EVALUATION OF RIVER PORT AND ROAD NETWORKS TO SUPPORT MINERAL DEVELOPMENT IN WESTERN ALASKA

ABSTRACT

The results of a comparative analysis of three potential river port sites and associated road networks to support mineral development activity in western Alaska are reported in this paper. A 50,000-square-mile area of western Alaska bounded by the Yukon and Kuskokwim rivers is experiencing accelerated mineral exploration and mining activity. One potential project, with 11 million ounces of drill measured and indicated gold resources and 16 million ounces of drill inferred gold resources would require annual delivery of between 240,000 and 470,000 tons of fuel and equipment. Geologists estimate that an additional 17 million ounces are likely to be discovered within the study area during the next 25 years.

Three potential river port locations and associated road corridors that could support anticipated, large-scale mining operations within the study area evaluated using a benefit-cost study approach. Two of the port and road corridor options generate estimated net present benefit values that exceeded estimated net present cost values. The port and road corridor option with the highest positive net present benefit value may not provide sufficient capacity to meet the area's logistical requirements, and two ports may be built to support anticipated mineral development activities.

By Kenneth M. Lemke

EVALUATION OF RIVER PORT AND ROAD NETWORKS TO SUPPORT MINERAL DEVELOPMENT IN WESTERN ALSASKA

Alaska is the largest state in the U.S. in land area, 3rd smallest in population, and the least densely populated. Approximately 67 percent of Alaska's population and jobs, and almost 100 percent of the land, is non-urban. About 92 percent of Alaska's roads are rural. Federally owned lands amount to 66 percent of the state's land area.

The 49th state is one-fifth the size of the rest of the states put together. Alaska is 1,420 miles (2,270 km) north to south and 2,400 (3,840 km) miles east to west. Of the 13,635 miles of roads in Alaska, the state controls approximately 43 percent and the federal government controls approximately 19 percent. Ownership of nonfederal rural roads consists of about 55 percent by the state; 22 percent, boroughs; and 23 percent, municipal and other categories (National Association of Development Organizations, 2003).

Alaska is the only state without a state-funded road construction program and is highly dependent on funding from the federal government (Denali Commission, 2003). The Alaska Department of Transportation and Public Facilities (ADOT&PF) is responsible for highways, transit, ferries, airports, ports, and harbors. ADOT&PF is more limited than most state departments of transportation because the state does not have a revenue source dedicated to funding of transportation projects. Most states have established highway trust funds supported by state gas taxes, motor vehicle excise taxes, licensing fees, and other transportation-related user fees. In Alaska, each transportation project and program must compete not only with other transportation projects but also with the other pressing social and infrastructure needs of the state to qualify for funding.

In 2001, ADOT&PF began work on the Northwest Alaska Transportation plan—one of a series of regional, multimodal transportation plans that are part of the Statewide Transportation

Plan. Final adoption of the Northwest Alaska Transportation plan is planned for spring 2004. Major goals of the plan are to improve year-round mobility and access for residents, and to broaden and diversify the region's transportation network.

Due to the remote and largely undeveloped character of the region, conventional methods for determining the value of system improvements used in typical urban and rural settings were not helpful and a two-pronged approach was employed. One prong aimed at an analysis of regional resource transportation needs and the second prong aimed at improving connections or access between communities in the region. Early discussions with regional leaders confirmed that the significant resource development issues in northern Alaska called for separate plans for the two major components

A Phase I Report (CH2M HILL, 2001) describes the region's mineral and energy resources and identifies traditional transportation systems currently in operation and potential transportation corridors that could be used in the future to access and transport natural resources. ADOT&PF used the results of Phase I to narrow the range of options under consideration and to select corridors that warranted further review and development. One project selected for further review was development of a Yukon River port and road network to support development of the mineral rich Tintina Gold Belt. This paper describes the benefit-cost approach used to determine planning level feasibility of such a port and road network.

Study Area

The 50,000-square-mile study area is bounded by the Yukon River on the north and west, the Kuskokwim River on the south, and the Nixon Fork mining district on the east. The study area does not lie within an organized borough (Alaska's version of counties). Lands within the study area include two national wildlife refuges; federal, state, a limited amount of private land;

and on the periphery, some military land (Figure 1). The military land consists of a Department of Defense radar site at Takotna Mountain, near McGrath.

