Port of Corpus Christi Bridge Improvements Project

Cost Benefit Analysis

August 19, 2010

COST-BENEFIT METHODOLOGY IN THE EVALUATION OF PROJECT COSTS AND BENEFITS

This document provides a description of the methods for computing costs and benefits of the Port of Corpus Christi Bridge Improvements project. In the first section covering benefits, discussion is provided on (a) a description of benefits from the project, including specific benefit categories; (b) computation approach; (c) monetizing values; and (d) life-cycle factors. The second section presents the primary CBA results relative to various sensitivity analyses that change parameters or assumptions.

Overview of Bridge Improvements Project Benefits

The project involves strengthening and replacing various bridge-related components along the UP railway corridor between the Port of Corpus Christi and Houston. In particular, the steel structures of two bridges to the north of the Port of Corpus Christi (Garcitas Creek Bridge and Colorado River Bridge) will be substantially replaced and 31 culvert and timber structures (Angleton Sub) will be upgraded. These improvements will lift the existing restrictions on dimensional and railcar load capacity for the corridor

The proposed improvements will allow the rail line to transport heavier railcars (from 268,000 to 286,000 pounds each, gross weight), which is rapidly becoming the standard of railcar cargo for bulk. Without the improvements, bulk going in and out of the Ports of Corpus Christi and Brownsville will not continue to grow, impacting future operation levels for the Ports. Bulk will be diverted to either other ports or to trucks. In addition, the improvements will increase the height and width of the bridges enabling them to carry larger cargo such as wind turbine towers.

Cost-Benefit Analysis (CBA) provides a consistent and sound method for monetizing the social value of a project, that is, its associated costs and benefits. A critical feature of CBA involves determining the *incremental* effect of the project which is its improvement with respect to a *baseline* level of performance (based on forecasts of a 'business-as-usual' level of investment). Incremental costs and benefits are tracked over the project planning horizon and *discounted* to reveal their respective present values so that they may be reasonably compared to the upfront investment. Results from CBAs include: (a) net present value (NPV), defined as the difference between present value benefits and costs; and (b) benefit cost ratio (BCR), defined as the ratio of present value benefits to costs. Projects for which NPV is greater than zero and BCR is greater than one indicate worthy projects. While projects with larger BCR and NPV indicate a relatively larger level of worthiness, they have different implications for total impact. BCR reflects the return on investment (as a percentage above the breakeven point); NPV determines the total value of a project to society. Larger projects generally generate higher NPV but not necessarily higher BCR.

Guidance from the Federal Register indicates that CBAs in support of TIGER II funding requests be performed with defensible and robust methods, data and assumptions. The guidelines stipulate that benefits should be tracked for at least 20 years (possibly more, depending on the project), and present values of costs and benefits should be determined with a seven percent discount rate. Many of the monetizing factors of project performance [e.g. accident costs per vehicle mile traveled (VMT)] are specified in guidelines as well. Other categories and measures of benefits are also acceptable, including qualitative assessments of the potential benefits. The guidelines also suggest that sensitivity analyses for discount rates and other assumptions can be conducted to provide a complete perspective on the range of potential value for the project. This is consistent with Office of Management and Budget (OMB) circulars, A-4 and A-94.

The Corpus Christi Bridge Improvements Project would generate shipping benefits for railroad users since it would allow more goods per railcar, reducing overall shipping costs, thus preventing diversion of cargo to alternative (and longer) rail routes as well as to other modes such as trucks..

Baseline and Alternative Scenarios

Baseline Scenario

Currently the two bridges along the UP corridor are not capable of accommodating the 286,000 pounds per railcar standard. The freight service in the corridor, operated by BNSF, addresses this constraint by running longer trains and incurring higher shipping costs. If the proposed bridge improvements along the corridor are not undertaken, there will not be much growth in rail freight along the corridor, impacting the growth potential for the Ports of Corpus Christi and Brownsville served by the corridor. Today, approximately 67% of the rail cargo into the two ports are served by BNSF.

The cargo volume at the Port of Corpus Christi is expected to grow at 2.66% annually in the immediate future and reach a stable level of growth of 1.55% annually[1]. The growth is projected to be primarily in bulk cargo and large commodities such as wind turbine towers and rotors. It will result in an increase in truck freight in and out of the ports in the area.

One of the key outcomes of the baseline scenario is a general increase in shipping costs associated with the Ports of Corpus Christi and Brownsville. This is due mainly to the higher shipping cost per ton by truck compared to rail. The increase in truck traffic can in turn cause highway congestion and imposes higher social costs due to environmental impacts and safety impacts.

