



# PELICAN ISLAND CAUSEWAY BRIDGE

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## BENEFIT COST ANALYSIS



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# Executive Summary

## Executive Summary

Pelican Island is a small coastal island (~5,000 acres) located in Texas, solely connected to the City of Galveston and the mainland by the Pelican Island Causeway Bridge (Figure ES.1). The island is home to Texas A&M University of Galveston, two preserved United States Naval ships and one of the most popular Galveston county public parks; Seawolf Park. Additionally, Pelican Island is



Figure ES.1 Pelican Island Causeway Bridge

home to hundreds of acres of undeveloped property; owned by the Port of Galveston and the Port of Houston. *Given its strategic location to open seas, potential for future development and current educational and recreational uses, Pelican Island must stay connected to Galveston Island and the mainland to further achieve the Economic Development Department’s mission of “lead[ing] and support[ing] efforts to recruit, retain and expand business and industry in Galveston County [and] to enhance employment opportunities and grow the local tax base”.*<sup>1</sup>

The Pelican Island Causeway Bridge is over 55 years old and is currently exhibiting environmental stress; the scour (caused by tidal movements) rating is critical or a ranking of 3 out of 9, with 9 being the best rating. Furthermore, the Texas Department of Transportation (TxDOT) Highway Bridge Division monitors and reports bridge data to the federal Bridge Replacement and Rehabilitation Program (BRRP). There several factors that are reported to the Federal Highways Administration, such as deck condition, substructure conditions, average daily traffic, scour condition, etc. These numerical representations are indexed into an overall bridge sufficiency rating. Sufficiency ratings range from 0 to 100, from worst to best. The Pelican Island Causeway Bridge’s overall sufficiency rating

*The Pelican Island Causeway Bridge’s overall sufficiency rating is 38.*

<sup>1</sup> County of Galveston. Economic Development Departments Mission Statement. Retrieved in Augustin 2017 from <http://www.galvestoncountytexas.gov/ed/Pages/MissionStatement.aspx>.

is 38. Additionally, due to current and projected traffic volumes and design, the Pelican Island Causeway Bridge has been rated “**functionally obsolete**”.<sup>2</sup>

The remaining useful life (or year of bridge obsolescence) for the Pelican Island Causeway Bridge, like thousands of other bridges in the United States, cannot be predicted with any certainty or accuracy, since there are too many variables in play. However, given the current scouring caused by never ending tidal currents and subsequently exposing the timber piles, the structural sub-surface conditions of ***the bridge will continue to deteriorate***. Additionally, the bridge is functionally obsolete due to its old design and increased to the average daily traffic. If the bridge were to fail, then there would be severe consequences. If the bridge were to fail and shut down, then there would be significant loss of economic, educational and recreational opportunities and access to the already invested infrastructure on Pelican Island. In order to not lose access to industry, education and recreational uses on Pelican Island, people would need to move from the Galveston Island and mainland to Pelican Island and therefore there either must be a new bridge (build scenarios) or a ferry system in place (No Build Scenario).

The *Pelican Island Causeway Bridge – Benefit Cost Analysis (BCA)* examines the costs and benefits from 2018 to 2040 (planning horizon) of a no-build and two build scenarios:

- No Build – this scenario assumes the bridge will be maintained, with an infusion of \$10 million of capital (to address scouring) in 2019. To move people from Galveston Island to Pelican Island a ferry system, like the Bolivar Ferry system, will be implemented.
- Construct Fixed Span Bridge Alignments 1 & 2 (Scenario A) – this scenario assumes the bridge will be replaced in 5 to 10 years with a new fixed span bridge following alignment option 1 or 2 (through Texas A&M at Galveston).
- Construct Fixed Span Bridge Alignment 3 (Scenario B)– this scenario assumes the bridge will be replaced in 5 to 10 years with a new fixed span bridge following alignment option 3 (north of Texas A&M at Galveston).

The BCA analysis examines how the no-build and build scenarios improves safety, state of good repair, economic, quality of life, and sustainability benefits (Table. ES.1)

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<sup>2</sup> Federal Highway Administration. National Bridge Inventory 2012-2017.

Table ES.1 Benefits Examined

Benefits Examined					
Criteria	Benefit(s)	Description	Qualitative	Quantified	Monetized
Safety	Accident reduction	Estimates property losses, injuries and fatalities due to reductions in automobile uses	X	X	X
	Emergency services access	Describes the increase in the emergency responders' response time	X		
	Shoulder width additions	Describes the benefits for a safe shoulder width for pedestrians and bikes	X		
State of Good Repair	Maintenance and operating savings	Estimates the cost to replace vs. maintain	X	X	X
Economic	Agency Benefits	Describes and monetizes the costs of no-build vs. build agency costs	X	X	X
	Travel Time Savings	Estimates number of aggregate minutes saved for vehicular and cargo movements	X	X	X
	Local Economic Stimulus	Estimates number of short-term jobs and Galveston County economic output from the construction of a new bridge	X	X	X
	Enhanced Maritime Industry Cluster Access	Describes how build scenarios will enhance the access to Pelican Island and thereby inducing development	X	X	
	Global economic competitiveness	Describes the build scenarios impact on the overall United States global economic competitiveness	X		
Quality of Life	Ladders of Opportunity - Connect	Describes how the build scenarios will provide more choices for the traditionally disadvantage populations	X		
	Ladders of Opportunity – Work	Refer to local economic stimulus section	X		
	Ladders of Opportunity – Revitalize	Describes how the build scenarios will close transportation barriers for the traditionally disadvantage populations	X		
Sustainability	Nitrogen Oxides (NOx)	Estimates harmful NOx output differences between build and no-build scenarios	X	X	X

A new Pelican Island Causeway Bridge would further develop the mission of the Galveston Economic Development Department. Either Build Scenario A or Scenario B would provide:

- Significant **safety** benefits, by
  - Reducing about 4 to 5 crashes annually; and
  - Replacing an old outdated bridge to avoid a catastrophic event.
- Robust **state of good repair** benefits; by
  - Saving the long-term operations and maintenance costs (\$750,000) annually and periodic capital infusions for major rehabilitation measures.
- Substantial **economic** benefits/impacts; by
  - Building now to ensure purchasing power does not decrease (5 percent annually);
  - Not implementing and operating an expensive ferry system (inflated to \$2035 - 160 million capital and \$17 million annual operating cost);
  - Not implementing a build option and operating an expensive ferry system (inflated to \$2035 - \$160 million capital and \$17 million annual operating cost);
  - Creating between 180 and 350 direct jobs during the three-year construction period;
  - Infusing about \$30 million to \$56 million dollars into the local Galveston County economy during the three-year construction period;
  - Providing significantly improved transportation access to hundreds of acres undeveloped land that can support maritime industries, which if only a mere 10% of the land is developed, like the Port of Galveston mix of used, then the economic output could be up to an additional 1,100 jobs, an annual increase in \$155 million dollars to the Galveston County economy and over \$2.3 million dollars in local taxes collected by Galveston County and another \$14 million in taxes collected for other government entities;
  - Enhancing the United States economic global competitiveness. The United States ranks 10<sup>th</sup> in the quality of Port infrastructure, 13<sup>th</sup> in roadway infrastructure and 12<sup>th</sup> in overall transport infrastructure and any major infrastructure improvements could only enhance the ranking and overall economic competitiveness of the United States.
- Improve quality of life; by
  - Creating more employment, educational and recreational access to traditionally disadvantage populations, much like many of the residents of Galveston Island;
  - Creating jobs for the traditionally disadvantage populations; and
  - Revitalizing communities through transportation infrastructure that closes barriers to access for persons that are low-income and/or don't own an automobile and Galveston Island has a very high rate of non-auto ownership.
- Better the environment through **sustainability** benefits; by

- Reducing harmful air pollutants, such as Nitrogen Oxides (NOx). Both build scenarios would emit about 0.94 tons less per year, with a gap between no-build and build significantly increasing after a ferry system would be needed.

The goal to any project is to have a benefit-cost ratio above 1, which means the monetized benefits outweigh the costs; discounted at 3% or 7% percent. Both build scenarios monetized benefits outweigh

**Top Reasons to Invest in New Bridge Now**

- Eliminate safety risks posed by the current outdated bridge
- Reduce annual maintenance costs
- Not lose significant purchasing power
- Provide developers with security that a new bridge will be built; and
- Provide a significant local economic stimulus.

the costs between 1.1 and 2.8, depending on the scenario and discount rate (Tables ES.3 & ES.4). Investing in a new Pelican Island Causeway Bridge provides significant qualitative and quantitative benefits. The investment should occur as soon as possible to eliminate the safety risks posed by the current outdated bridge, reduce annual maintenance costs, not lose significant purchasing power, provide developers with security that a new bridge will enhance access to undeveloped land, and provide a local economic stimulus to Galveston County.

Table ES.3 Benefit Cost Ratio – 7% Discount

Benefit Cost Ratio – 7% Discount		
Criterion	Build A	Build B
SAFETY	\$6,300,000	\$6,300,000
STATE OF GOOD REPAIR	\$16,400,000	\$16,400,000
<i>Residual Life</i>	\$13,000,000	\$25,100,000
ECONOMIC	\$68,600,000	\$78,500,000
SUSTAINABILITY	\$70,000	\$70,000
<b>TOTAL BENEFITS</b>	<b>\$94,370,000</b>	<b>\$116,370,000</b>
<b>TOTAL COSTS</b>	<b>\$57,280,000</b>	<b>\$110,040,000</b>
<b>BCA Ratio</b>	<b>1.6</b>	<b>1.1</b>

Table ES.4 Benefit Cost Ratio – 3% Discount

Benefit Cost Ratio – 3% Discount		
Criterion	Build A	Build B
SAFETY	\$10,600,000	\$10,600,000
STATE OF GOOD REPAIR	\$19,800,000	\$19,800,000
<i>Residual Life</i>	\$27,900,000	\$53,700,000
ECONOMIC	\$145,700,000	\$154,100,000
SUSTAINABILITY	\$200,000	\$200,000
<b>TOTAL BENEFITS</b>	<b>\$194,200,000</b>	<b>\$228,400,000</b>
<b>TOTAL COSTS</b>	<b>\$70,100,000</b>	<b>\$134,500,000</b>
<b>BCA Ratio</b>	<b>2.8</b>	<b>1.7</b>

# Pelican Island Causeway Bridge Benefit Cost Analysis

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## Project Overview

Pelican Island is a small coastal island (~5,000 acres) located in Texas, solely connected to the City of Galveston and the mainland by the Pelican Island Causeway Bridge (Figure 1). Pelican Island has a rich history. From the mid 1800's to the turn of the 20<sup>th</sup> century, the Island was used for public health uses to the mid-20<sup>th</sup> century and beyond for port and higher



Figure 1 Pelican Island Causeway Bridge

education uses. Pelican Island is home to Texas A&M University of Galveston, two preserved United States Naval ships and one of the most popular Galveston County public parks; Seawolf Park. Additionally, Pelican Island is home to hundreds of acres of undeveloped property; owned by the Port of Galveston and the Port of Houston. *Given its strategic location to open seas, potential for future development and current educational and recreational uses, Pelican Island must stay connected to Galveston Island and the mainland to further achieve the Economic Development Department's mission of "lead[ing] and support[ing] efforts to recruit, retain and expand business and industry in Galveston County [and] to enhance employment opportunities and grow the local tax base".<sup>3</sup>*

Pelican Island is solely connected to Galveston Island by the Causeway Bridge, which opened in 1958. The existing bridge, with approaches, is 3,236 feet long and originally was built to carry railroad and highway traffic. Currently, there is no railroad use on the bridge and some of the track has been removed. The Scherzer single-leaf rolling lift bascule main span is raised to allow passage of marine vessels along the Pelican Island Channel. This moveable span bridge is operated from a continuously manned control house on the south end of the bascule span.

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<sup>3</sup> County of Galveston. Economic Development Departments Mission Statement. Retrieved in Augustin 2017 from <http://www.galvestoncountytexas.gov/ed/Pages/MissionStatement.aspx>.

The Pelican Island Causeway Bridge is over 55 years old and is currently exhibiting environmental stress. Examples of environmental distress include salt water corrosion, marine borers, and tidal scour. This bridge has environmental distress under water. Scour has undermined the footings and has exposed the timber piles of the four southern flanking spans, the five northern flanking spans, and the bascule spans located at or near the navigation channel. Exposed timber pilings are susceptible to marine borers, fungus attack, and further decay. The Pelican Island Causeway Bridge scour rating is critical or a ranking of 3 out of 9, with 9 being the best rating.

*The Pelican Island Bridge scour rating is critical*

A critical scour condition or ranking of 3 means the “Bridge is scour critical; bridge foundations determined to be unstable for assessed or calculated scour conditions: scour within limits of footings or piles, or scour below spread-footing base or pile tips”.<sup>4</sup> Additionally, the bridge has been prioritized for further scour evaluation due to the environmental conditions for scouring (strong tidal currents) and the history of scour related problems. Logically, tidal currents will continue to scour the seabed around the Pelican Island Causeway Bridge footings and thereby continue to undermined the footings.

*The Pelican Island Bridge overall sufficiency rating is 38 and is functionally obsolete*

Furthermore, the Texas Department of Transportation (TxDOT) Highway Bridge Division monitors and reports bridge data to the federal Bridge Replacement and Rehabilitation Program (BRRP). There several factors that are reported to the Federal Highways Administration, such as deck condition, substructure conditions, average daily traffic, scour condition, etc. These numerical representations are indexed into an overall bridge sufficiency rating. Sufficiency ratings range from 0 to 100, from worst to best. The Pelican Island Causeway Bridge’s overall sufficiency rating is 38. Additionally, due to current and projected traffic volumes and design, the Pelican Island Causeway Bridge has been rated “**functionally obsolete**”.<sup>5</sup> In Texas, a sufficiency rating below 50 automatically qualifies the bridge for replacement or rehabilitation funding from the Highway Bridge Program (Figure 2).

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<sup>4</sup> Richardson, E.V., and S.M. Davis (2001). “Evaluating scour at bridges.” Publication No. FHWA NHI 01-001, HEC No. 18, U.S. Dept. of Transportation, Washington, D.C.

<sup>5</sup> Federal Highway Administration. National Bridge Inventory 2012-2017.

<b>Bridge Classification</b> <b>Not Deficient</b> Bridge with acceptable condition, configuration and design	or	<b>Sufficiency Rating</b> 81-100	=	<b>Eligibility for HBP Funding</b> Not Eligible
<b>Deficient</b> Structurally Deficient (Bridge in poor condition)		50-80	=	Eligible for Rehabilitation
or	and	0-49	=	Eligible for Replacement or Rehabilitation
Functionally Obsolete (Bridge with poor configuration and/or design)				

Figure 2 TxDOT HPB Eligibility Criteria

The remaining useful life (or year of bridge obsolescence) for the Pelican Island Causeway Bridge, like thousands of other bridges in the United States, cannot be predicted with any certainty or accuracy, since there are too many variables in play. However, given the current scouring caused by never ending tidal currents, subsequently exposing the timber piles, the structural sub-surface conditions of **the bridge will continue to deteriorate**. Additionally, the bridge is functionally obsolete due to its old design and increased average daily traffic. If the bridge were to fail, then there would be severe consequences. If the bridge were to fail and shut down, then there would be significant loss of economic, educational and recreational opportunities and access to the already invested infrastructure on Pelican Island. In order to not lose access to industry, education and recreational uses on Pelican Island, people would need to move from the Galveston Island and mainland to Pelican Island and therefore there either must be a new bridge (build scenarios) or a ferry system in place (No Build Scenario).

