Benefit Cost Analysis of the Delong Mountain Terminal Project

Critique and Independent Assessment of Key Parameters

Prepared for the Northern Alaska Environmental Center
By Center for Sustainable Economy

January 2007 Update

Bowhead whale by Richard Ellis.

1704-B Llano Street, Suite 194
Santa Fe, New Mexico 87505
(505) 986-1163
www.sustainable-economy.org
Benefit Cost Analysis of the Delong Mountain Terminal Project

Critique and Independent Assessment of Key Parameters

Prepared for the Northern Alaska Environmental Center

By

Dr. John Talberth¹
Nejem Raheem²
Richard Mietz³

January 2007 Update

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

¹ Senior Economist, Center for Sustainable Economy (jtalberth@cybermesa.com).
² Research Economist, Center for Sustainable Economy (nejemraheem@yahoo.com).
³ Environmental Law Fellow, Center for Sustainable Economy (rmietz@cybermesa.com)
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Executive Summary</strong></td>
<td>v</td>
</tr>
<tr>
<td>1.0 <em>Essential Components of Benefit Cost Analysis</em></td>
<td>1</td>
</tr>
<tr>
<td>1.1 Decide whose benefits and costs count</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Select the portfolio of alternative projects</td>
<td>3</td>
</tr>
<tr>
<td>1.3 Catalogue, predict, and monetize impacts</td>
<td>3</td>
</tr>
<tr>
<td>1.4 Discount or compound benefits and costs to find present values</td>
<td>7</td>
</tr>
<tr>
<td>1.5 Address uncertainty and perform sensitivity analysis</td>
<td>9</td>
</tr>
<tr>
<td>2.0 <em>National Economic Development Analysis</em></td>
<td>12</td>
</tr>
<tr>
<td>2.1 Determining the federal interest</td>
<td>12</td>
</tr>
<tr>
<td>2.2 “With and without” framework</td>
<td>13</td>
</tr>
<tr>
<td>2.3 Non-structural alternatives</td>
<td>14</td>
</tr>
<tr>
<td>2.4 Risk and uncertainty</td>
<td>15</td>
</tr>
<tr>
<td>2.5 Externalities</td>
<td>16</td>
</tr>
<tr>
<td>2.6 Opportunity costs</td>
<td>18</td>
</tr>
<tr>
<td>2.7 Displacement costs</td>
<td>18</td>
</tr>
<tr>
<td>2.8 Incorporating NED analysis into the NEPA process</td>
<td>19</td>
</tr>
<tr>
<td>2.9 Cumulative economic effects</td>
<td>21</td>
</tr>
<tr>
<td>3.0 <em>Critique of the Corps Benefit-Cost Analysis for the DMTP</em></td>
<td>24</td>
</tr>
<tr>
<td>3.1 Federal interest not established</td>
<td>25</td>
</tr>
<tr>
<td>3.2 Failure to properly incorporate NED analysis into the NEPA process</td>
<td>27</td>
</tr>
<tr>
<td>3.3 Cumulative economic effects are not addressed</td>
<td>32</td>
</tr>
<tr>
<td>3.4 Miscalculation of village fuel savings benefit</td>
<td>34</td>
</tr>
<tr>
<td>3.5 Failure to add compound interest to project costs</td>
<td>34</td>
</tr>
<tr>
<td>3.6 Incorrect assumptions about Red Dog Mine life</td>
<td>36</td>
</tr>
<tr>
<td>3.7 Erroneous assumptions about fuel price trends</td>
<td>37</td>
</tr>
<tr>
<td>3.8 Unwarranted assumptions about fuel delivery savings</td>
<td>44</td>
</tr>
<tr>
<td>4.0 <em>Independent Assessment of Key Parameters</em></td>
<td>48</td>
</tr>
<tr>
<td>4.1 RED costs associated with substitution of Singapore for Puget Sound fuel</td>
<td>48</td>
</tr>
<tr>
<td>4.2 Marine pollution costs</td>
<td>50</td>
</tr>
<tr>
<td>4.3 Forgone savings from investment in wind energy</td>
<td>52</td>
</tr>
<tr>
<td>4.4 Carbon emissions damage</td>
<td>54</td>
</tr>
<tr>
<td>4.5 Loss of passive use values for marine ecosystems</td>
<td>61</td>
</tr>
<tr>
<td>4.6 Non-market costs to subsistence</td>
<td>72</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>5.0 <strong>Reanalysis of the Benefit-Cost Ratio</strong></td>
<td>88</td>
</tr>
<tr>
<td>5.1 The Corps baseline adjusted for correct</td>
<td>88</td>
</tr>
<tr>
<td>village fuel savings</td>
<td></td>
</tr>
<tr>
<td>5.2 Sequential reanalysis of the benefit-cost</td>
<td>89</td>
</tr>
<tr>
<td>ratio</td>
<td></td>
</tr>
<tr>
<td>5.3 Discussion and recommendations for</td>
<td>92</td>
</tr>
<tr>
<td>additional analysis</td>
<td></td>
</tr>
</tbody>
</table>

**Appendices**

- A-1 Benefit-cost reanalysis spreadsheets      A1
- A-2 Carbon footprint analysis                 A2
- A-3 Contingent valuation survey of Alaska    A3
  residents
Executive Summary

Along the far northwest coast of Alaska, just south of the Native Village of Kivalina, the Alaska Industrial Development and Export Authority (AIDEA) and the Army Corps of Engineers (Corps) have proposed a major expansion of the Delong Mountain Terminal, a port facility that serves the Red Dog Mine, the world’s largest producer of lead/zinc concentrate. The proposed Delong Mountain Terminal Project (DMTP) is a proposed infrastructure investment of approximately $230.42 million designed to reconfigure the port facility to accommodate deep draft tankers and bulk cargo carriers. Should the project move forward as planned, the State of Alaska, through AIDEA, would shoulder roughly $193.38 million of this amount. The federal burden would be approximately $37 million.

Specific components of the proposed DMTP include: (a) construction of a 1,450-foot trestle with ore conveyor, fuel line, road, and communications lines; (b) construction of a 27,000 square foot loading platform; (c) up to 3.5 acres of wetland fill for a new generator site and other shoreline infrastructure; (d) a dredged channel and turning basin affecting up to 430 acres of ocean floor, and (e) a 5,600-acre offshore dredged material disposal area.

In May of 2003, the Corps released comment drafts of a Feasibility Study for the project required by the Water Resources Development Act and an Environmental Impact Statement (EIS) required by the National Environmental Policy Act (NEPA). CSE (formerly Ecology and Law Institute) prepared an initial version of this report in response to the release of those documents, and submitted our report into the Administrative Record. In September of 2005, the Corps released a Draft Interim Feasibility Report (DIFR) and Draft Environmental Impact Statement (DEIS) for public comment. According to these drafts, there will be five major DMTP benefits:

(1) Reduced lead/ zinc concentrate shipment costs from the Red Dog Mine.

Existing shipments of lead/ zinc concentrate from Red Dog are made by using a tug and barge fleet to transfer concentrate from the existing port (Portsite) to deep draft vessels docked offshore. After the DMTP is completed, deep draft vessels will dock at Portsite and be loaded from a conveyor system. Two barges and two tug boats will no longer be needed, resulting in a savings of $10,788,296 per year averaged over the project’s 50-year time horizon. The change in shipment mode is also expected to reduce the amount of lead/ zinc concentrate spills.

(2) Reduced port delay and queue costs associated with Red Dog operations.

The existing system of shipping lead/ zinc concentrate results in a number of delays caused by weather, capacity constraints, and shipment timing. The DMTP will eliminate some of these delays, resulting in an additional concentrate shipment savings of $3,333,190 per year averaged over the project’s 50-year time horizon.
(3) Additional lead/zinc concentrate shipments from the Red Dog Mine.

Red Dog Mine faces a capacity constraint in terms of how many tons of lead/zinc concentrate it can ship each season from the existing facilities. The DMTP will increase that capacity, enabling Red Dog to ship up to 23,481 additional tons per year. This will generate an economic benefit to Red Dog of $1,707,854 per year averaged over the project’s 50-year time horizon.

(4) Reduced fuel costs to the mine and regional villages.

The DMTP may allow the Delong Mountain Terminal to be used as a regional distribution center for fuel oil. If this center is established, villages may benefit from reduced fuel delivery costs. Cost savings are expected to be roughly $0.21 cents per gallon of diesel fuel delivered. The bulk of these savings will result from purchasing fuel oil from Singapore rather than from suppliers in Puget Sound and the Kenai Peninsula. Red Dog Mine is also expected to benefit from reduced fuel costs. Combined, the project is expected to generate $11,002,364 in reduced fuel costs per year with $5,983,500 accruing to area villages and $5,018,964 to the Red Dog Mine.

(5) Avoided costs for Portsite operations.

The DMTP will lower labor costs at Portsite, generating additional savings to Red Dog of $66,890 per year, averaged over the project’s 50-year time horizon.

Taken together, annual benefits averaged over the project’s 50-year time horizon are expected to be $26,898,700. Expected costs, including construction of navigation features and Portsite facilities, planning, interest charges, and maintenance dredging are expected to total approximately $230,419,771 million. This translates into an annualized cost of $22,339,308 spread out over the project’s 50-year time frame. Annualized net benefits are expected to be $4,559,392, resulting in a positive benefit-cost ratio of 1.20 to 1.

In August of 2006, Center for Sustainable Economy (CSE) initiated a review of the DIFR and DEIS in order to update our 2003 critique and independent assessment. Our findings are reported here. The first part of our assessment focuses on the extent to which the Corps analysis conforms to generally accepted methods of benefit-cost analysis as well as additional requirements set forth in Corps regulations governing civil works projects. We also review the Corps’ compliance with National Environmental Policy Act (NEPA) requirements with respect to disclosure of economic impacts. In this first stage, we uncovered several shortcomings of the Corps’ benefit cost analysis (BCA) that cause estimates of net project benefits to be significantly overstated and that otherwise invalidate the DIFR and DEIS as a basis for sound decision making. These include:

- The Corps failed to establish federal interest in the project since it is likely that all project benefits will accrue to a private entity – Teck-Cominco.

- The Corps failed to properly incorporate the BCA into the DEIS by failing to discuss and disclose other social and economic effects that may have bearing on the project’s justification.
• The DEIS fails to properly identify and evaluate cumulative economic effects associated with past, present, and reasonably foreseeable future activities affecting the same resources as those impacted by the DMTP.

• The Corps failed to apply compound interest rates to project costs incurred before 2011, the base year for the BCA.

• The Corps’ BCA is based on the assumption that the Red Dog Mine will continue operations through the end of 2041. However, information from Teck-Cominco, the mine’s owner, suggests otherwise. According to Teck-Cominco, operations are expected to terminate in 2029 at the latest.

• The BCA assumes regional diesel fuel prices remaining near $1.40 per gallon for fuel used in marine operations, by the mine, and by regional villages for home heating and electrical generation. The DIFR relies on price data available before 2003. Fuel prices have increased nearly 92% since that time, and the effects are now predicted to be permanent. As such, the Corps’ estimates for future fuel prices are at least one-half to one-third of the Energy Information Administration’s current fuel price projections.

• The Corps’ BCA fails to incorporate uncertainty into estimates of fuel delivery savings. For fuel delivery savings to occur, several unlikely events must coincide, including the establishment of a fuel distribution center at Port site by an unknown entity, favorable international prices, and an institutional arrangement which insures that delivered fuel oil cost savings will be passed on to end users.

• The BCA fails to incorporate several categories of costs. The most significant omitted cost is the reduction in economic activity caused by the substitution of Singapore fuel oil purchases for purchases now made in the United States. Other significant cost omissions include increased marine pollution, carbon emissions damage, loss of passive use values associated with the loss or degradation of nearly 7,000 acres of intact marine ecosystems, and costs generated by adverse changes in subsistence use patterns.

• The BCA fails to consider renewable energy investments as an alternative way to reduce energy costs in the northwest arctic region. Wind energy, solar, and biodiesel have emerged as reliable, preferable, and sustainable sources of energy in the region that can be delivered at a savings to end users. As such, the Corps has an obligation to consider the opportunity costs associated with investing in the DMTP instead of renewables. The BCA fails to consider these opportunity costs.

In the second stage of our assessment, CSE estimated how the BCA might change if these shortcomings were properly addressed. We recalculated the benefit-cost ratio stream by correctly compounding project costs, terminating project benefits accruing to the mine at the end of year 2029, using more realistic fuel price data, and discounting fuel delivery savings to reflect uncertainty.
We also recalculated the benefit-cost ratio by incorporating cost estimates for reductions in U.S. economic activity associated with the substitution of Singapore fuel oil for fuel oil now purchased domestically, increased marine pollution, carbon emissions damage, loss of passive use values, and adverse changes in subsistence use patterns. Our major findings include:

- By correctly compounding project costs, terminating benefits to the mine at 2029, incorporating the latest fuel price data and fuel price projections, and discounting village fuel savings benefits to reflect uncertainty, the benefit-cost ratio falls from 1.2160 to .7317.

- If the DMT is developed as a fuel distribution center, the potential for fuel oil spills will increase as the throughput of oil increases from 23 to 82 million gallons per year. The fuel spill model published in Appendix 10 of the DEIS predicts that on average, the DMTP will increase annual spills by 71 gallons. Although quite small, the 71 expected gallons of fuel spills generate externalized economic costs that can be quantified. We estimate this annualized cost to be $61,529. By adding this figure to total project costs, the benefit-cost ratio falls to .7298.

- By increasing the distance fuel oil is shipped to Portsite, by inducing greater concentrate shipments as well as fuel used by the Red Dog Mine, and by requiring 3 years of fuel-intensive construction and dredging activities, the DMTP will induce a significant increase in carbon emissions over and above the without project scenario. Carbon emissions are a significant source of externalized cost, especially in fragile Arctic regions. We estimate annualized DMTP induced carbon emissions damage to be $1,272,720. Including this figure in the BCA lowers the benefit-cost ratio to .6933.

- To estimate the potential magnitude of non-market costs resulting from the DMTP, we conducted an original contingent valuation survey of Alaska residents. The survey was designed to estimate “passive use” values associated with the loss of marine ecosystems. Our results suggest that households in our sample are willing to pay on average $21.44 per year to protect the marine ecosystems near the DMT, a value that is similar to other estimates reported in the literature. We convert this figure into an annualized value of $5,373,755. Including this cost lowers the benefit-cost ratio to .5724.

- Data gathered from an on site survey of subsistence hunters and fishers in Kivalina implies that the DMTP could result in the substitution of more distant hunting and fishing sites for more preferred sites closer to the village. Kivalina hunters and fishers could spend an additional $251,822 pursuing beluga whales, bearded seals, and Dolly Varden trout at these more distant locations. This converts into an annualized cost of $318,080. Including this cost lowers the benefit cost ratio to .5666.

- The results from a standard input-output model suggest that a 52,214,792 gallon reduction in fuel oil purchases at roughly $1.40 per gallon from U.S. suppliers will cause direct losses of over $72 million in lost labor income and value of output, indirect losses of nearly $16 million, and induced losses of roughly $55 million per year. Taken together, this is an annual cost of $144 million not addressed in any manner by the DIFR.
assuming a 50% likelihood that Portsite would actually be developed as a fuel distribution center and a Red Dog Mine life to 2029 we converted this $144 million figure into an annualized DMTP cost of $61,207,985 in direct, indirect, and induced costs associated with diversion of fuel purchases to Singapore. Including this cost drops the benefit-cost ratio falls to .1911.

Thus, by incorporating these changes, the benefit-cost ratio for the DMTP may be as low as .1911. In other words, costs may exceed benefits by more than a factor of 5. According to Corps regulatory guidance as well as general principles of benefit-cost analysis, federal participation in civil works project such as the DMTP is warranted only in situations where the benefit-cost ratio exceeds 1.0. The modifications suggested in the context of this report imply a benefit-cost ratio far below this threshold.

Because the revised benefit and cost figures we present are simply ballpark estimates of what the Corps may find should it investigate factors excluded from consideration in the DIFR in a rigorous manner, they are clearly subject to debate. Different assumptions, methods, and sources of information may yield considerably different results. However, there is little doubt that the types of modifications we suggest are strongly recommended if not explicitly required by the Corps own guidance for evaluating the contribution of civil works projects to national economic development. Thus, what is important is not the precise figures we report, but the types of modifications to the BCA we recommend.

The remainder of this report is organized as follows. In Section 1, we review some of the essential elements of benefit-cost analysis that must be addressed by all federal agencies when evaluating the economic feasibility of public investments. In Section 2, we present additional components of benefit-cost analysis required by the Corps national economic development analysis procedures and relevant requirements of NEPA. Sections 1 and 2 provide a yardstick for the critique of the DIFR and DEIS we present in Section 3. Section 3 also contains a reanalysis of the benefit stream to account for computational errors, reduced Red Dog Mine life, more realistic fuel price projections, and uncertainty in village fuel savings.

In Section 4, we present rough estimates of additional DMTP costs omitted from the Corps BCA including costs associated with the substitution of Singapore fuel oil for fuel oil now purchased domestically, increased marine pollution, carbon emissions, loss of passive use values, and adverse changes in subsistence use patterns. In Section 5, we present revised estimates of the benefit-cost ratio after incorporating the suggested modifications set forth in Sections 3 and 4. Section 5 also includes recommendations to the Corps for issues to address as final versions of the Feasibility Study and Environmental Impact Statement are prepared.
Like many federal agencies, the Corps relies on benefit-cost analysis (BCA) to inform its decision making process. This section provides a brief overview of some of the essential elements of BCA that must be addressed by all federal agencies when evaluating the economic feasibility of their project decisions. In Section 2, we review additional direction provided by the Corps own regulations and guidance manuals. Section 3 is a critique of the DMTP’s BCA based on the requirements reviewed in both Section 1 and Section 2.

BCA helps to determine whether a project can be justified on economic principles. The aim of BCA is to determine net present value (NPV), or net discounted benefits minus net discounted costs. This is done by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Office of Management and Budget (OMB) Circular A-94 has been the standard by which all federal agencies’ BCAs have been evaluated, and suggests the ultimate objective of BCA: “[p]rograms with positive net present value increase social resources and are generally preferred. Programs with negative net present value should generally be avoided.”

BCA can be performed before the project commences (ex-ante) in order to determine whether the project merits the allocation of resources, while the project is in progress (in medias res) to determine whether to continue or after the project has been finished (ex-post) to verify assumptions.

Boardman et al. (1996) suggest a basic format for completing a BCA:

1) Decide whose benefits and costs count.
2) Select the portfolio of alternative projects.
3) Catalogue, predict and monetize impacts.
4) Discount or compound benefits and costs to find present values.
5) Address uncertainty and perform sensitivity analysis.

The following sections look at each of these steps in more detail.

1.1: Decide whose benefits and costs count.

Any major civil works project generates a stream of benefits and costs that are enjoyed or incurred by a variety of businesses, groups, or individuals. For example, in the case of a bridge project, the beneficiaries may include taxi drivers, commuters, bicyclists seeking alternative

---

4 Office of Management and Budget. Circular A-94 at 3. The essential steps outlined by A-94 have been incorporated into the Corps internal guidance for national economic development analysis reviewed in Section 2.
ways to reach their destinations, and birdwatchers whose favorite hawks decide to nest on the pilings. The losers could include ferry operators whose traffic may be diverted to cars, recreational boaters, and individuals living near the bridge terminus who could be adversely affected by noise and atmospheric pollution due to increased car traffic. Any of these individuals might live within or beyond the boundaries of the municipality responsible for the construction and operation of the project. The George Washington Bridge connecting New York and New Jersey is operated by a joint authority, but drivers from Washington D.C., five hours south, receive benefits from the bridge daily.

Historically, many large federal projects have ignored important segments of society in conducting BCA, such as those who may live far away from a project area but who place intrinsic values on protecting species that may be extirpated or otherwise adversely affected. Brent (1996, 4) suggests that for a social BCA, which would include any project under the purview of the federal government, “all benefits and costs are to be included, consisting of private and social, direct and indirect, tangible and intangible (Italics original).” Brent explains that “[b]enefits are based on the consumer’s willingness to pay for the project. Costs are what the losers are willing to receive as compensation for giving up the resources.”

However, deciding exactly whose costs and whose benefits matter is an issue of considerable importance. Hanley and Spash (1993, 10) suggest some criteria. The benefits or costs should “(i) cause at least one person in the relevant population to become more or less happy; and/or (ii) change the level of quality or the output of some positively valued commodity.” While this clears matters up somewhat, it still leaves it in the hands of the analyst to determine the “relevant population.” Or more accurately, it leaves it in the hands of the government.

Benefits and costs of federal projects are not shared equally, but, instead, are distributed unevenly between various segments of society. When distributional inequities are significant, they must be addressed in the context of BCA. Distributional effects may be analyzed by grouping individuals or households according to income class, geographic region, or demographic group. Other classifications, such as by industry or occupation, may also be appropriate. Such analyses should aim at identifying the relevant winners and losers from project decisions. Thus, looking at a proposed project from the standpoint of distributional equity helps refine a list of whose benefits and costs should be counted.

Effects on the pre-existing structure of property rights are also critical to consider. For example, if a project causes an increase in air and water pollution in a surrounding community, and property rights have been defined in such a way as to give the community a right to the existing level of air and water quality, then the added pollution represents a liability for the project beneficiaries. BCA must be cognizant of such liabilities, if they are present.

Another way to ascertain whose benefits and costs count is to clearly state a policy rationale explaining why the project is being proposed in the first place. This helps to establish the range of benefits and costs that must be incorporated into the analysis. From an economic standpoint, it is important to state precisely the nature of the welfare improvement expected to result from the project, such as a decrease in unemployed resources, an improvement in efficiency, or a
reduction in costs for the government’s internal operations. Stating this precisely facilitates objective economic analysis and helps identify whose benefits and costs are important to consider.

For government-sponsored projects with environmental impact, the policy rationale requirement is also found in the National Environmental Policy Act (NEPA), which requires a “Purpose and Need” section in an environmental impact statement: “[t]he statement shall briefly specify the underlying purpose and need to which the agency is responding.”

1.2: Select the portfolio of alternative projects.

A thorough BCA should consider a “portfolio of alternatives” for providing the intended level of goods and services. The alternatives should vary with respect to scale, methods of provision, and different degrees of federal involvement. At the very least, the planner should consider benefits and costs under two scenarios, with the project and without. Under more sophisticated situations, however, there may be many options.

For example, if the project goal is to accommodate a more efficient flow of barge traffic in a given river, there may be more than one way of achieving that end, including additional locks, reducing demand through efficient taxes, or better traffic management scheduling, including tolls.

1.3: Catalogue, predict, and monetize impacts.

Identifying all relevant benefits and costs lies at the heart of the BCA process. This subsection involves three steps: (a) cataloging potential (physical) impacts and selecting measurement indicators; (b) predicting quantitative impacts over the life of the project; and (c) assigning monetary values to all impacts. These three steps are fairly involved. The first requires a general outline of what the project is expected to provide, and what the drawbacks might be. The second requires an explicit quantitative summary of what those benefits and drawbacks would be, and the third calls for assigning dollar values to these, whenever possible.

For a port expansion project, a schedule of benefits, generically, may include increased access for larger vessels, greater potential for output by certain industries involved in shipping their products, lower transportation costs from decreased use of barges to move materials, and job creation from the project in the short and long run. A cost schedule may include losses to competing local producers not included in the port scheme as the construction may be subsidized, losses to producers making substitutes for the materials to be shipped, wildlife losses from dredging and harbor construction and losses to indigenous groups from damage to subsistence use areas.

Once schedules of expected benefits and costs are compiled, they need to be formalized and quantified as precisely as possible so that the subsequent BCA narrative would read something like “seven hundred more stevedores will be hired over a fifteen year period at $40/ hour,” or

5 Id. at 5.
6 40 C.F.R. § 1502.13.
local Seminole groups will face a subsistence loss of $300/month per individual from disruption of fish migration due to the construction of the locks.”

In terms of assigning monetary values to benefits and costs, the first example is relatively clear. Jobs pay a certain market wage, which can be readily obtained for different parts of the country. However, for non-marketed effects such as “subsistence loss,” how do economists decide how much hunted food is worth? It does not have a market value. Bass caught or deer shot might involve measurable costs for tackle or ammunition, but for many groups, a subsistence lifestyle cannot be valued simply in terms of those expenditures.

Clearly, BCA must address the economic impacts to both marketed and non-marketed goods, services, uses and values. For example, guidelines for analyzing federal infrastructure investments contain 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.”

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 transfers, and replacement cost techniques. These are all widely accepted, peer-reviewed methods.

The travel cost method (TCM) and its variants such as the random utility model (RUM) use information on travel cost expenditures and recreational site choice to statistically estimate the demand for recreation, hunting, or fishing sites, and from there to infer values for various changes in access or environmental quality. Contingent valuation (CV) is a survey-based research method that seeks to elicit individuals’ (or households’) willingness to pay or willingness to accept compensation for a particular change in environmental amenities, either positive or negative. These amenities do not have a formal market, or the current market may not capture all available benefits or costs. Contingent valuation is frequently used to determine a household or individual’s willingness to pay to protect an endangered species or ecosystem, either locally or nationally.

CV is also used to elicit “nonuse” or “passive use” values that by definition have no discernible trail to market behavior (Carson et al., 1999). Perhaps the archetypal nonuse value is existence value, which is argued to arise from “simply knowing that some desirable thing or state of affairs exists” (Randall, 1991). To use an example, people often pay money to join an organization such as the Nature Conservancy, which protects lands they may never even see. Another example of a nonuse value is option value. Specifically, individuals may hold an option value for an environmental good or service even though they currently do not make use of the good or service. Instead, they value the option of potential future use (Freeman, 1993).

---

Carson et al., 1999. Principles for Federal Infrastructure Investments, Executive Order 12893 at Section 2(a)1.
Hedonic pricing (HP) studies use property values to determine homeowners’ willingness to pay for proximity to environmental amenities, such as open space or water, or the value of certain environmental qualities, such as clean air. HP can also be used to quantify negative economic values associated with living near disamenities such as landfills, airports, freeways, or toxic waste dumps (O’Byrne et al., 1985). The concept, simply stated, is that given a certain bundle of qualities, including distance from either a landfill or a pristine lake (or air quality in one neighborhood versus another) property values should vary consistently with proximity to these disamenities or amenities.

Benefits transfer is a technique that locates values estimated by studies in other, similar areas, and applies them to the analysis at hand by using certain calibration factors. For instance, a hedonic survey in a forested area of Minnesota would provide certain metrics for ascertaining property values relative to their distance from lakes. Should a planner determine that the landforms and property types were relatively similar in upstate New York or Ontario, they could use the same relationships without actually conducting a second survey. Benefits transfer is inexpensive relative to other approaches, though not always as accurate, for obvious reasons.

Replacement cost is a rather straightforward approach that asks what it would cost to find substitutes for the commodity or land use that is displaced, or to restore damaged ecosystems. For example, the World Bank and the State of Alaska both use similar methods to estimate the economic impact of adverse changes to subsistence fisheries (ADFG, 1998). The replacement value is proxied by the value of acceptable substitutes for the traditionally harvested product. For instance, some traditional Pacific Islanders no longer catch certain types of fish, due to pressure from commercial users. They have changed their diet to include tinned mutton, which has a certain market value. The loss of the traditional fish is estimated by using the value of the protein replacement from the substitute. In Alaska, there is a relatively well-developed market for wild fish and game, and the State has assigned a range of values to subsistence catch based on the replacement cost method. The State estimates a replacement cost of $5-$8 per pound. With these figures, the State can estimate the economic value of any changes to subsistence harvest.

The objective of all market and non-market valuation techniques is to determine the change in what is known as “consumer surplus” associated with a change in environmental quality. Consumer surplus is the amount beyond the price or social cost that a consumer would be willing to pay for a particular level of environmental quality. Figure 1 provides a simple example.

Assume that the environmental good in question here is the number of hunting and fishing sites made available in a particular watershed managed by a government agency. As more land is devoted to such uses, the cost of provision increases at the margin so the supply curve is upward sloping. Costs include the cost of managing and maintaining sites, but also include the forgone uses such as mining or timber extraction that are sacrificed to accommodate increased numbers of recreational users. Demand decreases with price, since people will demand fewer hunting and fishing sites as the social cost of providing those sites increases.

In Figure one, the most efficient amount of hunting and fishing sites made available is at Q*, where demand and supply meet. At this point, consumer surplus is measured by the area under the demand curve above the social cost line denoted by P*.
Now assume that there is a significant deterioration of environmental quality. Assume, for example, that fugitive dust emissions from a nearby mine increase the costs of maintaining pure drinking water and quality fish habitat at each of the watershed’s recreation sites. At each level of provision, then, the overall costs of maintaining recreation sites increases, and this is reflected in an upward shift of the supply curve to Supply’. A new balance between demand and supply at the higher cost schedule is indicated by points Q** and P**. At this new equilibrium, prices are higher and fewer recreation sites are maintained. Hunters and fishers lose the consumer surplus they enjoyed with more sites to choose from and lower costs per site. The loss of consumer surplus is indicated on the graph, and this loss is what economists refer to as the welfare loss associated with an adverse change in environmental quality. Travel cost, contingent valuation, hedonic pricing, benefits transfer, and replacement cost are various techniques employed to measure this welfare change.

FIGURE 1: CONSUMER SURPLUS LOSS

This concept of consumers’ surplus is essential to welfare economics, as it places value on utility (an economic term that translates roughly as “happiness” or “satisfaction”) that the consumer receives, which is generally not a concern of a private firm. However, in the evaluation of government (public) projects, the concept goes back as far as Dupuit in 1844 or even Gallatin in 1808. If the price (or social cost) exceeds what the consumer would be willing to pay then the WTP is negative, and described as a willingness to accept compensation (WTA). A person in this situation is a net loser from the project, and their loss must be counted as a cost.

For example, if the total social cost of a bridge project includes the extirpation of a species of fish, some commuters may not consider that cost worth the reduced commutation time. They would place a value on the existence of that fish that exceeds the benefits from the bridge. Theoretically, they could be compensated monetarily for the loss of the fish. The amount that they would require to compensate them for this loss is their WTA.
This overall social framework allows the analyst to look at the project socially, and not from the same point of view as a private firm would in making a decision. Economic theory tells us that the firm’s objective is to maximize profit, whereas the social planner’s objective is to maximize net social welfare, which is total social benefits minus total social costs.

1.4: Discount or compound benefits and costs to find present values.

Recognizing that benefits and costs are worth more if they are experienced sooner, BCA involves discounting future benefits and costs in order to determine net present value (NPV). Discount rates applied to future benefits and costs can be “real” (adjusted to eliminate the effects of inflation) or “nominal,” based on non-adjusted market interest rates. If the distribution of benefits and costs is unequal over time, incorporating inflation is essential for evaluating the real economic impacts of a project. If benefits and costs are incurred simultaneously, then it does not matter if a real or nominal rate is chosen as long as it is consistently applied.

The “discount rate” is, at an individual level, a measure of the value one places on the future. A lower discount rate indicates a preference for longer-term investments and for the future vs. today. A high discount rate tends to indicate a preference for receiving benefits now, rather than later. Importantly, the discount rate reflects the value of the project at various points in time. While this makes sense analytically, a 1990 survey found that in a sample of 90 U.S. municipalities with populations over 100,000, only 43% used discounting in evaluating projects (Zerbe and Dively, 1990).

To illustrate how a project’s economic feasibility is influenced by discounting, consider the following example. Suppose a water purification plant produces $100 of benefits per year, and that the plant was built in 2000. To assess the total benefit of the plant over time, the analyst assumes that $100 in 2020 is worth a different amount than in 2000.

To derive the present value of the plant, one must assume a discount rate $r$, and then put that into the normal formula for discounting, which is to sum over all years the initial value $V$ divided by 1 plus the discount rate all raised to the $t^{th}$ power, with $t$ being the year of operation. That looks like this: $V/ (1+r)^t$. In the first year, there is no discounting, and the project yields $100 of benefits. In the second year, it yields $100/ (1+r)$. Let us assume the discount rate is 3 percent, which is roughly the rate on Federal 30-year bonds, and a good estimate of what we will refer to as the “social” discount rate. This rate reflects the government’s cost of borrowing, which is considerably lower than the rate a private firm would face. We will discuss this later.

So, the discounting would look like this, if we assume a five-year operation:

$$ \text{PV} = 100 + \frac{100}{(1+.03)} + \frac{100}{(1+.03)^2} + \frac{100}{(1+.03)^3} + \frac{100}{(1+.03)^4} $$

Or, $100 + 97.09 + 94.26 + 91.51 + 88.85 = $471.71
Thus, $471.71 is the present value of the project if it were to operate for five years. Without discounting, the plant would yield $500 in benefits. This, of course, is assuming there are no costs. The cost discounting would look the same, but with the value of costs in the numerator.

The final step in discounting involves subtracting net discounted costs from net discounted benefits to determine net present value or NPV. Some have tried to infer a decision rule from the BCA – take the project with the highest NPV. While this has merits, such a basis is not sufficiently comprehensive to form a decision rule. The BCA, however, can inform the decision-making process by eliminating projects with negative NPVs and by indicating those projects with high NPVs. Further, by forcing the enumeration of all benefits and costs, BCA requires the analyst to specify all attributes of the project.

The formula for net present value is:

\[
\text{NPV} = \sum_{t=0}^{\infty} \frac{B_t}{(1 - i)^t} - \sum_{t=0}^{\infty} \frac{C_t}{(1 - i)^t}
\]

With \( B_t \) representing benefits and \( C_t \) representing costs, both discounted over time.

In some projects, including those financed by the Corps, project planners do not evaluate benefits and costs from the present year. Instead, a base year is chosen some time in the future. In those cases, benefits or costs incurred in the years prior to the base year must be “moved forward” to the base year by adding compound interest.8 The technique involves inverting the multipliers in equation [1], adding rather than subtracting interest, and counting the time variable in reverse. Thus, if the Corps decided that a project’s base year should be 2010, all benefits and costs before then should be evaluated as such:

\[
\text{NPV} = \sum_{t=3}^{\infty} B_t (1 + i)^t - \sum_{t=3}^{\infty} C_t (1 + i)^t
\]

In equation [2], the year 2007 has a value of \( t=3 \), 2008 \( t=2 \), etc. Benefits and costs incurred after the base year are discounted as before.

