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Susitna-Watana Hydroelectric Project: Benefit-Cost and Economic Impact Analyses

Prepared for

Alaska Energy Authority

March 31, 2015

Prepared by

Northern Economics

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Executive Summary

The Alaska Energy Authority requested Northern Economics to evaluate the economic merits of the proposed Susitna-Watana Hydroelectric Project. To evaluate the economic merits of the project, both a benefit-cost analysis and an economic impact analysis were conducted.

The benefit-cost analysis determines whether the expected benefits of the project are going to outweigh the costs of the project over the project life. This analysis looks at the first 50 years of operations, though the project life is expected to be much longer. The proposed project is anticipated to provide benefits (cost savings) achieved primarily through the offset of generation costs resulting from hydroelectric energy vis-à-vis existing hydrocarbon-based generation systems, and reduction of greenhouse gas (GHG) emissions. The costs of the proposed project include both the capital and operations and maintenance costs over the life of the project. Other potential benefits associated with the construction and operation of the project were also identified.

The economic impact analysis (also known as input-output analysis), on the other hand, provides information on potential direct, indirect, and induced employment, labor income, and economic output (or business sales) effects of the project during pre-construction, construction, and operations. These economic impacts are generated as a result of local spending associated with the various phases of the project. The IMPLAN™ input-output model was used for estimating the indirect and induced effects of the project; the indirect and induced effects are collectively referred to as the multiplier effects. The direct effects of the project are based on the detailed estimates of project costs that were prepared as part of the Engineering Feasibility Report (AEA 2014A).

The following are the highlights of the findings of the benefit-cost analysis:

Energy savings, in the form of reduced energy costs from other forms of power generation, is the primary benefit of the project; over the first 50 years of operation (2028–2077) these savings, expressed in 2014 dollars, total $11.2 billion. The project's capital and operations and maintenance costs amount to $4.7 billion in 2014 dollars. This results in a benefit-cost ratio (BCR) of 2.39 using a three percent discount rate for energy savings.[1] Additional benefits of the project include retirement of older generation facilities, reduction in GHG emissions, and reduction in the frequency of power outages. Retirement of older generation facilities that are no longer needed as backup capacity is estimated to have a net present value of $345 million, which increases the BCR to 2.46. Greenhouse gas emission reductions and the reduction in the frequency of power outages have greater uncertainty around the benefit estimates. If the benefits from these two items are included in the analysis, along with energy savings and retirement of older generation facilities, the BCR would increase to 3.07. The estimated benefits and costs are summarized in Table ES-1.

[1] Alaska Energy Authority has used a three percent discount rate for the analysis of other renewable energy projects, so that same discount rate is applied here. A discussion of how this determination was made is provided in Section 2.2. Using a different discount rate will change the benefit-cost ratio. On the basis of energy cost savings alone, the project has a benefit-cost ratio of 1 or higher for a discount rate of up to 7.6 percent.

Table ES-1. Benefit-Cost Analysis Findings and Benefit-Cost Ratio

Category	Net Present Value (2014 $)
Benefits	
Energy Cost Savings	11,179,771,428
Plant Retirement	344,988,357
Reduction in Power Outages	1,134,539,814
GHG Emission Reduction	1,698,678,912
Total Benefits	**14,357,978,511**
Costs	
O&M	489,522,530
Capital	4,195,681,789
Total Costs	**4,685,204,319**
Benefit-Cost Ratio	
Energy Cost Savings only	**2.386**
Energy Cost Savings and Plant Retirement	**2.460**
Energy Cost Savings, Plant Retirement, and GHG Emission Reduction	**2.702**
All Benefits	**3.065**

Additional energy generation (beyond the estimated annual energy production of 2,800 GWh) would improve the economics; each additional 50GWh generated would increase the BCR by 0.044.

The following are the highlights of the findings of the economic impact analysis:

The proposed project will provide jobs for many decades, throughout the pre-construction, construction, and operations phases of the project. These jobs will include the direct jobs associated with licensing activities, planning, engineering, construction, and environmental mitigation, as well as operations and maintenance of the hydroelectric facilities. In addition, the proposed project will generate indirect and induced jobs resulting from the stimulus effects of project spending, as Alaska businesses benefit from purchases of goods and services, and as workers spend their money in the local economy.

It is estimated that the pre-construction and non-construction activities could support up to 5,000 total direct jobs for the entire period, from 2010 to 2028. On an annualized basis, this would mean about 260 direct jobs a year. Indirect and induced jobs associated with these activities are expected to add up to about 3,800; or about 205 jobs on an annualized basis.

It is estimated that the entire construction period would require a direct construction workforce of over 12,000. Peak construction workforce is estimated to be 1,155 in year 2025. Indirect and induced jobs associated with construction spending are estimated to add up to over 11,000 over the entire construction period, or an annual average of about 1,300.

It is estimated that the operations phase of the project would require about 24 to 28 permanent year-round staff at the site. Indirect and induced jobs associated with the operations phase are expected to be about 100 jobs per year. A project of this magnitude is expected to benefit numerous Alaska businesses involved in the construction, engineering and technical services, environmental services, business support, camp operations, logistics (air transportation, rail transportation, water transportation, truck transportation, warehousing, and storage) sectors, as well as all retail and wholesale trade sectors.

The total estimated local spending for each of the spending categories is shown in Table ES-2. Approximately $800 million of local spending is projected for pre-construction (licensing and design costs) and other program costs, over $2.6 billion of local spending during construction, and annual local spending of $26.5 million during operations.

This potential local spending is projected to create multiplier effects in the state economy. These multiplier effects are summarized in the table below.

Table ES-2. Estimated Local Spending and Associated Multiplier Effects of Project Spending (2014 $)

		Multiplier Effects		
Project Spending Category	Local Spending ($)	Business Sales ($)	Jobs	Labor Income ($)
Spending on Licensing/Design and Other Program Costs	814,148,500	551,245,700	3,870	204,254,400
Construction Spending	2,658,465,300	1,837,133,150	11,305	627,307,200
Operations Spending	$26,500,000	18,494,000	105	6,435,000

Source: Northern Economics estimates

Note: Operations spending in this table does not include $40 million in spending for additional environmental monitoring which is anticipated for the first 5 years of project operations.

1 Introduction

The Susitna-Watana Hydroelectric project is a large dam project designed to provide long-term stable power for the Alaska Railbelt region. The project as proposed will generate 50 percent of the Railbelt's electric demand when it comes online. The proposed project would include construction of a dam, reservoir and related facilities; transmission lines connecting into the Railbelt transmission system; and an access road.

The Alaska Energy Authority (AEA) is currently working on the permitting process with the Federal Energy Regulatory Commission (FERC). As part of this process, a multitude of studies have been conducted since 2011. In 2014, AEA completed the Engineering Feasibility Report that incorporated results of prior engineering and environmental studies. The report provides details of the project's conceptual design including the construction plan and project costs.

AEA tasked Northern Economics with evaluating the economic merits of the proposed project using the Engineering Feasibility Report results. This study involves both a benefit-cost analysis (BCA) and an economic impact analysis (or input-output analysis). The benefit-cost analysis will show whether the expected benefits of the project are going to outweigh the costs of the project over the project life. The proposed project is expected to provide benefits (cost savings) achieved through the offset of generation costs resulting from hydroelectric energy, retirement of older generation facilities, reduction of greenhouse gas (GHG) emissions, and other items vis-à-vis existing hydrocarbon-based generation systems. The costs of the proposed project would include both capital and operation and maintenance costs over the life of the project. This analysis involved reviewing AEA materials on estimated project costs and the results of the energy modeling that served as the basis for quantifying the estimated savings in power generation and the other project benefits. A spreadsheet model was developed to calculate the net present value of the project benefits and costs.

The economic impact analysis provides information on potential job, income, and economic output effects of the project. The analysis involves determining potential local spending by sector by year and quantifying employment, income effects, and local business effects using the IMPLAN™ input-output model. The model inputs included itemized capital and operating costs by year, and assumptions regarding potential local spending. Local spending generates a stimulus effect on the state's economy and creates an increase in economic activity, jobs, and labor income.

The remainder of this report is divided into three main sections:

- Section 2 presents the approach and findings of the BCA
- Section 3 presents the approach and findings of the economic impact analysis
- Section 4 provides references used in the analyses

2 Benefit-Cost Analysis of the Proposed Susitna-Watana Hydroelectric Project

This section describes the approach and findings for the BCA of the project.

