58%
Whitehorse to Skagway via Carcross	164.16	109.75	66.85%
Eaglenest Creek to Hazelton	316.77	75.76	23.92%
Watson Lake to Minaret via BCR Extension Rail Bed	577.03	384.76	66.68%
Watson Lake to Mackenzie	601.58	228.95	38.06%
Watson Lake to Fort Nelson	512.68	284.31	55.46%
Whitehorse to Watson Lake via Alaska Highway	484.97	314.24	64.80%
Total	**4,603.20**	**2,580.22**	**56.05%**

Note: The segments shown in red appear to be approximate alignments only, hence % along water is very likely understated.

Figure 16. Proposed sub-corridors and distance from surface water bodies.

Figure 17. Comparison of the proposed sub-corridors based on relative amount of terrain disturbance.

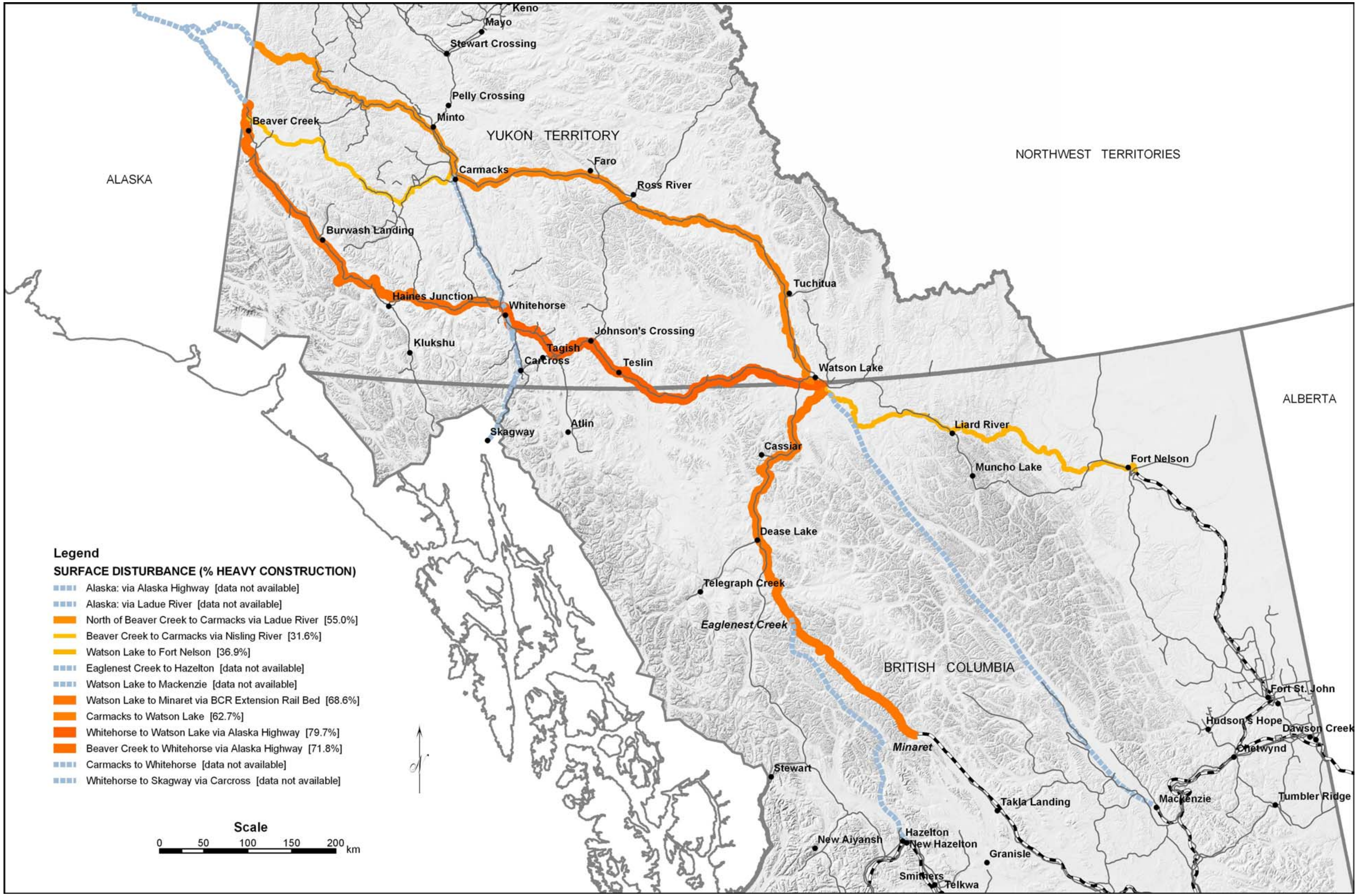


Figure 17. Comparison of the proposed sub-corridors based on relative amount of terrain disturbance.

Figure 18. Comparison of the proposed sub-corridors based on relative spill/ derailment risk.