*In order to not lose access to industry, education and recreational uses on Pelican Island, people would need to move from the Galveston Island and mainland to Pelican Island and therefore there either must be a new bridge (build scenarios) or a ferry system in place (No Build Scenario)*

The Pelican Island Rail/Vehicular Access Feasibility Study, completed in September 2015, outlined an approach and costs to either maintaining the existing bridge or replacing the bridge with a fixed span bridge (three alignments were evaluated). The *Pelican Island Causeway Bridge – Benefit Cost Analysis (BCA)* examines the costs and benefits from 2018 to 2040 (planning horizon) of a no-build and two build scenarios (Figure 3 and Figure 4):



Figure 3 Fixed Span Alignment 1 (Alignment 2)

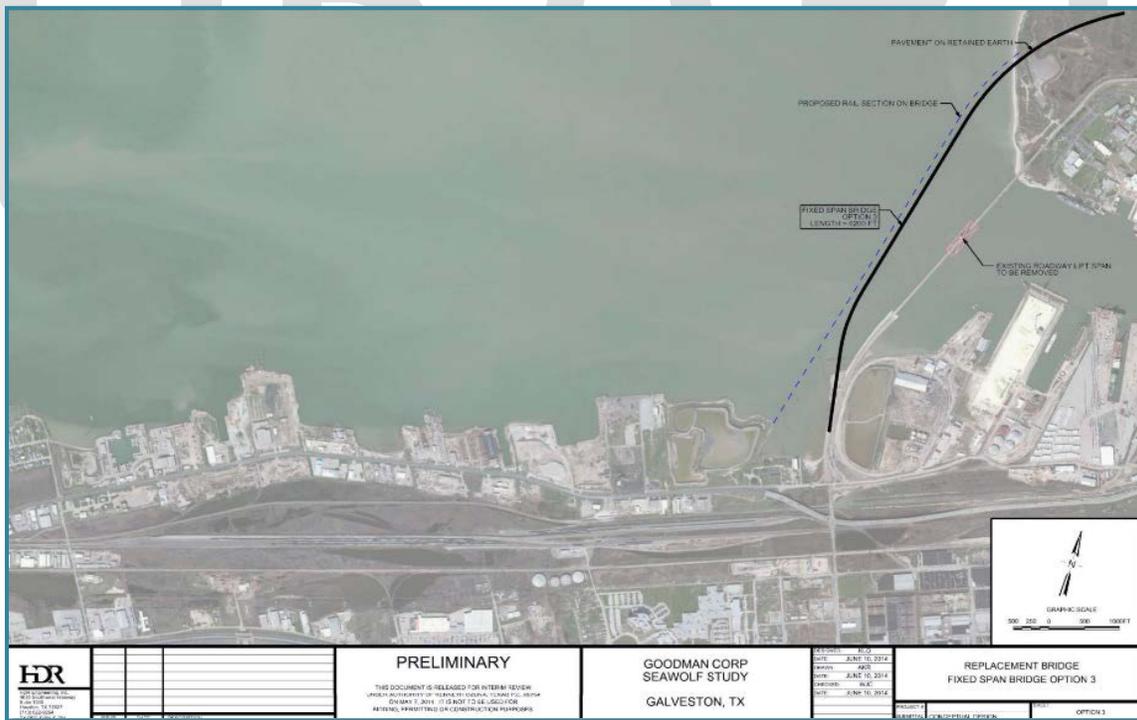


Figure 4 Fixed Span Alignment 3

## Evaluation Scenarios

For the purposes of this analysis the following no-build and build scenarios were evaluated:

- No Build – this scenario assumes the bridge will be maintained, with an infusion of \$10 million of capital (to address scouring) in 2019. To move people from Galveston Island to Pelican Island a ferry system, like the Bolivar Ferry system, would need to be implemented.
- Construct Fixed Span Bridge Alignment 1 or 2 (Scenario A) – this scenario assumes the bridge will be replaced in 5 to 10 years with a new fixed span bridge following alignment option 1 or 2.
- Construct Fixed Span Bridge Alignment 3 (Scenario B)– this scenario assumes the bridge will be replaced in 5 to 10 years with a new fixed span bridge following alignment option 3.

## Benefits Analysis Overview

The recent notices of funding availability for the (H-GAC) Houston-Galveston Area Council and United States Department of Transportation’s (USDOT) Transportation Improvement Generating Economic Recovery (TIGER) has provided recommended methodologies for evaluating large scale transportation infrastructure projects. The evaluations process examines the fundamental question of whether the expected benefits of the project justify the cost with the

understanding that some benefits and costs are difficult to quantify. *Pelican Island Causeway Bridge - BCA* examines how the no-build and build scenarios improves safety, state of good repair, economic, quality of life and sustainability throughout the planning horizon (2017-2040).

Several benefits are included in each criterion and each benefit is briefly described, quantified, and/or monetized (Table 1). Each monetized benefit is supplemented with a description of the methodology used to monetize the benefit. The diverse benefits have been studied by a variety of nationally recognized authorities, including the Transportation Research Board, National Research Council, and Governmental Accountability Office, where methods have been developed for predicting and monetizing the benefits associated with large scale transportation improvements.

The Office of Management and Budget (OMB) Circular A-94 provides guidance on real discount rates. As a default position, OMB Circular A-94 states that a real discount rate of 7% should be used as a base-case for regulatory analysis. The 7% rate is an estimate of the average before-tax

### Benefits Reviewed

Safety  
State of Good Repair  
Economic  
Quality of Life  
Sustainability

### Assumed Inflation Factors

Maintenance - 3.3%  
Capital - 5.0%  
Ferry Operations - 2%

rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital.

The effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called the social rate of time preference. This means the rate at which “society” discounts future consumption flows to their present value. Taking the rate that the average saver uses to discount future consumption as the measure of the social rate of time preference, the real rate of return on long-term government debt may provide a fair approximation. Over the last 30 years, this rate has averaged around 3% in real terms on a pre-tax basis. According to the USDOT BCA Guidance for TIGER Applicants; applicants should discount benefits that reflect the opportunity costs (3% & 7%) net the cost of inflation.<sup>6</sup> The cost of inflation is calculated using the Bureau of Labor Statistics Producer Price Index, Texas Department of Transportation Highway Cost Index, and other related sources for the ferry costs.<sup>789</sup>

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<sup>6</sup> United States Department of Transportation. *Benefit-Cost Analysis Guidance for TIGER Applicants*. Retrieved on April 12, 2017 from [https://www.transportation.gov/sites/dot.gov/files/docs/TIGER\\_VIII\\_NOFA\\_BCA\\_Appendix.pdf](https://www.transportation.gov/sites/dot.gov/files/docs/TIGER_VIII_NOFA_BCA_Appendix.pdf)

<sup>7</sup> Bureau of Labor Statistics. *Producer Price Index Maintenance and Repair Construction*. Years 2010-2014. Retrieved on 3/6/2017 from <https://data.bls.gov/timeseries/NDUBMRP--BMRP-->.

<sup>8</sup> Texas Department of Transportation. *Highway Costs Index (1997 Base) Index Report for March 2017*. Retrieved on 3/6/2017 from <https://ftp.dot.state.tx.us/pub/txdot-info/cst/hci-binder.pdf>.

<sup>9</sup> Luker Jr., William A. (June 1991) *Ferry Operations Feasibility Study*. Research Report 1930-1F.

Table 1 Benefits Overview

Benefits Overview					
Criteria	Benefit(s)	Description	Qualitative	Quantified	Monetized
Safety	Accident reduction	Estimates property losses, injuries and fatalities due to reductions in automobile uses	X	X	X
	Emergency services access	Describes the increase in the emergency responders' response time	X		
	Shoulder width additions	Describes the benefits for a safe shoulder width for pedestrians and bikes	X		
State of Good Repair	Maintenance and operating savings	Estimates the cost to replace vs. maintain	X	X	X
Economic	Agency Benefits	Describes and monetizes the costs of no-build vs. build agency costs	X	X	X
	Travel Time Savings	Estimates number of aggregate minutes saved for vehicular and cargo movements	X	X	X
	Local Economic Stimulus	Estimates number of short-term jobs and Galveston County economic output from the construction of a new bridge	X	X	X
	Enhanced Maritime Industry Cluster Access	Describes how build scenarios will enhance the access to Pelican Island and thereby inducing development	X	X	
	Global economic competitiveness	Describes the build scenarios impact on the overall United States global economic competitiveness	X		
Quality of Life	Ladders of Opportunity - Connect	Describes how the build scenarios will provide more choices for the traditionally disadvantage populations	X		
	Ladders of Opportunity – Work	Refer to local economic stimulus section	X		
	Ladders of Opportunity – Revitalize	Describes how the build scenarios will close transportation barriers for the traditionally disadvantage populations	X		
Sustainability	Nitrogen Oxides (NOx)	Estimates harmful NOx output differences between build and no-build scenarios	X	X	X

## Safety Benefits

Improving safety to the roadway system is one of the most important benefits when evaluating a transportation project. A USDOT strategic objective is to improve the safety of the transportation system by *improv[ing] the safety of the transportation system across all modes of travel by addressing behavioral, vehicular, and infrastructure safety issues through prevention, mitigation, data sharing and analysis, and response using innovative and effective partnerships,*

programs, and resources.<sup>10</sup> The replacement of the Pelican Island Causeway Bridge will help meet this national objective by improving the outdated design, reducing accidents, and providing better access for emergency responders. Quantified and monetized benefits can be derived from the number of crashes and property damage reduced.

### Traffic Accident Reduction

To evaluate the existing conditions on the Pelican Island Causeway Bridge and approaches, crash records were obtained from Texas Department of Transportation's (TxDOT) Crash Records Information System (CRIS) for 2012 to 2016.

Law enforcement data, such as found within the CRIS dataset, uses the KABCO Scale, which rates traffic crash injury on a five-point scale with categories designated as fatal (K), serious (A), moderate (B), minor (C), and none (O). The KABCO Scale is what TxDOT utilizes in the CRIS database.

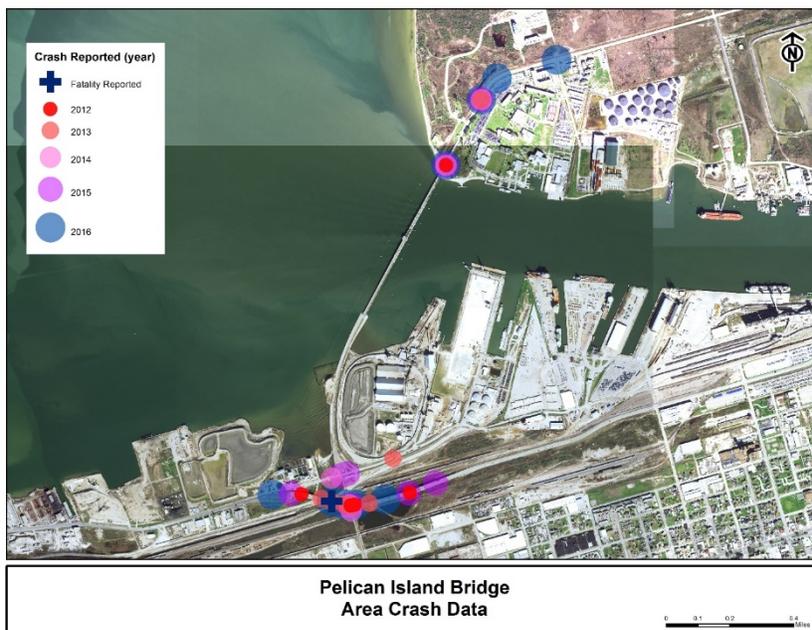


Figure 5 Crashes Reported within Pelican Island Causeway Bridge Area

The CRIS Data Conversion Table (Table 3) shows the conversion between the TxDOT crash classification system and the maximum Abbreviated Injury Scale (AIS). The AIS scale was developed by the Federal Highway Administration (FHWA) and ranks injuries on a scale of one to six, with one being minor, five severe, and six an unsurvivable injury. This represents the “threat to life” associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS 1 and AIS 2 is not the same as that between AIS 4 and AIS 5. The USDOT BCA Guidance for TIGER Applicants guidance

<sup>10</sup> Department of Transportation. Strategic Goals. Retrieved 2017, February 28, from <https://www.performance.gov/content/improve-safety-transportation-system-0#overview>.

recommends monetizing the value of injuries per the maximum AIS; however, accident data is not always reported as AIS numbers (Table 2), hence the conversion.<sup>11</sup>

By using the conversion table, a unit value by AIS scale can be applied. These unit values are the monetary values that would be realized from the improvements the project provides to the transportation system.

Table 2 Estimated Monetary Value of Injuries from Traffic Accidents

Estimated Monetary Value of Injuries from Traffic Accidents			
AIS Level	Severity	Unit value (\$2013)	Unit value (\$2017)
AIS 0	No Injuries	\$0	\$0
AIS 1	Minor	\$27,600	\$31,687
AIS 2	Moderate	\$432,400	\$496,422
AIS 3	Serious	\$966,000	\$1,109,028
AIS 4	Severe	\$2,447,200	\$2,809,539
AIS 5	Critical	\$5,455,600	\$6,263,370
AIS 6	Unsurvivable	\$9,200,000	\$10,274,490

The National Highway Traffic Safety Administration (NHTSA) provides a conversion matrix that allows KABCO-reported and generic accident data to be re-interpreted as AIS data. It is understood that an injury observed and reported at a crash site may end up being more severe than the KABCO scale indicates. Similarly, any accident can, statistically, generate several different injuries for the parties involved. Each column of the conversion matrix represents a probability distribution of the different AIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident. The USDOT’s 2014 Guidance on Treatment of the Economic Value of a Statistical Life was used to determine monetary values of potential safety improvements. The methodology to calculate the monetary cost of crashes, where such benefit exists, used values from Table 2 and the percentages from Table 3.