Benefit-cost analysis is used to compare the present value of all benefits and all costs from a proposed action to determine if the benefits exceed the costs. It is commonly used to compare alternatives, in this case the comparison is the total cost of energy with and without Watana. BCA is incremental, in that it considers the incremental changes in benefits and costs as a result of Watana being constructed and put into operation. The result of a BCA is a benefit-cost ratio (BCR), which expresses the ratio of the present value of benefits to the present value of costs. A BCR of 1 or higher indicates an economically feasible project.

The analysis considers four primary benefits:

1) The change in cost of energy to consumers in the system;
2) Operating expense savings from retirement of older generation facilities;
3) Reduction in the frequency of power outages;
4) Reduction of greenhouse gas emissions.

The analysis identifies additional sources of benefits, but these benefits have not been quantified and are only addressed qualitatively in this report. These additional benefits include:

1) Deferral of additional generation capacity;
2) Coordination with a natural gas pipeline project;
3) Reduction in the production of coal ash;
4) Other environmental benefits and costs

The analysis considers two types of costs:

1) Annual operations and maintenance costs;
2) Capital costs

The analysis does not consider the economic impacts of the project on the Railbelt and the State of Alaska, nor does it include consideration of the effect that different financing plans could have on the project's cash flows.

2.1.1 Energy Savings

Energy savings are calculated based on the energy demand and generation capacity assumptions used in the 2014 Engineering Feasibility Report (AEA 2014a). Railbelt energy demand forecasts from the report were used for the years 2014, 2024, 2034, and 2044; energy use for other years of the analysis was interpolated and extrapolated using compound annual average growth rates between the years included in the report. Overall energy use was then allocated to four sources (coal, gas and oil, wind, and hydro) in 2024 as identified in the Engineering Feasibility Report.

In 2028, Watana would come online and its energy would reduce the contribution of energy from natural gas and oil.

Over time, annual generation from wind and existing non-Watana hydroelectric was forecasted to remain stable (AEA 2014a). The Engineering Feasibility Report forecasted the installed capacity for coal and gas/oil sources, which was used to scale estimates of energy consumption over time. Gas and oil generation was assumed to be the balancing factor between annual energy use and generation from each source. This forecasting process was completed for the with-Watana and without-Watana alternatives.

The benefit associated with energy savings was estimated based on changes in the contribution of energy from coal and gas/oil generated energy to energy produced by Watana. Natural gas price forecasts from the AEA (2014) report were used for 2029, 2039, 2049, and 2059, with other years interpolated or extrapolated using compound annual average growth rates based on those four years. Gas/oil costs are conservative in that the costs are based on natural gas prices and no estimate is developed for the cost of oil that would be consumed. An average energy price for coal-fired generation in 2013 (National Mining Association 2014) was used for that source, with 2.75 percent annual escalation.

The present value of energy savings is $11.2 billion in 2014 dollars.

2.1.2 Retirement of Older Generation Facilities

AEA (2014a) estimates savings from the retirement of older generation facilities that would otherwise need to be maintained as standby units in the without-Watana case. Those savings in fixed operating costs were estimated at $16.5 million annually in 2024, $18.3 million annually in 2034, and $23.1 million annually in 2044. This analysis shifts those savings by four years to reflect the beginning of full operations in 2028 instead of 2024. Annual savings for 2030–2038 and 2040–2048 are interpolated from the estimates in AEA (2014a). Annual savings for 2050 and later years (through the end of the analysis period in 2077) are assumed to remain fixed at $23.1 million. The present value of savings attributed to retirement of older generation facilities is $345 million in 2014 dollars.

2.1.3 Reduction of Power Outages

Power outages can have a substantial financial impact on customers. A report published by Berkeley National Laboratories (LaCommare and Eto 2004) presents past estimates of the cost of power outages on the United States and a newer regression model for estimating the economic effects of power outages to residential, commercial, and industrial customers, based on factors such as the duration, season, time of day, and location of the outage. The impacts are modest per type of user and represent the time and cost required to reset digital clocks in a house for residential customers for example, reboot the cash registers in a commercial establishment, and restart a production line for an industrial customer for other examples.

The increased reliability of hydroelectric power could lead to a reduction in the number of generation-related outages in the Railbelt.[2] Based on estimates presented in the Engineering Feasibility Report (AEA 2014a), Watana could lead to two fewer outages annually for all customers in the Railbelt than the without-Watana case. The two outages are assumed to be a 0-second outage (sufficient to require computer reboots) and a sustained outage as described in the Berkeley report.

[2] Note that this analysis does not include the benefits from or costs of improvements to the transmission system, which is treated as independent from the project.

LaCommare and Eto (2004) estimated the costs to residential, commercial, and industrial customers in the Pacific region of 0 second and sustained outages. Those estimates, inflated to 2014 dollars, are shown in Table 1.

Table 1. Estimated Cost-per-Outage-per-Customer for the U.S., 2014 Dollars

Duration	Residential	Commercial	Industrial
0 second	2.37	795	2,475
Sustained interruption	3.22	1,382	5,410

Source: LaCommare and Eto (2004), Alaska Department of Labor & Workforce Development (2014), and Northern Economics, Inc. analysis

Given that Alaska's industrial users are likely of a different scale than most other industrial users in the Pacific Region, this analysis uses the commercial rate for industrial users. This results in the modified cost per outage shown in Table 2.

Table 2. Modified Estimated Cost-per-Outage-per-Customer for the U.S., 2014 Dollars

Duration	Residential	Commercial and Industrial
0 sec	2.37	795
Sustained interruption	3.22	1,382

Source: LaCommare and Eto (2004), Alaska Department of Labor & Workforce Development (2014), and Northern Economics, Inc. analysis

An estimate from the Energy Information Administration (2015) suggests there are 214,227 residential, 29,832 commercial, and 535 industrial customers served by the Railbelt utilities, as summarized in Table 3.

Table 3. Estimated Number of Railbelt Energy Customers by Type, 2014

	Count of Customers by Type		
Utility	Residential	Commercial	Industrial
GVEA	38,223	6,357	505
MEA	55,441	3,803	0
CEA	70,004	9,294	7
MLP	24,357	6,380	0
HEA	26,202	3,998	23
Total	**214,227**	**29,832**	**535**

Source: Energy Information Administration (2015) and Northern Economics, Inc. analysis

Applying the modified estimated cost per outage for each type of outage to the number of energy customers on the Railbelt yields an annual benefit from avoided outages of $67.3 million, beginning with Watana's first full year of operations in 2028. The present value of this benefit in 2014 dollars is $1.1 billion. It is important to note that the analysis has not assumed any changes in the number of customers by type, and therefore this estimate understates the potential future benefits.

2.1.4 Reduction in Greenhouse Gas Emissions

Current estimates by AEA (2014b) suggest that the Watana project would reduce GHG emissions by 1.3 million metric tons (tonnes) of CO_2 per year.

The social cost of GHG emissions is hotly contested and highly uncertain. However, some guidelines are available for estimating the social costs of GHGs. The Environmental Protection Agency (EPA) (2013) maintains estimates of the social cost of carbon, including costs to agriculture, human health, and property damage due to flooding. The EPA's estimated social cost of carbon for 2015–2055 is shown in Table 4 with an additional estimate prepared by Northern Economics to adjust the costs to 2014 $.

Table 4. Social Cost of CO_2 Emissions

Year	EPA Estimate of Social Cost of Carbon, 3% Discount Rate, in 2011 Dollars	Estimate in 2014 Dollars
	($ per Tonne of CO_2)	
2015	39.00	41.05
2020	46.00	48.41
2025	50.00	52.62
2030	55.00	57.88
2035	60.00	63.15
2040	65.00	68.41
2045	70.00	73.67
2050	76.00	79.99

Source: EPA (2013), Alaska Department of Labor & Workforce Development (2014), and Northern Economics, Inc. analysis

Applying the cost of GHG emissions to the estimated reduction of GHG emissions associated with the Watana project, the net present value of benefits is $1.7 billion.

2.1.5 Capital Costs

Watana will incur up-front licensing, construction, and program costs through completion of the facility in 2028. The BCA only considers those costs that will be incurred from the present (2015) through 2028. Licensing expenses incurred prior to 2015 (approximately $192 million) are sunk costs and are not considered in a BCA. Table 5 summarizes these capital expenditures from the present (2015) through 2028, based on the December 2014 Engineering Feasibility Report.