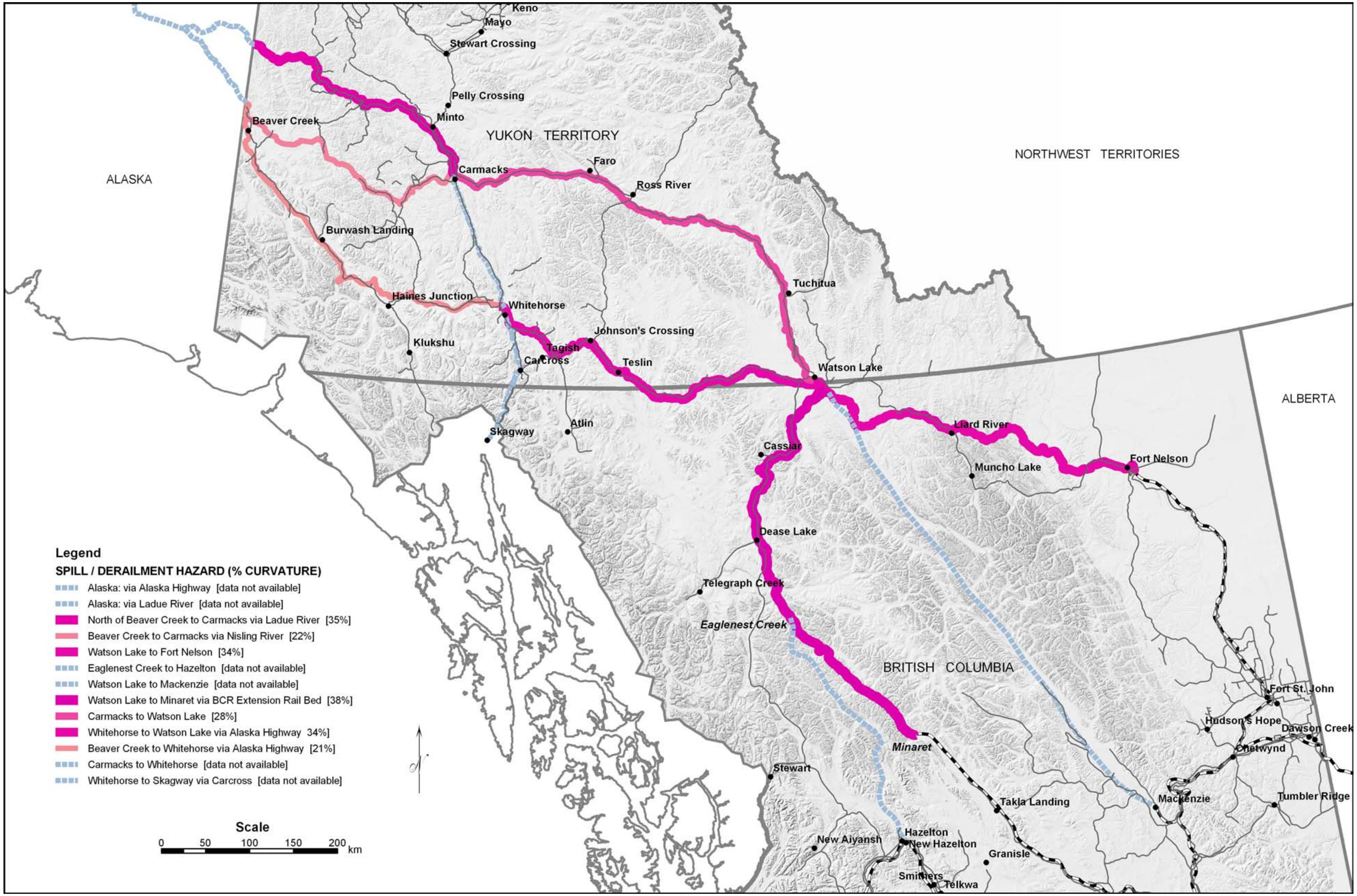


Figure 18. Comparison of the proposed sub-corridors based on relative spill/ derailment risk.

Figure 19. Identified mineral deposits within 200 km of the proposed sub-corridors.