<sup>11</sup> U.S. Department of Transportation. TIGER Benefit-Cost Analysis Resource Guide, 2014. Retrieved June 2016 from <https://www.transportation.gov/policy-initiatives/tiger/tiger-benefit-cost-analysis-bca-resource-guide>

Table 3 CRIS Data Conversion

CRIS Data Conversion <sup>12</sup>							
AIS Level	Severity	Death	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	No	AIS Level
AIS 0	No Injuries	0.0%	3.4%	8.3%	23.4%	92.5%	43.7%
AIS 1	Minor	0.0%	55.4%	76.8%	68.9%	7.3%	41.7%
AIS 2	Moderate	0.0%	20.9%	10.9%	6.4%	0.2%	8.9%
AIS 3	Serious	0.0%	14.4%	3.2%	1.1%	0.0%	4.8%
AIS 4	Severe	0.0%	4.0%	0.6%	0.1%	0.0%	0.6%
AIS 5	Critical	0.0%	1.8%	0.1%	0.0%	0.0%	0.3%
AIS 6	Unsurvivable	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<i>Sum (Probability)</i>		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The methodology uses the reduction in crashes associated with each roadway improvement, as identified in the Highway Safety Improvement Program (HSIP). The Highway Safety Improvement Program (HSIP) Work Codes correspond to different enhancements (e.g., new curbs, raised medians, additional stop signs). TxDOT has a work code table that provides associated definitions, reduction factors, service lives, applicable maintenance cost, and preventable crash codes. Preventable crashes are those with defined characteristics that may be affected by the proposed improvement as described by the work code. The codes correspond to numeric codes assigned in CRIS to the indicated variable. Information is collected from law enforcement crash reports and converted into a coded format (Table 4). The table below shows what crashes can be avoided with new Pelican Island Causeway Bridge and approaches.<sup>13</sup>

Table 4 HSIP Work Codes

## HSIP Work Codes

<sup>12</sup> U.S. Department of Transportation. TIGER Benefit-Cost Analysis Resource Guide, 2014. Retrieved June 2016 from <https://www.transportation.gov/policy-initiatives/tiger/tiger-benefit-cost-analysis-bca-resource-guide>

<sup>13</sup> Texas Department of Transportation (2015, Oct). TxDOT Highway Safety Improvement Program Work Code Table. Retrieved June 2017 from <http://ftp.dot.state.tx.us/pub/txdot-info/trf/hsipworkcodetable.pdf>

Modernize Facility to Design Standard	
Definition	TxDOT HSIP Work Code 501: Provide modernization to all features within the Right-of-Way to achieve current desirable standards.
Reduction Factor	15%
Service Life	20 years
Preventable Crash	All
Widen Bridge	
Definition	TxDOT HSIP Work Code 218: Provide additional width across an existing structure, either by rehabilitation or replacement. Specify existing bridge width, existing approach roadway width and roadway type (2 lane, 4 lane undivided, etc.)
Reduction Factor	55%
Service Life	Design service life 75 years
Preventable Crash	(Bridge Detail is not blank) OR (Vehicle Movements/Manner of Collision = 20, 21, or 30) OR (Roadway Related = 2, 3 or 4)

Using the average crash data from 2011 to 2015 in the CRIS dataset, the number of crashes are reduced by reduction factor above and monetized based on the AIS values. Also, when the number of crashes decrease with the roadway and bridge improvements, benefits also accrue from reduced property damages. This methodology is documented in the USDOT TIGER Benefit-Cost Analysis Resource Guide.<sup>14</sup> The guide values each crash at \$4,368 in damages (\$2017).

Using the average number of property damage crashes over a five-year period in the CRIS database and the annual growth rate from the microsimulation analysis completed for the preliminary engineering of the bridge is applied to determine how many crashes will occur in future years. The appropriate reduction factor is applied (in this case, 15% & 55%) and the damages avoided are quantified. Accumulated benefits from 2020 to 2040 are summed up and discounted at a 3% and 7% rate as shown in the box below.

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<sup>14</sup> U.S. Department of Transportation. TIGER Benefit-Cost Analysis Resource Guide, 2014. Retrieved June 2016 from <https://www.transportation.gov/policy-initiatives/tiger/tiger-benefit-cost-analysis-bca-resource-guide>

**Monetized Safety Benefits – Both Build Scenarios**  
**\$16,200,000 (2017\$) & \$10,600,000 (2017\$ Dis. @ 3%) & \$6,300,000 (2017\$ Dis. @ 7%)**

**Emergency services access**

The no-build scenario assumes the bridge will eventually be closed due to a low bridge sufficiency by 2035. Currently, there are no emergency responder services, ambulance, police and firefighting, located on Pelican Island. Under the no-build scenario, if emergency responders’ services were not located on the Island, then response time would be significantly longer with a ferry. The additional travel time would leave people on Pelican Island at major safety and health risk. If, emergency services were to be constructed and provided on Pelican Island, then it would significantly increase the cost of the no build scenario.

Build Scenarios A and B both provided enhance emergency access to Pelican Island. In fact, the clear span bridge will provide better access over the no-build in the short-term due to Bascule operations (prior to bridge closure) and in the long-term (after bridge closure). In the short term, the travel time across the channel will decrease from an average of 1.8 minutes to 1.5 minutes and the reduction in the bridge openings could reduce a 10-minute delay for emergency responders. In the long-term, after bridge closure, the travel time across the channel could increase from an average of 1.5 minutes to 15 min for ferry transport.

**Shoulder width additions**

The current Pelican Island Causeway Bridge does not have adequate shoulder width to accommodate pedestrians, bicyclists or a hard shoulder for emergency stopping (Figure 6). The no-build scenario assumes the bridge will be operational until 2035 and then a ferry system may be an option. Currently, the short-term existing geometric conditions are unsafe for pedestrians, bicyclists, motorists and first responders.

**Shoulders can reduce crash types including:**  
*Head on*  
*Rear-End*  
*Sideswipe*  
*Fixed object*  
*Pedestrian*

Build Scenarios A and B will include an additional 12ft general purpose lane and a 3ft shoulder (Figure 6). The FHWA Safety Program have studied and reviewed other studies that outline the benefits of shoulders on roadways. The major benefits of paved shoulders included but are not limited to safety, emergency services, enhances bicyclist comfort and provides space for variable signage.<sup>15</sup>

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<sup>15</sup> Federal Highway Administration. *Safety Benefits of Walkways, Sidewalks, and Paved Shoulders*. FHWA Safety Program Retrieved on March 22, 2017, from [https://safety.fhwa.dot.gov/ped\\_bike/tools\\_solve/walkways\\_trifold/](https://safety.fhwa.dot.gov/ped_bike/tools_solve/walkways_trifold/).

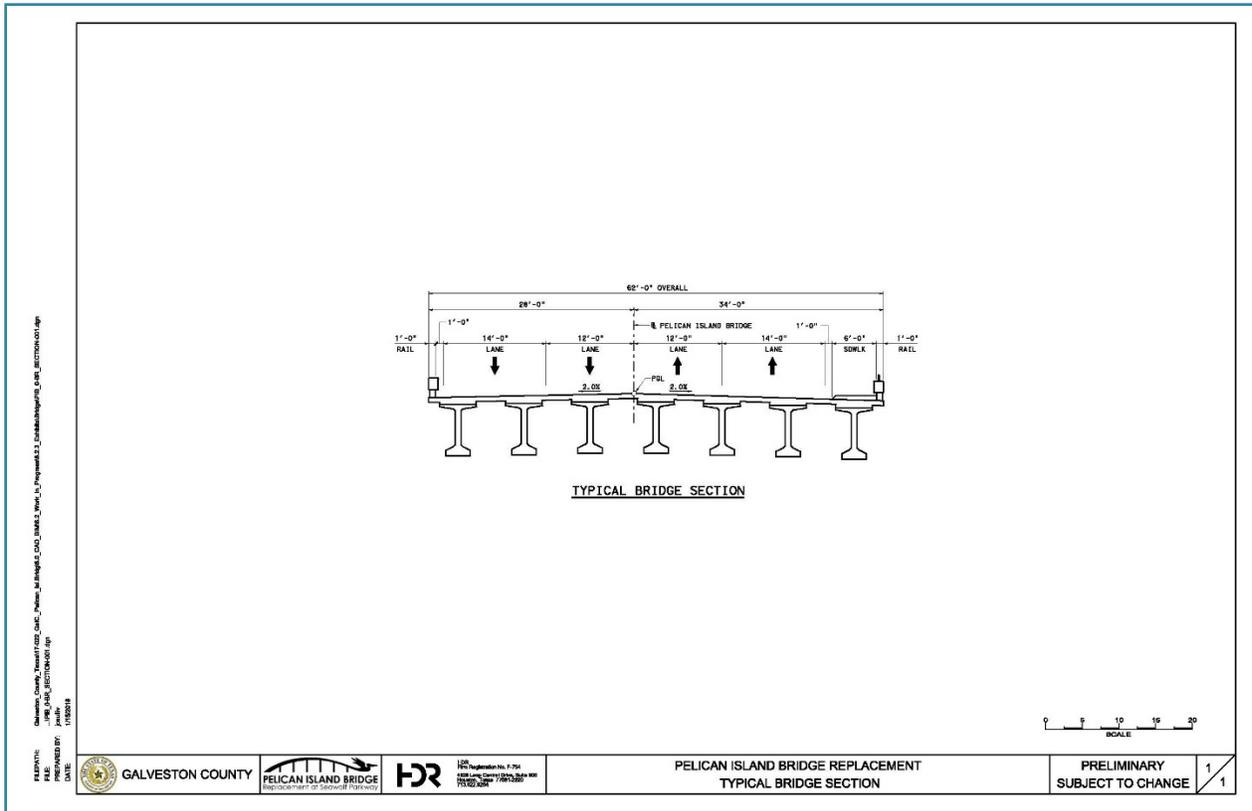


Figure 6 Scenario A and B Cross Section

## State of Good Repair Benefits

The cost for Pelican Island Causeway Bridge to continue to function in state of good repair (SGR) (on-going maintenance, operations, and rehabilitation costs) is greater than the cost to replace when factored over the next 20 years. The FHWA administration states that SGR *mean[s]: the existing physical conditions of bridge elements, components or entire bridges are such that the bridges (a) are functioning as designed and (b) are sustained through regular maintenance, preservation, and replacement programs.*<sup>16</sup> The Pelican Island Causeway Bridge is not currently meeting 21<sup>st</sup> century design standard and needs significant annual maintenance and rehabilitation to continue to function in SGR.

## Maintenance and operating savings

To evaluate the benefits of cost savings derived from a constructing a new bridge, the SGR costs were evaluated for no-build and two build scenarios. The no-build scenario assumes the an

<sup>16</sup> Federal Highway Administration. *Bridge Preservation Guide*. Retrieved on April 12, 2017 from <https://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf>

annual \$750,000 is needed to maintain SGR and operate the bascule. Both build scenarios are assumed to be built in 2020-2025. Both alignments are expected to have a life of 75 years, and will require \$20,000 in maintenance and upkeep costs per year after the bridge is built.

The state of good repair is calculated by taking the operating and maintenance cost, and periodic rehabilitation costs, for the no build scenario, and subtracting out the build scenario's operating and maintenance cost for each year. The timeframe for the state of good repair analysis is from 2017-2034 (year 2034 is the year assumed the current bridge will close). Summed over the 18 years, the SGR benefit for both Build Option A is \$13,800,000 (2017\$). Accumulated benefits from 2020 to 2034 are summed up and discounted at a 3% and 7% rate.

**Build Option A - Monetized State of Good Repair**  
**\$13,800,000 (2017\$) & \$9,800,000 (2017\$ Dis. @ 3%) & \$6,400,000 (2017\$ Dis. @ 7%)**

### Residual Life

It is assumed the replacement bridge will have a useful life of 75 years; far beyond the 20 year planning horizon. As such, the remaining uninflated 80% residual life remaining is added to the SOGR benefit as the residual life benefit.

**Build Option A - Residual Life Benefit**  
**\$50,400,000 (2017\$) & \$27,900,000 (2017\$ Dis. @ 3%) & \$13,000,000 (2017\$ Dis. @ 7%)**

**Build Option B - Residual Life Benefit**  
**\$97,000,000 (2017\$) & \$53,700,000 (2017\$ Dis. @ 3%) & \$25,100,000 (2017\$ Dis. @ 7%)**

### Economic Benefits

The Pelican Island Causeway Bridge is the only crossing to Pelican Island. It provides access for residents, academics, tourist and businesses to and from the island for commerce, education and other related activities. The Pelican Island Causeway Bridge is a bascule bridge, which can significantly decrease travel time. The Pelican Island Causeway Bridge is also a load restricted bridge (38 tons gross, 16 tons tandem axle), which is the maximum legal use weight of an 18-wheeler. However, due to the ever-decreasing stability of the bridge, this load restriction could be downgraded and further deter freight traffic. The construction of a new bridge, that enhances speed and removes the load restrictions, would significantly contribute to the local Galveston County economy.

Given the rising costs of materials and services, the lead agency would save millions of dollars by constructing a new bridge in the short-term rather than allowing the current bridge to become in disrepair and then implementing a ferry system. In addition to the agency, the user cost (travel time) benefits would be substantial. Hundreds of jobs would be created in the short term. The

business climate and thereby the economic productivity of the land would be enhanced. The significant economic impact would also enhance the United States global competitiveness.

### Agency Benefits

Inflation of goods and services should be considered when comparing the no-build and build scenarios. By constructing a new bridge sooner than later, the agency can greatly reap long-term financial benefits. Using average inflation factors over the past 20 years, the actual costs of each alternative scenario from the present day, 2017, over the planning horizon, to 2040 is calculated. The difference between the actual projected costs and today's value of a dollar, discounted at 3% and 7%, is the overall agency benefit (netting out the SOGR benefit).

#### *No Build*

The TxDOT operates a ferry between Galveston and Port Bolivar, to provide access on SH87 between Galveston Island and the Bolivar Peninsula. This system was used as an example of the type of service that would be put into place as a replacement for the Pelican Island Causeway Bridge. The Port Bolivar-Galveston (Bolivar Ferry) ferry runs 24 hours a day, 365 days per year. Given that there may be no bridge access, a similar service level example is assumed from the Pelican Island ferry. The capital costs are incurred first in 2035, the capital cost of a five ferry system is estimated at \$63,100,000 (\$2017) or not discounted at ~\$160,300,000 (\$2035).

Capital costs for the ferry system include docking, right of way and vessel costs. Docking costs are estimated at \$1,000,000 (\$2017) or not discounted at \$2,500,000 (\$2035).<sup>17</sup> To estimate right of way costs, the average value per acres of land is used. Using Galveston County Appraisal District data, the 3 parcels closest to the bridge on each side of the crossing have an average value of about \$21,000 per acre (\$2017) or not discounted at \$52,000 (\$2035). The right of way cost is assumed for 10 acres, which is the approximate footprint of the land area for the Bolivar Ferry. The Bolivar Ferry utilizes up to 5 vessels, thus it is assumed with a similar level of service, this ferry system will also need 5 vessels with similar passenger load and vehicle capacities. For a Class K vessel with 100-500 passenger capacity and up to a 50 vehicle capacity, the average cost is \$12,500,000 (\$2017) or not discounted \$31,500,000 (\$2035).<sup>18</sup> Thus, the \$63,000,000 (\$2017) or not discounted at \$157,300,000 (\$2035) will be needed for vessels (Table 5 & Table 6). Operating costs are assumed to be like the Bolivar Ferry, approximately \$11,700,000 (\$2017) annually or not discounted 16,700,000 (\$2035).

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17 Transportation Investment Generating Economic Recovery 2015 (TIGER 2015) Grants. Retrieved 2017.