In both discounting and compounding, there is the issue of selecting an appropriate discount rate. Analysts speak of “market” and “social” discount rates. As stated above, the rate the government uses is normally lower than the rate industry would use. This raises a debate over choice of the proper rate. Plainly, a higher discount rate would yield a lower NPV for the above project. Page (1977) observed that if the U.S. Army Corps of Engineers had raised their discount rate from 2.5% to 8.5%, it would have “killed off 80 percent of the dam projects approved in 1962.” If we assume that a project is to yield positive social benefits, including non-market values mentioned in the previous section, then it might make sense to use the social rate. However, if the benefits were to accrue to a single or a few firms, then the market rate might make more sense, as it reflects the opportunity costs faced by private firms, even if the project is undertaken by a federal agency (Hartwick and Olewiler, 1998).

8 ER 1105-2-100 Appendix D, Amendment #1, June 30th, 2005.
1.5: Address uncertainty and perform sensitivity analysis.

The estimation of benefit and cost streams in a project’s future is bound to be somewhat imprecise. Production of a resource can change, industry might be required to change production methods, demands may change, regulations may change, or prices of inputs may force industry to substitute away from current inputs. Additionally, modeling methods may result in inaccurate forecasts. All of these sources of uncertainty need to be explicitly analyzed and reported. For example, if studies of past projects of a similar nature have documented tendencies for cost growth beyond initial expectations, analyses should consider whether initial estimates of benefits of costs need to be revised.9

Arrow and Lind (1970) point out that there are at least three main points of view on risk and uncertainty:

1) Risk should be treated identically in the private and public sectors. The argument for this is that by treating risk differently for public sector evaluation, we run the risk of over investing in low-return government projects at the expense of higher-return, but riskier private-sector projects.

2) The government is better equipped to deal with risk than private investors as they tend to invest in many projects and can pool risk. Therefore the government should ignore uncertainty and behave as if indifferent to risk, using the market discount rate.

3) The government should set discounting policy and not be bound at all by market rates, but should determine their own public rate.

One way of addressing uncertainty is to calculate “expected value estimates.” These can be defined as a sum of possible outcomes weighted by their probabilities (Brent, 1996). For instance, if the best data predict that a mine will produce fifty thousand tons with a probability of 73%, and those fifty thousand tons are worth $100, the expected value of the output is (.73) * $100 = $73.00. Uncertainty can also be addressed by including best and worst-case scenarios, or upper and lower bounds for certain estimates. Another method is “sensitivity analysis.” This consists of recomputing outcomes to determine how sensitive they are to changes in assumptions.

Another method is to calculate “expected utility estimates” (Brent, 1996). This is similar to the above technique but uses utility estimates derived from econometric estimates of social utility functions. This concept relies on the standard economic theory that utility functions can be calculated. This utility data can be gathered from experimental or survey data. As Brent points out, a socially optimal outcome requires that utility, not income, be maximized. If there is a simple, proportional relationship between the two, then one could simply perform an expected value estimate.

Boardman et al. (1996) discuss using partial sensitivity analysis as one approach, which involves changing one parameter while holding others constant. This could include a best and worst-case scenario for each variable, or a range of scenarios for a single variable. For instance, one could

---

9 Office of Management and Budget, Circular A-94 at 12.
graph net benefit (or loss) from each value on the vertical axis against outcomes on the horizontal. The example used in their text is to map the benefits derived from a water storage facility against inches of summer rainfall. They provide two distributions, one a 45-degree line and one a negatively curved line. Depending on the probabilities associated with each distribution, the project’s values can be measured. This type of scenario modeling can be repeated with several variables to arrive at an NPV.

Another method they discuss is the Monte Carlo simulation, which assigns a probability distribution to each variable, draws random probabilities for each variable in several simulations, and then calculates the NPV based on those draws. Given this final fine-tuning of the NPV calculations to incorporate uncertainty, the analyst will be able to recommend the project with the highest NPV.

With this brief overview of standard BCA in hand, we can now explore additional requirements applicable to Corps navigation projects in more detail. These requirements set forth what the Corps must do to lay the groundwork for conducting a formal benefit-cost analysis.

Section 1 References


Section 2: National Economic Development Analysis

U.S. Army Corps of Engineers (Corps) civil works projects are justified on the basis of their contributions to national economic development (NED). 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” (WRC, 1983, 1).

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 (IWR, 1991a, 1). 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. As such, NED analysis and the standard benefit cost analysis described in Section 1 one work together. This section reviews some important features of NED analysis that have bearing on the economic feasibility of the Delong Mountain Terminal Project.

This section also reviews how NED analysis must be incorporated into environmental impact statements the Corps prepares to comply with the National Environmental Policy Act (NEPA). Properly incorporating NED analysis into NEPA documents requires some supplemental analyses to insure that costs and benefits omitted by NED procedures are accounted for and that Corps decisions are not skewed by such omissions. In addition, we review NEPA requirements with respect to cumulative economic effects – effects that are beyond the scope of NED analysis but which may have a significant bearing on a project’s feasibility.

2.1: Determining the federal interest.

One critical component of NED analysis is to ensure that federal navigation projects are in the general public interest and accessible and available to all on equal terms (USACE, 1999, 12-1). Indeed, prior to initiating a feasibility study for any water resources project, the Corps is required to make an affirmative finding that the project is in the federal interest.10

---

Corps regulations prohibit federal involvement in projects that primarily benefit single users or which primarily benefit land development schemes, waterway cargo transfer and lightering activities, or barge fleeting areas (Id.). The Corps has been directed not to recommend any federal cost participation in construction or expansion of a federal navigation project where the improvement would serve, for the foreseeable future, only property served by a single individual, commercial/business enterprise, or corporation (Id., 12-7).

There are limited exceptions to this rule. For example, if there is a “reasonable prospect” that the improvement would later serve multiple properties with multiple owners, the Corps may consider involvement, however, the test for reasonable prospect involves a rather extensive set of factors (Id., 12-8). These include: (a) availability, ownership, and suitability of adjacent waterfront land for development and location by other industries and users; (b) availability of land transport and other essential services; (c) the area’s economic potential; (d) intent of land owner and/or the potential developer, and (e) whether or not there are restrictive conditions in place that would prohibit the proposed improvement from serving/benefiting two or more single owner properties (and property owners) in the foreseeable future.

2.2: “With and without” framework.

To insure that Corps water resources projects contribute net economic benefits to the nation, NED analysis must be conducted in what is known as a “with and without” framework. This framework requires that the Corps address NED impacts 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” (IWR, 1991a, 52). 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” (WRC, 1983, 59). 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 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.11

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 (WRC, 1983, 4).

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 (WRC, 1983, v). If the without-project scenario maximizes NED benefits, than the Corps may not recommend federal involvement.

2.3: Non-structural alternatives.

A critical component of NED analysis for projects that require new infrastructure is the careful consideration of non-structural measures that can accomplish the same goals and objectives with lower environmental, economic, and social costs. Non-structural measures are complete or partial alternatives to traditional structural measures, and include modifications in public policy, management practice, regulatory policy, and pricing policy (WRC, 1983, 7). For navigation projects, non-structural alternatives include reasonably expected changes in management and use of existing vessels and facilities on land and water, such as changes in lightering, tug assistance, use of favorable tides, split deliveries, topping-off, alternative modes and ports, and transshipment facilities (WRC, 1983, 59).

Non-structural measures have been defined broadly to include any measures that can be implemented that result in no change in aquatic ecosystems or watershed hydrology (Shabman and Zepp, 2000, 19). In the without project condition, adoption of “reasonably expected” non-structural measures within the authority and ability of port agencies, other public agencies, and the transportation industry are assumed.

Non-structural measures include measures taken to manage both supply and demand. If demand reduction can be accomplished through some change in management, policy, or pricing, then various ways to reduce demand must be considered as a way to alleviate the need to engage in structural investments.12 Likewise, if a supply side solution exists, it must be considered. For instance, in the context of the Yazoo Backwater project in Mississippi and Alabama, the Environmental Protection Agency (EPA) and others advanced a non-structural alternative to

---

11 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).
flood control that involved reforestation as an alternative to a major new pumping station (EPA, 2000). The idea behind the non-structural alternative requirements is to avoid spending federal money on infrastructure investments when simpler, less costly solutions exist.

### 2.4: Risk and uncertainty.

Navigation projects sponsored 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 (NRC, 2001, 45). 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.” 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 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. Uncertainty permeates navigation planning. 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 (Males, 2002; NRC, 2001). 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 (Boardman, Greenberg et al., 2001, 159). 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 (Males, 2002, ix).

---

14 Ibid.
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 (NRC, 2001, 63-66). 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.

2.5: 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” (IWR, 1991a, 21). 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. 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. 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.

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 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 and metal toxicants, and solid wastes (Ofiara and Seneca, 2001, 92).

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 (IWR,

---

15 See, e.g. Office of Management and Budget, Circular A-94 at 6.
16 Principles for Federal Infrastructure Investments, Executive Order 12893 at Section 2(a)1.
17 Presidential Executive Order on Environmental Justice, Executive Order 12898 at Section 4-401.
1991b, 21). 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.18 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 (Ofiara and Seneca, 2001, 155). 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 a Corps navigation project 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 suggest that it may occur.19 Regardless of whether a worst-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” (Males, 2002, C-9).

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” (NRDC, 2004). By far the greatest source of air pollution related externalities is associated with carbon dioxide emissions. Recently, the Supreme Court heard arguments by Attorney Generals from across the nation arguing for EPA rules to regulate carbon dioxide as a criteria pollutant under section 202 of the Clean Air Act.20 Regardless of the outcome, it is clear that global warming caused by carbon dioxide emissions generates serious economic damage – estimated by one recent study to eventually reduce per capita consumption by 20% (Stern, 2006), a cost of over $9 trillion. As

---

20 See Massachusetts Attorney General website at: www.ago.state.ma.us/sp.cfm?pageid=1234.
such, carbon dioxide emissions damage is an externality that demands consideration in Corps NED analysis.

2.6: Opportunity costs.

Public infrastructure investments usually require resources that could be used to produce other goods or services instead (Boardman, Greenberg et al., 2001, 86). Thus, when the Corps expends funds on navigation projects, it is important to understand the alternatives uses of those public funds to insure that an alternative investment that results in higher NED returns is not overlooked. The costs of forgoing these alternative investments are known as opportunity costs.

For example, a $600 million public investment in a new lock or dam could have been used, instead, to reduce taxes and allow consumers to use that money for purchasing clothing, entertainment, or other consumer goods. The opportunity cost of the lock and dam, then, is the value of the consumer goods that would have been enjoyed had the project not been built (IWR, 1991b, 14). Corps navigation projects only make economic sense in situations where the opportunity costs of proceeding with the project are less than the benefits of proceeding.

Corps NED guidance explicitly requires consideration of opportunity costs, “[a]dverse effects in the NED account are the opportunity costs used in implementing a plan” (WRC, 1983, 8). When markets are efficient, and all benefits and costs are accounted for, opportunity costs are embodied in the market prices for goods and services. In these cases, the Corps need not go beyond use of market prices for assessing the opportunity costs involved with navigation improvements. However, when Corps actions affect non-marketed goods and services, generate externalized costs, result in distortions in the competitive environment, or create other market failures, opportunity costs must be evaluated in a more rigorous manner that accounts for “hidden” costs that typically do not show up in standard project accounts (Boardman, Greenberg et al., 2001, 92).

2.7: Displacement costs.

While navigation improvements may result in increased commodity production and exports from a particular region, through competitive effects, there may be corresponding losses in other U.S. regions that cancel out any real contribution to national economic development. Such losses are known as “displacement costs” or “transfers” of economic activity from one region to another, or from one economic sector to another. In such cases, federal involvement represents a type of market-distorting subsidy that favors some producers at the expense of others.

Some federal subsidies have been shown to contribute nothing at all to national economic development when the actions of competitors who do not receive subsidies are factored in. For example, a study of federal middle income housing programs showed that such programs “add nothing to the stock of housing” because federally subsidized construction is offset by reductions in construction by unsubsidized builders (Murray, 1999).

The Office of Management and Budget clearly requires consideration of displacement costs:
“Analyses should take particular care to identify the extent to which a policy such as a subsidy program promotes substitutes for activities of a similar nature that would occur without the policy. Either displaced activities should be explicitly recorded as costs or only incremental gains should be reported as benefits of the policy.”  

Likewise, the Corps NED guidance recognizes that transfers of economic activity from one U.S. region to another are a zero sum gain:

“In most cases, the project area’s gain is another area’s loss and the two effects represent a transfer of income that cancels out any net change... Corps guidance on navigation project evaluation is to include only net increases in traffic as project benefits” (IWR, 1991a, 35).

Likewise, the Water Resources Council guidance contains clear direction to disclose the “net income losses from plan-induced shifts of economic activity” from one region to another, and to list such transfers of economic activity in national economic development accounts (WRC, 1983, 12).

The Corps’ duty to analyze inter-regional transfers of economic activity must extend beyond a simple commodity for commodity approach and address the important issue of substitutes. In this regard, the Corp must carefully consider how enhancing production of commodities that benefit from its navigation subsidies may damage production and use of substitutes for these commodities, including recycled materials.

To properly demonstrate net NED benefits with full consideration of effects on other U.S. producers as well as producers of substitute commodities, the Corps can apply an interregional or multiregional input-output model where “the economic system is described in terms of interdependent industries and of interrelated regions” (Miernyk, 1965).

2.8: Incorporating NED Analysis into the NEPA Process.

In addition to formal benefit-cost analysis (BCA) required by the WRDA and its implementing regulations 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.

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. 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 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 water resource projects undertaken by the Corp 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 NED analysis but which, none the less, may have significant bearing on a project’s feasibility with those that are included in NED. 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 (WRC, 1983, 8).

- 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 (WRC, 1983, 11).

- 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 (WRC, 1983, 10).

- 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 (WRC, 1983, 12).

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.)” (WRC, 1983, 8). 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 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.

2.9: Cumulative economic effects.

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.” 40 CFR § 1508.25(a).

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. 40 CFR § 1508.25(c). The CEQ regulations define “effects” as being synonymous with “impacts.” 40 CFR § 1508.8. Direct effects are those caused by the action which occur at the same time and place. Indirect effects are those caused by the action which are later in time or farther removed in distance, but are still reasonably foreseeable. Id.

Indirect effects include the “growth inducing” effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and natural systems, including ecosystems. Id. 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. 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).

Pursuant to 40 C.F.R. §1508.25(c)(3), an environmental impact statement must consider a proposed project's "cumulative impact." 40 C.F.R. §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.” Id.

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. 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). 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.” See Society Hill Towers Owners’ v. Rendell, 20 F. Supp. 855 (E.D. Pa. 1998) (citing HUD regulations).

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.” 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 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).

Given these requirements, it is clear that any discussion of economic impacts associated with the DMTP must consider not only the direct costs and benefits of the projects, but include a meaningful analysis of any additional costs and benefits associated with past, present, and reasonably foreseeable actions.

This concludes our brief review of essential components of benefit-cost analysis applicable to the DMTP as well as procedures for incorporating benefit-cost analysis into the National Environmental Policy Act process. In Sections 3 and 4, we evaluate how well the Corps BCA and DEIS comply with these standards. ▲

Section 2 References


Section 3: 
Critique of the Corps 
Benefit Cost Analysis for the DMTP

In this section, we critique the Corps’ draft benefit cost analysis (BCA) supporting the Delong Mountain Terminal Project proposal presented in the following documents:

- Draft Interim Feasibility Report (DIFR).
- Economic Analysis supporting the Draft Interim Feasibility Report (Appendix E).
- Draft Environmental Impact Statement (DEIS).

In the context of these documents, the Corps has developed a preferred alternative (or National Economic Development Plan) that calls for the following features to be constructed at Portsite and offshore: (a) construction of a 1,450-foot trestle with ore conveyor, fuel line, road, and communications lines; (b) construction of a 27,000 square foot loading platform; (c) up to 3.5 acres of wetland fill for a new generator site and other shoreline infrastructure; (d) a dredged channel and turning basin affecting up to 430 acres of ocean floor, and (e) a 5,600-acre offshore dredged material disposal area. According to these drafts, there will be five major DMTP benefits:

1. Reduced lead/zinc concentrate shipment costs from the Red Dog Mine.

Existing shipments of lead/zinc concentrate from Red Dog are made by using a tug and barge fleet to transfer concentrate from the existing port (Portsite) to deep draft vessels docked offshore. After the DMTP is completed, deep draft vessels will dock at Portsite and be loaded from a conveyor system. Two barges and two tug boats will no longer be needed, resulting in a savings of $10,788,300 per year averaged over the project’s 50-year time horizon. The change in shipment mode is also expected to reduce the amount of lead/zinc concentrate spills.

2. Reduced port delay and queue costs associated with Red Dog operations.

The existing system of shipping lead/zinc concentrate results in a number of delays caused by weather, capacity constraints, and shipment timing. The DMTP will eliminate some of these delays, resulting in an additional concentrate shipment savings of $3,333,200 per year averaged over the project’s 50-year time horizon.

3. Additional lead/zinc concentrate shipments from the Red Dog mine.

Red Dog Mine faces a capacity constraint in terms of how many tons of lead/zinc concentrate it can ship each season from the existing facilities. The DMTP will increase that capacity, enabling Red Dog to ship up to 23,481 additional tons per year. This will generate an economic benefit to Red Dog of $1,707,900 per year averaged over the project’s 50-year time horizon.
(4) **Reduced fuel costs to the mine and regional villages.**

The DMTP may allow the Delong Mountain Terminal to be used as a regional distribution center for fuel oil. If this center is established, villages may benefit from reduced fuel delivery costs. Cost savings are expected to be roughly $0.21 cents per gallon of diesel fuel delivered. The bulk of these savings will result from purchasing fuel oil from Singapore rather than from suppliers in Puget Sound and the Kenai Peninsula. Red Dog Mine is also expected to benefit from reduced fuel costs. Combined, the project is expected to generate $11,002,364 in reduced fuel costs per year with $5,983,500 accruing to area villages and $5,018,964 to the Red Dog Mine.

(5) **Avoided costs for Portsite operations.**

The DMTP will lower labor costs at Portsite, generating additional savings to Red Dog of $66,900 per year, averaged over the project’s 50-year time horizon.

Taken together, annual benefits averaged over the project’s 50-year time horizon are expected to be $26,898,700. Expected costs, including construction of navigation features and Portsite facilities, planning, interest charges, and maintenance dredging are expected to total approximately $230,419,771 million. This translates into an annualized cost of $22,339,308 spread out over the project’s 50-year time frame. Annualized net benefits are expected to be $4,559,392, resulting in a positive benefit-cost ratio of 1.20 to 1.

In the sections that follow, we compare how the Corps went about arriving at these figures and other justifications for the project in terms of the framework for BCA and NED analysis set forth in Sections 1 and 2. In portions of this chapter, we recalculate some benefit and cost figures. These recalcifications as well as supplemental cost information developed in Section 4 form the basis of our recalculation of the benefit-cost ratio as a whole presented in Section 5.

### 3.1: Federal interest not established.

The Corps has failed to establish that the DMTP is worthy of federal involvement. As reviewed in Section 2.1, Corps involvement in navigation projects is limited to those projects that are clearly in the public interest. Federal involvement in projects such as the DMTP which primarily benefit a single user and which are primarily designed to improve waterway cargo transfer and lightering activities is specifically barred (ACOE, 1999). As explained in Section 2.1, there are limited exceptions to this rule, but to demonstrate that the DMTP qualifies for such an exemption, a rigorous analysis of federal interest must be completed using the factors identified on page 13. That analysis must demonstrate that a “reasonable prospect exists for the improvement to later serve multiple properties with multiple owners” (ACOE, 1999, 12-8). Neither the DIFR nor the DEIS contains such an analysis.

There is no doubt that the DMTP will primarily benefit a single user. The DMT portsite is used exclusively by Teck-Cominco Alaska (TCAK) operator of the Red-Dog mine, and all but one of

---

22 In addition, the Rivers and Harbors Act of 1920 directs the Corps to describe the “special or local benefit” as well as the “general or national benefit” of all proposed improvements.
the project benefits is designed to improve the efficiency of Red Dog Mine operations (Appendix E at 1). Only one benefit – fuel cost savings to villages – has any potential at all to benefit other interests. However, the probability that Alaska Native villages will benefit from development of the DMTP is low. Fuel cost savings have been cited as a potential benefit from development of the DMT ever since the Red Dog Mine first opened, and has been presented to Alaska Natives as a reason to support the DMTP ever since it was first proposed over a decade ago (EPA, 1984, V-32); (USACE, 2001).

Despite nearly 22 years of speculation, there remains no interest whatsoever in developing Portsite as a regional fuel distribution center. According to the Corps, there are two major obstacles that prevent Portsite from developing into a fuel hub at this time. The first is limited capacity for docking and loading, which necessitates the disruption of ore loading to handle fuel transshipment. The second is the fact that “at present there is no incentive to do this as there is no storage and redistribution point that can be used for the final leg to the villages” and that “[t]here is no guarantee that a delivery system will materialize” (Appendix E at 112). While implementation of the DMTP may alleviate the first obstacle somewhat, it will do little to alleviate the second major obstacle.

Even if some unknown commercial entity developed a distributorship at Portsite, it is unclear whether they would pass fuel cost savings on to consumers or simply take advantage of the situation to earn additional profits. It the Preliminary Draft EIS for the project, the Corps conceded that there would be “no certainty that distributors would pass savings along to users” (PDEIS at 317). In fact, given the fact that such a distributor would enjoy a monopoly in the region, it is highly unlikely that such savings would be passed on given standard monopolistic tendencies to maintain artificially high prices and to constrict output below the competitive equilibrium.

Another barrier to end users actually enjoying reduced fuel savings is whether or not regional electric utilities would be willing to pass such savings on. In the DMTP study area, Alaska Native villagers rely on diesel-powered generators that are managed and maintained by local electric cooperatives, such as the Alaska Village Electric Cooperative (AVEC). For the Corps to give credence to fuel distribution benefits, it would have to be shown that cooperatives such as AVEC have no other priorities for the extra revenues they may earn if they were able to purchase fuel at lower cost. However, this may be hard to show. It is well known that throughout the Northwest Arctic Borough many of the fuel storage and distribution facilities in the villages are old, in poor condition, and in need of serious upgrades (CH2MHill, 1993). According to University of Alaska researchers, Alaska faces a “huge backlog” of capital improvements for rural electric systems (EIC, 2002, 7). Until the backlog of capital improvements are dealt with, it is unlikely that all or even a significant portion of fuel cost savings would be passed on to end users.

Taken together, these uncertainties cast serious doubt as to whether the DMTP’s claim of fuel cost savings benefits for end users in Northwest Arctic Borough villages is credible at all, let alone credible enough to be the sole justification for federal involvement. Unless such savings can be cast as highly likely, it is unwarranted for the Corps to rely on such benefits to recommend continued federal involvement in the DMTP.
3.2: Failure to properly incorporate NED analysis into the NEPA process.

In Section 2.8, we reviewed regulatory standards for how the Corps must go about incorporating the BCA for the DMPT into the NEPA process. In addition to the plain language of the relevant standards contained in the Council of Environmental Quality (CEQ) regulations and the Corps’ own Water Resource Council (WRC) guidelines, standards can be taken directly from federal case law. Thus, we begin with a brief review of the most relevant cases.

3.2-1: Review of federal case law.

First, as most courts to consider the issue have recognized, while the CEQ Guidelines do not provide a specific definition of “cost-benefit analysis,” they make clear that such an analysis may be informal. See e.g., City of Sausalito v. O’Neill, 386 F.3d 1186 (9th Cir. 2004). As that court recognized, a “cost-benefit analysis” under the CEQ Guidelines consists of “any analysis identifying and assessing the comparative benefits and/or costs of environmentally different alternatives.” Furthermore, courts have routinely found that neither NEPA nor the CEQ regulations require an EIS to contain a formal, mathematically expressed cost-benefit analysis. See, e.g., Oregon Natural Resources Council v. Marsh, 832 F.2d 1489 (9th Cir. 1987); Clinch Coalition v. Damon, 316 F.Supp.2d 364 (W.D.Va. 2004)(refusing to find that the Forest Service’s choice of methodology to determine the non-timber costs and benefits of the proposed project was arbitrary and capricious.).

It should also be noted that courts will not require an agency to consider potential costs of a project which are too speculative or difficult to quantify. See e.g., Citizens Concerned About Jet Noise, Inc. v. Dalton, 48 F.Supp.2d 582 (E.D.Va. 1999)(refusing to require the Navy to quantify the precise economic impact of additional air traffic noise on surrounding property values). Furthermore, the mere fact that certain factors in a cost-benefit analysis are generally imprecise or unquantifiable does not render the resulting analysis inadequate. See Hughes River Watershed v. Johnson, 165 F.3d 283 (4th Cir. 1999); Sierra Club v. Lynn, 502 F.2d 43 (5th Cir. 1974).

However, the courts have made it clear that if a formal cost-benefit analysis is undertaken by an agency in the NEPA process, it must not be so misleading as to “taint” the basis for the agency’s resulting decision. For example, in Oregon Natural Resources Council v. Marsh, 832 F.2d 1489 (9th Cir. 1987), the Court recognized the requirement that any formal agency cost-benefit analysis not be misleading, but nevertheless rejected the claim that a Corps of Engineers EIS for a dam construction project was defectively misleading solely because it relied on a cost-benefit analysis using an unrealistic discount rate in the body, since the EIS also contained a more realistic cost-benefit analysis in an appendix.

Other court decisions have recognized that, where economic analysis forms the basis of choosing among alternatives, NEPA requires that the analysis not be misleading, biased, or incomplete. For example, in Seattle Audubon Society v. Lyons, 871 F.Supp. 1291 (W.D. Wash. 1994), the court acknowledged that to present a full and unbiased picture of proposed alternatives, an EIS must disclose both benefits and costs of a proposed action. However, the court went on to reject...
the argument that the economic effects analysis used by the Forest Service in that case was
defective in that it exaggerated the negative effects of lower timber harvests while failing to
quantify the positive effects. The court instead found that the agency had not ignored the costs
because the drawbacks of allowing any further timber harvests were mentioned “repeatedly” in
the FEIS, as well as the costs of minimizing harvests. The Court also made it clear that it would
not intervene to substitute the methodology proposed by the plaintiff’s economists over the
analysis employed by the agency in that case.

From a review of the handful of published cases where a court has directly addressed this issue,
it appears that the most likely circumstances in which the federal courts will choose to exercise
their judicial powers to set aside an agency’s decision based on a cost-benefit analysis is in cases
where the cost-benefit analysis employed was so faulty or skewed that it clearly disturbed the
overall balance of costs and benefits as determined by the agency sufficiently to require
reconsideration of the proposed action in light of those problems. See e.g., Sierra Club v. Sigler,
695 F.2d 957 (5th Cir. 1983)(setting aside Corps of Engineers permit for a port expansion due to
skewed cost-benefit analysis in the FEIS which emphasized the project’s economic benefits but
failed to consider associated economic and environmental costs). See also, Welch v. U.S. Air
Force, 249 F.Supp.2d 797 (N.D.Tex. 2003)(recognizing that when reviewing an agency’s cost-
benefit analysis, a court must consider whether the economic considerations, against which the
environmental considerations are weighed, were so distorted as to impair fair consideration of
those environmental consequences).

In Sierra Club v. Sigler, the Army Corps of Engineers had decided to issue a permit for a port
expansion without including in the project FEIS the environmental impacts of increased bulk
commodities activities associated with the deepening of the channels. At the same time the
Corps attributed substantial economic benefits to those increased activities, which the FEIS
assumed would grow dramatically as a result of the port expansion project. Although the FEIS
also discussed a few of the anticipated environmental or economic costs associated with the
expansion of the bulk commodities activities, it claimed a lack of sufficient data to evaluate or
quantify the effect of such possible costs as increased risks of oil spills, even though the Corps
had used projected data on the quantity of commodities shipping that would increase when it
promoted the economic benefits of the project. The FEIS also failed to discuss the pollution
costs, and other cost-increasing risks such as fire and explosion hazards associated with those
activities.

Faced with those facts, the Court in Sigler held that the Corps’ FEIS was deficient under NEPA
because the skewed cost-benefit analysis tainted the Corps’ decision-making process. It stated
that although the agency would not have had to evaluate the environmental and economic costs
of any activities which were not imminent, once the Corps “chose to trumpet the benefits” of
those activities as a “selling point” for the project, it effectively rendered a decision that those
activities were imminent. The Court held that the Corps could not “tip the scales” of an EIS by
promoting possible benefits while ignoring their costs. The Court stated that “simple logic,
fairness, and the premises of cost-benefit analysis, let alone NEPA, demand that a cost-benefit
analysis be carried out objectively.” The Court also stated that there can be no “hard look” at
costs and benefits as required by NEPA unless all costs of a project and associated activities are
disclosed.
The court went on to specifically find that the Corps’ decision to issue the permit for the project was flawed because it was affected by the skewed cost-benefit analysis in that the EIS’s failure to disclose all of the project’s environmental costs made it appear more attractive vis-a-vis the other alternatives than it actually was, and because the analysis also underestimated the environmental costs of the project. The court specifically focused on how the Corps’ skewed cost-benefit analysis “prevented discussion of commodities activities costs” and how none of the “many environmental, health, safety, or socioeconomic costs of the bulk commodities activities” were discussed in the EIS, yet the benefits of those activities were cited. The Court concluded that the skewed cost-benefit analysis contained in the Corps’ FEIS tainted the agency’s decision-making process by preventing the careful weighing of all relevant factors necessary in the “general balancing process” required by the Corps’ regulations. It therefore reversed the Corps’ decision to issue a permit for the project and ordered that the EIS be redone to consider the full costs of the project.

Another case in which a court rejected as a violation of NEPA an agency’s cost-benefit analysis which it found to be skewed because of a failure to consider important information is NWF v. Marsh, 568 F.Supp. 1001 (D.D.C. 1983). In that case, the court first rejected an argument that private costs to be borne by the proponent of a federally permitted project or some other private party and not by the general public are costs that must be considered in an agency’s cost-benefit computations. The court stated that such costs do not need to be considered because the cost-benefit analysis of NEPA is concerned primarily with environmental costs affecting the public, not with private economic costs.

The court also stated that it was authorized to examine the cost-benefit analysis “only as it bears upon the function of insuring that the agency has examined the environmental consequences of a proposed project,” and that judicial review of an agency’s cost-benefit analysis is limited to determining whether the economic considerations, against which the environmental considerations are weighed, were so distorted as to impair fair consideration of those environmental consequences. However, the court went on to find that the Corps of Engineers’ actions in misleadingly reducing the project’s transportation costs in that case was “a crucial component of NEPA’s cost-benefit analysis,” and that the agency’s failure to include that information in its FEIS violated NEPA since those benefits were “trumpeted” by the agency as outweighing all the environmental costs of the proposed project.

Another basis that courts have relied on in rejecting agency actions based on a skewed cost-benefit analysis is where the analysis contains inaccurate or misleading assumptions about project costs and/or benefits. For example, in Hughes River Watershed Conservancy v. Glickman, 81 F.3d 437 (4th Cir. 1996), the Court rejected the Army Corps of Engineers’ reliance on a flawed cost-benefit analysis which contained faulty and misleading assumptions in that its inflated estimate of recreation benefits substantially skewed the economic benefits of the project by relying on a study which calculated gross recreational benefits rather than net recreational benefits as required by the study’s contract.

The court stated that, for an EIS to serve its function, it is essential that any cost-benefit analysis relied on to evaluate alternatives not be based on misleading economic assumptions since such
assumptions “can defeat the first function of an EIS by impairing the agency’s consideration of the adverse environmental effects of a proposed project.” The court also found that misleading economic assumptions can also defeat the second purpose of an EIS by skewing the public’s evaluation of a project. The court stated that because of the potential for misleading economic assumptions to defeat the function of an EIS, it would engage in a “narrowly focused” review of the economic assumptions underlying a project to determine whether the economic assumptions “were so distorted as to impair fair consideration” of the project’s environmental effects.”

After examining the Corps’ cost-benefit analysis, the court found that figures used skewed the project benefits upward, and that those inflated estimates were crucial to the Corps’ evaluation of the project’s feasibility. The court therefore concluded that the agency’s reliance on the flawed cost-benefit analysis violated NEPA because it “impaired fair consideration of the project’s environmental effects.” However, after the case was remanded, the agency reevaluated the economic benefits of the project using a calculation of net rather than gross economic benefits and found that the project would have an overall positive benefit-cost ratio, after which the court upheld the Corps decision to proceed with issuing a permit for the project in a second decision. See Hughes River Watershed v. Johnson, 165 F.3d 283 (4th Cir. 1999). In that second case, the same court rejected the argument that the Corps’ calculation of the economic recreation benefits was still misleading since it found that the agency in making its revised economic recreational benefits determinations did consider such factors as the total number of visitors to the project, the number of visitors who would be diverted to the project from existing facilities, the consumer surplus figure, and non-use values.

While generally reaffirming the standards set out by the court in the first decision in Hughes River, the court in N.C. Alliance for Transp. Reform v. D.O.T., 151 F.Supp2d 661 (M.D.N.C. 2001), rejected arguments that several inaccuracies with the values used in the agency’s cost-benefit analysis in that case unlawfully skewed the decision-making process. The court distinguished the outcome in Hughes River by pointing out that in the previous case the erroneous cost-benefit analysis used by the agency inflated the projected economic benefit of the proposed project by 32%, resulting in a substantially inflated figure. The court found that even if the loss of property tax revenue and cost of induced travel was improperly excluded from the cost-benefit analysis in the present case, there was no indication that the resulting miscalculation “approaches the magnitude of the error in Hughes River.” The court also found that even under the least favorable discount rate assumptions, the alternatives detailed in the cost-benefit analysis had positive benefit/cost ratios. Therefore, the court concluded, it appeared that the cost-benefit analysis did not play a decisive role in the decision of whether to undertake the proposed project.