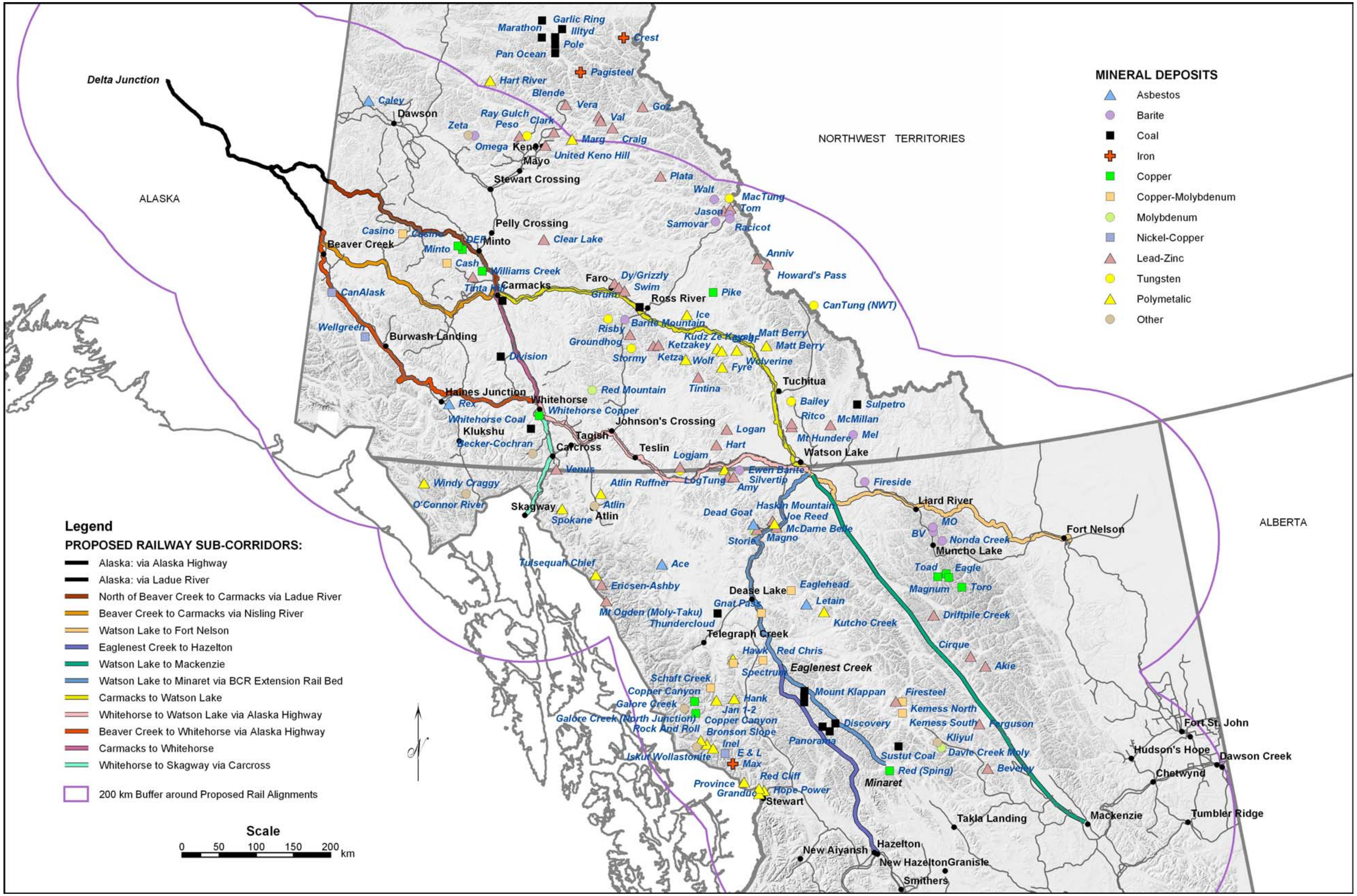


Figure 19. Identified mineral deposits within 200 km of the proposed sub-corridors.

3.0 SUMMARY OF NET BIOPHYSICAL EFFECTS IN CANADA

3.1 Précis of Most Significant Negative Effects

Within the context of the biophysical aspects of sustainability, the following speaks to a first-order determination of potentially significant biophysical effects, without consideration of mitigation or management, which may nullify or substantively diminish such effects. It is stressed that this is a most preliminary determination, based on the (incomplete) information in hand, and is intended primarily to identify biophysical issues that will need to be comprehensively addressed in further stages of design, construction and operation of an ACRL. The "Actions To Be Considered" contained in the aforementioned Table 3 suggest an approach to developing mitigation and management strategies to address negative effects.

Crucially inherent to the development of mitigation and management strategies is the need to seek and integrate further biophysical data. In the first instance, it is understood that significantly more data than could be collected for this study - due to time and resource constraints - is available. Depending on (probable) sub-corridor prioritization, this will need to be sourced and integrated. At that juncture, further analysis will determine if there are further data gaps that will require primary data collection. The quality of mitigation and management strategies and their consequent design and implementation is a function of the quality of the data acquired.

Finally, the scope of this study is strategic. What this means is that site-specific data or concerns are only relevant to the degree that they reflect the systemic and cumulative concerns. The reason for this is partly related to the width of the study corridor (40 km) and partly related to the fact that final, surveyed alignments have not been completed (as earlier discussed at page 3 and page 20). As a result any identified site-specific issues need to be addressed in a relevant strategic context to assist decisions during the planning and design process. It may be that such considerations will result in the avoidance, at that site, of a broadly perceived negative effect. The most significant potential negative biophysical impacts for each corridor are shown in bold in Table 16.

Table 16. Summary of the most significant biophysical negative effects for each sub-corridor.