Figure 1 Study Area
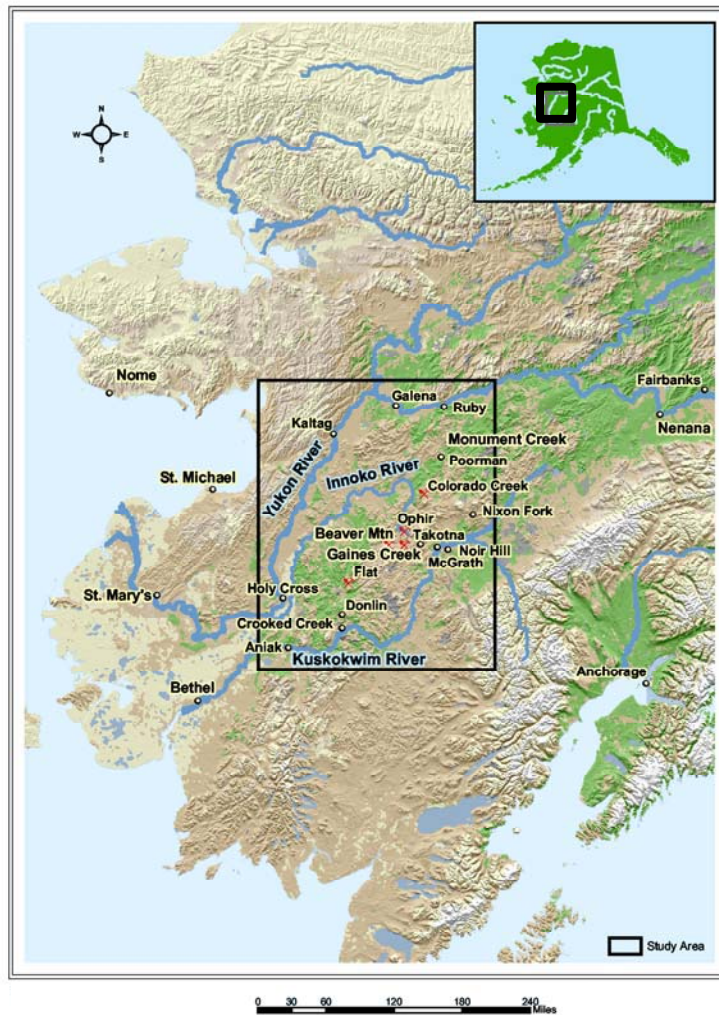
Prepared by CH2M-Hill from:
    USGS, Statewide vegetation/land cover, 1991
    USGS Alaska field office, 300m dem, 1997 Alaska in Maps

In 2002, approximately 5,800 people lived in 22 villages within the study area. Galena with 713 residents on the Yukon River is the largest village within the study area. In 2002,

unemployment averaged 19.2 percent within the region (Alaska Department of Labor and Workforce Development, 2002).

Residents of the study area are primarily Athabaskan Indians and the day-to-day economy is based on a blend of full and part-time jobs and subsistence activities. Subsistence is an essential element of the region's economy. Native residents hunt marine mammals and large and small game including birds. They fish year-round and collect eggs, berries, grasses, and other foods and products seasonally. The area's Regional Native Corporation—Doyon, Limited is a focal point for economic development. Its primary businesses include mineral resource development and commercial enterprises.

The majority of the communities in the study area are accessible primarily by air. Inter-community overland travel is predominantly by snowmachine in the winter and ATV in the summer where possible. Small commuter airlines based in Fairbanks serve the villages with passenger and bypass mail service. Most freight and fuel arrives in the area via barge service; however, there are several communities that fly in some freight and fuel via DC-6 aircraft. There is no waterborne commercial passenger service in the area. Personal watercraft is the main mode of waterborne travel between communities located on the rivers.

Information on the volume of freight and fuel delivered to the study area is inferred from data collected for a much larger geographic area and from interviews with barge operators that serve the area (CH2M HILL, 2001). These estimates vary widely, particularly for freight. In 2002, from 4,300 to 29,200 tons of freight and from 5.2 million to 7.9 million gallons of fuel were delivered to the study area by barge. An additional 8,443 tons of freight were delivered by air. The water-transported deliveries to villages along the Yukon River were primarily by shallow-draft barges from Nenana, which is 53 miles southwest of Fairbanks. Barge deliveries

to coastal villages are completed by a combination of large ocean-going barges and lighters. Typically, line-haul ocean barges move fuel and freight from Cook Inlet or Puget Sound to ports at Bethel or Saint Michael for off-loading and transportation to coastal villages by lighters.

The study area is located in the western half of the Tintina Gold Belt, which extends across central Alaska and Canada and is one of the major gold belts of the world. A large-scale mineral development activity, the Donlin Creek Mine, is being planned near Crooked Creek in the southern part of the study area. Construction of the Donlin Creek Mine, which is expected to begin in 2010, will require major improvements to the region's transportation and power infrastructure (Van Nieuwenhuyse, 2003). It is anticipated these improvements will stimulate further mineral development activities within the study area and generate the need for a new port on the Yukon River.

The port site locations considered for this study are along two stretches of the Yukon River: near the village of Holy Cross and near Ruby (Figure 1). The 27-year time period of the study corresponds to the expected construction and production period of the Donlin Creek Mine. Transportation requirements for the Donlin Creek Mine are used to illustrate the potential impacts of a Yukon River port and road network. Because of the long timeframe of the study, lack of infrastructure in the region, and the uncertainties and costs in mineral developments, several, major assumptions are required. The following assumptions form the base case.

1. **Donlin Creek Mine Is Fully Operational by 2012**—During its construction, approximately 374,000 tons of equipment and supplies will be moved by barge and 4,000 tons by air. Once operational, the mine will require annual delivery of approximately 273,000 tons of supplies by barge and 1,500 tons by air. Demand for power at the mine is estimated to be about 70 megawatts (Ridley, 2003). If a diesel power plant is constructed at the mine 140,000 tons of

fuel deliveries that will be required. These values reflect early planning estimates and may change significantly. Development of transportation infrastructure and a power source to support the mine will significantly lower the costs of mineral exploration and development within the region. Without the construction of the Donlin Creek Mine, it is unlikely that major transportation and power distribution infrastructure will be built in the area during the time frame of this study.

2. **A Kuskokwim River Port is Developed to Support Construction and Production phases of Donlin Creek Mine**—The mine operator plans to use a port built near Crooked Creek on the Kuskokwim River to support both the construction and production phases of the mine (Bush, 2003). Therefore, none of the potential benefits of the Donlin Creek Mine project can be attributed to a Yukon River port unless it can be shown that transportation costs would be lower than for the Kuskokwim River port. While a Yukon River port might reduce the risks of disruptions or delays associated with reliance on a single river port, analysis of such a benefit was beyond the scope of this study.

