Net Public Benefits of the Chuitna Coal Project

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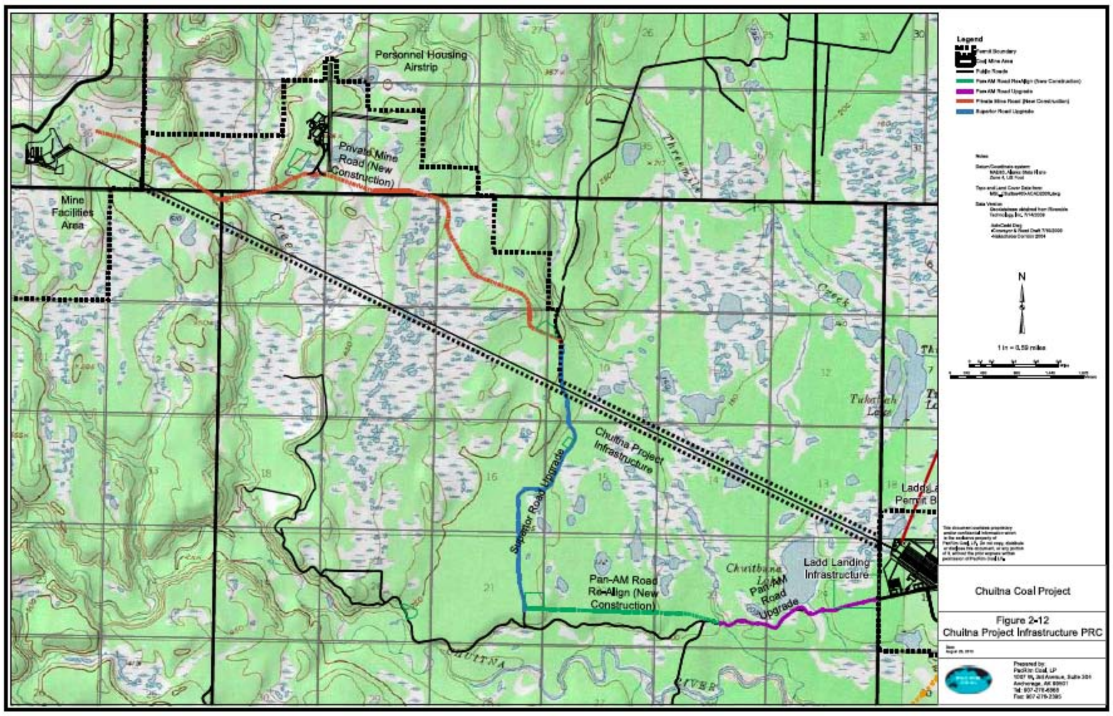
A Preliminary Assessment[1]



Prepared for Cook Inletkeeper

By

John Talberth, Ph.D.[2]
Evan Branosky[3]

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[2] Senior Economist, Center for Sustainable Economy, jtalberth@sustainable-economy.org.
[3] Environmental Policy Fellow, Center for Sustainable Economy, ebranosky@hotmail.com.

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Center for Sustainable Economy
1704 B Llano Street, Suite 194
Santa Fe, New Mexico 87505
(505) 986-1163
www.sustainable-economy.org

Executive Summary

Along the western shore of Alaska's Cook Inlet, the Army Corps of Engineers (Corps) and other federal and state agencies are in the midst of a permitting and environmental analysis process for the Chuitna Coal Project – the largest strip mine in Alaska's history. The project would consist of a 5,050 acre open pit coal mine, a 12 mile covered overland coal transport conveyor, a 4.5 mile power transmission line, mine access roads, a housing and airstrip facility, and a coal export terminal at Ladd Landing that will rely on a 10,000 foot trestle built into Cook Inlet to load Chuitna Coal onto transport ships destined for Asian ports.[4] At full production the mine is expected to produce 12 million metric tons per year for 25 years.

The project is anticipated to have a wide range of significant impacts to sensitive aquatic and terrestrial ecosystems of great economic importance to the region. Of particular concern is the extensive loss of salmon habitat and the commercial and recreational fishers that depend on this resource. Over 11 miles of highly productive salmon bearing streams could be lost.[5] The Cook Inlet beluga whale, whose critical habitat was recently designated within the project area, is also at risk since its depleted population relies heavily on fish that congregate at the mouths of the Chuitna River and because it is sensitive to human disturbance.[6] Scenic and aesthetic values associated with Cook Inlet's wildlands will also be degraded. The project will affect a high value subsistence use area that is "part of the economic, cultural, and social well being of the inhabitants in the area."[7] The project's footprint will impact 1,830 acres of wetlands that provide valuable ecosystem services such as water filtration and flood mitigation.[8] Recreational uses that include hunting, sport fishing, trapping, snow machining, berry picking, camping and hiking will be displaced.

But perhaps the greatest economic risk from the project is its contribution to global warming and hazardous air pollution in areas where Chuitna coal will be combusted. Each stage in the life cycle of coal—extraction, transport, processing, and combustion—generates a waste stream and carries multiple hazards for public health and the environment. Emissions of carbon dioxide, methane, nitrous oxide, sulfur dioxide, particulate matter, mercury and other pollutants from the burning of coal exact a heavy economic toll – $175 to $523.3 billion each year in the United States alone by one recent estimate. [9]

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[4] Environmental Protection Agency (EPA). 2006. Draft Scoping Document for the Chuitna Coal Project Supplemental Environmental Impact Statement.
[5] Trasky, Lance. 2009. Report on Chuitna Coal Project Aquatic Studies and Fish and Wildlife Protection Plan. Anchorage: Lance Trasky and Associates.
[6] http://www.fakr.noaa.gov/newsreleases/2011/cibelugahabitat040811.htm
[7] Oasis Environmental, Inc. 2006. Land Use Baseline Summary Report for the Chuitna Coal Project. Anchorage: DRven Corporation.
[8] HDR Alaska, Inc. 2006. Chuitna Coal Project – Summary of Previous Baseline Studies for Wetlands. Anchorage: HDR Alaska, Inc.
[9] Epstein, Paul R. Jonathan J. Buonocore, Kevin Eckerle, Michael Hendryx, Benjamin M. Stout III, Richard Heinberg, Richard W. Clapp, Beverly May, Nancy L. Reinhart, Melissa M. Ahern, Samir K. Doshi, and Leslie

The potential severity of environmental and economic impacts associated with the project necessitates the highest standards of analysis throughout the permitting process. Indeed, federal agencies are expected to rely on the best scientific information and methods available in the analysis of projects of this size and magnitude. These methods require that the Corps and its federal and state partners analyze the Chuitna Coal Project from the standpoint of net public benefits, and not the narrow perspective of financial benefit to project investors.

Two primary metrics are used in a net public benefits analysis: net present value and the benefit cost ratio.[10] The standard criterion for deciding whether a government policy, program, or project can be justified on economic principles is net present value – the discounted monetized value of expected net benefits (i.e., benefits minus costs).[11] NPV is a measure of the absolute magnitude of the gain or loss to society.

The benefit-cost ratio is simply the present value of benefits divided by the present value of costs. A benefit-cost ratio above 1.0 is indicative of a policy, program, or project that has a NPV > 0 and is economically worthwhile from a public perspective. A benefit-cost ratio of 1.0 represents the lowest value that should be considered for public support as long as the analysis incorporates all significant costs and benefits and if uncertainty is relatively low. A benefit-cost ratio below1.0 is indicative of a policy, program, or project that has a NPV < 0 and is not economically viable from a public perspective.

The Corps has operationalized the net public benefits standard in its guidelines for evaluating national economic development (NED) and regional economic development (RED) benefits associated with a proposed project. Such procedures require a full inventory of significant costs and benefits, both social and private. In this study, we report on the potential magnitude of net public benefits associated with the Chuitna Coal Project should it continue through the permitting process. The preliminary analysis is based on publically available information as of April 2011, and will be refined as more detailed financial and economic information is released.

With respect to national and regional economic development benefits, key findings include:

- The primary national economic development benefit associated with the project is the net revenues that will be earned from the sale of Chuitna Coal in the Asian market. Four price scenarios are modeled that reflect various policy options with respect to development of energy efficiency and clean fuels. Under the most optimistic scenario, Chuitna coal may fetch an average price of $125 per metric ton over the 25-year project life. Under a scenario where major investments in renewable energy reduce the demand for coal, average prices may be in the $74 per metric ton range. Four price scenarios and

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Glustrom. 2011. "Full cost accounting for the life cycle of coal" in *Ecological Economics Reviews*. Robert Costanza, Karin Limburg & Ida Kubiszewski, Eds. Ann. N.Y. Acad. Sci. 1219: 73–98.

[10] Office of the Secretary of Transportation (DOT). 2006. Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects. Washington, D.C.: Department of Transportation.

[11] Office of Management and Budget (OMB), Circular A-94 (Revised), Section 5(a). Available at: http://www.whitehouse.gov/omb/circulars/a094/a094.html.

two with respect to delivered coal costs suggest a range of net revenues of -$2.84 to $15.5 billion in present value terms.

- Importantly, if the low price scenario becomes likely due to more concerted policy commitment to low carbon development in Asia, the Chuitna Coal Project would not be viable even from a purely financial standpoint.

- Regional economic development benefits include jobs, income, and revenues generated for state and local government from royalties, taxes, and fees. Current data suggests that the project would generate 471 – 575 jobs and $26 to $31 million each year in personal income taking into account direct, indirect, and induced effects of spending as money circulates through the regional economy.

- Royalties, rents, taxes and fees are more uncertain, but could range between $14 and $20 million per year for state and local government.

With respect to national economic development costs, key findings include:

- Important categories of NED costs that can be estimated with publically available information include capital and operating costs, transportation costs, and non-market costs associated with carbon emissions damage, air quality damages, and lost ecosystem services.

- Publically available information, including mine cost models, preliminary cost estimates published by the National Energy Technology Lab, estimates supplied by PacRim, and recent coal cargo freight rates suggest a delivered coal cost of $55.26 to $88.05 per metric ton to Asian ports. Transportation costs are the most uncertain, and are the most significant source of variation in the delivered coal cost estimates.

- Carbon emissions damage associated with emissions throughout the life cycle of Chuitna coal would generate a present value cost of $17.26 billion over the mine's 25 year life, or $57.53 per metric ton of production.

- Air quality damages associated with emissions of sulfur dioxide, nitrous oxide, and particulate matter would generate a present value cost of $53.09 billion over the mine's 25 year life, or $176.98 per ton of production.

- Ecosystem service damages associated with lost fisheries, wetlands, and passive use values for both terrestrial and marine ecosystems degraded by the project's infrastructure would generate a present value cost of $2.08 billion over the mine's 25 year life, or $6.94 per metric ton of production.

With respect to the project's overall net public benefits, key findings include:

- Even under the most optimistic price scenario, the social costs of the Chuitna Coal Project are likely to exceed benefits by a wide margin.

- Taking all relevant costs into account suggests a NPV range of -$57.23 to -$75.27 billion and a benefit cost ratio of .3134 to .1713, meaning that costs exceed benefits by a factor of 3 to 6 (Table ES-1).

- Social costs could range between 193 and 604% of market price, a finding that corroborates the range published in existing literature.[12]

Given this, the only way the Chuitna Coal Project could proceed in a manner consistent with net public benefits is a tax on production that recoups these externalized costs or major reconfiguration of the project to internalize or mitigate these damages.

Table ES-1: Net Present Value (billions) and Benefit-Cost Ratio under the Four Price Scenarios and Delivered Costs of $52.26 and $88.05/ Metric ton

Asian Price Scenarios:	High coal cost		High oil price		Reference case		Low coal cost	
	NPV	BCR	NPV	BCR	NPV	BCR	NPV	BCR
Delivered cost of $52.26/ Metric ton	-57.23	0.3134	-63.56	0.2374	-64.27	0.2289	-67.79	0.1867
Delivered cost of $88.05/ Metric ton	-64.70	0.2876	-71.04	0.2179	-71.76	0.2101	-75.27	0.1713

As the permitting process unfolds, more detailed information on Asian market conditions, project development and annual operations costs, transportation costs, tax liabilities, and project configuration will make more refined estimates possible. However, given the wide margin of social costs over national economic development benefits estimated in this preliminary analysis and the fact that our estimates corroborate figures reported in the literature, it is unlikely that future refinements would affect project economics in any significant way.

This underscores the dilemma of developing new coal sources in an era of global warming. While market demand may support new coal mine development from the perspective of project investors, such projects are often not justified from a net public benefits perspective because they generate social costs far in excess of private financial benefits.

[12] Cherry, Todd L. and Jason F. Shogren. 2002. The Social Cost of Coal: A Tale of Market Failure and Market Solution.

Section 1: Regulatory Framework

As with all federal agencies, the U.S. Army Corps of Engineers (Corps) has an obligation to demonstrate that projects authorized or facilitated by the agency are justified on the basis of net public benefits. As such, the economic analysis undertaken in support of the Environmental Impact Statement (EIS), Clean Water Act Section 404 permitting decisions and other authorizations for the Chuitna Coal Project must disclose whether or not the project is economically feasible from the public perspective taking into account all relevant market and non-market benefits and costs. This net public benefits accounting framework is essential to sound decision making. In this section, we identify and discuss the essential components of a net public benefits analysis relevant to the Chuitna Coal Project.

1.1 Net Public Benefits Framework and Key Components

It is clear that development of the Chuitna Coal Project will require considerable involvement by public agencies at the federal, state, and local levels. At least four federal agencies will be participating in project decisions: the Corps, the EPA, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (Appendix 1). As of yet, it is unclear whether or not the Corps will be providing cost share assistance for the project's general navigation features or whether or not the project will receive other forms of public finance such as support from the Alaska Industrial Development and Export Authority's Development Finance Program.[13] Either way, the significant involvement by federal and state decision makers in this project requires that the economic feasibility of the Chuitna Coal Project be analyzed from a net public benefits perspective through benefit-cost analysis and not the narrow financial perspective of private investors.

Benefit-cost analysis (BCA) compares the present value of the social benefits of a public policy, program, or project against the present value of social costs. There are two fundamental results from performing a benefit-cost analysis: 1) net present value (NPV); and 2) benefit-cost ratio.[14] The "present worth" of a project is commonly referred to as its NPV. The standard criterion for deciding whether a government policy, program, or project can be justified on economic principles is net present value – the discounted monetized value of expected net benefits (i.e., benefits minus costs).[15] NPV is a measure of the absolute magnitude of the gain or loss to society. As described by the Office of Management and Budget (OMB), net present value is computed by assigning monetary values to all benefits and costs – regardless of who enjoys or incurs them – discounting future benefits and costs

[13] For example, AIDEA owns and operates the Delong Mountain Transportation System, used exclusively by Teck's Red Dog Mine.
[14] Office of the Secretary of Transportation (DOT). 2006. Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects. Washington, D.C.: Department of Transportation.
[15] Office of Management and Budget (OMB), Circular A-94 (Revised), Section 5(a). Available at: http://www.whitehouse.gov/omb/circulars/a094/a094.html.

using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement. Importantly, "[p]rograms with positive net present value increase social resources and are generally preferred. Programs with negative net present value should generally be avoided." Stated more precisely, projects that attain an NPV greater than 0 are worth investing in – the benefits over time outweigh the costs over the life of the project.[16]

The benefit-cost ratio is simply the present value of benefits divided by the present value of costs. A benefit-cost ratio above 1.0 is indicative of a policy, program, or project that has a NPV > 0 and is economically worthwhile from a public perspective. A benefit-cost ratio of 1.0 represents the lowest value that should be considered for public support as long as the analysis incorporates all significant costs and benefits and if uncertainty is relatively low. A benefit-cost ratio below1.0 is indicative of a policy, program, or project that has a NPV < 0 and is not economically viable from a public perspective. Benefit-cost analysis (BCA) can be used as a method to rank different projects or different alternatives for a single project all of which may have NPV of greater than zero and, therefore, are theoretically worthwhile. As explained by the Department of Transportation, "[i]n a capital-constrained situation, it is not possible to invest in every project with a positive NPV, and therefore a way to prioritize is required. The benefit-cost ratio is a measure of return on investment – 'bang for the buck'".[17]

The duty to evaluate the economic viability of projects financed or authorized by government entities from a benefit-cost perspective is firmly ensconced in statutes, rules, regulations and guidance manuals for virtually every government agency at the federal, state, and local levels. For example, OMB's Circular A-94 requirements "apply to any analysis used to support government decisions to initiate, renew, or expand programs or projects which would result in a series of measurable benefits or costs extending for three or more years into the future."[18] Individual federal agencies have adopted the benefit-cost perspective in their individual regulatory frameworks.

For example, benefit-cost analysis and net present values "are key components of EPA's policy development and evaluation process."[19] U.S. Army Corps of Engineers (Corps) navigation and civil works projects are justified on the basis of their contributions to national economic development (NED), discussed below. Contributions to NED are "increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation."[20] For the Corps to recommend federal cost share involvement in a project, the benefit-cost ratio must exceed 1.0.[21] In Alaska, the benefit-cost perspective was recently

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[16] DOT. 2006. Note 14, Section 7.2.
[17] Ibid.
[18] OMB. Note 15, Section 4(a).
[19] Environmental Protection Agency (EPA). 2000. Guidelines for Preparing Economic Analyses. Washington, D.C.: EPA. Page 33.
[20] Water Resources Council (WRC). 1983. Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. Washington, D.C.: Water Resources Council.
[21] Principles and guidelines contained in Chapter 6, ER 1105-2-100, regarding National Economic Development (NED) Benefit Cost Analysis.

mandated in the Alaska Gasline Inducement Act (AGIA). AGIA is designed to expedite construction of a natural gas pipeline that "maximizes benefits to the people of the state." In support of this purpose, the AGIA requires a strict NPV test for all projects as well as ranking of projects based on NPV.[22]

Thus, and the most important point made here, is that as decision makers at both the federal and state levels contemplate decisions to fund, authorize, or otherwise facilitate development of the Chuitna Coal Project those decisions must rest on a determination that project development is in the public interest through benefit-cost analysis and not narrow assessments of financial viability for potential investors. There are several key components to a rigorous analysis of net public benefits:

1.1.1 Incorporating both market and non-market costs and benefits

In a comprehensive net benefits analysis, everyone's costs and benefits count. To make the process of determining whether or not a policy, program, or project creates net public benefits "all economic benefits and costs must be described and, where possible, quantified."[23] These include costs and benefits that are easy to measure because they have direct effects in the market, as well as costs and benefits that are primarily non-market in nature but may be just as or even more significant economically. Thus, in the net public benefits analysis for the Chuitna Coal Project, it is critical for the Corps to consider all costs and benefits regardless of whether they are easy to measure market effects (i.e. consumer surplus for energy consumers) or more difficult non-market effects (i.e. health and other socio-economic costs of pollution or carbon emissions) regardless of who enjoys or incurs them.

Non-market effects are every bit as important economically, however, they do not manifest themselves in direct market transactions. Rather, they manifest themselves indirectly, through changes in home prices, recreational use patterns, subsistence hunting and fishing patterns, and expenditures on pollution control – for example – that are caused by changes in environmental quality associated with a policy, program, or project. Regulatory guidance provides a clear mandate to incorporate non-market effects into project analysis. For example, guidelines for analyzing federal infrastructure investments contains the following direction:

> "…all types of benefits and costs, both market and non-market, should be considered. To the extent that environmental and other non-market benefits and costs can be quantified, they shall be given the same weight as quantifiable market benefits and costs."[24]

[22] Alaska Statutes (AS) Sec. 43.90.170.
[23] Swanson, Cindy Sorg and John Loomis. 1996. Role of Nonmarket Economic Values in Benefit-Cost Analysis of Public Forest Management. USDA Forest Service General Technical Report PNW-GTR-361. Portland: Pacific Northwest Research Station.
[24] Executive Order 12893, Principles for Federal Infrastructure Development.

As another example, the USFWS regulations for issuing incidental take permits require, in part, that the agency determine the "effects on other environmental values or resources" in deciding what level of NEPA analysis to apply.[25] Likewise, in issuing permits for impacts to freshwater wetlands under its Clean Water Act Section 404 Program the Army Corps of Engineers must conduct a public interest determination that addresses all factors which may be relevant to the proposed wetland fill including:

> "…conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people" (33 CFR § 320.4).

Clearly, many of these impacts are economic, and non-market in nature, and thus require application of non-market valuation techniques to estimate their magnitude. Fortunately, economists have at their disposal a wide range of tools for measuring non-market effects, including travel cost and random utility models, contingent valuation surveys, hedonic pricing models, benefits transfer, choice experiments, and replacement cost techniques.

One non-market cost of particular concern is the loss of passive use values for Chuitna's exceptional wildlife habitat. Passive use values represent individual's willingness to pay for protecting a resource, even if they may never use it in any way. With respect to wildlife, people are clearly willing to pay to protect species – some of them halfway around the world – that they may never even view. Contributions to international wildlife organizations are an example of how that willingness to pay is manifested. Passive use values for Alaska's wilderness lands, wildlife refuges, and other intact landscapes extend to the entire U.S. population. For example, in Colt (2001) suggested that passive use values for 13.2 million acres encompassed by Bristol Bay Wildlife Refuges was in the order of $2.5 billion a year, or $3.5 billion in 2010 dollars. This translates into a value of $268 dollars an acre each year.[26]

Passive use values can be an extremely important component of total economic value of a resource, and should not be overlooked. They can be quantified through contingent valuation surveys and choice experiments.

As the Corps is well aware of, the wildlife and fishery resources of the lands and waters affected by the Chuitna Coal Project are exceptional. The project area supports five terrestrial species with high public interest and ecological values including moose (*Alces alces*), brown bear (*Ursus arctos*), black bear (*Ursus americanas*), trumpeter swan (*Cygnus buccinators*) and lesser sandhill crane (*Grus canadensis*). Aquatic species with the same status include beaver (*Castor canadensis*), beluga (*Delphinapturus leucas*), chinook salmon

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[25] U.S. Fish and Wildlife Service, Habitat Conservation Planning Handbook, Chapter 1, page 1-8.
[26] Colt, Steve. 2001. The Economic Importance of Healthy Alaska Ecosystems. Anchorage: Institute for Social and Economic Research, University of Alaska.

(*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), and rainbow trout (Sa*lmo gairdneri*).[27]

The exceptional abundance and diversity of wildlife in the Chuitna Coal Project area suggests that passive use values are likely to be significant, and should not be excluded from the EIS and supporting benefit-cost analysis.