SUB-CORRIDOR	Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Water Bodies (Lakes, Rivers & Streams)	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development (Mines)
North of Beaver Creek to Carmacks via Ladue River	Nordenskiold Habitat Protection Area 4,168 ha of protected areas within corridor	Peregrine Falcon, Woodland Caribou	Frenchman Lakes Corridor	Recreation areas and highway corridors, proposed Carmacks to Stewart Crossing transmission line	**90% of route within 1km of a water body** Major Rivers: Tatchun, Yukon, Selwyn, & White 20 significant crossings	**55% of route requires heavy or very heavy construction**	**35% of alignment is curves** Low gradient	Potential but not near/medium term.
Beaver Creek to Carmacks via Nisling River	Nordenskiold Habitat Protection Area 2,584 ha of protected areas within corridor	**Peregrine Falcon, Woodland Caribou, Wood Bison**	Nisling River Corridor Migratory waterfowl in Wellesley basin	Private and First Nation Lands, Robert Campbell Highway corridor	**56.6 % of route within 1km of a water body** Major Rivers: Yukon, Nisling, Donjek, & White 21 significant crossings	31.6% of route requires heavy or very heavy construction	22% of alignment is curves **Steep gradient**	Potential but not near/medium term.
Beaver Creek to Whitehorse via the Alaska Highway	**Kluane National Park, Kuane Game Sanctuary** **462,329 ha of protected area within corridor** **27% of route within protected areas**	Peregrine Falcon, Woodland Caribou, Wood Bison	**Burwash Uplands to Alsek River Valley** Shakwak trench flyway	**National Park and Game Sanctuary**	40% of route within 1km of a water body Major Rivers: Yukon, Takhini, Mendenhall, Aishihik, Jarvis, Slims, Donjek, Klondike, & White **36 significant crossings**	**71.8% of route requires heavy or very heavy construction**	21% of alignment is curves Low gradient	Potential but not near/medium term.
Carmacks to Whitehorse	Nordenskiold Habitat Protection Area 7,847 ha of protected areas within corridor	Peregrine Falcon, Woodland Caribou	--	Klondike Highway Corridor, private lands	**63.7% of route within 1km of a water body** Major Rivers: Nordenskiold River Lakes: Fox Lake 12 significant crossings	--	--	**Division Mountain, Minto; both assisted**.

SUB-CORRIDOR	Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Water Bodies (Lakes, Rivers & Streams)	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development (Mines)
Carmacks to Watson Lake	Nordenskiold Habitat Protection Area 3,166 of protected area within corridor	Peregrine Falcon, Woodland Caribou	Frenchman Lakes, Finlayson River, & French River corridors	Klondike & Robert Campbell Highway intersection	**62.6% of route within 1km of a water body** Major Rivers: Frances, Puchitua, Ketza & Lapie Lakes: Little Salmon, Finlayson, Frances, & Simpson Lakes **41 significant crossings**	**62.7% of route requires heavy or very heavy construction**	28% of alignment is curves Low gradient	**Wolverine; assisted.** **Fyre, Kudz Ze Kaya, Grum, Ice, Swim; all dependent.**
Whitehorse-Carcross-Skagway	Chilkoot Pass National Historic Site 12,770 ha of protected area within corridor	Peregrine Falcon, Woodland Caribou	Lewes & Watson River valleys	Follows existing corridor with summer use	**66.8% of route within 1km of a water body** **Lakes: Lewes & Bennett Lakes** 4 significant crossings	Expected to minimal if existing corridor is followed	--	Potential but not near/medium term..
Whitehorse to Watson Lake via the Alaska Highway	Blue/Dease Rivers Ecological Reserve, Nasutlin River National Wildlife Area 6,545 ha of protected area within corridor	Woodland Caribou	Squanga Lake to Teslin River Teslin Lake outflow	**Alaska Highway Corridor** **Alaska Gas pipeline corridor**	**64.8% of route within 1km of a water body** **Major Rivers: Little Rancheria, Tootsie, Swift, Morley, Teslin & Yukon** **31 significant crossings**	**79.7% of route requires heavy or very heavy construction**	**34% of alignment is curves** Low gradient	**Howard's Pass; assisted.**
Watson Lake – Minaret via BCR Extension rail bed	**Multiple protected areas including Spatsizi Headwaters, Spatsizi Plateau, & Stikine River Provincial Parks** **187,675 ha of protected area within corridor** **4.42% of route within protected areas**	Woodland Caribou	Dease, Stikine, & Klappan River valleys	**Crosses Stikine Provincial Park** **Interaction with multiple protected areas**	38.1% of route within 1km of a water body Major Rivers: Mosque, Duti, Kluatan, Spatsizi, Stikine, Tansilla, Dease, Cottonwood, French, & Blue Lakes: Dease Lake **construction along Skeena River**	**68.6% of route requires heavy or very heavy construction**	**38% of alignment is curves** **Very steep gradient**	Potential but not near/medium term..

