KALAELOA BARBERS POINT HARBOR FUEL PIER: Benefit-Cost Analysis

Plasch Econ Pacific LLC
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1. INTRODUCTION

The material below summarizes (1) the economic role of Kalaeloa Barbers Point Harbor ("**KBPH**"); (2) current tenants and their operations; (3) planned Fuel Pier improvements at the Harbor (the "**Project"**), plus other planned improvements; and (4) an analysis of the benefits and costs of the Project.

The analysis was prepared for the Hawai'i Department of Transportation, Harbors Division by Plasch Econ Pacific LLC under subcontract to Group 70 International.

2. ECONOMIC ROLE OF KBPH

Hawaii's economy and, in turn, the lifestyle and standard of living of its residents, are heavily dependent upon imports and exports. Nearly all business and consumer goods are supplied from overseas, including most foods and food products, household goods, clothes, medicines, building materials, vehicles, equipment, parts, petroleum and petroleum products, office supplies, etc. Only small volumes of goods are supplied by local producers, including a portion of the fresh produce consumed in Hawai'i (vegetables, fruits, and melons); some processed foods (coffee, nuts, jams, jellies, etc.); specialty wood products (flooring, furniture, artwork, etc.); aloha apparel; jewelry; etc.

In 2014, 98.2% of the cargo handled by the transportation terminals in Hawai'i passed through the harbors via ships and barges, while only 1.8% passed through the airports via cargo planes and in the holds of passenger planes (State of Hawai'i Data Book and US Corps of Engineers). Because of Hawai'i's mid-Pacific location, and unlike mainland states, no imports or exports are sent by train or truck, nor are goods transported inter-island by train or truck.

Six major harbors and three smaller harbors handle goods shipped to and from Hawai'i, as well as goods shipped among the islands. O'ahu has two commercial harbors: Honolulu Harbor and KBPH. These two harbors handle the largest volumes of goods: 14.613 million tons for Honolulu Harbor in 2014; 10.058 million tons for KBPH (including offshore unloading of crude oil); and 9.665 million tons for the harbors on the Neighbor Islands.

Goods traveling between islands are counted twice: once as an outshipment and again as a inshipment.

The volumes of goods shipped at the two O‘ahu harbors are large for two reasons: (1) O‘ahu hosts a large *de facto* population (resident, visitor, and military); and (2) these two harbors serve as the primary transshipment centers for shipping goods to or from the Neighbor Islands.

The two O‘ahu harbors have specialized roles. Honolulu Harbor is the primary harbor for container ships; auto carriers; ships carrying neo-bulk cargo; overseas and inter-island barges carrying containers, autos, and neo-bulk cargo; commercial fishing boats; and cruise ships and small passenger vessels.

KBPH serves as the primary harbor for liquid- and dry-bulk cargo, much of which consists of fuels and construction material. Given this role, KBPH contains a number of specialized cargo-handling facilities not found at Honolulu Harbor, such as a bulk-coal unloader system, and a pneumatic cement pump system.

In the event of natural and man-made disasters, KBPH also provides harbor space and supporting infrastructure for emergency deliveries of bulk material and large items, thereby speeding the recovery from such disasters.

About 8,194 tons (81.5%) of the KBPH volume in 2014 consisted of petroleum and petroleum products (crude petroleum, gasoline, fuel oil, naphtha, asphalt, etc.). Other large volumes passing through the KBPH included coal (786 tons), cement and concrete (468 tons), sand and gravel (293 tons), and iron and steel scrap (104 tons). These volumes include imports, some exports, and interisland shipments to supply the Neighbor Islands.

Imports and interisland shipments of crude oil, gasoline, diesel fuel, jet fuel, and coal are particularly important to Hawai‘i’s economy. In 2015, these fuels provided about 94% of the energy used in Hawai‘i; about 83% of Hawai‘i’s electrical power is generated by burning fossil fuels; all aircraft require aviation fuel; and all cars and trucks require gasoline, diesel fuel or, in the case of electric cars, imported fuels to generate electrical power (“Hawai‘i Energy Facts & Figures”).

Also important to Hawai‘i’s economy is the bulk construction material passing through KBPH. Such materials are used to build homes, resorts, stores, offices, roads and other improvements throughout the state.

3. CURRENT TENANTS

The major current tenants at KBPH are shown in Figure 1.