Alternative Scenario

The alternative scenario (build) features the improvements of the two bridges, including all culverts and timber structures along the UP railway corridor, allowing the new load standard to be handled. As a result, the corridor will be able to handle the expected cargo growth at the ports of Corpus Christi and Brownsville.

The bridge improvements will directly impact the overall shipping costs by rail mode and will result in diverting some of the truck trips from the highways. The alternative scenario thus represents a better freight shipping system with less average shipping costs, and lower levels of congestion, as well as decreased negative impacts on environment and increased safety.

Valuation of Project Benefits

Public benefits for this project fall into several categories, including: shipping cost savings from diverted freight, environmental (emissions and noise), safety, congestion and pavement maintenance cost savings. The following sections discuss the rationale for benefits associated with avoiding diversion to longer rail routes and to truck.

[1] Based on freight volume forecasts in the FAF Database

Diversion in the Baseline Scenario

Diversion Estimates

The diversion of cargo shipment from trucks to the BNSF-operated corridor forms the basis of social benefits. Based on the number of trains and railcars currently traveling on this railway corridor, a projected demand was estimated using growth rates from the Freight Analysis Framework (FAF) 2.0 Database for rail operations at the Ports of Corpus Christi and Brownsville. This estimated demand is referred to as the 'intrinsic' rail demand for the corridor.

Assuming a period of 3 years before the first cargo shifts to truck (thus allowing for the improvement of the bridges and structures), the rail operation level for the BNSF-operated corridor is assumed to remain constant in the future if the proposed bridge improvements are not undertaken. This operation level is defined as the baseline rail operation level for the corridor.

To determine the amount of cargo diverted to truck, the cross-price elasticity of 0.67 was applied to the estimated rail shipping cost savings resulting from heavier railcar loads at the ports (5%). This resulted in a 3.4% share of the corridor's cargo switching to truck.

General Assumptions

- 17 tons per truck was used throughout the analysis.
- Three trucks per railcar was used as the conversion factor between modes.
- Rail shipping cost savings of 5% due to heavier loads per railcar (after improvements).
- First Year of Diversion is assumed to be 2013, when the bridge improvement construction is completed.

Benefits from Diversion to UP Corridor

Shipping Cost Savings

The general shipping costs associated with rail and truck modes are $0.99 and $2.02 per ton-mile respectively. It is assumed that currently both rates are market-clearing and thus a reduction of 5% (resulting from the proposed improvements) is applied to each mode's rate to calculate shipping costs savings.

Environmental Cost Reduction

Environmental costs are increasingly considered as an important component in the evaluation of transportation projects. The main environmental impacts of vehicle use and exhaust emissions can impose wide-ranging social costs on people, material, and vegetation. The negative effects of pollution depend not only on the quantity of pollution produced, but also on the types of pollutants emitted and the conditions into which the pollution is released. The environmental cost reduction is calculated by subtracting from the cost of pollution produced by the diverted cargo traveling by truck the cost of pollution of that same cargo traveling along the BNSF-operated railway corridor. Air emissions externalities are included in the calculations and are estimated in monetized costs per ton mile for specific emission rates based on the pollutant.

Pavement Maintenance Cost Savings

Eliminating trucks from the highway directly reduces their impact on pavement and the maintenance associated costs. Heavy trucks, in particular, cause a tremendous amount of wear and tear on pavement. Lower public expenditures on these costs frees up public funds that can be used for other purposes.

Congestion and Noise Cost Savings

Avoiding circulation of trucks in the highways reduces congestion for all other vehicles that remain on the road over every mile traveled; similarly, it reduces noise creation in roads.

Accident Cost Savings

Accident costs, and impacts on life, limb and property, are a significant component of transportation user costs. Safety is a key economic factor in the planning of different means of transportation, as well as an important indicator of transportation efficiency. Outside of the economic context, transportation safety is often the object of public concern and a leading social issue. Estimating safety benefits requires data on the frequency and severity of accidents for the different means of transportation as well as the geographic area under consideration. In addition, the costs of injuries and fatalities must be monetized. Reducing truck circulation in the highways reduces traffic and the likeliness of accidents.