SUB-CORRIDOR	Designated Ecologically Sensitive and/or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Potential Land Use Issues	Water Bodies (Lakes, Rivers & Streams)	Surface Disturbance	Spill/ Derailment Potential Hazard	Induced Development (Mines)
Eaglenest Creek – Hazelton[1]	Multiple protected areas including Spatsizi Headwaters & Spatsizi Plateau Provincial Parks **84,225 ha of protected area within corridor** **1.77% of route within protected areas**	Woodland Caribou	Skeena, Klappan, Nass, & Kispiox River valleys	Interaction with multiple protected areas, crosses large areas of wilderness	23.9% of route within 1km of a water body	--	Approximately 1/3 curves Moderate gradient	**Kerness North and South; assisted.** **Lost Fox, Hobbit Boatch, Summit, Ground Hog Coalfield; all dependent.**
Watson Lake to Mackenzie[1]	**Multiple protected areas including Omineca, Dune Za Keyih, & Denetiah Provincial Parks** **310,509 ha of protected area within corridor** **1.77% of route within protected areas**	Woodland Caribou	Kechika & Finlay Rivers, Rocky Mountain Trench	**Crosses Dune Za Keyih, & Denetiah Provincial Parks** **Interaction with multiple protected areas**	38.1% of route within 1km of a water body **53 significant crossings**	--	25% of route is curves Gentle gradient	Potential but not near/medium term..
Watson Lake to Fort Nelson	Multiple protected areas including Liard Hot Springs & Liard River Corridor Provincial Parks **90,575 ha of protected area within corridor** **21.14% of route within protected areas**	**Woodland Caribou, Wood Bison, Hotwater Physa**	--	Alaska Highway Corridor Multiple protected areas	**55.5% of route within 1km of a water body** Major Rivers: Muskwa, Dunedin, Liard, Grayling, Deer, Smith, Rabbit, Kechika, & Dease **33 significant crossings**	36.9% of route requires heavy or very heavy construction	**34% of alignment is curves** **Low - moderate gradient**	Potential but not near/medium term.

-- Indicates a data gap
[1] – Based on a preliminary routing and subject to change if more detailed information becomes available.

Surface Disturbance

Construction activity will result in surface disturbance. Two sub-corridors offer a relatively lower extent of such disturbance. Detailed design parameters and construction practises including post-construction remediation activities offer significant opportunity for mitigation and management of this effect. Note that in areas where rock cuts are extensive, and depending on the type of rock, there is potential for acid rock drainage that can have a significant negative effect on surface water quality.

Spill and Derailment

The risk of potential spill and derailment hazard due to curvature is relatively constant to all sub-corridors (albeit slightly lower on two). Detailed design parameters offer scope for mitigation; the development and implementation of emergency response plans offers further management opportunity to address this effect. This effect is amplified where an alignment parallels within one kilometre of a water body. There is a range of amplitude evident between sub-corridors. Detailed design parameters offer significant opportunity for mitigation of this amplified effect. The extent to which the rail line can be set back from a lake or river, for example, can reduce this potential risk by reducing the chance of spill directly into a water body and by providing more time to react to prevent a spill from reaching a water body.

Habitat Fragmentation

The construction and operation of an ACRL will result in habitat fragmentation in all sub-corridors. Detailed design parameters and operational procedures offer significant opportunity to minimise and manage such fragmentation. In addition, consistent with the adoption of a "no-net-loss" habitat design and operational principle, habitat enhancements can further balance this effect.

The potential for wildlife displacement, collision, and disruption or alteration of corridors and/or ranges (direct, indirect and cumulative) is a complex issue. A "no-net-loss" operational principle provides both a target and sustainability measure to incorporate into planning, construction, and operation.

Fisheries

For the purposes of this study, it is assumed that all watercourses contain fish. Further, detailed data gathering will allow this assumption to be replaced by actual findings. Detailed design offers opportunity for reducing, on the one hand, and enhancing, on the other, fish habitat..

In addition, it is noted that current design assumptions identify the utilisation of (relatively) long bridge pipes. In the analysis it was assumed that a bridge pipe refers to a culvert. These structures range in length from 20 – 308 m depending on the alignment. The use of this type of crossing on a fish bearing stream will require careful design to ensure fish passage is maintained for all life stages.

Culverts have the potential to create a complete barrier to fish passage as a result of improper design or installation creating a hanging culvert or high water velocities through the culvert. High water velocities will be of particular significance in longer culverts where although the velocity may be within the appropriate range the length of culvert may be greater than the amount of time a fish can maintain that swimming speed. Long culverts may also create a barrier for some fish species due to the darkness in the culvert. A stream crossing that imposes a barrier to fish passage may be considered to result in a significant loss of fish habitat beyond what occurs as a result of culvert installation.

Where long bridge pipes are identified it is presumed that this is a result of a significant fill and therefore a significant amount of surface disturbance. This may also result in a significant impact on fish habitat if not mitigated. Adoption of a "no-net-loss" principle with respect to fish habitat will assist in balancing potential impacts on fisheries.

Species-at-Risk

The comparison notes that all sub-corridors hold federally designated species at risk, and some more species than others. This implies additional work will need to be done in regard to detailing actual habitat and presence of species in proximity to (possible) final design alignments, and adhering to process and management needs under federal regulation and/or federal/provincial/territorial harmonized regulation. It will be important to determine the spatial and temporal extent of identified species at risk in relation to an alignment in order to predict potential impacts. Similarly, the degree to which the final alignment traverses "roadless" areas may result in concern regarding a loss of wilderness as a result of increased access and intrusion on the landscape. While a rail corridor may have a smaller footprint than a road it does have the potential to affect the value of roadless wilderness areas.