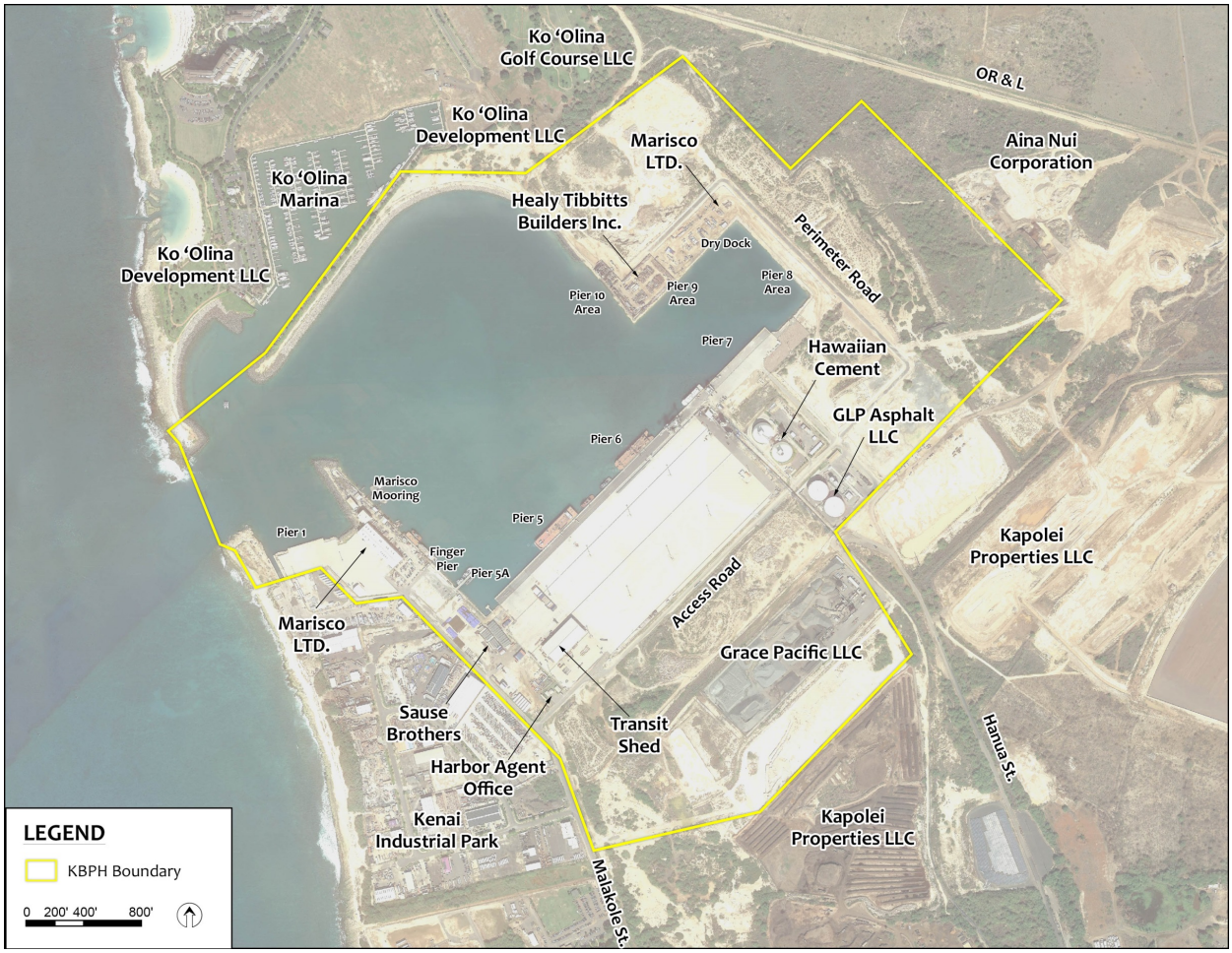

Figure 1. Current Tenants, KBPH

Aloha Petroleum, Island Energy Services, Hawaii Independent Energy, Hawai'I GAS, and HECO

Each of these companies either holds a lease for a pipeline easement; maintains their own private petroleum riser(s) and associated underground pipeline(s); or has a pipeline throughput agreement with Hawaii Independent Energy. These pipelines directly connect Piers 1, 5 and 6 to fuel storage tanks located off-site (see Figure 2).

Other users of fuel shipped through the Harbor, but which are not current tenants at the Harbor, include Mid Pac Petroleum, Chevron, Hawai'i Fueling Facilities Corporation (HFFC).

Figure 2. Fuel Pipelines, KBPH

AES Hawaii, Inc.

AES is an independent power producer (IPP), which imports coal and burns it to generate electrical power for Hawaiian Electric Co. (HECO). Located landside behind Pier 6½, AES maintains and operates a dry-bulk unloader and an enclosed conveyor system that transports coal shipments to a storage yard in nearby James Campbell Industrial Park.

GLP Asphalt, LLC

GLP Asphalt owns and operates an Asphalt Terminal southeast of Pier 7, directly across from the Hawaiian Cement Terminal. The Asphalt Terminal imports liquid asphalt cement in bulk and provides asphalt cement storage that serves as a distribution facility. The Asphalt Terminal helps ensure a consistent supply of liquid asphalt cement to meet Hawai‘i’s demand.

Grace Pacific, LLC

Grace Pacific imports and processes bulk aggregate and sand material which is used in the production of asphalt concrete for local use, and asphalt recycling operations at KBPH.

The Grace Pacific facility includes hot-mix asphalt (HMA) manufacturing, aggregate storage, and the crushing and screening of reclaimed asphalt pavement. The HMA plant produces over 200,000 tons of asphalt pavement each year for road construction on O‘ahu. Asphalt cement is sourced primarily from the neighboring Asphalt Terminal operated by GLP Asphalt.

Hawaiian Cement

Hawaiian Cement imports all of the cement for the state through KBPH, where it has a 60,000-metric-ton storage facility and distribution terminal. From there, the cement is distributed statewide to retail and commercial companies, most of which are in the construction industry.

Healy Tibbitts Builders, Inc.

Healy Tibbitts specializes in marine construction (piers and wharves), laying submarine pipelines and cables, pile-driving, dredging, constructing offshore systems, etc. The company stores its construction equipment at its baseyard in the Pier 9 area.

Marisco, Ltd.

Located in the Pier 3 area on the southwestern edge of the harbor basin, Marisco provides ship-repair and dry-docking services for small commercial and government owned vessels. Marisco’s floating dry dock, Lil’ Perris, is located in the Pier 9 area adjacent to their shoreside storage and baseyard.

Sause Bros.

Sause Bros. provides ocean towing, cargo handling, and ship assist services. Typical cargo handled by Sause Bros. includes neo-bulk cargos (lumber, plywood, paper, petroleum products, chemicals, and bulk commodities); containers; and oversized, overweight, and specialty project cargos. Sause Bros. fully utilizes the Pier 5A Transit Shed, and has dedicated paved stack areas at KBPH for storing plywood, paper, lumber and containers. These storage areas serve both O‘ahu and the Neighbor Islands.

4. PLANNED IMPROVEMENTS

a. Need for Harbor Improvements

Cargo shipments at KBPH have increased to the point that berths for ships are occasionally unavailable, thereby limiting the flow of cargo shipments. In view of this situation, improvements to KBPH are planned so as to accommodate projected increases in shipments. Otherwise, safety may be compromised, and deliveries of fuel and other bulk items to O‘ahu

and the Neighbor Islands may become unreliable. In turn, this could harm the economies of all the islands, affect lifestyles adversely, and make residents less well off due to occasional shortages.

As mentioned in Section 2, the KBPH is used for imports and inter-island shipments of crude oil, gasoline, diesel fuel, and jet fuel. As such, the Harbor is particularly important for supplying fuel: most electrical power is generated by burning fossil fuels; all aircraft require aviation fuel; and all cars and trucks require gasoline, diesel fuel or, in the case of electric cars, imported fuels to generate electrical power. The visitor industry, the military, and all other sectors of the economy depend heavily on imported fuels.