Table 5. Summary of Capital Costs

	Capital Costs (2014 $)			
Year	Licensing/Design	Construction	Program	Total
2015	90,000,000			90,000,000
2016	80,000,000			80,000,000
2017	80,000,000			80,000,000
2018	90,473,787			90,473,787
2019		138,893,704	102,780,023	241,673,727
2020		226,782,071	102,780,023	329,562,094
2021		639,826,619	102,780,023	742,606,642
2022		546,783,129	102,780,023	649,563,152
2023		405,651,442	102,780,023	508,431,465
2024		600,039,146	102,780,023	702,819,169
2025		647,784,230	102,780,023	750,564,253
2026		519,974,178	102,780,023	622,754,201
2027		197,681,439	102,780,023	300,461,462
2028		172,517,003	102,780,023	275,297,026

Source: AEA (2014c)

Note: Construction capital costs are based on an AACE Class 4 with elements of Class 3 incorporated. The sensitivity of results to the uncertainty in costs is explored in Section 2.3.1.2.

2.1.6 Operations and Maintenance Costs

Operations and maintenance cost estimates were provided by AEA (2014d). The annual operations and maintenance cost is estimated to be $26.5 million. An additional environmental monitoring cost was included for the first five years, consisting of $10 million annually for the first three years and $5 million for the fourth and fifth years.

2.1.7 Benefits and Costs Considered but Not Included

Additional benefits and costs were considered but not included in the BCA. These benefits and costs are discussed in the following sections.

2.1.7.1 Deferral of Addition of New Generation Capacity

In addition to savings from the retirement of older generation facilities, covered in Section 2.1.2, Watana would create savings by deferring the addition of new generation capacity. The timing of when additional generation capacity would be needed is uncertain, and capital costs for that additional capacity have not been developed.

2.1.7.2 Coordination with a Natural Gas Pipeline Project

There is a potential for the Alaska LNG natural gas pipeline project to work in a complimentary fashion with the Susitna-Watana Project. Susitna-Watana could be used to help power the compressor stations and ancillary facilities for the liquefaction plant during the summer, allowing for higher generation in summer and greater export of natural gas. This would permit Susitna-Watana to operate at a higher head in summer, thus generating more energy. In winter, natural gas from the Alaska LNG pipeline could help provide the firm energy that Susitna would otherwise provide, thereby allowing Susitna flows to be reduced during that period. Susitna-Watana would be available to meet system power demands.

2.1.7.3 Coal Ash Reduction

A recent report by Information Insights and Sustainable Alaskan Materials (2014) indicates that six coal-fired plants operating in Fairbanks produce more than 110,000 tons of coal combustion products annually, an amount that is expected to increase to 170,000 tons once two new facilities come online in the next few years.

Disposal of coal ash uses space in landfills, contributing to the eventual closure and replacement of those landfills. If coal ash were to be reduced, it would increase the life of the existing landfills and defer their closures and opening of new areas. This would have a positive financial impact on the entities maintaining these landfills.

Above and beyond this basic issue of landfill use, regulatory changes anticipated in the near future could bring additional costs to landfill operators. Information Insights and Sustainable Alaskan Materials (2014) indicate that under one regulatory scenario, the Fairbanks North Star Borough (FNSB) could incur $20 million up front, $10 million per landfill cell, and $10 million annually to construct and operate a modern lined coal ash landfill. It is not known what regulatory changes will occur or how the increased costs might be distributed between the FNSB and the landfill users.

Since the cost of coal-fired electricity is likely to be lower than that of Watana, at least initially, utilities are not expected to retire their coal-fired plants.

However, during the construction phase of the project, there is the potential for locally produced coal ash to be used to make cement for the dam and other structures. Use of local materials could slightly reduce the cost of the project, and reduce the time before a new coal ash landfill would be required, thereby deferring the FNSB's future capital costs, and potentially reduce the operating costs during the construction phase. The 2014 report by Information Insights, Inc. and Sustainable Alaskan Materials indicated that Alaska coal ash has a high unburned carbon content that would need to be removed prior to using the ash in Portland cement. There are no estimates of the volume of locally-produced coal ash, following carbon removal that may be competitive with imported coal ash so it is not possible to monetize these potential benefits at this time.

2.1.7.4 Other Environmental Benefits and Costs

Environmental effects of the project are still being evaluated but the potential exists for both adverse and beneficial effects on fish and wildlife, the natural environment, and human use of the resources of the Susitna River basin. Until the environmental studies for the project are completed, it is not possible to estimate the dollar value of such effects, and even then the monetary effects of the project on the environment will be subject to great uncertainty.

2.1.7.5 Debt Costs

The BCA considers costs when they are incurred and is calculated independent of the financing arrangements used to cover the licensing, construction, and program costs. If financing arrangements were to be factored in, the effect of financing would depend on the discount rate used in the analysis. If the discount rate is less than the effective financing rate, financing would have a detrimental effect on the economic feasibility of the project. Conversely, if the discount rate is greater than the effective financing rate, financing would have a positive effect on the economic feasibility.

2.2 Discount Rate

The discount rate is used to "discount" or reduce the value of future dollars to their present equivalent and is an integral part of the time value of money concept and benefit-cost analysis.

Discount rates may be chosen based on a variety of factors. For example, federal government agencies take guidance from Circular A-94 (OMB 1992) and Circular A-94 Appendix C (OMB 2014), which set rates of:

- 7 percent real discount rate for "benefit-cost analyses of public investments and regulatory programs that provide benefits and costs to the general public"
- 1.7–3.4 percent nominal discount rates, depending on length of term (3–30 years) for nominal cash flows typical of lease/purchase analysis
- 0.1–1.4 percent real discount rates, depending on length of term (3–30 years) for constant-dollar cash flows typical of cost-effectiveness analysis

A publication by the U.S. Fish and Wildlife Service (1998) outlining FERC standards for economic analysis of hydroelectric projects suggests that the default discount rate should be 10 percent, though rates as low as 7 percent have been used. A review of selected private entities' filings with FERC shows that the discount rates have typically been in this 7–10 percent range.

Benefit-cost analyses conducted for the Alaska Energy Authority's renewable energy grant program have used a 3 percent discount rate.

The rates presented in the preceding paragraphs reflect public entities. In a private context, the weighted average cost of capital is typically used as the basis for an entity's discount rate. This approach could be applied to Watana by using the average interest rate for the project's chosen financing plan.

There is also the social argument that discount rates for projects of this nature should be 0, reflecting no discounting of future dollars, because any positive discount rate devalues the benefits that could be afforded to future generations. It is also argued that discounting places an emphasis on consuming resources for the benefit of the present generation rather than later generations.

After reviewing potential discount rates, Northern Economics decided to use a discount rate of 3 percent, coupled with a sensitivity analysis discussed in Section 2.3.1.4 to determine the effect of the discount rate on the benefit-cost ratio (BCR).

2.3 Findings

The analysis finds that the BCR of the Watana project, using the approach and assumptions discussed earlier in this section, is 2.39 for energy cost savings alone. This means the net present value of benefits provided by energy cost savings amounts to 239 percent of the net present value of costs incurred by the project.

Table 6 summarizes the benefits, costs, and BCR for this analysis.

Table 6. Benefit-Cost Analysis Findings and Benefit-Cost Ratio

Category	Net Present Value (2014 $)
Benefits	
Energy Cost Savings	11,179,771,428
Plant Retirement	344,988,357
Reduction in Power Outages	1,134,539,814
GHG Emission Reduction	1,698,678,912
Total Benefits	**14,357,978,511**
Costs	
O&M	489,522,530
Capital	4,195,681,789
Total Costs	**4,685,204,319**
Benefit-Cost Ratio	
Energy Cost Savings only	**2.386**
Energy Cost Savings and Plant Retirement	**2.460**
Energy Cost Savings, Plant Retirement, and GHG Emission Reduction	**2.702**
All Benefits	**3.065**

Note: Capital costs are less than $5.6 billion due to the exclusion of sunk costs and discounting to 2014 dollars.

2.3.1 Sensitivity Analysis

Changing assumptions will result in a change to the BCR. This section discusses the impact of changes to three assumptions: the average heat rate for Railbelt utilities, additional power sales from Watana, and the discount rate used in the analysis.

2.3.1.1 Average Heat Rate for Railbelt Utilities

The analysis assumes an average heat rate for Railbelt utilities using natural gas based on the PROMOD results and calculated by AEA (Ott 2015). The with-Watana average heat rates for gas generation for the years 2029–2059 was estimated to be 7,664 British Thermal Units per kilowatt hour (BTU/kWh). The without-Watana average heat rates for gas generation for the years 2049–2059 was estimated to be 7,631 BTU/kWh. These heat rates were applied to all years for the with and without-Watana cases. Table 7 shows the effect of a different without-Watana heat rate on the BCR.