Subsequently, in Mooreforce, Inc. v. U.S. Dept. of Transp., 243 F.Supp.2d 425 (M.D.N.C. 2003), the same court reached a similar decision in a subsequent case in which it rejected an argument that the agency’s cost-benefit analysis was inadequate because it contained errors which skewed the project’s costs downward, and failed to consider costs such as added travel time and additional operating costs from induced traffic. The court again found that even if the agency’s cost-benefit analysis contained some miscalculations, those did not approach a sufficient magnitude to rise to the “clear error in judgment” required to satisfy the “arbitrary and capricious” standard necessary for the court to reject the agency’s EIS for the project.
In conclusion, given the standards discussed in those relatively few cases in which federal courts have evaluated and discussed the standards for cost-benefit analyses imposed by NEPA, it appears that the primary concerns which may lead a court to find that such an analysis is sufficiently skewed to warrant reversal of the agency’s proposed action include: (1) a failure to consider significant and reasonably foreseeable economic, environmental, and social costs of the project which are clearly pertinent to the agency’s consideration of alternatives for the project, and/or (2) errors or faulty assumptions in the analysis which substantially inflate the economic benefits of a proposed project or which substantially misrepresents or minimize the environmental and social costs.

3.2-3: Shortcomings of the DEIS.

It is abundantly clear that the Corps DEIS falls far short of these standards. With respect to the first set of concerns – failure to consider significant economic, environmental, and social costs – there are many. However, as a preliminary matter, it is plainly evident that the Corps did not even engage in the requisite types of analysis needed to identify such costs or evaluate their significance in the first place. This is because neither the DEIS nor the DIFR include three of the four accounts needed to satisfy the Corps NEPA obligations.

As discussed in Section 2.8, the Corps must include four sets of accounts to meet its NEPA obligations: a National Economic Development Account (NED), a Regional Economic Development Account (RED), an Environmental Quality Account (EQ), and an Other Social Effects account (OSE). Inclusion of these four accounts is the Corps standard approach for incorporating BCAs completed under NED procedures into the NEPA process thereby meeting the CEQ’s mandate to “the relationship between that analysis [NED] and any analyses of unquantified environmental impacts, values, and amenities” (40 CFR § 1502.23). Instead, the DEIS simply incorporates the BCA contained in the DIFR by reference (DEIS at 47) and provides no additional analysis to insure that the BCA’s findings and conclusions are balanced by a discussion of other significant environmental, economic, and social costs.

Therefore, by failing to include RED, EQ, and OSE accounts, the DEIS is facially inadequate. And because such accounts were not included, many important environmental, economic, and social costs were overlooked. As discussed below, as well as in Section 4, these costs include (1) cumulative economic costs associated with past, present, and reasonably foreseeable activities affecting the same resources as the DMT; (2) regional income and employment costs associated with diverting fuel purchases from Puget Sound to Singapore; (3) marine pollution costs; (4) forgone savings from renewable energy; (5) carbon emissions damage; (6) loss of passive use values, and (7) displacement of subsistence uses.

---

23 See, for example, the Corps Final Environmental Impact Statement for the Lower Snake River Juvenile Salmon Migration study, which neatly segregates the economic analysis (Appendix I) into the four required accounts (USACE, 2002).
With respect to the second set of concerns, again, there are many. As discussed in more detail later in this Section, the Corps BCA incorporated into the DEIS is seriously flawed in that it skews the DMTP’s costs and benefits in the following ways: (1) the Corps failed to add compound interest to project costs; (2) the Corps made erroneous assumptions about the life of the Red Dog Mine; (3) the Corps failed to discount village fuel delivery savings to account for uncertainty, and; (4) the Corps seriously underestimates fuel prices over the life of the project. These errors and faulty assumptions work to inflate project benefits and deflate project costs, thereby skewing the BCA’s analysis in favor of the project. Thus, because the Corps’ BCA incorporated by reference into the DEIS omits significant costs and is skewed, the DEIS fails to comply with the requirements of NEPA and the Corps’ own regulations, and cannot be relied on as a basis for decision making.

3.3: Cumulative economic effects are not addressed.

In Section 2.8, we briefly reviewed the Corps obligations under NEPA to substantively address the cumulative environmental, economic, and social impacts of all past, present, and reasonably foreseeable future actions that will add to the impacts associated with the DMTP. To comply, the DEIS identifies existing in water, on shore, and inland development in the affected region (DEIS at 392-393). Impacts associated with existing development are dismissed as minimal, and therefore not examined. For example, with respect to 1800 square miles of sea bottom between Kotzebue and Barrow, the DEIS simply concludes that “[t]here is no indication that any ecosystem function has been impaired by any existing development in that area” without any reference to any studies or sources of information on which the Corp relied to establish that fact (DEIS at 392). As another example, the Corps concludes that “[o]nshore and inland development is greater, but still light by standards anywhere else in the United States,” again failing to include any actual analysis (DEIS at 393).

However, in making these statements, there is no indication that the Corps considered the effects of factory trawling, pollution, oil and gas exploration or any other known environmental impact to the Arctic Ocean sea bottom nor the uniquely sensitive nature of onshore or inland habitats in the DMTP region that nullify any comparisons with “anywhere else in the United States.” As such, these sweeping generalizations about the lack of impact associated with all past and present actions are simply not credible.

The DEIS also contains a list of 12 reasonably foreseeable future actions including increased throughput for the Red Dog Mine, new zinc mining, other mining, coal mining in the northern Northwest Arctic Borough, development of transportation corridors, a new airport at Portsite, trans-shipment of goods for communities, fuel transfer to communities, a road system from the DMT to communities, Kivalina relocation, an expanded airport at Noatak, and natural gas exploration. Once again, however, the environmental, economic, and social impacts are not discussed or disclosed in any meaningful manner. For example, with respect to future natural gas drilling the DEIS simply concludes that “effects of future exploratory drilling would depend largely on the selection of drilling sites, access to the sites, and timing of the drilling” (DEIS at 415). Potential effects are not identified or discussed. With respect to new mining, the DEIS simply states that “[a] new mine more distant from the existing Red Dog Mine would have the same potential to cause environmental effects, with the added potential for effects related to the
road that would be required from the mine to Portsite” without identifying what those effects might be (DEIS at 404).

Courts have consistently frowned on such cursory treatment of cumulative effects. For example, the Ninth Circuit has held that “[g]eneral statements about ‘possible’ effects and ‘some risk’ do not constitute a ‘hard look’ absent a justification regarding why more definitive information could not be provided.” Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1380 (9th Cir. 1998).

In this case, the Corps justified its failure to analyze cumulative environmental, economic, or social effects of future actions by characterizing these actions as merely speculative, with no firm plans in place. For example, the Corps justified its failure to take a hard look at the cumulative effects of potential coal mining by asserting that “there is insufficient information about where mining projects would be developed, how they would be operated, what port location would be best, and how their operations would be regulated” (DEIS at 404). Similar assertions are made about almost every other future action identified by the DEIS. Such assertions, however, are groundless in many cases as existing documentation published by federal, state, and local agencies as well as private corporations provides more than enough specificity to enable the Corps to complete a meaningful analysis.

For example, since at least 2000 the Alaska Department of Transportation and Public Facilities (DOTPF) “has been working with the Arctic Slope Regional Corporation, NANA, and Teck-Cominco on finding a route approximately 90 miles long between the Deadfall Syncline high rank coal deposits and the Delong Mountain Terminal with the goal of moving 1 million to 2 million tons of coal a year” (DGGS, 2004). As another example, Teck-Cominco itself has signed a lease agreement with the Division of Oil and Gas to drill exploratory gas shale wells on the 19,200 acre Sakkan Unit immediately adjacent to the Red Dog mine (DOG, 2006). As yet another example, a recently completed analysis of potential new mining activity atop Howard pass concluded that there is a 85% to 95% probability that a deposit similar to the Red Dog deposit could be mined profitably if the material could be shipped through the DMT (Aventurine Engineering, 2006).

Within these documents, there is more than enough specificity in terms of activity location, magnitude, intensity, and duration for the Corps to take the requisite hard look at cumulative environmental, economic, and social impacts. Each of these potential actions generates economic benefits and costs relevant to the DMTP’s feasibility. For example, Teck-Cominco’s gas shale lease agreement states, as one economic benefit, the “potential to lower the cost of power at the Red Dog Mine, improving competitiveness of the mine…” (DOG, 10). Of course, if gas shale were to be substituted for fuel oil powering the mine, it would have significant consequences on the DMTP’s justification since the mine fuel savings benefit could no longer be counted. On the cost side, these future actions generate a significant range of financial costs borne by private and public parties, but also a range of non-market costs that, when combined with impacts associated with the DMTP, could be significant. These include additional fragmentation of fragile terrestrial and aquatic habitats, carbon emissions, increases in fugitive dust along the Red Dog Mine road, as well as increased Port activity and subsequent effects on marine mammals and subsistence uses. Thus, by failing to take a hard look at the cumulative
impacts of reasonably foreseeable future actions, the DEIS omits information with direct bearing on the DMTP’s economic feasibility.

3.4: Miscalculation of village fuel savings benefit.

For each project benefit24, the Corps calculated the following: (a) a discounted present value of each benefit in each year the benefit is expected, and (b) a single “annualized” benefit figure. Annual present value figures represent the discounted benefit in each year such benefits are expected. The benefit stream for the DMTP is expected to begin in 2011 and end in 2041 for benefits accruing to the Red Dog Mine. Village fuel savings benefits are expected to begin in 2014 and continue through 2061. Because of requirements governing the Corps’ planning horizon, benefits and costs need to be evaluated over a 50-year time horizon. In other words, the Corps needs to convert benefit and cost figures so that they reflect an average annual figure over each year of the 50-year project life. To accomplish this, the benefit or cost stream is totaled into a single present value figure, then converted to an annualized figure by using a standard statistical method that calculates a benefit (or cost) “payment” that would have to be received each year over a 50-year period at the project’s discount rate to equal the total present value figure reported for each benefit.

In the Corps 2003 Feasibility Report, there were several errors in this calculation method, which have now been corrected. However, the DIFR contains one additional error involving the calculation of the village fuel savings benefit. According to Appendix E, the annual village fuel savings benefit is $7,377,300 which is based on the potential savings associated with fuel purchases based in Singapore instead of Puget Sound (Appendix E at E-164). The benefit is assumed to begin in year 2011 and end in year 2061. The Corps then reports the annualized version of this figure to be $5,983,400. This is incorrect. The Corps figure is the discounted value of $7,377,300 in year 2014, not the annualized value of the total discounted benefit stream. The correct annualized value of the total discounted benefit stream ($107,798,312) is actually $6,250,212 at the project discount rate of 5 3/8%. Thus, the DIFR underestimates the value of the village fuel benefits savings – should it occur – by $266,812.

3.5: Failure to add compound interest to project costs.

Appendix E at page E-189 summarizes the expected installation costs of the DMTP. The costs are divided into two major project segments – first cost of the trestle, and first cost of the channel and turning basin. To these costs, interest during construction as well as annual operation, maintenance, repair, replacement, and rehabilitation activity (OMRR&R) costs are added. Table 1, below, presents the Corps costs figures. The nominal cost figures are reported in the column labeled “DIFR Costs” for each year during construction. The present values of these costs after adding interest during construction are included in the column labeled “DIFR Present Value.”

24 To replicate the Corps terminology, we will hereafter label these benefits as such: (1) reduced lead/ zinc concentrate shipment costs from the Red Dog mine = “reduced tug and barge costs;” (2) reduced port delay and queue costs associated with Red Dog operations = “port and queue savings;” (3) additional lead/ zinc concentrate shipments from the Red Dog mine = “induced tonnage;” (4) reduced fuel delivery costs to Red Dog mine = “mine fuel benefits;” (5) reduced fuel delivery costs to villages = “village fuel benefits”, and (6) avoided costs for Portsite operations = “avoided costs.”
The total present value of costs associated with trestle construction is expected to be $169,024,438, and another $81,811,174 for the channel and turning basin. This, in turn, yields an annualized cost estimate of $9,800,141 for the trestle, and $4,743,462 for the channel. Annualized OMRR&R costs are estimated to be $6,550,459 for the trestle and $1,245,246 for the channel. Total annualized costs are estimated to be $16,350,600 for the trestle, $5,988,708 for the channel, and $22,339,308 for the project as a whole.

There appears to be an error in the way the Corps calculated interest during construction, an error that works to understate true project costs. Instead of adding compound interest to project costs during construction, the Corps appears to have used a different methodology; however, this methodology has not been disclosed. As discussed in Section 1.4, Corps regulations and standard benefit cost analysis procedures require that “installation expenditures are brought forward to the end of the period of installation by charging compound interest at the project discount rate from the date the costs are incurred.”25 The formula for doing so is the right hand term (costs) in equation [2]. It involves raising one plus the project’s discount rate to the power of \( t \), then multiplying by the nominal cost figure in the year in question, where \( t \) is the number of years between the date the costs are incurred and the project’s base year.

Throughout the Corps BCA, the project’s base year (where \( t = 1 \))26 is set at 2011. Thus, the correct procedure for adding compound interest to costs incurred in year 2007 is to raise one plus the project’s discount rate (5 3/8%) to the power of 5 (if 2011 is year 1, 2007 is year 5), and then multiply this figure by project costs incurred in that year ($3,686,716) to get the correct present

<table>
<thead>
<tr>
<th>Year and Cost Component</th>
<th>DIFR Costs</th>
<th>DIFR Present Value</th>
<th>2011 Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Cost Trestle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>$3,686,716</td>
<td>$4,425,461</td>
<td>$4,789,913</td>
</tr>
<tr>
<td>2008</td>
<td>$41,701,708</td>
<td>$47,533,283</td>
<td>$51,416,699</td>
</tr>
<tr>
<td>2009</td>
<td>$73,986,209</td>
<td>$80,030,800</td>
<td>$86,569,227</td>
</tr>
<tr>
<td>2010</td>
<td>$36,077,989</td>
<td>$37,034,895</td>
<td>$40,060,604</td>
</tr>
<tr>
<td><strong>Total NPV:</strong></td>
<td>-</td>
<td>$169,024,439</td>
<td>$182,836,443</td>
</tr>
<tr>
<td><strong>Annualized:</strong></td>
<td>-</td>
<td>$9,800,141</td>
<td>$10,600,969</td>
</tr>
<tr>
<td><strong>Plus OMRR&amp;R Costs:</strong></td>
<td>-</td>
<td>$6,550,459</td>
<td>$6,550,459</td>
</tr>
<tr>
<td><strong>Trestle Annualized Costs:</strong></td>
<td>-</td>
<td>$16,350,600</td>
<td>$17,151,428</td>
</tr>
</tbody>
</table>

| **First Cost Channel**  |            |                    |                   |
| 2008                    | $28,936,405| $32,982,878        | $35,677,542       |
| 2009                    | $28,575,419| $30,909,999        | $33,435,311       |
| 2010                    | $17,455,325| $17,918,297        | $19,382,202       |
| **Total NPV:**          | -          | $81,811,174        | $88,495,055       |
| **Annualized:**         | -          | $4,743,462         | $5,130,998        |
| **Plus OMRR&R Costs:**  | -          | $1,245,246         | $1,245,246        |
| **Channel Annualized Costs:** | - | $5,988,708 | $6,376,244 |
| **Total Annualized Costs:** | - | $22,339,308 | $23,527,672 |

---

25 ER 1105-2-100 Appendix D, Amendment #1, June 30th, 2005, page D-8, D-9, and D-31.
26 All benefit figures were calculated with the year 2011 set at t=1.
value of the costs ($4,789,913). The rationale behind this is that if the project did not go forward, the money that would have been spent on the project could have been invested and earned an income stream equal to the project’s discount rate. In other words, compounding interest is a measure of the project’s financial opportunity costs.

The corrected figures for each year of construction are reported in the “2011 Present Value” column of Table 1. The total present value of trestle costs come to $182,836,443. This translates into an annualized value of $10,600,969. Annualized OMRR&R costs add another $6,550,459 to this figure. Thus, the correct annualized cost figure for the trestle is $17,151,428. The total present value of channel costs come to $88,495,055. This translates into an annualized value of $5,130,998. Annualized OMRR&R costs add another $1,245,246 to this figure. Thus, the correct annualized cost figure for the channel is $6,376,244. The correct value for total annualized costs of the project as a whole, then, is $23,527,672. By failing to follow standard procedures for adding compound interest to project costs incurred before 2011, then, the Corps has underestimated annualized project costs by $1,188,364, or 5.3%.

3.6: Incorrect assumptions about Red Dog mine life.

The feasibility of the DMTP is based on a rounded average of three estimates of how long the Red Dog Mine will stay in operation based on proven and probable reserves. It is assumed that the Red Dog Mine will operate continuously for 31 years after the 2011 project start date terminating operations at the end of the year 2041 (Appendix E at E-62). All of the DMTP benefits are based on this 31-year post 2011 mine life projection. However, the Corps recognizes that there is uncertainty in this forecast because it depends on Red Dog discovering additional reserves and bringing those new reserves into production.

According to the Corps, the range of estimates for Red Dog Mine life based on known reserves and prospects of new discoveries ranges from a low of 36 years after 2000 to a high of 63. This means that mine production may end as early as the end of 2036. Moreover, a 2003 personal communication with the Vice President for Environment for Teck-Cominco Limited indicates that the mine life is estimated to be “in the order of 25 to 30 years” from the present date. Thus, according to officials at Teck-Cominco, mine operations may end as early as 2028. In fact, Teck Cominco has now officially published its projection for an end date for Red Dog mine production: 2029. On its official website, last updated October 4th, 2006, the company states:

“The main pit has an expected life of seven years at current rates of production. Additional reserves have been identified in the vicinity of the processing facilities sufficient to extend the life of the operation by a further 16 years for a total mine life of 23 years.”

The Corps use of inaccurate mine life forecasts was underscored in Teck-Cominco’s comments on the DEIS and DIFR. According to Teck Cominco, “the DEIS is incorrect on the reported

---

27 Personal communication between Mara Bacsujlaky, Mining Coordinator, Northern Alaska Environmental Center and Michael P. Filion, Vice President, Environment, for Teck Cominco Limited, September 9th, 2003.
mine life of the Red Dog Mine.”29 Thus, rather than basing its mine life projections on speculation or estimates by outside sources, the prudent approach would be to base the DMTP analysis on Teck-Cominco’s own projections, which are probably the best that can be obtained.

A Red Dog Mine life ending in the year 2029 has a significant effect on the projected benefits stream. To be conservative, we assumed for now that Portsite will continue to operate as a fuel delivery hub after mine operations cease. Thus, the village fuel savings benefit stream remains intact. We recalculated all remaining benefit streams to terminate at 2029. The results appear side by side with the Corps estimates in Table 2, below.

Table 2
Benefit Stream Recalculation based on Red Dog Mine Life to 2029

<table>
<thead>
<tr>
<th>Annualized Project Benefit</th>
<th>DIFR Benefit Estimates</th>
<th>Mine Life to 2029</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Tug &amp; Barge Costs</td>
<td>$10,788,296</td>
<td>$8,469,714</td>
<td>-$2,318,582</td>
</tr>
<tr>
<td>Port and Queue Savings</td>
<td>$3,333,190</td>
<td>$2,616,833</td>
<td>-$716,357</td>
</tr>
<tr>
<td>Induced Tonnage</td>
<td>$1,707,854</td>
<td>$1,340,808</td>
<td>-$367,046</td>
</tr>
<tr>
<td>Avoided Costs</td>
<td>$66,890</td>
<td>$52,514</td>
<td>-$14,376</td>
</tr>
<tr>
<td>Mine Fuel Benefits</td>
<td>$5,018,964</td>
<td>$3,940,306</td>
<td>-$1,078,658</td>
</tr>
<tr>
<td>Village Fuel Benefits</td>
<td>$6,250,212</td>
<td>$6,250,212</td>
<td>$0</td>
</tr>
<tr>
<td>Total:</td>
<td>$27,165,406</td>
<td>$22,670,388</td>
<td>-$4,495,018</td>
</tr>
</tbody>
</table>

Overall, annualized project benefits drop from $27,165,406 to $22,670,288, a reduction of $4,495,018 each year. Thus, the effect of taking Teck-Cominco’s published mine termination date of 2029 over the Corps speculative estimates of a mine life until 2041 is to decrease overall project benefits by 17%.

3.7: Erroneous assumptions about fuel price trends.

The economic success of the DMTP relies in part on the accurate prediction of the costs of and demand for fuel. Fuel cost enters the benefit-cost equation in many ways; nearly every component of the project relies on fuel. Electricity generation at Portsite, mine operation, concentrate trucks, tugs30, village power and heating, and trestle construction all rely on fuel. Therefore, it is critical to use the most current and reasonable projections of fuel costs in order to determine project feasibility.

All the benefit and cost calculations set forth in the DIFR rely on a fuel price assumption of $1.40 per gallon. This figure was based on the midpoint between the Energy Information Administration (EIA) average low ($1.37) and high ($1.42) price projections for 2010 at the time the DIFR was drafted (Appendix E at E-209). The Corps also justified the use of $1.40 based on an analysis of actual prices for refined products used in the marine transportation industry within northwest Alaska, and regional fuel sales records prior to 2003. The Corps cut off its analysis of regional fuel prices in 2003 to “minimize market distortions” caused by the Iraq war (Id.).

30 “Probably the single variable, having the largest impact on cost of the tugs and which appears as a factor in all sources, is fuel cost, making up about 25% of tug total hourly cost...” (Appendix E at E-208).
Regardless of whether or not the Iraq war’s effect on oil prices is temporary, other factors have contributed to a major escalation in fuel prices since the DIFR was drafted. Fuel prices have increased nearly 92% since that time, and the effects are now predicted to be permanent. As such, the Corps’ estimates for future fuel prices are at least one-half to one-third of the EIA’s current fuel price projections. Appendix E at E-208 states “[i]n the EIA reference case, the average lower 48 crude oil price is projected to be $24.28 per barrel in 2010 and $27.00 per barrel in 2025.” In the 2006 EIA reference case\textsuperscript{31}, the crude oil price in 2010 is $43.99 and the 2025 price is $47.99. The DIFR uses EIA high case prices of $33.27 in 2010 and $35.03 in 2025. The 2006 EIA high case report states a 2010 forecast of $53.99 and a 2025 forecast of $84.98.

Significant increases in crude oil prices, in turn, translate into significant increases in the prices of distillate fuels. In its sensitivity analysis, the Corps assumed a fuel price range of between $1.07 and $1.58 per gallon for fuel oil used in tug and barge operations based on actual sales data during 2002 and 2003. Current fuel prices exceed this range by a wide margin, and expectations are for prices to continue their increase over the DMT project life. Based on the most recent data from the Pacific States Marine Commission (PSMC), marine fuel prices in Alaska for the same ports surveyed by the Corps in the DIFR now average $2.69 – an increase over 92% above the Corps’ $1.40 figure. The EIA 2006 reference case predictions for diesel now range from a low of $1.96 to a high of $2.34 in 2010, or an average of $2.15. Table 3, below, summarizes the change in crude oil price projections between 2005 and 2006 for the years 2010 and 2025. In the remainder of this section, we discuss the effects of this significant increase in fuel price projections on three variables of relevance to the BCA: tug and barge savings, village fuel demand, and construction costs.\textsuperscript{32}

### Table 3: Projected Prices of Crude Oil and Distillates 2003 and 2006

| Year Projection Made and Source | Projected Price of Crude Oil | Projected Price of Distillate Fuel
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 low (EIA)</td>
<td>$24.28</td>
<td>$27.00</td>
</tr>
<tr>
<td>2005 high (EIA)</td>
<td>$33.27</td>
<td>$35.03</td>
</tr>
<tr>
<td>2006 ref (EIA)</td>
<td>$43.99</td>
<td>$47.99</td>
</tr>
<tr>
<td>2006 high (EIA)</td>
<td>$53.99</td>
<td>$84.98</td>
</tr>
<tr>
<td>DIFR assumption (2005)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EIA 2006 average</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CSE estimate</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

3.7.1: Tug and barge savings

The DIFR assumes that the DMTP will generate $10,788,300 in annualized benefits for Red Dog Mine associated with lower operating costs for its tug and barge fleet. This benefit is based on

\textsuperscript{32} The Department of Interior has called for a reanalysis of the fuel delivery savings benefit in light of “recent spikes in fuel costs.” We address this indirectly by way of village fuel demand. See: USDI, Office of the Secretary, Comments on the DIFR and DEIS, December 27\textsuperscript{th}, 2005.
the $1.40 marine fuel price assumption. The Corps sensitivity analysis discusses how this benefit figure changes as fuel prices change. In particular, the sensitivity analysis found that a 13% increase in fuel cost from $1.40 to $1.58 will lead to a 4% increase in tug operating costs and reduce overall benefits by $416,400. Conversely, the sensitivity analysis found that a 24% decrease in fuel prices from $1.40 to $1.07 would lead to an 8% decrease in tug operation costs and increase overall benefits by $208,200.

Based on the new price data presented in Table 3, we have chosen a value of $2.42 per gallon as a more realistic estimate of fuel oil prices associated with the DMTP over the project’s life. The $2.42 figure is an average of the EIA’s estimate of $2.15 in 2010 and the most recent average marine fuel prices from the PSMC data ($2.69). To predict the effects of a price increase from $1.40 to $2.42 on tug and barge savings, we used linear extrapolation of the DIFR’s three data points relating fuel prices to tug and barge savings. Figure 2 is a graphical representation of these data points, and suggests linear extrapolation is a relatively safe approach.

By using an estimated point-slope formula, we first calculated the slope between the three data points. For predicted tug and barge savings there is a low value of $10,371,900 at $1.58 per gallon, a midpoint of $10,788,300 at $1.40, and a high point of $10,996,500 at $1.07. Plotting these three points gets us a slope of -$1,151,479.80. This suggests that for every $1.00 increase in fuel prices, tug and barge savings drop by approximately $1,151,480. Our $2.42 price assumption is an increase of $0.84 above the highest Corps prediction of $1.58. Multiplying that value times the slope (-$1,151,479.80), we get a value of -$967,243.05. Subtracting that from the benefit at $1.58 ($10,371,900), we get a new, lower benefit figure of $9,404,656.95.
Thus, by incorporating more realistic fuel price projections based on actual market data from 2006 and the EIA’s latest projections for 2010 we estimate tug and barge savings to be $1,383,463 less than what the DIFR suggests. To incorporate this value into our BCA critique, we simply subtracted an equivalent percent reduction (roughly 12.84%) from the Corps original annual benefit figure of $12,459,400. The adjusted annual benefit figure is $10,860,158. We then modeled this benefit from 2011 to 2029 (when Teck-Cominco states that the Red Dog Mine will close) and then annualized the total present value to get a new figure for annualized tug and barge savings: $7,382,573.

3.7-2: Village fuel use

The Corps predicts annualized fuel benefits from fuel use in the villages and the mine to be $11,002,400, with a low-high range of $9,375,100-$13,935,000 with variations due to changing fuel use rates. While significant increases in fuel prices may have a minimal effect on fuel demand directly (due to high inelasticities of demand) such increases certainly make fuel efficiency measures more cost effective. In this section, we examine the effects of likely fuel demand reductions associated with improved power generation efficiency on the projected fuel use benefits. We model these effects for villages, and keep the mine’s efficiency (therefore use) constant.

Appendix E at E-218 states “there is less certainty in the estimated amount of fuel to be used at various villages than there is at the mine; however, this uncertainty is mitigated by excluding any projected future increase beyond present day use.” In the absence of good data about village level fuel consumption, the Corps implements a formula for estimating fuel use in the smaller villages. The formula involves multiplying the AK Department of Community and Economic Development (ADCED) database’s estimate for number of jobs in each village by the consumption per job from similar villages. Their estimate of per employee consumption in smaller coastal villages is 2,900 gallons per employee. For Nome, the estimate is 5,500 gallons and for Kotzebue, 4,780 gallons per employee. The Corps has included several tables of estimates for village fuel use per year based on these figures. These can be found in Appendix E at E-143 through E-163. The DIFR assumes that fuel use in the villages has remained stable for some time, and they predict it will continue to do so. This assumption may have been reasonable at the time the DIFR was prepared, but is now much less so due to significant fuel price increases and expansion of some recent policies and programs aimed at promoting better fuel efficiency at the village level.

Among many official and informal documents describing rural fuel demand reduction programs, the AK Rural Energy Action Council (AREAC, 2005) has published their findings and action recommendations to Governor Murkowski for improving energy efficiency and fuel delivery to rural communities. Among the suggestions is an investment of approximately $2.8 million for “Diesel Powerhouse Efficiency Improvements.” Under that category, the AREAC suggests three ways to improve efficiency. Two are of concern here: (1) installation of automatic demand level paralleling switchgear with remote monitoring, and (2) installation of properly sized generators to meet the load profile of communities.
The paralleling switchgear “starts and stops different size generators automatically to match the proper size unit with the load demand of the community” (AREAC, 2005, 17). The automated switchgear brings a smaller, more fuel efficient generator on line and turns off the larger generator for most of the day and night. The switchgear monitors the load 24 hours a day and does not need an operator on duty to switch generators. Automatic demand level paralleling switchgear can reduce fuel consumption 10 – 20% per year. In order for the switchgear to work, communities will have to install several different sized generators. Fuel savings from installation of properly sized generators can run from 5,000 gallon a year to as high as 25,000 gallons per year (Id.).

There is evidence that fuel efficiency gains are already happening in rural Alaska. The Executive Summary for the Alaska Rural Energy Plan (AREP) at ES-4 reads “[t]hus, over the course of the 1990s, fuel efficiency gains saved rural Alaskan utilities roughly 5.5 million gallons of fuel per year.” While this rate should not be expected to continue, efficiency will increase. There are other efficiency gains to be made, such as installing appropriate sized generators. As stated above, this could lead to an up to 25,000 gallon per generator saving. Data on the number of generators used in each location are difficult to obtain.

There is also a significant push for installation of more wind generation and use of biodiesel. The AREP at ES-7 states “…the Rural Energy Plan recommends a wind resource development program on the order of $30 million over roughly five years ($27.5M capital + $1.6 M Wind Recon).” This investment is approximately the value of the Corps’ contribution to the Red Dog project. This is a substitution we proposed in our earlier report (ELI, 2003). However, as the outcomes of wind generation are hard to quantify, we omit potential demand reductions associated with wind for now and consider the effects of 10 – 20% efficiency gains as envisioned by AREAC.

We model potential effects of such gains on project (specifically fuel delivery) benefits. If the AREAC funding were to go through and existing efficiency improvements continued to expand in response to higher energy prices, the net effect could be a 10-20% decrease in fuel demand. Given enormous increases in fuel prices in recent years and rapid proliferation of efficiency programs and renewable energy options, we consider the 20% reduction to be highly likely, and thus we adopt it here as a basis for revised fuel savings benefits. To do this, we first disaggregated village fuel using the Alaska Rural Energy Statistics (ARES) data from the 2005 “Statistical Report of the Power Cost Equalization Program, (PCE)” compiled by the Alaska Energy Authority. They present the total amount of fuel used per village for electricity generation in FY 2005. There are some missing observations in our data, and where that occurs, we use Corps estimates from the DIFR. Our assumed village fuel use data is presented in the second column of Table 4.

The DIFR’s assumed village fuel use figures are presented in the first column of Table 4. In order to model a 10-20% fuel savings for electricity generation, it would be inaccurate for us to use these figures, since they include fuel used for home heating and other purposes. Therefore, we estimate fuel savings using the PCE data from the second column. We do this for the

following regions: Kotzebue and Kotzebue Area, Nome and Nome Area, 5 Swing Villages, Yukon Swing Villages, and the Yukon Delta Villages. We do not include potential fuel savings at the Red Dog Mine itself, as it is not a community and therefore not eligible for state funding for the REAC efficiency program.

To estimate total fuel use demand reduction associated with 10% efficiency improvements, we multiply the PCE column by 10%, then subtract this figure from DIFR fuel use in the first column. The same procedure is used to model the effects of a 20% efficiency gain. We present our results in Table 5, below. As Table 5 suggests, implementation of AREAC efficiency improvements will probably lead to a 1,112,411 – 2,217,281 gallon reduction in village fuel demand.

### Table 4
**Fuel Consumption Variation at Select Villages Under Different Generating Efficiency Improvements**

<table>
<thead>
<tr>
<th>Area</th>
<th>DIFR fuel use (gal/yr)</th>
<th>Fuel use estimates from PCE</th>
<th>10% reduction</th>
<th>20% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kotzebue area</td>
<td>3,013,890</td>
<td>2,593,087</td>
<td>2,754,581</td>
<td>2,502,813</td>
</tr>
<tr>
<td>5 swing villages</td>
<td>4,500,000</td>
<td>2,661,403</td>
<td>4,233,860</td>
<td>3,967,719</td>
</tr>
<tr>
<td>Nome and area</td>
<td>13,019,600</td>
<td>1,595,158</td>
<td>12,671,286</td>
<td>12,322,972</td>
</tr>
<tr>
<td>Yukon Delta villages</td>
<td>3,764,100</td>
<td>1,824,154</td>
<td>3,581,685</td>
<td>3,399,269</td>
</tr>
<tr>
<td>Yukon swing villages</td>
<td>1,864,600</td>
<td>562,323</td>
<td>1,808,368</td>
<td>1,752,135</td>
</tr>
<tr>
<td><strong>Village total</strong></td>
<td><strong>26,162,190</strong></td>
<td><strong>9,236,125</strong></td>
<td><strong>25,049,779</strong></td>
<td><strong>23,944,909</strong></td>
</tr>
<tr>
<td>Red Dog Mine</td>
<td>25,921,400</td>
<td>25,921,400</td>
<td>25,921,400</td>
<td>25,921,400</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>52,083,590</strong></td>
<td><strong>35,157,525</strong></td>
<td><strong>50,971,179</strong></td>
<td><strong>49,866,309</strong></td>
</tr>
</tbody>
</table>

### Table 5
**Fuel Savings Benefit Estimates for Different Fuel Use Scenarios**

<table>
<thead>
<tr>
<th></th>
<th>DIFR baseline</th>
<th>Low scenario</th>
<th>High scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corps fuel savings benefit estimates (mine and village)</td>
<td>$11,002,400</td>
<td>$9,375,100</td>
<td>$13,925,000</td>
</tr>
<tr>
<td>Gallons of fuel consumed at each estimate (DIFR)</td>
<td>58,746,700</td>
<td>49,982,400</td>
<td>64,150,900</td>
</tr>
<tr>
<td>Gallons of fuel consumed at each estimate (CSE)</td>
<td>-</td>
<td>49,866,309</td>
<td>50,971,179</td>
</tr>
</tbody>
</table>

In the sensitivity analysis, the Corps arrives at a spread of gallons (and therefore benefits) due to possible variation in the amount of fuel used. The lower bound of this spread is 49,982,400 gallons. Our lower estimate (20% fuel use reduction due to paralleling switchgear) is 49,866,309, and our upper bound (10% reduction) is 50,971,179. The annualized benefit accruing from the Corps low range estimate is $9,375,100. We suggest that this value be used, as opposed to the improbable baseline estimate of $11,002,400. Table 5 shows various potential fuel consumption outcomes and the allied benefits.