<http://www.maine.gov/mdot/tigergrants/tiger2015/>

<sup>18</sup> Ferry Lifecycle Cost Model for Federal Land Management Agencies: User's Guide (2016, September). Retrieved 2017. <https://www.volpe.dot.gov/transportation-planning/public-lands/department-interior-bus-and-ferry-lifecycle-cost-modeling>

Table 5 Ferry System Capital Costs (\$2017)

Ferry System Capital Cost (\$2017)			
Item	Units/Acres Required	Unit/Acre Cost	Total Cost
Facility	1 facility	\$1,000,000	\$1,000,000
Right of Way	10 acres	\$21,000	\$210,000
Vessels	5 boats	\$12,500,000	\$62,500,000
<b>Total</b>			<b>\$63,710,000</b>

Table 6 Ferry System Capital Costs (\$2035)

Ferry System Capital Cost (\$2035)			
Item	Units/Acres Required	Unit/Acre Cost	Total Cost
Facility	1 facility	\$1,000,000	\$1,000,000
Right of Way	10 acres	\$21,000	\$210,000
Vessels	5 boats	\$12,500,000	\$62,500,000
<b>Total</b>			<b>\$160,250,000</b>

DRAFT

### Build Scenarios

The capital costs for Scenarios A and B are from the 2015 Pelican Island Rail/Vehicular Access Feasibility Study. The 2015 Pelican Island Rail/Vehicular Access Feasibility Study estimates Scenario A’s capital cost at \$63,000,000 (\$2017) and Scenario B’s capital cost at \$121,250,000 (\$2017). Escalating these costs to \$2022 results in approximately \$81,400,000 million and \$156,700,000, respectively. Either alignment chosen is projected to begin in 2020-2025. Both alignments are expected to have a design life of 75 years, and will require \$20,000 (\$2017) in maintenance and upkeep costs per year after the bridge is built. Using the assumed inflation factors, each scenario’s actual costs were calculated (Table 7).

**Capital Costs (\$2017)**  
 No Build - \$75 Million  
 Scenario A - \$63 Million  
 Scenario B - \$121 Million

**50 Year Average Annual Operating Costs (\$2017)**  
 No Build - \$7.9 Million  
 Scenario A - \$0.6 Million  
 Scenario B - \$0.6 Million

Table 7 Agency Costs (less SOGR Costs)

Agency Costs (Less SOGR Costs)			
Discount Rate	No-Build	Scenario A	Scenario B
Real - 3% Discount	\$145,300,000	\$66,100,000	\$130,500,000
Real - 7% Discount	\$67,100,000	\$53,700,000	\$106,400,000

The agency benefit is calculated by subtracting Scenario A & B from the no build scenario. Over the next 20-years, there is an agency benefit for constructing either bridge alignment as soon as possible, expect for Build Option B discounted at 7%; however, Build Option B has a strong SOGR benefit at a 7%.

**Build Option A – Monetized Agency Savings**  
 \$90,600,000 (2017\$) & \$79,300,000 (2017\$ Real Rate @ 3% Disc.) & \$13,500,000 (2017\$ Real Rate @ 7% Disc.)

**Build Option B - Monetized Agency Savings**  
 \$32,300,000 (2017\$) & \$13,500,000 (2017\$ Real Rate @ 3% Disc.) & ~~-\$39,300,000~~ (2017\$ Real Rate @ 7% Disc.)

### Travel Time Savings

According to the USDOT “travel time or vehicle hours traveled (VHT) is a critical factor in evaluation the benefits of transportation infrastructure”.<sup>19</sup> One of the major decision points for decision makers to determine need is the ability of the transportation project to improve travel

<sup>19</sup> USDOT Memorandum to Secretarial Officers Modal Administrators. “Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis” Retrieved April 2017 from <https://www.transportation.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf>

time between Point A and Point B. These improvements include added capacity, new lanes, operational improvements, etc. Travel time savings benefits the user by allowing users to dedicate more time to production at work, enjoy leisure activities, and/or reduce stress. Travel time savings derived from freight traffic is more complex and savings are typically derived from variable truck costs (cost per hour), on-dock penalties for late arrival, and cargo related supply chain costs (product spoilage, delayed final sales, etc.).

The *INRIX National Traffic Scorecard 2016 Annual Report* provides a comprehensive analysis of the state of congestion across the U.S. Overall, Houston's congestion is ranked 11<sup>th</sup> in the nation.<sup>20</sup> These findings are reinforced by the *TTI 2015 Urban Mobility Report* which ranked Houston as the 10<sup>th</sup> most congested city in the nation. TTI researchers based its ranking on Delay per Traveler, Travel Time Index, and Total Delay. Based on 2014 travel data, the TTI report estimates that, on average, Houston drivers spend 61 additional hours per year driving (which ranks 8<sup>th</sup> in the nation) because of congestion. As a result, Houston's congestion contributes to about \$4.9 billion in lost productive time and excess fuel consumption (which is 4<sup>th</sup> in the nation).<sup>21</sup> An objective of the proposed project is to reduce vehicle hours traveled (VHT) for the region and to connect with freight regional ports.

#### Vehicle Hours Traveled

A licensed traffic engineer completed a microsimulation model to estimate the projected annual average daily traffic and growth, which was used to estimate travel time across the bridge. The current no-build traffic volumes were derived from field observation and 24-hour counts taken by video. The baseline counts are foundation to future traffic volume projections for the no-build and build scenarios.

#### *No Build Scenario*

The No-Build Scenario assumes the current bridge will be in service until 2035. The current travel time from 51<sup>st</sup> and Harborside Drive to Seawolf Pkwy is approximately 2.4 minutes. Additionally, the bridge opens about 7 times a day taking 10 minutes per open. It is assumed that 5 percent of the AADT is delayed due to the openings. Using real traffic counts, the current AADT in 2017 is 7,480 and expected to grow 3% annually until the bridge is closed in 2035 (assumed date). The total annual VHT is calculated using the following formula:

*The average annual VHT along the current bridge from 2017 to 2035 is about 78,000 vehicle hours.*

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<sup>20</sup> INFRIX 2016 Annual Report, National Congestion Scorecard, ES-1. Retrieved in August 2017, from <http://inrix.com/scorecard/>

<sup>21</sup> Texas Transportation Institute, Texas A&M. 2015 Urban Scorecard. Retrieved in August 2017, from <https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015-wappx.pdf>

Equation 1 Annual Vehicle VHT – No Build Scenario

$$\begin{aligned} \text{Annual VHT} &= (\text{AADT} \times (260 \text{ weekdays}) + \text{ADDT} \times (105 \text{ weekend} * 50\%)) \times 7,480 \text{ AADT} \times (1+3\%)^n \times 1.8 \text{ min})/60 \text{ min.} \\ &+ \\ \text{Opening Delay} &= (\text{AADT} \times (260 \text{ weekdays}) + \text{ADDT} \times (105 \text{ weekend} * 50\%)) \times 7,480 \text{ AADT} \times (1+3\%)^n \times 5\% \times 10 \text{ min.})/60 \text{ min.} \end{aligned}$$

After year 2035, the travel time across the channel via ferry boat is projected to take 15 minutes on average (7-10-minute travel time and 5-8 minutes loading). Given the increase in the travel time, it is assumed that there will be a 50% reduction in AADT and no growth rate. The total annual VHT is calculated using the following formula:

*The average annual VHT via ferry from 2035 to 2040 is about 107,000 vehicle hours*

Equation 2 Annual Ferry VHT – No Build Scenario

$$\text{Ferry} = (\text{AADT} \times (260 \text{ weekdays}) + \text{ADDT} \times (105 \text{ weekend} * 50\%)) \times 7,480 \text{ AADT} \times (1+3\%)^n \times 50\% \times 15 \text{ min.} * 1.25)/60 \text{ min.}$$

Build Scenarios

Both Build Scenarios assumes the proposed bridge will open to the public in 2022-2027 and be in service for at least 75 years. Given the modern design of the bridge, the speed will slightly increase. The projected travel time from 51<sup>st</sup> and Harborside Drive to Seawolf Pkwy is approximately 1.5 minutes. The total annual VHT is calculated using the following formula:

*The average annual VHT for the build scenarios from 2022 to 2040 is about 68,000 vehicle hours.*

Equation 3 Annual Vehicle VHT – Build Scenario

$$\text{Annual VHT} = (\text{AADT} \times (260 \text{ weekdays}) + \text{ADDT} \times (105 \text{ weekend} * 50\%)) \times 7,480 \text{ AADT} \times (1+3\%)^n \times 1.5 \text{ min})/60 \text{ min.}$$

To calculate the annual VHT savings, the build scenario VHT is subtracted from the no build scenario for each year between 2022 and 2040 (Table 8). The average annual VHT savings from building a new bridge from 2022 to 2040 is about 28,000 VHT or 540,000 VHT in total.

Table 8 VHT Savings

VHT Savings			
Year	No Build VHT	Build Scenarios VHT	Total VHT Savings
2022	76,416	51,802	24,614
2023	78,709	53,356	25,352
2024	81,070	54,957	26,113
2025	83,502	56,606	26,896
2026	86,007	58,304	27,703
2027	88,588	60,053	28,534
2028	91,245	61,855	29,390
2029	93,983	63,710	30,272
2030	96,802	65,622	31,180
2031	99,706	67,590	32,116
2032	102,697	69,618	33,079
2033	105,778	71,707	34,072
2034	108,952	73,858	35,094
2035	107,921	76,074	31,848
2036	107,921	78,356	29,566
2037	107,921	80,706	27,215
2038	107,921	83,128	24,794
2039	107,921	85,621	22,300
2040	107,921	88,190	19,731
<b>Totals</b>	<b>1,840,984</b>	<b>1,301,114</b>	<b>539,870</b>

#### Monetizing VHT Savings

Prior to monetizing the VHT savings, the VHT needs to be split between auto and truck trips. The auto trips have a different value of time than truck trips and there is typically 1.25 persons per vehicle for auto trips, as opposed to 1 person per person per vehicle for truck trips. Using actual 2017 counts, the auto/truck ratio was 90% auto trips and 10% truck trips. This ratio is used from 2022 to 2035. After 2035, the no-build vs build scenario auto to truck ratio changes. The No-build scenario would be ferry transportation and therefore it assumed there would be limited or no truck traffic utilizing the ferry. Using these assumptions, the total person hours savings is about 33,000 hours per year from 2022 to 2040. The total truck VHT savings is about 2,950 truck VHT saved per year from 2022 to 2035 (Table 9).

Table 9 Auto Person Hours and Truck VHT Savings by Mode

Auto Person Hours and Truck VHT Savings by Mode		
Year	Auto Person Hours Traveled Savings	Truck VHT Savings
2022	27,691	2,461
2023	28,522	2,535
2024	29,377	2,611
2025	30,258	2,690
2026	31,166	2,770
2027	32,101	2,853
2028	33,064	2,939
2029	34,056	3,027
2030	35,078	3,118
2031	36,130	3,212
2032	37,214	3,308
2033	38,331	3,407
2034	39,480	3,509
2035	39,810	-
2036	36,957	-
2037	34,019	-
2038	30,992	-
2039	27,875	-
2040	24,664	-
<b>Totals</b>	<b>626,785</b>	<b>38,442</b>

To monetize the benefits, a value per hours is assumed for person hours and truck VHT. The Houston-Galveston Area Council uses the average Value of Travel Time (VoTT) as \$16.49/hour (2017\$). The American Transportation Research Institute (ATRI) tracks and researched thousands of goods and services movements across the United States. In 2016, ATRI reported that the average cost per VHT for trucks is \$63.70.<sup>22</sup> Using a modest 2% inflation and the formulas below, the user saving are calculated.

Equation 4 Auto and Truck User Cost Savings.

$$\begin{aligned} \text{Auto User Savings} &= \text{Annual Person Hours} * \$16.69 (1+2\%)^n \\ &+ \\ \text{Auto User Savings} &= \text{Annual Truck VHT} * \$63.70 (1+2\%)^n \end{aligned}$$

Accumulated benefits from 2020 to 2040 are summed up and discounted at a 3% and 7% rate.

**Build Option A & B- Monetized Traveled Hours Saved**  
**\$19,700,000 (2017\$) & \$13,200,000 (2017\$ Dis. @ 3%) & \$8,000,000 (2017\$ Dis. @ 7%)**

<sup>22</sup> American Transportation Research Institute. 2016. *An Analysis of the Operational Cost of Trucking: 2016 Update*. Retrieved in May 2017 from <http://atri-online.org/wp-content/uploads/2016/10/ATRI-Operational-Costs-of-Trucking-2016-09-2016.pdf>.

## Local Economic Stimulus

Major capital projects require the work of planners, engineers, construction workers and many others, and have the potential of generating many job-years. A job is 12 months of employment which could be divided into two 6-month jobs or three 4-month jobs, etc.... The construction of the bridge will create about three years of short term job-years. These job-years will be generated by the investment of dollars to construction the bridge. There typically are three distinct effects, direct, indirect, and induced, during the analysis of economic impact. The total economic impact is the sum of the direct, indirect, and induced effects. These effects are defined as follows:

- **Direct Effect** represents the initial expenditures (e.g., construction expenditures) received by businesses located in the study area.
- **Indirect Effect** represents the impact of the additional “business spending” generated as these businesses sell more output and, in turn, purchase additional inputs from their suppliers (e.g., machinery manufacturers).
- **Induced Effect** represents the increase in economic activity, over and above the direct and indirect effects, associated with the increased labor income that accrue to workers and is spent on household goods and services purchased from area businesses.

There are several sources that provide the economic impact for the construction activity. For this analysis, IMPLAN, a nationally recognized modeling software, was used to estimate the economic benefits to Galveston County for the no-build, Build A and Build B scenarios.<sup>23</sup> The model is a traditional input-output model using region multipliers for the indirect and induced effects of the direct jobs created from the spending. Nationally, government spending on large scale projects and its related economic benefits on are typically a transfer benefit and therefore excluded from a traditional BCAs. However, given the scale of the project there will be a regional net benefit in employment and related economic benefits from project.

Creating local jobs is a key local economic stimulus indicator. Employees (direct jobs) need housing, medical, goods and services and other amenities. Employees will spend portions of their paychecks in the local economy, which in turn, creates more jobs

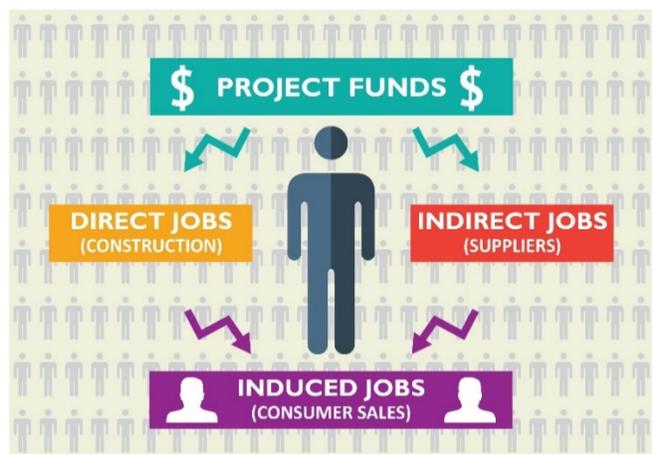


Figure 7 Direct and Indirect Jobs

<sup>23</sup> IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078

(induced jobs) that need to support that spending. Additionally, the products, such as concrete, that needs to support both the employees' welfare and the projects local material needs (indirect jobs) will have an impact on the local economy and those expenditures will then send another ripple wave through the local economy (induced jobs) (Table 7). Using IMPLAN, the total jobs are projected by job-year:

- The No Build Scenario would sustain about 15 job-years per year between the years for 2017 and 2030, <sup>24</sup> of which 8.5 are direct job-years, 3.4 are in indirect job-years and 3.0 are induced job-years.
- The Build A Scenario would sustain about 181.2 job-years per year between the design/construction years for 2020 and 2022, of which 112.8 are direct job-years, 29.8 are indirect jobs and 38.7 are induced job-years.
- The Build B Scenario would sustain about 348.7 job-years per year between the design/construction years for 2020 and 2022, of which 217.0 are direct job-years, 57.3 are indirect jobs and 74.4 are induced job-years.