Table 7. Sensitivity of Benefit-Cost Ratio to Railbelt Utility Heat Rate

	Benefit-Cost Ratio			
Heat Rate (BTU/kWh)	Energy Cost Savings Only	Energy Cost Savings and Plant Retirements	Energy Cost Savings, Plant Retirements, and Reduction in Outages	All Benefits
7,631	2.386	2.460	2.702	3.065
8,000	2.540	2.614	2.856	3.218
8,500	2.748	2.822	3.064	3.427
9,000	2.957	3.031	3.273	3.635
9,500	3.165	3.239	3.481	3.844
10,000	3.374	3.448	3.690	4.052
10,500	3.582	3.656	3.898	4.261
11,000	3.791	3.864	4.107	4.469
11,500	3.999	4.073	4.315	4.678
12,000	4.208	4.281	4.523	4.886
12,500	4.416	4.490	4.732	5.095

2.3.1.2 Uncertainty in Construction Costs

The analysis uses construction costs estimated to AACE Class 3 and Class 4 levels (see Table 5). Higher or lower construction costs would affect the benefit-cost ratio, as illustrated in Table 8. As seen in the table, while the benefit-cost ratio varies with changes in construction costs, it still remains favorable with costs in excess of 150 percent of the December 2014 estimate.

Table 8. Sensitivity of Benefit-Cost Ratio to Changes in Construction Cost

	Benefit-Cost Ratio			
Adjustment to Construction Cost from Base (%)	Energy Cost Savings Only	Energy Cost Savings and Plant Retirements	Energy Cost Savings, Plant Retirements, and Reduction in Outages	All Benefits
-50	3.566	3.676	4.038	4.580
-40	3.245	3.345	3.675	4.168
-30	2.977	3.069	3.371	3.824
-20	2.750	2.835	3.114	3.532
-10	2.555	2.634	2.893	3.282
0	2.386	2.460	2.702	3.065
+10	2.238	2.307	2.534	2.874
+20	2.107	2.172	2.386	2.706
+30	1.991	2.052	2.254	2.557
+40	1.887	1.945	2.136	2.423
+50	1.793	1.848	2.030	2.303

2.3.1.3 Additional Power Sales

If Watana were able to exceed the forecast energy generation assumed in this analysis, the displaced generation from natural gas plants would boost the BCR. Table 9 shows the BCR for the base generation forecast, plus an additional 50-300 gigawatt hours (GWh) annually. Each additional 50 GWh per year would contribute $207.6 million of benefits. Note that this would have to be a sustained increase in energy generation in order to realize this level of benefit.

Table 9. Sensitivity of Benefit-Cost Ratio to Higher Energy Generation

Watana Annual Energy Generation (GWh/year)	Benefit-Cost Ratio, Energy Cost Savings Only	Benefits, Energy Cost Savings Only (Billions of 2014 $)
2,800	2.386	11.180
2,850	2.430	11.387
2,900	2.475	11.595
2,950	2.519	11.802
3,000	2.563	12.010
3,050	2.608	12.218
3,100	2.652	12.425

2.3.1.4 Discount Rate

Results of the BCA are highly sensitive to the discount rate used to discount benefits and costs to the present. Use of a different discount rate affects the BCR due to the difference in timing of the benefits (which occur later) and the costs (which are heavily weighted toward the earlier years). Table 10 shows the range of BCRs that are estimated for the project under different discount rates. The analysis uses a three percent discount rate, which results in a BCR of 2.386 for energy costs savings only. Using a lower discount rate will maintain a BCR above 1. Increasing the discount rate above 7.6 percent will result in a BCR of less than 1.

Table 10. Sensitivity of Benefit-Cost Ratio to Discount Rate

	Benefit-Cost Ratio			
Discount Rate (%)	Energy Cost Savings Only	Energy Cost Savings and Plant Retirements	Energy Cost Savings, Plant Retirements, and Reduction in Outages	All Benefits
0	4.821	4.974	5.457	6.244
1	3.777	3.896	4.276	4.878
2	2.985	3.078	3.380	3.844
3	2.386	2.460	2.702	3.065
4	1.932	1.991	2.187	2.474
5	1.584	1.632	1.794	2.023
6	1.316	1.355	1.489	1.676
7	1.105	1.138	1.250	1.404
8	0.938	0.966	1.061	1.190
9	0.804	0.827	0.909	1.017

3 Economic Impacts of the Proposed Susitna-Watana Hydroelectric Project

This section presents the estimated economic impacts of the proposed Susitna-Watana hydroelectric project. The proposed project is expected to generate significant positive impacts on the state economy. These economic impacts are measured in terms of jobs, associated labor income, and economic output (or business sales).

The proposed project will provide jobs for many decades, throughout the pre-construction, construction, and operations phases of the project. These jobs will include the direct jobs associated with licensing activities, planning, engineering, construction, and environmental mitigation, as well as operations and maintenance of the hydroelectric facilities. In addition, the proposed project will generate indirect and induced jobs resulting from the stimulus effects of project spending, as Alaska businesses benefit from purchases of goods and services and as workers spend their money in the local economy.

The following sections describe the approach used in this analysis and the major findings.

3.1 Approach

The economic impacts of the proposed project were evaluated by quantifying the direct, indirect, and induced effects of projected project spending. This type of analysis is called input-output (I-O) analysis. Input-output analysis is an economic tool used to measure the effects of an economic activity on a region. In this case, the proposed project is going to create significant economic activities associated with licensing activities, planning, engineering, construction, environmental mitigation, as well as operations and maintenance of the hydroelectric facilities.

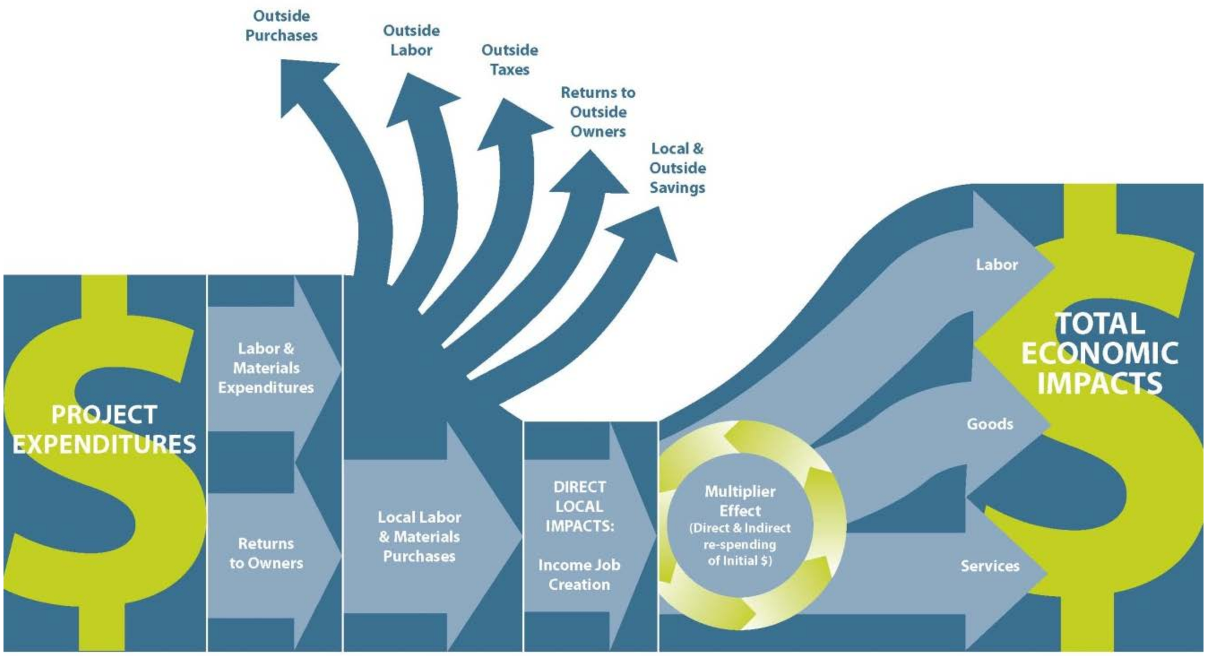
The I-O analysis is based on a model of the inter-industry transactions within a region; this particular analysis is statewide in scope. The I-O model is a matrix that tracks the flow of money between the industries within a specified economic region of interest. The model can measure how many times a dollar is re-spent in—or “ripples through”—the economic region before it leaks out through purchases of goods and services outside of the region. The I-O model yields multipliers that are used to calculate the indirect and induced effects on jobs, income, and business sales/output generated per dollar of spending on various types of goods and services in the study area.

To evaluate the economic impacts to the state, only the “local” (within the state) expenditures are used in the model; the rest are considered leakages. More leakages mean smaller multipliers; and the larger the local expenditures, the greater the multiplier effects. The multipliers for any given industry in any given location are unique, based on industry composition and geographic area.

