ALASKA-CANADA RAILROAD PROJECT

Incremental Expansion Project Breakout

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Preface

This short paper gives a brief history of the Alaska-Canada Rail Link Project (ACRLP) and identifies the key incremental railroad extension components of the project that can or may “stand on their own”. These individual projects are either a direct component of the ACRLP or provide necessary support features such as tidewater access. These individual projects greatly contribute to the ultimate development of the ACRLP and have business feasibility even in its absence.

A large amount of information and technical data has been produced by the University of Alaska Fairbanks (UAF) through a combination of investment in academic research and professional work on the ACRLP (see attached Summary of Work Products). Financial support to-date for this project is a combination of state and federal funding.

The Alaska Railroad Corporation is a supporter of the project and has been engaged at all levels. CN Rail has been briefed on the project and has provided technical guidance. Alaska’s Congressional Delegation is regularly briefed on the ACRLP initiative; United States Senator Lisa Murkowski has been a long-standing project champion.

1.0 State of Infrastructure in America's Far North

Alaska and Yukon are vast areas of land rich in mineral and energy resources with tremendous socio-economic value. A primary impediment to development of these resources is lack of transportation infrastructure. To be competitive in a world market, bulk commodities simply cannot be trucked great distances. Alaska is nearly 600,000 square miles with only 500 miles of railroad corridor. Yukon Territory is nearly 200,000 square miles and has no rail freight service. Combined, these two territories have mineral and energy resources with in-place gross values estimated in the 1,000's of billions of dollars; the majority of this wealth will remain stranded in the absence of heavy-haul transportation corridors.

The largest four sources of the world's coal resources in decreasing order are: Russia, Alaska, United States (contiguous) and China. Alaska's North Slope contains an estimated 5.5 trillion tons of low sulfur and high (15,000) Btu coal. The contained energy in this coal is greater than the proven petroleum resources of the entire globe. In addition to coal, less than one third of the 67 billion barrels of original oil in place in the Prudhoe Bay and Kuparuk Fields has been produced. Proven reserves of associated natural gas in these fields are estimated at 35 TCF. Estimated undiscovered conventional natural gas resources on the North Slope are estimated in excess of 100 TCF and natural gas hydrate resources are estimated at 600 TCF.

1.1 Alaska-Canada Rail Link Project Summary

The idea for connecting Alaska to the continental rail system has been around since at least the 1800s when it was proposed during the Harriman Expedition. In World War II, the Army Corps of Engineers conducted the first study of this link and surveyed a route from Prince George, B.C., to Fairbanks and on to Port Clarence at the western end of the Seward Peninsula. Given the urgent demands for steel for the war effort, the military chose instead to build the Alaska-Canada Highway.

A primary purpose of the ACRLP is to improve the economics of developing the extensive resource deposits in Alaska, Yukon, and British Columbia. With this objective in mind, U.S. Senator Frank H. Murkowski introduced the Rails to Resources Act in 2000. Passed by Congress and signed by President Clinton, the bill provided $6 million for a joint U.S.-Canada Commission to conduct a feasibility study for an Alaska Canada rail link. Due to the language of the legislation and concerns by the Canadian federal government it abstained from taking action under this legislation. In early 2005, the State of Alaska joined with Yukon Territory to conduct a joint bilateral pre-feasibility study for the rail link. The Yukon government appropriated $3 million for the study. Alaska provided $2 million of in-kind contributions by the University of Alaska, and $1 million from the Office of the Governor. The study was managed jointly by the State of Alaska and the Yukon Territory with the final report issued in 2006.

The Final Preliminary Feasibility Study for the ACRLP, released in November, 2006, shows that the Project would generate economic benefits that exceed the total costs of its construction, operation and maintenance. The Project would yield a return on investment of nearly 6% based primarily on the transport of iron ore from east-central

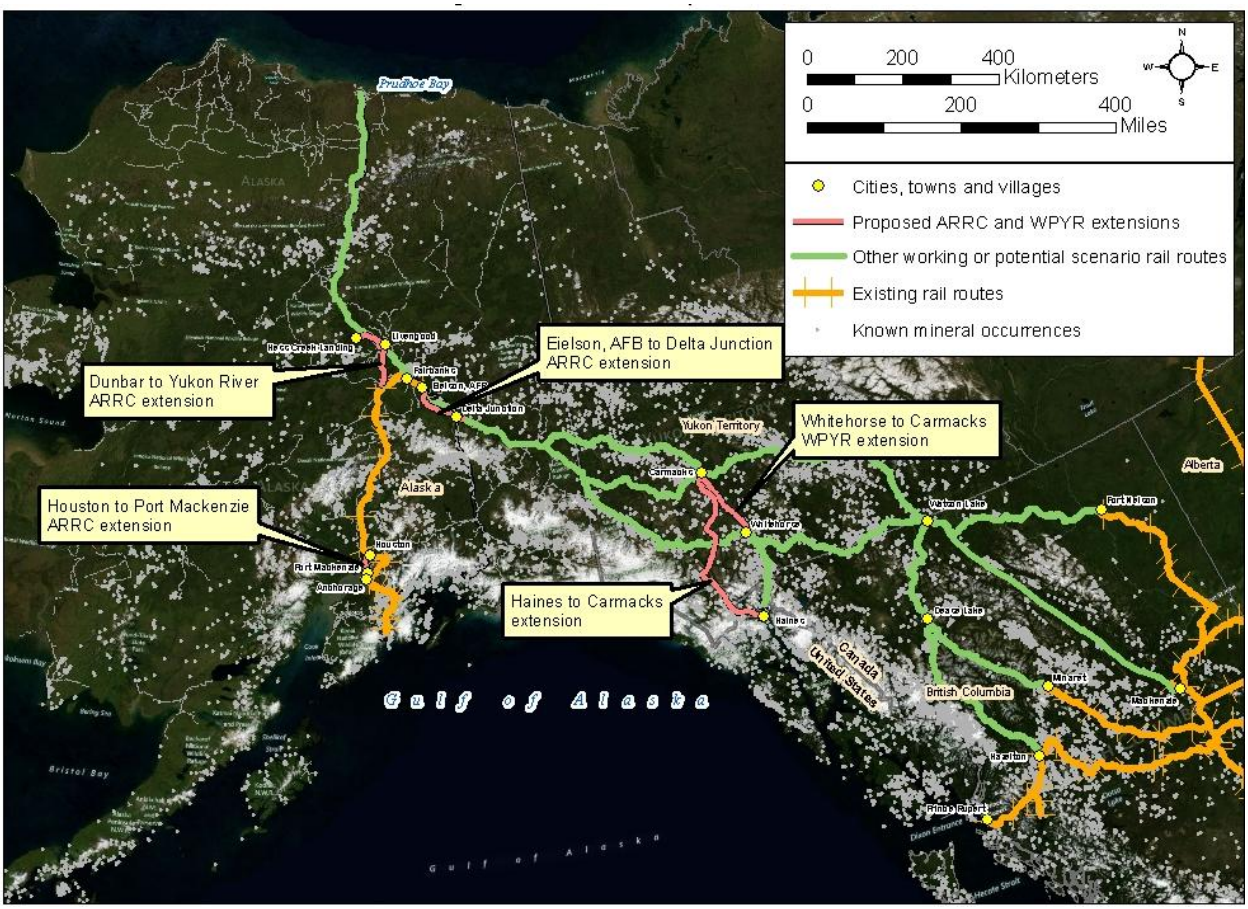
Yukon to a tidewater port in Alaska. This estimated return on investment was the first "business case" for the proposed ACRLP and makes the project competitive with other economic development investment opportunities available to the State.

In 2007, the State of Alaska provided $4.5 million to UAF to initiate preconstruction activities in support of the necessary environmental analysis and to develop data supporting railroad feasibility studies including estimates of rail freight revenues from other mineral and energy resources in Alaska, Yukon Territory, and northwestern British Columbia.

The connection would support ongoing energy developments, including construction of a natural gas pipeline, improve operating conditions of existing mines and positively impact mineral and energy exploration, resource development, and resource production. Benefits to the State are substantial and arise from increased economic development, reduced transportation costs, alternative transportation corridors, increased ports access and connection to manufacturing as well as population centers in the US and Canada and the Pacific Rim.

Figure 1-1 depicts existing and proposed corridors in Alaska, Yukon and British Columbia as included in the 2006 Preliminary Feasibility Study. The current Phase II Feasibility Study by the University of Alaska Fairbanks examines the extension of the Alaska Railroad from Fairbanks north to the Yukon River and ultimately to the energy resources of the Alaska North Slope.

Figure 1-1
Project Map Alaska-Canada Rail Link
Existing Corridors and Proposed Corridors



1.2 History of the Alaska Railroad Corporation

The Alaska Railroad was completed from Seward to Fairbanks in 1923. In 1984, ownership was passed from the federal government to the State of Alaska. The quasi-public Alaska Railroad Corporation (ARRC) and its seven-member board are established in legislation. It is owned by the state but incorporated and operated like a private business. ARRC is a self-sustaining, full-service railroad serving ports and

communities from the Gulf of Alaska to the Interior of Alaska. Revenue is generated through real estate, freight and passenger operations.