The total net job-years are calculated by subtracting the No-Build job-years created by the Build A or Build B scenarios job-years created. The build scenario's job-years are created during the design/construction years between 2020-2022. The jobs that are created by the construction far outweigh the jobs created by the long-term maintenance of the bridge through 2030. The total job-years created by Build A Scenario is 166.4 and Build B Scenario is 333.8 (Table 10).

Table 10 Annual (3 yrs) Net Job Years Created

Annual (3 yrs) Net Job Years Created		
Impact Type	Build A	Build B
Direct Effect	104.2	208.5
Indirect Effect	26.4	53.9
Induced Effect	35.7	71.4
<b>Total Effect</b>	<b>166.4</b>	<b>333.8</b>

<sup>24</sup> Due to the model limitation, benefits were analyzed for years 2017-2030.

In both build scenarios, many of the short-term job-years are being created in the construction, real estate and full-service restaurant industry. About 50 percent of the job-years created are created in the construction of new highways and streets. About 12% are created in architectural, engineering, and related services 2% are both in the real estate full-service restaurants. In other words, most of the induced jobs are spread among many different supporting industry sectors.

**Top Industries for Job-Year Created**

- Construction of new highways and streets
- Architectural, engineering, and related services
- Real estate
- Full-service restaurants
- Limited-service restaurants
- Wholesale trade
- Employment services
- Management consulting services

Another key local stimulus economic factor is total output or gross domestic product for Galveston County; which is the sum of employee compensation, proprietor income, other property taxes, taxes on production and imports and intermediate expenditures (supplies for the products). Using IMPLAN, the total output is projected:

- The No Build Scenario would output about \$2,210,000 per year between the years for 2017 and 2030, of which \$1,370,000 are direct outputs, \$470,000 are indirect outputs and \$370,000 are induced outputs.
- The Build A Scenario would output about \$29,580,000 per year between the design/construction years for 2020 and 2022, of which \$20,240,000 are direct outputs, \$4,550,000 are indirect outputs and \$4,790,000 are induced outputs.
- The Build B Scenario would about \$56,910,000 per year between the design/construction years for 2020 and 2022, of which \$38,950,000 are direct outputs, \$8,750,000 are indirect outputs and \$9,210,000 are induced outputs.

The total outputs are calculated by subtracting the No-Build outputs by the Build A or Build B scenarios outputs. The build outputs are only realized during the design/construction years between 2020-2022. The annual outputs for three years throughout the construction period by Build A Scenario is \$27.3 million (2017\$) and Build B Scenario is \$54.7 million (2017\$) (Table 11). Of these outputs about \$800,000 (2017\$) in net local sales and property taxes would be realized in Build Scenario A and \$2.0 million (2017\$) in Build Scenario B.

About \$800,000 (2017\$) in net local sales and property taxes would be realized in Build Scenario A and \$2.0 million (2017\$) in Build Scenario B.

Table 11 Annual 3-Year Net Output Realized

Annual (3 yrs) Net Output Realized		
Impact Type	Build A	Build B
Direct Effect	\$18,870,000	\$37,580,000
Indirect Effect	\$4,080,000	\$8,280,000
Induced Effect	\$4,420,000	\$8,840,000
<b>Total Effect</b>	<b>\$27,370,000</b>	<b>\$54,700,000</b>

Accumulated benefits from 2017 to 2030 are summed up and discounted at a 3% and 7% rate.

<b>Build Option A – Local Economic Stimulus</b> \$57,800,000 (2017\$) & \$53,200,000 (2017\$ Dis. @ 3%) & \$47,100,000 (2017\$ Dis. @ 7%)
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<b>Build Option B - Local Economic Stimulus</b> \$139,800,000 (2017\$) & \$126,000,000 (2017\$ Dis. @ 3%) & \$109,800,000 (2017\$ Dis. @ 7%)
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### Enhanced Maritime Industry Cluster Access

The maritime industry cluster is a vital part to the Galveston County economy. The maritime industry cluster consists of the following subsectors as defined by the North American Industry Classification System (NAICS) as the following:

- **Maritime Logistics and Shipping:** categories include but are not limited to railroad and trucking companies, tug services (including pilots), security assistance, longshoremen, stevedoring, terminal and warehouse operators and government officials supporting maritime functions.
- **Waterborne Passenger Activity:** categories include but are not limited to cruise lines and scenic and sightseeing activities.
- **Ship & Boat Building, Maintenance and Repair:** categories include but are not limited to maintenance and building of all vessels, both commercial and private.
- **Maritime Support Services:** categories include but are not limited to marine supplies, engineering services for construction of vessels/docks/ports, inspection agents, bunkering firms and chandlers.
- **Commercial Fishing & Seafood Processing:** categories include but are not limited to fishing, shell/fish and other maritime species production and markets.
- **Marina and Recreational Boating & Fishing:** categories include but are not limited to bait and tackle, boat dealers, yacht brokers, marinas and fishing equipment.

According to *Economic Impact of Galveston County’s Maritime Industry Cluster* (henceforth The Galveston County Economic Study) the total Galveston County Maritime industry directly created 15,016 jobs in 2015 and indirectly created 5,086 jobs which combined, induced 12,468 jobs in Galveston County. These jobs are mostly created through the Port of Galveston and Port of Texas

City industrial activities and the industries that support them. The report states that “the maritime industry cluster represent almost 20% of the total employment in Galveston County”.<sup>25</sup> The maritime sector is a dominate industry sector in Galveston County and any investments in public infrastructure to enhance access to the maritime sector will have significant economic impact for Galveston County.

The no build scenario does not enhance the maritime industry access to Pelican Island. In fact, if planning efforts were underway to demolish or close the bridge and not rebuild a new bridge, then the maritime industry access to Pelican Island would greatly suffer. This would likely result in no additional and/or decline in the maritime activities located on Pelican Island. Both build scenarios would significantly enhance the access to property owned by both the Port of Galveston and Port of Houston that is landbanked for maritime industry activities. A new bridge would allow for larger and heavier truck loads to access Pelican Island and all travelers would not incur an approximate 10-minute delay each time the bascule opens.

Pelican Island Bridge stakeholder outreach activities began in July 2013 under contract authorization from the Galveston County Rural Rail Transportation District (GCRRTD), which at that time was charged with exploring the feasibility of reestablishing industrial railroad access onto Pelican Island from Galveston Island.

During the course of this feasibility analysis, outreach occurred with the Pelican Island Organization (PIO). This organization is composed of governmental and private industry representatives such as the U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), Texas A&M University at Galveston, (TAMUG), Port of Houston Authority (POHA), Galveston County (county), City of Galveston (city), Port of Galveston (POG), Galveston County Navigation District No. 1 (GCND), the Harborside Management District (HMD), as well as Sullivan Interests, Texas International Terminal, Gulf Copper and other private entities.

These meetings established communication and outreach with the governing bodies of these entities. Numerous fact-finding meetings and subsequent progress reports to these bodies were conducted over the course of two years that culminated in a final feasibility analysis report that was presented to the GCRRTD board as a contract deliverable in September 2015.

In the course of this feasibility analysis, it was found that the emphasis on a railroad connection component to Pelican Island had shifted to exploring a the establishment of a new vehicular

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<sup>25</sup> Martin Associates. 2017. The Economic Impact of Galveston County’s Maritime Industry Cluster. Retrieved in August 2017 from <http://www.galvestoncountytexas.gov/ed/Documents/MaritimeStudy.pdf>.

bridge connection to the island. This emphasis shift resulted in an increased need for vehicular-centric stakeholder public involvement.

At that time Galveston County began to take the lead in stakeholder outreach and began those efforts connected with a vehicular bridge. Of the numerous stakeholder meetings held there were some milestone meetings that were facilitated by the Pelican Island Bridge Team comprised of The Goodman Corporation (TGC), HDR Engineering, Crouch Environmental Services led by Micahael Shannon, P.E., the Galveston County Engineer. These milestone meetings were:

- USACE pre-application meeting held on December 15, 2016
- USACE-Interagency Joint Evaluation Meeting (JEM) held on March 8, 2017 that was attended by numerous resource permitting agencies such as the US Fish and Wildlife (USFW), USCG, Nation Oceanic and Atmosheric Adminstration (NOAA), Texas Parks and Wildlife Department (TPWD), Texas General Land Office (GLO) and the Texas Department of Transportation (TxDOT).
- An invitation-only Stakeholder Partnering Workshop was held at the Galveston Convention Center (GCC) on July 27, 2017 that consisted of 165 stakeholder contacts.
- A public meeting was advertised and posted in various media that was held on September 13, 2017 at the GCC where public comments were received.

The overall consensus resulted in a majority of stakeholders preferring a clear-span bridge that would bypass the TAMUG campus. There were also some stakeholders that held a preference for a roadway/railroad dike structure that would require permanent closure of the existing navigation channel. This dike structure would significantly increase the project cost and development timeline. In the interest of timely vehicular bridge project development, the County, at this time, prefers to pursue funding of the vehicular bridge only and will devote further study to the possibility of a dike structure at some future date.

Pelican Island is mostly available for development, particularly development of maritime industry activities. The Port of Galveston owns about 265 acres of undeveloped land with another approximately 40 acres that could be redeveloped. The Port of Houston Authority owns approximately 1,100+ acres of undeveloped land (Figure 8); totaling about 1,400+ acres of undeveloped property. This is a large area of undeveloped land and will likely not be fully developed for many years to come, however, if the roadway access is enhanced, then the land could and likely would be developed. Again, if the roadway access ceases, then the land will likely will not be developed, but also lose tremendous value.

Figure 8 Port Owned Developable Property on Pelican Island



The maritime industry jobs per acre ratio is the foundation to projecting the jobs created and subsequent economic benefits to developing the Pelican Island maritime industries. There are several advantages to developing industries with similar industry clusters within the area; chiefly that support the existing local maritime industry and can support the new development. Pelican Island also has access to a deep-water channel for larger ships that are being used around the world. Additionally, there is easier and quicker access to the Gulf of Mexico than some of the larger ports located further inland in the Houston area. The Port of Galveston has these same competitive advantages and therefore it is assumed that, if developed, the Ports of Houston and Galveston would develop a Pelican Island maritime industry cluster like the existing Port of Galveston's maritime network. It is assumed that that cruise activity would not expand to Pelican Island and since cruise activities have a higher job per acre ratio, cruise activity was not included in the projection, as to not skew the results.

*The maritime industry jobs per acre ratio is the foundation to projecting the jobs and subsequent economic benefits to developing the Pelican Island maritime industries.*

Port of Galveston maritime (less cruise subsector) industry jobs per acre ratio includes Port of Galveston jobs in 2015 and acres developed in 2015. The Galveston County Economic Study reports the total number of direct jobs created by the Port of Galveston in 2015 was 3,912 jobs. Of these directly created jobs, the cruise subsector directly created 1,232 jobs in 2015. Therefore, all other Port of Galveston maritime industry subsectors directly created 2,680 jobs in 2015. Most of these jobs went to support the trucking, terminal operations, maritime services and longshoremen categories (Table 12).

Table 12 The Galveston County Economic Study Reported Port of Galveston Jobs

<b>The Galveston County Economic Study Reported Port of Galveston Jobs</b>	
<b>Job Categories</b>	<b>Port of Galveston Directly Created Jobs</b>
<b>Surface Transportation</b>	
Rail	71
Truck	491
<b>Maritime Services</b>	
Terminal	259
ILA	440
Tug Assist	33
Pilots	12
Agents	50
Maritime Services/Construction	555
Government (Army Corp)	25
Barge/Bunkers	322
Chandler/Surveyors	34
<b>Tenants</b>	<b>292</b>
<b>Port Authorities</b>	<b>96</b>
<b>Total</b>	<b>2,680</b>
<b>Cruise (Not Included in Ratio)</b>	<b>1,232</b>

The Port of Galveston owns about 775 acres of property that supports all if its maritime industry activities, of which about 50 acres accomodates the cruise subsector. Therefore, it takes about 725 acres to support the 2,680 jobs created by the Port of Galveston maritime industry (less cruise activity). In other words, for every 100 acres developed for maritime activities (less cruise activity) there are 370 jobs created (Table 13). This ratio is used for each job category, which is then inputted into the IMPLAN model (by category) for Galveston County.

Table 13 Port of Galveston maritime (less cruise subsector) Industry Jobs/100 Acres

Port of Galveston maritime (less cruise subsector) Industry Jobs/Acres		
Job Categories	Port of Galveston Directly Created Jobs	Jobs Created Per 100 Acres of Developed Land
<b>Surface Transportation</b>		
Rail	71	10
Truck	491	68
<b>Maritime Services</b>		0
Terminal	259	36
ILA	440	61
Tug Assist	33	5
Pilots	12	2
Agents	50	7
Maritime Services/Construction	555	77
Government (Army Corp)	25	3
Barge/Bunkers	322	44
Chandler/Surveyors	34	5
<b>Tenants</b>	292	40
<b>Port Authorities</b>	96	13
<b>Total</b>	<b>2,680</b>	<b>370</b>

The IMPLAN model was used for high, medium and low scenarios for maritime (less cruise subsector) industries developed on Pelican Island. The high scenario assumes 40% (~650 acres) of the undeveloped ports of Galveston and Houston owned land on Pelican Island will be developed. The medium scenario assumes 25% (~400 acres) of the undeveloped ports of Galveston and Houston owned land on Pelican Island will be developed. The low scenario assumes 10% (~160 acres) of the undeveloped ports of Galveston and Houston owned land on Pelican Island will be developed.

#### Jobs Created

Conservatively, if at least 10% of the undeveloped land on Pelican Island is developed like the maritime industry cluster supporting the Port of Galveston, then about 600 direct jobs will be created with an additional 290 indirect jobs; inducing about 210 jobs; totally 1,100 jobs created in Galveston County within the maritime industry. In a more aggressive scenario, if 40% of the undeveloped properties are developed, then about 2,400 total jobs will be directly created in Galveston County within the maritime industry (Table 14).