Any prolonged disruption of fuel deliveries or limitations on deliveries would severely impact Hawai‘i’s economy.

b. Components of the Project

A dedicated Fuel Pier and terminal will separate liquid-bulk cargo from dry-bulk cargo. The specific Project components are as follows:

— Fuel Pier and related improvements
  - Dedicated Fuel Pier and fuel terminal
  - Removed finger pier
  - Pipelines and other infrastructure

— Other Improvements
  - Small-vessel pier and T-pier improvements (gates, water, power, etc.)
  - Dry-bulk pier extension
  - Layberth for large vessel
  - A new barge ramp
  - Cargo yard expansion
  - Added bulk storage
  - New harbor office
  - Navigation and berthing aids (lighting, bollard, etc.)
  - Relocated maritime support service facilities (tenant facilities)
  - Personnel shelters (fixed tables with benches, an emergency life-ring, first aid station, emergency communication, water fountain, restrooms, electrical services, etc.)
  - Realigned perimeter road
  - Infrastructure (internal harbor road to connect to a new access road, parking, electrical power, potable water, fire-suppression systems, stormwater drainage, security fencing and access controls, landscaping, etc.)

c. Project Alternatives

There are two similar alternatives for the Project: Alternative A and Alternative B (see Figures 3 and 4). In Alternative A, the dedicated Fuel Pier would be located near the harbor entrance, while the maritime support services and the small vessel layberth would be located near the rear of the harbor. In Alternative B, these locations would be reversed.

The two alternatives are nearly the same in terms of planned improvements, construction costs, development schedules, and operations. Given the similarity of the two alternatives, the benefit-cost analysis which follows does not distinguish between them. Thus, the economic impacts of the Project can be interpreted as the economic impacts of Alternative A or Alternative B.

Project benefits and costs are given relative to a No Action Alternative of no major harbor improvements, although No Action may include some minor improvements such as bollards and expansion of the cargo yard.

5. PROJECT CONSTRUCTION

Table 1 summarizes estimated construction expenditures for the Project by major components and time.

a. Construction Expenditures

In 2017 dollars, total construction expenditures for the Project are estimated at about $89 million. As indicated in Table 1, the improvements will be built in two phases:

— Phase I: about $74 million

— Phase II: about $15 million

b. Development Period

The assumed development period is about 10 years—from about 2020 to 2030, with five years for each phase. However, development could require more or less time, depending on funding, permitting, construction delays, etc.

c. Life of Improvements

The Project improvements are expected to last about 50 years.

Figure 3. Harbor Configuration Alternative A

Figure 4. Harbor Configuration Alternative B

6. HARBOR OPERATIONS and Project Impacts

a. Cargo Shipments

In 2015, about 1.81 million tons of dry bulk cargo and about 1.57 million tons of liquid bulk cargo were shipped through KBPH. The liquid-fuel figure excludes offshore unloading of crude oil.

These shipments are are expected to increase over time. For the benefit-cost analysis, the future shipments are assumed to be about the same for (1) the Project, and (2) the No Action Alternative. In other words, the Project is expected to have no significant effect on the volume of cargo shipped through KBPH.

b. Revenues

For fiscal year ending June 30, 2015, State revenues from KBPH was $6.87 million, including $2.6 million from wharfage fees, $640,000 from dockage fees, $120,000 from port entry fees, $3.39 million from rentals, and $110,000 from utility fees (KKDLY).

The wharfage, dockage and port fees are expected to increase over time roughly in proportion to the increase in cargo shipments. However, since cargo shipments are expected to be about the same for the Project and the No Action Alternative, the future cash flow of harbor fees paid to the State are expected to be about the same for these two alternatives. Thus, the Project will have an insignificant impact on future State revenues derived from harbor operations.

The revenues earned by companies involved with bulk shipping are not known. However, since cargo shipments are expected to be about the same for both the Project and the No Action Alternative, the future cash flows of revenues earned by these companies are expected to be about the same for both alternatives with the exception of extra charges to cover higher demurrages for the No Action Alternative (see Subsection 6.e). Thus, the impact of the Project on these companies will be to reduce revenues by about the same amount as the demurrage savings.

The reduction in demurrages made possible by the Project will theoretically allow affected businesses to charge lower prices for the goods that they sell to other businesses and, eventually, to consumers. The resulting savings that consumers will realize can then be spent on other goods and services. Thus, the net effect of the Project will be to change the allocation of consumer expenditures among various goods and services, but not to change total consumer expending significantly.

c. Employment and Payroll

The State employment at KBPH includes a harbor master, a harbor master assistant, and a maintenance worker. Most other services are provided by contractors. For fiscal year ending June 30, 2015, State expenditures on personnel were about $200,000.

Private employment and payrolls of the private companies at KBPH are not known.

Regarding future operations, the Project is expected to result in about the same employment and payroll at KBPH as would be the case with the No Action Alternative. Thus, the Project will have an insignificant impact on future employment and payroll at KBPH.

d. Tax Revenues

With one exception, the Project is expected to result in about the same operating sales, employment, and payroll as would be the case with the No Action Alternative. As a result, most State and County tax revenues will be about the same for the Project as would be the case with the No Action Alternative.

The one exception is the reduction in demurrages made possible by the Project. This reduction could result in lower excise taxes paid by shipping companies to the State and County than would be the case with the No Action Alternative.

As mentioned in Subsection 6.b, the reduction in demurrages will allow affected businesses to charge lower prices for the goods that they sell to other businesses and, eventually, to consumers. In turn, this will allow consumers to spend more on other goods and services. The additional spending by consumers will generate excise taxes that will largely offset the above-mentioned reduction in excise taxes paid by shipping companies.

7. BENEFIT-COST ANALYSIS

a. Methodology

The benefit-cost analysis of the Project is shown in Table 2. The Project's benefits and costs are based on changes from the No Action Alternative.

The methodology used is based the approach recommended by the U.S. Office of Management and Budget (**OMB)** for evaluating Federal projects and programs (OMB, Circular A-94, Revised, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 29, 1992; and Circular A-94 Appendix C, Revised November 2016, "Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses.).

In keeping with the OMB methodology, the evaluation of the Project is based on its Present Value (**PV**). The analysis of the Project involves (1) projecting the **Cash Flow** of benefits and costs by year (they vary from year to year); (2) discounting each net benefit/cost to the present; (3) then summing the discounted values to determine the total discounted Present Value. Discounting adjusts for the time-value of monetary amounts: a dollar amount received in the distant future has a lower value than the same dollar amount received in the immediate future—largely because an amount received in the near term can be invested to

earn interest. The calculations to estimate PVs is similar to those for determining the amount owed on a mortgage that has a schedule of variable mortgage payments.