Quantitative Methods for Benefit Categories

Shipping Cost Savings – Truck Diversion

Since it is assumed that currently both truck and rail shipping rates are market-clearing, cost savings for current rail users that would shift to truck under the baseline scenario is determined as a percentage of the per-mile truck rate. Share of current traffic that can be diverted to truck is calculated using the cross-price elasticity between rail and truck and the estimated price reduction in rail shipping costs due to the higher railcar load capability. As such, multiplying a 0.67 elasticity by a rail shipping cost reduction of 5% results in 3.4% of the corridor's cargo shifting to truck.

The shipping cost savings are not fully saved by the shipper. Economic theory on consumer surplus suggests approximately 50% of that difference is accrued by the shipper, based on the area under the curve associated with diverted cargo benefits (see Figure 1). Therefore, 50% of the rate difference is applied to the analysis.

Analytical steps

- Expected shipping cost savings of 5 percent of the modal rate, which equals $0.05 per unit-mile for trucks.
- Average cross-price elasticity is 0.67 for a percent change in truck demand given a percent change in rail price.
- Estimated diversion of 3.4 percent of cargo to truck.

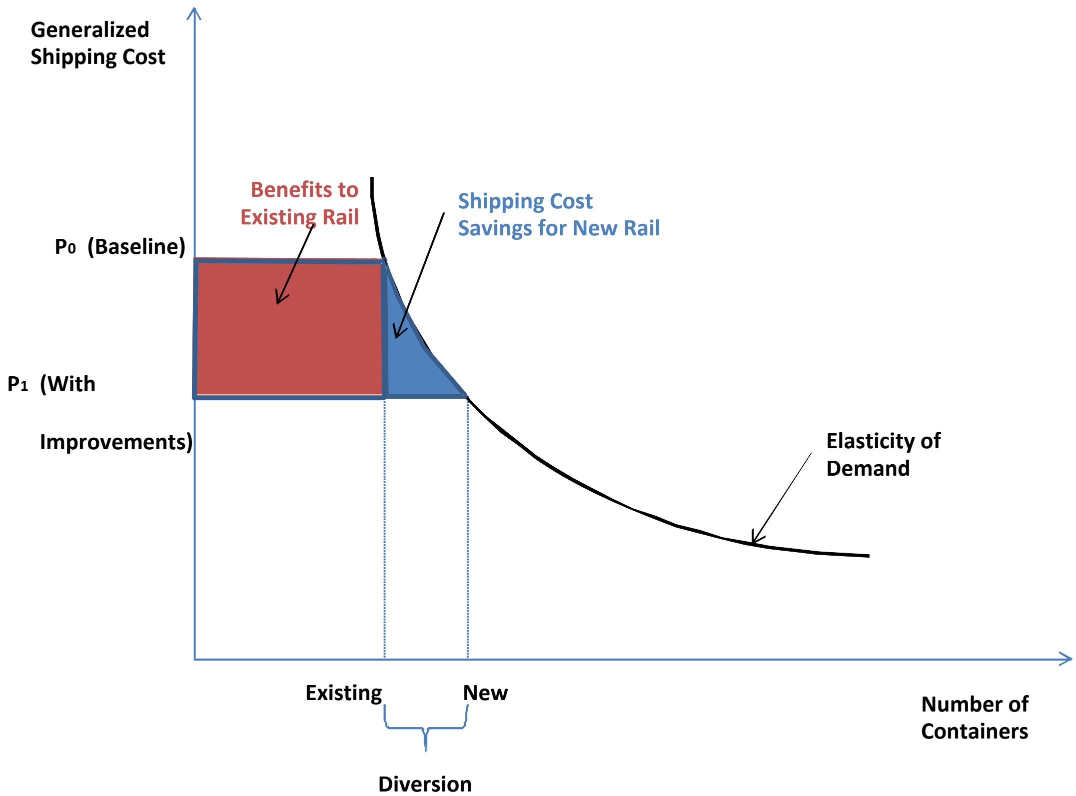

Figure 1. Sources of Shipping Benefits

Shipping Cost Savings – Existing Rail Users

Current users of rail at the corridor will benefit from lower rail shipping costs of 5% due to the improvements associated to the project.

Analytical steps

- Expected shipping cost savings of $0.05 per rail-mile for existing rail users.
- Multiply shipping cost saving and rail traffic along the corridor.

Environment/Pollution Cost

Benefits cover the major pollutants for which reasonably solid data inputs are available, including both Criteria Air Contaminants (CAC) and Greenhouse Gases (GhG): Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), Sulphur Oxides (SOx), Particulate Matter, and Carbon Dioxide (CO2). Changes in emission volumes would be estimated by vehicle class using EPA's Mobile 6 model for the projects specific geographic location, on the basis of changes in highway VMT and average vehicle speed, and emission factors. Forecasts of air emissions for rail are based on recent EPA analyses. These volume changes are then combined with unit emission costs (so-called unit damage values) to arrive at total emission cost savings. TIGER Guidance has provided values for various emissions elements.