1.1.2 Ecosystem services

Ecosystem services are economic benefits provided by nature free of charge, and represent a unique class of non-market effect. The range of services is immense, and falls into four key categories: provisioning, supporting, cultural, and regulating.[28] Some are more direct than others, such as the provision wild foods that support subsistence-based communities. Others are more indirect, such as carbon sequestration, that helps regulate global climate change. Ecosystem services are a significant source of economic value to nearby communities and the global economic system as a whole.

For example, in the Aleutians East Borough, a recent estimate put the weight of annual subsistence harvest of wild foods near 700,000 pounds.[29] A “replacement cost” value of $7 a pound implies an annual harvest value of roughly $4,900,000.[30] Colt (2001) prepared an ecosystem service assessment based on Costanza et al. (1997) suggesting ecosystem service values for Alaska marine and terrestrial ecosystems to range between $1 to over $76 per acre per year in 2010 dollars (Figure 1-1).[31] The loss of these services provides one quantitative measure of non-market costs associated with developing lands in the Chuitna Coal Project area.

Because ecosystem service values generated by wild habitats in the project area are significant, the Corps economic analysis should address ecosystem service values in a quantitative fashion. In the NEPA context, there are two key approaches. First, because analysis of the “no action” alternative needs to be as in-depth as any of the action alternatives, the existing economic value of ecosystem services should be documented. Otherwise, the NEPA analysis will be arbitrarily skewed in favor of the action alternatives since the economic value of no action alternative will be assumed to be zero. Secondly, action alternatives that adversely affect ecosystem services create economic costs that should be tabulated. Again, failure to do so would skew the analysis in favor of the action alternatives.

[27] U.S. Environmental Protection Agency, Region 10. 1990. Diamond Chuitna Coal Project Final Environmental Impact Statement, Volume II – Appendices. Seattle, Washington: EPA.
[28] Millennium Ecosystem Assessment 2005. *Ecosystems and Human Well-Being: Current State and Trends, Volume 1*. R Hassan, R. Scholes, and N. Ash (eds.) Washington, D.C.: Island Press.
[29] U.S. Army Corps of Engineers, 2003. Draft Environmental Impact Statement. King Cove Access Project. Project Application File Number: 2-2000-0300; Waterway Number: Cold Bay 12. July 2003.
[30] The replacement cost method and per pound value estimate are described in “Subsistence In Alaska: 1994 Update,” Division of Subsistence, Alaska Department of Fish and Game. The 2009 value of the $5 per pound figure used in that study is $7.
[31] Colt. 2001. Note 26.

Figure 1-1:

Costanza Methodology for Economic Value of Major Ecosystem Services Applied to Alaska Lands and Waters

(millions of 1998 dollars per year)

Biome	Millions of Acres in Alaska	Economic Value by Ecosystem Service (milions of 1998$ per Year)												
		Gas regulation	Climate regulation	Disturbance regulation	Water regulation	Water supply	Erosion control and sediment retention	Soil formation	Nutrient cycling	Waste treatment	Polination	Biological control	Habitat/ Refugia	Total
Marine														
Open Ocean	128.0	21.4	-	-	-	-	-	-	66.5	-	-	2.8	-	**90.7**
Coastal	19.2	-	-	7.4	-	-	-	-	310.9	-	-	3.2	0.7	**322.2**
Terrestrial														
Temperate / Boreal Forest	140.2	-	54.3	1.2	-	-	-	6.2	-	53.7	-	2.5	-	**117.9**
Grass and rangeland	17.6	0.5	-	-	0.2	-	2.2	0.1	-	6.7	1.9	1.8	-	**13.6**
Wetlands	10.4	6.1	-	207.9	0.7	174.0	-	-	-	191.3	-	-	13.9	**593.9**
Lakes & Rivers	13.5	-	-	-	323.7	125.9	-	-	-	39.5	-	-	-	**489.1**
Tundra	98.1	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ice/rock	84.9	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Cropland	1.0	-	-	-	-	-	-	-	-	-	0.1	0.1	-	**0.2**
Total	**512.8**	**28.1**	**54.3**	**216.5**	**324.6**	**299.9**	**2.2**	**6.3**	**377.4**	**291.3**	**2.0**	**10.4**	**14.6**	**1,627.6**
Marine	147.2	21.4	0.0	7.4	0.0	0.0	0.0	0.0	377.4	0.0	0.0	6.0	0.7	413.0
Terrestrial	365.7	6.6	54.3	209.1	324.6	299.9	2.2	6.3	0.0	291.3	2.0	4.4	13.9	1,214.6

Source: Colt (2001), see footnote 26.

There are many peer reviewed methods available to the Corps to put a price tag on both ecosystem service benefits provided by the no action alternative and the economic costs associated with ecosystem service degradation.[32] These methods represent the "best available science," and should be used. This is especially important because the Corps itself has been a leading proponent in revising its guidelines to incorporate ecosystem service values. As noted in the proposed revisions to the Corps procedures for analyzing water resource projects:

> "Consideration of ecosystem services can play a key role in evaluating water resource alternatives. Using the best available methods in the ecological, social, and behavioral sciences to develop an explicit list of the services derived from an ecosystem is the first step in ensuring appropriate recognition of the full range of potential impacts of a given alternative. This can help make the formulation and the analysis of alternatives more transparent and accessible and can help inform decision makers of the full range

[32] See, e.g. National Research Council. 2004. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies. Washington, D.C: National Academies Press.

> of potential impacts stemming from different options before them. The second step is establishing the significance or value of changes in the quality or quantity of services over time, with and without the effects of proposed alternatives on ecosystem services."[33]

The Corps can rely on many resources to apply state of the art methods for incorporating ecosystem service values in the EIS process.

1.1.3 Consumer surplus as the basis for benefit calculations

The basis for all benefit estimates should be changes in consumer and producer surplus, and not simple calculations of revenues, jobs, income and taxes generated from the sale of Chuitna coal. Consumer surplus is the excess amount that purchasers are willing to pay for a good or service over and above the market price (i.e., the area under the demand curve but above the price line). Consumer surplus serves as a measure of the social benefits of producing the good.[34] Policies that affect market conditions in ways that decrease prices will generally increase consumer surplus. This increase can be used to measure the benefits of the policy. As OMB recognizes, "[c]onsumer surplus provides the best measure of the total benefit to society from a government program or project."[35]

Corps guidance recognizes consumer (and producer) surplus as the required basis for benefit calculations for projects that induce new commodity movements:

> "New movement benefits are claimed when there are additional movements in a commodity or there are new commodities transported due to decreased transportation costs. The new movement benefit is defined as the increase in producer and consumer surplus, thus the estimate is limited to increases in production and consumption due to lower transportation costs" (ER 1105-2-100, 3-5).

With respect to coal, the presumed economic benefit is the consumer surplus households will receive associated with Chuitna coal relative to electricity derived from oil, gas, or renewables. This is a proper benefit from a public welfare perspective.

Analysts often confuse economic benefits with economic impacts. Economic impacts are the various local effects of spending and revenues. Economic impacts are described in terms of jobs, personal income, tax revenues, royalties, and rents generated by project spending and the revenues earned by market sales. The reason why these are not considered benefits from a welfare economics perspective is that they merely reflect a reallocation of spending and revenue away from other regions so that from a public perspective the net gain is often quite small or zero. So for example, investment by PacRim and its backers in Chuitna coal would come at the expense of investments in other regions or other energy projects (including renewables) that would confer a similar magnitude of economic impacts elsewhere.

[33] See Council on Environmental Quality. 2010. Updated Principles and Guidelines for Water and Land Related Resources Implementation Studies at: http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG.
[34] EPA. 2000. Note 19, Page 61.
[35] OMB. Note 15, Section 4(a).

The net economic effect of Chuitna relative to these other alternatives is difficult to discern, and so impacts are typically considered a separate kind of analysis and not suitable for use in a net public benefits or benefit-cost framework.

Decision makers often confuse benefits with impacts, erroneously comparing costs of development with economic impacts rather than benefits. This is not merely an esoteric consideration. Economic benefits are often far less than impacts, and so using impacts in a benefit-cost framework can significantly distort results. Thus, the Corps analysis should carefully distinguish between economic benefits in terms of the cost savings consumers receive (here and abroad) from the coal supplied by the Chuitna Mine and the regional economic impacts in Alaska. However, both benefits and impacts should be quantified with equal rigor using standard tools of economic analysis.

1.1.4 With and without framework

To insure that Corps water resources projects contribute net economic benefits to the nation, analysis must be conducted in what is known as a "with and without" framework. This framework requires that the Corps address net public benefits over the long term under two different scenarios: (a) the discounted stream of all market and non-market benefits and costs that can reasonably be expected in the absence of the project, and (b) the discounted stream of all market and non-market benefits and costs that would be generated with the project.

With and without analysis must take a long-term perspective. Typically, the Corps period of analysis extends to 100 years. According to the Corps NED guidance, "with and without project forecasts should be long run forecasts that avoid giving disproportionate weight to short run events."[36] Thus, if a water resource project provides short run benefits to commodity producers but creates long term costs in the form of damaged marine ecosystems, the long run perspective will insure that the short-term gain is not over-emphasized.

The without-project scenario is the "most likely condition expected to exist over the planning period in the absence of the plan, including any known change in law or policy."[37] The without-project scenario provides the basis for estimating the benefits of the with-project scenario. In projecting economic conditions in the without-project scenario, the Corps is required to take into account which structural and non-structural measures may be taken by port agencies, other public agencies, or the transportation industry to accomplish the same objectives of the proposed plan as well as changes in technology that may have bearing on the need for the proposed project (Id.).

The without-project scenario has an important parallel in the National Environmental Policy Act (NEPA) process the Corps must complete for every water resource project. In

[36] IWR. 1991a. National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis. Fort Belvoir, VA, U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, Page 52.
[37] WRC. 1983. Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. Washington, D.C., Water Resources Council, Page 59.

preparing environmental assessments or environmental impact statements pursuant to NEPA, the Corps must carefully consider the "no action" alternative. Moreover, consideration of this alternative must be completed with the same level of rigor applied to any of the action alternatives. Courts have consistently found that federal agencies must conduct "informed and meaningful" analysis of all alternatives, including no action, and to specifically address how the no action alternative affects environmental impacts and the cost-benefit balance.[38]

The with-project scenario is the one expected to exist over the period of analysis if a project is undertaken. As in the without-project scenario, the Corps must project changes in technical, environmental, social, and economic conditions over the life of the project. Various alternative configurations of the project must also be modeled. Forecasts of with and without-project conditions must use the inventory of existing conditions as the baseline, and should consider direct, indirect, and cumulative effects on income, employment, output, population, exports, land use trends, demands for goods and services, and environmental conditions.[39]

Once completed, the Corps must compare with and without-project scenarios with the same set of criteria. In order to recommend federal approval of a project, the Corps must demonstrate that one of the with-project alternatives is the alternative that maximizes NED benefits. If the without-project scenario maximizes NED benefits, the Corps may not recommend federal approval.

1.1.5 Externalities

To complete a reasonably accurate NED account, the Corps must provide a full accounting of costs and benefits that would accrue to all parties regardless of whether they are directly affected by a proposed project. As explained by the Corps in its NED guidance manual, "[m]any economic activities provide incidental benefits to people for whom they were not intended. Other activities indiscriminately impose incidental costs on others. These effects are called externalities."[40] The Corps has a mandate to incorporate externalized costs into its NED analysis: "[t]he NED principle requires that externalities be accounted for in order to assure efficient allocation of resources" (Id., 23). Tracking externalized costs is a standard requirement for evaluating all public expenditures.[41] Consideration of externalities, whether they affect marketed or non-marketed goods and services, is a required component of all economic analyses supporting federal infrastructure investments.[42] Federal environmental justice guidelines require the Corps to pay particular attention to externalized costs of pollution when subsistence uses by Native Americans is at issue.[43]

Marine and air pollution are examples of externalities that must be evaluated in the context of NED analysis. Navigation improvement projects sponsored by the Corps have the potential to both directly and indirectly contribute to greater amounts of marine pollution

[38] See, e.g. Bob Marshall Alliance v. Hodel, 852 F.2d 1223, 1228 (9th Cir. 1988); Alaska Wilderness Recreation and Tourism Association v. Morrison, 67 F.3rd 723, 729-30 (9th Cir. 1995).
[39] WRC. 1983. Note 37, Page 4.
[40] IWR. 1991a. Note 36, Page 21.
[41] See, e.g. Office of Management and Budget, Circular A-94 at 6.
[42] Principles for Federal Infrastructure Investments, Executive Order 12893 at Section 2(a)1.
[43] Presidential Executive Order on Environmental Justice, Executive Order 12898 at Section 4-401.

through dredging, construction of port infrastructure, greater throughput of marine traffic and cargo, and an overall increase in human use. Marine pollution can generally be divided into six major categories – oxygen demanding substances, suspended solids, pathogens, organic chemical toxicants, metal toxicants, and solid wastes.[44]

The presence of these substances in marine environment contaminates marine sediments, aquatic vegetation, benthic organisms, fish, shellfish, birds, mammals, and sea turtles (Id.). Contamination of marine ecosystems, in turn, translates into economic costs to humans in the form of adverse health effects, reductions in consumptive and non-consumptive use and enjoyment of marine environments, and adverse impacts to production activities in the seafood, wholesale trade, retail trade, travel, tourism, real estate, and housing sectors (Id., 94-95).

These costs are known as "externalized" costs since they are borne by individuals, communities, landowners and others who are not directly involved with Corps navigation projects.[45] In fact, marine pollution is cited by the Corps as the "classic" example of an externality, and externalities of all kinds are "commonly encountered in many of the Corps' missions" (Id., 22).

Externalized costs of Corps projects that lead to greater marine pollution can be quantified by any of the standard techniques for assessing both market and non-market effects of federal projects. However, the National Oceanic and Atmospheric Administration (NOAA) and the Department of Interior (DOI) have published special guidelines for how to assess the damage caused to natural resources from release of toxic substances.[46] In a nutshell, these natural resource damage assessment (NRDA) procedures call for an accounting of damage that reflects the sum three basic components: (a) restoration costs; (b) compensable value; (c) assessment cost. Restoration costs are defined as the costs of restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and services. Compensable value refers to lost use and non-use values to the public, and assessment costs refer to the costs of conducting the NRDA. Thus, when navigation project authorized by the Corps results in a risk of marine pollution, there are many methods available that can be used to assess the likely costs of such pollution under various scenarios.

One scenario that is often required by federal regulations is the "worst-case scenario," such as a major oil spill. Worst-case scenarios were a required part of NEPA analysis through the mid-1980s, however, the regulations were changed to place limits on when the worst-case scenario must be analyzed. The Supreme Court has interpreted the present NEPA regulations to retain the duty to describe the consequences of a remote, but potentially severe impact in cases where scientific opinion suggests that it may occur.[47] Regardless of whether a worst-

[44] Ofiara, D. and J. Seneca. 2001. Economic Losses from Marine Pollution. Washington, D.C.: Island Press.
[45] IWR. 1991b. National Economic Development Procedures Manual - National Economic Development Costs. Fort Belvoir: U.S. Army Corps of Engineers, Institute for Water Resources.
[46] National Oceanic and Atmospheric Administration. 1996. Natural Resource Damage Assessment Procedures: Final Rule. Federal Register 61(4), Friday January 5: 439-510; U.S. Department of Interior. 1987. Natural Resource Damage Assessments: Final Rule. Federal Register 52(54), Friday, March 20: 9042-9100.
[47] Robertson v. Methow Valley Citizens Council et al., Supreme Court of the United States, No. 87-1703. 490 U.S. 332; 109 S. Ct. 1835.

case scenario is required for all Corps projects, the Corps guidance on how to deal with risk and uncertainty suggests use of a worst-case scenario to establish an upper bound on unanticipated adverse outcomes: “a pessimistic or risk-averse decision maker may be interested in the maximum probable exposure or loss, or the worst-case scenario.”[48]

Air pollution is another externality often affected by Corps navigation projects because large vessels are often significant sources of pollutants in near shore environments. In fact, according to a recent study by the Natural Resources Defense Council “U.S. seaports are the largest and most poorly regulated sources of urban pollution in the county.”[49] Sources of air pollution related externalities associated with the Chuitna Coal Project will be greenhouse gases, nitrous oxide, sulfur dioxide, and particulate matter – all which adversely affect climate and public health.

In December of 2009 the EPA issued an Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act: “the Administrator finds that greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare.”[50] It is clear that global warming caused by greenhouse gas emissions generates serious economic damage – estimated by one recent study to eventually reduce per capita consumption by 2100 by 20% at an annual cost of over $9 trillion.[51] While there are no immediate regulatory restrictions related to coal, the fact that greenhouse gases are now formally recognized as air pollutants does require the Corps to address emissions associated with all phases of the Chuitna Coal Project and quantify the magnitude of negative externalities.

1.1.6 Uncertainty, risks, and sensitivity analysis

Navigation and other projects authorized by the Corps are planned in an environment replete with risk and uncertainty. As a result, the Corps is required to formally address risk and uncertainty in the context of NED analysis, and to not characterize the benefits and costs of its projects in certain terms. Mischaracterizing uncertain outcomes as certain can result in serious overstatements of project benefits.[52] Likewise, failing to acknowledge and quantify risks can lead to serious understatements of expected project costs.

The Corps defines risky situations as “those in which the potential outcomes can be described in reasonably well known probability distributions.”[53] For example, the probability of floods and severe storms occurring within a specified time frame is described reasonably well by a known probability distribution. Likewise, the probability of accidental spills of oil

[48] Males, R. M. 2002. Beyond Expected Value: Making Decisions Under Risk and Uncertainty. Cincinnati: U.S. Army Corps of Engineers, Institute for Water Resources.
[49] Natural Resources Defense Council. 2004. Harboring Pollution: Strategies to Clean Up U.S. Ports. San Francisco: Natural Resources Defense Council and the Coalition for Clean Air.
[50] Federal Register Volume 74, No. 239, Tuesday, December 15th, 2009.
[51] Stern, Nicolas. 2006. Stern Review Stern Review on the Economics of Climate Change – Executive Summary. London: New Economics Foundation.
[52] National Research Council. 2001. Inland Navigation System Planning: The Upper Mississippi River - Illinois Waterway. Washington, D.C.: National Academy Press.
[53] U.S. Army Corps of Engineers, Engineering Regulation 1105-2-100, Appendix E at E-11.

or other hazardous substances from specific types of vessels or port facilities can be calculated from historical records.

In contrast, when potential outcomes cannot be described in objectively known probability distributions they are labeled uncertain outcomes.[54] Uncertainty permeates environmental planning. With respect to navigation, uncertainty clouds commodity demand and price forecasts, predictions of required amounts of dredging, reliability projections for navigation structures and port facilities, transit times for commercial traffic, and many other factors that have bearing on project costs and benefits. Many projected benefits and costs of navigation projects do not have known probability distributions and, thus, are uncertain.

Expected value analysis is one method the Corps has at its disposal to incorporate risk into its NED analyses. Stated simply, expected value analysis requires multiplication of cost and benefit estimates, either point estimates or ranges, by the probability of their occurrence.[55] Expected value analysis, then, deflates benefit and cost estimates to reflect the inherent ambiguity about their future values. Expected value analysis is a rather crude way to incorporate risk, since it does not tell us anything about the specific risk factors associated with various alternatives. Because of this, the Corps has developed much more sophisticated methods to address both risk and uncertainty that fall under the general heading of “risk analysis,” which has three basic components:

1) risk assessment, which involves the analysis of the technical aspects of the problem to determine uncertainties and their magnitudes;
2) risk communication, which deals with conveying information about the nature of risks to all interested parties, and;
3) risk management, which involves decisions on how to handle risks.[56]

The National Research Council has also outlined ways in which the Corps should go about incorporating risk and uncertainty into decisions. NRC describes four “state of the art” methods including sensitivity analysis, Monte Carlo analysis, scenario analysis, and the process of finding “robust” alternatives that are immune to the volatility of benefit and cost estimates caused by uncertain parameters.[57] Thus, there are a variety of widely endorsed analytical tools the Corps can use to fulfill its obligations to incorporate risk and uncertainty into project planning.

1.2 Net Public Benefits and the Regulatory Framework for Chuitna

The statutes, regulations, and rules governing analysis of the Chuitna Coal Project underscore the importance of the net public benefits framework in general as well as many of the specific components of a proper analysis, such as benefit-cost analysis, addressing

[54] Ibid.
[55] Boardman, A., D. Greenberg, et al. 2001. Cost Benefit Analysis: Concepts and Practice. Upper Saddle River, NJ: Prentice Hall.
[56] Males. 2002. Note 48, ix.
[57] NRC. 2001. Note 52, Page 63-66.

externalities, non-market benefits and costs, and the with and without framework. For example:

1.2.1 Water Resources Development Act

As previously noted, Corps navigation and civil works projects are justified on the basis of their contributions to national economic development (NED), which is analogous to net public benefits. This requirement is set forth in the Water Resources Development Act (WRDA), the Water Resources Council (WRC) regulations implementing the Act, and Corps guidance manuals. According to the Water Resources Council (1983):

> "Contributions to national economic development are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed."[58]

NED analysis provides the basis for identifying appropriate benefits and costs associated with Corps flood control, navigation, hydroelectric, water supply or environmental projects to include in subsequent benefit cost analyses of these projects.[59] Benefit cost analysis is used to determine whether national economic development effects of a project are positive or negative. In other words, benefit cost analysis is undertaken to assure that the value of the outputs exceeds the value of the inputs.

1.2.2 Principles and Guidelines for Water and Related Land Resources Implementation Studies

The WRDA and NED analysis are implemented under procedures set forth in the Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. The first set of "Principles" was issued in September 1973 to guide the preparation of river basin plans and to evaluate federal water projects. Following a few attempts to revise those initial standards, the current principles and guidelines went into effect in March 1983. As established above, the Principles already provide unambiguous direction for the Corp to conduct economic analysis under the net public benefits framework. This mandate is being amplified and made even more explicit in revisions to the Principles that will likely be completed before the Corps begins formal economic analysis of the Chuitna Coal Project.

In the reauthorized Water Resources Development Act of 2007, Congress instructed the Secretary of the Army to develop a new Principles and Guidelines for the U.S. Army Corps of Engineers (section 2031). In an effort to modernize the approach to water resources development, the Obama Administration is expanding the scope of the Principles and Guidelines to cover all federal agencies that undertake water resource projects, not just the four agencies (i.e., U.S. Army Corps of Engineers, Bureau of Reclamation, Natural Resources

[58] WRC. 1983. Note 37, Page 1.
[59] IWR. 1991a. Note 36, Page 1.