---

34 PCE’s Alaska Rural Energy Stats are missing data for a few villages. For those villages, we have used the Corps estimates. Villages are Barrow, Teller, Koyukuk, Kotlik, Marshall, and Pitka’s Point.

35 10% and 20% reductions are as follows [(Corps estimate) –(Alaska Rural Estimate*0.1 or 0.2)]. Red Dog Mine fuel use does not change in this table.
Given that it seems a fairly high probability event that something will have to be done to reduce the long-terms costs of the Power Cost Equalization program (see “Current Community Conditions: Fuel Prices across Alaska”), and that our lower bound estimate so closely approximates the Corps, we recommend that the Corps use the lower bound benefit ($9,375,100) from their sensitivity analysis in the DIFR.

This figure represents a reduction in annualized fuel delivery savings of $1,627,300. Since we assume that mine fuel consumption will remain the same, all of this reduction should be taken from the village fuel benefit category. This translates into a reduction of annualized fuel savings benefits accruing to villages from $6,250,212 to $4,622,912 or 26%.

3.7-3: Construction costs

In Section 4.4 we discuss carbon emissions damage associated with the DMTP. In that section, we estimated that approximately 10% of trestle and channel costs are attributable to fuel. By applying this figure to overall project costs disclosed on page E-189 of Appendix E (excluding planning and engineering costs) and by assuming a fuel price of $1.40 we estimate that fuel used during trestle and channel construction would total 215,864 gallons in 2007, 4,322,933 gallons in 2008, 6,259,767 in 2009, and 3,188,995 gallons in 2010. To estimate the increase in construction costs associated with increased fuel prices we incorporated EIA price projections for 2007-2010 and simply multiplied gallons used by the price differential (EIA - $1.40) in each year. Table 6, below, summarizes the results.

<table>
<thead>
<tr>
<th>Year and EIA Fuel Price Estimate:</th>
<th>2007 ($2.01/gal)</th>
<th>2008 ($2.07/gal)</th>
<th>2009 ($2.00/gal)</th>
<th>2010 ($1.96/gal)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel cost of construction</td>
<td>$453,314</td>
<td>$8,948,471</td>
<td>$12,519,534</td>
<td>$6,250,430</td>
<td>$28,171,749</td>
</tr>
<tr>
<td>Remaining first cost trestle</td>
<td>$2,719,889</td>
<td>$31,833,960</td>
<td>$56,520,450</td>
<td>$26,527,223</td>
<td>$117,601,522</td>
</tr>
<tr>
<td>Remaining first cost channel</td>
<td>$0</td>
<td>$22,635,000</td>
<td>$22,352,625</td>
<td>$13,654,125</td>
<td>$58,641,750</td>
</tr>
<tr>
<td><strong>Revised total</strong></td>
<td><strong>$3,173,203</strong></td>
<td><strong>$63,417,431</strong></td>
<td><strong>$91,392,609</strong></td>
<td><strong>$46,431,778</strong></td>
<td><strong>$204,415,021</strong></td>
</tr>
<tr>
<td>DIFR</td>
<td>$3,022,099</td>
<td>$60,521,067</td>
<td>$87,636,750</td>
<td>$44,645,942</td>
<td>$195,825,858</td>
</tr>
<tr>
<td>Difference</td>
<td>$151,104</td>
<td>$2,896,364</td>
<td>$3,755,859</td>
<td>$1,785,836</td>
<td>$8,589,163</td>
</tr>
</tbody>
</table>

As shown in Table 6, overall project costs increase by a total of $8,589,163, with year by year cost increases shown in the last row. To recompute annualized costs, we added these year by year cost increases to the first cost trestle and channel costs in each year as estimated by Appendix E, Table 92, then calculated interest during construction in accordance with standard Corps methods described in Sections 1.4 and 3.5. By doing so, we estimate that overall annualized project costs will increase from $23,527,672 (the corrected cost figure from Section 3.5) to $24,115,887, an increase of 2.5%. This is likely an underestimate for two key reasons. First, we relied on EIA price projections which, at the time of this writing, were running far lower than existing marine fuel prices in Northwest Alaska. Secondly, we omitted fuel used during OMRRRR&R activities. A more complete analysis of the effects of fuel price increases on DMTP costs should address these factors.
3.8: Unwarranted assumptions about fuel delivery savings.

A widespread critique of Corps economic analyses in the past has been the Corps failure to recognize the uncertainty involved with its projections of civil works project benefits (NRC, 2001, 48-49). In the DIFR and Appendix E, the Corps has dealt with uncertainty by discussing the sensitivity of the economics to changes in data and methods (Appendix E at E-203 to E-227). The Corps selected thirteen factors to analyze in some detail.

There are a number of problems with how the Corps dealt with three of these: (1) maintenance dredging costs, (2) village fuel demand, and (3) fuel delivery savings. As the Corps recognizes, the goal of sensitivity analysis is to “reveal how the economic analysis result might vary if inputs selected for the benefit evaluation are selected differently or applied differently thereby providing insight to the amount of confidence one can have in the economic analysis” (Appendix E at 203). This necessitates the use of different assumptions regarding the magnitude of input variables, and a quantitative analysis of how these different assumptions alter the benefit-cost ratio.

For maintenance dredging, the Corps failed entirely to incorporate different quantitative estimates of maintenance dredging costs. Instead, the Corps simply assumed that varying such costs would be trivial to the DMTP benefit cost ratio, and concluded that “the question of impact on the project economics is of no material consequence” (Appendix E at 213). In making this determination, the Corps failed to recognize that forecasting maintenance dredging needs is highly uncertain. For example, the hydraulic design study completed for the DMTP notes that there is an uncertainty factor of 5 to 10 in forecasts of channel infilling volume and required maintenance needs (Appendix A at A-133, 134). In other words, maintenance dredging could be needed as many as 30 times rather than 3. Obviously, this would have a significant impact on project costs. Since the Corps has access to quantitative estimates of uncertainties in channel infill rates, it ought to have incorporated this information into the sensitivity analysis by analyzing DMTP benefits and costs with maintenance cycles that significantly exceed the three-year cycle assumed by the DIFR.

Another example involves village fuel demand. The DMTP economic analysis rests on the assumption that the most likely scenario for village fuel demand is that such demand is constant over the life of the project. The possibility that demand may significantly decline due to a combination of high fuel prices and various conservation and efficiency improvements was entirely ignored. Instead, the Corps simply varied demand based on an assumed error of plus or minus 10% from the chosen value (Appendix E at E-217 to E-219). In fact, as we have shown previously with respect to energy efficiency improvements and show later with respect to wind, the possibility exists for significant replacement of diesel use, at least in coastal villages where wind resources are most likely to be exploited. This scenario ought to have been incorporated into the “low” demand estimates in the sensitivity analysis.

Perhaps the most problematic aspect of the sensitivity analysis involves estimates of fuel delivery savings. As discussed earlier (Section 3.1) this benefit is dependent upon a number of highly uncertain events that need to occur in order for fuel delivery benefits to be realized by the mine and village. In particular (1) a fuel distribution center would have to be established; (2)
fuel purchases from Singapore would have to be cheaper than fuel purchased from Puget sound and the Kenai peninsula; (3) fuel delivery savings would have to be passed on to village electric cooperatives, and (4) village electric cooperatives would have to pass fuel delivery savings benefits on to end users. If these events are considered independent of one another, probability theory tells us that the probability of this compound event is just: Pr(1) * Pr(2) * Pr(3) * Pr(4), where Pr(i) is just the probability of event “i” occurring (Griffiths, Hill et al. 1993, 34-36). The effect of even a small level of uncertainty on the probability of the compound, or final event is significant. For example, if we assume that each event has a 95% probability of occurrence, then the probability of the final outcome occurring is just 81%.

In regards to fuel delivery benefits, the probability of any one of the required events occurring may be significantly lower than 95%. For example, we have already discussed in Section 3.1, there are a number of barriers to the establishment of a fuel distributorship at Portsite. As discussed there, the Corps believes that the DMTP will help alleviate one of two major obstacles for establishing a distribution center, however, the second – no marketing or economic access – will remain unaffected. The continuing uncertainties over fuel distribution to area villages were highlighted by the Northwest Arctic Borough in their comments on the DIFR and DEIS: “[t]his proposal needs much more attention because there is no mention of who would do the coordination, planning, implementation, and eventual distribution of bulk fuels to which villages.” NOAA also flagged this uncertainty, “[t]he DEIS fails to describe the necessary infrastructure, contracts, operators, nor delivery system necessary to realize such benefits.” If the two obstacles (capacity and economic access) have equal weight and are the only major barriers, it is reasonable to assume that, at best, the probability that a distributorship will be established at the Portsite is roughly 50%.

Fuel purchase price savings is another highly uncertain parameter, a parameter complicated further by exchange rates, which continue to move in an unfavorable direction. These issues are discussed in more depth by ELI (2003).

This extreme degree of uncertainty in the fuel savings benefit projection due to the uncertainty over whether a fuel distribution center will be established, historic prices and the exchange rate is further exacerbated by the issue of whether fuel price savings will actually be passed on to either the Red Dog Mine or end users in the villages. As discussed in Section 3.1, a local monopoly in fuel distribution coupled with a serious backlog of capital improvements raises serious questions as to whether any fuel price savings will actually be passed all the way to the end users.

Instead of recognizing the extreme uncertainty involved with multiple aspects of the fuel delivery savings benefit, the Corps simply assumed that there is a 100% probability that Singapore prices will always be cheaper, a 100% probability that a fuel distribution center will be established, and a 100% probability that fuel savings will be passed on to end users. The only factor the Corps varied in its sensitivity analysis was the degree of savings (Appendix E at E-215 to E-217). Clearly, this is erroneous.

36 Northwest Arctic Borough, Comments on the DIFR and DEIS, submitted by Roswell L. Schaeffer, Sr., Mayor, December 21st, 2005.
As discussed in Section 1.5, one way to deal with uncertainty in benefit stream calculations is to use expected values. An expected value is simply the potential value of the benefit stream weighted by its probability of occurrence. Given the extreme level of uncertainty over fuel delivery savings benefits resulting from the DMTP, an expected value approach is certainly warranted here. In fact, in the estimation of potential fuel delivery savings benefits from DMTP conducted by Northern Economics, expected values were used (Northern, 1999, 29).

To incorporate uncertainty over village fuel savings benefits into our BCA critique, we replicate our previous analysis (ELI, 2003) and assume a 50% probability that such benefits will be generated in the year the DIFR expects them to commence (2011) through 2061. In Section 3.7-2 we accounted for reduced village fuel demand associated with energy efficiency improvements and recalculated annualized fuel delivery savings to be $4,622,912. This amount translates into an annual benefit estimate of $5,456,500. If we discount this figure by 50% and then convert the resulting value ($2,728,250) into an annualized benefit value, we arrive at a more realistic figure for expected village fuel benefits: $2,311,434.

Section 3 References


Division of Oil and Gas (DOG, 2006). Findings and Decision Approving the Sakkan Unit Application. State of Alaska, Department of Natural Resources, Division of Oil and Gas.


Section 4: Independent Assessment of Key Parameters

In this section, we provide an independent assessment of key parameters that were overlooked in the Corps economic analysis supporting the DMTP. These parameters include (1) regional economic development (RED) costs associated with substitution of Singapore fuel oil for U.S. fuel oil; (2) marine pollution costs; (3) forgone savings from renewable energy investment; (4) carbon emissions damage; (5) loss of passive use values, and (6) non-market costs to subsistence uses. In Section 5, and where appropriate, these cost estimates will be combined with the recalculations presented in Section 3 in a reanalysis of the overall benefit-cost ratio for the DMTP.

4.1: RED costs associated with substitution of Singapore for Puget Sound fuel.

As discussed in Section 2.7, a critical issue Regional Economic Development (RED) analysis must address involves transfers of economic activity from one region to another. If a Corps project increases economic activity at one port at the expense of another, then the losses in economic activity at that port must be included as a RED cost. A project produces RED benefits only if those benefits are net of costs incurred by other ports or regions that experience transfers of economic activity away from their locations.

As established by the Draft Interim Feasibility Report and Appendix E, the most significant DMTP benefit is associated with the substitution of fuel oil currently purchased in the Puget Sound or Kenai Peninsula area for oil imported from Singapore (Appendix E at 1; Appendix E at 113). According to the Corps, the projected total yearly shipment of fuel from Singapore will result in the diversion of up to 58,746,700 (Appendix E at 151) gallons of fuel oil purchases from U.S. ports (primarily in the Puget Sound area) each year. At the DIFR’s fuel cost estimate of $1.40, this represents a diversion of over $82 million each year from the U.S. to Singapore. Obviously, this diversion will result in substantial losses in economic activity in the U.S. These losses include direct costs generated by the loss of income to Puget Sound refineries and fuel distributors as well as the jobs associated with that income. They also include indirect costs associated with the reduction in inputs used by these refiners and distributors. Finally, they include the induced economic costs associated with personal income that would otherwise be circulating in the local economy and spent on consumer goods and services.

Consideration of direct, indirect, and induced economic costs associated with Corps-induced transfer of economic activity out of a region is explicitly required by the Corps own regulations. In particular, WRC guidance requires (1) analysis of direct income changes arising from differences between the with and without plan conditions; (2) analysis of indirect income changes associated with expansion or reduction in the production of inputs to industries.

---

38 There are, in fact, many estimates of fuel consumption in the project area. For this IMPLAN estimation, we used the lowest figure we could find, in order to keep the estimates as conservative as possible. The value we used is 52,214,792 gallons per year. This value is derived from summing the values of various tables of village and mine fuel consumption in Appendix E section 12.0.
supplying the final product at issue (in this case fuel), and (3) analysis of induced changes in consumption expenditures generated by changes in personal income (WRC, 1983, 11).

The magnitude of this cost can be easily estimated by using what is known as an input-output (IO) model, the standard tool economists use to calculate the direct, indirect, and induced economic losses or gains associated with a change in final demand for goods and services in a particular sector in a particular region or for the nation as a whole. Use of an input-output model is “routine” for use in standard economic settings (Appendix E at 12-13). Input-output models are a device for organizing the basic accounting relations that describe the production sector of the economy. The input-output method starts with a very simple idea. All the sectors of the economy are tied together by virtue of economic relations called “linkages” and the production of a good or service can be described by a “recipe”. The ingredients of this recipe are the outputs of the other sectors of the economy as well as the primary inputs such as labor, capital, and other raw resources. A simple example will serve to demonstrate.

Consider a commodity such as steel. A particular economy with a given technology will allocate the steel it produces in a unique way. Some of the steel will be used to make equipment for making more steel (e.g., rolling mill equipment), some will be exported (or some will be imported), and some will be used in the manufacture of cars, buildings, bridges, etc.

Obviously, all of the steel that is allocated or used up must add up to all of the steel made. If the total amount of steel made is 1,000,000 tons an allocation might be as follows:

| Steel used to make steel | 500,000 tons |
| Steel used to make cars | 100,000 tons |
| Steel used to make bridges | 100,000 tons |
| Steel used to make buildings | 290,000 tons |
| Steel sold to households | 10,000 tons |
| **TOTAL steel production/allocation** | **1,000,000 tons** |

The steel used to produce other commodities in the economy reflects the “linkages” mentioned above. The extent to which the economy is an integrated whole depends on the strength of these linkages. Linkages that tie steel to the output of more finished products are known as forward linkages while those (not shown in this example) that relate steel to basic raw materials and labor are known as backward linkages. A similar table could be constructed for every commodity in the economy and, taken together, these would describe the entire economy and the full range of effects associated with increases or decreases in the production of any particular commodity. A common unit of measurement is necessary if the sectors are to be linked into a single model of the economy. Thus, all inputs and outputs are measured in dollar units rather than physical units.

An input-output model used by most federal agencies is the IMPLAN model, developed by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the Bureau of Land Management. We employed IMPLAN to calculate the direct, indirect, and induced economic costs associated with a reduction in final demand of 52,214,792 gallons of fuel oil in the Puget Sound area. The Puget Sound area lies within King County, WA. For this study we used Minnesota IMPLAN Group’s IMPLAN software using 2004 King County data.
files. The IMPLAN model enabled us to calculate direct, indirect, and induced losses in economic activity associated with the reduced U.S. fuel oil demand. Direct losses are those incurred by the petroleum-refining sector, indirect losses are those incurred by businesses that are linked to that sector, and induced losses are those associated with decreased household spending. The IMPLAN handbook available online at [www.implan.com](http://www.implan.com), describes how IMPLAN implements the above IO framework.

Table 7 summarizes the IMPLAN calculations. The results of the IMPLAN analysis suggest that a 52,214,792 gallon reduction in fuel oil purchases at roughly $1.40 per gallon from U.S. suppliers will cause direct losses of over $72 million in lost labor income and value of output, indirect losses of nearly $16 million, induced losses of roughly $55 million, and job losses of roughly 886 workers per year. Of course, whether or not the U.S. economy suffers these losses depends upon whether or not Portsite is actually developed into a regional fuel distribution center and whether fuel oil is actually purchased overseas. As discussed in Section 3.8, this scenario is highly uncertain, warranting use of an expected value for the costs displayed in Table 7.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Annual Costs</th>
<th>Lost Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct: petroleum sector</td>
<td>$72,684,234</td>
<td>300</td>
</tr>
<tr>
<td>Indirect: business linkages</td>
<td>$15,625,082</td>
<td>114</td>
</tr>
<tr>
<td>Induced: households</td>
<td>$55,427,921</td>
<td>455</td>
</tr>
<tr>
<td>Total:</td>
<td>$143,737,236</td>
<td>886</td>
</tr>
</tbody>
</table>

To incorporate these costs into our BCA critique, we applied the 50% discount factor discussed in Section 3.8 to year by year cost estimates beginning in year 2011. In years 2011 through 2029, we calculated the annualized direct, indirect, and induced costs associated with displacement of 52,214,792 gallons of Puget Sound fuel purchases now used by the mine and villages. We assumed that the DIFR’s $1.40 fuel cost estimate would hold throughout this period. In the years 2030 through 2061, we assumed that mine operations would have ceased and limited our cost calculations to village fuel use. This results in an annualized DMTP cost of $30,847,903 if only direct costs are considered, and $60,848,972 if direct, indirect, and induced costs are included. Despite this magnitude, the DIFR and DEIS are devoid of even a mention, much less than an analysis of these important direct, indirect, and induced economic costs.

### 4.2: Marine pollution costs.

In our 2003 report, ELI undertook to estimate the potential costs due to fuel oil spills to water during the construction, maintenance, and operation of the DMT as a fuel depot. At that time, ELI was responding to the fact that the Corps had not considered the possibility of spills as part of their benefit-cost analysis. The Corps has rectified that shortcoming in the DEIS Appendix 10-Fuel Risk Spill Analysis. We are pleased to see this potentially serious issue considered in full.
However, we still recommend attaching cost figures to their estimates, which the Corps did not do.

The Corps and TCAK conducted a thorough appraisal of the risk of fuel spills either from tanker vessels or Terminal Storage/Transfer facilities, and arrived at a combined figure, under the Trestle-Channel preferred alternative of 71 gallons per year spilled to water (DEIS Appendix 10 at 18). This is composed of an estimate of 43 gal/yr spilled to water from storage and transfer facilities and 28 gal/yr from tanker vessels. This value is derived from taking half of the AK statewide spill average of 1.7 gallons spilled per million gallons of throughput at individual storage/transfer facilities. The reason they use half of that estimate is that approximately half of any given spill is predicted to spill to water, and half to ground.

The Corps clearly states that this is a fairly low-probability even in any given year, but is a reasonable and conservative figure to use. This estimate is considerably lower than ELI’s estimate of 8,428-11,592 gallons per year. This discrepancy is based on a great deal of onsite research by TCAK, and reflects the use of data and methodology not available to ELI at the time of last analysis.

However, there is no calculation of potential costs to the marine environment. As stated in Section 4.3 of ELI (2003), a reasonable estimate of per gallon spill costs (to water) is $1,000. This includes assessment and restoration costs, and compensable damages. While the EPA, Coast Guard, or ADEC may have a minimum threshold for oil spill cleanups, and this value of 71 gallons may fall short of that, the $1,000/gallon figure stands as a cost irrespective of whether action is taken. It reflects an external cost that accrues even if the spill is not cleaned up. In Section 2.5, we discuss the imperative of accounting for such external costs in the NED framework. Thus, even if the spill figures predicted by the Corps are relatively small, the external cost of such spills ought to be estimated and incorporated in the BCA.

Table 8
Marine Pollution Costs Associated with Predicted Oil Spills

<table>
<thead>
<tr>
<th>Period:</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011-2029</th>
<th>2030-2061</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted gallons spilled/yr</td>
<td>22.22</td>
<td>25.71</td>
<td>27.35</td>
<td>24.74</td>
<td>71.00</td>
<td>22.24</td>
</tr>
<tr>
<td>Predicted cost/yr</td>
<td>$22,200</td>
<td>$25,710</td>
<td>$27,350</td>
<td>$24,740</td>
<td>$71,000</td>
<td>$22,240</td>
</tr>
</tbody>
</table>

To estimate marine pollution costs associated with predicted spills, we first estimated a predicted spill-to-water quantity under the trestle-channel alternative for every year of the project life, using the estimate of 1.7 gallons of spill for every 1,000,000 gallons of throughput, and dividing by two (since only half is expected to spill into the marine environment). Throughput figures were based on our estimate of gallons used during construction (See Section 4.4 below) and the Corps figures for mine and village use. We adjusted expected fuel throughput based on the three major phases of the DMTP.39 We then simply multiplied the expected number of gallons spilled in each time frame by $1,000. The results are reported in Table 8. As shown in Table 8, during

---

39 As in other sections of this analysis, we modeled three distinct time frames: (1) construction (2007-2010); (2) mine operation (2011-2029), and (3) post-mine operation (after 2029).
the construction phase, we could expect an annual spill to water range of 22 - 27 gallons, resulting in a per year projected cost of approximately $22,200 to $27,350. During the 2011-2029 phase of the project we recommend that the Corps include a probability-discounted figure of $71,000 per year as a cost arising from potential fuel spills to water. During the 2030-2061 phase (after mine closure), we again project just over 22 gallons per year spill to water, with an attendant value of $22,200. These costs translate into an annualized marine pollution cost of $61,529 over the life of the DMTP.

4.3: Forgone savings from investment in wind energy.

In our 2003 analysis, we estimated that by prolonging reliance on imported diesel fuels, the Corps was indirectly imposing annualized opportunity costs of $1.2 – 3.0 million on Northwest Alaska villages in the form of forgone savings from wind energy – a reasonable renewable alternative investment to the $37 million the Corps plans to spend on DMTP improvements (ELI, 2003). In response, the DIFR now contains at least a cursory analysis of wind energy potential. Appendix E at E-128 states “[w]ithout continued subsidies…high saturation wind energy will need to benefit from some form of accompanied cost reduction.” In addition, the Corps’ analysis found a “diesel fuel cost trade-off balance point” of $2.80. This is the point at which wind power would start to become favorable as compared to diesel generation (Id.). Given the DIFR’s diesel price assumption of $1.40 per gallon, the Corps has dismissed the potential benefits of investing in wind at this point in time. Because the DIFR now has at least some analysis, we did not update our 2003 calculations. However, there are two key reasons why the Corps analysis is not persuasive, and should be revisited.

First, there are rapidly evolving institutional changes that are likely to make wind energy a more viable option relatively soon. As energy costs increase in rural Alaska (Current Community Conditions 2005; PCE 2005; Administrative Order 23040) the state government, at the behest of Governor Murkowski, is looking into ways to lessen the burden. The Governor created the Rural Energy Action Council (REAC) in 2005, with the express intent of devising strategies to reduce the cost of energy in rural Alaska. The REAC put forth 11 proposals, including two we have mentioned in section 3.7: increasing generator efficiency, and increasing wind penetration. Recommendations 8f and 8g are specifically about improving wind power facilities in rural communities. 8f recommends investing in wind-diesel hybrid systems and 8g recommends investing in the installation of wind turbines in remote locations. As cited in section 3.7 the report states “The Alaska Rural Energy Plan of 2004 recommends roughly a $30 Million effort over five years towards installing wind-diesel systems in rural communities (REAC at 20).” The report also recommends the investment of $3-5 million dollars for the installation of wind turbines and systems.

The state already seems to making progress on these recommendations. On April 17, 2006, the Alaska Energy Authority (AEA) along with the Alaska Industrial Development and Export Authority (AIDEA) released a request for proposals (RFP) for projects that would reduce energy costs, including wind projects. The Commission had about $1.3 million to spend on the projects, as well as slightly over $5 million in loan financing through the Power Project Loan Fund.

As of December 1, 2006, AEA released another RFP, this time specifically for the construction of wind energy projects\(^{41}\). The RFP states that the US Department of Energy (DOE) has made approximately $1 million dollars available for these grants and that “State funds are available to assist with the cost share.” A large portion of the evaluation of proposals has to do with diesel use displacement. “Evaluators will rank projects in order of greatest impact (gallons of diesel fuel that will be displaced by the project) compared to the amount of grant funding provided through this RFP (p. 13).” Clearly the government of the state of Alaska is moving forward with the Council’s recommendations, and has a stated intention of reducing of diesel consumption.

Secondly, current fuel prices and fuel price projections now warrant a more thorough consideration of potential wind energy savings. As noted above, the Corps mentions a “diesel fuel cost trade-off balance point” of $2.80. This figure is quoted based on the operating costs of the Kotzebue Electric Association (KEA), and so may not apply elsewhere in the state, but that price has already been exceeded in much of rural Alaska. According to the Current Community Conditions report “[w]hen considering statewide heating fuel prices, Everts Fuel in Hughes (Western Alaska) reported the highest heating fuel retail price at $5.40 per gallon. In contrast, the City of Akutan (South Coastal Alaska) reports the lowest heating fuel retail price at $2.30 per gallon. On average, heating fuel retail price is $3.48 per gallon across Alaska with 93 communities reporting heating fuel prices.”

Clearly some of the variation in these prices is due to delivery expenses, as the Corps points out, but prices throughout the state are clearly increasing. The USDOE Energy Information Agency’s fuel price projections (reported in Section 3) also anticipate a considerable increase in heating and marine fuel prices. Their estimates are for the lower 48 states, not including Alaska, but the predicted prices increase to well over $2.00/gallon for heating fuel by 2018\(^{42}\)

From discussions with engineering staff at KEA in 2003, we found the same caveats as the Corps states in their current DIFR. For instance, wind generation will likely never cover 100% of energy generation needs in any location; installation of wind systems in remote locations is more expensive than anywhere in the lower 48 or even southeast Alaska; maintenance of the turbines and systems might not be entirely reliable given the limited technical skills of most people living in the Arctic region, and so on. Given these constraints, it still appears likely that the State of Alaska will move forward on improving energy options in rural areas, and that part of those improvements will be wind systems.

The Corps states “[t]he above comparison treats the spike in fuel cost caused by international unrest and crude oil flow disruption…as a short-term variation in the context of the 20-year life of the units and 50-year planning period (Appendix E at E-124).” The DOE EIA does not seem to take that for granted. Its reference price projections in the 2006 report far exceed those used by the Corps in 2003 and its high price projections obviously exceed even those. It would seem prudent for the Corps to take into account the probability that the price spikes, though currently diminished, maybe not be simply “a short-term variation”. If in fact they were not, Kotzebue itself may pass the “balance point” of $2.80 per gallon that would make wind more attractive.

---


\(^{42}\) Report #:DOE/EIA-0383(2006)
The Corps points out that the balance point may be as high as $4.25. That point has been exceeded in some communities in interior Alaska, but it does seem unlikely that Kotzebue will reach that point any time soon. However, given the state government’s more aggressive stance on wind generation, it is likely that fuel demand in the listed villages, and indeed at Kotzebue or even at Red Dog, will decline considerably over the next 20-50 years. Even if “development of wind power is going to have to rely on expectations of hard dollar benefits from long-term higher fuel displacement costs to become a viable energy alternative in remote arctic low plant factor locations (ibid),” the state’s determination to support such investments should make it a positive probability event. We therefore strongly recommend that the Corps revisit its assumptions about the viability of wind energy as an alternative to the $37 million the agency now plans on investing to prolong the region’s fossil fuel dependence.

4.4: Carbon emissions damage.

Global warming caused by anthropogenic emissions of carbon dioxide from the burning of fossil fuels is the world’s most compelling environmental concern. There is no longer any debate over whether or not our consumption of fossil fuels is causing global warming, nor is there any debate over whether or not global warming will lead to catastrophic environmental, economic, and social costs. Coastal flooding, extreme storm events, extinctions, heat waves, droughts, steep declines in agricultural productivity, and mass human migrations are just a few.

The Arctic has often been referred to as “ground zero” for global warming. According to the Arctic Climate Impact Assessment (2004) “[t]he Arctic is now experiencing some of the most rapid and severe climate change on earth.” Within the Arctic region, some of the most conspicuous effects will include dramatic or even total loss of permanent sea ice, changes in ocean salinity, disappearing tundra, collapse of both marine and terrestrial ecosystems, an increase in the severity and frequency of forest fires and insect outbreaks, increased exposure of coastal infrastructure to storms and shoreline erosion, infrastructure damage from thawing, and displacement of indigenous peoples from their ancestral lands (Hassol, 2004).

If unchecked, global warming will have devastating effects on the world’s economy. A newly released report prepared by economists at the Global Development and Environment Institute at Tufts University provides a summary of these dire consequences:

- **Agriculture:** Rising temperatures and variable, extreme weather events will reduce crop yields, an effect that will be particularly severe after 2050 when opportunities to adapt, introduce new crop varieties, or move agriculture to formerly colder areas are exhausted.
- **Industry and infrastructure:** Extreme weather events will strain urban infrastructure and require expensive new investments to deal with escalating demands for cooling, water supply, and repair or replacement of damaged structures.
- **Fresh water:** Climate change will continue to impact the quality and quantity of fresh water supplies needed for drinking, sanitation, agriculture, and industry. Higher temperatures will result in more evaporation and the need for more intense irrigation.
- **Human health:** The short term health consequences of warming will be increases in tropical diseases, deaths from heat waves, and malnutrition.
• **Ecosystems and extinctions:** Ecosystems on which humans depend for survival will be unable to adapt to rapid warming and collapse.

Taken together, these costs could amount to nearly $20 trillion a year by 2100, or 6-8% of global economic output (Ackerman and Stanton, 2006). According to Stix (2006), “[p]reventing the transformation of the Earth’s atmosphere from greenhouse to unconstrained hothouse represents arguably the most imposing scientific and technical challenge that humanity has ever faced.” And to accomplish this, immediate measures must be taken to halt additional growth in greenhouse gas emissions and speed the transition to renewable forms of energy.

Against this backdrop, the Corps’ plans to subsidize increased consumption of fossil fuels at the DMT and prolong fossil fuel dependence in Arctic Villages without even mentioning the potential environmental or economic consequences associated with increased carbon dioxide emissions in either the DEIS or the DIFR is an alarming oversight.

4.4-1: An analysis of carbon emissions is required by NEPA.

There is no question that the Corp is aware of the impacts of global warming, and the urgent need to transition to renewable energy sources. In its 2005 report “Energy Trends and Implications for U.S. Army Installations,” the Corp echoed the global consensus:

We must act now to develop the technology and infrastructure necessary to transition to other energy sources and energy efficient technologies. Policy changes, leap-ahead technology breakthroughs, cultural changes, and significant investment are requisite for this new energy future. Time is essential to enact these changes. The process should begin now. Our best options for meeting future energy requirements are energy efficiency and renewable sources (ACOE, 2005).

Nor is it in doubt that to fulfill its obligations under NEPA, carbon emission and the likely effects of such emissions must be discussed. Courts have expressly held that NEPA requires federal agencies to evaluate the impact of carbon emissions attributable to federal actions, even for projects where the total emissions were significantly smaller than the amounts at issue here. For example, in *Mid States Coalition*, 345 F.3d at 532, plaintiffs challenged the Surface Transportation Board’s approval of a new rail line to service coal mining operations in Wyoming's Powder River Basin. Plaintiffs alleged that the Board violated NEPA by failing to consider the indirect impacts resulting from eventual combustion of coal delivered by the rail line. The court agreed, finding that the eventual combustion of the coal was not “speculative” – as the Board claimed – but instead “almost certain.” Based on the fact that combustion of the fuel was reasonably foreseeable and that carbon emissions are a source of significant environmental damage the court concluded that the defendant was legally required to consider the project’s indirect carbon dioxide emissions in its NEPA analysis.

Similarly, in *Border Power Plant Working Group v. DOE*, 260 F. Supp. 2d 997 (S.D. Cal. 2003), the court found that the Department of Energy (DOE) was required to evaluate the greenhouse gas emissions of a single 500 MW gas-turbine power plant—despite the fact that the plant’s contribution to climate change may have been minor, and despite the fact that the plant was
located in Mexico. As stated in the published opinion, “[b]ecause these emissions have potential environmental impacts and were indicated by the record, the Court finds that the EA’s failure to disclose and analyze their significance is counter to NEPA”. Thus, even though the emissions associated with a single 500 MW plant are relatively small, DOE’s failure to consider these relatively minor emissions still rendered its decision inadequate.

In yet another opinion in an action against the Overseas Private Investment Corporation (OPIC) the court in Friends of the Earth et al., vs. Peter Watson and Phillip Merrill (No. C 02-4106 JSW, N.D. California) found that Plaintiff’s evidence was sufficient to demonstrate that it is reasonably probable that emissions from projects supported by OPIC threaten Plaintiff’s concrete interests and, thus, are subject to consideration in a NEPA analysis.