3. **Yukon River Port is Required to Support Additional Mineral Development**— There are differences of opinion among knowledgeable persons contacted for this study about the ability of a Kuskokwim River transportation system to handle all of the tug and barge movements required for delivery of fuel and supplies to the Donlin Creek Mine, let alone the fuel and supplies required for additional new mines that might be developed in the Tintina Gold Belt. Even a short disruption of barge traffic could have significant impacts on operations in the Tintina Gold Belt. The potential impacts of such disruptions may require large mine operators to use much more costly air delivery, maintain higher inventory levels of supplies and fuel, or severely curtail production during periods of low water flows. The

presence of a Yukon River port and road system that could serve the Donlin Creek Mine and other mines in the Tintina Gold Belt would reduce the risk of disruptions to the transportation of supplies and fuel. For these reasons, this analysis assumes that a Yukon River port and road system will be required at some point in the future, even with a Kuskokwim River transportation system in place.

4. **A Road North From Donlin Creek Mine Increases Exploration and Production Operations at Other Tintina Gold Belt Sites**— A road north from the Donlin Creek Mine could reduce transportation and energy costs for other mine operators and increase exploration and mineral development within the study area. Based on known mineral deposits and expert opinions, such a road could reasonably lead to production of an additional 9.6 million ounces of gold (Glavinovich, 2003) and the creation of an average of 475 additional jobs for local residents during the time frame of this study, 2003 to 2029. This assumption is required before the either a Yukon River port or a road network can generate significant benefits.

Using the assumptions above, a base case was derived for the study. The base case reflects recent trends within the study area and current plans to support construction and development of the Donlin Creek Mine. In the Base Case, a port is built at or near Crooked Creek on the Kuskokwim River and a two-land road is built north into the Tintina Gold Belt to a new port at Ruby.

Base Case

In the base case, development of the Donlin Creek Mine greatly increases the demand for and supply of transportation and power generation infrastructure within the study area. Reduced transportation and power costs encourage discovery and development of additional major

mineral deposits. While some villages on the Kuskokwim River may experience reduced transportation costs, most will not because of poor local dock facilities.

Donlin Creek Mine

Sand and gravel will account for 220,000 tons (59 percent) of the supplies and equipment transported by barge during mine construction. Sand and aggregate from sources previously identified at sites on the lower Kuskokwim River (PN&D, 1999) will be barged up the Kuskokwim River to Crooked Creek, near the mine site. Cook Inlet (Anchorage) and Puget Sound (Seattle) will be the primary sources for the remaining 55,000 tons of fuel (15 percent) and 98,000 tons of other supplies and equipment (26 percent) (Ridley. 2003). Fuel for the mine will be transported to the Bethel area on the coast by ocean-going barges and lightered to 2,500-ton barges for delivery to Crooked Creek 145 miles up the Kuskokwim River. Other supplies will move to the Bethel area by ocean-going barges and lightered to river barges for the trip to the Crooked Creek dock. The 2,500-ton barges will be light-loaded for the trip to Crooked Creek to meet restrictions imposed by low water depths in the river channel.

Lime will account for 135,000 tons (50 percent) of annual supplies and equipment transported by barge when the mine is at full production. If local supplies of lime or limestone are not economical, lime will be barged from Vancouver, British Columbia. Cook Inlet and Puget Sound will be the primary sources for the 37,000 tons of fuel (13 percent) and 101,000 tons of other supplies and equipment (37 percent) (Ridley, 2003b). The deliveries will be moved to the Bethel area on ocean-going barges and lightered to river barges for the trip to the Crooked Creek dock. If a diesel-fueled power plant is built at the mine or a port on the Kuskokwim or Yukon rivers, an additional 140,000 tons (38 million gallons) of diesel would be transported to the mine or port, an increase in overall tonnage of 51 percent (Ridley. 2003).

The barge season on the Kuskokwim River typically lasts 122 days. Precise data on water flow, limiting drafts and channel widths downriver from Crooked Creek are not available. However, data from a USGS operated stream gage on the Kuskokwim River at Crooked Creek (USGS, 2003) indicate that during 3 of the latest 49 years, barge traffic on the Kuskokwim River would have been severely restricted by low water for more than 40 percent of the barging season. During 3 of the remaining 46 years, barge traffic would have been severely restricted by low water between 30 and 39 percent of the barging season.

New Mineral Development

Successful development of the Donlin Creek Mine is expected to be a catalyst that sparks renewed interest in the Tintina Gold Belt. The demonstrated mineral potential of the Tintina Gold Belt and the presence of a generally lower cost and more efficient transportation alternative will encourage new investment in mineral development within the region. An expert in the study area's geology estimates that a high level of exploration activity by several professional exploration groups and individuals could reasonably lead to the discovery of at least one Donlin-sized (10,000,000-ounce) gold system plus three or four smaller systems, each capable of producing from 1 million to 2.5 million ounces (Glavinovich, 2003c). The estimated net present value (NPV) of the benefits to businesses, land owners, governments and residents from this new mineral production, is $69 million less than the costs of the additional transportation infrastructure—a two-lane road north from Donlin Creek to Ruby plus a port and fuel storage facilities.