The assumptions and PV calculations are discussed in the following subsection.

b. Overview of Assumptions and Calculations

The assumptions used in the Benefit-Cost Analysis are explained below. In the following tables, the primary assumptions are shown in the blue columns.

Valuation Date

The **Valuation Date** for the PV Costs is mid-**2017**.

Dollar Amounts

Dollar amounts are in terms of **2017 purchasing power ("2017 dollars" or "2017$")**, with no adjustment over time for inflation. Adjustments for future inflation are handled in the Discount Rate (see below).

Analysis Period

The **Analysis Period** spans the years from 2017 out to 2075, or about 50 years after the the end of Phase I.

Expenditure Dates

Expenditures are assumed to take place in **Mid-Year**. In practice, however, an expenditure can occur during any part of a year or may involve multiple expenditures spread over time.

Discount Rate and Factor

The primary **Discount Rate** used in the analysis is 3%, and the corresponding **Discount Factor** for each year is $1/(1.03)^n$, where "n" is the number of years from Year 2017. A future dollar amount in Year "n" is multiplied by the Discount Factor for that year to convert it to its present value.

The discount rate of 3% is the 30-year forecast of the "**Real**" interest rate from which the inflation premium has been removed. It is a common discount rate used for evaluating government infrastructure projects. Assuming long-term inflation of 2%, a 3% real interest rate corresponds to a 5% nominal interest rate (3% + 2%), which is higher than current interest rates on government bonds.

The analysis is performed using two other discount rates:

— 0.8%

This rate is based on a 2.8% interest rate of 30-year U.S. Treasury Bonds, less a long-term forecast of 2% inflation. This derived rate is also used to evaluate long-term Federal projects.

— 7%

This rate is also used to evaluate Federal projects. Assuming long-term inflation of 2%, a 7% real interest rate corresponds to a 9% nominal interest rate (7% + 2%), which is far higher than current government bond rates.

Projections

The assumptions and calculations for the benefit-cost analysis are shown in Table 2. the assumptions and sources appear in the blue rows, while the calculations are in the columns:

— Column A: calendar year

— Column B: years from 2017

— Column C: Discount Factor

— Columns D to F: projected cargo shipments

- Column D: projected dry bulk cargo shipments
- Column E: projected dry liquid cargo shipments
- Column F: percentage of cargo shipments that are liquid

— Columns G to J: projected shipping delays (ship-days per year)

- Column G: delays for the No Action Alternative
- Column H: delays for the Project and other harbor improvements
- Column I: decreased delays due to all harbor improvements (ie., the Project and non-fuel related improvements)
- Column J: decreased delays due to the Project (i.e., the improvements in handling the liquid cargo)

— Columns K and L: demurrage rate and benefits

- Column K: demurrage rate in in 2017 dollars
- Column L: demurrage benefits due to the Project (i.e., the improvements in handling the liquid cargo), expressed in 2017 dollars

— Columns M and N: projected decrease in injuries due to the Project

- Column M: projected decrease in injuries per 1 million tons of liquid cargo
- Column N: annual decrease in injuries due to the Project

— Columns O and P: safety benefits
  - Column O: average benefit (i.e., cost savings) per injury
  - Column P: annual safety benefits due to the Project
— Columns Q and R: Project benefits
  - Column Q: annual benefits based on reduced expenditures on demurrage and the value of fewer injuries
  - Column R: present (discounted) value of the benefits
— Columns S to U: Project costs
  - Column P: Phase I annual costs
  - Column Q: Phase II annual costs
  - Column R: present (discounted) value of Project costs

Cash Flows

The columns shown in **black** are the cash flows used in the benefit-cost analysis, while the columns shown in green are intermediate figures used to construct the cash flows.

Residual Values

Residual values of improvements, which are shown at the bottom of Table 2, are based on linear depreciation. For example, if an improvement has a useful life of 50 years, and 40 years will have elapsed from the when the improvement was installed to the end of the analysis period (2075), then the calculated residual value will be 20% of the initial value (10 years remaining ÷ 50-year life).

Findings

The results of the analysis are shown at the top of Table 2, including:

— PV of Project benefits
— PV of Project costs
— PV of the net benefits
— Benefit-cost ratio

c. Demurrage Benefits

In 2015, harbor congestion resulted in loading and unloading delays of totaling about 25 ship-days, and about $625,000 in demurrage paid to ship-owners for extra use of their vessels. With the No Action Alternative, delays and demurrages are expected to increase.

As shown in Table 2, Amergent has projected shipping delays with and without the Project and other harbor improvements. The decrease in shipping delays due to the Project (i.e. the improvements in handling the liquid cargo) is based on the share of bulk cargo that is liquid bulk cargo. The demurrage benefits were determined at an average demurrage rate of $27,000 per ship-day (2017 dollars) applied to the decrease in shipping delays of liquid cargo.

d. Safety Benefits

In addition to reduced shipping delays, the Project will result in safer harbor operations due to the various harbor improvements and reduced congestion in the harbor. The improved safety will result in fewer injuries and possibly fewer deaths.

OSHA Data on Severe Injuries

Since January 2015, Occupational Safety and Health Administration (OSHA) of the US Department of Labor has maintained records on severe injuries (e.g., loss of a limb). The data appear to exclude injuries involving ship crews and foreign workers.

Since the time period used by OSHA is short, injuries at Honolulu Harbor were analyzed since more injury data are available because of the large cargo volume. Over a period of 2.195 years, four severe injuries were reported at Honolulu Harbor, or about 1.823 severe injuries per year. The proportional annual rate for KBPH is about 0.419 severe injury (based on 3.38 million tons of cargo at KBPH versus 14.613 million tons at Honolulu Harbor).

The handling of fuel and bulk cargo at KBPH involves less labor per million tons than is the case for loading and unloading containers at Honolulu Harbor. Thus, to be conservative, the injury rate at KBPH is assumed to be half the proportional annual rate: about 0.21 severe injury per year ($0.419 \div 2$).

LHWCA Data on Injuries

The Department of Labor maintains records on all types of injuries reported under the Longshore and Harbor Workers' Compensation Act (LHWCA) and its extensions. Injuries include those to longshore workers, ship-repairers, shipbuilders, harbor construction workers, etc. Also included are injuries to civilian workers at military bases (e.g., Pearl Harbor) who are employed by private contractors. The data include injuries occurring on navigable US waters and adjoining areas (piers, docks, terminals, wharves, etc.) used in loading and unloading vessels. Excluded are injuries to ship crews, government employees, office workers, security workers, retail workers, restaurant workers, marina workers, temporary harbor workers, and workers involved with small recreational boats (under 65 feet). Also

excluded are injuries caused by intoxication or willful intention to harm oneself. Presumably, foreign workers are also excluded.