In fact, the Corps consistently addresses carbon emissions in the NEPA process. For example, in the agency’s Final Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement the Corps concludes that greenhouse gas inventory “is a prerequisite for evaluating the cost effectiveness and feasibility of mitigation strategies and reduction technologies” (ACOE, 2002a). The Feasibility Study and EIS present carbon emissions with and without dam removal in the air quality section. As another example, in its DEIS for the Cape Wind Farm project in New England, the Corps estimated that project would offset nearly 1,000,000 tons of carbon dioxide emission each year and cited this reduction as one of the key project benefits (ACOE, 2002b).

Thus, given the catastrophic environmental, economic, and social impacts of climate change, the Corps acknowledgment of the need for a speedy transition to renewable energy, precedent from case law, and precedent from the Corps’ own documents, it is abundantly clear that carbon emissions must be addressed by the Corp in its NEPA analysis of the DMTP. Even more so, since the project’s economic justification rests solely on its claims of more economical deliveries of diesel fuel.

4.4-2: An analysis of carbon emissions is required by the Corps’ NED procedures.

As discussed in Section 3, “[t]he NED principle requires that externalities be accounted for in order to assure efficient allocation of resources” (IWR, 1991a, pg. 21). As one of the most important externalities generated by the DMTP there is also little doubt that the Corp must incorporate carbon emissions damage into its benefit-cost analysis. This is especially true since estimates of carbon emissions damage per ton of carbon emitted have been available for well over 15 years. For example, in a recent meta-analysis of 103 separate emissions damage estimates from 28 published studies, Tol (2005) found a mean marginal damage cost of $93 per ton, but concluded that it is unlikely that marginal damages exceed $50 per ton. More recently, Ackerman and Stanton (2006) endorsed continued reliance on the UK Government Economic Service’s 2002 estimate of £70 ($131) per ton. Despite variation in damage estimates, these studies illustrate there is a wealth of information available to the Corp for assigning a cost to carbon emissions generated by the DMTP. As of this writing, the UK Treasury published the Stern Review Report on the Economics of Climate Change (2006), which uses a social cost per ton CO₂ emitted of $85.
In the remainder of this section, we provide quantitative analysis of carbon emissions damage that can be used to satisfy both the Corps’ NED and NEPA duties. First, we calculate the annual carbon emissions damage associated with the DMTP as an externalized cost factor that can be incorporated into the benefit-cost analysis. Secondly, as a purely environmental measure, we calculate the increase in the carbon footprint associated with operation of the Red Dog Mine as well as fuel consumption by regional villages induced by the DMTP.

4.4-3: Preliminary estimates of carbon emissions damage.

Our preliminary estimate of carbon emissions damages caused by the DMTP begins with an assessment of fuel use in both with and without project scenarios. In both scenarios, fuel use can be broken into four distinct categories: (1) fuel burned during construction activities; (2) fuel used at Portsite and the mine; (3) fuel burned by vessels, and; (4) fuel burned during annual operation, maintenance, repair, replacement, and rehabilitation activities (OMMR&R). Throughout our analysis, we assume that all fuel consumed is distillate fuel (No. 1, No. 2 or No. 4 fuel oil and diesel).

Because of the temporal variation in fuel use during the life of the DMTP, we also need to consider fuel use during seven distinct time periods: 2007, 2008, 2009, 2010, 2011-13, 2014-2029, and 2030-2064. In each of the first four years of the project (2007-2010) the only increase in fuel use associated with the DMTP is for construction activities and for OMMR&R, and since the amount of construction varies considerably year to year, we must consider each of the first four years separately. In its DIFR and supporting documents, the Corps does not provide detailed information on fuel use for these activities. The Corps does, however, provide annual cost estimates for both construction and OMRR&R. Thus, in order to derive an estimate for fuel use, we had to estimate the proportion of annual construction and OMRR&R expenditures attributable to fuel, then divide by $1.40 – the Corps’ assumed cost per gallon.

To accomplish this, we consulted variety of sources describing the proportion of operating costs for equipment used in construction as well as maintenance dredging and other OMRR&R activities associated with fuel use. These include the Corps official guidance memorandum EP-1110-1-8 (2005) – which breaks out hourly fuel costs associated with a wide array of construction equipment – as well as outside studies, such as a recent study by the General Accounting Office (2003) detailing operating costs for Hopper dredges used in many Corps port improvement projects. Taken together, these sources suggest that roughly 10% of Alaskan construction and OMRR&R costs are attributable to fuel consumption. Based on this figure, and based on Corps’ annual cost figures from the DIFR, we estimate that fuel used during construction totals 215,864 gallons in 2007, 4,322,933 gallons in 2008, 6,259,767 gallons in 2009, and 3,188,995 gallons in 2010. The DIFR presents OMRR&R costs only in terms of annualized figures, which are constant, so we estimate annual fuel consumption to be constant at 88,946 gallons.

During the 2011-2013 period, fuel use increases as a result of (1) OMMR&R activities; (2) increased fuel used by Portsite and the mine as concentrate production increases; (3) increased fuel used to ship that extra concentrate, and (4) increased fuel use by ships delivering fuel oil from Singapore rather than Puget Sound. We already calculated OMRR&R fuel needs.

57
Increased fuel use at Portsite and the mine associated with increased concentrate production is estimated by the DIFR to be 3,364,500 gallons per year. To estimate the increase in fuel needed to ship that extra concentrate, we assumed one additional shipment in a Handysize Panamax vessel would be needed and combined the Corps’ estimate of average days at sea for that vessel for concentrate deliveries (14) with published figures reporting fuel consumption for this vessel to be 45 tons per day (Maxim, 2001). A gallon of diesel fuel weighs just over 7.1 pounds and a ton is 2000 pounds so by multiplying 45 by 14 by 2000, then divide by 7.1 we arrive at 177,465 gallons per year as the fuel needed to ship the extra concentrate induced by the DMTP.

To calculate the additional fuel requirements caused by a shift in origin for fuel consumed at Portsite and the mine from Puget Sound to Singapore, we calculated the extra days at sea for the two Panamax sized vessels needed to transport the nearly 26 million gallons (92 tons) of fuel each year. Currently, this fuel is delivered by two vessels from Puget Sound averaging 528 nautical miles per day. The round trip distance is 3,902 miles so days at sea are 7.4 per vessel, or 14.8 total. The DMTP will cause a shift in origin to Singapore. The round trip distance becomes 12,400 miles, which translates into 47 days at sea total for both vessels. The difference in days at sea translates, in turn, into an additional 1,449 tons or just over 408,000 gallons of fuel used each year.

Between 2014 and 2029, villages will receive their fuel oil from Singapore rather than Puget Sound as well, so fuel used in shipping increases once again. It turns out that the increase in days at sea is identical to the increase associated with Portsite and mine fuel consumption because the same number of shiploads (2) is required to haul the 29.8 million gallons (105,810 tons) used by villages for end uses such as heating. Thus, during this period, consumption of an additional 1,449 tons or 408,000 gallons per year is induced by the DMTP. After 2029, and as discussed under Section 3.6, we assume mine operations terminate (as Teck-Cominco presently predicts), leaving annual OMRR&R activities and village fuel shipments as the only source of increased fuel use.

With the year by year increase in fuel consumption figures in hand, the remaining calculations needed to estimate annual carbon emissions damage are relatively straightforward. According to figures published by the Energy Information Administration, a gallon of distillate fuel emits roughly 22.38 pounds of carbon dioxide per gallon. Since the molecular weight of carbon is 12 and that of carbon dioxide 44, we multiply this figure by 12/44 or .2727 to extract the carbon component, which is 6.10 pounds. Multiplying this figure by the year by year increase in gallons of fuel consumed and then dividing by 2000 gives us the annual carbon emissions in tons induced by the DMTP over and above the amount of carbon emissions associated in the without project scenario.

The final step is to multiply this figure by the marginal damage cost of carbon emissions. Previously, we cited figures reported by Tol (2005) and the UK’s Government Economic Service. These studies present a range between $50 and $131 per ton. In this analysis, we adopt Tol’s estimated mean of $93 per ton as a midpoint, a figure not significantly different from the Stern Review’s estimate of $85 per ton. By multiplying this figure by the year to year increase in carbon emissions attributable to the DMTP we arrive at the estimates presented in Table 9.

below. The first seven lines of the table present the annual emissions damage estimates for the periods indicated, excluding OMRR&R activities. The values for periods with more than one year are annual estimates. When summed over the entire project life (2007-2061) and discounted (or compounded for years 2007 to 2010 since 2011 is the base year) at an annual rate of 5 3/8% we estimate the net present value of carbon emissions damage to be just under $20 million. Annualizing this value and then adding in the annualized damage from OMRR&R activities ($158,069) yields our final estimate of annualized carbon emissions damage: $1,272,720. To be complete, the Corp’s benefit-cost analysis must be adjusted to incorporate this important externality.

### Table 9
**Annual Carbon Emissions Damage**

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Damage from Construction Activities</th>
<th>Increase in Damage from Portsite and Mine Fuel Use</th>
<th>Increase in Damage from Fuel Used in Shipping</th>
<th>Total Annual Increase in Emissions Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>$61,277.34</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$61,277</td>
</tr>
<tr>
<td>2008</td>
<td>$1,227,150.31</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$1,227,150</td>
</tr>
<tr>
<td>2009</td>
<td>$1,776,959.16</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$1,776,959</td>
</tr>
<tr>
<td>2010</td>
<td>$905,259.67</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$905,260</td>
</tr>
<tr>
<td>2011-2013</td>
<td>$0.00</td>
<td>$955,080.00</td>
<td>$166,205.51</td>
<td>$1,121,286</td>
</tr>
<tr>
<td>2014-2029</td>
<td>$0.00</td>
<td>$955,080.00</td>
<td>$282,034.16</td>
<td>$1,237,114</td>
</tr>
<tr>
<td>2030-2061</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$115,828.64</td>
<td>$115,829</td>
</tr>
</tbody>
</table>

**Net present value (2007-2061):** $19,573,054  
**Annualized emissions damage (2007-2061):** $1,114,651  
**Annualized emissions damage from OMRR&R activities:** $158,069  
**Total annualized carbon dioxide emissions damage:** $1,272,720

### 4.4-4: Preliminary estimate of the DMTP carbon footprint.

The ecological footprint is one of the most ubiquitous measures of environmental sustainability in use today by governments, non-governmental organizations, and businesses (UNCBD, 2005). Stated simply, the footprint is a measure of how much of the Earth’s surface we are appropriating through our production and consumption activities. The footprint is subdivided into six distinct “biomes”: crop land, pasture land, forest land, marine and inland fisheries, built space, and energy land. For each biome, ecological footprint analysis calculates the amount of area appropriated by the particular consumption patterns of individuals, cities, nations, or the world as a whole expressed in normalized “global hectares” which account for the differences in biological productivity across biomes (Wackernagel et al., 2005). The fossil fuel subcomponent of the energy land biome calculates the amount of the Earth’s surface needed to sequester our carbon emissions. This particular subcomponent of ecological footprint analysis is known as the carbon footprint.

The carbon footprint of any population can be compared with the amount of land available to that population within its borders or on a “fair earth share” basis (i.e. the amount of carbon sequestration land available to each person if everyone on Earth had the same amount). This allocation of land is referred to as biological capacity. If the carbon footprint exceeds biological capacity a given population is said to be overstepping its ecological limits. If the footprint is less than or equal to its biological capacity, it is said to be sustainable. Carbon footprint analysis can
also be used as a measure of carbon intensity – i.e. carbon footprint per unit of production or per unit of value. Used this way, carbon footprint analysis is a way to compare the carbon intensity of various products or production processes. Calculating the carbon footprint is relatively straightforward once we know the actual or equivalent fossil fuel use associated with a particular individual, city, or nation’s production or consumption patterns. Based on calculations made by the Intergovernmental Panel on Climate Change, Venetoulis and Talberth (2006) determined that the average carbon absorption capacity of the Earth to be .06 tons of carbon per hectare, which translates into 16.67 hectares per ton. We incorporate this figure into our analysis of the DMTP carbon footprint.

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Footprint from Construction Activities</th>
<th>Increase in Footprint from Portsite and Mine Fuel Use</th>
<th>Increase in Footprint from Fuel Used in Shipping</th>
<th>Footprint from OMRR&amp;R Activities</th>
<th>Total Annual Increase in Carbon Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>10,983.80</td>
<td>0.00</td>
<td>0.00</td>
<td>28,333.44</td>
<td>39,317.23</td>
</tr>
<tr>
<td>2008</td>
<td>219,963.39</td>
<td>0.00</td>
<td>0.00</td>
<td>28,333.44</td>
<td>248,296.83</td>
</tr>
<tr>
<td>2009</td>
<td>318,515.15</td>
<td>0.00</td>
<td>0.00</td>
<td>28,333.44</td>
<td>346,848.59</td>
</tr>
<tr>
<td>2010</td>
<td>162,265.36</td>
<td>0.00</td>
<td>0.00</td>
<td>28,333.44</td>
<td>190,598.80</td>
</tr>
<tr>
<td>2011-2013</td>
<td>0.00</td>
<td>171,195.52</td>
<td>29,791.89</td>
<td>28,333.44</td>
<td>229,320.85</td>
</tr>
<tr>
<td>2014-2029</td>
<td>0.00</td>
<td>171,195.52</td>
<td>50,553.86</td>
<td>28,333.44</td>
<td>250,082.82</td>
</tr>
<tr>
<td>2030-206444</td>
<td>0.00</td>
<td>0.00</td>
<td>20,761.97</td>
<td>28,333.44</td>
<td>49,095.41</td>
</tr>
</tbody>
</table>

Total increase (2007-2064): 7,232,688.52
Annualized footprint increase (2007-2064): 133,938.68
Annualized DMTP benefits: $22,670,388
Footprint per $1,000.00 benefit: 5.91

Global carbon footprint per $1,000.00 in economic output: 2.79

As with carbon emissions damage, we are most interested in the incremental increase in the carbon footprint associated with the Corps approval of the DMTP. In the previous section, we calculated the additional fuel use associated various activities induced by the DMTP in various time frames. By multiplying the increase in carbon emissions associated with each of these activities in each time frame by 16.67, we arrive at the increase in the carbon footprint attributable to the DMTP. The results are displayed in Table 10. Detailed calculations appear in Appendix 2, pages A3-1 to A3-6. As before, by summing this increase across all time frames and then annualizing over the entire life of the project (54 years) we arrive at the annualized increase in the carbon footprint associated with the DMTP: 133,936 hectares, or nearly 331,000 acres. Thus, if approved, the DMTP will expand the area needed to sequester the carbon emissions associated with operation of the Delong Mountain Terminal by 331,000 acres.

It is also of interest to consider the total carbon footprint associated with operation of the Delong Mountain terminal instead of just the incremental increase associated with the DMTP. The calculations appear on page A3-7 of Appendix 2. If approved, carbon emissions associated with

---

44 The DIFR is ambiguous in when fuel delivery savings are terminated for purposes of analysis. In most cases, it is assumed to be 2061, but in others, it is assumed to be 50 after the benefit stream begins (2014). In this section, we used the latter.
operation of Portsite and the mine as well as fuel consumption in villages supplied by way of Portsite will average 157,256 tons per year in the peak years of 2011 to 2029. This translates into a carbon footprint of 2,621,454 hectares, or 6,477,612 acres. By way of comparison, this is nearly 10.5 times larger than the project area.

As discussed earlier, carbon footprint analysis can also be used as a general measure of carbon intensity. If we divide the increase in the annual carbon footprint associated with the DMTP by the annualized project benefits (from Modification 2, Section 5) we see that the DMTP will require 5.91 hectares for every $1000 in economic benefit. For economic output for the world as a whole, Venetoulis and Talberth (2006) find that figure to be 2.79 hectares per $1000. Thus, we can say that economic output associated with the DMTP will be 491% more carbon intensive than the global average.

4.5: Loss of passive use values for marine ecosystems.

As discussed in Sections 1.3 and 2.5 the Corps has a duty to discuss both market and non-market economic impacts and quantify the magnitude of significant externalities (whether positive or negative) it preparation of benefit-cost analyses. This duty is clearly set forth in Corps regulations governing NED analysis and the Corps NED guidance manuals (WRC, 1983; Apogee, 1996). It is also clearly set forth in Executive Order 12893, and discussed in numerous statutes and regulations governing water resource development. Despite these requirements, neither the DEIS nor the DIFR discuss non-market impacts or quantify even a single externality. In fact, the only reference to non-market effects at all is an attempt to refute the usefulness of the contingent valuation methodology (Appendix E at 6). However, because marine ecosystems generate a wide array of non-market benefits in their natural state which are eliminated or severely compromised by development projects such as the DMTP, the Corps must consider these effects in both the NED and NEPA processes.

Marine ecosystems generate enormous economic values in the form of food production, nutrient cycling, disturbance regulation, biological control, habitat for economically valuable species, and recreational and cultural uses. Since most of these “ecosystem services” are not formally traded in established markets, their importance must be measured by non-market valuation tools. Using such tools, Costanza et al. (1997) estimate that global marine ecosystems generate approximately $4,881 per hectare per year in ecosystem services. Colt (2001) applied these figures to Alaskan marine ecosystems. Colt’s estimate of the value of Alaskan marine ecosystems is nearly $393 million per year in 1998 dollars. While these estimates are certainly generalized, they nonetheless provide an important first step in understanding that marine ecosystems produce enormous economic values simply by existing in an unaltered state.

When marine ecosystems are damaged or destroyed, these benefits disappear, resulting in substantial economic costs to those who use marine ecosystems for subsistence and recreational uses or benefit from the many other ecosystem services they provide. As planned, the DMTP will adversely affect marine ecosystems in several ways, however, the most significant impact will be the direct loss or degradation of nearly 7,000 acres of marine habitat through dredging and dredge disposal.
Species and species groups adversely affected by this habitat loss and other aspects of the DMTP include king crabs (*hyas* and *telmessus* subspecies), crabs, shrimp, clams, anadromous fish, marine fish, beluga whales, bowhead whales, gray whales, ringed seal, bearded seal, spotted seal, and waterfowl (DEIS at 327-386). For some species, impacts will extend over a wide area. For example, “[b]earded seals would lose partial value of up to 10 square miles of potential food-producing habitat for one or more years after each dredging event” (DEIS at 373).

In Section 1.3, we reviewed several non-market valuation methods the Corps can employ to measure the non-market costs associated with the loss of marine ecosystems. Given the remoteness of the DMTP region, the most appropriate method is contingent valuation (CV) since a large portion of the economic value of marine ecosystems in the DMTP area are passive use values placed on preservation of these ecosystems by those who may never actually visit. A recent Corps analysis neatly defined passive use values: “[e]conomists generally recognize that there is a benefit associated with knowing that a resource exists, even if no use is made of it. These values are typically referred to as passive use, non-use, or existence values” (ACOE, 2002a, Appendix I at ES-20). In the context of NED analysis, the Corps’ planning guidance explicitly endorses the use of contingent valuation surveys to quantify passive use values, at least in terms of recreation activities (WRC, 1983; Loomis, 1999). The Corps also recognizes that quantifying passive use values is useful for addressing social values not formally included in NED analysis. For example, in its economic analysis of dam decommissioning and removal on the lower Snake River the Corps relied on a benefits transfer methodology to quantify passive uses and incorporated a discussion of passive use values in both the Feasibility Study and EIS (ACOE, 2002a).

One way that economists use CV to ascertain the values of marine ecosystems is to posit a hypothetical scenario of protection for that ecosystem. A common designation chosen for that scenario is that of a marine sanctuary. In this section, we present the results of an original CV survey that derives willingness to pay values from Alaska households for designation of a marine sanctuary in the waters around the DMTP. Such a designation would preempt the Corps from proceeding with the DMTP and, as such, these values provide a proxy for the non-market costs to marine ecosystems should the DMTP proceed as planned.

However, the Corps DIFR states that CV is inappropriate for the project area. Therefore this section will proceed as follows. We will first present the Corps objections to, and our arguments for the CV approach. We will then review the existing literature on economic values of marine sanctuaries and other marine protected areas. Following that, we will present our survey design, theoretical considerations, and results.

4.5-1: The Corps’ objections to the use of contingent valuation are unfounded.

The Economic Appendix to the DIFR states the following: “[a] decision was made to not apply contingent valuation methods as a basis for benefit evaluation of non-market effects for the following reasons:

- To be valid, CV questionnaires require reference to use of a realistic payment vehicle, however, none exists in the project area.
• Commodity shipment is the same with the project and without it making potential project effects very fuzzy if not unidentifiable.

• Significant controversy exists regarding extrapolation of CV findings to populations larger than the number of individuals actually interviewed.

• CV studies typically home in on one major issue (such as the value of a marine sanctuary, or the value of subsistence harvests) while ignoring less obvious but possibly offsetting values (such as family stability, employment possibilities and career paths, community participation, gains to arctic engineering, environmental justice, self esteem, etc.)” (Appendix E at 6).

In this, the Corps seems to completely sidestep any possibility of valuing non-market costs and benefits at all. Here we carefully address and refute these assertions, and then proceed to develop estimates of non-market damages caused by the DMTP to marine ecosystems.

**Payment vehicle**

When ELI designed and implemented the CV survey in 2003, our design was reviewed by a number of PhD environmental economists and the NAEC. None of the reviewers found that our hypothetical payment vehicle (contribution into a fund) was problematic. The Corps assertion that no “realistic” payment vehicle exists in the area is short-sighted. A review of the CV literature shows our methods to be more than acceptable. While other books (e.g. Mitchell and Carson, 1989) are commonly used, the NOAA panel report (1996) is considered the closest thing to guidance for civilian construction of CV. Addressing payment vehicles, the report states “[t]he payment scenario should be convincingly described, preferably in a referendum context.” Our vehicle is clearly and convincingly described, and is presented within a referendum framework. Following NOAA guidelines, Stanley (2005) uses a tax increase to pay into a Fund for protection of various endangered species in Orange County CA, and finds similar per household values for single-species protection as ELI (2003).

Bishop et al (1995) state “[t]he payment vehicle should relate naturally to the amenity or policy issue in question.” More recent work (Champ et al. 2002; p. 592) describes a situation similar to the one ELI used, and recommends the use of a fund contribution in a situation where tax increases (often politically undesirable) are likely to incur a “protest vote” of no for the proposed project. This could make Stanley’s (2005) work problematic in Alaska, where there is reputed strong opposition to tax increases of any kind. The problem of protest votes due to payment vehicles is addressed in Mitchell and Carson (1989) and several more recent papers (Schläpfer, 2006; Jorgensen et al., 1999). So while different payment vehicles may present valuation problems in different settings, it seems unreasonable to posit that none exist.

ELI’s original CV research violates none of these tenets in its survey design. Payment into a fund set up to “restore and manage the sanctuary (ELI 2003 at 4-18)” is a commonly used and accepted payment mechanism. For the Corps to propose that no realistic payment vehicle exists for the project area and to make that point without reference either to the literature or their own guidance is somewhat suspect. Indeed, if ELI were to propose running the survey again in the project area, there is no evident or stated reason why a fund contribution would be unrealistic for NWAB residents.
If the Corps economists feel our mechanism was unrealistic, they should address that issue, rather than state that no realistic mechanism exists. The use of a fund payment may be politically problematic and without precedent in the area, but surely the Corps at least has access to local expertise that could suggest a non-problematic mechanism.

**Commodity shipments**

Commodity shipment changes are only one part of the project. The construction effects on coastal, benthic, and terrestrial habitat are sufficient to suggest the generation of non-market costs. Additionally, the DIFR repeatedly mentions possible increased mine output and therefore shipment, and the possibility of increased mineral exploration, production, and shipment in the future.

The CV survey ELI conducted was meant to assess the values held by Alaskans for returning the proposed NMS to a condition describable as pre-Delong. Therefore, a specific criticism of the research could be that the survey design did not adequately address the proposed change (trestle, dredging, etc). However, this does not seem to be the point of the objection. The Corps appears to suggest that CV is not applicable in a situation wherein a single project effect or component remains fairly stable. Even a cursory look at the DEIS and DIFR will show that commodity shipments are merely part of the end result of a rather complex set of changes (including unspecified maintenance dredging throughout the project life). A CV study can have the objective of ascertaining aggregated values for some pre-project condition in order to provide insight into proposed changes. To assert that some component part of a project is relatively stable is not a viable objection to application of CV methodology.

**Extrapolation of contingent valuation results**

This is not as controversial as the Corps suggests. “If total values are to be estimated and there are reasons to believe that substantial non-use values are present, then the general population of a given geographic region may serve as a sampling frame (Bishop et al., 1995, 637).” Clearly there are non-use values to be considered here, as use-values for the project area apply to a very small fraction of the Alaskan (or U.S.) population. Therefore, surveying a sample of the general Alaskan population in order to obtain non-use values is the correct approach.

Obtaining a sufficiently large sample from which to make inferences about a population are standardized and widely recognized. Vaughn et al (2000) have developed a simple Excel module for calculating optimal sample size for CV research. Mitchell and Carson (1989) suggest that a sample size between 200 and 2500 is appropriate. Typically, however, research budget constraints tend to limit sample size. ELI faced a very tight budget constraint on this issue. We believe the USACE would have funds available for detailed CV research. A sufficiently large sample size would make extrapolation a non-issue.

An argument can always be made (especially in Alaska) that the politics of major urban and population areas do not accurately reflect those of the entire state. This too can be overcome by expanding sample size to include rural areas. ELI was unable to do this. However, we explicitly
detailed our extrapolation methods, and provided both a lower and an upper bound on our extrapolated estimates. Additionally, our relatively low (~14%) response rate could be improved by repeat mailings, and a larger up-front investment in survey design (Dilman, 2000; Mitchell and Carson, 1989). The funds to do either of these were also lacking. Again, USACE should be able to accomplish these tasks. Another point could be made that users and non-users might have different values for a given resource; even if a researcher is looking for non-use value it may be significantly different from use-value. However, Kniivila (2006) found that this is not so. Therefore, even to take CV to task for asking the question of individuals not intimately familiar with the good is insufficient. At any rate, there is ample precedent for CV research to address non-use values in areas away from the immediate impact.

**Offsetting values**

The “off-setting values” mentioned in the Corps objections to use of CV are also not a significant obstacle. If the Corps seriously contends that the values of “family stability, employment possibilities and career paths, community participation, gains to arctic engineering, environmental justice, self esteem, etc. (DIFR at E-6)” might offset the values of a proposed marine sanctuary (for example), then the Corps is suggesting that the project could generate positive externalities. As such, pursuant to NED guidance it is incumbent upon them to obtain those values: “[t]he NED principle requires that externalities be accounted for in order to assure efficient allocation of resources” (IWR, 1991a, 23).

First, they must demonstrate that the project could have significant effects on these components. Second, they must ascertain those values themselves. In our work with the village of Kivalina, we found that employment possibilities, environmental justice, community participation, and self esteem were perceived as being negatively affected (if at all) by the proposed project. In detailing the project’s contribution to all the above values, the Corps should take the opinion of local affected communities into account. Additionally, the principle of off-setting values is not extensively used in the literature. A search in the EconLit database on “off-setting values & contingent valuation” yielded no results. The only two components of the off-setting values which yielded results were “community participation (financing and ecotourism)” and “environmental justice (in Sweden, which, unlike the US, has a very homogeneous population in terms of income).” These two results were not apparently commensurate with what the Corps is suggesting.

The Corps must treat these issues seriously. Federal agencies (including the Corps) use CV regularly. The Corps must specify, with reference to its own guidance and its institutional understanding of the state of Alaska and the project area, why this method is not acceptable.

**4.5-2: Previous work on non-market values for marine sanctuary designation.**

In the U.S., the National Marine Sanctuary (NMS) program is administered by the Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA). The Marine Protection, Research and Sanctuaries Act of 1972 (as amended) allows the Secretary of Commerce to designate a NMS after consultation with various federal and state agencies. The stated purpose of such a designation is for) “preserving or restoring such areas for their
conservation, recreational, ecological or aesthetic values” (NAS, 2001, 59). Designation must be preceded by an assessment of the expected public and socio-economic benefits derived from the designation of the sanctuary (Id.). This assessment is part of the overall approval process for a proposed sanctuary (also including environmental impact statement, fisheries management guidance, ocean pollution regulations, etc.).

There are 13 NMSs as of 2003, with considerable variation in size (e.g., from 1 nmi² for the Monitor NMS, NC to 5328 nmi² for the Monterey Bay NMS, CA). They are evenly split between the Pacific (including Hawaii) and Atlantic (including the Gulf of Mexico) coasts, but there are none in Alaska (NAS, 2001). Taken together, they encompass a wide variety of habitats, but are not considered to constitute a representative system or network (Id.).

While oil and gas development is generally prohibited, there are a wide variety of consumptive and non-consumptive uses that occur within designated boundaries such as recreational and commercial fishing, diving, and subsistence harvesting depending on the management plan for a given NMS. More recently, as argued in a National Academy of Science review, “[c]hanging values and rising public expectations concerning the role of marine sanctuaries as true protected areas are bringing demands to increase the level of protection in sanctuaries” (NAS, 2001, 160).

As a general interpretation, a formal and rigorous assessment of the public benefits of marine sanctuary designation would require the application of non-market valuation tools. Given the limited number of marine sanctuaries in the U.S. and the time frame when many were designated, there are limited previous non-market valuation studies specific to marine sanctuaries and parks.

Appendix 9 in ELI (2003) provides a review of selected studies which used non-market valuation to assess the economic values associated with marine sanctuaries. All studies were conducted over the last dozen years, are based on survey data, and involve applications of either travel cost or contingent valuation methods. They include applications in the U.S. (Florida, Texas, and Hawaii) and elsewhere (Philippines, Sri Lanka, and the Caribbean).

As shown, these studies vary widely in the types of habitats examined and the range of non-market economic values and impacts found. Given the absence of any previous marine sanctuary designation in Alaska, and any convenient mapping from alternative sites, this limits the opportunity for a reliable benefits transfer, but does provide some general indication of the presence of significant values associated with marine sanctuaries. As noted above, the approval process for actual designation of a marine sanctuary would eventually require formal analysis of the public benefits from such a designation. But the policy conundrum is that support for

---

45 As general background to this argument see Lipton et al. (1995), NAS (2001), and the website for NOAA’s Coastal and Oceans Resource Economic (CORE) program [URL: http://marineeconomic.noaa.gov/; site accessed 6/17/03.] Among other items are detailed overviews of ongoing, multi-year, large-scale programs examining non-market values and economic impacts associated with Southern California Beaches and the Florida Keys. While currently in progress, both economic assessment programs involve consideration of areas involving marine sanctuaries.

46 For an explanation of the formal distinctions between a National Marine Sanctuary (NMS) and the concepts of a marine reserve (e.g., no fishing zones), marine parks, and marine protected areas generally in the US and elsewhere see NAS (2001).
designating a site would be aided by some preliminary idea of the scope and magnitude of the public benefits, including the non-market values associated with the site. Thus, to examine the potential non-market economic benefits associated with designating a marine sanctuary along the northwest arctic coast between Shishmaref and Point Hope, we designed an original survey.

4.5-3: Survey design.

In the design of a CV survey, respondents are presented with a contingent scenario, a specific change (or set of changes) in an environmental program or policy, a payment vehicle, and then an economic choice. Specifically, respondents are asked to make statements about their willingness to pay (WTP) or to willingness to accept (WTA) compensation for the proposed changes in environmental quality or access. Common elicitation formats for asking valuation questions include both open-ended (OE) and closed-ended formats. The latter includes the common dichotomous choice (DC) format where respondents must either accept or reject a given payment amount for the proposed change in environmental quality or access. DC formats include the hypothetical referendum format, as advocated by a Blue Ribbon NOAA Panel (Arrow et al., 1993).

Applications of both OE and DC elicitation formats remain common, although the latter is distinctly more costly to implement in terms of required sample size (given the discrete nature statistical data). Somewhat surprisingly, the accumulated evidence to date is that OE formats tend to produce conservative WTP estimates relative to DC formats (Schulze et al., 1996). While some sources attribute this difference to inherent “yea-saying” in the DC format, the caveat is that OE format may tend to produce “fair-share” or “reasonable” WTP responses (Bishop et al., 1995). This may be particularly the case when respondents have cost information about providing the good (Bohara et al., 1998).

As recently reviewed by Boyle (2002) the case supporting DC as the commonly preferred elicitation format remains ambiguous relative to a range of alternatives. In this applied CV study, we use the OE format, and following the suggestion of Boyle (2002), apply the Tobit model, which doesn’t allow negative values and accommodates a probability spike at zero ($0).47

In order to assess the non-market values of preserving an area of the Chukchi Sea in northwestern Alaska through designation as a marine sanctuary, ELI conducted a mail survey in the summer of 2003. The proposed marine sanctuary runs roughly from Shishmaref to Point Hope, and includes the coastline of Cape Krusenstern National Monument. The target population for random sampling consisted of households in the major Alaskan population centers of Anchorage, Fairbanks, and Juneau.

While public benefits from a federal designation are likely to extend to citizens outside of Alaska, it is expected that the values of Alaska residents are a prominent consideration in the larger assessment. Thus, we focus in this exploratory study, prior to any actual designation, on a targeted (but random) sample of Alaska households.

47 For other CV applications of the Tobit model see: Berrens et al. (1998), Desvouges. et al. (1992), Goodwin et al. (1993), and Halstead et al. (1991).
In the design stage, a number of individuals reviewed the draft survey and provided edits and clarifications. One economist from the University of Alaska, Fairbanks and one from the University of Alaska, Anchorage, as well as staff from the Northern Alaska Environmental Center reviewed preliminary drafts of the survey. Where appropriate, we incorporated language from previous peer-reviewed surveys. The full survey was mailed first class to a random sample of 3000. A follow-up reminder note card was sent to recipients 4 weeks after the original survey mailing. The reminder card thanked those who had responded, and requested those who had not to please complete the survey.

The adjusted response rate (adjusted for 283 undeliverable surveys that were returned) was 13.7 percent, providing a potential usable sample of 373. It should be noted here that this survey was conducted on a very small budget for projects of this type, and in a state somewhat known for a ferocious protection of privacy. Additionally, federal programs, particularly those that might impinge upon either development or subsistence hunting, are often regarded with a great deal of skepticism in Alaska. While we realize that a common lower bound for validity in these studies is 15%, we believe that our results, constrained as they are, make a convincing case.