ARRC extends from Seward (milepost 0) to Anchorage (milepost 114) and on to Fairbanks (milepost 470) with branchlines to Palmer, Whittier, Eielson, Fairbanks International Airport and Anchorage International Airport. The Alaska Railroad provides seam-less transportation from points outside Alaska by use of weekly rail barge marine service. ARRC maintains ports in Seattle, Seward, Valdez and Whittier.

The Alaska Railroad is a significant economic powerhouse and moves about eight million tons of freight per year and over 400,000 passengers. ARRC continuously reinvests in its infrastructure and recent efforts include bridge rehabilitation, installation of welded rail, curvature reduction, new locomotives, centralized traffic control and positive train control.

ARRC has embraced its economic development mission statement and is pursuing a number of expansion projects. Ground was recently broke at the Tanana River Bridge project, the first step in a larger 80-mile extension that will connect Eielson to Delta Junction. In central Alaska, the EIS is completed for a 32-mile extension to Port Mackenzie.

1.3 History of the White Pass and Yukon Route Railroad

The White Pass and Yukon Route Railroad (WPYR) is a wholly owned subsidiary of Clublink Enterprises Limited (TSX:CLK). Constructed in 1898, WPYR was a year-round, full service railroad until 1982 when the railroad suspended service following a Yukon mineral market collapse. After six years in mothballs, the railroad reopened a

portion of the line in 1988 as a tourist excursion operation that blossomed into a successful business hauling about 380,000 passengers in 2011, down from a peak of nearly 480,000 in 2007.

WPYR owns 110 miles of track and right-of-way between Skagway and Whitehorse, roughly paralleling the Klondike Highway. At Skagway, WPYR owns the two-berth Railroad Dock and controls both the Broadway Dock and Ore Dock under a long-term lease from the City of Skagway. Given its proximity to Yukon's mineral resources, the ice-free Port of Skagway is typically the preferred port of export for Yukon minerals.

WPYR is currently operated as a highly profitable seasonal tourist operation and derives all of its revenue from rail passenger excursions and from port tariffs. It remains a common carrier. WPYR is currently operated as narrow gauge (36-inch) and satisfies the Association of American Railroads clearance plate B.

In its present configuration, WPYR has no freight hauling capacity in terms of track condition or rolling stock. The northernmost 40 miles of railroad have not been used or maintained since 1982. UAF analysis reveals a modernization and rehabilitation program would enable a freight operation competitive with trucks.

The State of Alaska and Government of Yukon have continuously supported resumption of rail freight service to Whitehorse.

2.0 Summary of Institute of Northern Engineering Work to-date

The UAF Institute of Northern Engineering has completed several major investigations on the economic feasibility of both extending the Alaska Railroad in-state as well as connecting the Alaska Railroad to the North American Railroad grid.

UAF has been engaged in investigations of an Alaska Canada Rail Link and railroad extensions in Alaska to access the mineral and energy resources of the State for the past decade (see attached annotated bibliography). The University has received funding from the U.S. Department of Defense, the U.S. Department of State, and the U.S. Department of Transportation passed though the Alaska Department of Transportation and Public Facilities for such investigations. Major work products have included the, "Preliminary Design and Engineering Economic Analysis of Alternate Modes of Access to the Tanana Flats Training Area, Fort Wainwright Alaska", 2005 also known as the Eielson to Delta Junction Railroad Extension and Tanana River Bridge Project"; the "Rails to Resources to Ports – The Alaska Canada Rail Link Project, Phase I Feasibility Study", 2007; data compilation for the Mat-Su Borough in support of the Borough's "Economic Analyses of the Railroad Extension from Port MacKenzie to the Mainline of Alaska Railroad and its presentations to the Alaska State Legislature in support of funding for the extension, 2008 through 2011. Over the past decade, the work has included 56 products specifically by the University of Alaska Fairbanks or its sub-contractors including 14 completed over the past twelve months.

These work products and the proposed railroad extensions to the mineral and energy resources of Alaska are very critical to the economy of interior Alaska in particular and the economy of Alaska in general. The studies have demonstrated that the 7,200 plus known mineral occurrences in Alaska and the 16,000 plus known mineral occurrences along the proposed Alaska Canada Rail Link route in Yukon Territory and northwestern British Columbia could make significant long-term contributions to the economies of the State of Alaska, the Provinces of northwestern Canada and to the

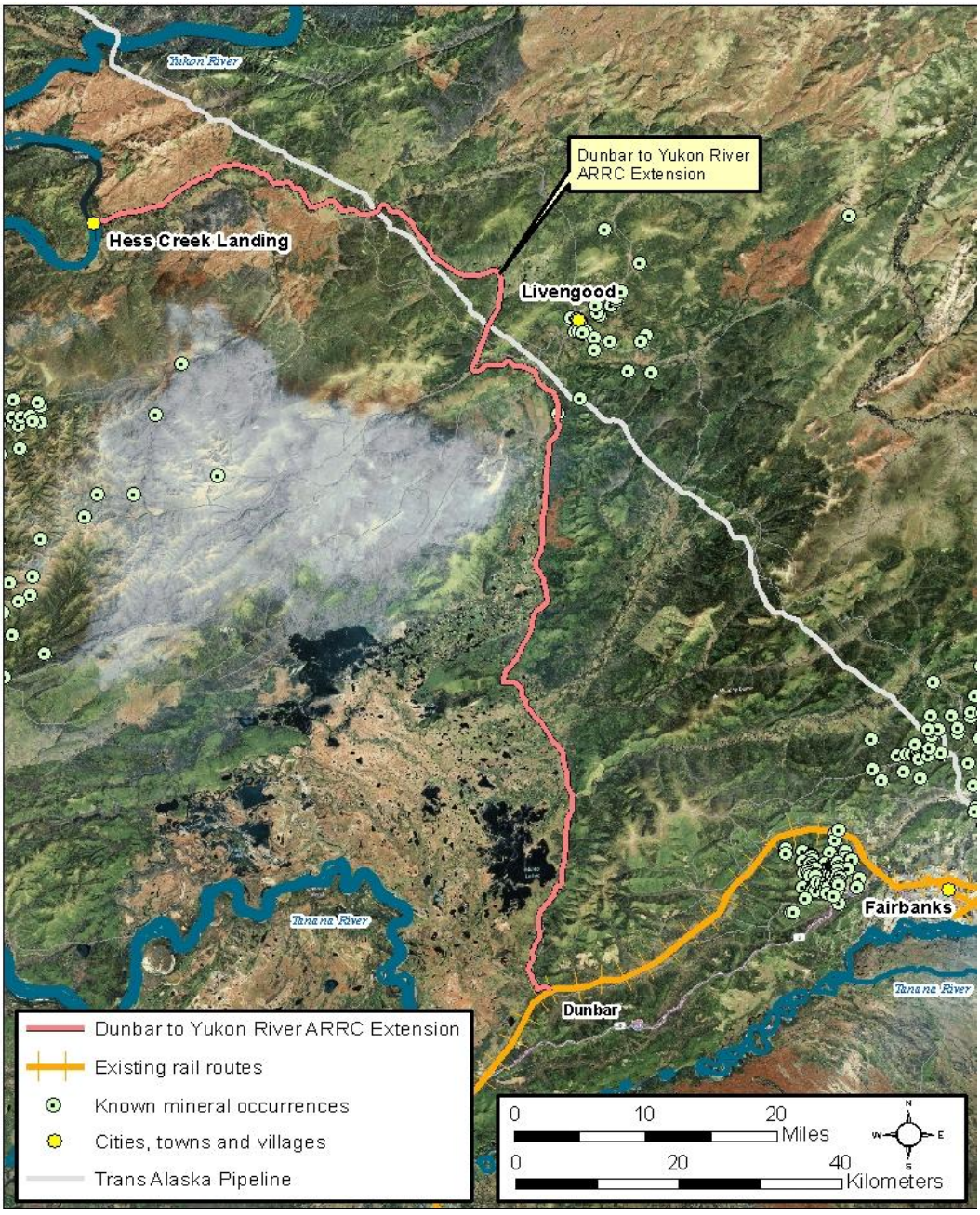
economies of the United States and Canada. The work products have also demonstrated the positive role the Alaska Canada Rail Link Project could have on the development of North Slope natural gas.

These work products and the proposed railroad extensions to the mineral and energy resources of Alaska are very critical to the economy of interior Alaska in particular and the economy of Alaska in general. Within the 100 mile-wide corridors for the Alaska Canada Rail Link and the various railroad extensions in Alaska there are 18,571 known mineral occurrences. Of these, only fifty percent (9,164 occurrences) have been assigned to particular mineral deposit models. These assignments provide a basis for estimating the potential mineral freight and gross metal value for these occurrences. Utilizing very conservative estimates for the probability one these occurrences becomes a productive mine over the next 30 years (probabilities ranging from 1 in 500 down to 5 in 10,000), it is estimated that the aggregate expected gross metal value of the 9,164 occurrences shall exceed $100 billion. Assuming the remaining 9,407 mineral occurrences fit similar mineral deposit models and have similar probabilities of development, then the total expected gross metal values shall exceed $200 billion. Comparing this expected gross metal value to the Pebble Cu-Mo-Au Project, a known mineral occurrence with proven mineral reserves with a gross metal value of at least $350 billion but located outside of the corridors, demonstrates the conservative nature of the estimated mineral endowment within these corridors.