Village transportation costs

Development of the Crooked Creek port to support the Donlin Creek Mine operation would provide opportunities for transportation economies from large-volume shipments to
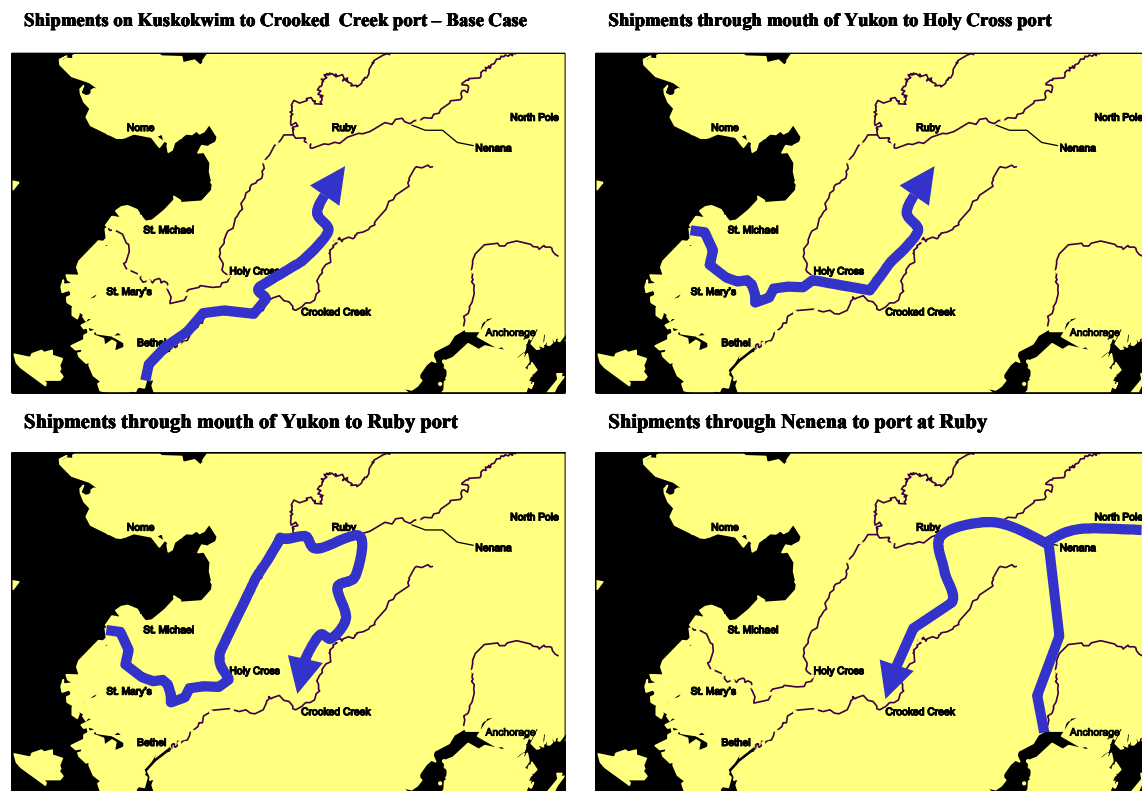
Kuskokwim River villages, especially those at locations near the mine. However, limited dock facilities in river communities would continue to have a significant negative impact on transportation costs. Without a major increase in the demand for transportation services, significant improvements in dock facilities at Yukon River villages, or both, transportation costs to villages along and near the Yukon River within the study area will most likely remain at their current high levels. Fuel deliveries to the region are expected to increase from between 5.1 million and 7.9 million gallons in 2002 to between 8.2 million and 12.5 million gallons in 2030. Non-fuel freight delivery is expected to increase from between 4,300 and 29,200 tons in 2002 to between 6,800 and 46,300 tons in 2030.

Alternative Scenarios

A port on the Yukon River with a road network to the Donlin Creek Mine could reduce the impact of disruptions to Kuskokwim River traffic. The availability of such a port might shift to the Yukon River large quantities of fuel traffic, freight traffic, or both that would be moving to the mine. The potential change in routing would reduce risk and congestion on the Kuskokwim River and permit diversification of suppliers. A Yukon River port might also reduce the cost of fuel and freight deliveries to some villages along the Yukon.

The short, 100-day barging season would be the major restriction on the use of the Yukon River. For barge traffic moving upriver through the river's mouth, a major restriction would be the shallow, shifting nature of entrances to the mouth of the Yukon River. For barge traffic moving downriver from Nenana or the Dalton Highway Bridge, major restrictions would be the shallow draft on the Tanana River and rapids on the Yukon River.

Figure 2—Base case and alternate routes

Shipments on Kuskokwim to Crooked Creek port – Base Case

Shipments through mouth of Yukon to Holy Cross port

Shipments through mouth of Yukon to Ruby port

Shipments through Nenena to port at Ruby

Prepared by Northern Economic, Inc.

Alternatives evaluated for this study included scenarios based on barge shipments of freight and fuel through the Mouth of the Yukon River to ports near Holy Cross or Ruby and scenarios based on barge shipments of freight and fuel downriver from Nenana to river ports also located near Holy Cross or Ruby (Figure 2). After an initial screening, three scenarios are retained for detailed analysis:

1. **Fuel and Freight Move Through the Mouth of the Yukon Upriver to Holy Cross—** 12,000-ton, ocean-going fuel-barges and 16,500 ocean going freight barges travel to the mouth of the Yukon River and off-load to three sets of fuel lighters and three sets of freight lighters—*barge operators raised very strong concerns about the risks associated with lightering fuel in the mouth of the Yukon River* (Sweetsir and Hnilicka, 2003). The

300-foot long lighter barge sets travel through the mouth of the Yukon River to a port near Holy Cross.