The 8-page survey and two map attachments are provided in Appendix 3. The first map indicates the coastal region of arctic Alaska, the second shows the boundaries of the proposed marine sanctuary near the DMTP site. The survey began with questions regarding use of Alaskan arctic ecosystems, knowledge of Native subsistence issues, knowledge of coastal development issues in the Alaskan arctic and knowledge about the existence of the DMT and the Red Dog Mine. Next, the survey asked respondents to rate their agreement or disagreement to a number of statements about preservation of coastal ecosystems.

After these questions, background information about marine sanctuaries in general, and the proposed sanctuary was provided. We specifically noted that designation of a marine sanctuary as shown on the second map would preempt the DMTP. The valuation section came next. In this section, respondents were asked whether they would vote “yes” to a referendum designating the sanctuary, then asked if they would make an annual contribution to a fund designed to restore and manage the sanctuary. If respondents answered “yes” to the latter question, they were asked to indicate the maximum they would be willing to contribute each year. The survey concluded with questions about reasons for their support or lack of support for the designation, and standard demographic questions.

4.5-4: Modeling considerations.

Given the design of the open-ended (OE) valuation question (QX) in our survey, we estimate several single-equation willingness to pay (WTP) models:

\[ WTP_i = \beta' x_i + e_i \]

Where \( x \) is a vector of characteristics for household \( i \), and \( \beta \) is the vector of corresponding parameters to be estimated. A primary consideration in estimating WTP is that WTP responses from survey data often consist of numerous zeroes and nonnegative values. Because a considerable fraction of observations of the dependent WTP variable are zero-valued classical
linear regression methods should not be used (Boyle, 2002; Greene, 1997). As shown in Appendix 9, Table 9A-2 in ELI (2003), there were 206 NO responses (55 percent) to the question of whether or not the household would be willing to make any annual contribution to the hypothesized fund. Therefore, several single equation Tobit models are used to handle the numerous zeroes and estimate the WTP function. The Tobit model is formulated in terms of an index function:

\[ WTP_i = \beta' x_i + e_i \quad e_i \sim N(0, \sigma_e^2) \quad i = 1, \ldots, N \text{ households} \]
\[ WTP_i = 0 \text{ if } WTP_i^* = 0 \]
\[ WTP_i + WTP_i^* \text{ if } WTP_i^* > 0 \]

The log-likelihood for the Tobit model is:

\[ \ln L = \sum_{WTP_i > 0} -\frac{1}{2} \left[ \ln(2\pi) + \ln\sigma^2 + \frac{(WTP_i - \beta' x_i)^2}{\sigma^2} \right] + \sum_{WTP_i = 0} \ln \left[ 1 - \Phi\left( \frac{\beta' x_i}{\sigma} \right) \right] \]

Definitions and descriptive statistics for the explanatory variables used in the various WTP models are shown in Appendix 9, Table 9A-2 in ELI (2003). In addition to some standard socioeconomic and demographic characteristics, there are a number of independent variables included in the decision to preserve a marine sanctuary. There are several Likert-type variables, scaled from one to five, that reflect the respondent’s opinion on ethical and policy issues. One example is respondents’ agreement or disagreement with the statement “[t]here are already too many government programs designed to protect coastal ecosystems.”

Our modeling also employed a logit approach. The logit model is a qualitative dependent variable model used to predict the probability of occurrence of a binary dependent variable. In this case, we used the logit model to determine the probability that a respondent would contribute a positive amount to the marine sanctuary fund for a given set of demographic characteristics and a given set of responses to the survey questions.

The log-likelihood for the monomial logit model takes the form:

\[ \ln L = \sum_{t=1}^{n} Y_t \ln(P_t) + \sum_{t=1}^{n} (1 - Y_t) \ln(1 - P_t) \]

With the probability of a positive response \{F(X_t'\beta)\} taking the form:

\[ P_t = \frac{e^{X_t'\beta}}{1 + e^{X_t'\beta}} \]

4.5-5: Empirical results.

The results of various specifications of the Tobit and logit models are presented in Appendix 9, Table 9A-3 of ELI (2003). Our model predicts a WTP of approximately $30 per household per
year to protect a marine sanctuary offshore from the DMTP, somewhat higher than our sample
mean of $21.44. The mean WTP/hh value is presented in Table 11, below. Papers reviewed by
Colt (2001) found WTPs for wildlife habitat preservation at similar numbers, between $25 and
$50 per household per year. Colt uses the lower bound of $25 from a Goldsmith and Hall (1998)
paper on WTP to preserve wildlife habitat in Bristol Bay, Alaska. Thus, with a mean of $22.52
per household/year, our results cannot be said to overestimate the value as reported by
existing literature.

Some interesting results of the models was that in each of the models the GOV variable had a
strongly negative and highly significant effect and the POLLUTE variable always had a strongly
positive and highly significant effect. Education levels also played a positive and significant role
in all of the regressions. As could be expected, the INCHI variable (high-income dummy) had a
generally strong positive and significant effect in the Tobit but not always in the logit models.
This follows a certain reasoning: income should have an effect on the amount the respondent is
willing to pay, but not necessarily the decision to pay. We found a strong gender bias in the
Tobit models that was not always present in the logit models. As reported in the introduction,
female WTP was almost thrice male WTP ($39.88 vs. $14.87). The FEM variable was usually
positive and significant in both logit and Tobit models.

Whether the respondent had heard of the Red Dog mine or Delong Mountain Terminal, had ever
spent time in arctic Alaska, or was a Republican never had a significant effect on either outcome.
In the logit regressions, the truncated model predicted a participation rate of 33% and the
extended model predicted 43%. The former estimate is very close to the actual participation rate
of 27.7%. If our sample is representative of all Alaskans, this means that a third of all Alaskans
would be willing to make positive contributions to a fund to protect the proposed marine
sanctuary. This confirms that non-market values associated with intact marine ecosystems in the
DMTP area are widely held, and significant.

4.5-6: Estimating non-market costs to marine ecosystems.

With these empirical results in hand, we can estimate the annualized non-market costs to marine
ecosystems resulting from the DMTP. First, it is important to note that our WTP results may be
relatively conservative estimates because the open-ended responses to a voluntary fund
mechanism may be particularly susceptible to “fair-share” type responses, and thus themselves
be conservative estimators of value (Bishop et al. 1995; Bohara et al. 1998). Also, our response
rate was somewhat low. While we recognize this as a shortcoming, we believe our sample is
fairly representative of all Alaskans since the majority of the State’s population (57.4%) can be
found in the three cities we sampled.

Fairbanks’ population as of 2003 was 83,656, Juneau’s was 31,187, and the Anchorage
Municipality population was 266,281. This, from a 2005 Census estimate of a total State
population of 663,661 (http://quickfacts.census.gov/qfd/states/02000.html accessed October 13,
2006)\(^{48}\), is 57.4% of the state’s total. The State number of occupied housing units is 233,252,
which is 85.1% of the State’s total housing units (274,246).

\(^{48}\) Data for City and Borough of Juneau, Fairbanks Northstar Borough, and Anchorage Municipality can be obtained
by following the links at the top of this page.
The total number of housing units in Anchorage is 108,787 (102,277 occupied-94%), in Fairbanks 34,046 (30,741 occupied-90.3%), and in Juneau 12,282 (11,543 occupied-94%). That total out of the State total is 61.97%. Therefore our sample could be said to represent 61.97% of all Alaskan households. Despite this majority, we felt it would be more reasonable to extrapolate the mean WTP to a point between two assumptions. The lower bound is the assumption that the sample only reflects values for residents of those three cities. The upper bound is the assumption that our mean WTP values reflect values for all Alaskan households.

Table 11
Variation in Mean WTP Values and Decisions to Vote Yes for Marine Sanctuary Designation

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Description</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP</td>
<td>Mean Willingness to Pay (WTP) From Entire Survey</td>
<td>323</td>
<td>21.44</td>
<td>70.92</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>MWTP</td>
<td>WTP for Males</td>
<td>228</td>
<td>14.87</td>
<td>71.49</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>FWTP</td>
<td>WTP for Females</td>
<td>82</td>
<td>39.88</td>
<td>71.42</td>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>EWTP</td>
<td>WTP for Members of Environmental Organizations</td>
<td>80</td>
<td>38.94</td>
<td>68.28</td>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>DWTP</td>
<td>WTP for Members of the Democratic Party</td>
<td>58</td>
<td>42.16</td>
<td>77.70</td>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>RWTP</td>
<td>WTP for Members of the Republican Party</td>
<td>72</td>
<td>5.83</td>
<td>23.88</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>VOTE</td>
<td>Whether the respondent would vote yes or no in a non-binding, statewide referendum designating the area on the map as a marine sanctuary. Yes =1, No=0</td>
<td>352</td>
<td>0.41</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MVOTE</td>
<td>Descriptive Statistics for the VOTE variable (DSV) for Males</td>
<td>249</td>
<td>0.33</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>FVOTE</td>
<td>DSV for Females</td>
<td>93</td>
<td>0.67</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>EVOTE</td>
<td>DSV for Members of Environmental Organizations</td>
<td>85</td>
<td>0.62</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>DVOTE</td>
<td>DSV for Members of the Democratic Party</td>
<td>63</td>
<td>0.76</td>
<td>0.43</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>RVOTE</td>
<td>DSV for Members of the Republican Party</td>
<td>76</td>
<td>0.16</td>
<td>0.37</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 12
Annual Non-Market Costs to Marine Ecosystems

<table>
<thead>
<tr>
<th>Extrapolation assumption</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Bound (Residents of Anchorage, Fairbanks and Juneau)</td>
<td>$3,255,659.50</td>
</tr>
<tr>
<td>Midpoint</td>
<td>$4,254,364.87</td>
</tr>
<tr>
<td>Upper Bound (All Alaskans)</td>
<td>$5,253,070.25</td>
</tr>
</tbody>
</table>

The results are shown in Table 12, which indicates the total non-market costs to marine ecosystems given the three extrapolation assumptions. Given these rather conservative estimates of yearly WTP for the establishment and administration of a marine sanctuary, we can say that there is a significant value to this designation for Alaskans and a significant annual cost if the marine ecosystems in the proposed designation were destroyed or degraded.

One last step in this section is to annualize cost estimates over a fifty-year project life as we have done for all other costs and benefits discussed in this report. To do so, we take the mid-point
value of $4,254,365 per year, apply the Corps’ 5 3/8% discount rate, and assume that the duration of impacts extends from 2007 through 2061 since modification of the marine environment associated with the DMTP is an irreversible effect. We also compound costs forward from 2007, the starting year for construction. By doing so, we estimate the annualized non-market costs to marine ecosystems caused by the DMTP to be $5,373,755. This estimate represents an important and significant cost currently missing from the Corps analysis of the DMTP, and a category of cost that is clearly required by statutes, regulations, and guidance manuals governing how the Corps conducts its analysis of national economic development benefits.

4.6: Non-market costs to subsistence.

The previous section estimates the range of potential non-market costs to marine ecosystems from a survey designed to capture passive use, or existence values for these ecosystems held by all Alaskan households regardless of whether they engage in any kind of active use of the waters affected by the DMTP. There is, however, another significant category of non-market costs incurred by local Alaska Natives whose subsistence uses of the marine ecosystems in and around the DMTP may be adversely affected.

Federal and Alaskan law define subsistence as “the customary and traditional uses” of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade” (ADFG, 1988). The Corps defines subsistence as “the noncommercial hunting, fishing, and gathering of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, and handicrafts, and for trade, barter, or sharing” (DEIS at 82). The impacts of the DMTP on these “use” values is another critical component of a comprehensive assessment of DMTP benefits and costs. The DEIS contains two thoroughly researched sections on subsistence behavior in the area, including details of quantity and method of harvest per species over time. More importantly, Section 4.3 investigates potential effects to subsistence via the analysis of four objectives, such as “Identify locations where important resources used in subsistence would be directly or indirectly affected by any of the alternatives considered in detail” (DEIS at 269). Also, Section 4.9 (Environmental Consequences) addresses further potential effects.

We believe this to be a considerable improvement over previous work. However, the DEIS and Appendix E still do not attempt to quantify any of these potential effects in monetary terms. This could significantly understate the costs of any of the proposed alternatives. For instance, the DEIS (at 100), states “[s]ome hunters believe this occasional noise, combined with the beluga’s memory of noise at the site in the past and the physical presence of the facilities, may cause beluga to avoid coastal waters near Portsite during their spring migration,” yet does not discuss this avoidance (or that of any other species) in economic terms. We maintain that this is an essential component of BCA and should at least be addressed.

4.6-1: Importance of subsistence in the DMTP impact area.

Native peoples throughout the world still rely on traditional methods of hunting and gathering to provide a large component of their daily nutritional needs. In arctic Alaska, as in many parts of
the indigenous world, this subsistence way of life is closely tied to ancient cultural norms and an intimate understanding of the world in which the native people live. VanderMeer (2000) recounts how, at the International Conference on Arctic Development, Pollution and Biomarkers of Human Health, representatives of arctic indigenous people from throughout the North Polar region made it clear that “the preparation and consumption of the typical subsistence diet in the arctic not only meets nutritional needs but is a fundamental component of the peoples’ spiritual and cultural life,” and that they have “no acceptable alternative to subsistence fishing and hunting.”

There are three Alaska Native communities fairly close to Portsite and the Red Dog Mine that may be affected by the proposed port expansion. These are Point Hope, with a population of 757, Noatak, population 428, and Kivalina, with a population of 377. The DIFR and DEIS present subsistence use data for these communities derived from surveys conducted by NANA, the Alaska Department of Fish and Game’s (ADF&G) Subsistence Division, and a number of scholars. In addition, ELI collected subsistence data from a small sample of households in Kivalina, the community closest to Portsite.

The ADF&G subsistence surveys provide extensive demographic data for all of these villages except Point Hope, but do not provide average income, or percentage of subsistence foods in the diet. From ELI’s Kivalina survey, the average household numbered approximately five people (this agrees with the ADF&G data) with an average income per household of $29,318. The average percentage of subsistence foods as a part of overall diet was 72%. From past surveys conducted by NANA Corporation, 85% of Kivalina residents obtained at least half of their food from subsistence activities (DEIS at 83), and 22.3% of Kivalina residents said they obtained all or most of their food from subsistence.

The three major sources of food for the Native Village of Kivalina are bearded seal, Dolly Varden trout (char), and caribou. Though residents hunt and fish many other species, such as beluga, these three tend to dominate. For this reason, we will mainly discuss potential impacts to these three species. We will also discuss potential impacts to belugas, as the villagers were very concerned about Portsite development impacts on that species. From the ADFG surveys, the ten year average take of bearded seal (1992-2002) was 111 seals per year, the average take of char was 69,106 lbs, and the take of caribou averaged 420 per year. The data collected by ELI was from a very small sample, but showed an average of 3-4 bearded seal per person/year, a char average of 400 lbs per person per year, and 7 caribou per person per year.

Berries are also an important part of the traditional diet, and the ADFG data show that there were 4,615 lbs of berries gathered by Kivalina residents in the 1991-92 survey year. Our survey shows an average of 15 gallons of berries per person per year.

Most of the fishing and hunting of large land mammals takes place in and around the Wulik River and Kivalina lagoon during the summer. In winter, hunters travel much more widely hunting caribou, as snow machines make overland travel easy and rapid. Char is still taken up the Wulik and in the lagoon. There is some fishing up the Kivalina River, but not nearly as much as on the Wulik. Wulik river sites are generally preferred over Kivalina river sites. The

49 Data from Maniilaq’s website http://www.maniilaq.org/aboutNWAlaska.html, accessed December 19, 2006
bearded seal harvest takes place generally within 10-20 miles north and south of Portsite. Portsite itself was historically (according to our interviewees) the choice location for bearded seal hunting, but no longer. Belugas were historically taken very close to the village, but are now taken further out to sea, within a band roughly twenty miles wide (north-south) and sometimes extending fairly far out to sea. The DEIS provides excellent details\(^{50}\) as to current hunting location and methods, which were corroborated by our interviewees.

4.6-2: Existing impacts to subsistence activities.

The Iñupiat we interviewed and many who attended a public meeting ELI conducted in Kivalina stated almost unanimously that mine and Portsite activity had already caused negative impacts on animal and plant stocks and the productivity of subsistence uses. The DEIS at 278 does make the point that there is a possibility that construction and ongoing loading activities might have adversely affected a few species: “[t]here is at least a low probability that the existing Portsite facilities have been a factor in reduced beluga harvest by Kivalina hunters and that harvest decline may be culturally important and may have significantly affected the people who used those belugas.”

The area at Portsite was traditionally the best place to gather salmon berries, and that area is now considered too contaminated by lead for berry picking. The immediate offshore area at Portsite was one of the best locations for bearded seal hunting, and we were told that now the seals avoid that place and can only be found significantly further out to sea and further north or south. The Portsite area is an important breeding ground for shrimp, a primary food of bearded seals. Interviewees and individuals who attended an ELI sponsored public meeting told us that ship traffic had already disturbed this shrimp nursery and therefore the seal populations. We were also told that beluga no longer can be taken along the coast near the village, and are only found significantly further out to sea.

The villagers also told us that mine waste entering the Wulik River upstream had negatively impacted char runs. Corps scientists contest this view, pointing out that pre-mine metal contamination of the upstream tributaries was already at high levels, and the contamination is from ground water flowing through the ore body, rather than from mine waste.\(^{51}\)

Another complaint is that the haul road has effectively bisected the caribou migration. This issue was raised in many of the scoping comments and we heard it firsthand from many up in Kivalina. In addition, there is concern that contamination from the trucks carrying concentrate is entering the food chain through flora and the caribou, a concern bolstered by a report by Ford and Hasselbach (2001) about heavy metals contamination along the haul road.

“Highest levels near the Red Dog Haul Road equal or exceed (1.5 – 2.5 times) maxima reported for samples from severely polluted regions in Central Europe. The order of magnitude elevation in Pb and Zn in the road dust relative to other materials (e.g., soils at depth, and so on) is consistent with the results from enrichment factor analysis (section 4)\(^{50}\)

\(^{50}\) See DEIS Section 3.3 at 94,97,102,107,111,115.

\(^{51}\) This argument is fleshed out in minutes from Project Review Meeting #17 on 4/18/2001.
in suggesting that much of the source material for dust probably derives from ore concentrate.”

This extract suggests that local mosses are highly contaminated. The report does not go into detail about food chain effects on local caribou, but at the very least, Kivalina residents’ fears of lead and zinc contamination justifies further study.

Additional information about past and present impacts can be gleaned from the 1984 EIS supporting the decision to permit development of the Red Dog mine and the existing DMT port (EPA, 1984). That EIS states that operation of both the mine and port “might have an indirect impact upon caribou by displacing some animals from marginal winter range” (EIS at X). The EIS also suggests that caribou habitat loss “could, as other developments occurred in the region, be significant on a greater than local basis if changes to historical caribou migrations occurred” (EIS at XII). In terms of marine mammal impacts, the EIS concedes that “Port construction and noise from year-round activities aboard the offshore transfer facility would likely displace some marine mammals from the immediate area” (EIS at XII).

Finally, in the Environmental Consequences section, the Subsistence subsection lists four possible impacts to subsistence resources: (1) habitat degradation; (2) interference with fish and wildlife life cycles or migration patterns; (3) increased harvest pressures, and (4) incompatible work arrangements (EIS at v-25). Thus, there is quite a bit of evidence to suggest that subsistence uses have already been significantly impacted by operation of the mine, haul road, and Portsite in their current state.

To assess current impacts, we use the no-action alternative analyses in the various subsections. The DEIS makes the case that current operations at Portsite might have some impact on beluga harvest, but that case cannot be made with any serious conviction. While beluga harvests in recent years have been smaller than in previous decades (a common complaint among the hunters we interviewed), the DEIS states “…there are too many other factors that could have affected beluga harvest in that period (ibid).” This statement is buttressed by data on yearly variation in harvest. In terms of bearded seal “[t]he existing operations at Portsite have had no apparent affect (sic) on subsistence harvest (DEIS at 288).” Finally, in terms of fish, the DEIS at 341 states “If the existing structures have any direct adverse or beneficial effect on fish, those effects would appear to be limited to the area very close to the structures.” It also states that “effects of noise on fish from the existing operations cannot be measured with any certainty because there are too many variables and because the habitat at Portsite is so localized that the act of sampling itself would influence fish distributions” (DEIS at 342).”

4.6-3: Potential future impacts: the Corps perspective.

The feasibility study and DEIS downplay the potential for additional impacts resulting from the DMTP. The Corps maintains that additional impacts will be limited in duration, limited to waters in and around the Portsite, and insignificant overall. The current DEIS is much more thorough than the Preliminary version in its considerations of effects on various subsistence species, and impacts are acknowledged either directly or indirectly.
Beluga whale

The DEIS recognizes that the increase in noise from construction may affect local hunters’ ability to harvest beluga. For example, the DEIS states “If construction caused all the summer belugas to move so far offshore hunters from Kivalina could not harvest them, based on average harvest in recent history Kivalina would lose the one or two summer belugas they take on average during that 3-year period” (DEIS at 281). The DEIS also states that beluga might be driven away during maintenance dredging years. As a result of these impacts, the PDEIS posited a “worse case” scenario of a loss of 10 belugas over the 50 year project life, which is corroborated in the current DEIS.

The loss of these non-harvested belugas is accounted for in caloric and cultural terms (DEIS at 283). However, there is nothing in the Corps analysis to refute the findings of ELI (2003) that the hunters from Kivalina might travel further out to sea if the summer beluga are not found at the normal locations. This extra travel would require greater expenditure of time and fuel at the very least, and can be quantified within some reasonable bounds of probability. We see no reason why the Corps cannot incorporate some form of contingent behavior/travel cost analysis such as we did in our earlier report.

Bearded seal

In the subsection on bearded seal, the DEIS mentions that the channel and disposal area would disrupt benthic productivity and could therefore reduce the number of bearded seal available for harvest (DEIS at 290). According to the DEIS at 290, “…loss of productivity at the disposal area and channel could cause a small percentage of bearded seals to be displaced to adjacent habitat in the region. This might reduce bearded seal densities at Portsite and increase densities in the neighboring areas.” However, the Corps argues that there is similar habitat up and down the coast for breeding shrimp and other ugruk prey species, so there would be density displacement, but not in any long-term way, and that “the benthic invertebrate community near Portsite is made up of species that are motile or that would recolonize in one or two seasons” (DEIS at 290). There is no prediction as to whether there would any fewer seal harvested in the traditional area, though “there is a possibility that there could be fewer shrimp and consequently fewer bearded seals for subsistence harvest (Id.).” Again, this does not seem to refute our results.

Anadromous fish

The DEIS maintains that effects on anadromous fish will be mixed. Beneficial impacts may include an increase in the amount of cover and feeding habitat created by in-water structures and beneficial changes in ocean bottom topography (DEIS at 344-5). On the other hand, noise, construction activity, and turbidity may displace fish from the Portsite area and dredging may diminish the biological productivity of the water column in and around the channel and disposal site (Id.).
The DEIS predicts that there will be no measurable impacts to any other subsistence species, and that impacts to the few species that will be affected will be minor and not affect subsistence patterns in any significant way. While “some subsistence users were concerned that turbidity, activity, and noise would reduce the return of Dolly Varden and other anadromous fish to the Wulik River and other streams,” there is no instance of marine construction “causing a reduction in return of anadromous fish in similar conditions” (DEIS at 354). Local subsistence hunters contest this view.

The DEIS at 350 goes on to list potential effects to fish population from noise and sedimentation. It points out that the effects from noise tend to be temporary, in both freshwater and marine environments, and that the turbidity produced by dredging will tend to be very short-lived and not significantly impact fish movements and populations.

4.6-4: Potential future impacts: local perspectives.

In the summer of 2003, ELI researchers visited the Native Village of Kivalina to gather site-specific information about the potential impacts of the DMTP on subsistence uses. As the Alaska Beluga Whale Committee notes, “[t]he lack of information about habitat use in the scientific literature should not be confused with the lack of knowledge by local residents about the importance of this area.”52 According to the Arctic Slope Regional Corporation, “[i]ncorporation of traditional knowledge from local hunters is important to understanding the effects Trestle and Channel construction have on the important subsistence resources in the area.”53

In recognition of the need to gather this local knowledge, we employed two separate processes: a public meeting using the Delbecq Nominal Group Technique (NGT) and household interviews. NGT is a planning tool designed to identify priority issues and concerns a community holds in common (Delbecq et al., 1975; 1971). The NGT involves six basic steps: (1) silent generation of ideas in writing; (2) recorded round-robin listing of ideas on a chart; (3) discussion of each idea; (4) preliminary vote on priorities; (5) discussion of preliminary vote, and (6) final vote (Delbecq and Van de Ven, 1971). We conducted a modified form of the NGT to a group of 30 residents of Kivalina, most of whom were directly involved with subsistence hunting, fishing, and gathering activities. During the course of the meeting, attendees were asked to identify and discuss all of the benefits and costs of the DMTP from their perspective and to rank these in terms of importance.

In regards to subsistence impacts, the majority of those present voiced similar concerns about the impacts of the DMTP, and these tended to fall into the following categories: (1) acoustical disturbance from dredging and increased ship traffic driving marine mammals further out to sea; (2) further damage to ugruk feeding grounds from the dredging and disposal of dredged materials; (3) increased water pollution in the Wulik River from increased throughput at the

52 Comments from the Alaska Beluga Whale Committee on the DIFR and DEIS, submitted by Kathryn J. Frost, Secretary, January 4th, 2006.
53 Comments from the Arctic Slope Regional Corporation on the DIFR and DEIS, submitted by Teresa Imm, Director-Resource Development, December 27th, 2005.
mine, and (4) adverse impacts to caribou and increased levels of contamination resulting from increases in haul road traffic.

In addition to concerns about impacts to subsistence hunting, there were many complaints about failure to deliver on past promises about cheaper fuel oil and more work at the mine for villagers. There were concerns about the potential for a fuel oil spill, which might impact hunting or human health. There were also some predictions of flooding upcoast (near Kivalina) due to destabilization of the seafloor from dredging, and of decreased water quality along the coast affecting marine animals’ ability to feed.

ELI also gathered information from a small sample of heads of households directly involved with subsistence hunting, fishing, and gathering. We used an interview format to elicit data about demographics and hunting patterns. Our survey instrument was based on a subsistence survey instrument designed and used by the ADFG’s Division of Subsistence, conducted in Shungnak. Each respondent was asked about the location and quantity of take for several dozen subsistence species, their views on how the DMTP would affect this take, and alternative sites where they would go if the DMTP adversely affected the productivity of their preferred sites. While the sample of people we interviewed is not statistically significant, the process still yielded some usable and interesting results. For example, we found that overall, nearly everyone used the same general areas for fishing and hunting, and would relocate to the same areas if their predictions about the DMTP’s impacts came to pass. In the context of household interviews, villagers had these specific concerns to raise in regards to their subsistence use of several key species:

**Bearded seal**

The native hunters we spoke with told us that Portsite was once one of the most productive bearded seal hunting areas, and has already shown decreased productivity due, in part, to permanent damage to shrimp populations. They insisted that dredging and disposal could permanently alter ugruk feeding patters and drive the animals south to Sealing Point or north to Point Hope. The villagers did not believe that the benthic communities would ever be restored to anything near historical productivity, and that they would have to relocate hunting activities for ugruk to these locations.

**Beluga whale**

The villagers we interviewed believe that dredging, both initial and maintenance might drive the beluga away permanently, and that operation of larger vessels may do the same.

**Anadromous fish**

The villagers’ main concern during our interviews in terms of the effects on Dolly Varden char were from potential increased production in the pit area leading to worse contamination of the Wulik River through its tributaries. In addition, some villagers believe that anadromous fish may avoid entering the Wulik River in the future as marine water quality declines north of the
Portsie, and as noises increase. As a result, villagers expect to have to relocate at least some of their fishing activities to the Kivalina River.

**Caribou**

The principal concern of the hunters from Kivalina had to do with potential increases in production at the mine and associated increases in truck traffic and contamination along the haul road. They told us repeatedly that the road forms a barrier that the caribou simply will not cross. They also discussed concerns that the contamination along the road is entering the caribou and therefore themselves. Should the mine increase output, the villagers believe that the caribou may move yet further, totally changing their migration routes, with uncertain future effects. They do not believe, however, that it will get any easier to take individuals from that herd. Villagers were also extremely concerned that the DMTP will be a catalyst for a more ambitious development scheme that will bisect their caribou hunting grounds with more roads, mines, and other developments.

Despite the rather drastic difference in views regarding impacts to subsistence, there appears to be at least some consensus between the Corps and villagers that the DMTP may, at the very least, result in changes in the geographic pattern of hunting and fishing. This is an effect that has economic costs since it displaces hunters and fishers from more preferred to less preferred locations and may, indirectly, cause a change in the composition of subsistence users’ diets by reducing available quantities of preferred foods. Quantitative methods have been developed to measure the potential magnitude of this change, a discussion we turn to next.

### 4.6-5: Methods of valuing changes in subsistence use

There are three major methods regularly used to calculate the economic value of changes in subsistence uses: (1) the replacement cost method; (2) contingent valuation, and (3) the travel cost method and its variants including random utility models. The Subsistence Division of the Alaska Department of Fish and Game (ADFG) uses the replacement cost method to estimate a dollar value of the subsistence harvest throughout Alaska. In a nutshell, the replacement cost method assigns a range of values to wild foods that reflect what it would cost to purchase similar protein and caloric replacements in stores. Using this method, ADFG uses a lower bound of $3/lb and an upper of $5/lb to arrive at an estimate of between $31,521,765 and $52,536,756 for yearly subsistence consumption in arctic Alaska (ADFG, 1988).

However, ADFG acknowledges that such values are conservative, since they don’t reflect the cultural values associated with subsistence. The ADFG recognizes the cultural importance and market economic importance of the subsistence lifestyle throughout the state, pointing out that “successful families in rural areas combine jobs with subsistence activities and share wild food harvests with cash-poor households who cannot fish or hunt, such as elders, the disabled, and

---

54 A change in hunting and fishing locations from more preferred to less preferred sites may affect diet composition in two ways: (1) trips to less preferred locations may decline as compared with the number of trips taken to the preferred sites, and as a consequence, the resulting decrease in take may force the substitution of less preferred for more preferred foods, and (2) the less preferred sites are less productive, again, leading to a decline in take and the need for substitution.
single mothers with small children” (Id.). Therefore, there are distributional advantages that might become harder to achieve under a market system. These distributional or cultural values do not appear in replacement cost models. Likewise, Haener et al. (2001) determined that “[a] limitation of replacement cost methods is their inability to provide insight into determinants of Aboriginal hunting behavior” noting, instead, that cultural values may drive decisions over subsistence use far more than simple economic considerations.

The use of contingent valuation (CV) to measure changes in subsistence has been discussed by Colt (2001). As set forth in Section 1.3, CV is a survey method, referred to as a “stated preference” technique by economists, which seeks to place a value on certain goods and services by asking individuals and households how much they would be willing to pay for them. Importantly, CV is a method that can capture cultural values that transcend the mere market value of subsistence foods. For example, Duffield (1997) conducted a CV study after the Exxon Valdez spill that determined people would be willing to pay between $32 and $118 per pound harvested to engage in subsistence. The study found that, using these bounds, the total Alaska subsistence harvest of 53.4 million pounds would yield an estimate of $1.7 billion dollars. By comparison, the upper bound estimate by the ADFG for the whole state was $267,273,090. Thus, as clearly shown here, cultural values can exceed mere market values by many times over.

Another way of valuing changes in behavior is to use the travel cost method (TCM) and its variants including random utility models (RUM). Both TCM and RUM methods can be used to calculate welfare losses resulting from changes in the attributes of preferred subsistence sites, or the welfare losses associated with losing those sites altogether. Changes in distance traveled are a key component of both approaches (Haener et al., 2001). Because potential changes in distance traveled to fishing and hunting sites has been identified as a primary concern of subsistence users in Kivalina, the development and application of a TCM or RUM model may be the best approach for developing subsistence use damage estimates resulting from the DMTP.

What might the Corps find if a TCM or RUM model were implemented? To answer this, we combined information generated from our interviews with information about travel costs to paint a rough picture of at least some of the economic costs that would result from the DMTP if it caused villagers in Kivalina to (1) substitute existing hunting sites for ugruk and beluga for sites near Point Hope and Sealing Point, and (2) substitute fishing sites along the Wulik River for sites along the Kivalina river. Respondents to our household interviews identified these areas as the likely alternatives if their preferred sites were made less productive due to DMTP induced changes.

In the course of our interviews, respondents plotted both sets (i.e. preferred locations and alternative locations) of hunting and fishing sites for Dolly Varden char, beluga, and bearded seal on a map. Appendix 14 in ELI (2003) indicates the linear distances between existing and substitute sites. The data on which the map is based is presented in Appendix 15 in ELI (2003). These data indicate that the mean current distance hunters travel for Dolly Varden is 8.5 miles, and the mean worst-case to substitute sites on the Kivalina is 12.4. When we look at beluga and bearded seal, the difference becomes much greater. The current mean distance traveled for beluga is 10.2 miles, but the mean worst case is either 47.3 miles (to Sealing Point) or 72.7 miles (to Point Hope). This makes a difference of nearly 40 miles each way, or 80 miles roundtrip for
Sealing Point or 125 miles roundtrip for Point Hope. The current mean distance traveled for bearded seal is 9.3 miles, and the worst-case mean is also 47.3 or 72.7 miles. The differences for that species are roughly the same as for beluga.

If we make the simplifying assumption that hunters and fishers will take the same number of trips to substitute sites as they do to preferred sites\(^55\), we can calculate the changes in travel costs by focusing on the most important component of these costs – fuel. From an interview with Mr. Jerry Norton, Sr., head of the Kivalina Subsistence Committee and a respected elder hunter, we obtained ballpark estimates of frequency of hunting trips for each of these species as well as fuel cost estimates. Mr. Norton told us that hunters would go out after beluga approximately 32 times per year, ugruk approximately 30 times and Dolly Varden up to 260 times per year. With fuel prices currently at approximately $2.25/gallon\(^56\) and Mr. Norton’s estimates of fuel efficiencies\(^57\) we were able to estimate ballpark travel cost figures for the current vs. worst-case scenarios. The travel cost figures are based only on fuel cost estimates. It is commonly assumed that fuel costs represent only a certain percentage of total travel cost. Given that assumption, we can say that these estimates are fairly conservative.