From 2000 to 2016, all harbors in Hawai‘i had an average of 603.3 injuries per year: This figure may include injuries to civilian workers at Pearl Harbor, but it excludes injuries to ship crews.

The proportional rate for KBPH is about 59.4 injuries per year based on cargo volume (based on 3.38 million tons at KBPH versus 34.336 million tons statewide). As before, this rate is halved to about 29.7 injuries per year at KBPH because the harbor handles less labor-intensive bulk cargo, not containerized cargo. The estimated accident rate at KBPH is about 8.79 injuries per million tons of cargo (29.7 injuries ÷ 3.38 million tons).

The KBPH breakdown by days lost or deaths is as follows:

— No days lost and salary continuation	6.46 injuries/year
— 0 to 3 days lost	3.10 injuries/year
— 4 or more days lost	20.08 injuries/year
— Deaths	0.06 death/year

KBPH Injuries by Severity

The above KBPH estimates are reallocated as follows:

— Minor (e.g, a laceration) (from no days lost and salary continuation)	6.46 injuries/year
— Moderate (e.g., a broken bone) (from 0 to 3 days plus 50% of 4+ days lost)	13.14 injuries/year
— Serious (e.g., a compound fracture) (50% of 4+ days lost less severe injuries)	9.83 injuries/year
— Severe (e.g., loss of a limb) (from OSHA)	0.21 injury/year
— Deaths (from above)	0.06 death/year

Death and Injury Costs

The U.S. Department of Transportation provides guidelines on the value of a statistical life" ("**VSL"**) and the cost of injuries. These figures are to be used in assessing the benefits of preventing fatalities and injuries. The VSL in 2015 was estimated at $9.6 million, or about $10 million in 2017 dollars (based on the Honolulu Consumer Price Index of 260.2 in 2015 and 271.9 in 2017). The estimated costs are as follows:

— Minor injury	0.3% of VSL
— Moderate injury	4.7% of VSL
— Serious injury	10.5% of VSL

— Severe injury	26.6% of VSL
— Critical injury	59.3% of VSL
— Unsurvivable injury	100.0% of VSL

Average Accident Rate at KBPH and Cost per Accident

Based on the above, the estimated accident rate at KBPH is about 8.79 injuries per million tons of cargo (29.7 injuries ÷ 3.38 million tons). The allocation of accidents by severity and the cost by severity indicates an average cost of about $600,000 per accident.

Safety Benefits

By reducing harbor congestion, the Project will reduce the injury rate at KBPH by an undetermined amount. For the analysis, it is conservatively assumed that the injury rate will be reduced by about 25%, or about 2.2 fewer injuries per million tons of liquid cargo (25% × 8.79 injuries). For the sensitivity analysis, it is further assumed that the injury rate per million tons of cargo could range from 1.76 fewer injuries (a 20% reduction) to 2.6 fewer injuries (a 30% reduction).

The decrease in injuries due to the Project and the safety benefits calculated as shown in Table 2.

e. Environmental Benefits

A major spill of liquid cargo in the harbor could adversely affect (1) the harbor itself, (2) the adjoining Ko ʻOlina small-boat harbor, (3) nearby ocean and shoreline areas, and (4) Ko ʻOlina Resort.

Safer harbor operations will reduce the risk of spilling liquid bulk cargo into the harbor. However, the environmental benefits are not estimated due to a lack of information on the frequency of spills, the estimated change in frequency due to the Project, the magnitude of the spills, and the value of the environmental benefits.

f. Economic Benefits

For the No Action Alternative, there is a risk that increased harbor congestion could result in occasional shortages of liquid fuels supplies on Oʻahu and/or the Neighbor Islands, especially over the very long term as the volume of cargo flowing through the harbor increases. Such fuel shortages could adversely affect airline flights to and from Hawaiʻi; the visitor industry; ground transportation of goods; power generation; military operations, etc.

Thus, for the No Action Alternative, the economies of all the islands eventually could be adversely affected by fuel shortages. Statewide growth of sales, employment, payroll, and tax revenues could be somewhat less than would be the case with the Project.

While the economic benefits of reducing risks of fuel shortages may become large, these benefits are not addressed in this analysis since they are expected to occur far into the future. As a result, the benefits would be heavily discounted in a present-value analysis.

g. Project Expenditures

As summarized in Table 1, the Project is expected to cost about $89 million in 2017 dollars. As indicated in Table 2, about $74 million would be expended over a 5-year period starting in 2023, followed by about $15 million expended over the subsequent 5-year period.

8. SUMMARY OF FINDINGS

a. Net Benefits and B-C Ratio

Table 2 shows the benefit-cost analysis for the Project. Based on a 3% discount rate and other assumptions, the findings are as follows:

— PV of Benefits	$79.6	million
— PV of Costs	$72.6	million
— PV of Net Benefits	$7.0	million
— B-C Ratio	1.10	

As noted above, the analysis does not include all future benefits. In particular, the analysis excludes the environmental benefits of fewer fuel spills into the harbor, and the economic benefits of expanded harbor capacity which would reduce the risks of fuel shortages.

b. Sensitivity Analysis

Discount Rate

The PV of benefits and costs are very sensitive to the discount rate:

— 0.8% discount rate

• PV of Benefits	$152.7	million
• PV of Costs	$83.3	million
• PV of Net Benefits	$69.3	million
• B-C Ratio	1.83	

— 3.46% discount rate (breakeven rate)
  - PV of Benefits $70.5 million
  - PV of Costs $70.5 million
  - PV of Net Benefits $0 million
  - B-C Ratio 1.00

— 7% discount rate
  - PV of Benefits $32.0 million
  - PV of Costs $56.7 million
  - PV of Net Benefits $(24.7) million
  - B-C Ratio 0.56

These results reflect the fact that large expenditures occur early in the analysis period, while annual benefits are spread out over the life of the improvements. With high discount rates, future benefits are discounted heavily. Low discount rates are generally used to evaluate government projects having (1) high initial costs, (2) benefits that span many decades, and (3) financing using low-interest government bonds.