#### Top Ten Industries for Jobs Created

- Maritime Industry
- Couriers and messengers
- Real estate
- Postal service
- Services to buildings
- Employment of local govt, non-education
- Support activities for oil and gas operations
- Full-service restaurants
- Limited-service restaurants
- Warehousing and storage

Table 14 Permanent Jobs Created by Development on Pelican Island

Permanent Jobs Created by Development on Pelican Island			
Permanent Jobs	Developed @ 10%	Developed @ 25%	Developed @ 40%
Direct	600	1,500	2,400
Indirect	290	680	1,150
Induced	210	510	850
<b>TOTAL</b>	<b>1,100</b>	<b>2,690</b>	<b>4,400</b>

#### Annual Gross Domestic Product

The annual gross domestic product (GDP) for Galveston County is the sum of employee compensation, proprietor income, other property taxes, taxes on production and imports and intermediate expenditures (supplies for the products). Conservatively, if at least 10% of the undeveloped land on Pelican Island is developed, then it is projected that Galveston County will annually increase its GDP \$155 million. In the more aggressive scenario, if 40% of the undeveloped properties are developed, then it is projected that Galveston County will annually increase its GDP by \$621 million (Table 15).

Table 15 Annual GDP Increase Due to Development on Pelican Island

Annual GDP Increase Due to Development on Pelican Island			
Annual Galveston County GDP Output	Developed @ 10%	Developed @ 25%	Developed @ 40%
Direct	\$91,500,000	\$216,800,000	\$366,000,000
Indirect	\$37,600,000	\$88,900,000	\$150,200,000
Induced	\$26,400,000	\$63,600,000	\$105,600,000
<b>TOTAL</b>	<b>\$155,500,000</b>	<b>\$369,300,000</b>	<b>\$621,800,000</b>

#### Annual Taxes Collected

The annual taxes is an important metric to project. The annual taxes on payroll, production, imports, property, corporations, social security and other items are used to reinvest in public goods and services. The annual taxes collected is a sub-set of GDP. Conservatively, if at least 10% of the undeveloped land on Pelican Island is developed, then it is projected that Galveston County will receive about \$2.3 million annually in sales and property taxes; the total taxes received could be as high as \$16.7 million annually. In the more aggressive scenario, if 40% of the undeveloped properties are developed, then it is projected Galveston County will receive about \$9.1 million annually in sales and property taxes; the total taxes received could be as high as \$66.9 million annually (Table 16).

*The annual taxes collected is a sub-set of GDP.*

Table 16 Taxes Received Due to Development On Pelican Island

Taxes Received Due to Development On Pelican Island			
Annual Taxes Collected	Developed @ 10%	Developed @ 25%	Developed @ 40%
Local Sales & Property	\$2,300,000	\$5,400,000	\$9,100,000
State & Other Local	\$2,000,000	\$4,900,000	\$8,200,000
Federal	\$12,400,000	\$29,800,000	\$49,600,000
<b>TOTAL</b>	<b>\$16,700,000</b>	<b>\$40,100,000</b>	<b>\$66,900,000</b>

The enhanced access to Pelican Island could result in further development of the maritime industry (less cruise subsector) in Galveston County. If development were to have a similar mix as the Port of Galveston, then over 1,000 jobs could be created, which will in turn increase the Galveston County GDP and tax collection. Not building a new bridge would severely inhibit the opportunity to develop Pelican Island and therefore would not be realized. A new bridge could not only enhance the local economy, but also enhance the United States' global economic competitiveness.

### Global Economic Competitiveness

The World Economic Forum annually releases the *Global Competitive Index* (GCI), which assesses the global competitiveness of 138 economies through both the annual Executive Opinion Survey (14,000 business leaders from around the world) and statistical data from the agencies like the International Monetary Fund; the United Nations Educational, Scientific and Cultural Organization; and the World Health Organization. The GCI is comprised of twelve pillars that represent the overall economic global competitiveness. The pillars range from institutions, infrastructure, labor market efficiency to innovation.<sup>26</sup>

Globally, the United States ranks 10<sup>th</sup> in the quality of Port infrastructure, 13<sup>th</sup> in roadway infrastructure and 12<sup>th</sup> in overall transport infrastructure.

In 2016-2017, according to the World Economic Forum's GCI, the United States ranked in 3<sup>rd</sup> position, behind Switzerland and Singapore. The United States ranks 10<sup>th</sup> in the quality of Port infrastructure, 13<sup>th</sup> in roadway infrastructure and 12<sup>th</sup> in overall transport infrastructure; which is one

the highest weighted pillars to global economic competitiveness. Effective transportation infrastructure, including bridges (e.g. Pelican Island Causeway Bridge) that provided enhanced access to competitive deep-water ports, provide industry, in this case the maritime industry, to move their goods and services in timely and secure manner.

<sup>26</sup> World Economic Forum. *The Global Competitiveness Report 2016-2017*. Information and Data Retrieved in August 2017 from <http://reports.weforum.org/global-competitiveness-index/>.

Additionally, a new Pelican Island Causeway Bridge would provide access to the Texas A&M - Galveston Campus. This is an “ocean-oriented campus” which provides several science, engineering and business programs focusing on maritime and marine studies. Higher Education and training is the 5th pillar to a competitive global economy. The United States ranked 8<sup>th</sup> in the Higher Education category, but ranked 33<sup>rd</sup> in the quality of math and science education sub category. Improving the quality of the math and science program within the United States will allow the U.S. to move up the global value-added chain beyond simple tasks to more complex tasks. A new Pelican Island Causeway Bridge would ensure continued access to a top-notch secondary institution that focuses on educating the workforce in complex maritime and marine sciences.

The World Economic Forum summarized the United States as follows

“The position of the United States is driven by innovation, business sophistication, market size, financial market development, labor market efficiency, and higher education and training. These findings highlight important challenges if the country is to remain in the top 10 over the long term, and possible bottlenecks indicating the supply-side constraints that are holding back progress and reducing the effectiveness of monetary policy for jump-starting growth.”<sup>27</sup>

In other words, the lack of production in the United States economy is unable to keep up with demand due to a variety of factors; including inadequate infrastructure. A new Pelican Island Causeway Bridge would significantly enhance a piece of the United States transportation infrastructure and provide long-term access to deep water channels and a top-notch science focus institution. By improving transportation infrastructure and enhancing access to undeveloped properties, that could easily develop into maritime (Port) industry activities and higher education facilities, the United States global economic competitiveness would strengthen.

## Quality of Life Benefits

According to the USDOT Notice of Funding Opportunity for TIGER 2016, *Increasing transportation choices and improving access to essential services for people in communities across the United States, particularly for disadvantaged groups* [is an indicator of improved quality of life].<sup>28</sup> To assess if a project enhanced the quality of life of the community, the USDOT assesses the projects

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<sup>27</sup> World Economic Forum. *The Global Competitiveness Report 2016-2017 United States Profile*. Information and Data Retrieved in August 2017 from <http://reports.weforum.org/global-competitiveness-index/country-profiles/#economy=USA>.

<sup>28</sup> United States Department of Transportation. *Notice of Funding Opportunity for the Department of Transportation's National Infrastructure Investments Under the Consolidated Appropriations Act, 2016*. Retrieved in June 2017 from <https://www.transportation.gov/sites/dot.gov/files/docs/2016%20TIGER%20NOFO%20FR.pdf>.

through the lens of the six livability principles derived from the Livability Partnership. The Livability Partnership brings together the US Housing and Urban Development, DOT, and Environmental Protection Agency to plan for communities that are efficient consumers of housing, transportation, and energy use. The Livability Partnership has adopted the following six principles to guide its mission:<sup>29</sup>

- **“Provide more transportation choices.** *Develop safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health.*
- **Promote equitable, affordable housing.** *Expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.*
- **Enhance economic competitiveness.** *Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well as expanded business access to markets.*
- **Support existing communities.** *Target federal funding toward existing communities—through strategies like transit-oriented, mixed-use development and land recycling—to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes.*
- **Coordinate and leverage federal policies and investment.** *Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy*
- **Value communities and neighborhoods.** *Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods—rural, urban, or suburban.”*

The Livability Partnership focuses on several different policies, such as environment, housing and transportation. As such, not all transportation projects will further the principles outlined by the partnership.

The USDOT further defined Livability Partnership principles through the lens of transportation via

#### Ladders of Opportunity Principles

Connect

Work

Revitalize

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<sup>29</sup> United States Environmental Protection Agency. *HUD-DOT-EPA Partnership for Sustainable Communities*. Retrieved in June 2017 from [https://19january2017snapshot.epa.gov/smartgrowth/hud-dot-epa-partnership-sustainable-communities\\_.html#Principles](https://19january2017snapshot.epa.gov/smartgrowth/hud-dot-epa-partnership-sustainable-communities_.html#Principles).

the Ladders of Opportunity Initiative. The Ladders of Opportunity Initiative seeks to invest in transportation projects that “create a workforce opportunity to lift more Americans into middle class” through projects that **connect** people with employment, education and other essential services, **create jobs** and transportation infrastructure that **revitalize** communities by bringing development and services and residential communities closer together.<sup>30</sup> Galveston County has an opportunity to leverage this focus to improve its overall quality of life to residents by providing better connectivity to jobs, education and parks, creating short term jobs and providing transportation infrastructure to spur long-term job creation and bringing these jobs and opportunities closer to traditionally disadvantaged populations.

### Connect - Choices for Traditionally Disadvantaged Populations Benefits

One of the primary goals of a new Pelican Island Causeway Bridge is to provide safe, reliable and economical access between disadvantaged populations to the popular Seawolf County Park, existing and future potential maritime industry, and Texas A-M Galveston Campus. The H-GAC uses primary and secondary indicators to determine if a population is an “environmental justice” (EJ) population as defined by Executive Order 12898 and regional policy.<sup>31</sup> The goal of an EJ assessment is to ensure projects are not disproportionately effecting EJ populations. However, transportation projects can also have beneficial impacts to EJ populations; such as providing access to park, education and labor markets.

Without a new Pelican Island Bridge the Galveston area EJ populations would possibly need to travel longer distances to the Galveston mainland (which increases transportation costs) to access needed education, recreational and employment activities.

Both the EO 12898 and H-GAC define minority populations and low-income (below poverty level) populations as primary indicators of EJ populations. H-GAC defines an area of high concentration as an area that is one standard deviation above the regional average; which is

- Minority Population areas > 60%
- Low-Income (below poverty) Persons > 24.95%

The Pelican Island Causeway Bridge would primarily provide enhanced access to parks, education and current and potential future maritime industry to the direct impact area residents (due to

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<sup>30</sup> United States Department of Transportation. Ladders of Opportunity Summary. Retrieved in August 2017 from <https://www.transportation.gov/sites/dot.gov/files/docs/Opportunities%20Agenda%20Fact%20Sheet%2011.2016.pdf>.

<sup>31</sup> Houston-Galveston Area Council. 2040 Regional Transportation Plan. Appendix B Environmental Justice Analysis. Retrieved in May 2017 from <https://www.h-gac.com/taq/plan/2040/docs/Appendix%20B%20Environmental%20Justice.pdf>.

proximity) and secondary impact area; Galveston County mainland residents. Twenty percent (four (4) of 20) census tracts in the study area (Figure 9 & Figure 10) are above both primary indicators high concentration threshold and (nine (9) of 20) 45% are either above the minority population or the low-income indicators. The direct impact area’s average minority population is 56.8% and the low-income households is 23.8%, nearing the high concentration thresholds.

Figure 9 Minority Population Concentrations

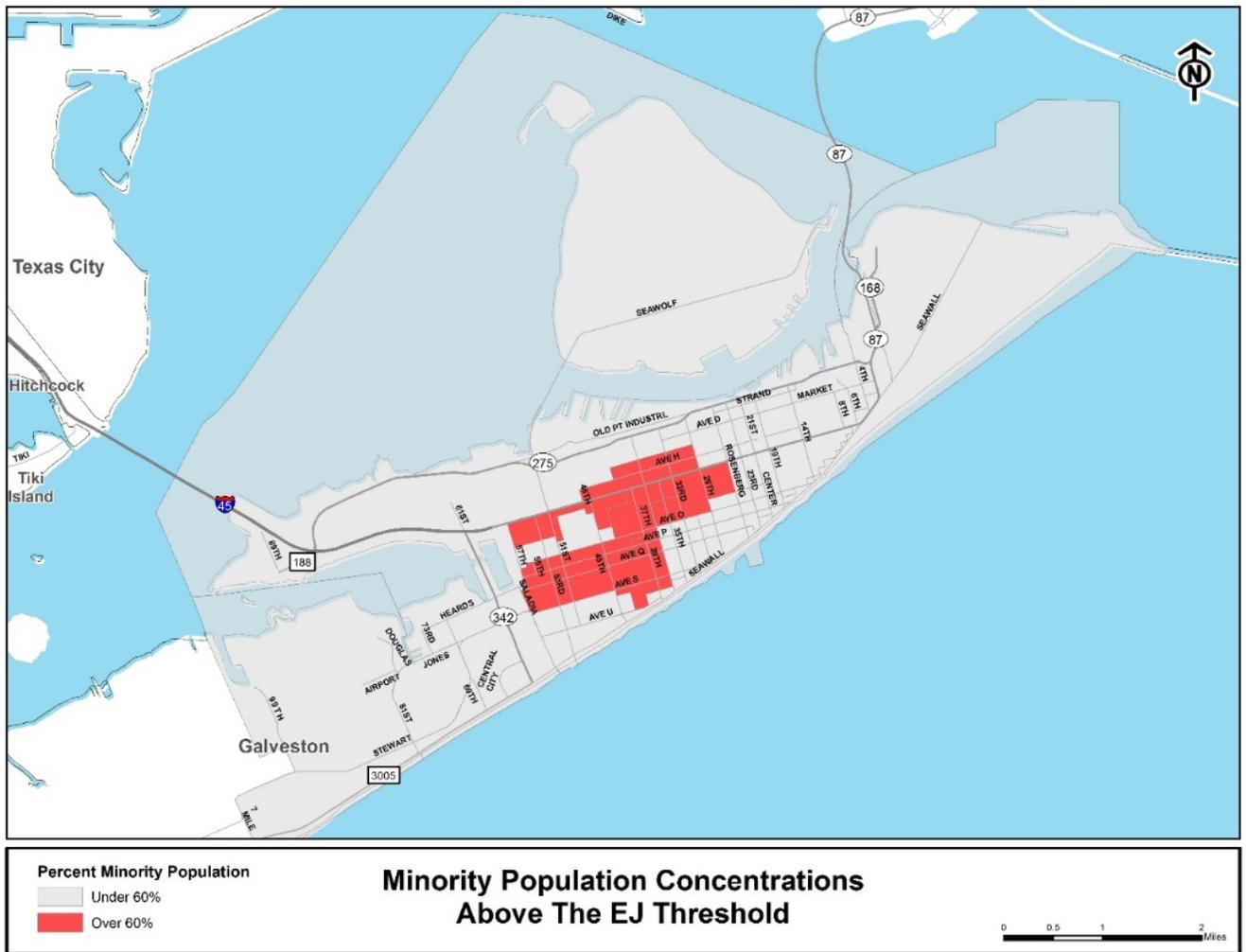
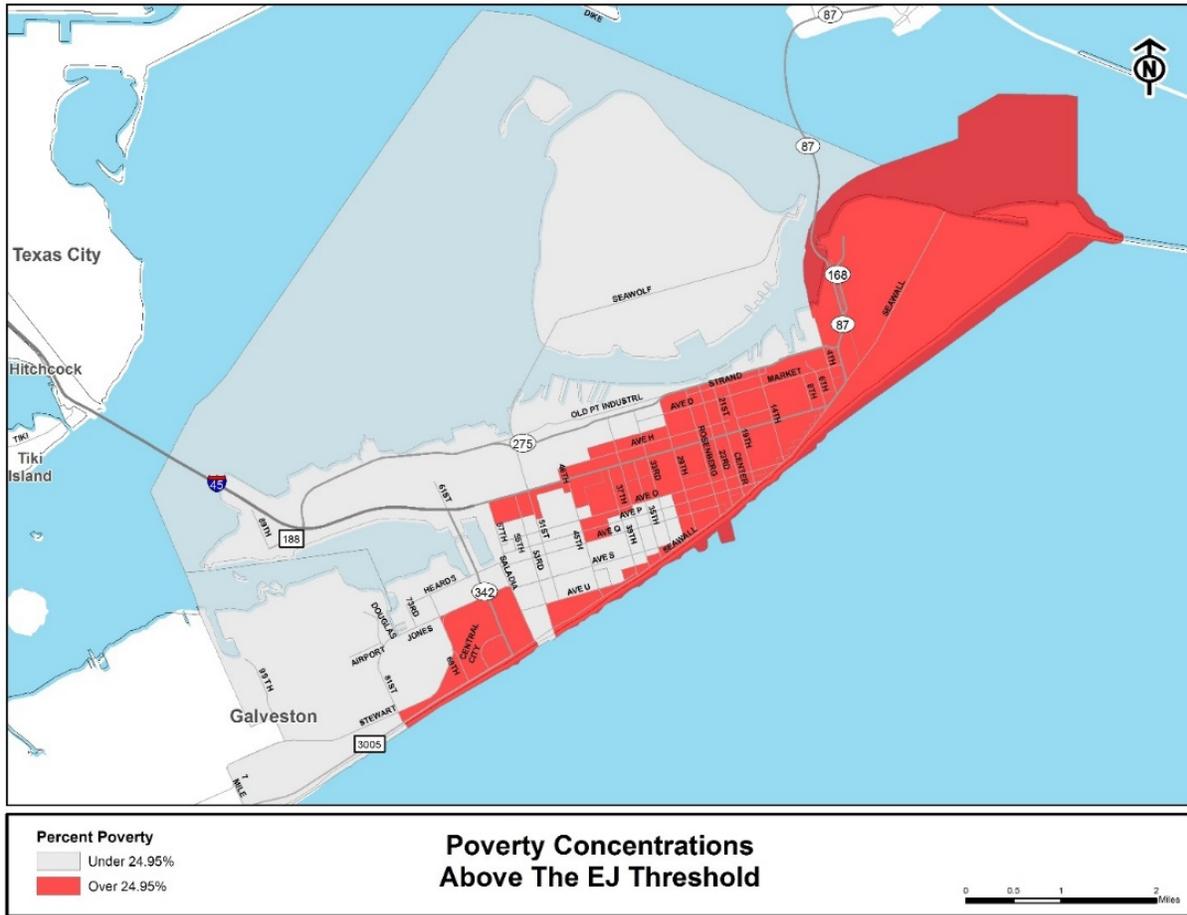