Analytical steps

- Determine forecasts of vehicle emission rates per ton-mile for trucks and rail from EPA.
- Apply emission rate forecasts for trucks and rail to diverted truck ton-miles and its associated rail ton-miles, respectively.
- Apply valuation of emissions to total emission for trucks and rail.
- Determine forecast of emissions and compute net emissions value.

Table 1: Valuation of Environmental Emissions

Parameter	Value	Units
Volatile Organic Compounds ($/ton)	1,350	2009 U.S. $/ton
Nitrogen Oxides ($/ton)	5,480	2009 U.S. $/ton
Particulate Matter ($/ton)	300,090	2009 U.S. $/ton
Sulfur Dioxide ($/ton)	32,080	2009 U.S. $/ton
Carbon Dioxide	22.10	2009 U.S. $/ton

Savings in Pavement Maintenance

The cost of pavement maintenance is estimated in per truck mile and is multiplied by the total avoided truck VMT for annual cost savings in pavement maintenance.

Analytical steps

- Pavement maintenance costs for different truck loads (40 kip, 60 kip, etc.) and locations (urban / rural) are based on FHWA Highway Cost Allocation Study (2000).
- Assume diverted truck loads are split 50%/50% for 60 kip and 80 kip loads, avoided miles are 35% urban/65% rural, to determine the weighted value of 14.19.
- Inflate values using CPI from 2000 to 2010 dollars determine the value: 18 cents per mile.
- Determine diverted truck miles and multiply by pavement maintenance cost.

Congestion and Noise Cost Per Truck Mile

Measures of congestion and noise cost savings are applied per truck mile.

Analytical steps

- Apply same methodology for congestion costs for trucks as discussed above for pavement maintenance.
- Computed value of congestion costs per mile is 10 cents per truck mile, while cost of noise is 1/10 cent per truck mile.

Reduced Accident Cost

TIGER Guidance has established values for injuries and deaths and can be used in this analysis. To calculate the monetized benefits from accident reduction savings, the model nets out the accident costs from transporting diverted cargo via rail from the accident cost from increased truck mileage associated to the diverted cargo.

Analytical steps

- Apply value $0.31/VMT for truck accidents and $13.24/train for rail accidents (source: HDR calculations using Traffic Safety Facts FARS/GES Annual Reports and BTS data).
- Determine avoided truck miles and their equivalent rail miles for the diverted cargo and apply corresponding accident cost value.

Model Inputs

Specific values in the model have been obtained based on recommendations made in the Federal Register for the TIGER Grant Application, USDOT studies and standard values from transportation industry. The following table provides the values used in monetizing benefits:

Table 2: Model Inputs and Assumptions

General Assumptions	Values
Real Discount Rate	7%
Construction - Start Year	2010
Construction - End Year	2012
Time Frame	30
Year Benefits Begin to Accrue	2013
End Year	2042
Tons per Truck	17
Trucks per Railcar	3
Percentage of cargo deviated to truck (baseline scenario)	3.4%
Congestion Cost per Vehicle Mile	$0.10
Accident Cost per Vehicle Mile	$0.31
Accident Cost per Train Mile	$13.24
Noise pollution cost per vehicle mile	$0.001
Pavement Maintenance cost per vehicle mile	$0.18
Avg. Rail Rate	$0.99
Avg. Truck Rate	$2.02
Realized Shipper Cost Savings (associated with diverted trucks)	50%
Carbon Monoxide ($/ton)	$520
Volatile Organic Compounds ($/ton)	$1,350
Nitrogen Oxides ($/ton)	$5,480
Particulate Matter ($/ton)	$300,090
Sulfur Dioxide ($/ton)	$32,080
Carbon Dioxide (U.S. domestic value)	$22.10

The following table presents the key assumptions used in the analysis of the baseline and alternative scenarios:

Table 3: Key Assumptions in Baseline and Alternative Scenarios	
Railcars per year in corridor (current)	41,540
Railcars per year in corridor (in no-build scenario)	43,784
Years until first switch to truck	3
Increased mileage for Rail relative to trucks	15%
Percentage of railcars diverted to truck in baseline scenario	3.4%

Overview of the Port of Corpus Christi Bridge Improvements Project Results

The following tables present the results of the cost benefit analysis for the Port of Corpus Christi Bridge Improvements Project. At the 7 percent discount rate the project is expected to generate $38.22 million in discounted benefits compared to a discounted cost of $15.64 million. Consequently, the BC ratio for the project is estimated at 2.4 with a net present value of $22.58 million.