2. **Fuel and Freight Move Through the Mouth of the Yukon Upriver to Ruby**—12,000-ton, ocean-going fuel-barges and 16,500 ocean going freight barges travel to the mouth of the Yukon River and off-load to three sets of fuel lighters and three sets of freight lighters—*again barge operators raised very strong concerns about environmental risks associated with the lightering fuel in the mouth of the Yukon Rive* (Sweetsir and Hnilicka, 2003). The 300-foot long lighter barge sets travel through the mouth of the Yukon River to a port near Holy Cross.

3. **Fuel and Freight Move Down the Yukon River to Ruby**—for this alternative, routes for fuel and freight differ because of their different origins. Fuel is trucked from North Pole to Nenana and light-loaded (170,000 gallons) onto 160-foot river barges then transported to a Yukon River port at Ruby—*barge operators raised very strong concerns about the risks associated with this alternative for the downriver delivery of large quantities of fuel* (Sweetsir and Hnilicka, 2003). General cargo for the Donlin Creek Mine originates in Puget Sound or Anchorage and is transported to Nenana for downriver shipment to Ruby.

The major potential benefits of a Yukon River port and road network include:

- **Transportation expense reductions**—A more efficient logistics system would allow better utilization of transportation equipment and corresponding reductions in transportation costs to area residents and businesses (including mine operators).

- **Resource development**—A more efficient transportation system would encourage a more rapid development of natural resources and development of some resources that might otherwise not be economically viable.

- **Reductions in risks to the supply chain**—Reductions in risks to the supply chain would increase the likelihood a project will obtain financing and possibly lower financing costs.

- **Government and landowner revenues**—Development of natural resources would increase net revenues to landowners and governments.

- **Employment**—Development of natural resources would increase training and employment opportunities and incomes for residents in an area of very high, persistent unemployment.

The major potential costs of a Yukon River port and road network include:

- **Capital and maintenance costs**—A river port and road network would require large expenditures for construction and maintenance.

- **Subsistence disruptions**—Local residents are concerned that a port and road network would encourage exploitation of local, subsistence resources by non-residents. Because of the importance of subsistence activities to local economies, any threat to these resources would generate significant opposition from the local communities.

The impacts of the base case and all alternative scenarios on job opportunities, local freight and fuel costs, and potential adverse impacts to subsistence are judged to be essentially

equal. The base case does have a clear advantage over all of the alternatives when mineral development and transportation infrastructure and delivery costs are considered. However, the estimated NPV of benefits, in the base case, from the development of a road north from the Donlin Creek Mine to Ruby is less than the estimated NPV of the costs.

Analysis of Benefits and Costs

Each Yukon River alternative would require capital expenditures for roads, fuel storage facilities, and docks. During construction, these capital projects would create employment opportunities and labor income for local residents. Increases in local employment are not usually included as national benefits in benefit-cost studies. However, the persistent high unemployment levels within the study area—in each of the years between 1998 and 2002, the unemployment rate in the study area was at least two and a half times the national average—would meet U.S. Army Corps of Engineers (COE) guidelines for including employment of local residents as a national benefit during the construction Stage of a project (COE, 2000).

From a review of information in previous reports prepared for the Donlin Creek Mine, it is anticipated that at least 60 percent of the construction labor force would be residents of the region (Charles, 2003); the balance of the construction labor force is anticipated to be from other locations without persistent, high unemployment. During the operating periods of new mines in the Tintina Gold Belt that would be opened as a result of improved access associated with a Ruby to Donlin Creek Mine road, local residents would benefit from employment opportunities at the mines and increased incomes. The COE does not include such income when calculating its National Economic Development Plan benefits for a project. However, from the perspective of the State of Alaska and local residents, the additional employment and associated labor income would be benefits.

Table 1 presents a comparison of NPV of the benefits and costs over the 27-year period of the study for each of the scenarios compared to the base case—a port at Crooked Creek with a road network to and north from the Donlin Creek Mine. Transportation facilities costs include road construction and maintenance costs, fuel storage construction and maintenance costs, dock construction and maintenance costs, and power line construction and maintenance costs. Benefits in Table 1 are for new mines in the Tintina Gold Belt. Other than potential reductions in transportation costs, Table 1 does not include benefits from production at the Donlin Creek Mine. Other potential benefits from the Donlin Creek Mine, such as state and local government revenues, are not included because the production company has announced plans to rely on a port at Crooked Creek (Bush, 2003). If it is later determined that the level of production at the Donlin Creek Mine would be increased by the presence of a Yukon River Port, additional benefits from the mine could be included in the evaluation of alternatives. Benefits in Table 1 consist of the following:

- Industry profits after federal, state, and local government taxes

- Landowner revenues

- State and local government revenues

- Income to local residents from mine construction and operations

- Income to local residents from construction and maintenance of roads, fuel storage facilities, and docks

Table 1

NPV of benfits and costs, transport facilties for Yukon and Kuskokwim River port and road networks

Costs and benefits	Net present value[a] in 2003 $ million			
	Base Case Shipments on Kuskokwim through Crooked Creek port	Shipments through mouth of Yukon and port near Holy Cross	Shipments through mouth of Yukon and Ruby port	Shipments through Nenena and Ruby ports
NPV transport facilities costs				
Road costs[b]				
Construction	514.3	573.9	514.3	514.3
Maintenance	137.0	153.7	137.0	137.0
Fuel storage facilities costs				
Construction	51.9	51.9	77.8	103.8
Maintenance	15.4	15.4	23.2	30.9
Docks facilities costs				
Construction	5.9	5.9	5.9	11.8
Maintenance	1.3	1.3	1.3	2.5
Power line costs				
Construction	7.9	24.9	-	-
Maintenance	0.2	0.7	-	-
NPV total transportation costs	$733.9	$827.7	$759.5	$800.3
NPV benefits of additional mineralization activities in Tintina Gold Belt				
Industry profits after state and local government taxes	207.9	192.8	128.1	101.0
Landowner revenues	8.3	7.7	5.1	4.0
State and local government revenues	6.2	5.8	3.8	3.0
Local labor income				
Road, port and powerline construction and maintenance	220.2	248.3	227.9	240.1
Mine construction and operations	222.3	222.3	222.3	222.3
NPV total additional benefits	664.9	676.9	587.2	570.5
NPV benefits minus facilities costs	(69.0)	(150.8)	(172.3)	(229.8)
Transportation cost savings for Donlin Creek Mine[c]				
Fuel	-	(11.0)	(107.4)	(115.1)
Supplies	-	(34.4)	(173.4)	(214.6)