Given the fuel efficiency of the skiffs, an average hunting trip for beluga would currently cost about $6.75 one-way or $13.50 roundtrip. In the worst-case scenario (we assume that people would make the same number of trips), it would cost about $68.66 roundtrip to Sealing Point and $105.53 roundtrip to Point Hope. With an estimate of 32 trips per year, this gives us a rough yearly cost of $432.00 for the current distance, $2,197.16 for the Sealing Point trip and $3,377.03 for Point Hope. This is an increase of between $1,765.16 and $2,945.03 per year.

An average bearded seal hunting trip, currently, would cost about $14.81 roundtrip. With an average of 30 trips per year, the current per-year per hunter cost is approximately $444.19. The worst-case gives us the same estimates as beluga. The difference between the Sealing Point and the current trip would be $1,615.65, while the difference between the Point Hope trip and the current trip would be $2,721.77.

For Dolly Varden, a current average roundtrip costs about $12.34 roundtrip. The alternate distance would cost about $18.00 for a roundtrip. With 260 trips per year, the current yearly Dolly Varden trip expenditure is about $3,208.06. The yearly alternate would be about $4,680.00. This is an increase of about $1,471.94.

According to Maniilaq, Kivalina has a population of 377 and an average household size of 5. If, according to the NANA survey, 22.3% of all residents obtained most or all of their food through subsistence, we could say that roughly 17 households obtained most of their food through subsistence. We will use this as a basis for calculating a lower bound estimate. Also according

\(^{55}\) Of course, as distance and cost increase, the number of trips taken declines. In TCM and RUM models, this results in a welfare loss equivalent to the change in the area under the demand curve for a particular site. In lieu of calculating this welfare change, we use the increase in cost associated with an identical number of trips as a rough proxy.

\(^{56}\) This price is derived from the document “Statistical Report of the Power Cost Equalization Program (2005).”

\(^{57}\) Approximately 12 miles/gallon for snow machines and 3.1 mpg for whaling skiffs. These fuel efficiency figures were corroborated through interviews with other residents of Kivalina.
to NANA, about 85% of residents obtained at least half of what they ate through subsistence. This comes out to about 64 households. We will use this as an upper bound for estimating costs.

Table 13 below shows our estimates for potential cost increases. For Dolly Varden as there is only one alternative, the Kivalina River, our lower bound is the total trip increase times 17 households; for the upper bound we use 64 households. In terms of Beluga and Bearded Seal, since there are two worst case alternatives, we use a different approach. For a lower bound, we use the mean between 17 and 64 households making the trip to Sealing Point, the closer of the two worst-case scenarios. For our upper bound, we use the same method for the trip to Point Hope, the farther of the two. In both instances, the mean is just the arithmetic mean between those two points. As these hunts are independent of one another, it is reasonable to sum these values. A sum of the means gives us a figure of $251,822 per year for the entire village.

<table>
<thead>
<tr>
<th>Species</th>
<th>Lower bound estimate</th>
<th>Upper bound estimate</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beluga</td>
<td>$71,489</td>
<td>$119,273</td>
<td>$95,381</td>
</tr>
<tr>
<td>Bearded Seal</td>
<td>$83,423</td>
<td>$110,232</td>
<td>$96,828</td>
</tr>
<tr>
<td>Dolly Varden</td>
<td>$25,023</td>
<td>$94,204</td>
<td>$59,613</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$179,935</strong></td>
<td><strong>$323,709</strong></td>
<td><strong>$251,822</strong></td>
</tr>
</tbody>
</table>

To be compatible with other estimates in this report, these figures need to be annualized. To do so, we took the mean cost estimate from Table 13 and assumed that the cost would be incurred throughout the project period, ending in 2061. By doing this, we estimate the annualized non-market costs to subsistence uses caused by displacement of hunters and fishers from their preferred sites to be $318,080.

Of course, this figure must be put in proper context. For one, it is not generated by a complete travel cost or random utility model; rather, it is a ballpark estimate of economic costs associated with just one component of these models – fuel cost changes – and, as such, significantly underestimates potential welfare loss. Secondly, it does not incorporate any changes in the number of trips taken, an important consideration in a true TCM or RUM model. Third, Table 13’s estimates were extrapolated to the entire village from a small sample of households, and may not be representative. Finally, the analysis presupposes that the predicted changes in behavior will occur as a result of the DMTP, and as such, really reflect a worse case scenario rather than expected values. Never the less, the forgoing analysis suggests that potential changes in subsistence use patterns represent a significant economic cost that merits formal modeling in the context of the analysis supporting the DMTP decision.

Section 4 References


United Nations Environmental Program, Convention on Biological Diversity (UNCBD, 2005). Indicators for Assessing Progress Towards the 2010 Target: Ecological Footprint and Related Concepts, Published as a note by the Executive Secretary for the meeting of the Subsidiary Body on Scientific, Technical and Technology Advice, Montreal, November 28th to December 2, 2005.


In Sections 3 and 4 we presented a critique of the DMTP’s benefit cost analysis set forth in the Draft Interim Feasibility Report (DIFR) and discussed other concerns with the adequacy of the DIFR and the Draft Environmental Impact Statement (DEIS). In the course of this examination, we presented a series of corrections and modifications to the Corps benefit and cost stream calculations as well as an independent assessment of additional costs excluded from the Corps analysis. In this section, we analyze the effects of these corrections, modifications, and additional cost considerations on the project’s benefit-cost ratio. We begin with the Corps baseline, as corrected for apparent errors in calculating village fuel savings benefits. We then make nine modifications to that baseline warranted by the analyses presented in Sections 3 and 4. The detailed calculations are presented in a series of panels displayed in Appendix 1. Each panel displays raw and present value cost figures for each year of construction broken down into costs associated with the trestle and channel. We also display additional cost calculations where appropriate. Each panel also reports annualized project benefits. Below that appears the benefit-cost ratio.

5.1: The Corps baseline adjusted for correct village fuel savings benefit.

The DMTP will be a cooperative project sponsored by the Alaska Industrial Development and Export Authority (AIDEA) and the Corps. Costs for construction of navigation features and local service facilities are anticipated to be $230,419,771. Of this, the Corps share is $37,041,086 million and AIDEA’s share is $193,378,685 million. In addition, the project will incur $20,415,841 million in interest charges during construction. Annualizing both construction and interest costs yields $14,543,603. Additional annualized costs for OMRR&R activities are expected to be $7,795,705, yielding a total annualized project cost of $22,339,308.

The DIFR discusses six categories of annualized project benefits totaling $26,898,594. These include savings associated with reduced tug and concentrate barge costs in the future ($10,788,296), reduced port delay and queue costs ($3,333,190), induced concentrate shipment benefits ($1,707,854), reduced fuel delivery costs for the mine ($5,018,964) and for regional villages ($5,983,400), and avoided costs for operations at Portsite ($66,890). The Corps benefit cost ratio is reported as 1.2041 to 1, or $26,898,700/ $22,339,308.

As discussed in Section 3.4, the Corps made an apparent error in the conversion of annual village fuel benefits savings ($7,377,300) into an annualized amount. Apparently, the Corps used the present value of the 2011 benefit instead of the annualized value of the entire benefit stream over the 2011 – 2061 period. By doing so, we concluded that the Corps underestimated the value of the village fuel benefits savings – should it occur – by $266,812. The correct annualized value of the total discounted benefit stream ($107,798,312) is actually $6,250,212 at the project discount rate of 5 3/8%. By using this corrected figure, we re-estimate the project’s initial benefit-cost ratio to be 1.2160 to 1 or $27,165,406/ 22,339,308. The detailed calculations appear in the first panel of Appendix 1, page A1-1.
5.2: Sequential reanalysis of the benefit-cost ratio.

With a corrected baseline benefit-cost ratio in hand, we can now look at how the ratio changes as we modify the BCA to account for the additional corrections and omissions identified in Sections 3 and 4. In the following narrative, we discuss these modifications one at a time.

Modification 1: Adding compound interest to project costs incurred before 2011

Although the Corps did not disclose how it arrived at estimates of interest during construction, there appears to be an error in the calculations as compared with the precise formula for doing so set forth in Corps regulations. By failing to properly compound project costs incurred before 2011, we estimated that the DIFR underestimated project costs by $1,188,364, or 5.3%. Our analysis appears in Section 3.5, and the corrected costs figures appear in Table 1 and the second panel (Modification 1) of Appendix 1 at page A1-1. By properly compounding costs, we estimate total annualized costs to be $23,527,672. This lowers the benefit-cost ratio to 1.1546 to 1 or $27,165,406/ $23,527,672.

Modification 2: Reduced Red Dog Mine life

The DIFR and DEIS assume that the Red Dog Mine will be in operation through the end of 2041. However, as discussed in Section 3.6, information published on Teck-Cominco’s website indicates that the mine will shut down in 2029. Personal interviews with Teck-Cominco managers confirm this end date. A shorter mine life reduces the benefit stream significantly. Recalculating the benefit stream to terminate in year 2029 rather than year 2041 reduces the maximum annualized benefits resulting from the DMTP from $27,165,406 to 22,670,388 and the benefit-cost ratio to .9636 to 1 or $22,670,388/ $23,527,672. The cost stream is unaffected since the DMT is expected to continue to operate as a fuel distribution center after the mine shuts down. Detailed calculations appear in Table 2 and the third panel (Modification 2) of Appendix 1 at page A1-1.

Modification 3: Incorporating current fuel price projections

The DIFR’s benefit cost analysis assumes regional diesel fuel prices remaining near $1.40 per gallon for fuel used in marine operations, by the mine, and by regional villages for home heating and electrical generation. The DIFR relies on price data available before 2003. Fuel prices have increased nearly 92% since that time, and the effects are now predicted to be permanent. As such, the Corps’ estimates for future fuel prices are at least one-half to one-third of the Energy Information Administration’s current fuel price projections. In Section 3.7, we discussed the effects of this significant increase in fuel price projections on three variables of relevance to the BCA: tug and barge savings, village fuel demand, and construction costs. By incorporating EIA’s most recent fuel price projections into the benefit-cost analysis we estimate a reduction in annualized tug and barge savings benefits from $8,469,714 (under the 2029 mine life assumption) to $7,382,573, a reduction of annualized fuel savings benefits accruing to villages from $6,250,212 to $4,622,912, and an increase in annualized project costs from $23,527,672 (the corrected cost figure from Section 3.5) to $24,115,887. Taken together, this lowers the
benefit-cost ratio further to .8275 to 1 or $19,955,947/ $24,115,887. Detailed calculations appear in Tables 3 through 6 and the fourth panel (Modification 3) of Appendix 1 at page A1-1.

Modification 4: Uncertainty in village fuel delivery savings

As discussed in Section 3.8, there is high degree of uncertainty involved with the calculation of certain benefits and costs attributable to the DMTP. However, the most significant source of uncertainty involves fuel delivery savings to area villages, which depends on establishment of a fuel distribution center at Portsite by an unknown entity. Despite the highly uncertain nature of these savings, the DIFR assumes that these benefits will be generated with 100% certainty once the DMTP is completed. To correct this, we modeled the expected value of the benefit stream under an “uncertain” scenario where the probability that the benefit will be generated is 50%. This reduces the expected value of the annualized village fuel delivery savings benefit from $4,622,912 to $2,311,434 and the benefit-cost ratio to .7317 to 1 or $17,644,469/ $24,115,887. Detailed calculations appear in the fifth panel (Modification 4) of Appendix 1 at page A1-2.

Modification 5: Marine pollution costs

By dramatically increasing the throughput of fuel oil at Portsite, the DMTP will increase the risk of marine pollution. The fuel spill model published in Appendix 10 of the DEIS predicts that on average, the DMTP will increase annual spills by 71 gallons. This is significantly less than the ELI (2003) estimate that relied on spill frequency data from the State of Alaska and the International Tanker Owners Pollution Association. Nonetheless, for purposes of this analysis, we adopted the DEIS prediction. Although quite small, the 71 expected gallons of fuel spills generate externalized economic costs that can be quantified. In Section 4.2, we estimated this cost to be between $22,000 and $25,000 per year during construction, $71,000 during the peak project period (2011 – 2029) and just over $22,000 thereafter until 2061. This represents an annualized cost of $61,529 over the life of the project. By adding this figure to total project costs, the benefit-cost ratio falls to .7298 to 1 or $17,644,469/ $24,177,416. Detailed calculations appear in Table 8 and the sixth panel (Modification 5) of Appendix 1 at page A1-2.

Modification 6: Carbon emissions damage

By increasing the distance fuel oil is shipped to Portsite, by inducing greater concentrate shipments as well as fuel used by the Red Dog Mine, and by requiring 3 years of fuel intensive construction and dredging activities, the DMTP will induce a significant increase in carbon emissions over and above the without project scenario. Carbon emissions are a significant source of externalized cost, especially in fragile Arctic regions. Most estimates place the magnitude of the damage in the $50 - $ 131 range per metric tonne of carbon emitted. In Section 4.4, we completed a carbon footprint analysis comparing emissions under with and without project conditions and concluded that the DMTP will generate an additional $1,272,720 in annualized carbon emissions damage each year using $93 per tonne as an estimate of the damage. Adding this cost reduces the DMTP benefit-cost ratio to .6933 to 1 or $17,644,469/ 25,450,136. Detailed carbon footprint calculations appear in Appendix 2. Detailed calculations of the carbon emissions damage appear in Tables 9 and 10, Appendix 2, and the seventh panel (Modification 6) of Appendix 1 at page A1-2.
Modification 7: Loss of passive use values

Another serious shortcoming of the economic analysis supporting the DMTP is the failure to incorporate any non-market costs resulting from the loss and/or degradation of nearly 7,000 of marine habitat in and around Portsite and offshore in the area designated for disposal of dredged materials. As discussed in Section 4.5, non-market costs are incurred by all those who are willing to pay positive amounts to protect marine ecosystems from development as well as those who use and enjoy the affected areas for recreational and subsistence uses. Such costs can be estimated through standard non-market valuation techniques such as contingent valuation.

To estimate the potential magnitude of non-market costs resulting from the DMTP, we conducted an original contingent valuation survey of Alaska residents. The survey was designed to estimate “passive use” values associated with the loss of marine ecosystems. A copy of the survey and map attachments has been included as Appendix 3. Our results suggest that households in our sample are willing to pay on average $21.44 per year to protect the marine ecosystems near the DMT, a value that is similar to other estimates reported in the literature. Using conservative assumptions about how to extrapolate this estimate to all Alaskan households, we estimate a mid point for annual loss of passive use values to be $4,254,365 per year. By assuming the loss begins in 2007 and extends until 2061 and by applying the Corps’ 5 3/8% discount rate we convert this figure into an annualized value of $5,373,755.

This estimate represents an important and significant cost currently missing from the Corps analysis of the DMTP, and a category of cost that is clearly required by statutes, regulations, and guidance manuals governing how the Corps conducts its analysis of national economic development benefits. Including this cost lowers the benefit-cost ratio to .5724 to 1 or $17,644,469/ $30,823,891. Detailed survey results are presented in Tables 11 and 12 as well as Appendix 9 of ELI (2003). Detailed benefit-cost calculations appear in the eighth panel (Modification 7) of Appendix 1 at page A1-2.

Modification 8: Non-market costs to subsistence

As planned, the DMTP has the potential to alter the geographic pattern of hunting and fishing by native villagers in Kivalina and other nearby communities and reduce the number of animals taken for subsistence use. This represents another kind of non-market economic cost, but, unlike the costs addressed by our contingent valuation survey, these costs are incurred by active users of the DMTP impact area.

There are a number of ways to quantify the economic costs associated with these subsistence impacts. One simple way involves calculating the changes in travel costs in the event that subsistence users are displaced from their desired hunting and fishing locations to alternative sites. In Section 4.6, we developed an estimate of the possible magnitude of these costs incurred by hunters and fishers in Kivalina based on a survey of villagers conducted in the summer of 2003. The data gathered from this survey imply that if the DMTP were to result in the substitution of more distant sites for hunting and fishing, Kivalina hunters and fishers could spend an additional $251,822 pursuing beluga whales, bearded seals, and Dolly Varden trout at
more distant locations. Assuming this increased travel cost begins in 2007 and extends throughout the project life (2061) and by applying the DMTP discount rate of 5 3/8% we convert this value into an annualized amount of $318,080. Including this cost lowers the benefit cost ratio to .5666 to 1 or $17,644,469/ $31,141,971. A more detailed discussion and analysis of the travel cost survey of Kivalina hunters and fishers appears in ELI (2003). Travel cost calculations also appear in Table 13. The adjusted benefit-cost ratio calculations appear in the ninth panel (Modification 8) of Appendix 1 at page A1-3.

Modification 9: RED costs associated with substitution of Singapore fuel oil for U.S. fuel oil

In Section 4.1, we identified a serious omission from the Corps analysis involving the reduction in economic activity in the U.S. associated with the substitution of fuel oil now refined and shipped by U.S. companies for fuel oil refined in Singapore. The results from a standard IMPLAN input-output model suggest that a 52,214,792 gallon reduction in fuel oil purchases at roughly $1.40 per gallon from U.S. suppliers will cause direct losses of over $72 million in lost labor income and value of output, indirect losses of nearly $16 million, and induced losses of roughly $55 million per year. Taken together, this is an annual cost of $144 million not addressed in any manner by the DIFR. By assuming a 50% likelihood that Portsite would actually be developed as a fuel distribution center and a Red Dog Mine life to 2029 we converted this $144 million figure into an annualized DMTP cost of $61,207,985 in direct, indirect, and induced costs associated with diversion of fuel purchases to Singapore. Corps regulatory guidance is unclear whether this cost is to be calculated separately in a regional economic development (RED) account, or whether RED costs are to be incorporated into the benefit-cost ratio if they can be monetized. If the latter interpretation is correct, the benefit-cost ratio falls to .1911 to 1 or $17,644,469/ $92,349,956. Detailed calculations appear in Table 7 and the tenth panel (Modification 9) of Appendix 1 at page A1-3.

5.3: Discussion and recommendations for additional analysis.

According to Corps regulatory guidance as well as general principles of benefit-cost analysis, federal participation in a civil works project such as the DMTP is warranted only in situations where the benefit-cost ratio exceeds 1.0. As clearly indicated by the foregoing analysis, the modifications suggested in the context of this report cause the benefit-cost ratio to fall far below this threshold. In fact, even if the suggested modifications were off by a factor of 5, the DMTP would still generate NED and RED costs in excess of anticipated benefits.

Because the revised benefit and cost figures used in our modifications are simply ballpark estimates of what the Corps may find should it investigate factors excluded from consideration in the DIFR in a rigorous manner, they are clearly subject to debate. Different assumptions, methods, and sources of information may yield considerably different results. However, there is little doubt that the types of modifications we suggest are strongly recommended if not explicitly required by the Corps own guidance for evaluating the contribution of civil works projects to national economic development.

As such, we have the following recommendations to make as the Corps prepares its final benefit-cost analysis (BCA) and FEIS:
1) The Corps has an affirmative duty to establish a federal interest in the DMTP. Establishing the federal interest is essential for setting the parameters of the benefit-cost analysis and identifying whose benefits and whose costs matter. The current DIFR and DEIS do not contain a discussion of what federal interest is served by the DMTP. This omission should be addressed in the final documents.

2) The DIFR and DEIS fail to include three of the four accounts identified by Corps regulations as necessary for meeting the Corps obligations under the National Environmental Policy Act (NEPA). In particular, the DIFR and DEIS fail to include a regional economic development (RED) account, an environmental quality account (EQ), or an other social effects (OSE) account. While the Corps has flexibility to omit these accounts when there are no other significant economic, social, or environmental effects beyond those considered by the NED account, clearly, in this case, there are many other significant effects that warrant analysis. The final feasibility study and FEIS should include all four accounts.

3) The DEIS does not contain a meaningful analysis of the cumulative economic costs and benefits associated with past, present, and reasonably foreseeable actions affecting the same resources as the DMTP. As such, the DEIS and DIFR fail to address economic considerations of critical importance to the feasibility of the DMTP. The final EIS and DIFR should make use of readily available – such as concrete plans for gas shale exploration, coal mining, and roads to the DMT – enabling such an analysis to be completed in a rigorous manner.

4) The DIFR projects a Red Dog Mine life extending through the end of 2041. This assumption appears to be erroneous, as Teck-Cominco itself projects a mine life extending to 2029. As a result, the final BCA should analyze a stream of benefits and costs that terminate at the end of year 2029.

5) The BCA contained in the DIFR assumes a fuel price of $1.40 per gallon throughout the analysis period, including construction. This figure is now woefully outdated, and use of this figure seriously overstates project benefits and understates project costs. We highly recommend a new BCA based on current fuel prices and current EIA energy price forecasts.

6) DMTP benefits are highly uncertain, yet the BCA assumes a 100% probability of achieving them. The Corps has developed methods for incorporating uncertainty, and we recommend that these be used to deflate at least some of the projected benefits. The fuel delivery savings benefit is, perhaps, the most uncertain because it depends upon the simultaneous occurrence of several unlikely events.

7) The current BCA entirely fails to address the contraction in economic activity that will occur as a result of the substitution of Singapore fuel oil for U.S. fuel oil. Water Resources Council (WRC, 1983) guidance is unambiguous on this issue. When civil works projects cause a contraction in economic activity in one region to benefit another,
benefits are calculated net of the contraction in the other region. In this case, the lost economic activity associated with a reduction in demand for 52,214,792 gallons of U.S. fuel oil each year must be accounted for through use of standard input-output models such as IMPLAN.

8) The DMTP will increase marine pollution and carbon emissions. The economic damages associated with these water and air pollutants must be disclosed and discussed in the final feasibility study and FEIS to meet the Corps regulatory guidance with respect to externalities.

9) The DMTP represents a $37 million federal investment in energy cost savings because such savings represent the sole public purpose of the project. As such, alternative investments that achieve the same goal need to be considered. The most viable and desirable alternative in arctic Alaska is wind. Biodiesel is another option. While the DIFR touches upon wind energy potential, it fails to provide an analysis of the benefits associated with an investment of $37 million in wind. Neither the DIFR nor the DEIS discuss the burgeoning number of federal and state level programs now in place to subsidize wind energy, or the current diesel fuel price situation which makes wind far more feasible than it was when the DIFR was prepared. The final BCA should estimate the forgone benefits of achieving energy cost savings by investing in wind rather than the DMTP using updated information about alternative energy programs and the current fuel price situation.

10) The Corps has an obligation to incorporate information about the non-market costs of the DMTP using standard non-market valuation techniques such as contingent valuation or random utility models. Important non-market costs associated with the DMTP include the loss of passive use values associated with preservation of marine ecosystems as well as adverse changes in subsistence use patterns. As currently drafted, the BCA fails to address these non-market costs in any manner.

Modifying the benefit-cost analysis to address these concerns will insure that the Corps decision over whether or not to lend federal assistance to the DMTP is guided by a more complete and accurate accounting of benefits and costs. ▲
## Appendix 1

### Benefit-Cost Reanalysis Spreadsheets

**Corps discount rate:** 0.053750

### 1.053750 Corps discount rate: 0.053750

#### Corps Baseline
- **Modification 1**
  - First Cost Trestle
  - Compounding @ 5 3/8% w/ Mine Life to 2029
  - Current Fuel Price Projections

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$80,030,800</td>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$86,569,227</td>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$86,569,227</td>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$37,034,895</td>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$36,077,989</td>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$36,077,989</td>
<td>2010</td>
<td>2</td>
<td>$37,256,976</td>
<td>$37,369,735</td>
</tr>
</tbody>
</table>

### Total NPV:
- **Total NPV:** $169,024,439
- **Annualized NPV:** -$9,800,141
- **Plus OMRR&R:** -$6,550,459
- **Total:** -$16,350,600

#### Corps Baseline (Corrected)
- **Modification 1**
  - First Cost Trestle
  - Compounding @ 5 3/8% w/ Mine Life to 2029
  - Current Fuel Price Projections

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$80,030,800</td>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$86,569,227</td>
<td>2009</td>
<td>3</td>
<td>$73,986,209</td>
<td>$86,569,227</td>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$37,034,895</td>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$36,077,989</td>
<td>2010</td>
<td>2</td>
<td>$36,077,989</td>
<td>$36,077,989</td>
<td>2010</td>
<td>2</td>
<td>$37,256,976</td>
<td>$37,369,735</td>
</tr>
</tbody>
</table>

### Total NPV:
- **Total NPV:** $182,836,443
- **Annualized NPV:** -$10,600,969
- **Plus OMRR&R:** -$6,550,459
- **Total:** -$17,151,428

### Additional Costs

<table>
<thead>
<tr>
<th>Costs</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tug &amp; Barge</td>
<td>2007</td>
<td>5</td>
<td>$10,788,296</td>
<td>2007</td>
<td>5</td>
<td>$10,788,296</td>
<td>2007</td>
<td>5</td>
<td>$10,788,296</td>
<td>2007</td>
<td>5</td>
<td>$10,788,296</td>
</tr>
<tr>
<td>Induced Tonnage</td>
<td>2009</td>
<td>3</td>
<td>$1,707,854</td>
<td>2009</td>
<td>3</td>
<td>$1,707,854</td>
<td>2009</td>
<td>3</td>
<td>$1,707,854</td>
<td>2009</td>
<td>3</td>
<td>$1,707,854</td>
</tr>
<tr>
<td>Village Fuel Benefits</td>
<td>2012</td>
<td>1</td>
<td>$6,250,212</td>
<td>2012</td>
<td>1</td>
<td>$6,250,212</td>
<td>2012</td>
<td>1</td>
<td>$6,250,212</td>
<td>2012</td>
<td>1</td>
<td>$6,250,212</td>
</tr>
</tbody>
</table>

### Total Costs: $23,527,672

### Benefits

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tug &amp; Barge</td>
<td>2007</td>
<td>5</td>
<td>$8,469,714</td>
<td>2007</td>
<td>5</td>
<td>$8,469,714</td>
<td>2007</td>
<td>5</td>
<td>$8,469,714</td>
<td>2007</td>
<td>5</td>
<td>$8,469,714</td>
</tr>
<tr>
<td>Port and Queue</td>
<td>2008</td>
<td>4</td>
<td>$2,616,833</td>
<td>2008</td>
<td>4</td>
<td>$2,616,833</td>
<td>2008</td>
<td>4</td>
<td>$2,616,833</td>
<td>2008</td>
<td>4</td>
<td>$2,616,833</td>
</tr>
<tr>
<td>Induced Tonnage</td>
<td>2009</td>
<td>3</td>
<td>$1,340,808</td>
<td>2009</td>
<td>3</td>
<td>$1,340,808</td>
<td>2009</td>
<td>3</td>
<td>$1,340,808</td>
<td>2009</td>
<td>3</td>
<td>$1,340,808</td>
</tr>
<tr>
<td>Avoided Costs</td>
<td>2010</td>
<td>2</td>
<td>$52,514</td>
<td>2010</td>
<td>2</td>
<td>$52,514</td>
<td>2010</td>
<td>2</td>
<td>$52,514</td>
<td>2010</td>
<td>2</td>
<td>$52,514</td>
</tr>
</tbody>
</table>

### Total Benefits: $24,115,887

### Benefit/Cost Ratio
- **1.2160**
- **1.1546**
- **0.9636**
- **0.8275**
## Appendix 1

### Benefit-Cost Reanalysis Spreadsheets

<table>
<thead>
<tr>
<th>Modification</th>
<th>First Cost Trestle</th>
<th>First Cost Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uncertainty in Village Fuel Savings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>T</td>
<td>Cost</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>$37,256,976</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total NPV:</td>
<td>$189,578,196</td>
<td>Total NPV:</td>
</tr>
<tr>
<td>Annualized:</td>
<td>-$10,991,860</td>
<td>Annualized:</td>
</tr>
<tr>
<td>Total:</td>
<td>-$17,542,319</td>
<td>Total:</td>
</tr>
</tbody>
</table>

| **Uncertainty in Village Fuel Savings** | | |
| Year | T | Cost | Present Value | Year | T | Cost | Present Value | Year | T | Cost | Present Value | Year | T | Cost | Present Value |
| 2007 | 5 | $30,140,012 | $37,161,546 | 2007 | 5 | $30,140,012 | $37,161,546 | 2007 | 5 | $30,140,012 | $37,161,546 |
| 2008 | 4 | $29,639,829 | $34,680,748 | 2008 | 4 | $29,639,829 | $34,680,748 | 2008 | 4 | $29,639,829 | $34,680,748 |
| 2009 | 3 | $18,062,174 | $20,056,040 | 2009 | 3 | $18,062,174 | $20,056,040 | 2009 | 3 | $18,062,174 | $20,056,040 |
| 2010 | 2 | $18,062,174 | $20,056,040 | 2010 | 2 | $18,062,174 | $20,056,040 | 2010 | 2 | $18,062,174 | $20,056,040 |
| 2011 | 1 | | | 2011 | 1 | | | 2011 | 1 | | |
| Annualized: | -$5,328,322 | Annualized: | -$5,328,322 | Annualized: | -$5,328,322 | Annualized: | -$5,328,322 |
| Total: | -$6,573,568 | Total: | -$6,573,568 | Total: | -$6,573,568 | Total: | -$6,573,568 |

| **Additional Costs** | | |
| | Marine Pollution | | |
| Additional Costs | $61,529 | Marine Pollution | $61,529 | Marine Pollution | $61,529 |

| | | |
| | | |
| **Avoided Costs** | | |
| Port and Queue: | $2,616,833 | Port and Queue: | $2,616,833 | Port and Queue: | $2,616,833 |
| Induced Tonnage: | $1,340,808 | Induced Tonnage: | $1,340,808 | Induced Tonnage: | $1,340,808 |
| Avoided Costs: | $52,514 | Avoided Costs: | $52,514 | Avoided Costs: | $52,514 |
| Village Fuel Benefits: | $2,311,434 | Village Fuel Benefits: | $2,311,434 | Village Fuel Benefits: | $2,311,434 |

| | | |
| $17,644,469 | $17,644,469 | $17,644,469 |

| | | |
| 0.7317 | 0.7298 | 0.6933 | 0.5724 |
## Appendix 1
### Benefit-Cost Reanalysis Spreadsheets

#### Modification 8
**First Cost Trestle**

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5</td>
<td>$3,837,820</td>
<td>$4,986,233</td>
<td>2007</td>
<td>5</td>
<td>$3,837,820</td>
<td>$4,986,233</td>
</tr>
<tr>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>$37,256,976</td>
<td>$41,369,739</td>
<td>2010</td>
<td>2</td>
<td>$37,256,976</td>
<td>$41,369,739</td>
</tr>
</tbody>
</table>

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319

#### Modification 9
**First Cost Trestle**

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5</td>
<td>$3,837,820</td>
<td>$4,986,233</td>
<td>2007</td>
<td>5</td>
<td>$3,837,820</td>
<td>$4,986,233</td>
</tr>
<tr>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
<td>2009</td>
<td>3</td>
<td>$76,677,658</td>
<td>$89,718,417</td>
</tr>
</tbody>
</table>

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319

#### First Cost Channel

**Compounding @ 5 3/8% w/ Mine Life to 2029**

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5</td>
<td>$30,140,012</td>
<td>$37,161,546</td>
<td>2007</td>
<td>5</td>
<td>$30,140,012</td>
<td>$37,161,546</td>
</tr>
<tr>
<td>2008</td>
<td>4</td>
<td>$29,639,829</td>
<td>$34,680,748</td>
<td>2008</td>
<td>4</td>
<td>$29,639,829</td>
<td>$34,680,748</td>
</tr>
<tr>
<td>2009</td>
<td>3</td>
<td>$18,062,174</td>
<td>$20,056,040</td>
<td>2009</td>
<td>3</td>
<td>$18,062,174</td>
<td>$20,056,040</td>
</tr>
</tbody>
</table>

Total NPV: $91,898,334  
Annualized: -$5,328,322  
Plus OMRR&R: -$1,245,246  
Total: -$6,573,568

**Additional Costs**

- Marine Pollution: -$61,529  
- C Emissions Damage: -$1,272,720  
- Passive Use Loss: -$5,373,755  
- Subsistence Damage: -$318,080

Total Additional Costs: $-31,141,971

#### Total

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319

### Marine Pollution

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>Cost</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>-$61,529</td>
<td>$-61,529</td>
</tr>
</tbody>
</table>

### Additional Costs

- Marine Pollution: -$61,529  
- C Emissions Damage: -$1,272,720  
- Passive Use Loss: -$5,373,755  
- Subsistence Damage: -$318,080

Total Additional Costs: $-31,141,971

### Total

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319

### Avoided Costs

- Mine Fuel Benefits: $3,940,306  
- Village Fuel Benefits: $2,311,434

Total Avoided Costs: $6,251,740

### Total

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319

### Total

Total NPV: $189,578,196  
Annualized: -$10,991,860  
Plus OMRR&R: -$6,550,459  
Total: -$17,542,319
## Appendix 2

### Carbon Footprint Analysis Totals

#### A. Annual Figures

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Activities</strong></td>
<td>$61,277.34</td>
<td>$1,227,150.31</td>
<td>$1,776,959.16</td>
<td>$905,259.67</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Portsite</strong></td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$955,080.00</td>
<td>$955,080.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Shipping</strong></td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$166,205.51</td>
<td>$282,034.16</td>
<td>$115,828.64</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$61,277.34</td>
<td>$1,227,150.31</td>
<td>$1,776,959.16</td>
<td>$905,259.67</td>
<td>$1,121,285.52</td>
<td>$1,237,114.16</td>
<td>$115,828.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Activities</strong></td>
<td>10,983.80</td>
<td>219,963.39</td>
<td>318,515.15</td>
<td>162,265.36</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Portsite</strong></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>29,791.89</td>
<td>50,553.86</td>
<td>20,761.97</td>
</tr>
<tr>
<td><strong>OMRR&amp;R</strong></td>
<td>28,333.44</td>
<td>28,333.44</td>
<td>28,333.44</td>
<td>28,333.44</td>
<td>28,333.44</td>
<td>28,333.44</td>
<td>28,333.44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39,317.23</td>
<td>248,296.83</td>
<td>346,848.59</td>
<td>190,598.80</td>
<td>229,320.85</td>
<td>250,082.82</td>
<td>49,095.41</td>
</tr>
</tbody>
</table>
Appendix 2  
Carbon Footprint Analysis