Table 4: Summary of Results

		Total
Discount Rate		**7%**
Project Impacts		
	Gallons of Fuel Avoided (Millions)	**3.9**
	Reduced Truck Miles on Highway (Millions)	**110**
	Reduced CO2 Emissions (tons)	**7,096**
Monetized Benefits		
	Shipper Cost Savings associated with Truck Diversion (Millions, $)	**$1.8**
	Shipper Cost Savings associated with Rail Traffic (Millions, $)	**$20.5**
	Pavement Maintenance Savings (Millions, $)	**$6.3**
	Accident Cost Savings (Millions, $)	**$5.9**
	Congestion Savings (Millions, $)	**$3.6**
	Emissions Savings (Millions, $)	**$0.13**
	Increased Employment (Millions, $)	**$0.0**
	Noise Savings (Millions, $)	**$0.04**
Benefit Cost Analysis Results		
	Total Discounted Benefits (Millions, $)	**$38.22**
	Total Discounted Costs (Millions, $)	**$15.64**
	Net Present Value (Millions, $)	**$22.58**
	Benefit - Cost Ratio	**2.4**
	Year of Payback	**-**
Cost Effectiveness Measures		
	Tons of CO2 Reduction per $1000	**0.5**

Investment Cost of Removing Trucks from Road	**$87.0**

Table 5 below present the cost benefit analysis result in terms of TIGER II selection criteria.

Table 5: Summary of Primary Selection Criteria - Long Term Outcomes

State of Good Repair	**Total**
Pavement Maintenance Savings (Millions, $)	**$6.3**
Economic Competitiveness	**Total**
Logistics/Reliability Cost Savings (Millions, $)	**$22.3**
Livability	**Total**
Reduced Truck Miles on Highway (Millions)	**110**
Congestion Savings (Millions, $)	**$3.6**
Sustainability	**Total**
Gallons of Gasoline Avoided (Millions)	**3.9**
Reduced Emissions (tons)	**7,150**
CO	**14**
VOC(HC)	**1**
NOx	**38**
PM	**1**
CO2	**7,096**
Emissions Savings (Millions, $)	**$0.13**
CO ($)	**$0.01**
VOC(HC) ($)	**$0.01**
NOx ($)	**$0.03**
PM ($)	**$0.03**
CO2 ($)	**$0.05**
Safety	**Total**
Accident Cost Savings (Millions, $)	**$5.93**
Benefit Cost Analysis Results	**Total**
Total Discounted Benefits (Millions, $)	**$38.22**
Total Discounted Costs (Millions, $)	**$15.64**
Net Present Value (Millions, $)	**$22.58**
Benefit - Cost Ratio	**2.4**
Year of Payback	**-**
Cost Effectiveness Measures	**Total**
Tons of CO2 Reduction per $1000	**0.5**
Investment Cost of Removing Trucks from Road	**$87.0**

Table 6 presents the sensitivity analysis for the cost benefit analysis results.

Table 6: Sensitivity Analysis

	7% Discount Rate	3% Discount Rate	Cross-price elasticity of truck and rail of 0.8	Price reduction on rail shipping costs of 6.7%
Benefits	$38.2	$69.8	$41.5	$51.8
Costs	$15.6	$16.3	$15.6	$15.6
B/C Ratio	2.4	4.3	2.7	3.3
Net Present Value	$22.6	$53.5	$25.9	$36.1

Table 7 presents the yearly stream of benefits.

Table 7. Yearly benefits by category (in current $)