The IMPLAN™ software was used to develop the statewide I-O model for Alaska. IMPLAN uses specific data on what inputs (goods and services) are needed by a particular sector to produce a commodity or a service (or a road construction project for example) and data on what goods and services are available locally to meet the supply needs. The IMPLAN software has economic data on these inter-industry transactions for 528 economic sectors. The Alaska I-O model however, has 299 economic sectors (or industries); several industries, particularly in the manufacturing sector, do not exist in Alaska. The most recent (2013) IMPLAN data on multipliers for all the economic sectors in the statewide model were applied.

Figure 1 illustrates conceptually how the total economic impacts or benefits are determined.

Figure 1. Framework in Evaluating the Economic Impacts of Project Spending



Source: Northern Economics, Inc.

3.1.1 Direct Effects

The direct effects represent all the direct project spending associated with the pre-construction, construction, and operations and maintenance of the hydroelectric facility. These are called direct effects because they are the first round of spending that occurs within the economic region. The direct effects for this particularly study were obtained from the detailed engineering study commissioned by the AEA. The Engineering Feasibility Report (AEA 2014a) contained detailed information on estimated project costs for all the phases of the project. The itemized project costs were reviewed and assumptions regarding potential local content (or local spending) were made based on information from other major construction projects in Alaska.

Local labor content for the construction activities was based on current residency data for the Alaska construction industry, as reported by the Alaska Department of Labor and Workforce Development. According to the latest residency data for the construction industry, 78 percent of the construction workers are residents of Alaska (ADOLWD 2013).

3.1.2 Multiplier Effects: Indirect and Induced

Indirect effects result from the subsequent rounds of spending in the economy, particularly, all the subsequent business spending that occurs in sectors that supply goods and services for the pre-construction, construction, and operations activities.

Induced effects result from further shifts in spending for food, clothing, housing, entertainment, and other consumer goods and services generated by the increase in labor income or personal income in the region; this is sometimes referred to as payroll effects or household income effects.

Indirect and induced effects are collectively referred to as multiplier effects. As noted above, the multiplier effects are driven by the amount of local (or in-state) spending. The projected amount of local spending associated with the project was used as inputs for the Alaska input-output model to generate the estimated potential multiplier effects of the project.

3.2 Findings

This section presents the findings of the input-output analysis. The discussion of results is organized according to the different types of project spending (or phases): 1) pre-construction and other non-construction program spending, 2) construction spending, and 3) operations and maintenance spending.

3.2.1 Economic Impacts of Pre-Construction Activities and other Program Spending

Total project spending on pre-construction activities and other program costs is estimated to amount to $1.6 billion (2014 $). Project spending under this category includes:

- FERC licensing
- Administration and legal costs
- Initial camp and access
- Engineering design for licensing, detailed design, and engineering during construction
- Construction management
- Environmental monitoring during construction
- Geotechnical investigations
- Logistics for site investigation
- Quality control and inspection
- Environmental mitigation (including land costs)
- Owner insurance

Spending on the above activities started in 2010 and is expected to last through the end of the construction phase. FERC licensing and engineering design activities are expected to occur through the end of 2018, while spending for the other non-construction program costs would occur starting in year 2019 (when the construction phase is assumed to commence) through year 2028 (end of the construction phase).

3.2.1.1 Direct Effects

It is estimated that total local spending (local business sales) associated with these activities would amount to about $800 million (52 percent of total projected cost). Local contracts with companies involved in the environmental and technical consulting services, legal services, architectural, engineering, and related services, transportation services, insurance carriers, and construction management are expected.

To date, an estimated 350 scientists, surveyors, archeologists, biologists and other specialists have already been engaged and have traveled to the project site to study the surrounding environment, and area (encompassing a total of about 186,000 acres). According to AEA's Project Report to the

Legislature, their studies are going to generate data on water, cultural, botanical, and other biological resources including land mammals, birds and fish (AEA 2013). According to the AEA report, local small businesses are already receiving direct economic benefits in support of the Project's field activities. Local restaurants, hotels and lodges, tackle shops, hardware stores, helicopter and fixed-wing aircraft operators, boat operators, and other businesses are providing goods and services to field crews and the project team. These kinds of effects are included in the multiplier effects discussed in the next section.

It is estimated that the pre-construction activities and other program spending could support up to 5,000 total direct jobs for the entire period, from 2010 to 2028. On an annualized basis, this would mean about 260 direct jobs a year. The direct jobs for this category were estimated using IMPLAN data. IMPLAN provides estimates of average number of part-time and full-time jobs per million dollars of spending. Note that this approach is different from the approach used in estimating direct jobs for the construction activities, which are based on detailed engineering estimates of manpower requirements.

3.2.1.2 Multiplier Effects

The estimated total multiplier effects associated with the pre-construction and program spending are shown in Table 11. In addition to the direct business sales, it is projected that approximately $551 million worth of indirect and induced economic output (or business sales) will be generated by direct local project spending. About 3,800 indirect and induced jobs will be created with an associated labor income of about $200 million.

These multiplier effects will be generated in various economic sectors across the state including the technical services, trade, utilities, transportation, and hospitality sectors, and even the personal services sector.

Table 11. Estimated Multiplier Effects of Pre-Construction and Other Program Spending

Multiplier Effects	Amount (2014 $)
Economic Output (business sales), $	551,245,700
Jobs (average number of full-time and part-time jobs)	3,870
Labor Income, $	204,254,400

Source: Northern Economics estimates based on projected project cost data and IMPLAN model.

3.2.2 Economic Impacts of Construction Spending

The construction of the Susitna-Watana hydroelectric facility is estimated to cost about $4 billion (in 2014 $). The construction of this proposed large hydro project includes roads, a powerhouse and related facilities, and the dam site itself. The construction period is assumed to start in 2019 and last until 2028.

The cost estimates for the construction work and the associated support and supply chain activities were divided into 12 construction contracts:

- Main access road construction
- Railroad offloading facility construction
- Site development (for the infrastructure)
- Supply and erect camp
- Main civil works construction

- Turbine and generator supply
- Transmission line and interconnection construction
- Site and reservoir clearing
- Air transport services
- Railroad operations
- Camp operations
- Medical services.

The Engineering Feasibility Report (AEA 2014a) contains detailed estimates of manpower requirements (in man-hours), labor costs, materials costs, and equipment costs associated with the various construction activities. This information was used to estimate the potential local economic impacts during construction.

3.2.2.1 Direct Effects

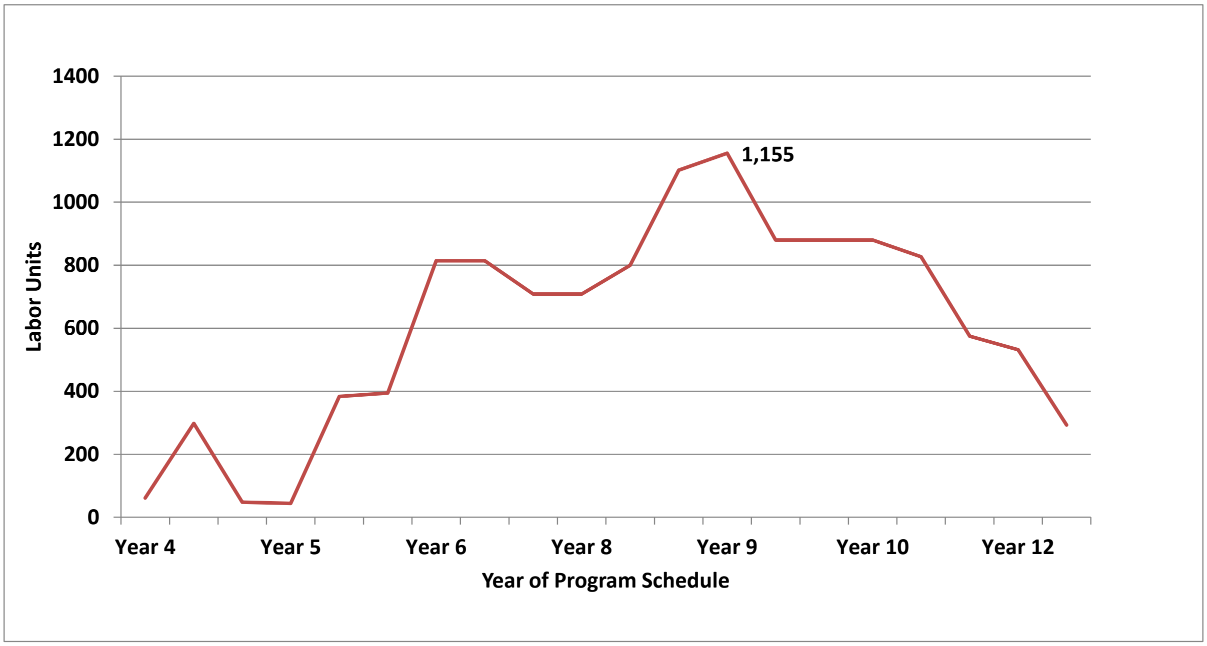
Of the $4.09 billion in total construction spending, it is estimated that potential local spending could amount to $2.66 billion; this represents roughly 65 percent of the total construction spending. While the main civil works contractor and most of the specialty construction materials and equipment will be sourced from outside companies with significant large dam construction experience, there is still a significant portion of project spending that is expected to benefit local contractors and suppliers.