[a] NPVs are calculated using a 3.2 percent discount rate. Analysis indicated that use of a 7.0 percent discount rate from OMB (2003) or a 6.875 interest rate from the COE (2003) did not change the conclusions of the study.

[b] Road costs are for 2-lane AASHTO standard construction

[c] NPV of transportation costs for an alternative minus NPV transportation costs for base case. Positive values indicate transportation costs for shipments to Donlin Creek Mine are lower than the base case; negative values indicate higher transportation costs. Values assume all traffic to Donlin Creek Mine is captured by alternative.

Source: Values calculated by Northern Economics, Inc. Construction and maintenance values were provided by CH2M HILL. Marine transport costs were derived from COE, Institute for Water Resources (2000b) and Bringloe (2003). Motor transport costs were derived from Trimac Logistics Ltd. (2002). Mineral development activity is based on Glavinovich (2003c). Labor income estimates for road and port construction are based on values from Minnesota IMPLAN Group (2000).

As shown in Table 1, the base case has lower construction and maintenance costs and lower transportation costs for delivery of fuel and supplies to the Donlin Creek Mine than any of the alternatives. However the estimated NPV of the base case benefits are $69 million less than the estimated costs.

Fuel and Freight Through the Mouth of the Yukon to Holy Cross

- **Transportation costs for Donlin Creek Mine**—Transportation costs for shipment of fuel and freight through the mouth of the Yukon River to near Holy Cross are estimated to be $11.0 and $34.4 million higher, respectively, than for shipments on a road and port system on the Kuskokwim River.

- **Development of natural resources**—The NPV of the estimated mineral development benefits from this alternative would be $150.8 million less than the NPV of the estimated construction and maintenance costs for the entire planned road network.

- **Net revenues to landowners and governments**—The estimated NPV of the net revenues to landowners and governments from a road network north into the Tintina Gold Belt is $13.4 million or $1.1 less than for a Kuskokwim River port. This difference is due to higher transportation costs and reductions in net revenues to mine operators.

- **Construction and maintenance expenses**—The NPV of estimated construction and maintenance costs of this alternative are $827.7 million, $93.8 more than the NPV of these costs for a Crooked Creek port and road network.

Fuel and Freight Through the Mouth of the Yukon to Ruby

- **Transportation costs for Donlin Creek Mine**—Transportation costs for shipment of fuel and freight through the mouth of the Yukon River to Ruby would be $107.4 and $173.4 million higher, respectively, than for shipments on a road and port system on the Kuskokwim River.

- **Development of natural resources**—The NPV of the estimated mineral development benefits from this alternative would be $172.3 less than the NPV of the estimated construction and maintenance costs for the entire planned road network.

- **Net revenues to landowners and governments**—The estimated NPV of the net revenues to landowners and governments from a road network north into the Tintina Gold Belt is $8.9 million or $5.6 less than for a Kuskokwim River port. This difference is due to higher transportation costs and reductions in net revenues to mine operators.

- **Construction and maintenance expenses**—The NPV of estimated construction and maintenance costs of this alternative are $759.5 million, $28.6 more than the NPV of these costs for a Crooked Creek port and road network.

Fuel and Freight Down the Yukon River to Ruby

- **Transportation costs for Donlin Creek Mine**—Transportation costs for shipment of fuel and freight from Nenana or the Dalton Highway Bridge down the Yukon River would be $115.1 and $214.6 million higher, respectively, than reliance on a road and port system on the Kuskokwim River.

- **Development of natural resources**—The NPV of the estimated benefits of mineral development for this alternative would be $229.8 million less than the NPV of the estimated construction and maintenance costs for the planned road network.

- **Net revenues to landowners and governments**—The estimated NPV of the net revenues to landowners and governments from a road network north into the Tintina Gold Belt is $7.0 million, $7.5 million less than for a Kuskokwim River port. This difference is due to higher transportation costs and reductions in net revenues to mine operators.

- **Construction and maintenance expenses**— The NPV of estimated construction and maintenance costs of this alternative are $800.3 million, $ 66.4 more than the NPV of these costs for a Crooked Creek port and road network.

Table 1 also illustrates potential transportation cost savings for Donlin Creek Mine operators—alternatively, these could have been considered increases in company profits. In Table 1, the NPV of transportation costs for each alternative are subtracted from the NPV of transportation costs for the base case. Negative values indicate how much higher the NPV of transportation costs of an alternative are than those costs for the base case. For example, the NPV of fuel transportation costs for fuel and freight movement through the Mouth of the Yukon to Holy Cross are $11.0 million higher than those costs for shipping fuel through Crooked Creek.