Protected Areas

Five of the sub-corridors traverse parks and protected areas, and three to a significant degree. Such areas are so designated in large part due to the significant flora and fauna they contain, and the need for their protection. In addition, their scenic and recreational qualities are highly valued. Such areas have specialized regulatory imperatives and management strategies and plans in place that will need to be adhered to should the design of an eventual ACRL seek to traverse these areas.

Induced Development

Such development, potentially opportunistic in all sub-corridors to varying degree, goes to enlarging the environmental footprint of the ACLR due to the accumulation of environmental effects. This analysis has focused primarily on current or imminent mining potential, noting the attendant needs for increased energy production and transmission. Further ACRL design work will require comprehensive environmental assessment of such development.

It is also acknowledged that induced development may result in biophysical impacts, both positive and negative, on varying scales. In the context of this assessment the potential for cumulative effects was considered the primary issue in relation to induced development.

Climate Change

It is acknowledged that the impacts of climate change in northern Canada are becoming more apparent. Over the projected 40-year life span of the railway, climate change may result in a number of biophysical changes that are difficult to predict. Specific areas of concern include (but are not limited to):

- The potential for permafrost degradation resulting increased requirements for repair and maintenance of the rail bed,
- Changes in precipitation patterns resulting changes in avalanche patterns, river hydrographs, etc., and
- Alterations in vegetation thus watersheds and aquatic and wildlife (corridors and ranges) distributions.

Final design, construction and operation activities will need to consider adaptation to climate change. Mitigation and management plans and their implementation will need to reflect the adaptation of the bio-physical environment to climate change.

3.2 Resumé of Sub-Corridor Assessment

3.2.1 Summary of Biophysical Effects

This section provides a summary of the four scenarios from a biophysical perspective. Table 16 *Summary of Net Potential Biophysical Effects and Data Gaps, by Scenario, for all Sub-corridors* provides the reader a SEA level overview that can be used to refine the scope of subsequent work that will be required at the next level of route definition and planning. As would be expected with a project of this magnitude and potential cost, planning and route selection will be an iterative process.

There are four principal phases in the project definition where a full appreciation of the biophysical context is important. At the planning and approval stage the SEA report alerts the proponent to key issues as they relate to route selection definition, preliminary engineering considerations and the inter-related socio-economic consequences. For the responsible permitting agencies, the SEA provides a "heads-up" about the scope and potential complexity of issues that will need to be considered when the proponent prepares the more detailed environmental assessment. This process evolves once a corridor routing decision is made.

During the construction and operation phases, both the proponent and government approval agencies have roles to play in monitoring compliance with terms and conditions set out in the approval. The purpose is to ensure mitigation strategies are implemented and there are no unforeseen consequences. The SEA report contributes to this component by flagging potential risks – and to the extent of the information available – identifying the likelihood of occurrence if appropriate risk management measures are not implemented to mitigate the chances of negative consequences occurring. Not all risks can be anticipated or predicted with any certainty, though the possibility of occurrence is usually determined through statistical probability and professional judgement. From a sustainability perspective, the precautionary principle always governs. This is the reason for example, why agencies such as the Department of Fisheries & Oceans in Canada have adopted a "no net habitat loss" objective in fisheries resource management.

At the SEA level, from a biophysical perspective, the first step is to answer the question:

- Do we have enough information to establish the baseline condition and parameters for subsequent planning?

Clearly data gaps are to be expected and there is a time and cost associated with filling such deficiencies to allow planning to move forward. Time and cost is also influenced by the parameters of this evaluation. As noted at the outset and confirmed during this study, there are significant information gaps. This does not necessarily mean the information required does not exist but rather that its availability, currency and accuracy could not be verified within the study timeframe. For example, it is acknowledged that considerable information exists for the Alaska Highway routing option because of work done on highway reconstruction and for the Alaska Highway Pipeline studies. Some of this information is in the public domain and some is proprietary. In other areas little if any baseline information pertinent to this project exists. In addition, induced development will extend the ecological footprint of the rail line. At this juncture, mineral developments that are likely to proceed with or without the railroad but which may be assisted by it if it is constructed are identified as are those that have the potential to proceed but are dependent on rail line construction. Further data will need to be collected to address the cumulative effects of these developments.

If the available biophysical information is not consistent across all corridor options this can also introduce bias particularly in the qualitative assessment. It also makes it very difficult to draw any substantive conclusions about the net biophysical effect.

To that end, in Table 18, the comments recorded are intended only to "flag" the potential hotspots along each sub-corridor to help the project proponents understand the general relationships and focus subsequent work. Note that the sub-corridors are grouped under scenarios, representative of possible stages of the proposed ACRL. This scenario grouping is replicated in further detail in the integrated products of this SEA.

Table 17. Summary of net potential biophysical effects and data gaps for all sub-corridors.