Figure 10 Poverty Concentrations



The entire direct impact area may not reach the EJ high concentration threshold as a whole, but the areas with low-income rates far exceed the regional, state of Texas, and national averages. Additionally, the study area is denser than the regional, state of Texas, and national averages (Table 17). Without a new Pelican Island Causeway Bridge, a dense area of EJ populations would possibly need to travel longer distances to the Galveston County mainland (which increases transportation costs) to access needed education, recreational, and employment activities. A new Pelican Island Causeway Bridge would ensure these dense areas of EJ populations would have safe, reliable, and economical access for years to come.

## Minority and Low Income Rates

Geographic Area	Density <sup>32</sup> (Pop/sq. Mi.)	Share of Low-Income HHs <sup>33</sup>	Share of Minorities <sup>34</sup>
United States	89	15.5%	37.7%
State of Texas	101	17.3%	56.2%
HGAC Region	4,326	15.7%	61.5%
<b>Study Area</b>	<b>5,208</b>	<b>23.7%</b>	<b>56.6%</b>

Table 17 Minority and Low-Income Rates

## Work – Creating Jobs

\*See Section E Economic Benefits for how a new Pelican Island Causeway Bridge would *create short term jobs and provide opportunities for long-term job creation.*

## Revitalize – Closing the Barriers

The direct impact areas’ population is nearly 25% low-income or in poverty. This is nearly 10% higher than the regional average. Additionally, the direct impact area has a significantly higher share of households without an automobile than the U.S., region and state (Table 18) (Figure 11), which is another indicator of populations that rely on shorter travel distances for employment, services and recreation. The 2009 National Highway Travel Survey showed that individuals in poverty have the greatest rate of bike and pedestrian trips – about 50% higher than non-poverty persons.<sup>35</sup> The current bridge is, simply put, unsafe and uninviting for bicyclist and pedestrians and therefore limiting access to a large portion of the direct impact areas’ population to education, parks and current maritime industrial activity jobs.

Table 18 Share of Households without an Automobile

## Share of Households without an Automobile

<sup>32</sup> United States Census Bureau. “2011-2015 American Community Survey 5-Year Estimates” Tables S0101 & G001. Retrieved in July 2017 from <https://factfinder.census.gov/>.

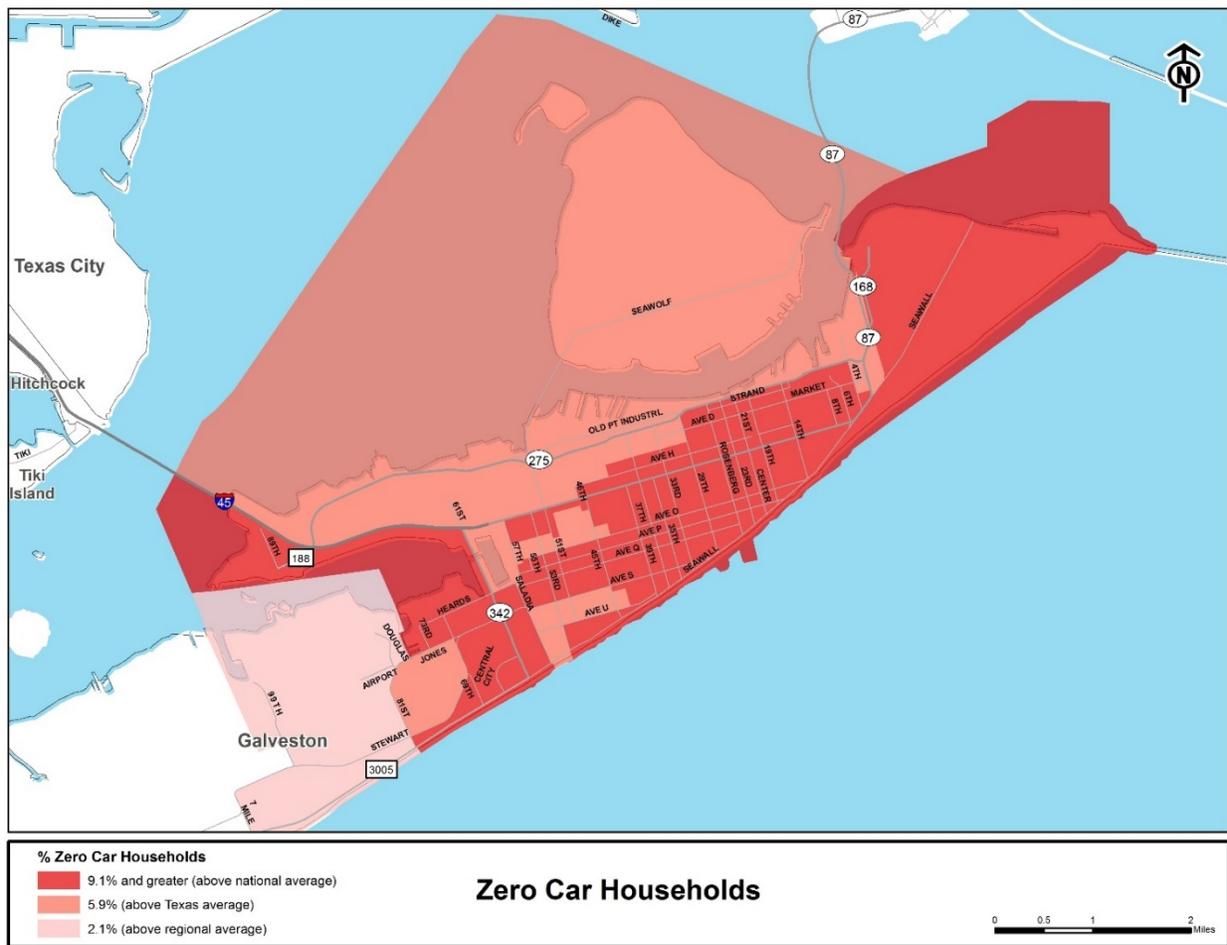
<sup>33</sup> United States Census Bureau. “2011-2015 American Community Survey 5-Year Estimates” Table S1701. Retrieved in July 2017 from <https://factfinder.census.gov/>.

<sup>34</sup> United States Census Bureau. “2011-2015 American Community Survey 5-Year Estimates” Table DP-05. Retrieved in July 2017 from <https://factfinder.census.gov/>.

<sup>35</sup> United States Department of Transportation Federal Highways 2014. *Mobility Challenges for Households in Poverty*. Retrieved in August 2017 from <http://nhts.ornl.gov/briefs/PovertyBrief.pdf>.

Geographic Area	% of HHs without an Automobile <sup>36</sup>
United States	9.1%
State of Texas	5.8%
HGAC Region	2.1%
<b>Study Area</b>	<b>16.0%</b>

Figure 11 Zero-Automobiles Available Population Concentrations



A new Pelican Island Causeway Bridge would create a safe crossing for bicyclists and pedestrian to access the educational, recreational, and employment services (current and future) for all residents, including the lower-income and/or no vehicle available residents. Not only would a new bridge close the gap to a transportation barrier, but it would also promote public health in the direct impact area.

<sup>36</sup> United States Census Bureau. “2011-2015 American Community Survey 5-Year Estimates” Table B25044. Retrieved in July 2017 from <https://factfinder.census.gov/>.

Public health focuses on improving a population’s physical, mental, and social well-being. Public health and public transportation share goals such as the reduction in air pollutants (see section E. Sustainability Benefits), prevention and injuries or deaths related to traffic accidents (see section A. Safety Benefits), and improved physical and mental health.

The Center for Disease Control (CDC) reports that physical activity is a major contributor to better health. The CDC recommends at least 2.5 hours of moderate-intensity aerobic exercise (brisk walking) every week and muscle-strengthening on two or more days a week that work all major muscle groups. The health benefits from physical activity include weight control, stronger bones and muscles, better mental health and mood, more ability to do daily activities, longer life and reduction to the risks for cardiovascular disease, type 2 diabetes and metabolic syndrome, and some cancers.<sup>37</sup>

A new bridge would enhance the opportunity for additional recreation and access to Pelican Island which would help eliminate barriers to move up the economic ladder and aide in bettering overall public health of the community.

### **Sustainability Benefits**

The United States Environmental Protection Agency (EPA) has classified the Houston-Galveston-Brazoria area in severe nonattainment of the eight-hour ozone standard. In other words, the Houston-Galveston-Brazoria air quality does not meet federal air quality standards. This investment in infrastructure that would produce environmental benefits due to reduction in harmful air pollutants are top priority for areas in nonattainment. The H-GAC models the following harmful air pollutants, at various speeds and idling times: Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), Carbon Monoxide (CO). The Environmental Protection Agency has set emission standard for maritime vessels for the following harmful air pollutants: Particulate Matter (PM), NOx, and Hydrocarbon (HC). In order, to adequately evaluate the emissions delta between the No-Build and Build scenarios, NOx was the only emissions factor evaluated.

### **NOx Emissions**

Nitrogen Oxide are a mixture of gases that composed of nitrogen and oxygen. This mixture can form nitric oxide and nitrogen dioxide. These gases contribute to “bad” ozone; aka smog. The combination of NOx and VOC with sunlight causes smog. Smog can irritate the respiratory

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<sup>37</sup> Centers for Disease Control and Prevention. *Physical Activity*. Retrieved in June 2017 from <http://www.cdc.gov/physicalactivity/everyone/health/index.html>.

system, reduce lung function, aggravate asthma and damage the lungs.<sup>38</sup> In 2016, The Houston-The Woodlands-Sugarland had 107 Ozone days; with 22 in the orange and one in the red categories, which was the most in Texas in 2016.<sup>39</sup> NOx is emitted from the exhausts of motor vehicles, boats, planes, rail and lawn mowers and therefore reducing these activities will reduce the smog in the Houston area.

#### No Build Scenarios - NOx Emissions

The No-Build scenario would continue to maintain and operate the Pelican Island Causeway Bridge until approximately 2035 and at which point a ferry system may need to be implemented. Between 2017 and 2035, the NOx emission would be directly contributed by the annual vehicle mile traveled at an average speed of 40 mph, in addition to 5 percent of the annual vehicle miles traveled at 2.5 mph (due to bridge openings). Between 2035 and 2040 (and beyond the study horizon), the NOx emissions would be derived by the four to five ferry boats making a total of about 100 trips daily, 365 days per year.

H-GAC provides the NOx (g/mi.) for various roadway types, time of day and vehicle. The grams of NOx emitted per VMT in 2017 for a non-truck composite vehicle traveling 40 mph along an arterial (averaged 24-hr rate) is 0.91 g/mi and for a heavy truck is 1.37 g/mi. The grams of NOx emitted per VMT in 2018 for a non-truck composite vehicle traveling 2.5 mph along an arterial (averaged 24-hr rate) is 1.64 g/mi and for a heavy truck is 2.14 g/mi (Table 19). Due to cleaner burning vehicles, these emissions rates decrease about 8%-9% annually until 2025, when the rates tend to level off.

Table 19 No Build NOx (g/mi.) Emission Rates

No Build NOx (g/mi.) Emission Rates		
2018 NOx Emission Factor (24hr average along arterial)	Non-Truck	Truck
Speed – 2.5 MPH	1.37 g/mi	2.14 g/mi
Speed – 40 MPH	0.91 g/mi	1.64 g/mi

The annual VMT, is the total AADT (average about 9,700) multiplied by the miles driven, in this case 1.25 miles at 40 mph and .15 miles at 2.5 mph (about 5% of the AADT). Using the emission factors provided by H-GAC and the assumptions used for AADT and VMT, the total NOx emitted would be about 1.87 tons per year until 2035.

<sup>38</sup> United States Environmental Protection Agency. *Smog—Who Does It Hurt?*. Retrieved in August 2017 from <https://www3.epa.gov/airnow/health/smog.pdf>

<sup>39</sup> Environment Texas. Preliminary data from U.S. Environmental Protection Agency on ozone (smog) and particulate (soot) pollution in Texas metro areas in 2016. Retrieved in August 2017 from <http://environmenttexas.org/resources/txe/2016-epa-air-quality-data-texas-metro-areas>.