Year / Category	Pavement Maintenance Savings	Railway Maintenance Savings	Shipper Savings associated with Truck Diversion	Shipper Savings associated with Rail Traffic	Increased Employment	Congestion Savings	Noise Savings	Emissions Savings	Accident Savings
2010	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
2011	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
2012	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
2013	$330,635.7	$0.0	$94,984.0	$1,379,953.1	$0.0	$187,805.6	$1,934.4	$11,848.4	$313,477.0
2014	$441,228.1	$0.0	$126,754.6	$1,426,905.6	$0.0	$250,623.6	$2,581.5	$13,910.4	$418,330.0
2015	$456,212.8	$0.0	$131,059.4	$1,475,365.4	$0.0	$259,135.1	$2,669.1	$12,784.4	$432,537.1
2016	$470,697.4	$0.0	$135,220.5	$1,522,207.7	$0.0	$267,362.6	$2,753.9	$11,947.0	$446,269.9
2017	$485,605.4	$0.0	$139,503.2	$1,570,419.2	$0.0	$275,830.5	$2,841.1	$11,257.5	$460,404.3
2018	$500,948.7	$0.0	$143,911.0	$1,620,038.5	$0.0	$284,545.7	$2,930.9	$10,507.5	$474,951.3
2019	$516,739.5	$0.0	$148,447.3	$1,671,105.1	$0.0	$293,515.1	$3,023.3	$10,016.0	$489,922.6
2020	$532,990.5	$0.0	$153,115.8	$1,723,659.8	$0.0	$302,745.9	$3,118.3	$9,627.7	$505,330.2
2021	$546,421.4	$0.0	$156,974.2	$1,767,094.7	$0.0	$310,374.8	$3,196.9	$9,345.1	$518,064.2
2022	$560,137.1	$0.0	$160,914.4	$1,811,450.4	$0.0	$318,165.5	$3,277.2	$9,207.4	$531,068.1
2023	$574,143.7	$0.0	$164,938.2	$1,856,746.8	$0.0	$326,121.4	$3,359.1	$9,140.5	$544,347.7
2024	$588,447.4	$0.0	$169,047.3	$1,903,004.3	$0.0	$334,246.2	$3,442.8	$9,293.9	$557,909.2
2025	$603,054.8	$0.0	$173,243.7	$1,950,243.7	$0.0	$342,543.4	$3,528.3	$9,508.5	$571,758.5
2026	$617,381.5	$0.0	$177,359.4	$1,996,575.5	$0.0	$350,681.2	$3,612.1	$9,799.2	$585,341.7
2027	$631,961.9	$0.0	$181,548.0	$2,043,727.4	$0.0	$358,963.0	$3,697.4	$10,112.5	$599,165.4
2028	$646,802.4	$0.0	$185,811.4	$2,091,720.7	$0.0	$367,392.6	$3,784.2	$10,548.5	$613,235.7

2029	$661,909.5	$0.0	$190,151.3	$2,140,576.3	$0.0	$375,973.6	$3,872.6	$11,029.7	$627,558.9
2030	$677,289.9	$0.0	$194,569.7	$2,190,315.6	$0.0	$384,709.9	$3,962.6	$11,447.1	$642,141.0
2031	$693,639.8	$0.0	$199,266.7	$2,243,190.4	$0.0	$393,996.9	$4,058.2	$17,223.0	$657,642.5
2032	$710,261.8	$0.0	$204,041.8	$2,296,944.8	$0.0	$403,438.4	$4,155.5	$17,281.2	$673,401.9
2033	$727,164.3	$0.0	$208,897.5	$2,351,606.5	$0.0	$413,039.3	$4,254.4	$17,397.6	$689,427.2
2034	$744,355.7	$0.0	$213,836.2	$2,407,202.5	$0.0	$422,804.2	$4,355.0	$16,485.6	$705,726.4
2035	$761,844.3	$0.0	$218,860.2	$2,463,759.4	$0.0	$432,738.0	$4,457.3	$16,873.0	$722,307.4
2036	$778,988.0	$0.0	$223,785.2	$2,519,201.4	$0.0	$442,475.9	$4,557.6	$17,252.7	$738,561.4
2037	$797,133.7	$0.0	$228,998.1	$2,577,883.4	$0.0	$452,782.8	$4,663.7	$17,654.5	$755,765.4
2038	$815,625.0	$0.0	$234,310.2	$2,637,683.1	$0.0	$463,286.1	$4,771.9	$18,064.1	$773,297.1
2039	$834,508.0	$0.0	$239,734.8	$2,698,749.6	$0.0	$474,011.9	$4,882.4	$18,482.3	$791,200.1
2040	$853,790.2	$0.0	$245,274.2	$2,761,107.2	$0.0	$484,964.5	$4,995.2	$18,909.3	$809,481.6
2041	$873,478.7	$0.0	$250,930.2	$2,824,778.6	$0.0	$496,147.8	$5,110.4	$19,345.4	$828,148.4
2042	$893,580.0	$0.0	$256,704.9	$2,889,785.0	$0.0	$507,565.6	$5,228.0	$19,790.6	$847,206.5