SUB-CORRIDOR	NET BIOPHYSICAL EFFECT	DATA GAPS
North of Beaver Creek to Carmacks (Ladue)	Majority of route within 1 km of water bodies, surface disturbance due to construction requirements, greater relative spill/ derailment potential hazard	Effect of potential Induced development Traditional knowledge Climate change adaptation
Beaver Creek to Carmacks (Nisling)	Three SARA Schedule 1 species, over half the route within 1 km of a water body, relatively greater spill/ derailment potential hazard	Effect of potential Induced development Traditional knowledge Climate change adaptation
Beaver Creek to Whitehorse along the Alaska Highway	Direct impact on Kluane National Park and Kluane Game Santuary, wildlife corridor from Kluane National Park, relatively high number of significant river crossings, highest potential for surface disturbance of all sub-corridors	Effect of potential Induced development Traditional knowledge Climate change adaptation
Carmacks to Whitehorse	Majority of route within 1 km of a water body	Wildlife corridor, surface disturbance, water body crossings, spill/ derailment potential hazard, induced development, with two assisted mines identified; extent of effect unknown. Traditional knowledge. Climate change adaptation.
Carmacks to Watson Lake	Majority of route within 1 km of a water body, relatively high number of significant river crossings, relatively high potential for surface disturbance	Wildlife corridors, induced development with one assisted and five dependent mines identified; extent of effect unknown. Traditional knowledge. Climate change adaptation.
Whitehorse-Carcross-Skagway	Majority of route within 1 km of a water body	Wildlife corridors, spill/ derailment potential hazard, effect of potential induced development. Traditional knowledge. Climate change adaptation.
Whitehorse to Watson Lake	Land use conflicts with Alaska Highway and pipeline corridors, majority of route within 1 km of a water body, relatively high number of significant river crossings, highest potential for surface disturbance of all sub-corridors, greater relative spill/ derailment potential hazard	Induced development with one assisted mine identified; extent of effect unknown. Traditional knowledge Climate change adaptation

SUB-CORRIDOR	NET BIOPHYSICAL EFFECT	DATA GAPS
Watson Lake – Minaret via BCR Extension rail bed	Direct impact on protected areas, land use conflicts with protected areas, construction along Skeena River, relatively high potential for surface disturbance, highest relative spill/ derailment potential hazard among all sub corridors	Wildlife corridors, effect of potential induced development unknown. Traditional knowledge. Climate change adaptation
Eaglenest Creek – Hazelton	Direct impact on protected areas	Wildlife corridors, surface disturbance, water body crossings, spill/ derailment potential hazard, induced development with two assisted and four dependent mines identified; extent of effect unknown. Traditional knowledge. Climate change adaptation.
Watson Lake to Mackenzie	Direct impact on protected areas, land use conflicts with protected areas, potentially high number of significant water body crossings	Wildlife corridors, surface disturbance, water body crossings, spill/ derailment potential hazard, effect of potential induced development. Traditional knowledge. Climate change adaptation.
Watson Lake to Fort Nelson	Direct impact on protected areas, three SARA Schedule 1 species, over half the route within 1 km of a water body, relatively high number of significant river crossings, relatively greater spill/ derailment potential hazard	Wildlife corridors. Traditional knowledge. Effect of potential induced development. Climate change adaptation.

Table 18. Summary of SEA Level Biophysical Hotspots

SCENARIOS	CORRIDOR HOTSPOTS
Scenario One	
Delta Junction to Tanacross (standalone, common to remaining sub-corridors)	Refer HDR report
Tanacross to North of Beaver Creek to Carmacks (via Ladue River)	Aesthetics, land use conflicts Minto to Carmacks with proposed power line routing east side of Klondike Highway, Tantalus Bluff
Tanacross to Beaver Creek to Carmacks (via Nisling River)	Permafrost, migratory birds (wetlands), lack of biophysical information on Nisling River drainage, candidate SMA, potential for rare plants, roadless wilderness area
Tanacross to Beaver Creek to Whitehorse along the Alaska Highway	Permafrost, seismic, migratory birds (Pickhandle Lakes), Chisana caribou, major land use conflicts Kluane National Park at Slims River, Spruce beetle at Haines Junction, Bison & Elk, rare plants Takhini Valley, routing at Whitehorse
Scenario Two	
Carmacks to Whitehorse	Nordenskiold wetlands, Braeburn elk, Fox Lake (land use conflicts, aesthetics, soils and grades, routing at Whitehorse and Yukon River crossing
Whitehorse to Skagway via Carcross	Routing at Whitehorse, Yukon River crossing, Southern lakes caribou, Lewes Lake, Carcross, Bennett Lake
Scenario Three	