As shown in Table 1, the base case, Crooked Creek port on the Kuskokwim River, provides the lowest transportation facility costs and the greatest net benefits when comparing additional mineralization activity with transportation facility costs. The base case also provides the lowest costs for shipments to the Donlin Creek Mine. However, the short operating season

(122 days), shallow drafts (4.5 to 6 feet), and narrow channel on the Kuskokwim River, plus the large number of tows that would be required to deliver supplies to the Donlin Creek Mine (186 round trips if the power plant is located at Crooked Creek or the mine, 129 round trips if the power plant is located elsewhere), could pose significant risks to mine operators if they relied solely on the Kuskokwim River for transportation access.

Neither the base case nor any of the alternatives initially considered produced positive net benefits. However, after discussion with area experts two new options were identified that did generate positive net benefits.

New Scenarios

Initially all road networks were assumed to extend north from Donlin Creek Mine to Ruby and to consist of two-lanes built to AASTHO standards. Subsequent analysis looked at the use of pioneer road standards north of the Donlin Creek Mine and the shortening of road networks. Because of the low anticipated traffic volume, single-lane, pioneer roads with turnouts were judged sufficient for initial exploration of the area. Shortening the road network by 90 miles to an area near Colorado Creek, south of Ruby, would still allow access to virtually all of the known mineral deposits within the region. Analysis indicated that a Crooked Creek port and road network with pioneer road construction north of Donlin Creek Mine to near Colorado Creek could generate $148.7 million of net benefits (Table 2). Using the same analysis, a new scenario with shipments through the mouth of the Yukon to a port near Holy Cross and a road network to Colorado Creek using single-lane, pioneer road construction north of the Donlin Creek Mine, generated $66.0 million of net benefits.

Table 2

NPV of benfits and costs, transport facilties for Yukon and Kuskokwim River port and road networks with pioneer construction and shortend routes

Costs and benefits	Net present value[a] in 2003 $ million					
	Base Case Shipments on Kuskokwim through Crooked Creek port			Shipments through mouth of Yukon and port near Holy Cross		
	Two-lane road	Pioneer road	Pioneer road, shortened routes	Two-lane road	Pioneer road	Pioneer road, shortened routes
NPV transport facilities costs						
Road costs						
Construction	514.3	380.3	284.6	573.9	440.0	344.2
Maintenance	137.0	73.2	55.6	153.7	89.9	72.3
Fuel storage facilities costs						
Construction	51.9	51.9	51.9	51.9	51.9	51.9
Maintenance	15.4	15.4	15.4	15.4	15.4	15.4
Docks facilities costs						
Construction	5.9	5.9	5.9	5.9	5.9	5.9
Maintenance	1.3	1.3	1.3	1.3	1.3	1.3
Power line costs						
Construction	7.9	7.9	7.9	24.9	24.9	24.9
Maintenance	0.2	0.2	0.2	0.7	0.7	0.7
NPV total transportation costs	733.9	536.1	422.8	827.7	630.0	516.6
NPV benefits of additional mineralization activities in Tintina Gold Belt						
Industry profits after state and local government taxes	207.9	207.9	207.9	192.8	192.8	192.8
Landowner revenues	8.3	8.3	8.3	7.7	7.7	7.7
State and local government revenues	6.2	6.2	6.2	5.8	5.8	5.8
Local labor income						
Road, port and powerline construction and maintenance	220.2	160.8	126.8	248.3	189.0	155.0
Mine construction and operations	222.3	222.3	222.3	222.3	222.3	222.3
NPV total additional benefits	664.9	605.5	571.5	676.9	617.6	583.5
NPV benefits minus facilities costs	(69.0)	69.4	148.7	(150.8)	(12.4)	66.9
Transportation cost savings for Donlin Creek Mine[b]						
Fuel	-	-	-	(11.0)	(11.0)	(11.0)
Supplies	-	-	-	(34.4)	(34.4)	(34.4)

[a] NPVs are calculated using a 3.2 percent discount rate. Analysis indicated that use of a 7.0 percent discount rate from OMB (2003) or a 6.875 interest rate from the COE (2003) did not change the conclusions of the study.

[b] NPV of transportation costs for an alternative minus NPV transportation costs for base case. Positive values indicate transportation costs for shipments to Donlin Creek Mine are lower than the base case; negative values indicate higher transportation costs. Values assume all traffic to Donlin Creek Mine is captured by alternative.

Source: Values calculated by Northern Economics, Inc. Construction and maintenance values were provided by CH2M HILL. Marine transport costs were derived from COE, Institute for Water Resources (2000b) and Bringloe (2003). Motor transport costs were derived from Trimac Logistics Ltd. (2002). Mineral development activity is based on Glavinovich (2003c). Labor income estimates for road and port construction are based on values from Minnesota IMPLAN Group (2000).

Conclusions and recommendations

While a port at Crooked Creek appears to be the lowest cost option, there are several reasons for considering the development of a Yukon River port. First, the risks of relying solely on a Crooked Creek port, especially the risks of long periods of low water, may be so great as to require development of the more costly Yukon River port alternative. Second, a port near Holy Cross, with a road to the Donlin Creek Mine and a pioneer road to Colorado Creek generated estimated benefits that exceed estimated costs by $66 million. Third, the transport costs for large mine operations using a Yukon River port near Holy Cross were only slightly higher than the transportation costs of using the Crooked Creek port and within the margin of error for this study.

There are unanswered questions about the ability of the Kuskokwim River to support the Donlin Creek Mine and large-scale future mineral development in the Tintina Gold Belt. If the Kuskokwim River can support anticipated, major mineral development activities, the need for a Yukon River port appears uncertain. If the Kuskokwim River cannot support anticipated major mineral development, a Yukon River port has the potential to provide positive net benefits.