A construction project of this magnitude is expected to benefit numerous Alaska businesses involved in the construction sector, engineering and technical services sector, environmental services, business support sector, camp operations, the logistics sector—air transportation, rail transportation, water transportation, truck transportation, warehousing, and storage—as well as all retail and wholesale trade sectors.

Carpenters, welders, truck drivers, electricians, equipment operators, pipefitters, laborers, and other trades will be needed for the entire construction period. Peak construction workforce is estimated to be 1,155 in Year 9 of the program schedule, or Year 2025 based on the assumed construction schedule (see Figure 2).

It is estimated that the entire construction period would require a total direct construction workforce of over 12,000; the annual construction workforces for each of the construction activities are shown in Figure 3 through Figure 11 below.

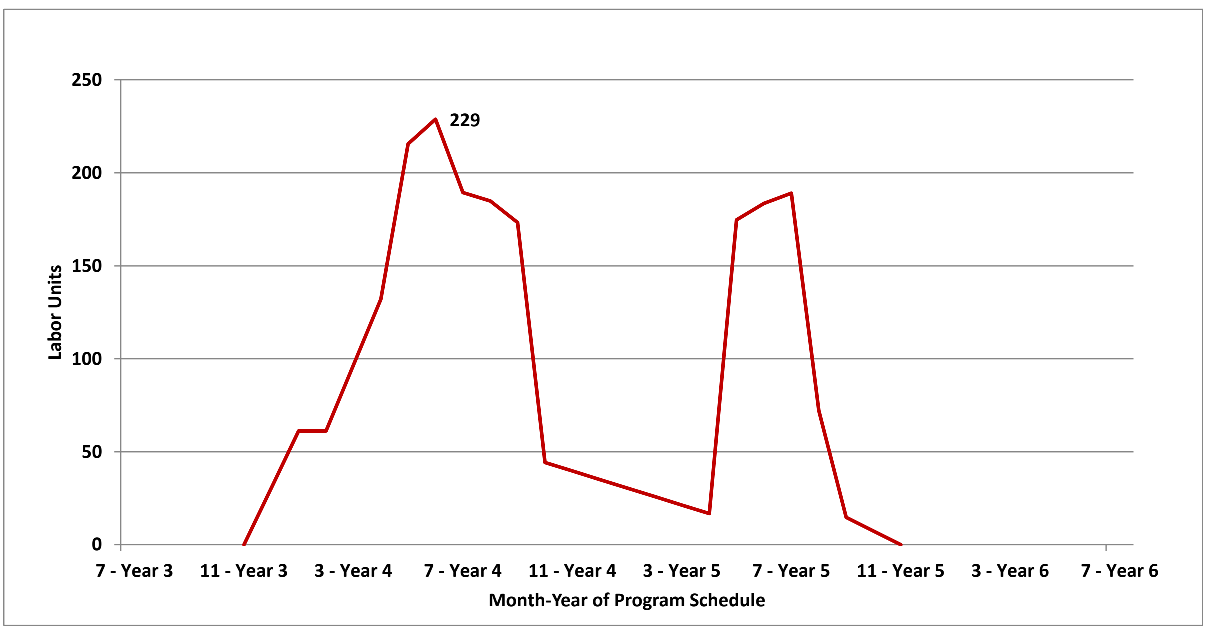
Figure 2. Estimated Total Annual Direct Manpower Estimates during Construction



Source: AEA, 2014a.

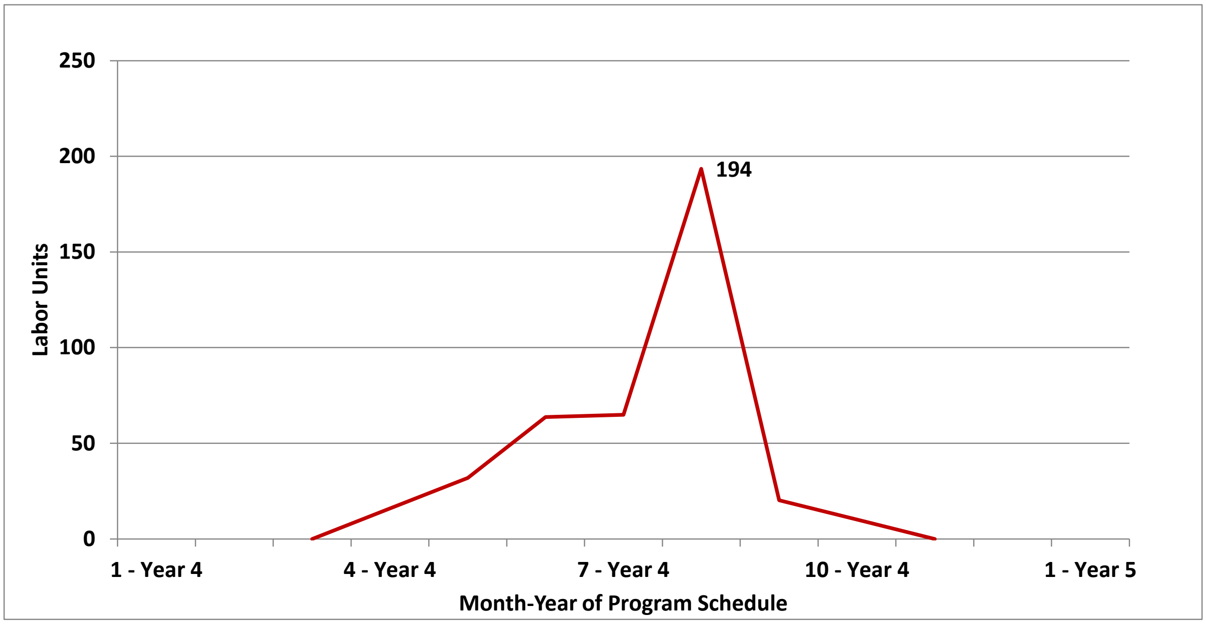
The following figures show the direct manpower requirements for the various construction activities as reported in the Engineering Feasibility Report.

Figure 3. Estimated Direct Manpower Requirements for the Permanent Access Road Contract



Source: AEA, 2014a.

Figure 4. Estimated Direct Manpower Requirements for the Rail Offloading Facility Contract



Source: AEA, 2014a.

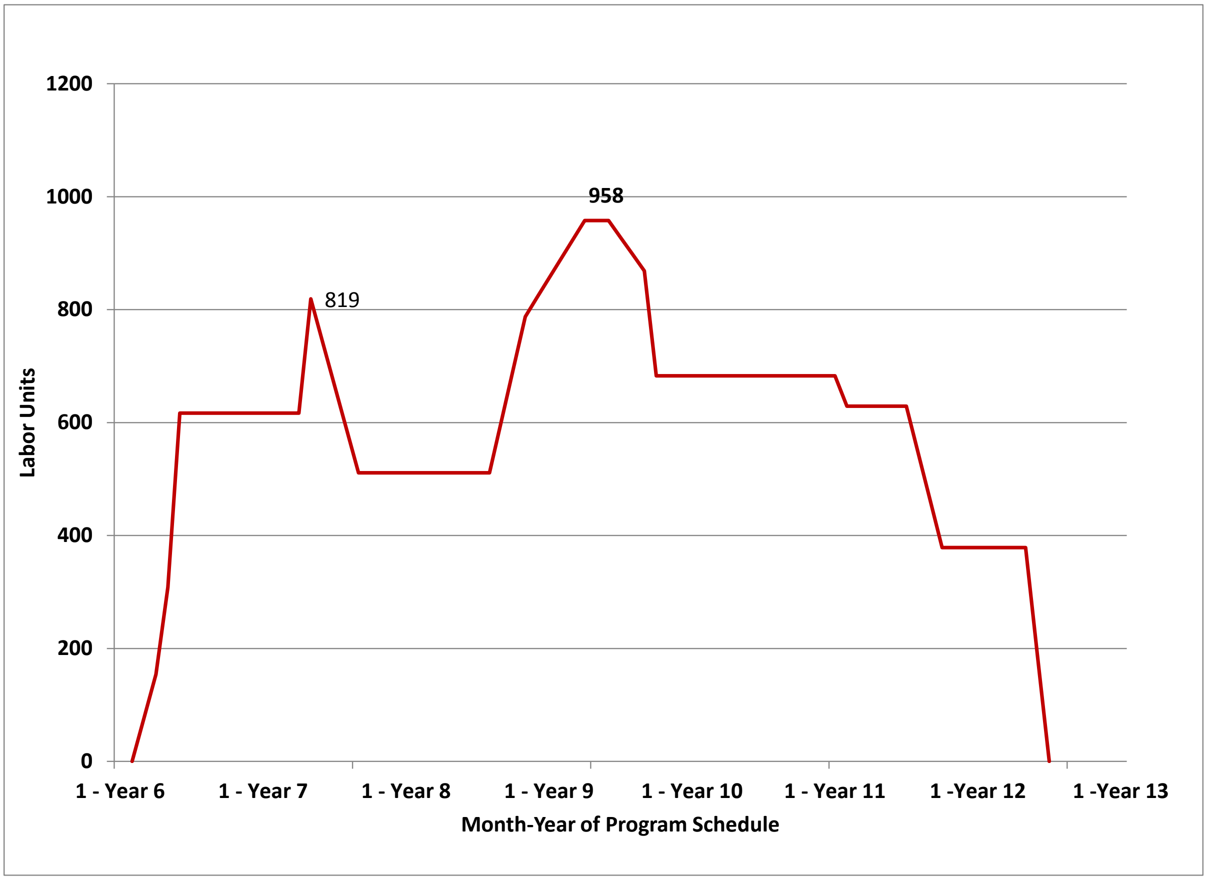
Figure 5. Estimated Direct Manpower Requirements for Camp Civil Works