3.0 Dunbar to Yukon River ARRC Extension

The rail extension from Dunbar, Alaska to the Yukon River (Figure 3-1) will provide rail access to the river as well as provide rail access to the significant metallic mineral resources in interior Alaska as well as to the massive Tolovana Limestone deposit. This deposit can sustain both world class lime and Portland cement production in Alaska. The lime production can supply the needs of the existing and expanding metal mining industry. The Portland cement plant will provide in-state supply for the $4.5 billion Susitna Dam complex and the large needs for drilling platforms for oil and gas development in the Chukchi Sea. This extension is approximately 114-miles and connects with ARRC mainline at Dunbar near milepost 431. Capital cost estimates for the rail extension range from $685-million to $720-million.

Figure 3-1
Dunbar to Yukon River ARRC Extension Vicinity Map



Access to the Yukon River will open a new trans-shipment corridor enabling re-supply of Yukon River from an in-land rail-based point. The Yukon River is ice-free for approximately six months each summer. Rail access will greatly enhance the productivity, effectiveness and zone of influence of river barge service.

UAF has completed a rail corridor and feasibility report and geological site investigation from Dunbar to Livengood and is expected to complete the geological site investigation from Livengood to the Yukon River during the 2012 field season. This project is sufficiently advanced that the Environmental Impact Statement (EIS) process could begin relatively quickly. The estimated cost of the EIS based on the recently completed EIS for the Eielson, AFB to Delta Junction EIS is $25 million.

This extension is the first step in a future railroad corridor to Alaska's North SIope oil fields. Alaska's North Slope is the only oil field of its size in the world without rail or 12 month tidewater access.

As with all railroad new construction projects in the US, the Surface Transportation Board (STB) will be the federal agency overseeing the environmental impact statement (EIS) in accordance with the National Environmental Policy Act (NEPA). The EIS process is estimate to take 18 to 24 months.

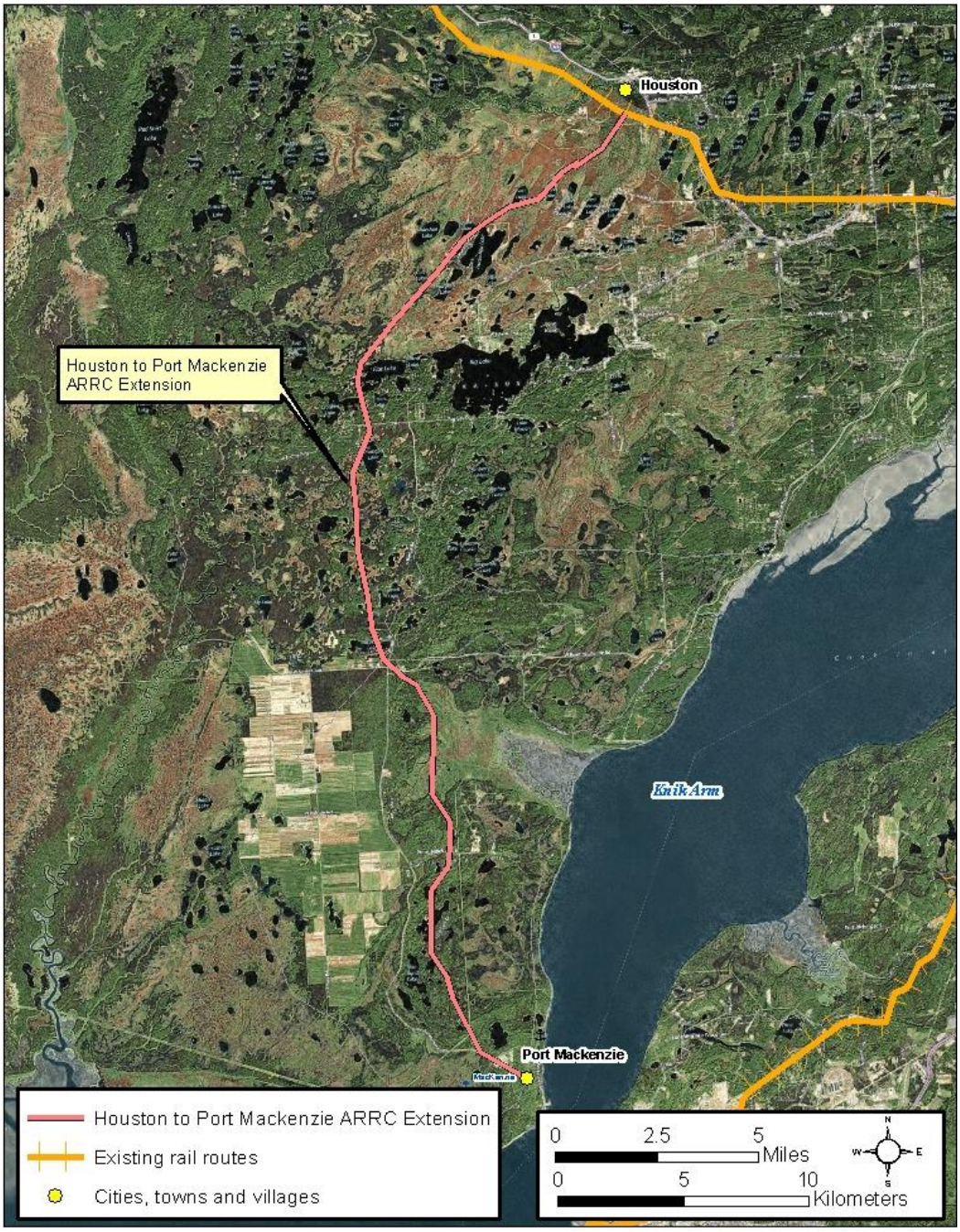
4.0 Houston to Port Mackenzie ARRC Extension

This 32-mile rail corridor will connect Port Mackenzie to the ARRC mainline near milepost 175. Figure 4-1 is a vicinity map. Port Mackenzie is an industrial port without rail access. This rail link will shorten the distance bulk commodities must travel to tidewater by about 90 miles.

Port Mackenzie is owned by the Matanuska-Susitna Borough (MSB). The Surface Transportation Board (STB) approved and released the EIS document in June 2011. MSB received $37-million from the State of Alaska to begin construction on the first phase of the project. ARRC is managing the design and construction. MSB has before the State of Alaska a $27-million funding request.

Port Mackenzie is sited on 9,000 acres of industrial zoned mostly undeveloped land. Port Mackenzie is dredge free with draft in excess of 60-feet. The project is broken into five phases; the first phase is construction of the rail embankment on the south (terminal) end. Total corridor cost is $300-million. The current timeline, funding dependent, calls for completion in 2015.

Figure 4-1
Houston to Port Mackenzie ARRC Extension Vicinity Map



5.0 Eielson, AFB to Delta Junction ARRC Extension (Northern Rail)

ARRC plans to extend the existing rail line from its existing terminus near Eielson, AFB, Alaska, 80 miles to a point near Delta Junction (Figure 5-1). The line will ultimately provide improved transportation options for the U.S. military, mass transit, and freight movement. This rail extension is a direct component of the eventual ACRLP. This project is referred to as the “Northern Rail Extension” (NRE).

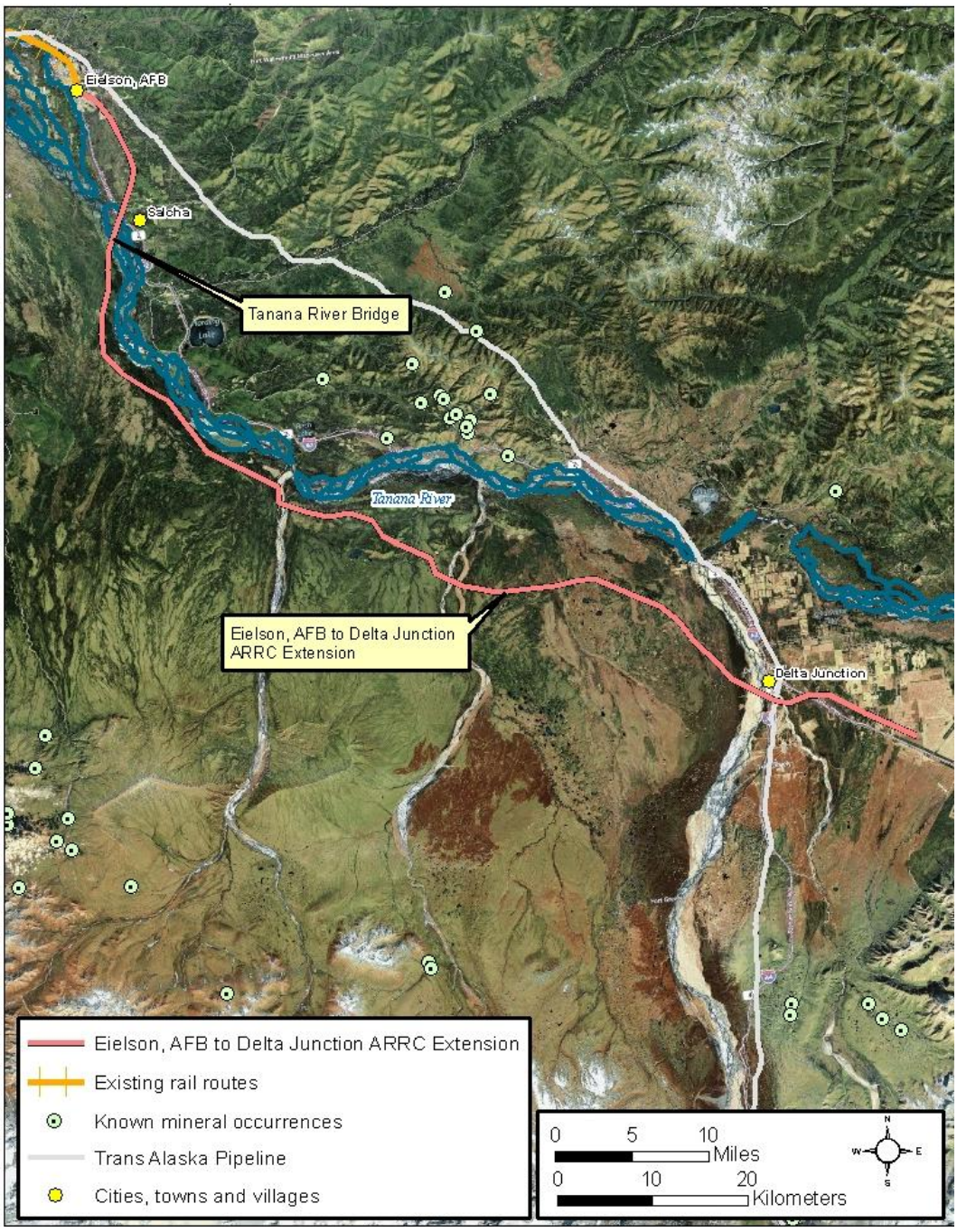
The NRE project has 4 phases. Phase 1 is construction of the Tanana River Bridge near Salcha. Construction of phase 1 began in fall of 2011. Funding for phase 1 is from state and federal sources.