Conservation Service and the Tennessee Valley Authority) which are subject to the current Principles and Guidelines. The revised Principles include a number of important changes that modernize the current approach to water resources development in this country and which underscore the importance of economic analysis under the net public benefits standards.[60] As explained by the Council on Environmental Quality, the revisions address two key considerations: maximizing net public benefits broadly, and incorporating both monetary and non-monetary benefits:

- Achieving co-equal goals: The Administration's proposal reiterates that federal water resources planning and development should both protect and restore the environment and improve the economic well-being of the nation for present and future generations. While the 1983 standards emphasized economic development alone, the new approach calls for development of water resources projects based on sound science that maximize net national economic, environmental, and social benefits.

- Considering monetary and non-monetary benefits: The revised Principles and Guidelines shift away from the earlier approach to project selection. Specifically, this revised version will consider both monetary and non-monetary benefits to justify and select a project that has the greatest net benefits – regardless of whether those benefits are monetary or non-monetary. For example, the monetary benefits might capture reduced damages measured in dollars while the non-monetary benefits might capture increased fish and wildlife benefits, or biodiversity.

1.2.3 National Environmental Policy Act

In addition to formal benefit-cost analysis (BCA) required by the WRDA and its implementing Principles all Corps water resource projects that may significantly affect environmental quality must be accompanied by an environmental impact statement pursuant to the National Environmental Policy Act (NEPA, 42 U.S.C. § 421 et seq.) While NEPA by itself does not generally require federal agencies to conduct a formal cost-benefit analysis, the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR § 1502.23) set out the requirements for incorporating any BCA that may be prepared into the NEPA process. In addition, NEPA and its implementing regulations guide other components of the economic analysis including establishing a purpose and need, addressing cumulative impacts, and rigorous consideration of the "no action" alternative.

Incorporating BCA into the NEPA process

The CEQ regulations state that, if a BCA relevant to the choice among environmentally different alternatives is being considered for a proposed action under NEPA, it shall be incorporated into the EIS as an aid in evaluating the environmental consequences of the project.[61] Furthermore, the regulation requires that any BCA must discuss "the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities." The regulation also provides that, although the weighing of the merits

[60] See CEQ's website at: http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG.
[61] 40 CFR § 1502.23.

and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis, an EIS must "at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision."

The WRC regulations operationalize the CEQ requirement with respect to benefit cost analysis (BCA) prepared for water resource projects undertaken by the Corps and other federal agencies. The WRC regulations require the Corps to maintain four separate sets of accounts which enable Corps decision makers to compare economic values and impacts that are not included in the formal BCA but which, none the less, may have significant bearing on a project's feasibility with those that are included.[62] The four accounts include:

- The National Economic Development (NED) account. The NED account describes that part of the NEPA human environment, as defined in 40 CFR §1508.14, that identifies beneficial and adverse effects on the economy.

- A Regional Economic Development (RED) account. The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment. The regions used for RED analysis are those regions with in which the plan will have particularly significant income and employment effects.

- An Environmental Quality account (EQ) account. The EQ account is a means of displaying and integrating into water resources planning that information on the effects of alternative plans on significant EQ resources and attributes of the NEPA human environment, as defined in 40 CFR § 1507.14, that is essential to a reasoned choice among alternative plans. Significant means likely to have a material bearing on the decision making process.

- An Other Social Effects (OSE) account. The OSE account is a means of displaying and integrating into water resource planning information on alternative plan effects from perspectives that are not reflected in the other three accounts. The categories of effects in the OSE account include the following: urban and community impacts; life, health, and safety factors; displacement; long-term productivity; energy requirements and energy conservation.

Importantly, all four accounts are needed to satisfy the CEQ NEPA obligations: "[t]hese four accounts encompass all significant effects of a plan on the human environment as required by the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.)."[63]

Thus, the proper manner in which to incorporate BCA findings into an EIS is to include the BCA in the NED account, and then compare its findings and values with those reported by the other three accounts. In this way, the Corps is able to meet its obligations to

[62] WRC. 1983. Note 37, Pages 8-12.
[63] Ibid, Page 8.

discuss the relationship between NED analysis and any analyses of unquantified environmental impacts, values, and amenities or other considerations not related to environmental quality as required by 40 C.F.R. §1503.23. Failure to do this gives too much emphasis to the BCA in the decision making process.

Establishing a purpose and need

The purpose and need section is the most critical section of an EIS. CEQ regulations require federal agencies to "[s]pecify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action" (40 CFR § 1502.13). A precise definition of the purpose and need establishes "why the agency is proposing to spend large amounts of taxpayers' money while at the same time causing significant environmental impacts."[64] A clear, well-justified purpose and need section demonstrates why expenditure of public funds and permits or authorizations for natural resource disturbances are necessary and worthwhile and why the project is being prioritized relative to other needed land management, transportation, or infrastructure projects.

In addition, "although significant environmental impacts are expected to be caused by the project, the purpose and need section should justify why impacts are acceptable based on the project's importance."[65] As with other aspects of the Corps economic analysis, establishing purpose and need must identify the public benefits (i.e. NED benefits) associated with the project, and not simply report why the project is important to a small number or even a single private entity.

Cumulative impacts

The CEQ regulations require agencies to consider three types of actions when preparing an EIS: 1) "connected actions," which means they are closely related and therefore should be discussed in the same impact statement; 2) "cumulative actions," which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement; and 3) "similar actions," which when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography."[66]

Federal agencies must also consider three types of potential environmental impacts or "effects" of their proposed actions and programs in the EIS process: direct, indirect, and cumulative.[67] The CEQ regulations define "effects" as being synonymous with "impacts." Direct effects are those caused by the action that occur at the same time and place. Indirect effects are those caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects include the "growth inducing" effects and other effects related to induced changes in the pattern of land use, population density or

[64] NEPA and Transportation Decision Making: See http://www.environment.fhwa.dot.gov/projdev/tdmneed.asp.
[65] Ibid.
[66] 40 CFR § 1508.25(a).
[67] 40 CFR § 1508.25(c).

growth rate, and related effects on air and water and natural systems, including ecosystems. Court decisions construing NEPA have recognized that federally-assisted projects which contribute to urban sprawl are required to evaluate the growth inducing effect of additional development.[68]

Pursuant to 40 C.FR. §1508.25(c)(3), an environmental impact statement must consider a proposed project's "cumulative impact." 40 C.FR. §1508.7 defines cumulative impacts as the impact on the environment which results from the "incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." Cumulative impacts can result from "individually minor but collectively significant actions taking place over a period of time."

Court decisions have uniformly construed NEPA's cumulative effects requirement to require Federal agencies to conduct a comprehensive analysis of the impact of connected or cumulative actions in order to prevent agencies from dividing one project into multiple individual actions each of which has an insignificant environmental impact, but which collectively have a substantial impact.[69] As other Court decisions have recognized, at least some Federal agencies contributing to urban sprawl have a specific duty under their own NEPA regulations to "group together" and evaluate as a single project, all individual activities which are related on either a geographical or functional basis, or are logical parts of a "composite of contemplated actions."[70]

The CEQ regulations recognize that evaluation of the "significance" of major Federal actions involves consideration of context as well as the intensity of potential environmental impacts. This means that the significance of proposed actions must be analyzed in several contexts, including "the affected region" and the "locality" of those actions (40 CFR § 1508.27(a)). The CEQ regulations also suggest that, when preparing EIS's on broad federal actions (including proposals by more than one agency), agencies "may find it useful" to evaluate the proposal(s) on a geographical basis, including actions "occurring in the same general location, such as body of water, region, or metropolitan area" (40 CFR §1502.4(c)(1)).

In recent decisions construing NEPA's requirement that agency's evaluate the cumulative impacts of a proposed project, the Ninth Circuit has held that an environmental impact statement must "catalogue adequately past projects in the area" and provide a "useful analysis of the cumulative impact of past, present, and future projects."[71]

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[68] See e.g., City of Davis v. Coleman, 521 F.2d 661 (9th Cir. 1995) (highway construction); Carmel-by-the-Sea v. U.S. Dept. of Transportation, 123 F.3d 1142 (9th Cir. 1997) (highway construction); Morongo Band of Mission Indians v. FAA, 161 F.3d 569 (9th Cir. 1998) (airport expansion).

[69] See e.g., National Wildlife Federation v. FERC, 912 F.2d 1471 (D.C. Cir. 1990); Natural Resources Defense Council, Inc. v. Hodel, 865 F.2d 288, 297-98 (D.C. Cir. 1988).

[70] See Society Hill Towers Owners' v. Rendell, 20 F. Supp. 855 (E.D. Pa. 1998) (citing HUD regulations).

[71] See e.g., Northwest Environmental Advocates v. National Marine Fisheries Service, 2006 WL 2422681 (9th Cir. 2006) (noting that the Army Corps of Engineers was required to evaluate the cumulative impacts of a channel deepening project, including disposal of dredged material at a deepwater site, on sediment availability and transport in light of existing projects, and coastal erosion, as well as salinity in light of past actions) citing,

Given these requirements, it is clear that any discussion of economic impacts associated with the Chuitna Coal Project must consider not only the direct costs and benefits associated with the surface coal mine and associated support facilities, mine access road, coal transport conveyor, personnel housing, air strip facility, logistic center, and coal export terminal but also include an analysis of effects associated with increased access to the area, potential for mine expansion, separate future mining activities and other potential induced or connected future actions made possible by the Project's infrastructure.[72]

Rigorous consideration of the "no action" alternative

As previously noted, the stream of market and non-market benefits associated with the Project must be compared in a "with and without" context. Importantly, this requires a detailed consideration and valuation of all of the existing beneficial uses of the project area, including subsistence use, passive use values for native wildlife, carbon sequestration benefits, fish production, and other ecosystem services. By doing so, alternatives in the EIS are not improperly skewed towards the action alternatives and the economic benefits of leaving the Chuitna Coal Project area intact are identified and quantified where possible.

1.2.4 <u>Clean Water Act</u>

The Clean Water Act regulates several aspects of the Chuitna Coal Project. The duty to consider economic impacts broadly, from the net public benefits framework is found in multiple sections. For example, Section 404(b)(1) sets forth guidelines for specification of disposal sites for dredged or fill material. With limited exceptions, no discharge of dredged or fill material is permitted which will cause or contribute to significant degradation of the waters of the United States. Guidelines for findings of significant degradation related to the proposed discharge are based upon appropriate factual determinations, evaluations, and tests required by other subparts. Taken together, effects contributing to significant degradation considered individually or collectively, include:

- Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.

- Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes;

City of Carmel by the Sea, 123 F.3d 1142 (9th Cir. 1997); Lands Council, 395 F.3d at 1027. See also, Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1380 (Ninth Cir. 1998) (ruling that the Forest Service must consider cumulative impacts of a proposed project, and that to "consider" cumulative impacts some quantified or detailed information is required).

[72] These three cumulative actions were identified in the Scoping Report, page 16.

- Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or

- Significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.

Clearly, the duty to consider loss of ecosystem service values and other market and non-market effects envisioned by the net public benefits standard are reiterated by the plain language of these Clean Water Act regulations.

1.2.5 Fish and Wildlife Coordination Act (FWCA)

The Chuitna Coal Project will require diversion of a substantial amount of freshwater for dust control, processing of wastes, tailings impoundments, and operations. Under the FWCA, the application must obtain an authorization from the U.S. Fish and Wildlife Service for any water diversions.[73] As part of that authorization, the USFWS must estimate "wildlife benefits or losses."[74] Wildlife benefits associated with mitigation measures targeted at improved wildlife resources must be compared with the costs of implementing these measures. To be complete, non-market valuation – including estimation of passive use benefits – is an important part of this analysis since the majority of wildlife benefits are non-market in nature.

1.2.6 Solid waste management permit

The mine and infrastructure components of the Chuitna Coal Project could require solid waste disposal or management permits.[75] The Alaska Department of Environmental Conservation is responsible for issuing waste permits in compliance with 18 AAC 60. These regulations envision a social benefit-cost test to demonstrate that the benefits of constructing and operating the source outweigh its externalized social and environmental costs. An important part of the analysis supporting the permit includes "a demonstration that the benefits of construction, operation, or modification of the stationary source will significantly outweigh the environmental and social costs incurred."[76] To secure a waiver of applicable regulations, applications must demonstrate that:

> (1) compliance with the identified provision would cost significantly more than the value of the environmental benefit, public health risk reduction, and nuisance avoidance that could be achieved through compliance with the identified provision; or

[73] Fish and Wildlife Coordination Act, 16 USC § 661-666c
[74] Ibid, Section 3.
[75] The Final Environmental Impact Statement for the Diamond Chuitna Coal Project noted that solid waste disposal permits would be required for the mine and housing units. See U.S. Environmental Protection Agency.
[76] 18 Alaska Administrative Code 60

> (2) the proposed alternative action will provide equal or better environmental protection, reduction in public health risk, and control of nuisance factors than compliance with the identified provision. [77]

These provisions underscore the necessity of valuing largely non-market benefits and costs associated with environmental protection, public health risk and nuisance factors.

1.2.7 Marine, Protection, Research, and Sanctuaries Act Section 103(MPRSA)

Dredged material from development of the Ladd Landing Facility and deep draft channels accessing the export facility may be dumped offshore. As such, provisions of the MPRSA may apply. Permits for ocean dumping must be obtained from the U.S. Army Corps of Engineers using environmental criteria developed by the Environmental Protection Agency. The criteria must ensure "that such dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."[78] In addition, the criteria must consider the externalized costs of the proposed dumping and specifically include "the effect of such dumping on human health and welfare, including economic, esthetic, and recreational values."[79]

1.2.8 Dam safety certification

Tailings impoundment dams associated with the Chuitna Coal Project would require dam safety certification by the Alaska Department of Natural Resources (ADNR). Issuance of the certificate requires ADNR to classify the dam into one of three hazard types. As part of the hazard classification process, ADNR must consider potential losses or damage to human life, health, infrastructure, commercial and residential properties, anadromous fish and other economic resources should the dam fail.[80] A consideration of these potential costs should be part of the overall risk assessment for the project.

1.2.9 Alaska Coastal Management Plan consistency review

Because the Chuitna Coal Project lies within the coastal zone and affects offshore areas, estuaries, and wetlands, it is subject to an Alaska Coastal Management Plan consistency review led by ADNR. In the Coastal Zone Management Act (CZMA), Congress created a federal-state partnership for management of coastal resources. Section 307 of the CZMA requires that federally licensed or permitted activities be consistent with state coastal management policies (e.g., land use planning statutes, marine spatial planning, and water quality standards. A consistency determination is the process used to implement this requirement for federal permits and licenses.

Federal consistency reviews are not performed by one single agency. Rather ADNR's Department of Ocean and Coastal Management coordinates a collaborative process review

[77] Ibid. at 131.
[78] Marine Protection, Research, and Sanctuaries Act. 16 USC § 1431 et seq. and 33 USC §1401 et seq.
[79] Ibid. at 5.
[80] 11 Alaska Administrative Code 93.157.

involving Alaska's natural resource agencies. Participants in the coastal consistency review process include the applicant, state agencies, the affected coastal district(s), interested members of the public, and relevant federal agencies. As part of the review process, ADNR and its collaborators must determine whether or not the Project impairs management of coastal and offshore habitats and includes mitigation measures that adequately protect competing economic uses. For example, both offshore areas and estuaries must be managed "to avoid, minimize, or mitigate significant adverse impacts to competing uses such as commercial, recreational, or subsistence fishing."[81] Quantifying both market and non-market values associated with these competing uses and predicting how the Project would alter such values is critical for determining whether or not the Project surpasses the significance threshold.

1.3. Specific Recommendation for the Economic Analysis

Based on the foregoing, the scope and substance of the economic analysis the Corps will be preparing for the Chuitna Coal Project should include the following:

- Net public benefits should be the framework adopted for the analysis. The Corps existing National Economic Development (NED) procedures and guidance should be used in combination with guidance applicable to all federal agencies such as those published by Office of Management and Budget as well as economic analysis guidance contained in the numerous statutes, regulations, and rules governing each of the permitting activities associated with the project (Appendix 1-1).

- Both market and non-market benefits and costs should be described and quantified to the extent practicable based on the best available sources of information and methods. This includes quantification of externalities and the benefits of ecosystem services.

- Original valuation studies should be implemented to develop rigorous values to assign to changes in passive use values, subsistence use, loss of fisheries, carbon emissions damage, air quality damages, and other non-market effects. The costs of such studies are typically a small fraction on what the Corps will spend on other aspects of its feasibility analysis.

- The Chuitna Coal Project is ideal for demonstration of how ecosystem service values can be incorporated into regulatory analysis. As such, we recommend that the Corps and other partners on the USDA Environmental Markets Team adopt this project as pilot.

- In accordance with net public benefits analysis standards and NED guidance, potential benefits of the Chuitna Coal Project should be described and quantified in terms of changes in consumer and producer surplus. These benefits should be distinguished from economic impacts, which include jobs, income, tax revenues, and coal revenues. Economic benefits, not impacts, should be used in the formal benefit-cost analysis.

[81] 11 Alaska Administrative Code 112.300 (b)1-2.

In the sections that follow, we present a preliminary analysis of net public benefits in order to provide a sense of what the Corps will likely find once it completes a sufficient analysis with detailed site-specific information provided by PacRim. We begin with an analysis of the potential NED and RED benefits associated with the project in terms of net revenues from sale of Chuitna Coal on the Asian markets as well as employment, income, and regional tax benefits in Section 2. We then discuss financial and non-market costs in Section 3. Benefits and costs are combined in Section 4 to generate initial estimates of potential net public benefits.

Appendix 1-1: Regulatory and Permitting Requirements for the Chuitna Coal Project

Regulatory process	Agency	Chuitna Coal Mine	Chuitna Infrastructure	Ladd Landing Development
National Environmental Policy Act (NEPA) Supplemental Environmental Impact Statement (SEIS)	US Environmental Protection Agency (USEPA)	✓	✓	✓
Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) permit(s)	USEPA	✓	✓	✓
Air quality permit review	USEPA	✓	✓	✓
Safe Drinking Water Act (SDWA) Underground Injection Control (UIC) permit(s)	USEPA	✓	To be determined (TBD)	TBD
Spill Prevention, Control, and Countermeasure (SPCC) plan	USEPA	✓	TBD	✓
Federal landowner authorization	US Department of the Interior (USDI)	TBD	TBD	TBD
Bald Eagle Protection Act clearance	USDI	TBD	TBD	TBD
Migratory Bird Protection review	USDI	TBD	TBD	TBD
Fish and Wildlife Coordination Act review	USDI	TBD	TBD	TBD
Threatened and Endangered Species Act (ESA) consultation	USDI	✓	✓	✓
Federal landowner authorization	US Department of Agriculture (USDA)	TBD	TBD	TBD
CWA section 404 dredge and fill permit(s)	US Army Corps of Engineers (COE)	TBD	TBD	TBD
Marine, Protection, Research, and Sanctuaries Act Section 103 compliance	COE	✓	✓	✓

Appendix 1: Regulatory and Permitting Requirements for the Chuitna Coal Project (Page 2)

National Historic Preservation Act Section 106 Historical and Cultural Resources Protection review	COE	✓	✓	✓
Rivers and Harbors Act (RHA) Section 10 permit	COE	TBD	TBD	TBD
ESA consultation	National Oceanic and Atmospheric Administration (NOAA)	✓	✓	✓
Marine Mammal Protection Act review	NOAA	TBD	TBD	TBD
Essential Fish Habitat review	NOAA	TBD	TBD	TBD
Fish and Wildlife Coordination Act review	NOAA	TBD	TBD	TBD
CWA section 401 certificate of reasonable assurance of EPA section 402 NPDES permits	Alaska Department of Environmental Conservation (ADEC)	✓	✓	✓
CWA section 401 certificate of reasonable assurance of ACE section 404 permits	ADEC	✓	✓	✓
Solid waste management permit	ADEC	TBD	TBD	TBD
Domestic and non-domestic wastewater disposal permits	ADEC	TBD	TBD	✓
Air quality permit	ADEC	TBD	TBD	✓
Approval to construct and operate a public water supply system	ADEC	TBD	TBD	TBD
Plan review for non-domestic wastewater treatment system	ADEC	TBD	TBD	TBD
Plan review and construction approval for domestic sewage system	ADEC	TBD	TBD	✓

Appendix 1: Regulatory and Permitting Requirements for the Chuitna Coal Project (Page 3)

Stormwater discharge pollution prevention plan	ADEC	✓	TBD	✓
Oil discharge prevention and contingency plan	ADEC	✓	TBD	✓
Monitoring plan (surface/groundwater/wildlife)	ADEC	✓	✓	✓
Landfill permit and bonding	ADEC	TBD	TBD	TBD
Surface coal mine permit	Alaska Department of Natural Resources (ADNR)	✓	TBD	TBD
Right-of-way for access and utilities	ADNR	TBD	TBD	TBD
Millsite lease	ADNR	TBD	TBD	TBD
Permit to appropriate water	ADNR	TBD	TBD	TBD
Dam safety certification	ADNR	TBD	TBD	TBD
Upland or tideland leases	ADNR	TBD	TBD	TBD
Material sale	ADNR	TBD	TBD	TBD
Winter travel permits	ADNR	TBD	TBD	TBD
Cultural resource protection	ADNR	✓	✓	✓
Alaska Coastal Management Plan (ACMP) consistency review	ADNR	✓	TBD	✓

Appendix 1: Regulatory and Permitting Requirements for the Chuitna Coal Project (Page 4)

Fish Habitat title 16 permit(s)	Alaska Department of Fish and Game (ADF&G)	TBD	TBD	✓
Fishway permit(s)	ADF&G	TBD	TBD	TBD
Special area permit(s)	ADF&G	TBD	TBD	TBD
Scientific collection permit(s)	ADF&G	TBD	TBD	TBD
Fish resource permits(s)	ADF&G	TBD	TBD	TBD

Sources:

ADNR Office of Project Management and Permitting. 2008. "Permitting Large Mine Projects in Alaska." Available at: http://dnr.alaska.gov/mlw/mining/largemine/lmpt_process.pdf.

USEPA. 2006. "Draft Scoping Document for the Chuitna Coal Project Supplemental Environmental impact Statement." Chuitna Coal Project, Beluga Coal Field Alaska.

ADNR Division of Mining, Land, and Water. 2008. "Chuitna Coal Project Permit Application, ASCMCRA Permits/Project Components." Available at: http://dnr.alaska.gov/mlw/mining/largemine/chuitna/pdf/Chuitna_app_081808.pdf.