If Donlin Creek Mine is built, building a pioneer road north from the mine would generate the highest return to the state. If a Yukon River port is needed to support Donlin Creek Mine or new mines in the Tintina Gold Belt, a Port near Holy Cross is expected to generate the greatest return to the state.

References

Alaska Department of Labor and Workforce Development. 2002. *Alaska Unemployment Rates*. <http://almis.labor.state.ak.us/cgi/databrowsing>. Accessed June 2003.

Alaska Department of Transportation and Public Facilities. 2004, November. *Northwest Alaska Transportation Plan.* <http://www.dot.state.ak.us/>. Accessed February 2003.

Bringloe, J. Thomas, Sr. Vice President, The Glosten Associates, Inc. 2003, August 20. Personal communications with Ken, Lemke, Northern Economics, Inc.

Bush, Gregg, General Manager, Donlin Creek Joint Venture, Placer Dome U.S. Inc. 2003, October 10. Personal communication with Ken Lemke, Northern Economics, Inc..

CH2M HILL. 2001, August. *Resource Transportation Analysis, Phase 1—Potential Corridors Identification.* Revised Draft. Prepared for Alaska Department of Transportation and Public Facilities. Prepared in association with Sandwell Engineering Inc.; Northern Economics, Inc.; HDR Alaska, Inc.; Kelley Hegarty & Associates; and Kevin Waring Associates.

Charles, Bob, Vice President, Government & Corporate Relations, Calista Corporation; Jeffery Foley, Senior Exploration Geologist. Calista Corporation; and June McAtee, Vice President Land and Natural Resources, Calista Corporation. 2003, February 4. Interview with Ken Lemke, Northern Economics, Inc.

Denali Commission. 2003. Rural Alaska Challenges, Transportation. <http://www.denali.gov/content/challenges/rural.htm>. Accessed on March 10, 2003.

Glavinovich, Paul S., Minerals Consultant. 2003, March. *Potential Mineral Resources of the Proposed Land Route Poorman, AK, to Crooked Creek, AK.* Prepared for Northern Economics, Inc.

Minnesota IMPLAN Group, Inc. 2000, June. *IMPLAN Professional Version 2.0*

National Association of Development Organizations, Regional Transportation Online Center. 2003. *Alaska: The Rural Context for Transportation Consultations.* <http://www.nado.org/rtoc/library/ak.html>. Accessed on March 12, 2003.

Office of Management and Budget. 2003a, January. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.* Circular No. A-94 Revised. <www.whitehouse.gov/omb/circulars/a094/a094.html>. Accessed July 2003.

Office of Management and Budget. 2003b, January 30. *2003 Discount Rates for OMB.* Circular No. A-94. <www.whitehouse.gov/omb/memoranda/m03-08.html>. Accessed July 2003.

Peratrovich, Nottingham, & Drage, Inc. (PN&D). 1999, March. *Donlin Creek Mine Late Stage Evaluation Study.* Prepared for Placer Dome Technical Services Ltd.

Ridley, Richard, Placer Dome. 2003, March 14. Personal communication with Ken Lemke, Northern Economics, Inc.

Sweetsir, Matt, President, Yutana Barge Lines, and Charles Hnilicka, Inland Barge Service. 2003, February 21. Personal communication with Ken Lemke, Northern Economics, Inc.

Trimac Logistics Ltd. 2002. *Operating Costs of Trucks in Canada - 2001, Final Study Report.* Prepared for Transport Canada. http://www.tc.gc.ca/pol/en/Report/OperatingCost2001/OperatingCost2001.pdf. Accessed March 2003.

U.S. Army Corps of Engineers (COE). 2000, April. *ER 1105-2-100, Planning Guidance Notebook.* <http://www.iwr.usace.army.mil/iwr/planningcapabilities/docs/planform/11052100e.pdf>. Accessed March 2003.

U.S. Army Corps of Engineers (COE), Directorate of Civil Works Planning and Policy. 2003, July. *Economic Guidance Memorandum 03-02, Federal Discount Rate FY 2003.* <http://www.usace.army.mil/inet/functions/cw/cecwp/General_guidance/egm03-02.pdf>. Accessed July 2003.

U.S. Army Corps of Engineers (COE), Institute for Water Resources. 2000, April. *Economic Guidance Memorandum 00-05, FY 2000 Shallow Draft Vessel Operating Costs.* <http://www.iwr.usace.army.mil/iwr/pdf/egm051.pdf>. Accessed March 2003.

U.S. Department of Commerce, National Ocean Service. 2002a. *Distances Between United States Ports, 2002*. 9th edition.<http://chartmaker.ncd.noaa.gov/nsd/distances-ports/distances.pdf>. Accessed March 2003.

U.S. Department of Commerce, National Ocean Service. 2002b. *United States Coast Pilot, Pacific and Arctic Coasts Alaska: Cape Spencer to Beaufort Sea.* 2002 (20th) Edition.

U.S. Department of Labor, Bureau of Labor Statistics. 2003. Producer Price Index Series. <http://data.bls.gov/cgi-bin/srgate>. Accessed June 2003.

U.S. Geological Survey (USGS). 2003. Surface Water Data for Alaska. <http://waterdata.usgs.gov/ak/nwis/sw>. Accessed September 2003.

Van Nieuwenhuyse, Rick, President and Chief Executive Officer, NovaGold Resources Inc. 2003, February 20. Personal communication with Ken Lemke, Northern Economics, Inc.

Wang, Meifu. 2002. *Appendix A Y-K Delta Population Projection Using a Cohort-Survival Model, 1995-2020.*

Acknowledgements