B. Annualized Figures

Discount rate: 0.05375  
Compound factor: 1.0538  
Discount factor (roe): 0.9490

<table>
<thead>
<tr>
<th>Year</th>
<th>T</th>
<th>C Damage</th>
<th>Present Value</th>
<th>C Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5</td>
<td>$61,277.00</td>
<td>$79,613.26</td>
<td>39,317.24</td>
</tr>
<tr>
<td>2008</td>
<td>4</td>
<td>$1,227,150.31</td>
<td>$1,513,032.00</td>
<td>248,296.83</td>
</tr>
<tr>
<td>2009</td>
<td>3</td>
<td>$1,776,959.16</td>
<td>$2,079,171.00</td>
<td>346,848.59</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>$905,259.67</td>
<td>$1,005,190.44</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>$1,121,285.52</td>
<td>$1,009,813.19</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2012</td>
<td>2</td>
<td>$1,121,285.52</td>
<td>$958,304.33</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2013</td>
<td>3</td>
<td>$1,121,285.52</td>
<td>$903,616.71</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2014</td>
<td>4</td>
<td>$1,121,285.52</td>
<td>$857,524.75</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2015</td>
<td>5</td>
<td>$1,121,285.52</td>
<td>$813,783.87</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2016</td>
<td>6</td>
<td>$1,121,285.52</td>
<td>$772,274.13</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2017</td>
<td>7</td>
<td>$1,121,285.52</td>
<td>$732,881.74</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2018</td>
<td>8</td>
<td>$1,121,285.52</td>
<td>$695,498.69</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2019</td>
<td>9</td>
<td>$1,121,285.52</td>
<td>$660,022.48</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2020</td>
<td>10</td>
<td>$1,121,285.52</td>
<td>$626,355.85</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2021</td>
<td>11</td>
<td>$1,121,285.52</td>
<td>$594,406.50</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2022</td>
<td>12</td>
<td>$1,121,285.52</td>
<td>$564,086.83</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2023</td>
<td>13</td>
<td>$1,121,285.52</td>
<td>$535,313.72</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2024</td>
<td>14</td>
<td>$1,121,285.52</td>
<td>$508,086.83</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2025</td>
<td>15</td>
<td>$1,121,285.52</td>
<td>$482,095.64</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2026</td>
<td>16</td>
<td>$1,121,285.52</td>
<td>$457,504.76</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2027</td>
<td>17</td>
<td>$1,121,285.52</td>
<td>$434,095.41</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2028</td>
<td>18</td>
<td>$1,121,285.52</td>
<td>$411,967.52</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2029</td>
<td>19</td>
<td>$1,121,285.52</td>
<td>$391,041.64</td>
<td>229,320.80</td>
</tr>
<tr>
<td>2030</td>
<td>20</td>
<td>$115,828.64</td>
<td>$40,650.34</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2031</td>
<td>21</td>
<td>$115,828.64</td>
<td>$38,576.84</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2032</td>
<td>22</td>
<td>$115,828.64</td>
<td>$36,609.10</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2033</td>
<td>23</td>
<td>$115,828.64</td>
<td>$34,741.73</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2034</td>
<td>24</td>
<td>$115,828.64</td>
<td>$32,969.61</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2035</td>
<td>25</td>
<td>$115,828.64</td>
<td>$31,287.89</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2036</td>
<td>26</td>
<td>$115,828.64</td>
<td>$29,691.95</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2037</td>
<td>27</td>
<td>$115,828.64</td>
<td>$28,177.41</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2038</td>
<td>28</td>
<td>$115,828.64</td>
<td>$26,740.13</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2039</td>
<td>29</td>
<td>$115,828.64</td>
<td>$25,376.16</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2040</td>
<td>30</td>
<td>$115,828.64</td>
<td>$24,081.77</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2041</td>
<td>31</td>
<td>$115,828.64</td>
<td>$22,853.40</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2042</td>
<td>32</td>
<td>$115,828.64</td>
<td>$21,687.68</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2043</td>
<td>33</td>
<td>$115,828.64</td>
<td>$20,581.43</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2044</td>
<td>34</td>
<td>$115,828.64</td>
<td>$19,531.61</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2045</td>
<td>35</td>
<td>$115,828.64</td>
<td>$18,535.33</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2046</td>
<td>36</td>
<td>$115,828.64</td>
<td>$17,589.88</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2047</td>
<td>37</td>
<td>$115,828.64</td>
<td>$16,692.65</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2048</td>
<td>38</td>
<td>$115,828.64</td>
<td>$15,841.18</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2049</td>
<td>39</td>
<td>$115,828.64</td>
<td>$15,033.15</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2050</td>
<td>40</td>
<td>$115,828.64</td>
<td>$14,266.34</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2051</td>
<td>41</td>
<td>$115,828.64</td>
<td>$13,538.63</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2052</td>
<td>42</td>
<td>$115,828.64</td>
<td>$12,848.05</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2053</td>
<td>43</td>
<td>$115,828.64</td>
<td>$12,192.69</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2054</td>
<td>44</td>
<td>$115,828.64</td>
<td>$11,570.77</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2055</td>
<td>45</td>
<td>$115,828.64</td>
<td>$10,980.56</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2056</td>
<td>46</td>
<td>$115,828.64</td>
<td>$10,420.45</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2057</td>
<td>47</td>
<td>$115,828.64</td>
<td>$9,888.93</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2058</td>
<td>48</td>
<td>$115,828.64</td>
<td>$9,384.51</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2059</td>
<td>49</td>
<td>$115,828.64</td>
<td>$8,905.83</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2060</td>
<td>50</td>
<td>$115,828.64</td>
<td>$8,451.55</td>
<td>49,095.41</td>
</tr>
<tr>
<td>2061</td>
<td>51</td>
<td>$115,828.64</td>
<td>$8,020.45</td>
<td>49,095.41</td>
</tr>
</tbody>
</table>

Net present value: $19,573,053.90  7,085,402.29
Annualized: $(1,114,651.27)  (131,211.15)
Plus OMRR&R: $158,068.95  0 (included)
Total: $1,272,720.22  (131,211.15)
## Appendix 2
### Carbon Footprint Analysis

#### Carbon Footprint Analysis Construction Activities

<table>
<thead>
<tr>
<th>I. Carbon Emissions Damage</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction activities</td>
<td>$61,277.34</td>
<td>$1,227,150.31</td>
<td>$1,776,099.16</td>
<td>$905,259.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Carbon Footprint</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction activities</td>
<td>10,983.80</td>
<td>219,963.39</td>
<td>318,515.15</td>
<td>162,265.36</td>
</tr>
</tbody>
</table>

#### Construction activities analysis

<table>
<thead>
<tr>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cost trestle ($ per year)</td>
<td>$3,022,099.00</td>
<td>$35,371,067.00</td>
<td>$62,800,500.00</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>$302,209.90</td>
<td>$3,537,106.70</td>
<td>$6,280,050.00</td>
</tr>
<tr>
<td>Fuel consumption (gallons) @ $1.40 gallon</td>
<td>215,864.21</td>
<td>2,526,504.79</td>
<td>4,485,750.00</td>
</tr>
<tr>
<td>Carbon dioxide emissions (tons)</td>
<td>2,415.95</td>
<td>28,276.64</td>
<td>50,204.51</td>
</tr>
<tr>
<td>Carbon emissions (tons)</td>
<td>658.90</td>
<td>7,711.81</td>
<td>13,692.14</td>
</tr>
<tr>
<td>Carbon footprint (hectares)</td>
<td>10,983.80</td>
<td>128,555.89</td>
<td>228,247.98</td>
</tr>
<tr>
<td>Carbon emissions damage ($2004)</td>
<td>$61,277.34</td>
<td>$717,198.45</td>
<td>$1,273,369.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cost channel ($ per year)</td>
<td>0</td>
<td>$25,150,000.00</td>
<td>$24,836,250.00</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>0</td>
<td>$2,515,000.00</td>
<td>$2,483,625.00</td>
</tr>
<tr>
<td>Fuel consumption @ $1.40 gallon</td>
<td>0</td>
<td>1,796,428.57</td>
<td>1,774,017.86</td>
</tr>
<tr>
<td>Carbon dioxide emissions</td>
<td>0</td>
<td>20,105.63</td>
<td>19,854.81</td>
</tr>
<tr>
<td>Carbon emissions</td>
<td>0</td>
<td>5,483.35</td>
<td>5,414.95</td>
</tr>
<tr>
<td>Carbon footprint</td>
<td>0</td>
<td>91,407.50</td>
<td>90,267.18</td>
</tr>
<tr>
<td>Carbon emissions damage</td>
<td>0</td>
<td>$509,951.85</td>
<td>$503,590.13</td>
</tr>
</tbody>
</table>

#### Constants and conversion factors

- Fuel cost percentage of construction costs: 10.00%
- CO2 emissions (pounds) per gallon diesel fuel: 22.38
- Carbon emissions (pounds) per gallon diesel fuel: 6.10
- Footprint (hectares) per ton carbon: 16.67
- Marginal carbon emissions damage ($ per ton) 93

#### Carbon Footprint Analysis Increased Portsite Fuel Consumption

<table>
<thead>
<tr>
<th>I. Annual Carbon Emissions Damage</th>
<th>2011-2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Portsite fuel consumption</td>
<td>$955,080.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Annual Carbon Footprint</th>
<th>2011-2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Portsite fuel consumption</td>
<td>171,195.52</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portsite fuel consumption analysis</th>
<th>2011-2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portsite fuel consumption without project (gallons per year)</td>
<td>22,367,000.00</td>
</tr>
<tr>
<td>Portsite fuel consumption with project (gallons per year)</td>
<td>25,721,500.00</td>
</tr>
<tr>
<td>Difference (gallons per year)</td>
<td>3,364,500.00</td>
</tr>
<tr>
<td>Increased carbon dioxide emissions (tons)</td>
<td>37,655.48</td>
</tr>
<tr>
<td>Increased carbon emissions (tons)</td>
<td>10,269.68</td>
</tr>
<tr>
<td>Increased carbon footprint (hectares)</td>
<td>171,195.52</td>
</tr>
<tr>
<td>Increased carbon emissions damage ($2004)</td>
<td>$955,080.00</td>
</tr>
</tbody>
</table>

#### Constants and conversion factors

- CO2 emissions (pounds) per gallon diesel fuel: 22.38
- Carbon emissions (pounds) per gallon diesel fuel: 6.10
- Footprint (hectares) per ton carbon: 16.67
- Marginal carbon emissions damage ($ per ton) 93
## Carbon Footprint Analysis

### Increased Fuel Used in Shipping

#### I. Annual Carbon Emissions Damage

<table>
<thead>
<tr>
<th>Year</th>
<th>Increased concentrate shipments</th>
<th>Increased fuel use by vessels from Singapore (Portsite only)</th>
<th>Increased fuel use by vessels from Singapore (Villages only)</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2013</td>
<td>$50,376.87</td>
<td>$115,828.64</td>
<td>$0.00</td>
<td>$166,205.51</td>
</tr>
<tr>
<td>2014-2029</td>
<td>$50,376.87</td>
<td>$115,828.64</td>
<td>$0.00</td>
<td>$282,034.16</td>
</tr>
<tr>
<td>2030-2064</td>
<td>$0.00</td>
<td>$115,828.64</td>
<td>$0.00</td>
<td>$115,828.64</td>
</tr>
</tbody>
</table>

#### II. Annual Carbon Footprint

<table>
<thead>
<tr>
<th>Year</th>
<th>Increased concentrate shipments</th>
<th>Increased fuel use by vessels from Singapore (Portsite only)</th>
<th>Increased fuel use by vessels from Singapore (Villages only)</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2013</td>
<td>9,029.92</td>
<td>20,761.97</td>
<td>0.00</td>
<td>29,791.89</td>
</tr>
<tr>
<td>2014-2029</td>
<td>9,029.92</td>
<td>20,761.97</td>
<td>20,761.97</td>
<td>50,553.86</td>
</tr>
<tr>
<td>2030-2064</td>
<td>0.00</td>
<td>20,761.97</td>
<td>20,761.97</td>
<td>41,523.87</td>
</tr>
</tbody>
</table>

#### A. Increased concentrate shipments analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>Concentrate shipments without project</th>
<th>Concentrate shipments with project</th>
<th>Gain in concentrate shipments</th>
<th>Gain in vessels</th>
<th>Days at sea</th>
<th>Increased fuel consumption (gallons)</th>
<th>Increased carbon dioxide emissions (tons)</th>
<th>Increased carbon emissions (tons)</th>
<th>Increased carbon footprint (hectares)</th>
<th>Increased carbon emissions damage ($2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2013</td>
<td>1,520,519.00</td>
<td>1,544,000.00</td>
<td>23,481.00</td>
<td>1</td>
<td>14.00</td>
<td>177,464.70</td>
<td>1,986.18</td>
<td>541.69</td>
<td>9,029.92</td>
<td>$50,376.87</td>
</tr>
<tr>
<td>2014-2029</td>
<td>1,544,000.00</td>
<td>1,544,000.00</td>
<td>0.00</td>
<td>1</td>
<td>14.00</td>
<td>20,761.97</td>
<td>20,761.97</td>
<td>20,761.97</td>
<td>20,761.97</td>
<td>$115,828.64</td>
</tr>
<tr>
<td>2030-2064</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### B. Increased fuel use by vessels from Singapore (Portsite only)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel use at Portsite (gallons) without project</th>
<th>Fuel use at Portsite (tons) without project</th>
<th>Required shipments without project</th>
<th>Round trip miles without project (Kotzebue-Puget Sound)</th>
<th>Days at sea without project</th>
<th>Fuel use (tons) without project</th>
<th>Fuel use at Portsite (tons) with project condition</th>
<th>Fuel use at Portsite (tons) in with project condition</th>
<th>Required shipments with project</th>
<th>Round trip miles with project (Singapore-Portsite)</th>
<th>Days at sea with project</th>
<th>Fuel use (tons) without project</th>
<th>Fuel use differential (tons) with - without project</th>
<th>Fuel use differential (gallons) with - without project</th>
<th>Increased carbon dioxide emissions (tons)</th>
<th>Increased carbon emissions (tons)</th>
<th>Increased carbon footprint (hectares)</th>
<th>Increased carbon emissions damage ($2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2013</td>
<td>22,357,000.00</td>
<td>79,367.35</td>
<td>2.00</td>
<td>3,902.00</td>
<td>14.78</td>
<td>665.11</td>
<td>91,311.33</td>
<td>91,311.33</td>
<td>2.00</td>
<td>12,400.00</td>
<td>46.97</td>
<td>2.113.64</td>
<td>1448.52</td>
<td>408,034.37</td>
<td>4,566.72</td>
<td>2,113.64</td>
<td>$115,828.64</td>
<td></td>
</tr>
<tr>
<td>2014-2029</td>
<td>22,357,000.00</td>
<td>79,367.35</td>
<td>2.00</td>
<td>3,902.00</td>
<td>14.78</td>
<td>665.11</td>
<td>91,311.33</td>
<td>91,311.33</td>
<td>2.00</td>
<td>12,400.00</td>
<td>46.97</td>
<td>2.113.64</td>
<td>1448.52</td>
<td>408,034.37</td>
<td>4,566.72</td>
<td>2,113.64</td>
<td>$115,828.64</td>
<td></td>
</tr>
<tr>
<td>2030-2064</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

#### C. Increased fuel use by vessels from Singapore (Villages only)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel use by villages (gallons) without project</th>
<th>Fuel use by villages (tons) without project</th>
<th>Required shipments without project</th>
<th>Round trip miles without project (Kotzebue-Puget Sound)</th>
<th>Days at sea without project</th>
<th>Fuel use (tons) without project</th>
<th>Fuel use by villages (tons) with project</th>
<th>Fuel use by villages (tons) in with project condition</th>
<th>Required shipments with project</th>
<th>Round trip miles with project (Singapore-Portsite)</th>
<th>Days at sea with project</th>
<th>Fuel use (tons) without project</th>
<th>Fuel use differential (tons) with - without project</th>
<th>Fuel use differential (gallons) with - without project</th>
<th>Increased carbon dioxide emissions (tons)</th>
<th>Increased carbon emissions (tons)</th>
<th>Increased carbon footprint (hectares)</th>
<th>Increased carbon emissions damage ($2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2013</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>2014-2029</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>2030-2064</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

### Constants and conversion factors

- **CO2 emissions (pounds) per gallon diesel fuel:** 22.38
- **Carbon emissions (pounds) per gallon diesel fuel:** 6.10
- **Footprint (hectares) per ton carbon:** 16.67
- **Marginal carbon emissions damage ($ per ton):** 93
- **Panamax Handysize load (dwst):** 39500
- **Panamax Handysize days at sea:** 14
- **Weight of one gallon of diesel fuel (pounds):** 7.1
- **Gallons in one ton of diesel fuel:** 281.69
- **Panamax fuel capacity (tons):** 49,935
- **Panamax miles per day:** 528
- **Panamax fuel use (tons per day):** 45
Appendix 2  
Carbon Footprint Analysis

Carbon Footprint Analysis OMRR&R

<table>
<thead>
<tr>
<th>I. Carbon Emissions Damage</th>
<th>2007-2064</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMRR&amp;R</td>
<td>$158,068.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Carbon Footprint</th>
<th>2007-2064</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMRR&amp;R</td>
<td>28,333.44</td>
</tr>
</tbody>
</table>

**Construction activities analysis 2007-2064**

- **OMRR&R trestle (annualized $ per year)**: $6,550,459.00
- **Fuel costs**: $655,045.90
- **Fuel consumption (gallons) @ $1.40 gallon**: 467,889.93
- **Carbon dioxide emissions (tons)**: 5,236.62
- **Carbon emissions (tons)**: 1,428.17
- **Carbon footprint (hectares)**: 23,807.60
- **Carbon emissions damage ($2004)**: $132,819.83

- **OMRR&R channel (annualized $ per year)**: $1,245,246.00
- **Fuel costs**: $124,524.60
- **Fuel consumption @ $1.40 gallon**: 88,946.14
- **Carbon dioxide emissions**: 995.49
- **Carbon emissions**: 271.50
- **Carbon footprint**: 4,525.84
- **Carbon emissions damage**: $25,249.13

**Constants and conversion factors**

- **Fuel cost percentage of construction costs**: 10.00%
- **CO2 emissions (pounds) per gallon diesel fuel**: 22.38
- **Carbon emissions (pounds) per gallon diesel fuel**: 6.10
- **Footprint (hectares) per ton carbon**: 16.67
- **Marginal carbon emissions damage ($ per ton)**: 93
# Carbon Footprint Analysis

## Carbon Footprint Analysis Overall
(Annualized 2007-2029)

<table>
<thead>
<tr>
<th>Footprint Element</th>
<th>Without Project</th>
<th>With Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annualized carbon emissions</td>
<td>0.00</td>
<td>1,941.00</td>
</tr>
<tr>
<td>Annualized carbon footprint</td>
<td>0.00</td>
<td>32,356.47</td>
</tr>
<tr>
<td><strong>Ports site and mine fuel consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual fuel consumption (gallons)</td>
<td>52,162,700.00</td>
<td>55,527,200.00</td>
</tr>
<tr>
<td>Carbon dioxide emissions (tons)</td>
<td>583,804.94</td>
<td>621,460.42</td>
</tr>
<tr>
<td>Carbon emissions (tons)</td>
<td>159,219.53</td>
<td>169,489.21</td>
</tr>
<tr>
<td>Carbon emissions annualized</td>
<td>130,270.52</td>
<td>138,672.99</td>
</tr>
<tr>
<td>Carbon footprint (hectares)</td>
<td>2,654,189.54</td>
<td>2,825,385.07</td>
</tr>
<tr>
<td>Carbon footprint total (20011-2029)</td>
<td>47,775,411.77</td>
<td>50,856,931.19</td>
</tr>
<tr>
<td>Carbon footprint annualized</td>
<td>2,171,609.63</td>
<td>2,311,678.69</td>
</tr>
<tr>
<td><strong>Shipping</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessel loads</td>
<td>30.00</td>
<td>31.00</td>
</tr>
<tr>
<td>Vessel days at sea</td>
<td>420.00</td>
<td>472.00</td>
</tr>
<tr>
<td>Fuel consumption (tons)</td>
<td>18,900.00</td>
<td>21,240.00</td>
</tr>
<tr>
<td>Fuel consumption (gallons)</td>
<td>5,323,941.00</td>
<td>5,983,095.60</td>
</tr>
<tr>
<td>Carbon dioxide emissions (tons)</td>
<td>59,585.55</td>
<td>66,962.81</td>
</tr>
<tr>
<td>Carbon emissions (tons)</td>
<td>16,250.60</td>
<td>18,262.58</td>
</tr>
<tr>
<td>Carbon emissions annualized</td>
<td>13,295.95</td>
<td>14,942.11</td>
</tr>
<tr>
<td>Carbon footprint (hectares)</td>
<td>270,897.57</td>
<td>304,437.27</td>
</tr>
<tr>
<td>Carbon footprint total (20011-2029)</td>
<td>4,876,156.21</td>
<td>5,479,870.79</td>
</tr>
<tr>
<td>Carbon footprint annualized</td>
<td>221,643.46</td>
<td>249,085.04</td>
</tr>
<tr>
<td><strong>OMRR&amp;R</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annualized carbon emissions</td>
<td>0.00</td>
<td>1,699.67</td>
</tr>
<tr>
<td>Annualized carbon footprint</td>
<td>0.00</td>
<td>28,333.50</td>
</tr>
</tbody>
</table>

Total annualized carbon emissions: 157,256
Total annualized carbon footprint: 2,621,454
Appendix 3
Contingent Valuation Survey

Protecting Coastal Ecosystems in Alaska’s Arctic Region
A Questionnaire for Alaska Residents

We need your input!

As an Alaska resident, you have probably heard quite a bit about coastal management issues in Alaska’s arctic. Currently there are various proposals by federal, state, and local public agencies to promote development of oil and mineral resources in this region. In making coastal management decisions, policy-makers need to know the values people place on either developing or protecting coastal environments.

While information about the values people place on development of oil and mineral resources are reflected in their market prices, decision makers seldom have useful information available to them about how people value various options to protect coastal environments. In this survey, you are being asked to provide information about your knowledge of coastal management issues in Alaska’s arctic region, your use of coastal resources, and your opinions about protection of coastal environments. This survey is being conducted by Ecology and Law Institute, a national network of University-based researchers working on conservation issues.

Your household was drawn from a random sample of Alaska residents. In order to ensure that our results are truly representative of Alaska residents, it is important that this questionnaire be completed and returned by an adult of the household. The results of the questionnaire will be used to inform federal, state, and local agencies about households’ opinions regarding coastal management in arctic Alaska. You may be assured of complete confidentiality. The questionnaire is strictly voluntary, and you may omit any questions you wish. This is not a solicitation for money in any way. Rather, it is simply a survey to help us understand what values people do or do not place on protection of coastal environments in arctic Alaska.

All of the instructions and necessary information are included. It should take you no more than 25 minutes to answer all the questions. When you are finished, please place the questionnaire in the enclosed return envelope and mail it back to us. Please feel free to keep the maps that have been provided. If you have any questions please write or call me at the address and phone provided below. Thank you in advance for your voluntary participation and assistance!

Sincerely,

John Talberth, Senior Economist
Ecology and Law Institute
P.O. Box 80506
Fairbanks, Alaska 99708
1-888-354-6770
jtalberth@cybermesa.com
Appendix 3
Contingent Valuation Survey

About the Enclosed Maps

Two maps have been enclosed in this questionnaire packet (on the flip side of each other). Please locate them now. Map 1 shows the coastal region in arctic Alaska, and identifies important communities and natural features. Map 2 shows the coastal region in a portion of arctic Alaska bordering the Chukchi Sea. Map 2 also identifies important communities and natural features in that region and shows the boundaries of a proposed marine sanctuary. More details about the proposed marine sanctuary are provided later on in this survey.

About Your Familiarity with Coastal Management Issues

Q1. How many days over the past year have you engaged in recreational uses such as boating or watching wildlife in coastal ecosystems anywhere in Alaska?

   ______ days

Q2. How many days over the past year have you engaged in recreational hunting or fishing in coastal ecosystems anywhere in Alaska?

   ______ days

Q3. How many days over the past year have you engaged in subsistence hunting or fishing in coastal ecosystems anywhere in Alaska?

   ______ days

Q4. How many times over the past ten years have you visited Alaska’s arctic coastal region, as described by Map 1?

   ______ times

Q5. How would you rate your familiarity with Alaska Native subsistence management issues? (Please circle a number).

   Unfamiliar 0 1 2 3 4 5 Very familiar

Q6. How would you rate your familiarity with coastal development issues in the Alaskan arctic? (Please circle a number).

   Unfamiliar 0 1 2 3 4 5 Very familiar
Appendix 3
Contingent Valuation Survey

Q7. Have you heard or read anything about the Red Dog Mine or the DeLong Mountain Terminal project, as shown on Map 2? (Please circle either yes or no).

Yes  No

<table>
<thead>
<tr>
<th>Your Opinions About Coastal Management Issues</th>
</tr>
</thead>
</table>

People often have different views about environmental and economic issues. Please indicate your view by CIRCLING ONE NUMBER FOR EACH STATEMENT.

Note that 1 = strongly disagree, 5 = strongly agree and 0 = don’t know

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Neutral</th>
<th>Strongly Agree</th>
<th>Don’t Know</th>
</tr>
</thead>
</table>

Q8. If carefully managed, development should be allowed in sensitive coastal ecosystems.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q9. If human activities harm a coastal ecosystem, we should work to protect that ecosystem from collapse, even if it does not seem important to human well-being.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q10. There are already too many government programs designed to protect coastal ecosystems.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q11. If jobs are lost due to coastal ecosystem protection programs, the cost of protection is too high.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q12. I am glad that coastal ecosystems are protected even if I never see them.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q13. Protection of coastal ecosystems is a responsibility I am willing to pay for.

| 1 | 2 | 3 | 4 | 5 | 0 |

Q14. If the two are incompatible, I believe that the subsistence lifestyle of Alaska Natives should take precedence over coastal development.

| 1 | 2 | 3 | 4 | 5 | 0 |

A3 - 3
Appendix 3
Contingent Valuation Survey

Q15. Have you ever encountered any of the following species, either in a zoo, aquarium, or in the wild? (Please circle either yes or no).

- Beluga whale: Yes  No
- Bowhead whale: Yes  No
- Bearded seal: Yes  No
- Walrus: Yes  No
- Polar bear: Yes  No
- Spectacled eider (sea duck): Yes  No

Q16. Are you concerned about the effects of marine pollution from coastal development projects? (Please circle one number).

- Unconcerned: 0
- Concerned: 1, 2, 3, 4, 5
- Very concerned

Q17. Do you believe that development of renewable energy sources such as solar and wind is an important way to reduce the risk of marine pollution from oil development in coastal Alaska? (Please circle either yes or no).

- Yes  No

About Marine Sanctuaries

One way to protect coastal ecosystems from incompatible development is to establish a marine sanctuary. Marine sanctuaries have been described as “national parks” for the oceans, and are designed to protect breeding grounds for whales, seals, and sea turtles, hotspots of marine biodiversity such as coral reefs, and sites that preserve unique cultural resources. The National Oceanic and Atmospheric Administration (NOAA), a federal agency, oversees designation and management of marine sanctuaries in U.S. coastal waters. Local sanctuary advisory councils made up of local residents, business leaders, educators, conservationists, and government officials assist NOAA by developing and implementing sanctuary management plans. There are currently 13 national marine sanctuaries in the United States, but none in Alaska.

A coastal marine sanctuary designation typically includes important harbors, estuaries, and deltas along the coast and extends up to 35 miles offshore. Within the sanctuary, high-impact activities such as dredging the ocean bottom, dumping waste, and construction of piers, oil rigs, pipelines, and port facilities are not allowed. Scientific research, monitoring, education programs, fishing, boating, and other low impact activities are allowed and encouraged. Subsistence use of marine mammals and fish is preserved by the marine sanctuary designation.
Appendix 3
Contingent Valuation Survey

Your Support for Marine Sanctuary Designation in Alaska’s Arctic Region

Map 2 identifies a possible marine sanctuary designation in the Chukchi Sea coastal region in northwest Alaska. This site is just one of many potential sites for marine sanctuary designation in Alaska’s coastal arctic region. This area is of major importance to Alaska Native villagers living in the nearby communities of Kivalina, Kotzebue, and Noatak because it supports dense concentrations of marine mammals such as beluga whales, bowhead whales, bearded seals, and fish such as char, grayling, salmon, and cod. These species are vital to the subsistence economy of the area. The coastlines and lagoons in this area provide ecologically critical nesting habitat for large flocks of migratory birds. Unique geological features found in Cape Krusenstern National Monument, which borders the proposed sanctuary, preserve 9,000 year old evidence of prehistoric human use of the coastline.

The proposed marine sanctuary shown on Map 2 is one of special interest because the area is currently being assessed for development. In particular, the Alaska Industrial Export Authority and the Army Corps of Engineers have proposed a major port expansion project at this site. The proposed project would facilitate increased shipments of zinc and lead from the nearby Red Dog mine and enhance delivery of fuel oil to villages throughout northwest Alaska. Some negative environmental impacts that may result from the project include decreases in the abundance of marine mammals in the project area, decreased subsistence use, loss of marine habitat in areas used for dredging and dumping of dredged material, loss of habitat for migratory birds, and an increase in the risk of a major fuel oil spill near the shore. Designation of a marine sanctuary in this area would allow existing uses to continue but would prevent these additional negative environmental impacts from occurring. Designation of a marine sanctuary would provide a high degree of protection for the many marine mammals, fish, and migratory birds that use the area, but would prevent the proposed port expansion.

Q18. Suppose that designation of the marine sanctuary shown on Map 2 was the subject of a non-binding, statewide advisory referendum, where the results were provided to federal, state, and local policy-makers. Would you vote Yes (for the designation) or No (against the designation)? (Please circle either yes or no).

Yes  No

Q19. Establishing and managing a marine sanctuary requires use of public funds to finalize sanctuary boundaries, clean up beaches and lagoons, protect wildlife and fish populations, conduct educational programs, develop a management plan, and identify future threats. Suppose that a fund managed by a local non-profit advisory council was established by NOAA to implement these activities. If a marine sanctuary were designated as shown on Map 2, would your household be willing to make an annual contribution to such a fund? (Please circle either yes or no).

Yes  No
Appendix 3
Contingent Valuation Survey

Q20. What is the maximum amount your household would be willing to donate each year to this fund? Please fill in a dollar amount in the space below. In answering, please keep in mind your household budget and what you can actually afford. You may also fill in zero.

_________ $ per year.

If you voted NO to designation of a marine sanctuary or NO to funding its establishment and management, please tell us why.

We are interested in the reason(s) why you voted NO. Please check all that apply:

____ A marine sanctuary is not worth any money to me.
____ It is unfair to expect me to pay for a marine sanctuary.
____ I believe that a marine sanctuary designation will not help preserve this part of Alaska.
____ I do not want additional restrictions placed on coastal development in this area.
____ I am opposed to paying for more government programs.
____ The loss to coastal Alaskan communities and their economic livelihood is too large.
____ Other, please explain:

____________________________________________________________________________

If you voted YES to designation of a marine sanctuary or YES to funding its establishment and management, please tell us why.

We are interested in the reason(s) why you voted YES. Please check all that apply:

____ I would get pleasure from knowing that I had contributed to a good cause.
____ I would pay because I have a duty to do my share to protect coastal ecosystems in the Alaskan arctic.
____ I would get pleasure from knowing that pristine coastal ecosystems will continue to exist in the Alaskan arctic.
____ I enjoy watching wildlife in coastal arctic Alaska.
____ I am concerned that other people may not support this program.
____ I am concerned about environmental quality in general.
Appendix 3
Contingent Valuation Survey

___ I want the option to visit a wild coastal ecosystem in the Alaskan arctic in the future.
___ I believe subsistence hunting and fishing in the coastal Alaskan arctic should be protected.
___ I wish to protect this type of area for future generations.
___ Other, please explain:

---

About You

These questions will help us evaluate how well our sample represents Alaska residents. *Your answers are strictly confidential and will only be used for the analysis of this questionnaire. You will not be identified in any way.* As before, these questions are strictly voluntary, and you may omit any questions you wish.

Q21. Are you    ________ Male    ________ Female

Q22. What is your age?    ________ Years

Q23. Are you retired?    ________ Yes    ________ No

Q24. With which political party are you affiliated? (Please circle one).
       Republican   Democrat   Green   Libertarian   Independent   Reform   No affiliation

Q25. Did you vote in the last national election?    ________ Yes    ________ No

Q26. Are you a member of a conservation or environmental organization?    ________ Yes    ________ No

Q27. What is your highest level of formal schooling? (Please circle one).
       1    2    3    4    5    6    7    8    9    10    11    12    13    14    15    16    17    18    19    20 +
       (Elementary)   (Jr. High)   (High School)   (College/ Tech. School)   (Graduate/ Professional)

Q28. What is your annual household income, before taxes?
       ___ less than $20,000    ___ $20,000 to $29,999    ___ $30,000 to $39,999
       ___ $40,000 to $49,999    ___ $50,000 to $59,999    ___ $60,000 to $69,999
       ___ $70,000 to $79,999    ___ $80,000 to $89,999    ___ $90,000 to $99,999
       ___ $100,000 to $109,999 ___ $110,000 to $120,000 ___ over $120,000

Q29. How long have you lived at your residence?    ________ Years

Q30. How many people live at your residence?    ________ People

A3 - 7
Appendix 3
Contingent Valuation Survey

Q31. How long have you lived in Alaska? ________ Years

Q32. Do you own or rent your place of residence? _____ Own _____ Rent

Q33. What is your zip code? _______________

Your responses are greatly appreciated! Please place this questionnaire in the enclosed envelope and return to:

Ecology and Law Institute
PO Box 80506
Fairbanks, AK 99708

Please feel free to use the space below or the back of this page for any comments.
Appendix 3
Contingent Valuation Survey

Map 1: Coastal Region in Arctic Alaska

Map 2: Proposed Marine Sanctuary in the Chukchi Sea