Phase 2 is rail construction from Moose Creek near North Pole to the newly constructed Tanana River Bridge at the Salcha crossing. Construction for this phase is planned from 2012 through 2014, though it is funding dependent.

Phase 3 is rail construction from the Salcha crossing to the Donnelly West Training Area (TA). There is no set timeline for this phase of the project and it is also funding dependent.

Phase 4 is rail construction from Donnelly to Delta Junction. As with Phase 3, there is no set timeline for construction and it is funding dependent. The total estimated cost of the NRE less the cost of the Tanana River Bridge is $600 million.

Figure 5-1
Eielson AFB to Delta Junction ARRC Extension Vicinity Map



6.0 Whitehorse to Carmacks WPYR Extension

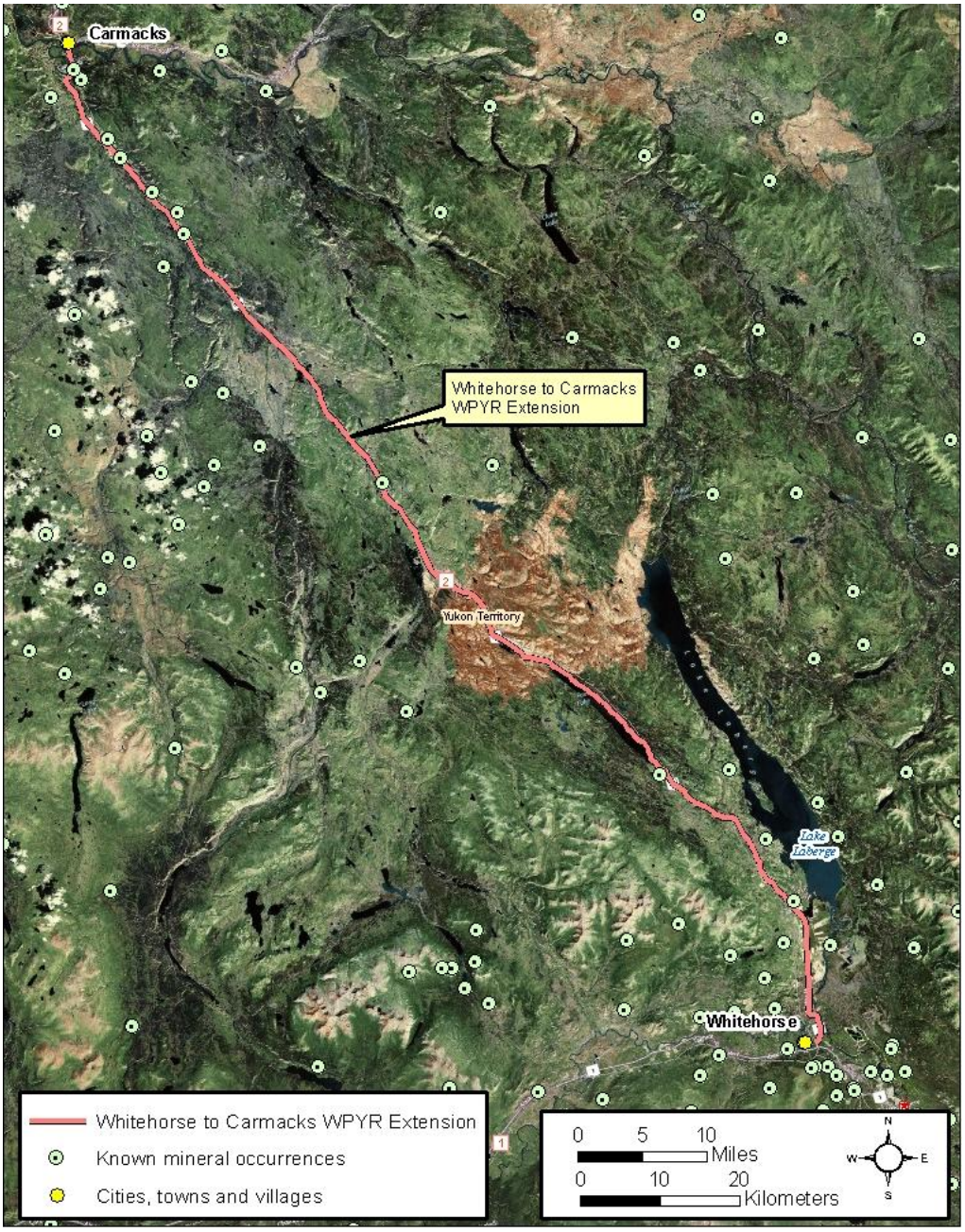
This project will upgrade WPYR and restore freight service between Yukon and the Port of Skagway; and will extend the railroad 112 miles north to Carmacks, YT. Carmacks is a 'funnel point' for Yukon's interior mineral resources. The general route is depicted in Figure 6-1. This project will eliminate costly truck haul routes for operating mines and will drastically improve conditions for future developments. This expansion will substantially reduce the cost of resupply and will enable cost effective delivery of energy such as liquefied natural gas (LNG). Integral to this rail freight option is rail-barge service to Skagway from Seattle, Vancouver and/or Prince Rupert allowing a "continuous" rail link from the lower-48 states and Canada to interior Yukon. WPYR is privately owned and development initiatives will not require legislation.

A preliminary corridor assessment with capital cost estimates between Whitehorse and Carmacks was conducted. First-cut revenue projections show favorable project economics. Rehabilitation and upgrade work on existing right-of-way between Skagway and Whitehorse will not require a full-scale environmental review. New construction beyond Whitehorse will require all appropriate environmental reviews. Early engagement with stakeholders and First Nations is crucial for successful development.

The first step is to begin a detailed feasibility study along with a corridor analysis between Whitehorse and Carmacks. Dependent upon favorable rate of return analysis, further investment can be made on the rehabilitation of WPYR with concurrent efforts starting on the Carmacks environmental permitting.

A feasibility study, corridor analysis, and environmental permitting will take 18 to 24 months with an estimated cost of $35 million. Total investment, including permitting and design costs, and rehabilitation of the existing line, ranges from $600-million to $800-million.