State of Alaska Large Mine Team, USCOE, and USEPA. Date unknown. "The Process and Requirements for Large Mine Permit Applications in Alaska." Available at: http://dnr.alaska.gov/mlw/mining/largemine/may5pptcolor1.pdf

ADNR Division of Mining, Land, and Water. Monthly reports for November 2007 to April 2009. Available at: http://dnr.alaska.gov/mlw/mining/largemine/chuitna/index.htm

ADNR, Division of Mining, Land, and Water. 2009. "Alaska Surface Coal Mining Program: Regulations Governing Surface Coal Mining in Alaska." Available at: http://dnr.alaska.gov/mlw/mining/coal/coalreg_apr09.pdf

Section 2: National and Regional Economic Development Benefits

As set forth in Section 1, the Corps has operationalized the concept of net public benefits in procedures the agency uses to evaluate the contribution of water resource projects to national economic development (NED). In other words, net public benefits and NED are synonymous. NED analysis represents the agency's best scientific methods. The components of NED analysis are established by the 1983 Water Resource Council (WRC) Principles and Guidelines.[82] Civil works projects for which NED analysis is required include navigation, flood damage reduction and ecosystem restoration, as well as for storm damage prevention, hydroelectric power, recreation, and water supply.[83] An analysis of NED benefits and costs is thus required for the coal export facility proposed at Ladd Landing since this falls under the definition of a general navigation facility. However, since the Chuitna Coal conveyor, associated infrastructure, and mine would not exist without development of Ladd Landing and vice versa the entire Chuitna Coal Project must be considered as an integrated plan to which NED analysis is applied.[84]

In addition to NED benefits, civil works projects must disclose regional economic development (RED) impacts. The RED analysis registers changes in the distribution of regional economic activity that result from the proposed plan. Two measures of the effects of the plan on regional economies are used: regional income and regional employment. In addition, RED analysis often considers effects on state and local tax collections. The regions used for RED analysis are those regions within which the plan will have particularly significant income and employment effects.[85]

As of this writing, neither the Corps nor PacRim has submitted detailed cost and expenditure data or revenue projections from the sale of Chuitna coal into the official project record. Thus, to generate preliminary estimates NED and RED benefits and impacts, we rely on other published sources of information.

2.1 NED Benefits

General navigation features of harbor or waterway projects are channels, jetties or breakwaters, locks and dams, basins or water areas for vessel maneuvering, turning, passing, mooring or anchoring incidental to transit of the channels and locks. Also included are dredged material disposal areas and shoreline facilities to facilitate the transfer of commodities from land

[82] WRC. 1983. Note 37.
[83] Engineering Regulation (ER) 1105-2-100, page 1-1.
[84] WRC (1983, p. 17) tiers its definition of the NED planning area to the National Environmental Policy Act: "The NED account describes that part of the NEPA human environment, as defined in 40 CFR 1508.14, that identifies beneficial and adverse effects." NEPA, in turn, requires analysis of all "connected actions" together in a single environmental impact statement. Connected actions are "actions that are closely related and therefore should be discussed in the same impact statement" (40 CFR § 1508.25(a)).
[85] WRC. 1983. Note 37.

to water.[86] The Corps describes four general categories of NED benefits associated with the development of general navigation facilities. These include:

1. Cost reduction benefits for commodities for the same origin and destination and the same mode of transit thus increasing the efficiency of current users.
2. Shift of mode benefits for commodities for the same origin and destination providing efficiency in waterway or harbor traversed.
3. Shift in origin and destinations that would provide benefits by either reducing the cost of transport, if a new origin is used or by increasing net revenue of the producer, if a change in destination is realized.
4. New movement benefits are claimed when there are additional movements in a commodity or there are new commodities transported due to decreased transportation costs.
5. Induced movement benefits are the value of a delivered commodity less production and transportation costs when a commodity or additional quantities of a commodity are produced and consumed due to lower transportation costs.[87]

Chuitna coal represents a new commodity on the market and a new origin and thus NED benefit categories 4 and 5 apply. Development of the Ladd Landing export facility will make development of the mine possible, presumably because alternative transport options are not currently available or cost prohibitive (i.e. constructing new roads or rail lines). Development of the Ladd Landing facility can be seen, then, as a decrease in transportation costs for Alaska coal in general or a facility that lowers transportation costs to the point where new commodity (Chuitna coal) shipments become possible. Regardless, the calculation of NED benefits involves quantification of three basic variables:

a. The likely selling price of Chuitna coal in the Asian market.
b. The delivered cost of Chuitna coal taking into account capital, operating, and maintenance costs associated with all project components and transportation costs to Asia.
c. The difference between the cost of transportation with the project and the maximum cost the shipper would be willing to pay.

Benefit category 4 is further refined by Corps regulations to include increases in consumer and producer surplus. Consumer surplus was discussed in Section 1 and would be difficult to calculate in this analysis since neither the specific end users of Chuitna coal nor the energy alternatives available to those users has been identified in the project record. Thus, it is not possible to calculate the cost savings to consumers associated with consumption of Chuitna coal relative to other sources of energy. Producer surplus is calculated as the area above an industry supply curve but below the price line. Producer surplus can also be calculated for an individual source of supply if marginal costs are known at various levels of production. This information, however, is also not available in the Chuitna Project record. A good proxy for produce surplus, however, is simply net revenues, calculated by subtracting the second term from the first (a – b). This also meets the literal terms of the NED benefit definition for category 5.

[86] Engineering Regulation (ER) 1105-2-100, page 3-2.
[87] Engineering Regulation (ER) 1105-2-100, page 3-5.

Corps guidance further refines benefit category 5 to include the third variable (c), which appears to be different in both concept and calculations than the former two. However, since the maximum cost a shipper would be willing to pay would, in fact, be a function of the difference between delivered cost (including production and transportation) and expected sale revenues, it is safe to simply focus on the first two variables.

2.1.1 Gross revenues from Chuitna coal sales in the Asian market

As of this writing, the project record does not specify a final destination for Chuitna coal. However, since inception of the Chuitna Coal Project it has been widely assumed that the end use of Chuitna coal would be for generation of commercial and residential electricity supply by coal-fired plants in China or other Asian nations. According to a recent article that appeared in the Alaska Journal of Commerce: "A dock jutting two-miles out into the Inlet would shuttle the coal onto 1,200-foot freighters several times a week. The giant vessels would travel through Shelikof Strait and along the Aleutian Chain to deliver the coal to Asian power plants."[88] Indeed, the state's only coal mine in operation – Usibelli – exports a significant share of its production to South Korea. Japan is also testing the feasibility of coal imports.[89] Thus, for purposes of our analysis, it is reasonable to assume that the basis for gross revenue projections should be the selling price of Chuitna coal in Asian markets over the 25 year project life. To estimate the likely selling price, we examine current and historical import prices at major ports as well as future forecasts based on International Energy Agency data.

Current and historical price trends

The most authoritative source for current coal export and import prices is the International Energy Agency's quarterly publication "Coal Price Trends." The publication provides historical export and import price data for ports in all major coal producers including a number of ports in Japan, Korea, and China. The data provide historical import price data based on cost, insurance, and freight (CIF) prices, and export data in terms of freight on board (FOB) prices. The distinction is as follows, according to the Globe Express Services Dictionary of International Trade:[90]

- **Cost, Insurance and Freight (CIF) –** An international trade term of sale in which, for the quoted price, the seller/exporter/manufacturer clears the goods past the ship's rail at the port of shipment (not destination). The seller is also responsible for paying for the costs associated with transport of the goods to the named port at destination. However, once the goods pass the ship's rail at the port of shipment, the buyer assumes responsibility for risk of loss or damage as well as any additional transport costs. The seller is also responsible for procuring and paying for marine insurance in the buyer's name for the shipment. The Cost and Freight term is used only for ocean or inland waterway transport.

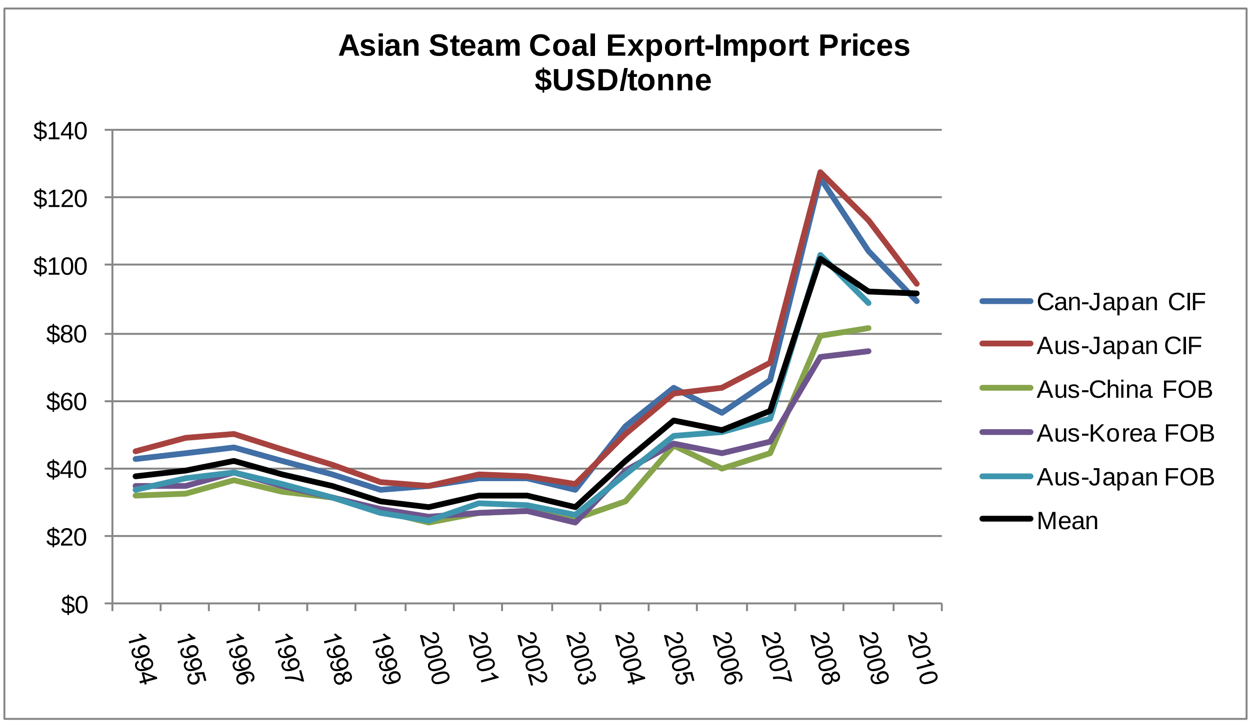
[88] Alaska Journal of Commerce. 2010. "Comment period open until Sept. 24 for Chuitna exploration permits." Viewed on-line at: http://www.alaskajournal.com/stories/091710/fis_cpo.shtml
[89] Ground Truth Trekking. 2010. "Exporting Alaska's Coal." Viewed online at: http://www.groundtruthtrekking.org/Issues/AlaskaCoal/AlaskaCoalExports.html
[90] http://www.speedycargo.com/resource-center/cif-vs-fob

- **Free On Board (FOB) –** An international trade term of sale in which, for the quoted price, the seller/exporter/manufacturer clears the goods for export and is responsible for the costs and risks of delivering the goods past the ship's rail at the named port of shipment. The Free On Board term is used only for ocean or inland waterway transport.

The distinction is not dramatic, but important is that there is a lag time between official reporting of CIF and FOB prices, with the latter taking longer to "catch up" in official statistics.

In Figure 2-1, we show historical CIF and FOB prices in $US (2010) per metric ton for the largest Asian coal shipments from Australia and Canada to Japan, China, and Korea. These shipments represent the lion's share of Asian imports, and so are indicative of what shipments from Chuitna would need to sell for in order to stay competitive. Price data reflect a rather long period of stability from 1994 to 2004 in the $30-$40 price range, a dramatic spike to nearly $130 between 2004 and 2008 and a dramatic drop thereafter. Currently, mean prices are hovering in the low $90s.

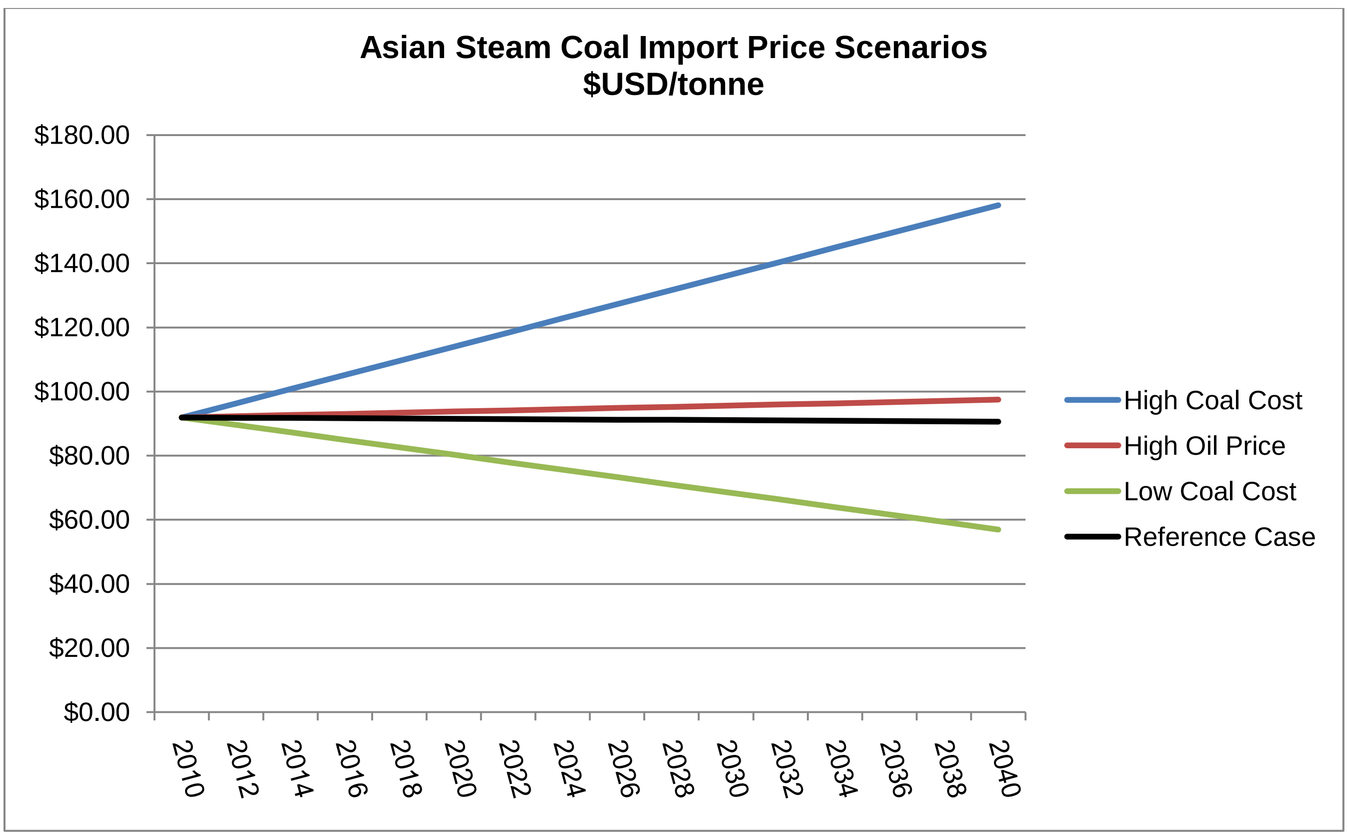
Figure 2-1:



To get a sense of gross revenues from the sale of Chuitna coal in the Asian market, we need to project these prices forward. In order to do this, a number of demand and supply factors need to be taken into account such as the potential for major investment in renewable energy, China's recent entry into coal export markets, and the relative price of coal with respect to oil. There are no publicly available sources of data projecting Asian import price data; however, we can nonetheless model several scenarios by combining coal price scenarios published by the U.S. Energy Information Administration (EIA) with coal demand projections published by International Energy Agency (IEA) in its regular World Energy Outlook. Each of these sources provides a similar set of future scenarios. In its latest forecasts, the EIA models four separate scenarios: (1) high coal cost; (2) high oil price; (3) a reference case, and (4) low coal cost.[91] Prices are dependent on assumptions about coal production (which varies across the EIA cases under different assumptions about the costs of producing and transporting coal), the outlook for economic growth, and the outlook for world oil prices. EIA also recognizes that government interventions to reduce greenhouse gas emissions could play a significant role on coal production and prices, though no scenario explicitly addresses this.

Assumptions about economic growth primarily affect the projections for overall electricity demand, which in turn determine the need for coal-fired generation. In contrast, assumptions about the costs of producing and transporting coal primarily affect the choice of technologies for electricity generation, with coal capturing a larger share of the U.S. electricity market in the Low Coal Cost case and a smaller share in the High Coal Cost case. In the High Oil Price case, higher oil prices stimulate the demand for coal-based synthetic liquids, leading to a substantial expansion of coal use at coal to liquid plants. Production of coal-based synthetic liquids totals 919,000 barrels per day in 2035 in the High Oil Price case, nearly four times more than in the Reference case.

Figure 2-2:



[91] U.S. Energy Information Administration. 2010. Annual Energy Outlook 2010. Washington, D.C: EIA.

Coal production in the reference case increases by 6% by 2030, whereas the alternative cases show changes ranging from a decrease of 7% to an increase in 16%. These variations in production, in turn, underlie EIA coal price projections 2010 to 2040 as follows: +72.22% (High Coal Cost); +5.56% (High Oil Price); -1.39% (Reference Case); -38.89% (Low Coal Cost). Because the EIA did consider international factors in its analysis, it is useful to project these four scenarios on Asian import prices. Figure 2-2 presents four price scenarios based on these percentage changes for Asian coal imports beginning with the baseline price of $91.93 in 2010. By 2040, coal prices across the scenarios range from a high of $158 to a low of $57 per metric ton.

Corroboration for EIA's general thinking on its scenarios comes from the International Energy Information's World Energy Outlook 2010 (WEO).[92] In WEO, the IEA has three basic coal production scenarios that are highly dependent on government policy interventions to reduce greenhouse gas emissions. The Current Policies Scenario assumes no change in government policy, strong global economic growth and a near tripling of electricity demand in non-OECD countries. This lifts coal demand to over 7.5 billion metric tons by 2035, a 60% increase. In its New Policies Scenario, the IEA takes into account planned reforms of fossil-fuel subsidies and implementation of measures to meet climate and energy efficiency targets. Demand still rises, though modestly, by 18%. In the 450ppm Scenario, the IEA assumes that countries take decisive implementation of greenhouse gas reduction measures now and even more aggressive measures after 2020 with the objective of limiting to 2° C the long term rise in the global average temperature. In this scenario, world coal demand drops by 25% over the period.

IEA has not taken this analysis a step further to predict effects on prices, however, since the range of demand changes (+60% to -25%) are in more or less in line with the EIA price scenarios range (+72% to -39%) it is reasonable to use the latter as a ballpark estimate of what prices Chuitna coal could fetch in the Asian market on a competitive basis.

Gross revenues

Given these scenarios and an assumption of 12 million metric tons of production from Chuitna each year between 2015 and 2040, gross revenues can be projected over the life of the project. The revenue projections are summarized in Figure 2-3. Depending on which price scenario is chosen, annual revenues received from the sale of Chuitna coal in the Asian market could range between $1 and $1.2 billion in 2015, and $684 million to nearly $1.9 billion in 2040.

Present value

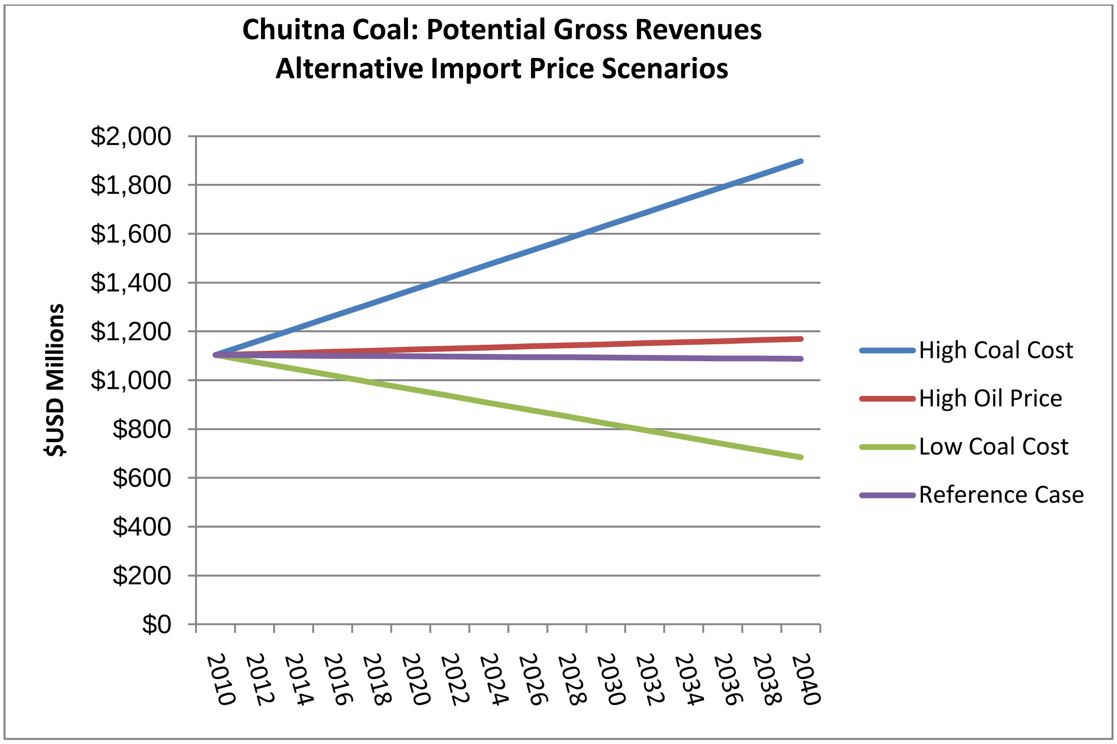
In accordance with standard NED procedures, these revenue streams can be discounted over the life of the project at a standard discount rate to arrive at a net present value figure for gross revenues. The choice of discount rate for Corps projects is critical, since most projects involve large up front construction costs and benefit streams that extend far into the future. So a small increase in the discount rate can have large implications for economic feasibility since it tends to dramatically reduce benefits for projects with long time horizons.