Source: AEA, 2014a.

Figure 6. Estimated Direct Manpower Requirements for the Camp Construction

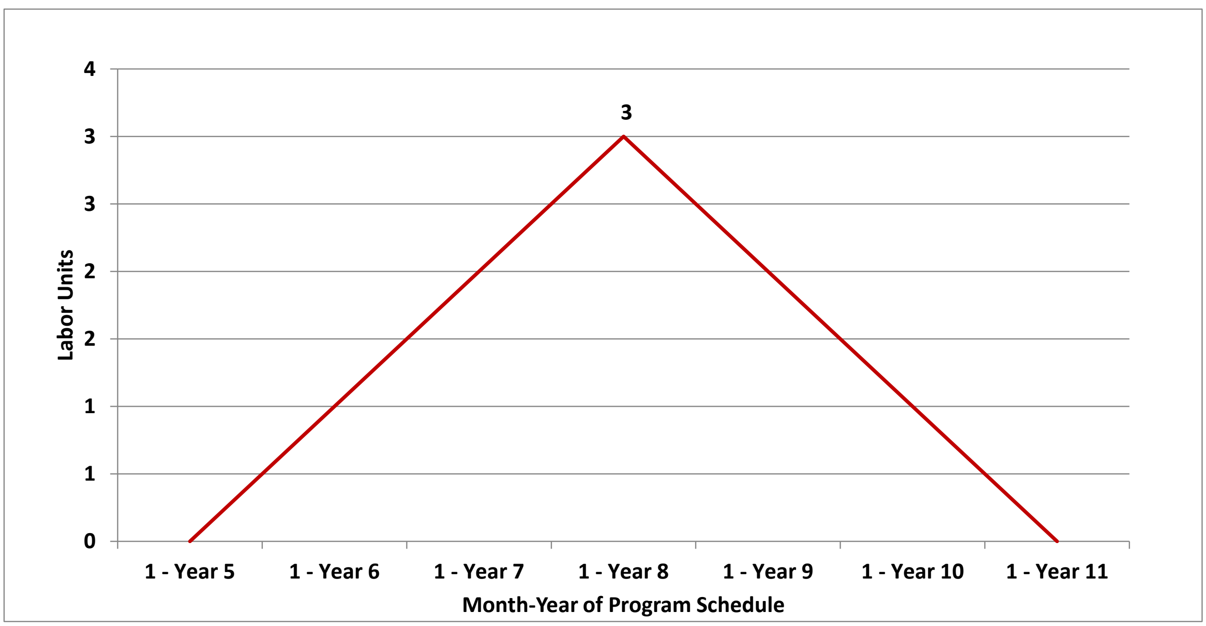
Source: AEA, 2014a.

Figure 7. Estimated Direct Manpower Requirements of the Main Civil Works Construction



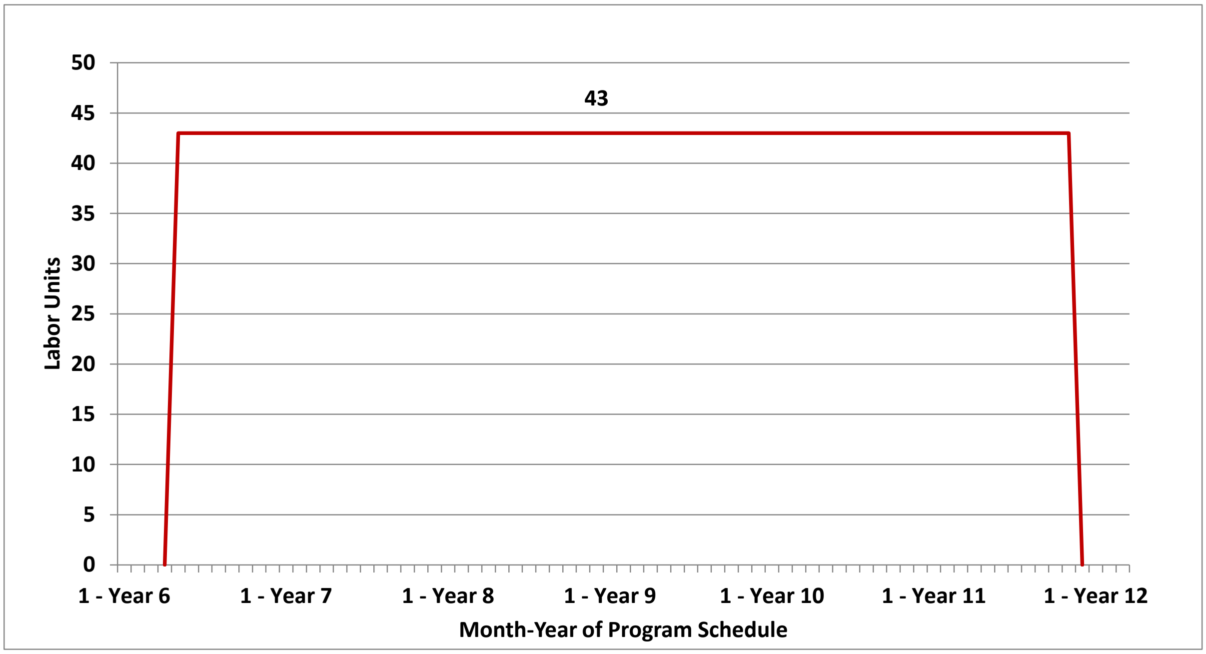
Source: AEA, 2014a.

Figure 8. Estimated Direct Manpower Requirements for Turbine and Generators Supply Contract



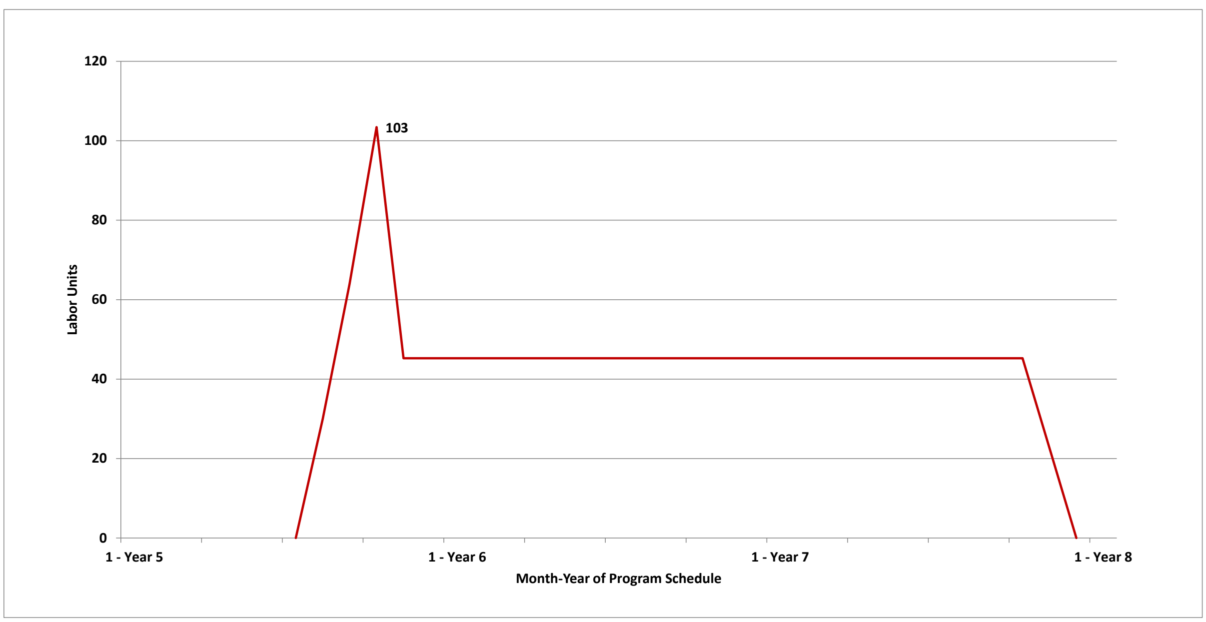
Source: AEA, 2014a.