Figure 6-1
Whitehorse to Carmacks WPYR Extension Vicinity Map

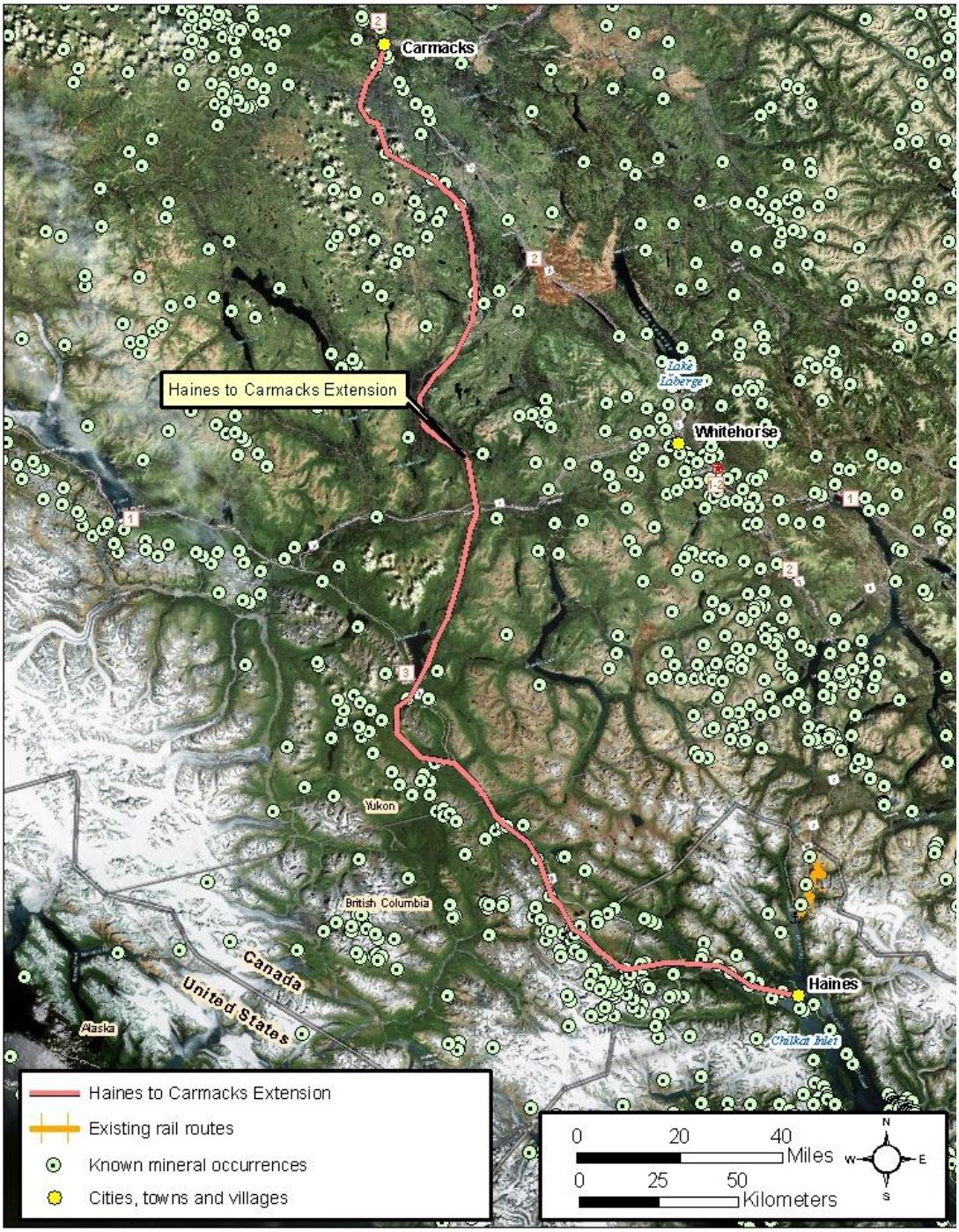


7.0 Haines to Carmacks

A rail route from tidewater at Haines, Alaska to the interior was broached in 1913 when Congress was first contemplating constructing a railroad within Alaska. Ultimately, Seward was chosen as the initial beachhead and Haines was forever since left wanting. This route received only cursory evaluation during the Phase 1 ACRLP study in 2006 as it was deemed redundant to the White Pass and Yukon Route Railroad and was determined to be overly capital intensive. A vicinity map is shown in Figure 7-1.

Haines has a few advantages over WPYR and the Port of Skagway in the way of available tidelands and potential for gentler operating grades. This project has several challenges that need evaluation including: identification of possible alignments and profiles, identification of sites for port development, solutions for routing right-of-way through developed residential areas and wildlife refuges. The estimated cost of this geotechnical evaluation is $500,000.

Figure 7-1
Haines to Carmacks Rail Vicinity Map



8.0 Estimated Capital Costs of Proposed Extension Segments

Table 8-1 summarizes the estimated capital costs for proposed extension segments for the ACRLP. These segments can provide access to tidewater for mineral and energy resources in the absence of the entire build out of the ACRLP. These are individual opportunities for the State of Alaska, the Yukon Territory and the private sector to expand the bulk transportation capabilities of Northwestern North America and facilitate the delivery of vast quantities of mineral and energy resources to North America and the Pacific Rim.

Table 8-1
Capital costs of various proposed extension segments for the Alaska Canada Rail Link Project.

Extension Route/Length in Miles	Preliminary Route Assessment and Geotechnical Eval	Preliminary Design and Permitting (EIS)	Construction	Total Capital Cost
Dunbar to Yukon River / 114	$200,00 (balance)	$35 million	$685 million	$720 million
Houston to Port Mackenzie / 32	Complete	Complete	$236 million (balance)	$300 million
Eielson, AFB to Delta Junction / 80	Complete	Complete	$600 million	$600 million
Whitehorse to Carmacks / 112	$350,000	$35 million	$765 million	$800 million
Haines to Carmacks / 200	$500,000	$60 million	$1,200 million	$1,260 million
Totals	$1,050,000	$130 million	$3,486 million	$3,616 million

Currently statutory authority for such Public Private Partnerships does not exist in Alaska. This is a critical issue in the establishment of the incentives for the private

sector to consider investment in major infrastructure projects. The University of Alaska could play a major role in addressing this issue as it fulfills its role as a facilitator of economic development in the State.

Appendix A

Mineral Occurrence Revenue Estimation and Visualization Tool (MOREV). A cooperative project between the University of Alaska Fairbanks and Michigan Tech Research Institute.

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Mineral Occurrence Revenue Estimation and Visualization Tool

A cooperative project between the University of Alaska – Fairbanks (UAF) and the Michigan Tech Research Institute (MTRI)

www.mtri.org/mineraloccurence.html

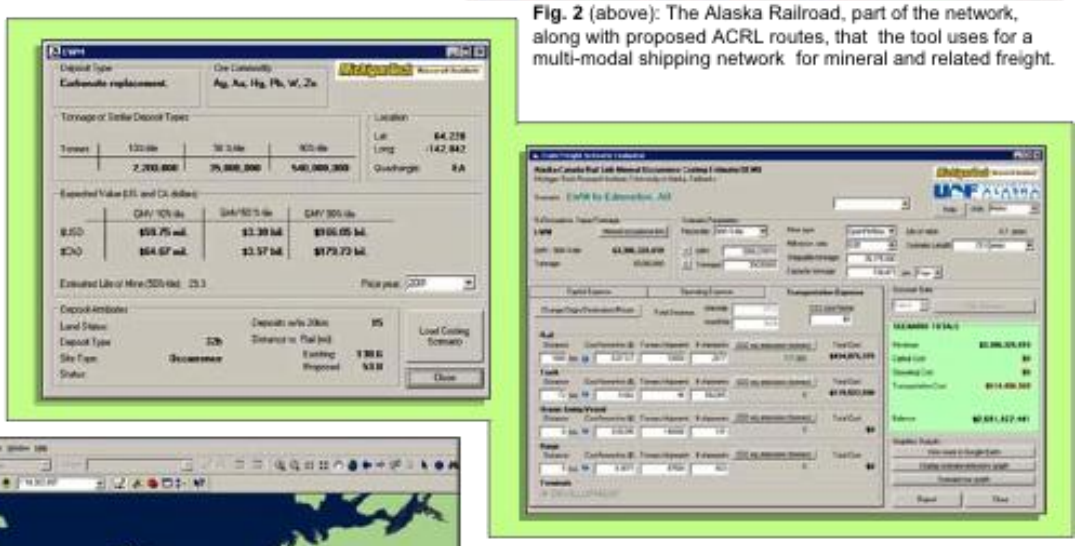
UNIVERSITY OF ALASKA FAIRBANKS

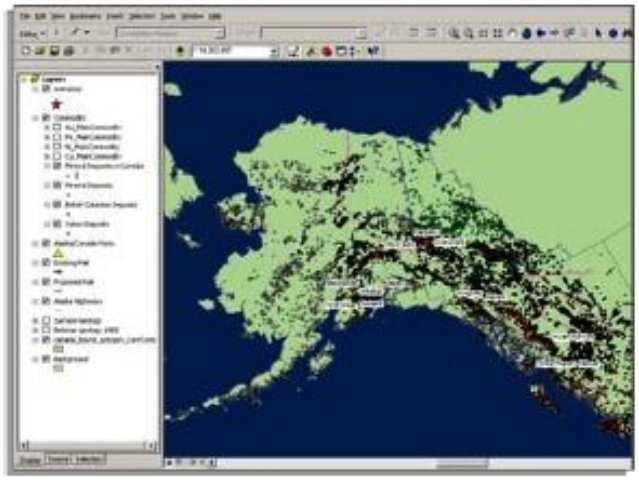
Under a cooperative project between MTRI and UAF, we are creating a flexible and map-based Mineral Occurrence Revenue Estimation and Visualization (MOREV) tool for existing and planned Alaska and Canadian railroads, including the proposed Alaska-Canada Rail Link. Estimates of carbon emissions for multi-modal shipping of mineral commodities are included in a flexible tool module.

MOREV uses existing high-quality geospatial data on metallic and non-metallic mineral resources, and other commodities for Alaska, Yukon, and British Columbia to estimate potential future revenues under pre-defined and user-generated scenarios within the existing and future railroad corridors in the region.

Fig. 2 (above): The Alaska Railroad, part of the network, along with proposed ACRL routes, that the tool uses for a multi-modal shipping network for mineral and related freight.

Fig. 1 (right): Example of the MOREV tool input tables, used to calculate revenue scenarios and transportation greenhouse gas emissions.