[92] International Energy Agency. 2010. World Energy Outlook 2010. Paris: IEA.

There are two discount rates to consider: one that reflects the opportunity costs of capital investment, and one that reflects an individual's time preference for consumption now over consumption in the future.

With respect to investment, and for projects authorized primarily for private commercial gain, economists recommend that the rate should reflect the cost of displacing private investment, specifically the rate of return on capital in private markets.

Figure 2-3:



For projects authorized primarily for public uses, Corps discount rate formulas are tiered to the average yield of long-term government securities.[93] Given that the Chuitna Coal Project, at least for the foreseeable future, is a project that will generate few if any public benefits, the appropriate discount rate is the former.

One method for calculating a discount rate that approximates the next best use of capital, known as the opportunity cost of capital (OCC), is the pre-tax return on investment. The pre-tax return on investment is the rate of return on private-sector investments, adjusted for inflation. Most federal benefit-cost analyses use a discount rate based on this approach as established by the Office of Management and Budget (OMB). Specifically, in Circular A-94, OMB sets a base discount rate that is the average rate of return to private capital consistent with national income and product accounts. The OMB believes that this rate is appropriate for evaluating public

[93] Congressional Research Service. 2003. Benefit-Cost Analysis and the Discount Rate for the Corps of Engineers' Water Resource Projects: Theory and Practice. Washington D.C.: CRS.

investments because it accounts for the displacement of private investment. The rate is currently set at 7%.[94] This is the rate that will be used in calculations of the present value of Chuitna Coal Project costs.

To discount the benefit, or revenue stream, federal guidance is fairly consistent in using a rate that reflects the consumption rate of interest over the life of the project. In general, this rate will be lower than the opportunity cost of capital. As noted by EPA, 3 percent is commonly used for the consumption rate of interest.[95] Using a discount rate of 3 percent Table 2-1 shows present value figures for gross revenues generated by the sale of Chuitna coal in the Asian import market under the four price scenarios described by Figure 2-3 using average prices for the 2015-2040 period.

Table 2-1: Present Value of Gross Revenues from Chuitna Coal Sales at a 3% Consumption Discount Rate

Price Scenario	Average Price (2015-2040) ($/ Mt)	Present Value ($2010 billions)
High cost coal	$125.02	$26.12
High oil price	$94.69	$19.79
Reference case	$91.29	$19.08
Low cost coal	$74.46	$15.56

2.1.1 <u>Net revenues</u>

From these gross revenue figures, the costs of production and transportation need to be deducted to estimate the potential magnitude of NED benefits associated with the sale of Chuitna coal on the Asian market. In Chapter 3, we arrive at a baseline financial cost estimate range of $52.26 to $88.05 per metric ton taking into account all capital and operating costs associated with the mine, the conveyor, Ladd Landing, and shipping costs to Asian ports. For now, we assume that these costs will remain relatively constant over the project life.

Table 2-2, below, deducts these costs from gross revenue figures reported in Table 2-1. By doing so, the resulting net present value figures – which range from -$2.84 to $15.20 billion – provide a first cut at the magnitude of NED benefits associated with development and operation of the Chuitna Coal Project with just direct, financial costs taken into account. It should be noted that the project would probably not be feasible from the standpoint of investor returns if future coal price trends fall much below the reference case scenario.

[94] See OMB Circular A-94 at: http://www.whitehouse.gov/omb/circulars_a094#8.
[95] See Environmental Protection Agency (EPA) "Discounting Benefits and Costs" at: http://www.epa.gov/ttnecas1/econdata/Rmanual2/8.3.html.

Table 2-2: Net Revenues from Chuitna Coal Sales at a 3% Consumption Discount Rate and Production Costs of $52.26 and $88.05 per Metric Ton

Price Scenario	Net Revenue @ $52.26 ($/ Mt)	Net Present Value ($2010 billions)	Net Revenue @ $88.05 ($/ Mt)	Net Present Value ($2010 billions)
High cost coal	$72.76	$15.20	$36.97	$7.73
High oil price	$42.43	$8.87	$6.64	$1.39
Reference case	$39.03	$8.16	$3.21	$0.67
Low cost coal	$22.20	$4.64	-$13.59	-$2.84

2.2 Regional Economic Development Impacts

Although not included in the actual accounting of a project's net present value and benefit cost ratio, a discussion of jobs, income, and revenues to state and local government are often included in order to provide information about the regional economic development (RED) benefits of a proposed project. They are not included because these items are simply a different way to describe the costs of doing business – i.e. fees paid to the state, labor costs – so to include them in the benefit cost analysis would be to double count. Instead, these impacts are described in parallel, to help decision makers understand the beneficial effects of spending patterns by project developers. In this case, the RED benefits would result from PacRim's planned expenditures of $500 - $600 million or so for project development plus annual operations and maintenance expenditures over a 25-year period.

2.2.1 <u>Jobs and income</u>

PacRim has provided estimates of 300-350 for long-term jobs associated with project operation, and 300-500 for project development.[96] Weighted averages (assuming a 3 year construction period) suggest a range of 300 - 366 employees on an annual basis over a 28-year period. We can use these estimates of direct job creation in combination with published average labor cost data as well as multiplier data to predict indirect and induced jobs and income generated in the regional economy. Indirect jobs and income are created in the regional economy as local businesses that do business with the Chuitna mine and export facilities in turn spend their money to purchase supplies and services they need. Induced jobs and income are created as a result of the spending on local goods and services by households who directly benefit from the salaries they earn associated with the Chuitna Coal Project. Standard multipliers are used to calculate indirect and induced effects.

In 2006, the McDowell Group published multiplier data for Alaska's coal industry based on estimates from regional economic impact models. The multipliers were 1.9 for jobs and 1.5 for personal income.[97] In other words, for every job directly created at Chuitna and every dollar paid for salaries, these multipliers suggest another 1.9 jobs and $1.50 in income are created as that money circulates through the local economy and benefits local households and businesses.

[96] Stiles, Robert B. 2007. Status Update: Chuitna Coal Project. DRven Corporation; PacRim Coal, Inc. 2011. Chuitna Coal Project: April 5th, 2011 update.
[97] McDowell Group, Inc. 2006. The Economic Impact of Alaska's Mining Industry. Anchorage: Alaska Miners Association, page 24.

On an annual basis, the Alaska Miner's Association publishes estimates for direct and total jobs created by the mining industry as a whole.[98] The jobs multiplier used in the 2008 to 2011 publications is 1.57. Another estimate appears in a recent analysis of the proposed Wishbone Hill coal mine by the Institute of Social and Economic Research (ISER) at the University of Alaska.[99] That analysis estimated the multiplier to be roughly 1.56. Given that the latter two estimates are derived from recent data, it is reasonable to adopt either. Using 1.57 then, construction and operation of the mine over the next 28 years could be expected generate total 471 – 575 total jobs in the regional economy each year.

As for income, there are several relevant estimates, drawn from the same studies. The McDowell (2006) study used a figure of $6,000,000 in direct income for the 92 jobs directly involved with coal mining operations, or $65,217 in 2004 dollars. This represents $75,291 in 2010 dollars. The ISER study reports average annual wages of $71,613 for both mine and port workers, $72,795 in 2010 dollars. An average of the two estimates is $74,043. Multiplying this by the range of direct employment yields a direct income estimate of $22,212,900 - $27,099,738 per year. The McDowell study assumes an income multiplier of 1.5 while ISER uses 1.16. The Alaska Miners Association annual reports used a multiplier range of 1.05 to 1.21 for the mining industry as a whole. The mean value is 1.13. The ISER estimate is the closest to this mean and perhaps the most precise, so using this yields a total direct, indirect, and induced income range of $25,766,964 - $31,435,696 per year.

2.2.2 Royalties, rents, and fees to state and local government

Both state and local governments in Alaska collect taxes on mineral production. State taxes include an income tax on net income to corporations, a mining license tax on all net income from product sales from all lands, a production royalty on net income from product sales from state lands, and miscellaneous taxes and license fees and reclamation bonding fees. State claim-related rents or leasehold assessment fees are collected in particular circumstances. In addition, boroughs levy property taxes, sales or excise taxes, and in a few cases, severance taxes on production.

Accurate estimates for public revenues generated by the Chuitna Coal Project cannot be calculated without more detailed economic and project configuration information. For example, until more precise information is made available about project costs, depreciation, and other exemptions that may apply, net income (and therefore) royalty and license fee predictions are difficult to make. However, as before, we can rely on published information for ballpark figures.

There are four relevant sources from which to draw. The first is Alaska's Division of Geological and Geophysical Surveys, which publishes regular information circulars on Alaska's mining industry. Its 2010 update provides information on the production value of coal produced in the state in 2007, 2008, and 2009. Production value is an important determinant of royalties and license fees. According to the report, production value has risen from $32.83 to $36.95 per

[98] Alaska Miners Association. 2008 – 2011. The Economic Impacts of Alaska's Mining Industry, annual updates. Available on-line at: www.alaskaminers.org.
[99] Colt, Steve and Tobias Schwoerer. 2010. Socio-economic Impacts of Potential Wishbone Hill Coal Mining Activity. Anchorage: Institute of Social and Economic Research.

ton over the past three years, or $36.12 to $40.65 per metric ton.[100] This suggests that a value of $41 per metric ton is a reasonable short-term estimate.

The second source is the AMA series, which reports the total production value of all minerals produced in the state each year, and corresponding payments to state and local governments for property taxes, rents, royalties, fees, licenses, and other relevant obligations. AMA reports indicate an average of $4,902 per million dollars mineral production value paid to local governments and $33,384 to the state. A 12 million metric tons per year production rate from Chuitna at a production value of $41 per metric ton would yield $2,411,784 in annual local government payments and $16,424,928 to the state. Over the 25-year mine life, this would amount to $60.29 million in local government payments, and $410.62 million to the state. Revenues to Kenai Borough would also be generated through right of way easements and leases for the Ladd Landing coal export facility. Kenai Borough indicates that these payments are $70,838 per year with a lease term of 30 years. Total revenues over this period from the lease and easements would be $2,125,140.

The third and fourth sources are from PacRim's forecasts (Note 96). In those forecasts, PacRim estimates local government payments to amount to $100 million to the Kenai Peninsula Borough and $300 - $350 million to the state ($4 and $12 million per year, respectively).

Table 2-3 summarizes these various estimates on regional economic development impacts.

Table 2-3: Potential Regional Economic Development Impacts

Impact	Lower bound (Annual)	Upper bound (Annual)
Direct jobs	300	366
Total jobs	471	575
Direct income	$22,212,900	$27,099,738
Total income	$25,766,964	$31,435,696
Local government revenues	$2,482,622	$4,000,000
State government revenues	$12,000,000	$16,424,928

[100] Hughes, R.A., D.J. Szumgala and L.A. Harbo. 2010. Information Circular 60: Alaska's Mineral Industry 2009: A Summary. Anchorage: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys.

Section 3: National and Regional Economic Development Costs

There are two primary categories of NED costs associated with authorization of the Chuitna Coal Project: (a) market or financial costs associated with development, operation, decommissioning and reclamation of the project over time, and (b) non-market costs that reflect the environmental, economic, and social costs not included in market prices. As established in Section 1, to comply with various requirements of the National Environmental Policy Act, Clean Water Act, Water Resources Development Act, Marine Protection, Research, and Sanctuaries Act as well as implementing regulations for these and other applicable statutes all relevant market and non-market costs should be considered. In this Section, we provide preliminary estimates of the range of both market and non-market costs associated with the Chuitna Coal Project based on publically available information. As this information is supplemented with project-specific cost data from the project record, we expect these estimates to be refined.

3.1 Financial Costs

The three most important categories of financial costs associated with the Chuitna Coal Project include capital costs incurred during development of the mine, conveyor system, and Ladd Landing export facility, annual operations and maintenance costs associated with these project elements, and transportation costs of shipping Chuitna coal to Asian ports. Table 3-1 identifies the important capital cost elements for each project element. An accurate estimate of capital costs would be based on multiple quotes from vendors who would supply the necessary equipment and labor, energy costs incurred during project development and operation, food and transportation costs for workers, and any relevant markups needed to account for the uncertainties associated with developing a project of this magnitude in a harsh climatic setting. In lieu of element-by-element cost data, our preliminary cost calculations rely on comparable cost data and cost modeling from the literature.

3.1.1 Mine development and operation

To estimate preliminary mine development and operation costs, we rely on an updated version of O'Hara (1980) and comparable mine cost data recently published by Shafiee et al. (2009).[101] In 1980, O'Hara developed a set of exponential equations to estimate capital, stripping, equipment, maintenance, labor, and supply costs of new mines. Despite some limitations, these equations nonetheless are considered "still one of the best approaches in cost estimation literature."[102] Thus, they are a good place to start in developing mine costs estimates

[101] O'Hara, T.A. 1980. "Quick guide to the evaluation of ore bodies." *CIM Bulletin* February, pp. 87-89; Shafiee, S., M. Nehring and E. Topal. 2009. "Estimating average total cost of open pit coal mines in Australia." *Proceedings of the Australian Mining Technology Conference*, 27-28 October 2009, pp. 134-145.
[102] Shafiee et al. 2009. Note 101 at 137.

for Chuitna in the absence of more accurate data from the project record. O'Hara's original capital cost equation for new mines is given by:

Table 3-1: Chuitna Coal Project Capital Cost Components[103]

Project component	Associated structures	Sub-structures
Chuitna coal mine		
	Surface coal mine	
	Shop, office, and warehouse facility	
	Fuel storage facility and fueling station	
	Electrical substation	
	Ready line	
	30,000 ton covered surge bin and enclosed coal crusher	
	Truck dump	
		Stilling shed
		Coal crusher
	Roads and power distribution	
Conveyor and Other Infrastructure		
	Mine access road	
	Coal transport conveyor	
	Personnel housing	
	Air strip facility	
	Power transmission facility	
Ladd Landing Development		
	Logistical center	
		Warehouse and office building
		Open bulk storage and laydown area
		Bulk fuel transfer and storage tanks
		Vehicle wash facility
		Septic tank and drain field
		Water well, tank, and distribution
		Drainage and sediment control
		Security fence and gates
		Area lighting
		Snow storage area
		Bulkhead structure
	Coal export terminal	
		Coal stockyard
		Sediment ponds
		Equipment wash facility
		10,000 foot trestle facility
		Dredged channels
		Offshore vessel berth

[103] U.S. EPA. 2006. Draft Scoping Document for the Chuitna Coal Project Supplemental Environmental Impact Statement. Chuitna Coal Project Beluga Coal Field, Alaska. Available at http://www.chuitnaseis.com/files/Chuitna_Scoping_Document_060607_FINAL.pdf; Pac Rim. 2008. Chuitna coal project updates -- Logistics center. Available at http://www.chuitnaseis.com/files/Updates/Project%20Description%20-%20Ladd%20Logistics%20Center%20081606.pdf

Applying this equation to an expected 32,887 per day mean production rate at Chuitna and updating the result to 2010 dollars suggests an initial capital outlay of $543,259,069 to develop the mine. Annualized over 25 years with an opportunity cost of capital (OCC) of 7% (see discount rate discussion in Section 2) and then dividing the result by the expected annual production of 12 million metric tons yields a unit cost estimate of $3.88 per ton.

Corroboration for this ballpark cost figure comes from Shafiee et al. (2009) who present mine cost estimates for dozens of recent mines in Australia with a wide range of annual production rates and expected mine life. Annualizing their capital cost figures over expected mine life at an OCC rate of 7% and updating figures to 2010 U.S. dollars yields unit cost figures ranging from $1.79 to $9.67 per metric ton. The average across all recent (1998 and later) mines was $4.25 per ton, quite close to the O'Hara estimate for Chuitna. Given the relative proximity of these values and given a recent rough capital cost estimate from PacRim of $500 million we adopt the O'Hara estimate ($3.88) as the low end of our range and the Shafiee et al. (2009) midpoint ($4.25) as the high for the expected unit capital cost for developing the Chuitna mine.

In their paper, Shafiee et al. (2009) develop a new model of annual operations and maintenance costs to supplement O'Hara. They relate annual operations and maintenance costs per ton to deposit average thickness in meters (DAT), stripping ratio in tons overburden per tons coal (SR), capital cost in millions (CC), and daily production rate in thousand ton units (PR) in the following manner:

According to the 1990 EIS, deposit thickness ranges from 1.6 to 6.1 meters with a stripping ratio (volume to weight) of 3.9 cubic meters of overburden for each metric ton of recoverable coal.[104] To convert this ratio into a weight-to-weight measure, we assume an overburden weight range of 1.6 to 3 tons per cubic meter in accordance with standard weights for overburden composed of both rock and soil.[105] These translate into a weight-to-weight stripping ratio of 6.24 to 11.7. We note that the range of ratios reported in Shafiee et al. (2009) are considerably higher (10.2 – 40.6) but feel these are unrealistic given the rather shallow nature of the Chuitna deposits. Using an average deposit thickness of 4 meters, a capital cost of $543 million and a daily production rate as before of 32,887 tons per day yields an operating cost range of $17.56 to $26.74 per ton.

Combined with capital costs, these figures suggest a mine-mouth price of Chuitna coal in the $21.44 to $30.99 range. This compares with a range of $20.13 to $22.83 (updated to $2010 dollars) estimated by the National Energy Technology Laboratory (NETL) in their 2006 feasibility study for the Beluga Coal Gasification plant using different methodologies than those presented here.[106] The fact that these ranges overlap suggests that the either can be used as a

[104] FEIS at 2-5.
[105] See: http://www.ehow.com/facts_7551539_standard-crushed-rock-per-meter.html
[106] Chaney, Robert and Lawrence Van Bibber. 2006. Beluga Coal Gasification Feasibility Study: Phase I Final Report. DOE/NETL – 2006/1248. Anchorage: National Energy Technology Laboratory (NETL) Arctic Energy Office.

reasonable first approximation of mine development and operation costs associated with the Chuitna Coal Project.

3.1.2 Conveyor costs

The second major project component is the 12 mile long conveyor system needed to transport coal from mine mouth to the Ladd Landing export facility. There are few publically available sources of information to price out capital and operating costs for modern conveyor systems. Nor has PacRim made public the specifications for which system it intends to use. Nonetheless, we have developed rough estimates based on three sources of information. The first is the 2006 NETL study referenced above. In that study, NETL developed a unit cost estimate for transportation of Chuitna Coal to Ladd Landing via conveyor of $3 per metric ton, $3.25 in 2010 dollars, inclusive of both capital and operating costs.

The second is an older estimate of $.11 per ton-mile derived from a 1983 model published by Edgar (1983).[107] This corresponds to a marginal cost of $3.49 per ton in 2010 dollars, quite close to the NETL estimate. The third is a recent cost to port estimate published by DeVere Mining Technologies Limited for their breakthrough CARIAT (Continuous Articulated Rail In a Tube) system, purportedly the state of the art in coal conveyance systems. DeVere reports $1.50 per ton for cost to port transport, $1.68 in 2010 dollars.[108] It is unknown whether this type of system is applicable to Chuitna, but given that this cost estimate is significantly lower than either NETL (2006) or Edgar (1983) and could represent the limits of new technology it is reasonable to adopt it as a lower bound. Our conveyor cost range, then, is set at $1.68 to $3.49 per ton inclusive of all capital and operating costs pending the release of more precise Chuitna-specific cost data from PacRim.

3.1.3 Ladd Landing export facility costs

The third major cost category for the Chuitna Coal Project is costs associated with initial capital outlays during construction and annual operations and maintenance costs for the Ladd Landing export facility. Three sources of information provide a sense of the magnitude. The first is a detailed economic feasibility study completed by the Corps for the Delong Mountain Terminal Project (DMTP) along the northwest arctic coast near Kivalina Alaska. The Delong Mountain Terminal Project involved construction of port facilities with several project components similar to what will be needed at Ladd including an offshore trestle, ore concentrate loading capabilities, on-shore management facilities, fuel storage tanks, and dredged channels. Talberth et al. (2007) estimated capital costs for the trestle and on-shore facilities to be roughly $271 million (2010 dollars) and annual operating costs to be $8.4 million.[109] Transferring these cost estimates to Ladd Landing suggests a unit cost of $2.64 per ton for Chuitna coal.

[107] Edgar, T.F. 1983. Coal Processing and Pollution Control. Houston: Gulf Publications Company.
[108] http://www.deveremining.com/final-web-pages/CARIAT.html
[109] Talberth, John, Nejem Raheem and Richard Mietz. 2007. Benefit-Cost Analysis of the Delong Mountain Terminal Project: Critique and Independent Assessment of Key Parameters. Fairbanks: Northern Alaska Environmental Center.

The second estimate comes from NETL ($2006). The NETL study estimated combined capital and operating costs to be $3.25 per ton for loading Chuitna coal onto coal barges at Ladd Landing (2010 dollars). Costs associated with the Seward coal export facility were the basis of this cost estimate. The third estimate is costs reported for a coal export facility on the Russian Barents Sea coast.[110] The details of the facility are not available; however, the capital cost range was reported to be $300 to $500 million for a facility capable of processing 18 million metric tons per year – just above the capacity planned for Ladd. Updating these figures to 2010 dollars and converting them into unit costs implies a range of $2.14 to 3.57 per ton. These two estimates form the lower and upper bound of our range since the other estimates fall in between.

3.1.4 Shipping costs

The cost of shipping Chuitna coal to Asian ports is, perhaps, the most uncertain cost component. Over the past decade, there has been tremendous variation in dry bulk cargo shipping costs across all types of carriers. The Australian floods and the global recession have added to that volatility. Until markets stabilize and the backlog of coal shipments from Australia is eased, price volatility will continue. Prior to the recession, Mjunction – a respected authority on dry bulk cargo rates – reported unit prices of $44 to $72 per ton for major coal routes from Australia to Asia across three sizes of coal carriers.[111] HGCA, Inc. reported a similar range for dry bulk shipments from the U.S. to Asia.[112] Currently, markets are depressed. Chinamining.org reports a current average of $27 per ton across all major coal routes. Given these pre and post recession estimates, we adopt a range of $27 to $50 per ton as a placeholder pending more precise unit cost estimates for shipments from Alaska.

3.1.5 Total unit cost range

Table 3-2 summarizes the foregoing analysis by reporting unit cost ranges for each of the four major cost elements. Taken together, capital and operating costs associated with development of the mine, conveyor, and Ladd Landing export facility and transportation costs for shipping Chuitna coal to Asia will likely fall in the $52 to $88 per metric ton range if the comparable cost estimates discussed in this section are indicative of costs associated with the Chuitna Coal Project.