Injury Rate

As shown in Table 2, the safety benefits are much greater than the demurrage benefits. This analysis is based on 2.2 fewer injuries per million tons of liquid cargo, which reflects a 25% reduction in the injury rate due to the Project.

Assuming a 3% discount rate and alternative assumption for the decrease in injuries, revised estimates for the PV of benefits and costs are as follows:

— 1.79 fewer injuries per million tons of liquid cargo (a 20% reduction in the injury rate
  - PV of Benefits $68.8 million
  - PV of Costs $72.6 million
  - PV of Net Benefits $(3.8) million
  - B-C Ratio 0.95

— 2.60 fewer injuries per million tons of liquid cargo (a 30% reduction in the injury rate
  - PV of Benefits $90.1 million
  - PV of Costs $72.6 million
  - PV of Net Benefits $17.5 million
  - B-C Ratio 1.24

9. REFERENCES

Amergent Techs LLC. 2017.

Group 70 International. "Kalaeloa Barbers Point Harbor Fuel Pier & Harbor Improvements, Draft Environmental Impact Statement." July 2016.

KKDLY. "Harbors Division Department of Transportation, State of Hawai'i, Financial Statements and Supplemental Information." Annual.

U.S. Office of Management and Budget (OMB). Circular A-94 Appendix C, "Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses." November 2016.

U.S. Office of Management and Budget (OMB). Circular A-94, Revised, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." October 29, 1992.

US Corps of Engineers, Department of the Army. "Waterborne Commerce of the United States." Annual.

Table 1: Kalaeloa Barbers Point Harbor, Fuel Pier Costs

Item	CPI =	Costs (2015$) 260.20	Costs (2017$) 271.90	Source
Phase I, Major Improvements: 2020 to 2025				
Pier 3 & 4A: fuel pier construction		$ 35,300,000	$ 36,887,279	FEIS, p. 2-83
Fuel Terminal: fuel terminal construction		$ 26,300,000	$ 27,482,590	FEIS, p. 2-83
Fuel Terminal: pipeline installation		$ 9,220,000	$ 9,634,581	Arcadis
Total, Phase I		$ 70,820,000	**$ 74,004,450**	
Phase II, Major Improvements: 2025 to 2030				
Remove finger pier		$ 100,000	$ 104,497	Gr 70
Pier 8: Replacement to finger pier		$ 6,000,000	$ 6,269,792	Gr 70
Pier 4B: fuel pier extension		$ 8,300,000	$ 8,673,213	FEIS, p. 2-83
Total, Phase II		$ 14,400,000	**$ 15,047,502**	
Total Cost of Improvements		$ 85,220,000	$ 89,051,952	

Table 2: Kalaeloa Barbers Point Harbor, Fuel Pier: Benefit/Cost Analysis (2017 dollars)

PV of Benefits = $ 90.1 million
PV of Costs = $ (72.6) million
PV of Net Benefits = $ 17.5 million
B-C Ratio 1.24