Within the tool, users will be able to select particular resource types and locations to retrieve what the estimated extractable resource amounts and associated revenue would be if an operational railroad existed nearby. Potential railroad routes can be displayed and customized by users to quickly evaluate the enhanced economic feasibility of currently stranded resources.

Fig. 3 (left): The GIS interface to the MOREV tool, showing mineral deposit locations in Alaska, Yukon, and B.C.

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The revenue estimation equations and relationships underlying the tool are based on expert input from a wide variety of stakeholders in the Alaska-northwest Canada region. Present military and future national security usage, including natural disaster preparedness, of a trans-continental railroad system will also be also modeled. A web-mapping version of the tool to help users understand the tool's functionality is being developed for general use in early 2011. A site-specific desktop GIS version, for detailed, in-depth analysis, will be available by contacting Colin Brooks, Dr. Paul Metz, or Dr. Robert Shuchman (see below).

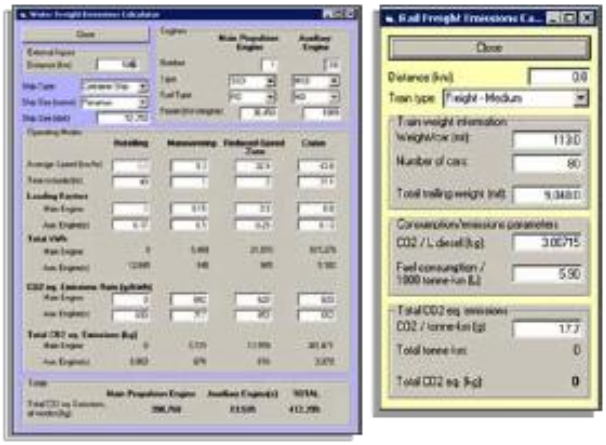

Fig. 4 (above): Examples of the detailed emissions tables used to calculate potential carbon emissions related to mineral freight shipping.

This project is part of a larger cooperative international investigation linking Alaska and Canada rail systems involving the University of Alaska, Michigan Technological University, and the University of Calgary.

Collaborators:
UAF - Dr. Paul Metz, Mark Taylor, P.E.
MTRI - Dr. Robert Shuchman, Colin Brooks, Helen Kourous-Harrigan, Eric Keefauver, Michael Billmire, Richard Dobson, Nathaniel Jessee, and Michelle Wienert
Project Consultant – Leon Van Wyhe

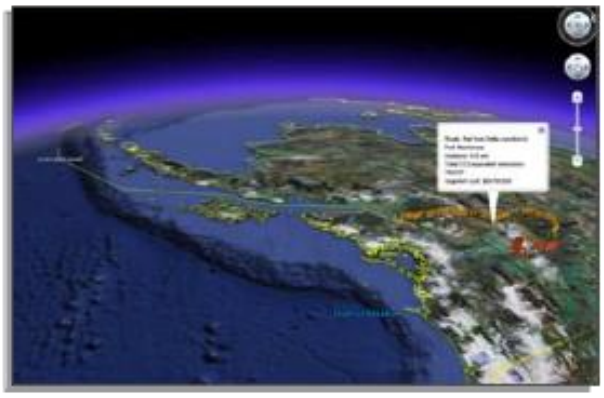

Fig. 5 (above): An example of displaying a revenue & shipping scenario in Google Earth using the tool's visualization capabilities.

Transportation Carbon Accounting Module (TCAM):

With the recent increased focus on energy efficiency and carbon accountability, the revenue estimation tool also incorporates carbon accounting to help users minimize carbon footprints. This includes calculating carbon footprints of user-selected multi-modal networks to ship mineral and supporting freight to continental and international destinations.

Fig. 6 (right): The Fort Knox Gold mine near Fairbanks, AK – the potential revenue impacts of developing new resources such as these will be easier to calculate with the MOREV tool.

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Appendix B

Alaska Canada Rail Link Project
Bibliography of Work Products Completed or In Progress That Were Conducted or Commissioned by the University of Alaska Fairbanks

Alaska Canada Rail Link Project
Bibliography of Work Products Completed or In Progress That Were Conducted or Commissioned by the University of Alaska Fairbanks

Note: The following list does not include approximately 70 additional Work Products commissioned by the Joint Working Group for the Phase I Feasibility Study. The Working Group consisted of representatives from the State of Alaska, the Yukon Territorial Government, and the University of Alaska Fairbanks in a technical advisory role. The University of Alaska has overseen the archiving of the these additional work products on a dedicated server originally operated by Gartner Lee Ltd., a Canadian geotechnical firm with offices in Whitehorse, Calgary and Toronto, Canada. The data is being migrated to a server in the United States that is being operated under a service contract from the University of Alaska Fairbanks to the Michigan Tech Research Institute in Ann Arbor, Michigan.

Completed Work Products with Annotations for 2011 Publications

1. Metz, P.A., 2011, Site characterization for a railroad extension in the sub-arctic of interior Alaska: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

    - The presentation included a discussion of the geological and geotechnical considerations for the route location of the proposed railroad extension from Dunbar siding to Livengood, Alaska. This extension would initially support the development of major mining projects in the Livengood area as well as the timber resources in this section of the Tanana Valley State Forest. The extension would support the major project goal of ultimately connecting the Alaska North Slope to the railroad grid thereby enhancing the development of the oil and natural gas fields in the region. The railroad extension would reduce the travel distance for re-supply of the North Slope from south-central Alaska by 100 miles. The route would also support the logistics for the construction of both a large diameter Trans-Continental Gas Pipeline and an In-State Natural Gas Pipeline.

2. Billings, Matt and Metz, P.A., 2011, Lime treatment of fine-grained, interior and south-central Alaska soils: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

    - The existing railroad system and the proposed extensions of the system to connect the North Slope oil and natural gas fields and major mineral resources of northern Alaska to the railroad grid in Alaska, transect either clay rich glacial morainal soils or wind blown silty soils. The project demonstrates that the bearing capacity of these soils may be increased ten fold with the addition of relatively small amounts of lime. The laboratory testing was done at low curing temperatures to model soil

temperatures in south-central and interior Alaska. Continuing work shall test the effect on lime treatment on soil permeability and frost heave susceptibility. This work is one of three M.S. theses in Geological Engineering that are expected to be completed by December 20, 2011.

3. Bohart, Charlie, 2011, Engineering economic analysis for a railroad extension from Dunbar siding to Livengood, Alaska: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

    - As noted above, the proposed railroad extension from Dunbar siding to Livengood shall enhance the economic feasibility of several major mineral occurrences that are under various stages of exploration and development in the Livengood area. The Livengood Gold Project is the most advance exploration project in the region with nearly 20 million ounces of measured, indicated, and inferred resources. Adjacent to the gold project is a potentially large Cu-Mo-Au Porphyry mineral occurrence that would require a bulk transportation system to make the project economic. Also in the area is a large resource of high purity limestone for the production of lime and Portland cement. These resources could provide the large volumes of mineral freight necessary to make the railroad extension economic. In addition to these resources, there are over 400 known critical and strategic mineral resources including Rare Earth Elements in a 50 mile wide corridor from Dunbar siding to the Yukon River. This is one of three M.S Theses in Geological Engineering that will be completed by December 20, 2011.

4. Bolz, Patti, and Metz, P.A., 2011, Geological and geotechnical site investigation for a carbon dioxide rich flue gas direct injection and storage facility: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

    - The large coal resources of interior and northern Alaska have been examined for the production of synthetic fuels, primarily Jet-A and diesel fuel. These fuels are in high demand in Alaska. The U.S. Air Force is examining the potential for the location of Coal-to-Liquids (CTL) plant in interior Alaska. A plant producing 50,000 barrels of fuel per day would require an annual coal production of 3.5 million tons. This coal would be transported to such a plant by rail along existing tracks or along several of the proposed railroad extensions included in the Alaska Canada Rail Link Project. A major constraint for the operation of a CTL plant is the capturing and sequestration of the very large volumes of carbon dioxide produced from such facilities. Rock units favorable for such sequestration have been located along the proposed railroad extensions to Delta Junction and the Canadian Border as well as to Livengood and the Yukon River.

5. Brooks, Collin, Billmire, M., Keefauver, E., Kourous-Harrigan, H., and Metz, P.A., 2011, Mineral occurrence revenue estimation and visualization (MOREV) tool for Alaska-Canada rail and mineral resource evaluation: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

    - The MOREV tool provides a systematic method for estimating mineral freight form known but undeveloped mineral resources. This is an Arc-GIS based system that can be utilized for any transportation system. It has been developed to assess the 7,000 known metallic mineral occurrences in Alaska including Critical and Strategic and Rare Earth Element minerals and the 3000 known similar occurrences in the Yukon Territory and 13,000 occurrences in northwestern British Columbia along the proposed routes of the Alaska Canada Rail Link.

6. Brooks, Colin, Helen Kourous-Harrigan, Mike Billmire, Paul Metz, D. Eric Keefauver, Robert Shuchman, Rick Dobson, K. Arthur Endsley, and Mark Taylor, 2011, Expanding Alaska-Canada Rail: Jointly Visualizing Revenue Freight, Development Cost, Mineral Commodity Value, and CO_2 Impacts. Journal of the Transportation Research Record, 10 p.