Table 3-2: Preliminary Unit Cost Estimates

Project component	Lower bound ($/Metric ton)	Higher bound ($/Metric ton)
Coal mine capital costs	$3.88	$4.25
Coal mine operations and maintenance costs	17.56	26.74
Conveyor costs	1.68	3.49
Export facility costs	2.14	3.57
Shipping costs	27.00	50.00
Total:	**$52.26**	**$88.05**

[110] See: http://www.rzd-partner.com/press/2010/10/12/359060.html
[111] See: http://www.mjunction.in/market_news/logistics_1/test_1.php
[112] See: http://www.openi.co.uk/h070821.htm#r3

3.2: Non-market Costs

As previously noted, net public benefits analysis incorporates both market and non-market costs. With respect to the Chuitna Coal Project, important non-market costs include the externalities associated with pollution of air and water and the costs of lost ecosystem services associated with degradation of marine, riverine, and terrestrial habitats within the project area.

3.2.1 Carbon emissions damage

The reduction of greenhouse gas pollution is one of the most important environmental challenges humanity has ever faced given the catastrophic environmental, economic, and social costs of climate change now unfolding throughout the world. Economists predict that costs associated with climate change could represent up to 20% of gross world product by 2100.[113] These costs are not reflected in the prices paid for oil, coal, or natural gas. As such, the production of these fossil fuel energy sources generates climate change related externalities to society that should be quantified and internalized if fossil fuel markets are to be efficient. The point of extraction is the logical place to assign such costs, since once fossil fuels are extracted and made ready for market, their combustion is assured.

Corps regulatory guidance specifically calls for quantification of externalities associated with projects authorized or financed by the agency. In Section 1.1.5 we identified various statutes and regulations that set forth this duty across a wide range of externalized cost sources including air and water pollution, habitat loss, degradation of scenery, loss of subsistence use and reduction in recreation and tourism.

Addressing the externalized costs of greenhouse gas emissions (GHGs) is, then, a necessary component of a comprehensive net public benefits analysis. The following analysis estimates externalities associated with GHG emissions (in carbon equivalent units) throughout the life-cycle of the Chuitna Coal Project from project development and operation to end use combustion of coal.

Scope of analysis

A thorough lifecycle emissions inventory would quantify the scope one, two, and three[114] emissions produced from developing, operating, and maintaining the coal mine and associated support facilities. In addition, the inventory would include emissions from transporting extracted coal from Ladd Landing to end markets. Finally, the inventory would include emissions from combustion of the sold coal.

It is relatively straightforward to identify the components of a thorough lifecycle emissions inventory for the Chuitna Coal Project. However, a dearth of data makes it difficult to

[113] Stern. 2008. Note 51.
[114] "Scope 1" emissions are directly emitted from the entity undertaking the emissions inventory. "Scope 2" emissions are once removed, and "scope 3" emissions are twice removed, from the entity undertaking the emissions inventory.

quantify produced emissions. For example, no decision has been made on the design of the shop, office and warehouse facilities, so an assessment based on square footage or end use of that structure cannot be conducted. In another example, a literature review found no GHG emissions data for building and operating an electrical substation, surge bin, airstrip facility, and other project components. Assumptions could be made on emissions produced through those activities, but they would be so superficial as to be irrelevant.

Instead, a more robust inventory would focus solely on project activities that produce significant amounts of GHGs and have substantial findings from empirical research to support their emissions estimates. A literature review found three project components that meet those criteria:

- Extraction activities that produce methane (CH_4);
- Transportation that produces methane, carbon dioxide, and nitrous oxide (CH_4), (CO_2), and (N_2O); and
- Combustion that produces CH_4, CO_2, and N_2O.

Extraction that produces CH_4

Coal mining activities not including transportation and combustion accounted for one percent of total U.S. GHG emissions in 2008.[115] The only reported emitted gas was CH_4. Coal mining accounted for 12 percent of total U.S. CH_4 emissions in 2008, making it the fourth largest CH_4 source that year.

At least one report inventories individual mine contributions toward total CH_4 emissions from coal mining in the United States. Kirchgessner et al. (2000) developed two new spectroscopy techniques to estimate CH_4 emissions from thirty U.S. coalmines and published findings in 2000.[116] Emissions were estimated for underground mines, surface mines, and abandoned underground mines. The authors specifically note that emissions estimates for coal handling operations (i.e., components of the Chuitna support facilities and day-to-day operations) are "unavailable and impractical to collect."

The findings from Kirchgessner et al. (2000) that are most relevant to the Chuitna project are the surface coalmine emissions estimates (Table 3-3). Using their new spectroscopy techniques, the authors estimated cursory CH_4 emissions from thirty coalmines throughout the continental United States. They found that auger sites in Appalachia and lignite sites in Oklahoma, Texas, and the Dakotas emitted little or no CH_4. Those sites were excluded from further analysis. Rather, all measured CH_4 emissions were produced at non-lignite-and-auger sites in the Powder River region of Wyoming and Montana and the Northern Appalachian region of Pennsylvania. Based on those findings and the findings of other articles referenced in the

[115] U.S. Environmental Protection Agency (EPA). 2010. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2008: Executive Summary. Available at http://www.epa.gov/climatechange/emissions/downloads10/US-GHG-Inventory-2010_ExecutiveSummary.pdf

[116] Kirchgessner, David, Stephen Piccot, and Sushma Masemore. 2000. An Improved Inventory of Methane Emissions from Coal Mining in the United States. U.S. Environmental Protection Agency Office of Research and Development.

report, the authors determined that emissions data from test sites could be extrapolated to all non-lignite-and-auger sites.

Table 3-3: Methane Emissions from Coal Mining

Mine Site	Coal Production (10^6 tons/yr)	Methane Emissions (tons/yr)	Exposed Area (ft^2)	Methane Emissions Factor ($tons/ft^2$-yr)	Mining Region
A	14.00	1,354	3,089,429	0.000438	Powder River
B	16.80	1,253	3,389,056	0.000370	Powder River
C	9.90	786	1,911,686	0.000411	Powder River
D	15.30	1,369	3,203,366	0.000427	Powder River
E	1.20	43	129,168	0.000333	Northern App.
F	0.24	5	21,500	0.000241	Northern App.
Average	---	---	---	**0.000370**	---

Source: Kirchgessner et al. 2010.

Based solely on coal production, study site "A" most closely matches the initial phase of Chuitna project development. The 20,571-acre lease area is divided into local mining units (LMUs). LMU1 is a 220,000,000-ft^2 site, though the entire area will not be developed at once. LMU1 is expected to produce 12,000,000 metric tons of coal per year. Assuming that the site will be non-lignite-and-auger[117] and assuming that only a portion of the area is developed, a direct transfer of the projected CH_4 emissions from site A would yield 1,228 metric tons per year.

Methane is a far more potent greenhouse gas than carbon dioxide, and so to represent methane emissions in terms of carbon dioxide equivalent units (CO_2e) requires multiplication of these emissions by a global warming potential emissions factor. For methane, that factor is 25. Thus, extraction of 12,000,000 metric tons of Chuitna coal per year could be expected to produce 1,228 x 25 or 30,700 metric tons of CO_2e per year. Over the 25-year life span of LMU 1, this amounts to **767,500 CO_2e**.

[117] Lignite coal is the lowest-quality recoverable coal. The coal seam developed through the Chuitna project will be sub bituminous (see the combustion section for more information).

Transportation that produces CH_4, CO_2, and N_2O

Extraction and transportation activities will require heavy machinery and vehicles powered by fossil fuel combustion. Emissions from heavy machinery and vehicles used during the extraction phase are difficult to quantify because of the data issues discussed previously. However, calculation tools for mobile combustion provide a suitable option for calculating CH_4, CO_2, and N_2O emissions from transportation, particularly shipping.

The Greenhouse Gas Protocol (GHG-Protocol) developed by the World Resources Institute (WRI) is a methodology that guides entities through their emissions inventory. WRI has developed tools to support the GHG-Protocol process. One tool, the Mobile Combustion GHG Emissions Calculation Tool Version 2.0, produces emissions forecasts based on user-inputted data.[118] Emissions forecasts are calculated using emissions factors from the U.S. Environmental Protection Agency.

To calculate emissions from a transportation event, a user inputs:

- Region as U.S., U.K., or other. The region category allows the tool to identify appropriate country-specific emissions factors.
- Mode of transport as road, rail, water, or aircraft. The mode of transport category corrects for the different rates of emissions delivery to the atmosphere from different environmental mediums. For example, emissions discharged underwater will have less global warming effect than emissions released directly into the air.
- Scope as scope 1 or 3. The scope category assists the user in organizing the emissions inventory.
- Type of activity data as vehicle distance, passenger distance, weight distance, custom fuel, or custom vehicle. The type of activity category provides the user with options for calculating emissions based on the available data.
- Vehicle type as one of twenty+ vehicle models. The vehicle type category refines the emissions estimate. The options available to the user are contingent on the type of activity data selected.
- Distance traveled as numeric distance in desired units. The distance traveled category is a key variable for calculating emissions for the entire journey.
- Gross weight as numeric value of vehicle and cargo in desired units. The gross weight category further refines the emissions estimate.
- Unit of distance as metric ton mile, short ton mile, short ton kilometer, or metric ton kilometer. The unit of distance category further refines the emissions estimate.
- Fuel used as one of twelve types of fuel. The fuel used category further refines the emissions estimate.

[118] World Resources Institute (2008). GHG-Protocol tool for mobile combustion. Version 2.0.

- Fuel amount as numeric amount in desired units. The fuel amount category further refines the emissions estimate.
- Unit fuel amount as one of seven fuel units. The unit fuel amount category further refines the emissions estimate.

The following user-inputted data applies for the Chuitna project:

- Region: US.
- Mode of transport: Water.
- Scope: 3.
- Type of activity data: Weight distance.
- Vehicle type: Very large bulk carrier (80,000 metric tons deadweight).

  For this analysis, a "very large bulk carrier" is assumed to be a Panamax ship at the maximum size possible and still able to travel through the Panama Canal.
- Distance traveled: 3,612 miles.

  Distance is calculated as an average to various ports with the Asian region, in nautical miles.
- Gross weight: 80,000 metric tons.

  The maximum deadweight for a Panamax ship is 80,000 tonnes (Lloyd's 2007).[119] A literature review did not find gross weight.
- Unit of distance: Ton mile (metric).
- Fuel used: Residual fuel oil 3s, 5, and 6.

  Residual fuel oil No. 6 is the standard fuel oil for shipping activities (GS 2010).[120]

The user inputted data above generates 25,512 metric tons CO_2, 51,342 kg CH_4, and 256,774 kg N_2O for a one-way trip. Total transportation emissions in CO_2e over the twenty-five year mine lifespan are calculated as follows:

(51,342 kg CH_4/1000 kg) = 51.342 mt CH_4

(256,774 kg N_2O/1000 kg) = 256.774 mt N_2O

(25,512 mt CO_2 x 1 CO_2 GWP) = 25,512 mt CO_2e

(51.342 mt CH_4 x 25 CH_4 GWP) = 1,284 mt CO_2e

[119] Lloyd's Register (Lloyd's). 2007. "Infosheet No. 30: Modern Ship Size Definitions." Available at http://www.lr.org/Images/30%20ship%20sizes_tcm155-173543.pdf.
[120] Global Security.org (GS). 2010. "Military: Fuel oil." Available at http://www.globalsecurity.org/military/systems/ship/systems/fuel-oil.htm

(256.774 mt N_2O x 298 N_2O GWP) = 76,519 mt CO_2e

(25,512 mt CO_2e + 1,284 mt CO_2e + 76,519 mt CO_2e) = 103,315 mt CO_2e emissions for a one-way trip

If a single trip transports 70,000 mt of cargo and the mine is expected to produce 300,000,000 mt of coal over a twenty-five year lifespan, the total number of trips will be:

(300,000,000 mt of coal / 70,000 mt of cargo) = 4,286 one-way trips

(103,315 tonnes CO_2e emissions for one-way trip x 4,286 one-way trips) =

442,808,090 mt CO_2e

Combustion that produces CH_4, CO_2, and N_2O

According to the EPA's draft scoping report, the Chuitna project will develop an ultra low sulfur sub bituminous coal reserve. By far, the largest amount of emissions associated with the project will be generated by combusting the extracted coal. Emissions vary among coal types and range from 215 pounds of CO_2 per million Btu for the lowest quality lignite coal to 227 pounds of CO_2 per million Btu for the highest quality anthracite coal (EIA 2010).[121] Sub bituminous coal emits 213 pounds of CO_2 per million Btu.

Similar to its mobile combustion calculation tool, the GHG-Protocol has a tool for stationary combustion. The GHG-Protocol Tool for Stationary Combustion Version 4.0 produces emissions forecasts for the GHGs produced from coal combustion.[122] The tool uses emissions factors from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories because country-specific emissions factors are not relevant for estimating emissions from all types of combustion.

To calculate emissions from combustion, a user inputs:

- Sector as energy, manufacturing, construction, commercial, institutional, residential, agriculture, forestry, or fisheries. The sector category provides direction for calculating CH_4 and N_2O emissions that are affected in part on the machinery that combusts the fuel.
- Fuel type as solid fossil, liquid fossil, gaseous fossil, or biomass. The fuel type category affects the release rate of gasses into the atmosphere.
- Fuel as one of 15 fuels including sub bituminous coal. The fuel category is probably the most important factor for estimating emissions.

[121] U.S. Energy Information Administration (EIA). 2010. "Questions about environment and emissions…" Available at http://www.eia.doe.gov/ask/environment_faqs.asp.
[122] World Resources Institute (2008). GHG-Protocol tool for stationary combustion. Version 4.0.

- Amount of fuel as numeric amount in desired units. The amount of fuel category refines the emissions estimate.
- Units as one of nine fuel units. The units category contains mass (e.g., tonnes, pounds) and activity (e.g., kWh, mmBtu) and further refines the emissions estimate based on available data.

The following user-inputted data applies for the Chuitna project:

- Sector: Energy.

  Sub bituminous coal is used primarily for steam-electric power generation in coal-fired powered plants.
- Fuel type: Solid fossil.
- Fuel: Sub bituminous coal.
- Amount of fuel: 300,000,000.
- Units: metric ton.

The user-inputted data above generates 544,887,000 mt CO_2, 5,670 mt CH_4, and 8,507 mt N_2O.

Total combustion emissions in CO_2e over the twenty-five year mine lifespan would be:

(544,887,000 tonnes CO_2 + (5,670 mt CH_4 x 25 CH_4 GWP) + (8,507 mt N_2O x 298 N_2O GWP)) = **547,563,836 mt CO_2e**

Social costs

Based on the foregoing analysis, GHG emissions associated with development of the Chuitna Coal Project (LMU 1) over its 25-year life would be 991,135,140 metric tons (Table 3-4) or 39,645,405 per year. Such emissions represent a significant externalized economic cost in a world already suffering from the catastrophic effects of global warming. Putting aside the issue of who bears responsibility for internalizing these costs (i.e. customers who use electricity from coal fired plants, utilities, importers, or producers) it is clear that to be complete, an analysis of net public benefits from developing new coal sources needs to account for these costs to reflect the true costs of such decisions on society.

In terms of assigning a monetary value to this global externality, we rely on a meta-analysis of marginal damage costs from GHG emissions completed by Tol (2007).[123] After reviewing 211 estimates, he found a mean social cost of $23 per metric ton carbon (tC). Dr. Tol raised his mean to $25/tC to accommodate uncertainty in the estimates. Using a $25/tC social cost and a 3 percent discount rate yields a present value figure of $17.26 billion, which translates into $57.53 for each ton of Chuitna Coal delivered to the Asian market and combusted in coal-fired plants.

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[123] Tol, Richard S.J. 2007. The Social Cost of Carbon: Trends, Outliers, and Catastrophes. Available at http://fnu.zmaw.de/fileadmin/fnu-files/publication/working-papers/margcostmetawp.pdf.

Table 3-4: Life Cycle Carbon Emissions Damage from the Chuitna Coal Project

GHG emissions source	Total emissions (Metric tons CO2e)	Social costs (PV – $ billions)	$/ Metric ton
Extraction activities	767,500	$.02	$.05
Transportation (shipping)	442,808,090	$7.71	$25.70
End use combustion	547,563,836	$9.53	$31.78
Total:	991,135,140	$17.26	$57.53

Mitigating carbon emissions damage through offsets

Offsets could provide an option for mitigating the $17.26 billion cost to society from Chuitna project activities. An offset is simply a reduction in emissions made in order to compensate an emission made elsewhere. Offsets may occur anywhere in the world because one metric ton of CO_2e emitted in one region affects global warming the same as one metric ton of CO_2e emitted in another region.

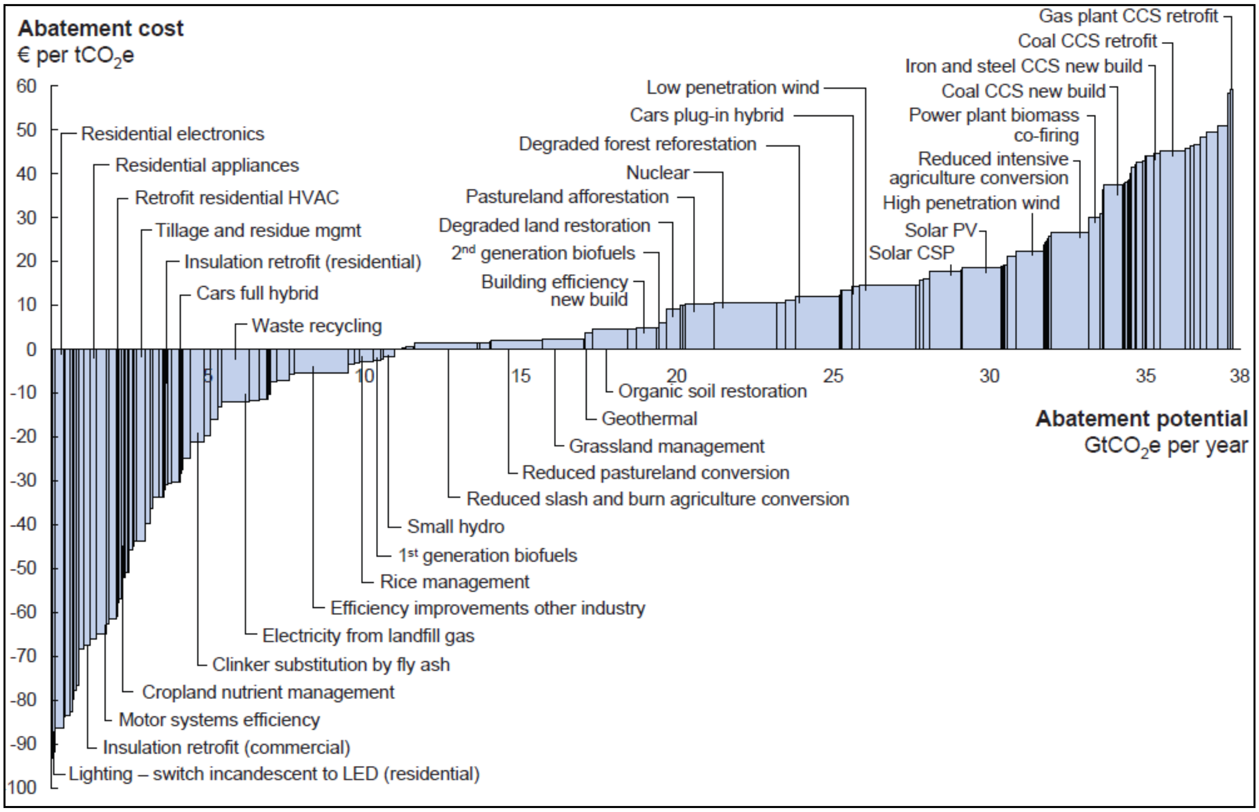
The fungible nature of offsets reduces the social cost of emissions from Chuitna project activities when the avoided emissions have a social cost lower than the $25/tC global average. In addition, offsets for the entire 25-year mine lifespan can be purchased up-front; thus avoiding the interest that raises social cost.

In *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Curve*, McKinsey & Company demonstrates potential practices to reduce emissions below 1990 GHG levels by 2030 (Figure 3-1).[124] The McKinsey & Company analysis shows that companies have many options in selecting low-cost offsets projects to mitigate their emissions. Many of these projects would provide a net benefit to the company (i.e., those to the left of reduced slash and burn) while many would reduce significant emissions for a low capital cost (i.e., low-cost options to the right of small hydro).

Companies could enter a physical transaction to reduce emissions through a GHG emissions market, direct investment in an on- or off-site domestic or international capital project, or another exchange.

[124] McKinsey & Company. 2009. Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Curve.

Figure 3-1: Global GHG abatement cost curve beyond business as usual – 2030



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60/tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

3.2.2 Air quality damages

Each phase of the lifecycle of Chuitna coal (i.e., extraction, transportation, processing, combustion) will generate aerial pollutants with significant public health and ecosystem impacts. Regardless of where these pollutants are emitted, a comprehensive net public benefits analysis would account for these impacts, which represent a significant external economic cost.

This section identifies aerial pollutants produced during each phase of the lifecycle, notes their impacts, and assigns a social value to the produced coal based on marginal cost data reported in the literature. Since most Chuitna coal is likely to be exported to Asian markets and not used in the domestic United States, this section includes a short case study on the air quality impacts of combusted coal in China on California to illustrate the links between the two regions. A conclusion is that social value must be considered regardless of where the coal will be used.

Aerial pollutants are produced during each phase of the coal lifecycle

Each phase of the lifecycle to produce and use four dominant coal types (i.e., anthracite, bituminous, lignite, sub-bituminous) generates aerial pollutants. The extraction phase relies on machinery powered by fossil fuel combustion to remove coal deposits through underground or surface mining. The machines emit greenhouse gases and criteria pollutants including sulfur dioxide, nitrogen oxide, and particulate matter (i.e., SO_2, NO_X, $PM_{2.5}$, PM_{10}); the physical act of extracting coal releases underground methane (CH_4); and the process of removing overburden lying on top of coal seams releases aerial sediment and particulate matter. The transportation phase generates the same pollutants as coal travels from the point-of-extraction to the point-of-processing over rail, truck, or barge. During processing, machines that wash coal emit more greenhouse gases and criteria pollutants, as well as arsenic, cadmium, lead, and mercury. The combustion phase, however, produces the largest amount of aerial pollutants by far.