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
			Cargo (million tons)			Shipping Delays (ship-days/year)				Demurrage Benefits		Fewer Injuries		Safety Benefits		Project Benefits		Project Costs (2017$)		
Year	Years from 2017	Discount Factor	Dry Bulk	Liquid Bulk		No Action	Harbor Impr	Decrease	Decrease Liquids	Daily Rate	Annual Benefit	Rate/ M Tons	Annual	Daily Rate	Annual Benefit	Total Benefits	PV of Benefits	Phase I	Phase II	PV of Costs
Assumptions																				
Rate		3.00%								$ 27,000		2.60		$ 600,000						
Cost 2017$																		$ 74,000,000	$ 15,000,000	
Start Date																		2021	2026	
Duration (years)																		5	5	
Life (years)																		50	50	
Source/Calc		OMB	Amergent	Amergent		Amergent	Amergent	G – H	F x I	Amergent	J x K	PEP	M x E	PEP	N X O	L + P	C x Q	Table 1	Table 1	C x (S +T)
2017	0	1.000	1.873	1.595		32.2	25.2	7.0	-	$ 27,000	$ -			$ 600,000	$ -		$ -			$ -
2018	1	0.971	1.903	1.608		35.8	25.3	10.50	-	$ 27,000	$ -			$ 600,000	$ -		$ -			$ -
2019	2	0.943	1.932	1.621		39.4	25.4	14.0	-	$ 27,000	$ -			$ 600,000	$ -		$ -			$ -
2020	3	0.915	1.962	1.635		43.0	25.5	17.5	-	$ 27,000	$ -			$ 600,000	$ -		$ -			$ -
2021	4	0.888	1.991	1.648		46.4	23.4	23.0	-	$ 27,000	$ -			$ 600,000	$ -		$ -	$(14,800,000)		$ (13,149,608)
2022	5	0.863	2.020	1.661		49.8	21.3	28.5	-	$ 27,000	$ -			$ 600,000	$ -		$ -	$(14,800,000)		$ (12,766,610)
2023	6	0.837	2.050	1.674	45%	53.2	19.2	34.0	15.3	$ 27,000	$ 412,735	2.60	4.35	$ 600,000	$ 2,612,100	$ 3,024,835	$ 2,533,252	$(14,800,000)		$ (12,394,767)
2024	7	0.813	2.079	1.688	45%	56.6	17.1	39.5	17.7	$ 27,000	$ 477,823	2.60	4.39	$ 600,000	$ 2,632,800	$ 3,110,623	$ 2,529,221	$(14,800,000)		$ (12,033,754)
2025	8	0.789	2.109	1.701	45%	60.0	15.0	45.0	20.1	$ 27,000	$ 542,487	2.60	4.42	$ 600,000	$ 2,653,500	$ 3,195,987	$ 2,522,942	$(14,800,000)		$ (11,683,257)
2026	9	0.766	2.138	1.714	44%	62.4	15.6	46.8	20.8	$ 27,000	$ 562,287	2.60	4.46	$ 600,000	$ 2,674,200	$ 3,236,487	$ 2,480,498		$ (3,000,000)	$ (2,299,250)
2027	10	0.744	2.168	1.728	44%	64.8	16.2	48.6	21.6	$ 27,000	$ 581,983	2.60	4.49	$ 600,000	$ 2,694,900	$ 3,276,883	$ 2,438,309		$ (3,000,000)	$ (2,232,282)
2028	11	0.722	2.197	1.741	44%	67.2	16.8	50.4	22.3	$ 27,000	$ 601,580	2.60	4.53	$ 600,000	$ 2,715,600	$ 3,317,180	$ 2,396,402		$ (3,000,000)	$ (2,167,264)
2029	12	0.701	2.226	1.754	44%	69.6	17.4	52.2	23.0	$ 27,000	$ 621,081	2.60	4.56	$ 600,000	$ 2,736,300	$ 3,357,381	$ 2,354,800		$ (3,000,000)	$ (2,104,140)
2030	13	0.681	2.256	1.767	44%	72.0	18.0	54.0	23.7	$ 27,000	$ 640,489	2.60	4.60	$ 600,000	$ 2,757,000	$ 3,397,489	$ 2,313,524		$ (3,000,000)	$ (2,042,854)
2031	14	0.661	2.285	1.781	44%	74.4	16.9	57.5	25.2	$ 27,000	$ 679,907	2.60	4.63	$ 600,000	$ 2,777,700	$ 3,457,607	$ 2,285,886			$ -
2032	15	0.642	2.315	1.794	44%	76.8	15.8	61.0	26.6	$ 27,000	$ 719,117	2.60	4.66	$ 600,000	$ 2,798,400	$ 3,517,517	$ 2,257,760			$ -
2033	16	0.623	2.344	1.807	44%	79.2	14.7	64.5	28.1	$ 27,000	$ 758,125	2.60	4.70	$ 600,000	$ 2,819,100	$ 3,577,225	$ 2,229,208			$ -
2034	17	0.605	2.373	1.820	43%	81.6	13.6	68.0	29.5	$ 27,000	$ 796,936	2.60	4.73	$ 600,000	$ 2,839,800	$ 3,636,736	$ 2,200,285			$ -
2035	18	0.587	2.403	1.834	43%	84.0	12.5	71.5	30.9	$ 27,000	$ 835,557	2.60	4.77	$ 600,000	$ 2,860,500	$ 3,696,057	$ 2,171,044			$ -
2036	19	0.570	2.432	1.847	43%	86.4	12.9	73.5	31.7	$ 27,000	$ 856,513	2.60	4.80	$ 600,000	$ 2,881,200	$ 3,737,713	$ 2,131,566			$ -
2037	20	0.554	2.462	1.860	43%	88.8	13.3	75.5	32.5	$ 27,000	$ 877,388	2.60	4.84	$ 600,000	$ 2,901,900	$ 3,779,288	$ 2,092,500			$ -
2038	21	0.538	2.491	1.873	43%	91.2	13.7	77.5	33.3	$ 27,000	$ 898,182	2.60	4.87	$ 600,000	$ 2,922,600	$ 3,820,782	$ 2,053,859			$ -
2039	22	0.522	2.521	1.887	43%	93.6	14.1	79.5	34.0	$ 27,000	$ 918,898	2.60	4.91	$ 600,000	$ 2,943,300	$ 3,862,198	$ 2,015,652			$ -
2040	23	0.507	2.550	1.900	43%	96.0	14.5	81.5	34.8	$ 27,000	$ 939,539	2.60	4.94	$ 600,000	$ 2,964,000	$ 3,903,539	$ 1,977,891			$ -
2041	24	0.492	2.579	1.913	43%	98.4	14.9	83.5	35.6	$ 27,000	$ 960,107	2.60	4.97	$ 600,000	$ 2,984,700	$ 3,944,807	$ 1,940,584			$ -
2042	25	0.478	2.609	1.927	42%	100.8	15.3	85.5	36.3	$ 27,000	$ 980,604	2.60	5.01	$ 600,000	$ 3,005,400	$ 3,986,004	$ 1,903,737			$ -
2043	26	0.464	2.638	1.940	42%	103.2	15.7	87.5	37.1	$ 27,000	$ 1,001,031	2.60	5.04	$ 600,000	$ 3,026,100	$ 4,027,131	$ 1,867,359			$ -
2044	27	0.450	2.668	1.953	42%	105.6	16.1	89.5	37.8	$ 27,000	$ 1,021,391	2.60	5.08	$ 600,000	$ 3,046,800	$ 4,068,191	$ 1,831,455			$ -
2045	28	0.437	2.697	1.966	42%	108.0	16.5	91.5	38.6	$ 27,000	$ 1,041,685	2.60	5.11	$ 600,000	$ 3,067,500	$ 4,109,185	$ 1,796,029			$ -
2046	29	0.424	2.727	1.980	42%	110.4	16.9	93.5	39.3	$ 27,000	$ 1,061,916	2.60	5.15	$ 600,000	$ 3,088,200	$ 4,150,116	$ 1,761,087			$ -
2047	30	0.412	2.756	1.993	42%	112.8	17.3	95.5	40.1	$ 27,000	$ 1,082,085	2.60	5.18	$ 600,000	$ 3,108,900	$ 4,190,985	$ 1,726,630			$ -
2048	31	0.400	2.785	2.006	42%	115.2	17.7	97.5	40.8	$ 27,000	$ 1,102,193	2.60	5.22	$ 600,000	$ 3,129,600	$ 4,231,793	$ 1,692,663			$ -
2049	32	0.388	2.815	2.019	42%	117.6	18.1	99.5	41.6	$ 27,000	$ 1,122,243	2.60	5.25	$ 600,000	$ 3,150,300	$ 4,272,543	$ 1,659,187			$ -

Table 2: Kalaeloa Barbers Point Harbor, Fuel Pier: Benefit/Cost Analysis (2017 dollars)

PV of Benefits = $ 90.1 million
PV of Costs = $ (72.6) million
PV of Net Benefits = $ 17.5 million
B-C Ratio 1.24