    - This work extends the MOREV tool to include the impacts of carbon dioxide emissions from the extraction and well as the transport of mineral and energy commodities. This greatly increases to functionality of the tool particularly in the event that carbon emissions are taxed in the future.

7. Bundtzen, T.K., Metz, P.A., Laird, G., Laird, C., Bolz, P., Obermiller, K., and Billings, M., 2011, Material Site investigations , Dunbar Siding to Livengood Railroad Extension Route, interior Alaska: Contract Report to Alaska Department of Transportation and Public Facilities and the Alaska Railroad Corporation, June 2011, 154 p., Map, 1 Sheet, scale 1: 120,000.

    - This work includes an engineering geologic map for the proposed railroad extension for Dunbar siding to Livengood as well as an assessment of potential material sites along the route. Excellent quality material for railroad ballast has been sampled at several localities. Test results have been received from a certified laboratory. Based on the outcrop distribution only, there is a high probability of large amount of excellent construction material in the northern portion of the railroad extension near Livengood.

8. Ferrel, S. M., and Lautala, P. T., 2011, Rail embankment stabilization techniques for permafrost: Assoc. of Environmental and Engineering Geologists Annual Meeting, Anchorage, September 19-24, 2011.

- This is an extract of material included in a sub-award contract to the Railroad Engineering Program at Michigan Technological University entitled, “Best Practices for Railroad Construction and Operation in Areas of Permafrost and Deep Seasonal Frost”. This paper specifically addresses various techniques for stabilizing embankments for railroads constructed in permafrost terrains. This work is based on site visits to China, Russia, Sweden, Norway, Finland, Canada, and Alaska.

9. Zhenhua, Rui, Metz, P.A., Reynolds, D.B., Chen, Gang, and Zhou, Xiyu, 2011, An analysis of pipeline construction cost overruns: International Journal of Oil, Gas, and Coal Technology, 5(1). Accepted for publication in January 2012.

    - A major original goal of the Alaska Canada Rail Link Project was to examine the impacts of the rail link on the economics of the construction of a large diameter Trans-Continental Natural Gas Pipeline. Pipeline cost escalation and over-supply of natural gas in the contiguous states have had a major negative impact on the economics of North Slope natural gas production. The following three papers address some of the issues with respect to the cost overruns for pipelines.

10. Zhenhua, Rui, Metz, P.A., Reynolds, D.B., Chen, Gang, and Zhou, Xiyu, 2011, Historical pipeline construction cost analysis: International Journal of Oil, Gas, and Coal Technology, 4(3), p 244-263.

    - See comments above.

11. Zhenhua, Rui, Metz, P.A., Reynolds, D.B., Chen, Gang, and Zhou, Xiyu, 2011, Regression models to estimate pipeline construction costs: Oil & Gas Journal, 109(14) p. 120-127.

    - See comments above.

12. Metz, P.A., 2011, Natural Resource Development and Port MacKenzie Rail Extension: Presentation to the Senate Finance Committee, Alaska State Legislature, February 23, 2011, 6 p.

    - Presentation on the significance of the Port MacKenzie Rail Extension to mineral and energy development along the transportation corridor from the Port to interior Alaska.

13. Brooks, C., Metz, P.A., and Shuchman, R., 2011, Mineral Occurrence Revenue Estimation and Visualization Tool: Michigan Tech Research Institute and University of Alaska Fairbanks Pamphlet, February 2, 2011, 2 p.

    - Pamphlet to be distributed to potential users of on-line version of the tool.

14. Shuchman, R., Brooks, C., Billmire, M., Kourous-Harrigan, H., Keefauver, E., Metz, P.A., and Taylor, M.L., 2011, Transportation Carbon Accounting Module: Michigan Tech Research Institute and University of Alaska Fairbanks Pamphlet, February 2, 2011, 2 p.

    - Pamphlet to be distributed to potential users of on-line version of the module.

15. Metz, P.A., 2010, Coal-to-Liquid Fuels Production: Key to U.S. Economic Prosperity and Energy Security: Arctic International Mining Symposium, Alaska Miners Association, Fairbanks, Alaska March 9-13, 2010.

16. Bohart, C., Thorum, E., and Metz, P.A., 2010, Dunbar-Livengood Rail Extension Pre-feasibility Study: Arctic International Mining Syposium, Alaska Miners Association, Fairbanks, Alaska March 9-13, 2010.

17. Brooks, C., Shuchman, R., Kourous-Harrigan, H., Keefauver,E., Billmire, M., Dobson, R., Jessee, N., Wienert, M., Taylor, M., and Metz, P.A., 2010, Mineral Occurrence Revenue Estimation and Visualization Tool – *A System for Evaluating Potential Revenue and Greenhouse Gas Emissions from Mineral Resources for Existing and Expanded Rail Networks in the Alaska –Northwest Canada Region:* Arctic International Mining Syposium, Alaska Miners Association, Fairbanks, Alaska March 9-13, 2010.

18. Brooks, C., P. Metz, M. Billmire, D.E. Keefauver, H. Kourous-Harrigan, R. Shuchman, R. Dobson., 2010, Expanding Alaska-Canada Rail: Visualizing Mining Revenue and CO2 Impacts. Proceedings of the 2010 ESRI International User Conference, San Diego, CA.14p.(ESRI put a version of the paper online here:
http://proceedings.esri.com/library/userconf/proc10/UC/papers/pap_1399.pdf).

19. Li, Hui, 2009, Experimental and numerical study of sonic wave propagation in freezing sand and silt: unpublished University of Alaska Fairbanks, Ph.D. dissertation, 171 p.

20. Metz, P.A., Miller, S., and Thorum, E., 2009, Annotated Bibliography of the Alaska Railroad: unpublished University of Alaska Fairbanks report, 19 p.

21. Kumar, Pradeep, 2008, Planning and design of material handling system for sand and gravel: A case study, Port Maxkenzie area, Matanuska-Susitna Borough, Alaska: unpublished University of Alaska Fairbanks, M.S. Project Report, 42 p.

22. Jing, Liping, M.S., 2008, Modeling the dynamic active layer in permafrost with GIS-based terrain and climatic data analysis: unpublished University of Alaska Fairbanks, M.S. thesis, 66 p.

23. Penjore, Tshering, 2008, Aggregate resources and aggregate processing plant in Port MacKenzie area, Matanuska-Susitna Borough, Alaska: unpublished University of Alaska Fairbanks, M.S. Project Report, 35 p., Appendices A-C.

24. Rai, Pravat, 2008, Lime stabilization on the Railroad Extension to Port MacKenzie, Matanuska-Susitna Borough, Alaska: unpublished University of Alaska Fairbanks, M.S., Project Report, 42 p, Appendices 1-7.

25. Metz, P.A., 2008, Landslide risk assessment near Denali National Park and Preserve, Alaska: Program and Abstracts, Assoc. of Engineering Geologists Annual Meeting, New Orleans, September 15-21, 2008.

26. Metz, P.A., and Li, Hui, 2008, Mineral freight forecasts and expected gross metal values for mineral occurrences in the Alaska Canada Rail Link Corridor: Arctic International Mining Symposium, Fairbanks, Alaska, March 18-22, 2008.

27. Metz, P.A., Dhungana, J.R., D'Chuna, N., Thorum, E., and Miller, S, 2008, Route locations and summary of benefits to Alaska from the Alaska Canada Rail Link: Arctic International Mining Symposium, Fairbanks, Alaska, March 18-22, 2008, Map 1 sheet, scale 1:1,000,000.

28. Wiltse, Nathan, 2007, Feasibility simulation and risk analysis of a rock quarry operation site at Flag Hill, Interior, Alaska: unpublished University of Alaska Fairbanks M.S. Project Report, 66 p., Appendices 1-3.

29. Metz, P.A., 2007, Expanding resources and economic development frontiers through the Alaska gas pipeline and Alaska Canada rail link: 3rd Annual Alaska Oil & Gas Symposium, Anchorage, Alaska, September 17-18, 2007.

30. Boland, K., Metz, P.A., and others, 2007, Alaska Canada rail link feasibility study, Phase I Final Report: Contract Report to Alaska Department of Transportation & Public Facilities and U.S. Department of Transportation, May 2007, 71 p.

31. Metz, P.A., 2007, Alaska Railroad extension – Port MacKenzie to the Canadian Border: Advantage Northern: Resource Development and Northern Transportation Conference: Whitehorse, YT, May 28-30, 2007.

32. Metz, P.A., 2007, Mineral occurrences along the Alaska Railroad extension – Port MacKenzie to the Canadian Border: Alaska Miners Association, Fairbanks, Alaska, April, 2007.

33. Metz, P.A., 2007, Mineral occurrences along the Alaska Railroad extension in Alaska and Northwestern Canada: Regional Meeting, Society of American Military Engineers, Anchorage, Alaska, March, 2007.

34. Staff, Alaska Canada Rail Link Working Group, 2006, The Alaska Canada Rail Link Project Pre-Feasibility Study: unpublished Working Group Report, November 2006, 173 p.

35. Blaszak, Michael, 2006, Alaska Canada Rail Link Feasibility Study – Project Finance Regulatory Review: Van Horne Institute, University of Calgary Final Report to the University of Alaska Fairbanks, October, 2006, 36 p.

36. Staff, HDR, Inc., 2006, Cost-benefit Analysis for the Alaska Canada Rail Link: HDR/HLB Decision Economics, Inc. Final Report to University of Alaska Fairbanks, October 27, 2006, 57 p.