Figure 9. Estimated Direct Manpower Requirements for Transmission Line and Interconnection Construction



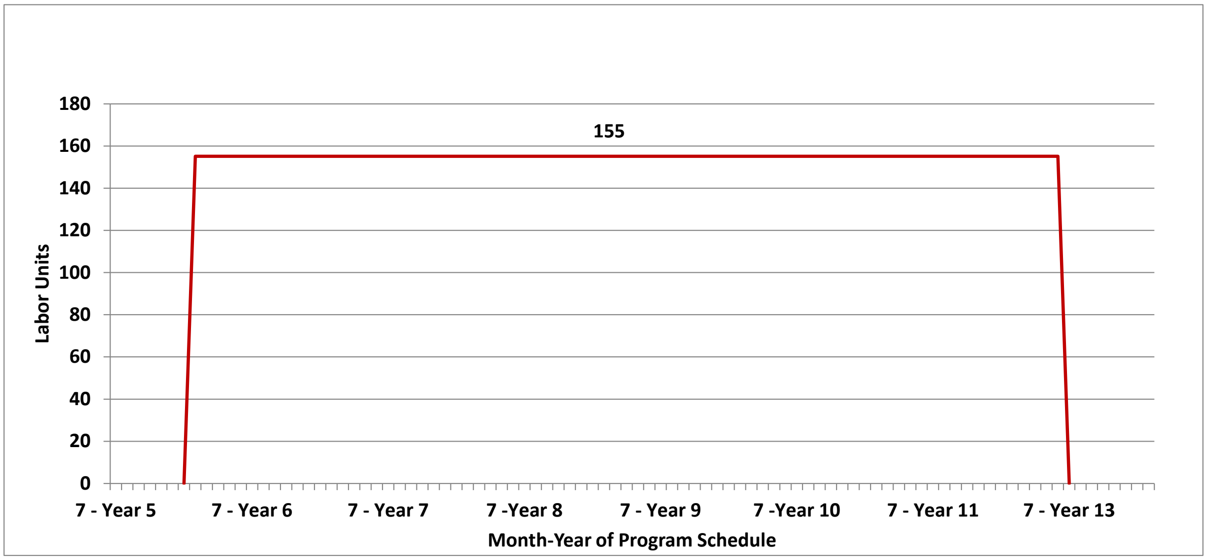
Source: AEA, 2014a.

Figure 10. Estimated Direct Manpower Requirements for Site and Reservoir Clearing



Source: AEA, 2014a.

Figure 11. Estimated Direct Manpower Requirements of All Services Contracts



Source: AEA, 2014a.
Note: This includes the air transport services, railroad operations, camp operations, and medical services contracts.

3.2.2.2 Multiplier Effects

The estimated total multiplier effects associated with all the local project spending during the construction phase are shown in Table 12. In addition to the $2.6 billion in direct business sales for the construction contracts, it is projected that approximately $1.8 billion worth of indirect and induced economic output (or business sales) will be generated as a result of direct project spending. About 11,000 indirect and induced jobs will be created with an associated labor income of about $630 million. On annualized basis, about 1,300 indirect and induced jobs are projected to be created per year during the construction period.

Table 12. Estimated Multiplier Effects of Project Spending during Construction

Multiplier Effects	Amount (2014 $)
Economic Output (business sales), $	1,837,133,147
Jobs (average number of full-time and part-time jobs)	11,305
Labor Income, $	627,307,182

Source: Northern Economics estimates based on projected project cost data and IMPLAN model.

Table 13 shows the estimated indirect and induced effects of the projected local construction spending by activity. The potential for local content for the construction services, particularly the air transport services, railroad operations, camp operations, and the site clearing is expected to be high. Even the fabrication of the camp facilities is expected to be accomplished by Alaska businesses.

The Alaska Railroad Corporation is also expected to benefit from construction logistics associated with transporting construction materials and equipment to the project site.

Table 13. Estimated Indirect and Induced Business Sales, Jobs, and Labor Income Resulting from Construction Spending by Activity in 2014 $

Construction Activity	Business Sales ($)	Jobs	Labor Income ($)
Permanent Access Road	113,673,584	640	35,541,502
Railroad Offloading Facility	18,855,269	121	6,303,251
Site Development (Camp and Airstrip)	18,144,478	102	5,673,103
Supply and Erect Camp (Camp and Airstrip)	85,848,160	778	43,929,775
Main Civil Works	1,162,499,948	7,095	390,244,977
Turbine and Generator Supply	7,802,295	36	2,197,171
Transmission Line and Interconnection	76,013,661	489	26,269,929
Site and Reservoir Clearing	26,880,990	174	9,159,755
Air Transport Services	132,078,813	643	41,334,149
Railroad Operations	63,784,408	292	17,962,053
Camp Operations	117,265,500	839	43,741,939
Medical Services	14,286,040	96	4,949,579
Total	**1,837,133,147**	**11,305**	**627,307,182**
Annualized	**204,125,905**	**1,256**	**69,700,798**

Source: Northern Economics estimates based on projected project cost data and IMPLAN model.

3.2.3 Economic Impacts of Operations and Maintenance Spending

This section presents the long-term annual local economic impacts associated with the operations phase of the proposed project.

3.2.3.1 Direct Effects

The annual operations and maintenance spending of the Susitna-Watana Hydroelectric facility is estimated to amount to $26.5 million per year, except for the first five years, when additional costs for environmental monitoring are anticipated. Environmental monitoring costs for the first three years are expected to amount to $10 million per year (2014 $), and $5 million per year for years four and five of the operations phase.

The project will create long-term jobs associated with operations of the facility. Based on the Engineering Feasibility Report, a staff of 24 to 28 would be needed for operations at the site; note that this is a preliminary estimate. Positions would include a plant manager, plant/engineer asset specialist, electrical supervisor, operators, maintenance trade workers, planner, environmental coordinator, administrative assistants, and security personnel.

3.2.3.2 Multiplier Effects

The estimated total annual multiplier effects associated with project spending during the operations phase are shown in Table 14. It is projected that approximately $18.5 million worth of indirect and induced business sales per year will be generated as a result of direct project spending on operations and maintenance; that is after year five of operations. The first five years would generate higher economic effects associated with environmental monitoring activities.

Approximately 100 indirect and induced jobs will be created per year with an associated labor income of about $6.4 million per year.

Table 14. Estimated Multiplier Effects of Project Spending during the Operations Phase in 2014 $

Multiplier Effects	Year 1–3	Year 4–5	Year 6 and beyond
Economic Output (business sales), $ millions	26.36	22.43	18.49
Jobs, average number of full-time and part-time jobs	162	134	105
Labor Income, $ millions	9.42	7.93	6.44

Source: Northern Economics estimates based on projected project cost data and IMPLAN model.

3.2.3.3 Additional Economic Impacts of the Proposed Project during Operations

The proposed project would change the cost of living and/or business operating cost within the Railbelt region. The proposed project is expected to lower the cost of electricity to residential, commercial, and industrial customers in the Railbelt region once the project comes online. The direct effect of this is the change in local business activity occurring as a result of the change in household and/or business operating costs. To calculate this, it is necessary to estimate the change in disposable household income and business operating costs, and how they would affect consumer spending and business sales volume. Lower monthly electricity bills would mean higher disposable income that could be spent in the regions where the customers are located. This additional spending will generate additional multiplier effects within the state. These economic effects would be difficult to quantify, however, given the differences in the level of cost savings for each customer and the manner in which each customer would spend their money. This typically requires economic modeling that is beyond the scope of this work.

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