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
			Cargo (million tons)			Shipping Delays (ship-days/year)				Demurrage Benefits		Fewer Injuries		Safety Benefits		Project Benefits		Project Costs (2017$)		
Year	Years from 2017	Discount Factor	Dry Bulk	Liquid Bulk		No Action	Harbor Impr	Decrease	Decrease Liquids	Daily Rate	Annual Benefit	Rate/ M Tons	Annual	Daily Rate	Annual Benefit	Total Benefits	PV of Benefits	Phase I	Phase II	PV of Costs
2050	33	0.377	2.844	2.033	42%	120.0	18.5	101.5	42.3	$ 27,000	$ 1,142,235	2.60	5.29	$ 600,000	$ 3,171,000	$ 4,313,235	$ 1,626,203			$ -
2051	34	0.366	2.874	2.046	42%	122.4	18.9	103.5	43.0	$ 27,000	$ 1,162,172	2.60	5.32	$ 600,000	$ 3,191,700	$ 4,353,872	$ 1,593,713			$ -
2052	35	0.355	2.903	2.059	41%	124.8	19.3	105.5	43.8	$ 27,000	$ 1,182,055	2.60	5.35	$ 600,000	$ 3,212,400	$ 4,394,455	$ 1,561,716			$ -
2053	36	0.345	2.933	2.073	41%	127.2	19.7	107.5	44.5	$ 27,000	$ 1,201,884	2.60	5.39	$ 600,000	$ 3,233,100	$ 4,434,984	$ 1,530,213			$ -
2054	37	0.335	2.962	2.086	41%	129.6	20.1	109.5	45.2	$ 27,000	$ 1,221,663	2.60	5.42	$ 600,000	$ 3,253,800	$ 4,475,463	$ 1,499,204			$ -
2055	38	0.325	2.991	2.099	41%	132.0	20.5	111.5	46.0	$ 27,000	$ 1,241,391	2.60	5.46	$ 600,000	$ 3,274,500	$ 4,515,891	$ 1,468,686			$ -
2056	39	0.316	3.021	2.112	41%	134.4	20.9	113.5	46.7	$ 27,000	$ 1,261,070	2.60	5.49	$ 600,000	$ 3,295,200	$ 4,556,270	$ 1,438,658			$ -
2057	40	0.307	3.050	2.126	41%	136.8	21.3	115.5	47.4	$ 27,000	$ 1,280,701	2.60	5.53	$ 600,000	$ 3,315,900	$ 4,596,601	$ 1,409,119			$ -
2058	41	0.298	3.080	2.139	41%	139.2	21.7	117.5	48.2	$ 27,000	$ 1,300,285	2.60	5.56	$ 600,000	$ 3,336,600	$ 4,636,885	$ 1,380,067			$ -
2059	42	0.289	3.109	2.152	41%	141.6	22.1	119.5	48.9	$ 27,000	$ 1,319,825	2.60	5.60	$ 600,000	$ 3,357,300	$ 4,677,125	$ 1,351,498			$ -
2060	43	0.281	3.138	2.165	41%	144.0	22.5	121.5	49.6	$ 27,000	$ 1,339,319	2.60	5.63	$ 600,000	$ 3,378,000	$ 4,717,319	$ 1,323,411			$ -
2061	44	0.272	3.168	2.179	41%	146.4	22.9	123.5	50.3	$ 27,000	$ 1,358,771	2.60	5.66	$ 600,000	$ 3,398,700	$ 4,757,471	$ 1,295,801			$ -
2062	45	0.264	3.197	2.192	41%	148.8	23.3	125.5	51.0	$ 27,000	$ 1,378,180	2.60	5.70	$ 600,000	$ 3,419,400	$ 4,797,580	$ 1,268,666			$ -
2063	46	0.257	3.227	2.205	41%	151.2	23.7	127.5	51.8	$ 27,000	$ 1,397,548	2.60	5.73	$ 600,000	$ 3,440,100	$ 4,837,648	$ 1,242,001			$ -
2064	47	0.249	3.256	2.218	41%	153.6	24.1	129.5	52.5	$ 27,000	$ 1,416,876	2.60	5.77	$ 600,000	$ 3,460,800	$ 4,877,676	$ 1,215,803			$ -
2065	48	0.242	3.286	2.232	40%	156.0	24.5	131.5	53.2	$ 27,000	$ 1,436,164	2.60	5.80	$ 600,000	$ 3,481,500	$ 4,917,664	$ 1,190,069			$ -
2066	49	0.235	3.315	2.245	40%	158.4	24.9	133.5	53.9	$ 27,000	$ 1,455,414	2.60	5.84	$ 600,000	$ 3,502,200	$ 4,957,614	$ 1,164,793			$ -
2067	50	0.228	3.344	2.258	40%	160.8	25.3	135.5	54.6	$ 27,000	$ 1,474,626	2.60	5.87	$ 600,000	$ 3,522,900	$ 4,997,526	$ 1,139,971			$ -
2068	51	0.221	3.374	2.272	40%	163.2	25.7	137.5	55.3	$ 27,000	$ 1,493,802	2.60	5.91	$ 600,000	$ 3,543,600	$ 5,037,402	$ 1,115,599			$ -
2069	52	0.215	3.403	2.285	40%	165.6	26.1	139.5	56.0	$ 27,000	$ 1,512,942	2.60	5.94	$ 600,000	$ 3,564,300	$ 5,077,242	$ 1,091,672			$ -
2070	53	0.209	3.433	2.298	40%	168.0	26.5	141.5	56.7	$ 27,000	$ 1,532,046	2.60	5.98	$ 600,000	$ 3,585,000	$ 5,117,046	$ 1,068,185			$ -
2071	54	0.203	3.462	2.311	40%	170.4	26.9	143.5	57.4	$ 27,000	$ 1,551,116	2.60	6.01	$ 600,000	$ 3,605,700	$ 5,156,816	$ 1,045,133			$ -
2072	55	0.197	3.492	2.325	40%	172.8	27.3	145.5	58.2	$ 27,000	$ 1,570,153	2.60	6.04	$ 600,000	$ 3,626,400	$ 5,196,553	$ 1,022,511			$ -
2073	56	0.191	3.521	2.338	40%	175.2	27.7	147.5	58.9	$ 27,000	$ 1,589,157	2.60	6.08	$ 600,000	$ 3,647,100	$ 5,236,257	$ 1,000,314			$ -
2074	57	0.185	3.550	2.351	40%	177.6	28.1	149.5	59.6	$ 27,000	$ 1,608,129	2.60	6.11	$ 600,000	$ 3,667,800	$ 5,275,929	$ 978,537			$ -
2075	58	0.180	3.580	2.364	40%	180.0	28.5	151.5	60.3	$ 27,000	$ 1,627,069	2.60	6.15	$ 600,000	$ 3,688,500	$ 5,315,569	$ 957,174			$ -
Residual Value		0.180																$ -	$ 1,500,000	$ 270,105
Total Net PV										$ 58,148,474					$ 166,965,900		**$ 90,142,045**	$(74,000,000)	$(13,500,000)	**$ (72,603,681)**