Aerial pollutants impact people and ecosystems

Aerial pollutants from phases of the coal lifecycle impact public health and ecosystems. Particulate matter causes asthma, lung cancer, chronic obstructive pulmonary disease, and emphysema. Brook et al. (2002) demonstrate the immediate impact of fine particles and ozone on narrowing brachial and other arteries, aerial pollutants are linked to cases of acute myocardial infarctions (i.e., heart attacks), and neurological impacts, such as stroke and loss of intellectual capacity from mercury emissions, rise in accordance with long-term exposure to certain aerial pollutants.[125] Regarding ecosystems, the lifecycle phases could impair surface water quality by increasing sediment and heavy metal concentrations. In addition, nitrogen aerial deposition from NO_X causes eutrophication and acid rain from SO_2 degrades tree canopy and affects fish populations. There are many other impacts as well.

Impacts can be used to assign a social cost to produced coal

Impacts from aerial pollutants generated during different phases of the coal lifecycle cost people, governments, and the private sector money. During treatment, patients consume limited medical resources, cannot work and contribute to the economy, and require sick days that affect productivity for businesses and companies. In the long-term, victims who are unable to work may not realize their full professional potential. Likewise, impacts on ecosystems cost money when reduced forest cover increases water treatment costs, mercury contamination renders fish in recreation areas inedible, and acid rain causes unsightly defoliation that lower property values. There are too many potential social costs to list them all here.

Several studies have attempted to assign a social cost to aerial pollutants produced during the coal lifecycle. Most have focused on coal-fired power plants because of the large percentage of aerial pollutants emitted during combustion. Levy et al. 2009, Muller et al. 2009, and NRC 2009 all estimate the criteria air pollutant damages associated with individual coal-fired power plants.[126] EPA 2005 forecasts the benefits of reducing SO_2 and NO_X from coal-fired power

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[125] Brook, R.D., J.R. Brook, B. Urch, R. Vincent, S. Rajagopalan, and F. Silverman. 2002. "Inhalation of fine particulate air pollution and ozone causes acute arterial vasoconstriction in healthy adults." *Circulation 2002*; 105(13): 1534–1536; Peters A., D.W. Dockery, J.E. Muller, and M.A. Mittleman. 2001. "Increased particulate air pollution and the triggering of myocardial infarction." *Circulation 2001*; 103(23): 2810–2815; Lockwood, A.H., K. Welker-Hood, M. Rauch, and B. Gottlieb. 2011. Coal's Assault on Human Health: A Report from Physicians for Social Responsibility. Available at http://www.psr.org/resources/coals-assault-on-human-health.html (accessed March 20, 2011).

[126] Levy, J.I., L.K. Baxter, and J. Schwartz. 2009. "Uncertainty and variability in health-related damages from coal-fired power plants in the United States." *Risk Anal*. 29(7):1000-1014; Muller, N., R. Mendelsohn, and W. Nordhaus.

plants through the Clean Air Interstate Rule. While findings are similar, all analyses vary somewhat because they use different input data. Regarding impacts of aerial pollutants, the most influential impacts are the model for pollutant fate-and-transport (i.e., the model assumptions regarding dispersal of smokestack emissions), value of a statistical human life (VSL), included pollutants, and geographic region for the analysis. The studies mentioned here use different models and VSL values, but all include SO_2, NO_X, $PM_{2.5}$, and PM_{10} and focus exclusively on the continental United States.

The most current of the analyses is NRC 2009. For the NRC forecast, authors used a model based on U.S. county-level emissions from 406 plants compared to more precise models based on sub-county grids and less precise models based on U.S. states. The VSL is $6,000,000 (USD 2000), which is approximately a mean value for other studies listed in the NRC report. The authors apply the value to all ages and assume that lives are lost in the same year as significant exposure. The last two assumptions are significant; other studies vary VSL depending on the victim's age and assume the victim will still be productive for some time after exposure. The authors find aggregate damages associated with criteria-pollutant forming emissions from coal-fired electricity generation in 2005 were approximately $62 billion ($USD 2007). Costs were calculated on a per kilowatt hour (kWh) basis (Table 3-5) but the authors note that site-specific variables cause costs to vary greatly across the country.

Table 3-5: Mean Value of Criteria Air Pollutant Damages per kWh Associated with Emissions from 406 Coal-fired Power Plants in 2005

Pollutant	Cents/kwh
SO_2	3.800
NO_X	0.340
$PM_{2.5}$	0.300
PM_{10}	0.017
Total (equally weighted)	4.400
Total (weighted by net generation)	3.200

Source: NRC 2009

The kWh estimate provides an easy way to assess the value of air pollutant damages for coalmines. Local mining unit (LMU) 1 in the Chuitna coal project could produce 300,000,000 tonnes of coal over the course of a 25-year lifespan. To determine the social value of air quality damages

1. Convert 300,000,000 tonnes to short tons (300,000,000 x 1.10231131 = 330,693,393 short tons);

2. Multiply 330,693,393 short tons by 17,000,000 Btu per short ton[127] (5.622 x 10^15 Btu);

2009. Environmental Accounting for Pollution: Methods with an Application to the United States Economy; National Research Council of the National Academies (NRC). 2009. Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use. Washington, D.C.: The National Academies Press.

[127] On an as-received basis, U.S. sub-bituminous coal produces between 17-and-18,000,000 Btu per ton, from: U.S. Energy Information Administration (EIA). 2007. Annual Coal Report, Glossary.

3. Divide 5.622 x 10^15 Btu by 3413 Btu per kWh[128] (5.622 x 10^15 / 3413 = 1.647 x 10^12); and

4. Update per kWh figures to $2010 dollars.

5. Multiply 1.647 x 10^12 by corresponding values and divide by 100 to find dollar amount.

6. Divide by 25 and take present value to reflect cost stream over this period.

7. Divide by 300,000,000 metric tons to derive unit costs.

The present value of impacts from LMU 1 could be $53,092,868,407 ($176.98/ mt) or $38,613,000,271 ($128.71/mt) depending on whether the estimate is based on simple weighting or weighting according to net generation (Table 3-6).

Table 3-6: Air Pollution Damages Associated with Emissions from Chuitna Coal

Pollutant	Marginal damage (2010 cents/ kWh)	Annual damage ($2010)	Present value ($2010)	$/ Metric ton ($2010)
SO_2	4.00	$2,633,236,400	$45,852,934,339	$152.84
NO_X	0.36	$235,605,360	$4,102,630,924	$13.68
$PM_{2.5}$	0.32	$207,887,200	$3,619,970,517	$12.07
PM_{10}	0.02	$117,802,680	$2,051,315,465	$6.84
Total (equally weighted)	4.63	$3,049,010,400	$53,092,868,407	$176.98
Total (net generation weighted)	3.37	$2,217,462,400	$38,613,000,271	$128.71

Air quality damage can extend to the United States

Aerial pollutants can transcend natural and political jurisdictions. For example, dust storms in China pick up air particulates from coal-fired power plants and carry them across the Pacific Ocean to the United States. Recent empirical analysis demonstrates the prominence of such particulates. From December 2007 to May 2008, University of California, Berkeley researchers collected particulate pollution samples from Chabot Observatory and Mount Tamalpais near San Francisco Bay. The sites were chosen where city pollution would be limited. The researchers filtered out PM2.5 from each site and measured concentrations of the isotope ^{208}Pb. Spikes in the prevalence of the isotope corresponded to time periods of intense Asian dust storms, leading the researchers to conclude that emissions in eastern Asia were contributing to Bay area air pollution. The median portion of Asian lead in the $PM_{2.5}$ was 29 percent over a six-month time period.

The Berkeley study demonstrates a causal connection between east Asian coal combustion and aerial pollutants in the United States that cause significant public health and

[128] Btu per kWh value is from Oak Ridge National Laboratory (ORNL). 2011. “List of Conversion Factors used by the Bioenergy Feedstock Development Programs.” Available at http://bioenergy.ornl.gov/papers/misc/energy_conv.html.

ecosystem impacts. The value of such pollutants can be assessed. The proposed Chuitna coal project will export coal to Asia and perhaps within the United States. In so doing, it will generate billions of dollars in costs for affected people in both Asia and the United States.

3.2.3 Ecosystem service damages

The proposed Chuitna Coal Project includes (1) a surface coal mine and associated support facilities; (2) a mine access road; (3) a coal transport conveyor; (4) personnel housing; (5) an air strip facility; (6) a logistics center, and (7) a coal export terminal at Ladd Landing.[129] Construction and operation of these seven project components may adversely affect the long term productivity of a wide range of terrestrial and aquatic ecosystems and the economic benefits they provide on a sustainable basis.

Ecosystem service values of lands and waters in the Chuitna Coal Project area

Significant aquatic and terrestrial ecosystems include freshwater and coastal wetlands, riparian zones, lakes, ponds, bogs, muskeg, fen, spruce-hardwood forest, bottomland spruce-poplar forest, high brush, streams, rivers, shorelines, and near shore marine environments.[130]In recent years, economists have coined the term "ecosystem services" to describe the various economic benefits intact lands and waters provide for human communities. The terrestrial and aquatic ecosystems affected by the Chuitna Coal Project provide all of these services. Ecosystem services are generally classified into four major categories:[131]

- ***Provisioning services*** are the goods or products obtained from ecosystems such as food, freshwater, timber, and fiber. These services are tangible and many—but not all—are often tradable and priced in the marketplace. Terrestrial and aquatic ecosystems in the Chuitna Coal Project area provide fish, game, wood, berries, and medicinal plants gathered by native and subsistence users.[132]

- ***Regulating services*** are the benefits obtained from an ecosystem's control of natural processes such as carbon sequestration, erosion control, water flows, and pollination. Maintaining regular surface and groundwater flows of clean water is one of the major regulating services offered by terrestrial and aquatic ecosystems in the Chuitna Coal Project area in its natural state.[133]

[129] U.S. Environmental Protection Agency. 2006. Draft Scoping Document for the Chuitna Coal Project Supplemental Environmental Impact Statement. Seattle: U.S. EPA Region 10.

[130] HDR. 2006. Chuitna Coal Project Summary of Previous Baseline Studies for Wetlands. Anchorage: HDR Alaska, Inc.; U.S. Environmental Protection Agency. 1990. Diamond Chuitna Coal Project Final Environmental Impact Statement (FEIS). Chapter 4: Affected Environment. Seattle: EPA Region 10; Oasis. 2006. Aquatic Biology: Existing Information for the Chuitna Coal Project. Anchorage: Oasis Environmental, Inc.

[131] Millennium Ecosystem Assessment. 2005. Ecosystems and Well-Being. Volume 1: Current State and Trends. Findings of the Condition and Trends Working Group. Washington D.C.: Island Press.

[132] FEIS at 4-83; Fall, James, Daniel J. Foster, and Ronald T. Stanek. 1983. The Use of Moose and Other Wild Resources in the Tyonek and Upper Yentna Areas: A Background Report. Anchorage: Alaska Department of Fish and Game, Subsistence Division.

[133] FEIS at 4-13 to 4-14; Riverside. 2010. Chuitna Coal Project Groundwater Baseline Report – Draft 1982 through January 2010. Ft. Collins: Riverside, Inc.

- ***Cultural services*** are the nonmaterial benefits obtained from an ecosystem such as recreation, scenic and aesthetic enjoyment, and spiritual renewal. Fishing and hunting are two important recreational activities within the Chuitna Coal Project Area. These are enjoyed by both tourists and residents alike.[134] The inland and offshore areas affected also provide scenic and aesthetic values important not only to direct users of the area, but all Alaskans.[135]

- ***Supporting services*** are natural processes—such as nutrient cycling, primary production, and water cycling—that maintain the other ecosystem services. For example, marsh and muskeg wetlands within the Chuitna Coal Project area can contribute to flow of nutrients within freshwater and marine environments.[136]

These benefits create jobs, income, and value in the Cook Inlet and Alaskan economy through many different channels. Sport fishing generates jobs and income in the local economy through angler expenditures on vessels, fuel, tackle, and supplies. As these expenditures circulate through the regional economy, they create even more jobs and income indirectly by way of the multiplier effect. According to Helvoigt et al. (2010), direct expenditures for sport fishing in Cook Inlet in 2007 totaled more than $730 million.[137]

Combining both direct and indirect effects, the Alaska Department of Fish and Game estimates that sport fishing was responsible for an estimated $828 million in economic output, $279 million in regional income, and about 8,000 jobs in Cook Inlet in 2007.[138] Commercial fishing also generates significant economic benefits to the Cook Inlet economy. Helvoigt et al. (2010) estimated the wholesale value of salmon harvested from Cook Inlet to be over $61 million and total economic impact to be over $100 million each year.[139] Over 1,000 jobs were supported by this activity.

The value of personal and subsistence uses of fish, game, and wild plants is another indicator of ecosystem service values associated with the Chuitna Coal Project area. In many cases, the cost to replace the ecosystem services provided by intact landscapes and aquatic ecosystems would place a significant economic burden on local residents, if they could be replaced at all. According to Helvoigt et al. (2010), roughly one-half of Tyonek and Beluga residents rely on wild foods and "[d]uring the 2005–06 study year, the community of Tyonek harvested more than 43,000 pounds of wild resources, averaging 664 pounds per household and 217 pounds per person." Salmon and moose represent the largest share. Using a "replacement

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[134] Helvoigt, Ted , Ph.D., Tobias Schwoerer, M.S. and Diane Charlton. 2010. Economic Analysis of the Chuitna Watershed & Cook Inlet. Eugene: Eco-Northwest.

[135] According to State of Alaska's Division of Oil and Gas, Department of Natural Resources: "The entire coastline of the Cook Inlet basin holds an abundance of vistas, natural features, and man-made scenic resources of varying aesthetic value. Scenic resources may include wetlands, tideflats, beaches, vertical bluffs, rocky coasts, lakes, stream corridors, undulating hills, bays, and inlets. They may be enclosed in a wooded canopy or open with one or more unique natural features in view." See: http://www.dog.dnr.state.ak.us/oil/products/publications/cookinlet/cia1999_final_finding/chap5.htm.

[136] FEIS at 4-13 to 4-14.

[137] Helvoigt. 2010. Note 134.

[138] Alaska Department of Fish and Game, Division of Sport Fish. 2009. Economic Impacts and Contributions of Sportfising in Alaska, Summary Report 2007. Anchorage: ADFG.

[139] Helvoigt. 2010. Note 134.

cost" (i.e., what would it take to replace this harvest with commercial purchases in stores) value of $7.36/ lb in accordance with Alaska Department of Fish and Game methods suggests the annual value of Tyonek's subsistence harvest to be roughly $320,000.[140]

Northern Economics (2006) evaluated the consumptive and non-consumptive value of moose in Alaska, considering benefits associated with sport and subsistence food supply, tourism, and aesthetic appreciation (i.e., passive use). Annual benefits totaled $47 million. The discounted present value of moose to Alaska's economy over a 20-year period was estimated to be $476 million (in 2010 dollars).[141]

Intact wildlands and resources throughout the Chuitna Coal Project area generate significant scenic and aesthetic values. Economists refer to scenic and aesthetic values as "passive use" values, because people hold these values even if they never directly use the resource in question. They are measured by survey methods that measure people's willingness to pay to protect these resources. For example, Colt (2001) concluded that passive use values for 13.2 million acres encompassed by Bristol Bay Wildlife Refuges were in the order of $2.5 billion a year, or $3.5 billion in 2010 dollars. This translates into a value of $268 dollars an acre each year.[142] There is no reason why undeveloped landscapes surrounding Cook Inlet would not generate a similar magnitude of passive use benefits.

Helvoigt et al. (2010) found Alaska's annual marginal non-use willingness to pay for a Upper Cook Inlet salmon to be $4.19 and the total annual non-use economic value of the entire Upper Cook Inlet salmon fishery to be approximately $294 million per year, aggregated across Alaska's total population. Talberth et al. (2007) found Alaskan household's mean willingness to pay to be $22.56 per year to maintain passive use values for marine ecosystems and Beluga habitat jeopardized by expansion of port facilities for the Red Dog mine along the Arctic coast.[143] This translates into an annual value aggregated across all Alaskan households of $5,580,000 per year to maintain passive use values on the nearshore and offshore areas that would otherwise be disturbed by port construction, ship traffic, and ocean dumping of dredged material.

These scenic and aesthetic values, in turn, play an important role in the regional economy by providing the basis for nature-based tourism. Nature-based tourism is big business in Alaska, and Cook Inlet sightseeing and boating are a significant part of this industry (Colt 2001). Alaska's visitor industry accounted for a total of 36,200 full and part-time jobs in 2008-09, over

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[140] The replacement cost method and per pound value estimate are described in "Subsistence In Alaska: 1994 Update Division of Subsistence, Alaska Department of Fish and Game." The 2010 value of the $5 per pound figure used in that study is $7.36.

[141] Northern Economics. 2006. The Value of Alaska Moose. Prepared for the Anchorage Soil and Water Conservation District and the Alaska Soil and Water Conservation District. Anchorage: Northern Economics.

[142] Colt, Steve. 2001. The Economic Importance of Healthy Alaska Ecosystems. Anchorage: Institute for Social and Economic Research, University of Alaska.

[143] Talberth, John, Nejem Raheem and Richard Mietz. 2007. Benefit Cost Analysis of the Delong Mountain Terminal Project: Critique and Independent Assessment of Key Parameters. Fairbanks: Northern Alaska Environmental Center.

$1.1 billion in labor income, and $3.4 billion in total spending, including all direct, indirect and induced effects.[144]

Some studies tie together multiple ecosystem services to estimate the economic value of particular ecosystems on a per acre basis. According to the Millennium Ecosystem Assessment (2005) the economic value of 63 million hectares of wetland around the world is between about $200 billion a year and $940 billion for a subset of important ecosystem services.[145] This translates to between $1,435 and $6,745 per acre per year in 2010 dollars. A meta-analysis by the Economic Research Service found median market, non-market, and ecological function wetland values to be $48,208 in 2010 dollars across a number of studies.[146] A study sponsored by NOAA for the Washington State Department of Ecology estimated the value of flood protection alone to be $10,869 to $69,287 per acre in 2010 dollars depending on local circumstances.[147] The wide range of these values reflects the necessity of site-specific valuation studies.

Nonetheless, if the mean from this range ($35,361) reflects wetland values in the Chuitna Coal Project area, it implies ecosystem service values from wetlands and other waters (i.e., ponds) to be in the order of $64,710,630 each year for the 1,830 acres of wetlands and waters affected by the project's footprint.[148] Thus, ecosystem services provided by intact aquatic and terrestrial ecosystems within the Chuitna Coal Project area are a significant source of value to the Alaska and Cook Inlet economy on a sustainable basis.

On-site and offsite impacts of the project

As currently planned, the Chuitna Coal Project will likely cause irreparable damage to these ecosystem services. There are no studies of which CSE is aware that suggest reclamation of surface coal mining will restore ecosystem service benefits or values to their baseline condition. In particular, there have been no documented successful (i.e. pre-mining functions and values) reclamation examples of a wild salmon stream in cold, wet conditions similar to conditions that exist at the Chuitna Coal Project site. Indeed, what literature exists suggests that damage is permanent. For example, the Environmental Protection Agency (EPA) this spring announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine in West Virginia.[149] Similar to Chuitna, the proposed fill affects an area of high fishery and clean water values. EPA's final decision to veto the permit focused on an exhaustive review of the science showing

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[144] McDowell Group. 2010. Economic Impact of Alaska's Visitor Industry. Prepared for State of Alaska Department of Commerce, Community, & Economic Development.

[145] Millennium Ecosystem Assessment. 2005. Ecosystems and Well-Being. Volume 1: Current State and Trends. Findings of the Condition and Trends Working Group. Washington D.C.: Island Press.

[146] Heimlich, Ralph E., Keith D. Wiebe, Roger Claassen, Dwight Gadsby and Robert M. House. 1998. Wetlands and Agriculture: Private Interests and Public Benefits. AER-765. Washington: USDA Economic Research Service.

[147] Leschine, Thomas, Katharine F. Wellman, and Thomas H. Green. 1997. The Economic Value of Wetlands: Wetland's Role in Flood Protection in Western Washington. Lacy: Washington State Department of Ecology and the National Oceanic and Atmospheric Administration.

[148] Footprint figures from: HDR Alaska, Inc. 2006. Chuitna Coal Project – Summary of Previous Baseline Studies for Wetlands. Anchorage: HDR Alaska, Inc.

[149] U.S. Environmental Protection Agency. 2011. Final Determination of the U.S. Environmental Protection Agency Pursuant to § 404(c) of the Clean Water Act Concerning the Spruce No. 1 Mine, Logan County, West Virginia

the irreparable harm that occurs when mining companies permanently bury and pollute natural headwater streams with mining waste.

The Chuitna Coal Project jeopardizes ecosystem service functions and values in several ways, most directly through habitat loss, fragmentation, and disruption of both surface and groundwater flows, and more indirectly through water pollution. Many impacts are predicted by the 1990 Final Environmental Impact Statement (FEIS), including:[150]

- Sheetgale-grass fen, a key wetland ecosystem plant, would decline from 291 acres to 0 acres;
- Rearing habitat for coho and Chinook salmon in the Chuitna River drainage could be reduced by 40 to 80 percent depending on mining plans and the success of stream restoration;
- Chinook salmon escapement could decline by 30 percent per year in the later years of mine life;
- Spawning habitat for 23,571 Chinook rearing salmonids, 57,208 coho, and 14,615 Dolly Varden could be lost after 10 years of mining activity. After 30 years, 91,086 Chinook rearing salmonids, 179,348 coho, and 14,615 Dolly Varden could lose habitat;
- Stream flow could be reduced by 8.5 to 25 percent in Lone Creek;[151]
- Stream channel length in Stream 2003 could be reduced by 46,570ft;
- Watershed area for Stream 2003 could be reduced by 5.75mi^2; and
- Stream flow for Stream 2004 could be reduced by 21 percent.

The FEIS also notes that the Diamond Chuitna Coal Project would have reduced open water from 18 to 0 acres and spruce birch, a key wetland ecosystem type, from 984 to 549 acres. There are also likely to be significant impacts to areas that are downstream from the mine, including the impacts to marine ecosystems associated with development and operation of the coal export terminal at Ladd Landing.