After year 2035, the number of trips would likely decrease by 50% and a ferry system could move these trips and thereby the total NOx emitted would be the ferry emissions subtracted by the vehicle emissions no longer driving this segment. Ferry vessel emission rates are derived from the United States Code of Federal Regulations Title 40 Chapter I Subchapter U Part 1042.101 Tier 4 Standards for Category 2 and Commercial Category 1 Engines at or Above 600kW, which is 1.8 NOx (g/kW-hr). Assuming the federal government does not apply more strict standards between now and 2035, then the ferries needed would like emitted 1.8 NOx (g/kW-hr). The calculation for kW-hrs is as follows, with assumptions shown in Table 20.

Equation 5 KW-Hrs Generated by Ferry

$$kW\text{-hrs} = (DS / SV) \times (SL \times [WTV / 7]) \times kWV$$

Table 20 Assumptions for Calculating kW-Hrs Generated.by Ferry

Assumptions for Calculating kW-Hrs Generated.by Ferry		
Where:	Assumption	Basis
DS = distance of segment S in nautical miles between the start and end ports	0.5	Mapping
SV = typical speed of vessel V in knots – average	12.5	Speed of Bolivar system
SL = length of the ferry season in days	365	Based on demand
WTV = number of trips made in a week for vessel V	100	2 trips per hour per vessel (4) – about 12-14 hours of operation.
kWV = kW rating of main engines for vessel V	3,355	Bolivar Ferries rating (national average is 3,087)

Using the formula provided by the EPA to determine annual kW-Hrs, the total annual Kw-Hrs for the ferry system will be about 4.89 million Kw-Hr, which equates to about 8 tons of NOx emitted annually. Throughout the study horizon the NOx emitted in the No-Build Scenario would be about 3.41 tons per year, with a sharp increase in 2035.

#### Build Scenarios - NOx Emissions

The Build scenarios would significantly enhance the design of the current bridge. Traffic would not be stopped by the opening of the bridge and would travel at about 60 mph. The NOx emission would be directly contributed by the annual vehicle mile traveled at an average speed of 60 mph. The grams of NOx emitted per VMT in 2017 for a non-truck composite vehicle traveling 60 mph along an arterial (averaged 24-hr rate) is 1.27 g/mi and for a heavy truck is 2.22 g/mi. Due to cleaner burning vehicles, these emissions rates decrease about 8%-9% annually until 2025, when the rates tend to level off (Table 21).

Table 21 No Build NOx (g/mi.) Emission Rates

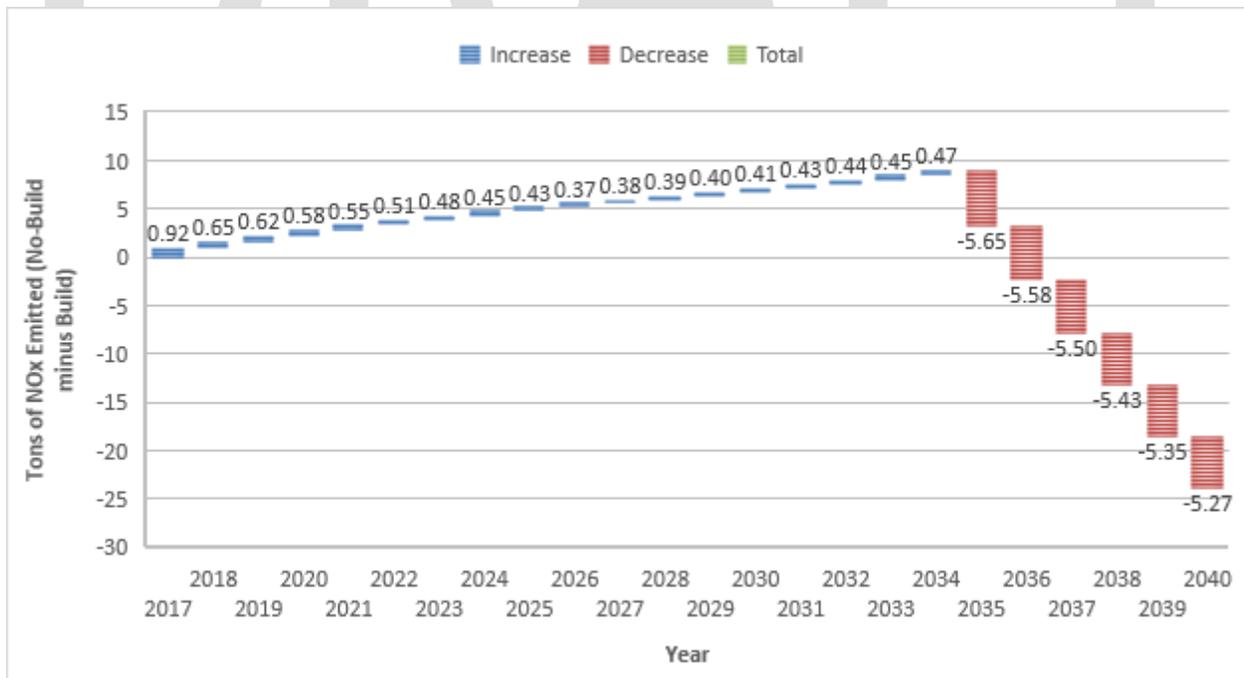
No Build NOx (g/mi.) Emission Rates		
2018 NOx Emission Factor (24hr average along arterial)	Non-Truck	Truck
Speed – 60 MPH	1.27 g/mi	2.22 g/mi

The annual VMT, is the total AADT (average about 9,700) multiplied by the miles driven, in this case 1.25 miles at 60 mph. Using the emission factors provided by H-GAC and the assumptions used for AADT and VMT, the total NOx emitted would be about 2.41 tons per year throughout the study horizon and beyond.

### NOx Emissions Reduction - Monetized

The No-build Scenario would contribute about 3.41 tons NOx per year and either Build Scenario would contribute about 2.41 tons of NOx per year. The net reduction between the No-Build and Build Scenarios is about 0.94 tons per year or 23.85 tons throughout the horizon year. It is important to note, due to cars emitting less NOx at 40 mph than 60 mph, the No-Build Scenario would contribute less NOx emissions until 2035, when the ferry system could be implemented (Figure 12).

Figure 12 Tons of NOx Emitted



Additionally, NOx has a measurable societal economic impact on the economy. The USDOT BCA Guidance for TIGER Applicants provides recommended monetized values for NOx (\$8,797 per metric ton in 2017\$ and annually inflated 2.8% thereafter). This value was used to calculate the

both Build Scenarios benefits derived from the reduction of harmful air pollutants. Accumulated benefits from 2020 to 2040 are summed up and discounted at a 3% and 7% rate.

**Build Option A & B - Monetized NOx Emission Savings**  
**\$410,000 (2017\$) & \$200,000 (2017\$ Dis. @ 3%) & \$70,000 (2017\$ Dis. @ 7%)**

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## Summary of Monetized Benefits

As previously stated, not all benefits can be quantified. When they can be quantified, they can also often be monetized. The input values used in the following analysis are taken from the US DOT guidance on the preparation of benefit/cost analyses, including the recently published guidelines for the TIGER Notice of Funding Announcements and Houston-Galveston Area Council Call for Projects for the 2015 Transportation Improvement Plan. Where the U.S. DOT has not provided valuation guidance or a reference to guidance, standard industry practices and recent research have been applied (Table 22).

Table 22 Monetization Values and Sources

Monetization Values and Sources			
Factor	Unit	Unit Monetized Value	Source
<b>SAFETY</b>			
Accident Reduction	Share of value of statistical life	\$10,274,490	Citation 9
<b>STATE OF GOOD REPAIR</b>			
Replacing Infrastructure	Operating and maintenance costs of current and new bridge	\$750,000 annually	Galveston County Navigation District and TxDOT
<b>ECONOMIC</b>			
Agency Benefit (Net, less SOGR)	Capital cost of new bridge Capital and operating cost of ferry system (\$2017)	No-Build: \$157 million Build A: \$63 million Build B: \$121 million	Pelican Island and Vehicular Access Feasibility Study 2015 & Citations 15 & 16
Travel Time Savings	Hours (\$2017)	Auto - \$19.97 Freight - \$66.27	Citations 17 & 20
Local Economic Stimulus	Total GDP	Various depending on job type created	Citation 21
<b>SUSTAINABILITY</b>			
NOx Savings	Metric Tons	\$8,797 (\$2017)	Citation 9

## Benefits Monetized

The goal to any project is to have a benefit-cost ratio (B/C) above 1, which means the benefits outweigh the costs. Assuming a very conservative seven percent (7%) discount rate, Build A scenario's \$57 million in discounted project construction and life cycle costs generates over \$97 million in net benefits, or a benefit-to-cost ratio of 1.6 to 1. Assuming a seven percent (7%) discount rate, Build B scenario's \$110 million in discounted project construction and life cycle costs generates over \$121 million in net benefits, or a benefit-to-cost ratio of 1.1 to 1 (Table 23)

Assuming a modest three percent (3%) discount rate, Build A scenario’s \$70 million in discounted project construction and life cycle costs generates \$196 million in net benefits, or a benefit-to-cost ratio of 2.8 to 1. Assuming a three percent (3%) discount rate, Build B scenario’s \$134 million in discounted project construction and life cycle costs generates over \$233 million in net benefits, or a benefit-to-cost ratio of 2.1 to 1.(Table 24).

Table 23 Benefit Cost Ratio – 7% Discount

<b>Benefit Cost Ratio – 7% Discount</b>		
<b>Factor</b>	<b>Build A</b>	<b>Build B</b>
<b>SAFETY</b>		
Accident Reduction	\$6,300,000	\$6,300,000
<b>STATE OF GOOD REPAIR</b>		
Replacing Infrastructure	\$6,400,000	\$6,400,000
Residual Life	\$13,000,000	\$25,100,000
<b>ECONOMIC</b>		
Agency Benefit (Net, less SOGR)	\$13,500,000	(\$39,300,000)
Travel Time Savings	\$8,000,000	\$8,000,000
Local Economic Stimulus	\$47,100,000	\$109,800,000
<b>SUSTAINABILITY</b>		
NOx Savings	\$70,000	\$70,000
<b>TOTAL BENEFITS</b>	<b>\$94,370,000</b>	<b>\$116,370,000</b>
Capital Costs	\$57,060,000	\$109,820,000
Operating Costs	\$220,000	\$220,000
<b>TOTAL COSTS</b>	<b>\$57,280,000</b>	<b>\$110,040,000</b>
<b>BCA RATIO</b>	<b>1.6</b>	<b>1.1</b>

Table 24 Benefit Cost Ratio – 3% Discount

<b>Benefit Cost Ratio – 3% Discount</b>		
<b>Factor</b>	<b>Build A</b>	<b>Build B</b>
<b>SAFETY</b>		
Accident Reduction	\$10,600,000	\$10,600,000
<b>STATE OF GOOD REPAIR</b>		
Replacing Infrastructure	\$9,800,000	\$9,800,000
Residual Life	\$27,900,000	\$53,700,000
<b>ECONOMIC</b>		
Agency Benefit (Net, less SOGR)	\$79,300,000	\$14,900,000
Travel Time Savings	\$13,200,000	\$13,200,000
Local Economic Stimulus	\$53,200,000	\$126,000,000
<b>SUSTAINABILITY</b>		
NOx Savings	\$200,000	\$200,000
<b>TOTAL BENEFITS</b>	<b>\$194,200,000</b>	<b>\$228,400,000</b>
Capital Costs	\$69,700,000	\$134,100,000
Operating Costs	\$400,000	\$400,000
<b>TOTAL COSTS</b>	<b>\$70,100,000</b>	<b>\$134,500,000</b>
<b>BCA RATIO</b>	<b>2.8</b>	<b>1.7</b>

## Recommendation

A new Pelican Island Causeway Bridge would further develop the mission of the Galveston Economic Development Department. If the bridge were to fail and shut down, then there would be significant loss of economic and recreational opportunities and access to the already invested infrastructure on Pelican Island. In order to not lose access to industry, education and recreational uses on Pelican Island, people would need to move from the Galveston Island and mainland to Pelican Island and therefore there either must be a new bridge (build scenarios) or a ferry system in place (No Build Scenario) The *Pelican Island Causeway Bridge Benefit Cost Analysis* shows that either Build Scenario A or Scenario B would provide::

### Top Reasons to Invest in New Bridge Now

- Eliminate safety risks posed by the current outdated bridge
- Reduce annual maintenance costs
- Not lose significant purchasing power
- Provide developers with security that a new bridge will be built; and
- Provide a significant local economic stimulus.

- Significant **safety** benefits, by
  - Reducing about 4 to 5 crashes annually; and
  - Replacing an old outdated bridge to avoid a catastrophic event.
- Robust **state of good repair** benefits; by
  - Saving the long-term maintenance costs (\$750,000 annually and periodic large rehabilitation capital infusion).
- Substantial **economic** benefits; by
  - Building now to ensure purchasing power does not decrease (5 percent annually);
  - Not implementing and operating an expensive ferry system (inflated to \$2035 - 160 million capital and \$17 million annual operating cost);
  - Creating between 180 and 350 jobs during the three-year construction period;
  - Infusing about \$30 million to \$56 million dollars into the local Galveston County economy during the three-year construction period;
  - Providing significantly improved transportation access to hundreds of acres undeveloped land that can support maritime industries, which if only a mere 10% of the land is developed, like the Port of Galveston mixed use, then the economic output could be up to an additional 1,100 jobs, an annual increase in \$155 million dollars to the Galveston County economy and over \$2.3 million dollars in local taxes collected by Galveston County and another \$14 million in taxes collected for other government entities;
  - Enhancing the United States economic global competitiveness. The United States ranks 10<sup>th</sup> in the quality of Port infrastructure, 13<sup>th</sup> in roadway infrastructure and 12<sup>th</sup> in overall transport infrastructure and any major infrastructure improvements could only enhance the ranking and overall economic competitiveness of the United States.

- Improve quality of life; by
  - Creating more employment, educational and recreational access to traditionally disadvantage populations, much like many of the residents of Galveston Island;
  - Creating jobs for the traditionally disadvantage populations; and
  - Revitalizing communities through transportation infrastructure that closes barriers to access for persons that are low-income and/or don't own an automobile and Galveston Island has a very high rate of non-auto ownership.
- Better the environment through **sustainability** benefits; by
  - Reducing harmful air pollutants, such as Nitrogen Oxides (NOx). Both build scenarios would emit about 0.94 tons less per year, with a gap between no-build and build significantly increasing after a ferry system would be needed.

Investing in a new Pelican Island Causeway Bridge provides significant qualitative and quantitative benefits. The investment should occur as soon as possible to eliminate the safety risks posed by the current outdated bridge, reduce annual maintenance costs, not lose significant purchasing power, provide developers with security that a new bridge will enhance access to undeveloped land, and provide a local economic stimulus to Galveston County and the region.

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