SCENARIOS	CORRIDOR HOTSPOTS
Whitehorse to Watson Lake (via the Alaska Highway)	Yukon River crossing & wetlands, Marsh Lake land use conflicts, Squanga Lake whitefish, Johnson Crossing Teslin River crossing), Teslin Lake Nisutlin Bay (waterfowl, grades, routing) Rancheria (aesthetics, bull trout, caribou), Liard River crossing
Carmacks to Watson Lake	Routing at Carmacks, aesthetics, Yukon River crossing, raptors, Little Salmon Lake, migratory flyway, routing at Watson Lake
Scenario Four	
Watson Lake to Fort Nelson	Liard River Crossing, Liard River Hotsprings & Corridor Park, aesthetics and multiple wildlife conflicts, unusual boreal forest bird/plant diversity
Watson Lake to Mackenzie	Roadless wilderness, important wildlife migration corridor, Kechika River drainage & Rocky Mountain trench have multiple wildlife habitat interests including Denetiah and Dune Za Keyih provincial parks,
Watson Lake – Minaret via BCR Extension rail bed	Aesthetics, Dease Lake, Stikine & Klappan Rivers, Skeena River headwaters, proximity to Spatzizi Wilderness park, multiple wildlife concerns
Eagle nest Creek – Hazelton	Kispiox, Nass, Skeena rivers have high fisheries and recreation values, encroachment into roadless valleys with high wilderness values, duplication of existing unfinished rail bed

There are key biophysical data gaps and they are large enough to merit significant additional investigation. In particular all corridors lack documentation on traditional environmental knowledge and use. Furthermore, the information gaps along each sub-corridor are large enough to suggest proceeding with caution from a biophysical perspective. The biophysical data for each sub-corridor needs to be brought up to a common base standard to effectively contribute to the selection of a preferred routing. A number of issues raised in this assessment could have substantial time and cost implications that would affect project economics. For example, a significant portion of all route segments parallel lakes and rivers within 1 km. Obviously, if the rail line follows the immediate shoreline, there is sufficient historical evidence to suggest that the spill risk and consequences thereof will be greater than if there is a significant setback. Similarly, while the number of stream crossings is generally known, it is also necessary to determine which are fish bearing and which may need to be crossed by a bridge rather than a culvert to ensure safe fish passage. Culvert length is also a key consideration.

It also follows that spill contingency planning during construction and subsequent operation should place a corresponding emphasis on water protection issues.

Once it is determined that adequate base biophysical information exists, the significance of individual and collective biophysical values can be evaluated. In some cases, impacts may be species specific as in the case of SARA listed species such as woodland caribou, while others may be very site specific (e.g. a location containing rare plants). Each routing segment will require examination in the field by scientists and engineers to ensure the final routing applies "best practices" and risk assessment methodology to moderate projected biophysical impacts.

At this stage of planning the key questions are:

- Which biophysical impacts can be predicted and mitigated and which cannot?
- What is the severity and significance of these impacts and are they independent or interdependent?
- Are the consequences of these biophysical impacts predictable and addressed in the risk assessment in terms of probability of occurrence?
- Are these impacts direct, indirect, induced and/or cumulative?

At the operations stage, the focus is on identifying those biophysical considerations that need to be monitored over the life of the railroad operation. For planning purposes, the railroad has been given a 40-year operational life. Since one of the key premises behind this project is that the rail line will facilitate development of mining resources in particular, it is logical to assume that a number of branch lines will be constructed to link potential mineral properties to the main line. Many of these mineral properties are likely to have a significantly shorter lifespan. Thus it is reasonable to assume that various branch lines will be constructed and decommissioned before any consideration is given to the main alignment.

That said, during a 40-year operating life, various biophysical impacts and associated risks would become clearer as operational history is acquired. Specifically, areas prone to avalanche, flooding and ground instability will become apparent. At the largest scale, the principal concern is likely to be climate change. There will be biophysical effects on permafrost and vegetation and there could be induced effects on wildlife movement and changes in habitat quality that aggravate predicted displacement issues. Ongoing monitoring of these adaptations to climate change offers significant research opportunity; operational adjustments to them offers applied research opportunities. Some issues will surface from operational experience such as moose mortality on the Alaska railroad that necessitated a change in snow clearing operations during the winter.

Temperature extremes can also result in equipment and rail failure leading to derailments and spills. While new technology, better materials etc may reduce the probability of accidents occurring, the reality is that accidents will happen at some point during the operational life. Appropriate monitoring and maintenance procedures are a key ingredient but are not a substitute for careful initial planning and rail routing decisions. Wherever possible, avoidance of a potential issue is the first choice followed by mitigation of potential risk.

As a railway has a relatively small linear footprint, many potential biophysical impacts can be mitigated. However some induced impacts have a substantially larger footprint especially if they are also routed in the same corridor at a later date while others would not. For example, the addition of a road or major power line would have a substantially greater impact than a buried pipeline or communication cable especially if the routing is through an existing roadless, wilderness area.

In summary, it is difficult to determine the net biophysical effects likely to occur at this stage. The SEA analysis has flagged issues based on the quantitative and qualitative information that the study team was able to obtain within the study timeframe. Data gaps are significant and much additional work will be required to allow a full comparative analysis of route segment options from a biophysical perspective. Section 2.3 provides a start while section 3.1 provides 7 broad themes that should be explored further in a detailed environmental assessment.

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