37. Staff, Lockheed Martin Space Operations (LMSO), 2006, Alaska Canada Rail Link Feasibility Study Phase I – Analysis of Rail Link Impact on North Slope Development, Current Transportation Risks, and Shared Corridor Synergies: LMSO Final Report to University of Alaska Fairbanks, June, 2006, 96 p.

38. Staff, Lockheed Martin Space Operations (LMSO), 2006, Alaska Canada Rail Link Feasibility Study, Market Analysis of Current and Future North Slope Oil and Gas Activity: LMSO Final Report to University of Alaska Fairbanks, May, 2006, 70 p.

39. Metz, P.A., 2006, Site selection for a major petrochemical complex in Alaska: Assoc. of Engineering Geologists Annual Meeting, Boston, Nov 1-3, 2006.

40. Metz, P.A., 2006, Mineral freight forecast for the Alaska Canada rail link project: International Workshop on the Alaska Canada Rail Link, Vancouver B.C., April 5-6, 2006.

41. Metz, P.A., Bundtzen, T.K., and Donnellan, B, 2006, Current and intermediate term supply and demand for limestone in Alaska: Arctic International Mining Symposium, Fairbanks, Alaska, March 13-17, 2006.

42. Metz, P.A., 2006, Mineral occurrences and potential sources of freight for the Alaska railroad extension – Fairbanks to the Canadian border: Arctic International Mining Symposium, Fairbanks, Alaska, March 13-17, 2006.

43. Metz, P.A., 2005, Pipeline Development in Arctic and Sub-Arctic Regions: Northern Transportation Conference: Yellowknife, NWT, Canada, November 9-11, 2005.

44. Metz, P.A., 2005, Opportunity and Risk Analysis of the Alaska/Canada Rail Link: Project Workshop on the Alaska/Canada Rail Link, Whitehorse, YT, Canada, November 2-3, 2005.

45. Jing, Liping, Zhou, Wei, Li, Hui, and Metz, P.A., 2005, Modeling the dynamic active layer inpermafrost with GIS-based terrain and climatic data analysis: Assoc. of Engineering Geologists Annual Meeting, Las Vegas, Sept 19-24, 2005.

46. Metz, P.A., 2005, Preliminary design and engineering economic analysis of alternate modes of access to the Tanana Flats Training Area, Fort Wainwright, Alaska: Final Contract Report to U.S. Army Alaska, June 2005, 414 p.

47. Metz, P.A., 2005, Mineral and energy resources along the Alaska rail corridor: Alaska Canada Rail Link Corridor Conference, Prince George, B.C., Canada, April 7-8, 2005.

48. Metz, P.A., 2004, Assessment of the geologic hazards along the proposed routes of the Alaska Natural Gas Pipeline: Association of Engineering Geologists 47th Annual Meeting, Dearborn, Michigan, September 2004.

49. Metz, P.A., 2004, Energy, minerals, and infrastructure requirements in support of a petrochemical industry in interior Alaska: Alaska Miners Association, 19th Biennial Conference on Alaska Mining, Fairbanks, Alaska March 15-19, 2004

50. Metz, P.A., 2003, Extension of the Alaska Railroad from Fairbanks to Big Delta: Report Fairbanks North Star Borough Railroad Task Force, 15 p., Maps, 10 sheets, scale 1:63,360.

51. Metz, P.A., 2002, Geologic hazards along the proposed routes of the Alaska natural gas pipeline: Association of Engineering Geologists 45th Annual Meeting, Reno, Nevada, September, 2002.

52. Metz, P.A., 2001, Alaska/Canada rail link – A component of a North American energy transport system: Proceedings of Conference on Alaska/Canada Rail Link, October 10, 2001, Fairbanks, Alaska, 15 p.

53. Metz, P.A., 2001, Testimony before the Alaska State Legislature Joint Committee on Natural Gas Pipelines, August 15, 2001, Fairbanks, Alaska, 2 p., Map, 1 sheet, scale 1:1,000,000.

54. Metz, P.A., 2001, Alaska mineral resources and the Alaska/Canada rail link: Alaska/Canada Rail Link Roundtable Meeting, Calgary Chamber of Commerce, August 8, 2001, Calgary, Alberta, Canada, 2 p.

55. Metz, P.A., 2001, Testimony before the Alaska Legislature Joint House Committee on the status of the Alaska-Canada rail link, February 20, 2001, Juneau, Alaska, 2 p., Maps, 3 sheets, scale 1:1,000,000.

56. Metz, P.A., 2000, Mineral resources along the proposed extension of the Alaska Railroad from Fairbanks to the Canadian Border: Conference on the Alaska-Canada Rail Link, Vancouver, B.C., January 20, 2000.

Work In Progress

Lautala, P.T., 2011, Best Practices for Railroad Construction and Operation in Areas of Permafrost and Deep Seasonal Frost: Railroad Engineering Program, Michigan Technological University Final Contract Report to the University of Alaska Fairbanks, expected completion of final editing, November 30, 2011.

- Includes site visits to operating railroad systems in Alaska, Canada, Russia, China, Finland, Sweden, and Norway. This is the most current and complete compilation and analysis of railroad engineering practices in colds regions.

Billings, Matthew, 2011, Lime treatment of fine-grained, interior and south-central Alaska soils – A potential method of embankment stabilization for transportation systems: M.S. student in Geological Engineering, expected graduation December 2011.

- See comments in previous section for the same author

Bohart, Charles, 2011, Engineering economic analysis for a railroad extension from Dunbar siding to Livengood, Alaska, unpublished University of Alaska Fairbanks M.S. thesis, defense completed, final editing expected completion November 15, 2011.

- See comments in previous section for the same author

Metz, P.A., Taylor, M.L., and Van Wyhe, Leon, 2013, Alaska Canada Rail Link Feasibility Study, Market Analysis of Current and Future North Slope Oil and Gas Activity: Update of LMSO Final Report to University of Alaska Fairbanks, May, 2006, 70 p.

- A major focus of the Phase I Feasibility Study was the assessment of the impact that a railroad link to the North American railroad grid would have on the construction of a Trans-Continental Natural Gas Pipeline from the North Slope of Alaska to the Calgary Hub or on to the Chicago area. Since the Lockheed Martin Space Operations Report in 2006, there have been significant changes in the plans for a Trans-Continental natural gas pipeline to commercialize North Slope natural gas. This work product will assess the impact that the various proposed railroad extensions will have on the various alternatives for commercialization of North Slope natural gas. It is proposed that this product be completed at the end of the not cost time extension to include all of the natural gas commercialization alternatives that exist at that time (December, 2013).

Taylor, P., 2011, Livengood Railroad Corridor Report: Pacific Contract Company: editing of draft report, expected completion November 30, 2011.

- Assessment of alternate routes for proposed railroad extensions from the Dunbar siding to the Yukon River. Report includes estimated capital costs and a preliminary engineering economic analysis.

Thorum, Elliot, 2011, Economic Analysis of Trolley Assisted Ore Truck Haulage in Potential Large Open Pit Mines in the Alaska: M.S. student in Geological Engineering, expected graduation December 2011.

- Trolley assisted ore truck haulage system could reduce the demand for low sulfur diesel fuel at a particular mine site and thus would reduce in-bound rail freight requirements. In-bound freight requirements generally range between 5% and 10% of the out-bound freight from base metal, iron ore, coal, and industrial mineral mines. Reducing the cost of energy for these deposit types has the potential to significantly increase the economics of mines in a transportation corridor if that corridor includes a power distribution system as well as a railroad. The results of the research demonstrate that even medium scale mines can benefit from trolley assisted haulage systems in the transportation corridor from Dunbar siding to the Yukon River.

Zhenhua, Rui, 2011, Regression models to estimate pipeline construction costs and analysis of pipeline cost overruns, Interdisciplinary Ph.D. Program, dissertation; defense schedule for November 16, 2011; expected graduation, December 2011.

- See comments in previous section for papers by same author

Proposals Submitted to ADOT & PF for Work Related to Previous ACRL Investigations

1. Alaska Railroad Master Plan: Alaska Department of Transportation and Public Facilities, $1,100,000.

    - The Alaska Railroad Master Plan would benefit from the large volume of data and reports generated by the Alaska Canada Rail Link Project. The plan must include provisions for the route locations necessary to connect the major mineral and energy resources of Alaska with a bulk transportation system provided by the Alaska Railroad Corporation. Incorporating this data in the short time period necessary to comply with the federal mandate to have such a plan in place by the end of 2012 shall be a challenge. To date there has been no reply to the proposal

2. Western Alaska Transportation Corridor Assessment and Mineral Freight Forecast: Alaska Department of Transportation and Public Facilities, $404,130.

- The Alaska Department of Transportation and Public Facilities has proposed the construction of roads to Nome and to the Brooks Range Copper Belt to provide road access to the mineral resources in the regions. This proposal provides for the application of the mineral freight forecast tools developed for the Alaska Canada Rail Link Project to assess of all the mineral resources along the various road corridors to western and northern Alaska. This tool can be utilized to estimate the expected tonnages of mineral and energy materials that may occur in the regions and thus determine the most appropriate method or methods for developing transportation systems within a transportation corridor. To date there has been no reply to the proposal.

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