Impacts to marine ecosystems are likely to be diverse, and long lasting. They include loss of intertidal wetlands, disturbance to the seafloor associated with construction of a 10,000 foot trestle, an increase of 150 to 250 vessel transits per year, planned and accidental discharges of sediment, coal, oil, and toxic substances, changes in local ice flow patterns, noise, and disruption of habitat use patterns by fish and marine mammals.[152]

Impacts to terrestrial and aquatic ecosystems are likely to cause damage to important aesthetic values and long-range productivity of ecosystems within the project area. The potential magnitude of economic impacts can be estimated by combining reported ecosystem service values discussed above with the predicted changes in ecological conditions associated with

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[150] In their intervention memo for the Trustees for Alaska petition, PacRim Coal, LP notes that the EPA issued final permits based on information contained in the FEIS. In so doing, they supported the notion that the project should proceed. In addition, PacRim notes that changes to mitigate the environmental impacts of the project have been made since the FEIS was received in 1990. Nonetheless, the FEIS remains the only document that details impacts from developing lands associated with the Chuitna Coal Project.
[151] The flow reduction would likely occur in year 10 of mine life and end at the end of mine life.
[152] HDR. 2006. Note 148; FEIS at 5-95-5-111.

project development and operation. Preliminary estimates can be made for loss of fisheries, loss of passive use values for terrestrial ecosystems, loss of passive use values for marine ecosystems, and loss of wetlands. Because such impacts will extend well beyond the operations phase of the mine, we have modeled the impacts out over a 50 year period, a standard time horizon for Corps civil works projects.

Loss of passive use values for fisheries

If the long term projected loss of salmonid habitat and fish production occurred today, it would represent a discounted loss of aesthetic (i.e., passive use) values of nearly $31 million over a 50-year period, or $0.10 per ton of production. Impacts to fisheries can be expected to extend well beyond the mine life, so a 50-year time horizon is used in accordance with standard Corps procedures. This value assumes a loss of $1,194,355 per year for 285,049 fish with passive use values of $4.19 per fish when none of the lost production would be restored by reclamation activities. One could argue that not all habitat loss would occur immediately; it would be spread out over the project life. On the other hand, the impacts of initial project development include a range of disturbance factors for fish, such as increased runoff and water pollution, so it is reasonable to front-load fisheries impacts towards the earlier phases of the project. Regardless, the magnitude of this figure illustrates the potential significance of lost aesthetic values associated with the project's impacts on salmon.

Loss of passive use values for terrestrial ecosystems

According to the scoping report, the development of LMU 1 would impact roughly 5,050 acres of terrestrial and aquatic ecosystems in the upland portion of the project area. Another 360 acres would be impacted by the proposed airstrip and housing facilities. Additional acreage would be affected by the 12-mile access road. With respect to habitat loss, a general rule of thumb is 5 acres per mile,[153] which translates into 60 acres for the Chuitna project.

If the Colt (2001) passive use value calculation of $268 per acre is applied here to the 5,470 acres of direct impact it suggests an annual loss of $1,465,960. As with fishery impacts, it is reasonable to "front load" these impacts to the earlier project phases to account for indirect effects such as habitat fragmentation. Modeled over a 50-year period, this translates into a present value cost of $37,718,804 associated with loss and degradation of terrestrial ecosystems in the project area. This represents an additional unit cost of $0.13 per ton of production.

Loss of passive use values for marine ecosystems

Given the relatively high ecological values of marine ecosystems affected by the Chuitna Coal Project, passive use values are also likely to be high. Recently, this fact was underscored by the final designation of critical habitat for the Cook Inlet beluga whale. In its April 8th, 2011 notice, NOAA designated 3,016 square miles of marine and estuarine environments considered by scientists to be essential to the whale's survival as critical habitat including cetacean feeding

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[153] M. M. Rowland, M. J. Wisdom, B. K. Johnson, and M. A. Penninger. 2005. Effects of Roads on Elk: Implications for Management in Forested Ecosystems. Pages 42-52 in Wisdom, M. J., technical editor, The Starkey Project: a synthesis of long-term studies of elk and mule deer.

areas at the mouths of important salmon streams.[154] All of the marine ecosystems affected by the Chuitna Coal Project fall into this critical habitat designation, and so passive use values associated with beluga whales are a reasonable proxy for values associated with these ecosystems as a whole. As part of the preparatory analysis for the designation, NOAA recognized the significance of passive use values for beluga whales:

> "Passive use value to society of critical habitat designation reflects the increased well-being obtained from the knowledge that Cook Inlet beluga whales persist *within their natural habitat in Cook Inlet*. Society would not derive the same level of well-being (i.e. would not have an equivalent WTP) for a remnant population of Cook Inlet beluga whales being kept in an artificial environment, such as an aquarium tank at the Port of Anchorage" (italics in original).[155]

Passive use values for at risk species and the magnitude of losses associated with projects that put these species at risk can be empirically measured, primarily through contingent valuation surveys. A recent meta-analysis of a set of 29 U.S. studies found annual household willingness to pay values for actions to protect threatened and endangered species to range from $11 to $350 in 2006 dollars.[156] Of particular relevance for an assessment of the economic value of critical habitat for the Cook Inlet beluga whale are non-market valuation studies that focus on estimating the public's WTP for protecting threatened and endangered marine mammals in the United States. The NOAA analysis cited a WTP range of $16.18 to $142 per household per year for a range of U.S. studies addressing a wide variety of species.[157]

One non-U.S. study addressed beluga whales in particular. Olar et al. (2007) used CV methods to estimate the WTP to improve the St. Lawrence beluga whale population, a distinct population group of the species in Canada, from its current threatened status to not a risk at all (i.e., to fully recovered). Using an Internet panel-based sample, consisting of 2,006 Canadians (52% response rate), they estimated the mean household WTP to be $122 per year (2006 Canadian dollars).[158]

As discussed previously, there are few Alaska studies available to estimate passive use values for preservation of beluga whales or other aspects of the marine ecosystems affected by the Chuitna Coal Project. However, the Talberth (2007) study cited previously is directly on point, since it addressed WTP to preclude a project of a similar magnitude and range of impacts as Chuitna, such as increased mine production, port facilities, a trestle, increased ship traffic, and beluga habitat. The mean household WTP value reported in that study – $22.56 – for a marine protected area designation that would preclude development of the Delong Mountain Terminal

[154] http://www.fakr.noaa.gov/newsreleases/2011/cibelugahabitat040811.htm
[155] NOAA Fisheries Service. 2010. Final RIR/4(b)2 Preparatory Assessment/ FRFA for the Critical Habitat Designation of Cook Inlet Beluga Whale. Anchorage: U.S. Department of Commerce, National Oceanic and Atmospheric Association, Fisheries Service Alaska Region at 5-7.
[156] Richardson, Leslie, and John Loomis. 2009. "The total economics value of threatened, endangered, and rare Species: an updated meta-analysis." *Ecological Economics* 68: 1535-1548.
[157] NOAA (2010) at A-10 – A-11.
[158] Olar, M., W. Adamowicz, P. Boxall, and G.E. West. 2007. Estimation of the Economic Benefits of Marine Mammal Recovery in the St. Lawrence Estuary. Report to the Policy and Economics Branch, Fisheries and Oceans Canada, Regional Branch Quebec.

Project can therefore be used as a preliminary estimate of passive use values at risk. This value is within the range of other values reported in the literature, but conservative. True values are likely to be considerably higher, since the beluga stocks considered in that study were far from Alaska's population center, and not listed as threatened. On the other hand, since the Chuitna Coal Project affects only a portion of Cook Inlet beluga habitat, WTP values to preclude its adverse impacts (i.e. through a similar MPA designation) may not be as high as the literature suggests.

Extending this $22.56 WTP value to all Alaska households (236,597 from the most recent census estimates) implies annual passive use damages of $5,337,628, a present value cost of $137,335,917 over 50 years, and a unit cost of $0.46 per ton.

Loss of wetlands

Long term productivity losses associated with reduction of food, fiber, water supply, and other ecosystem services provided by wetlands in the project's footprint could amount to a present value cost of $1,664,989,238 over a 50-year period assuming the mean marginal (i.e., per acre) wetland values previously discussed are valid for the Chuitna Project area. This represents $5.55 per ton of production. However, this figure does not account for actual mitigation costs associated with wetland loss in Alaska, which can be considered an additional regulatory compliance cost related but not necessarily overlapping with lost ecosystem service values.

As noted above, the Chuitna Coal Project footprint is expected to affect 1,830 acres of wetlands and aquatic ecosystems. State and federal regulations could require project developers to avoid, minimize, or mitigate the impacts to these aquatic resources. The State of Alaska identifies two types of wetlands for which mitigation is required. Freshwater wetlands are "environments characterized by rooted vegetation that is partially submerged either continuously or periodically by surface freshwater with less than 0.5 parts per thousand salt content and not exceeding three meters in depth" and saltwater wetlands are "coastal areas along sheltered shorelines characterized by halophilic hydrophytes and macro algae extending from extreme low tide to an area above extreme high tide that is influenced by sea spray or tidally induced water table changes."

At least two state-level permitting programs affect waters that meet these definitions. Applicable to both freshwater and saltwater wetlands, the Alaska Department of Natural Resources (ADNR) awards permits to projects that will affect "various rivers, lakes, and streams or parts of them that are important for the spawning, rearing, or migration of anadromous fish." Also applicable to both types, the federal Clean Water Act (CWA) §401 provides the Alaska Department of Environmental Conservation (ADEC) authority to certify federal activities that discharge into waters of the United States and coastal zones. All Corps public notifications for CWA §404 permits also request §401 certification.

The CWA §404 permits are the federal regulations that affect wetlands in Alaska. As part of the CWA §404 permitting process, through §401 or other requirements, applicants are often required to compensate for unavoidable impacts to jurisdictional waters by providing mitigation. In some circumstances, such as for discharge into coastal zones, ADNR reserves authority to determine whether or not Corps mitigation requirements satisfy state requirements. If not, ADNR may impose additional mitigation requirements.

Mitigation can occur through three actions: 1) permittee-responsible compensatory mitigation; 2) credit purchases from a mitigation bank; or 3) in-lieu fee mitigation.[159] Mitigation actions result in additional costs for project developers. The developer pays for mitigation. In practice, many factors (e.g., aesthetic, wildlife habitat, and recreation benefit) affect the choice of mitigation practice. From the economic perspective, however, a rational developer would choose the least-cost option. In some cases, permittee-responsible compensatory mitigation is the least-cost option, but in most cases, mitigation banks or in-lieu fees are cheaper.

According to the Environmental Law Institute (ELI), Alaska had one mitigation bank (i.e., Natzuhinni Wetland Mitigation Bank) and four wetland and stream in-lieu fee programs (i.e., Alaska Great Land Trust Program, Alaska Kachemak Heritage Land Trust, Alaska Southeast Alaska Land Trust, and Alaska Conservation Fund) as of 2008.[160] More recently, the Corps authorized use of the Su-Knik Mitigation Bank in the Fish Creek Watershed, Little Susitna Watershed and the Lower Susitna Watershed.[161] An internet review was unable to find costs for mitigation bank credits in Alaska. However, Ecosystem Marketplace (2011) notes that wetland credit prices range from $6,000 to $300,000 depending on the location.[162]

Another consideration is the ratio that converts impacted wetlands to required credits. Wetland credits are calculated as one acre of impacted wetland to between one and three acres of restored wetland. If a credit payment does not create a new wetland, the ratio can range from one to ten. Taking the mid-point of credit prices ($153,000) but applying no ratio suggests mitigation bank costs for the Chuitna Coal Project to be $279,990,000, which translates into $0.93 per ton of production. However, since mitigation bank credit prices are not made public, a more refined estimate may be to use in lieu-fee rates as a proxy, as suggested by Ecosystem Marketplace.[163]

The Alaska Great Land Trust sets in-lieu fee rates annually.[164] The rates are based on the cost to offset wetland impacts in Anchorage so could be higher than the cost for in-lieu fees for the Chuitna Coal Project. Developers are assessed a fee based on the Relative Ecological Value (REV) of their project. The Corp's methodology for calculating REV is set forth in a technical

[159] Hough, P. and M. Sudol. 2008. "New regulations to improve wetland and stream compensatory mitigation". *National Wetlands Newsletter*. Washington, D.C.: Environmental Law Institute.

[160] Environmental Law Institute. 2008. State Wetland Protection: Status, Trends, and Model Approaches, A 50-state study by the Environmental Law Institute. Alaska Appendix. Available at http://www.eli.org/pdf/core_states/Alaska.pdf.

[161] See: http://www.su-knikmitigationbank.com/#

[162] Ecosystem Marketplace. 2011. U.S. Wetland Banking. Available at http://www.ecosystemmarketplace.com/pages/dynamic/web.page.php?section=biodiversity_market&page_name=uswet_market (accessed March 22, 2011).

[163]See: http://www.ecosystemmarketplace.com/pages/dynamic/web.page.php?section=biodiversity_market&page_name=uswet_market

[164] Great Land Trust of Southcentral Alaska. 2011. Feed-based compensatory mitigation within the Municipality of Anchorage. Available at http://www.greatlandtrust.org/_docs/2011ILFrates.pdf.

manual that is now being revised.[165] For projects deemed to impact wetlands with high REV, the cost is greater. For projects deemed to impact wetlands with lower REV, the cost is less. As of the February 1, 2011, the following rates were charged:

- REV 1 Debit: $163,891 per acre
- REV 2 Debit: $163,891 per acre
- REV 3 Debit: $ 18,795 per acre

In comparison, Ecosystem Marketplace lists the following rates:

- $24,000 - $46,000 per acre of non-riparian wetland in North Carolina
- $36,000 - $63,000 per acre of riparian wetland in North Carolina
- $156,000 per acre of coastal wetland in North Carolina
- $55,000 - $65,000 per acre of nontidal wetland in Southeast Virginia
- $125,000 - $150,000 per acre of nontidal wetland in Northern Virginia
- $400,000 - $653,000 per acre of tidal wetland in Virginia
- $84,500 per acre of wetland in Oregon

The Corps has yet to disclose how many acres of wetlands impacted by the Chuitna Coal Project fall into the various REV categories. However, draft 2010 guidance suggests that there may be a significant amount of this acreage in the REV 1 and 2 categories. For example, wetlands that support salmonids generally fall into REV 1 or 2, as do intertidal wetlands important to shorebirds and beluga whales.[166] Thus, it is reasonable to assume that affected wetlands fall into all three categories.[167]

Assuming an equal distribution and that no credit ratio applies, an in-lieu fee mitigation cost would be ($163,891 * 610 (REV1) + $163,891 * 610 (REV2) + $18,795 * 610 (REV3)) = $211,411,970 or $0.70 per ton of production. If the payment were spread out over a 50 year period commensurate with other ecosystem service damage estimates, it would amount to roughly $4,228,220 in annual costs, however, in-lieu fees are typically paid up front so this figure is for comparison purposes only.

[165] U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and Municipality of Anchorage. 2005. The Anchorage debit-credit method: A method for determining development debits and compensatory mitigation credits for aquatic areas in Anchorage, Alaska.
[166] See: Table 1: Polygons,and Relative Ecological Values (REVs), Grouped by Landform, 2010 draft update to the debit-credit methodology.
[167] The Corps does include a category of lower ecological value – REV4 – but it appears that few if any acres in the Chuitna Coal Project area would be classified as such.

Table 3.7 summarizes the potential magnitude of damages to ecosystem services in terms of annual costs, net present value, and unit costs per ton of production.

Table 3-7: Ecosystem Service Damages

Ecosystem Service Damage	Annual costs ($2010)	Present value ($ millions)	$/ Metric ton
Passive use damage - fisheries	$1,194,355	$30.73	$0.10
Passive use damage - terrestrial ecosystems	$1,465,960	$37.72	$0.13
Passive use damage - marine ecosystems	$5,337,628	$137.34	$0.46
Use and non-use damage - wetlands	$64,710,630	$1,665.00	$5.55
Mitigation cost – wetlands[168]	$4,228,220	$211.41	$0.70
Total:	$76,936,793	$2,082.20	$6.94

[168] Mitigation costs are typically paid up front. The annual cost figure is indicated here for comparative purposes only.

Section 4: Net Public Benefits

The Chuitna Coal Project will involve numerous federal and state authorizations to proceed. As discussed in depth in Section 1, these authorizations require that federal and state agencies including the Army Corps of Engineers (Corps) Environmental Protection Agency, National Marine Fisheries Service, and Alaska Department of Natural Resources consider the potential economic impacts of the proposal from the standpoint of net public benefits and not restrict their analysis to the financial benefits to mine owners, the state, and local government. The Corps regulatory framework operationalizes the net public benefit analysis requirements in its National Economic Development (NED) and Regional Economic Development (RED) procedures. These procedures represent the best analytical methods and science available to the agency with respect to economic analysis.

In Sections 2 and 3, we provide preliminary estimates of the likely magnitude of several important categories of NED and RED benefits and costs. These preliminary estimates are based on publicly available information and not more detailed project specific information that PacRim will provide to the Corps and other federal and state agencies during the permitting process. Thus, the preliminary estimates should be considered ballpark figures that will be refined as the permitting process unfolds.

4.1: Net Present Value and Benefit-cost Ratio

The net public benefits framework relies on two key metrics: net present value and the benefit cost ratio. Tables 4-1 and 4-2 consolidate figures from Sections 2 and 3 into estimates of net present value and the benefit-cost ratio under each of the long term price assumptions and for the low and high delivered coal cost estimates of $52.26 and $88.05 per metric ton. Even under the most optimistic price scenarios, the social costs of the Chuitna Coal Project are likely to exceed social benefits by a wide margin as reflected by negative net present value figures and benefit-cost ratios below one in these tables. Taking these costs into consideration suggests a net present value range of -$57.23 to -$75.27 billion over the life of the project and a benefit-cost ratio range of .3134 to .1713, meaning that costs exceed benefits by a factor of 3 to 6.

A slightly different metric evaluates the social costs relative to market prices. The comparison is provided in Table 4-3. This analysis suggests that the social costs of Chuitna coal are likely to range between 193 and 604% of the market value depending on the long-term prices 1in Asia or locally in Alaska, a range that is consistent with values reported in the literature. For example, in a 2002 review, Cherry and Shogren (2002) found the social costs of coal to range from 300 to over 650% of the market price.[169] Given this, the only way the Chuitna Coal Project could proceed in a manner consistent with net public benefits is a tax on production that recoups these externalized costs or major reconfiguration of the project to internalize or mitigate these damages.

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[169] Cherry, Todd L. and Jason F. Shogren. 2002. The Social Cost of Coal: A Tale of Market Failure and Market Solution.

Table 4-1: Cumulative Net Present Value (billions) and Benefit-Cost Ratio under the Four Price Scenarios and a Delivered Cost of $52.26/ Metric ton

Scenarios	High coal cost		High oil price		Reference case		Low coal cost	
	NPV	BCR	NPV	BCR	NPV	BCR	NPV	BCR
Financial costs alone	$15.2	2.3900	$8.87	1.8100	$8.16	1.7500	$4.64	1.4200
-Carbon emissions damage	-2.06	0.9269	-8.39	0.7023	-9.10	0.6771	-12.62	0.5522
-Air quality damages	-55.15	0.3214	-61.48	0.2435	-62.19	0.2348	-65.71	0.1915
-Fisheries damage	-55.18	0.3213	-61.51	0.2434	-62.22	0.2347	-65.74	0.1914
-Terrestrial ecosystem damage	-55.22	0.3211	-61.55	0.2433	-62.26	0.2346	-65.78	0.1913
-Marine ecosystem damage	-55.36	0.3206	-61.69	0.2429	-62.40	0.2342	-65.92	0.1910
-Use and non-use value for wetlands	-57.02	0.3142	-63.35	0.2380	-64.06	0.2295	-67.58	0.1872
-Mitigation cost wetlands	-57.23	0.3134	-63.56	0.2374	-64.27	0.2289	-67.79	0.1867

Table 4-2: Cumulative Net Present Value (billions) and Benefit-Cost Ratio under the Four Price Scenarios and a Delivered Cost of $88.05/ Metric ton

Scenarios	High coal cost		High oil price		Reference case		Low coal cost	
	NPV	BCR	NPV	BCR	NPV	BCR	NPV	BCR
Financial costs alone	$7.73	1.4200	$1.39	1.08	$0.67	1.04	-$2.84	0.85
-Carbon emissions damage	-9.53	0.7325	-15.87	0.5550	-16.59	0.5351	-20.10	0.4363
-Air quality damages	-62.62	0.2943	-68.96	0.2230	-69.68	0.2150	-73.19	0.1753
-Fisheries damage	-62.65	0.2942	-68.99	0.2229	-69.71	0.2149	-73.22	0.1753
-Terrestrial ecosystem damage	-62.69	0.2941	-69.03	0.2228	-69.75	0.2148	-73.26	0.1752
-Marine ecosystem damage	-62.83	0.2936	-69.17	0.2225	-69.89	0.2145	-73.40	0.1749
-Use and non-use value for wetlands	-64.49	0.2882	-70.83	0.2184	-71.55	0.2105	-75.06	0.1717
-Mitigation cost wetlands	-64.70	0.2876	-71.04	0.2179	-71.76	0.2101	-75.27	0.1713

Table 4-3: Ratio of Social Costs to Market Price

Scenarios	High coal cost	High oil price	Reference case	Low coal cost	AK production value
Market price ($/ Metric ton)	$125.02	$94.69	$91.29	$74.46	$40.00
Social costs ($/ Metric ton)	$241.44	$241.44	$241.44	$241.44	$241.44
Ratio (Social costs/ market price)	1.93	2.55	2.64	3.24	6.04

4.2: Future Refinements

This preliminary analysis provides an estimate of the potential net public benefits associated with the Chuitna Coal Project based on publicly available sources of information as of April 2011. It provides a snapshot of important categories of costs and benefits that must be taken into account from the broad perspective of net public benefits, and not financial costs and benefits alone.

As the permitting process unfolds, more detailed information on Asian market conditions, project development and annual operations costs, transportation costs, tax liabilities, and project configuration will make more refined estimates possible. This new information will help reduce the range of variation in the estimates. For example, as countries continue to pursue low carbon development strategies in China and throughout Asia, it may be more likely that coal prices will continue to decline from their recent historic highs making the high cost coal price scenario unrealistic and thus excluded from future analysis. More precise project development and transportation cost data provided by PacRim would enable more accurate estimates of delivered coal costs, as well as jobs, income, and tax benefits to the regional economy.

However, given the wide margin of social costs over national economic development benefits estimated in this preliminary analysis and the fact that our estimates corroborate figures reported in the literature, it is unlikely that future refinements would affect project economics in any significant way. This underscores the dilemma of developing new coal sources in an era of global warming and increasing damages from air and water pollution. While market demand may support new coal mine development from the perspective of project investors, such projects are not justified from a net public benefits perspective because they generate social costs far in excess of private financial benefits.