Dunedin Causeway Bridge Project Development

Dunedin, FL

A. Benefit-Cost Analysis Technical Memorandum

Bridge Investment Program (BIP)
Grant Application

SEPTEMBER 2022

Contact

Pinellas County Board of County Commissioners

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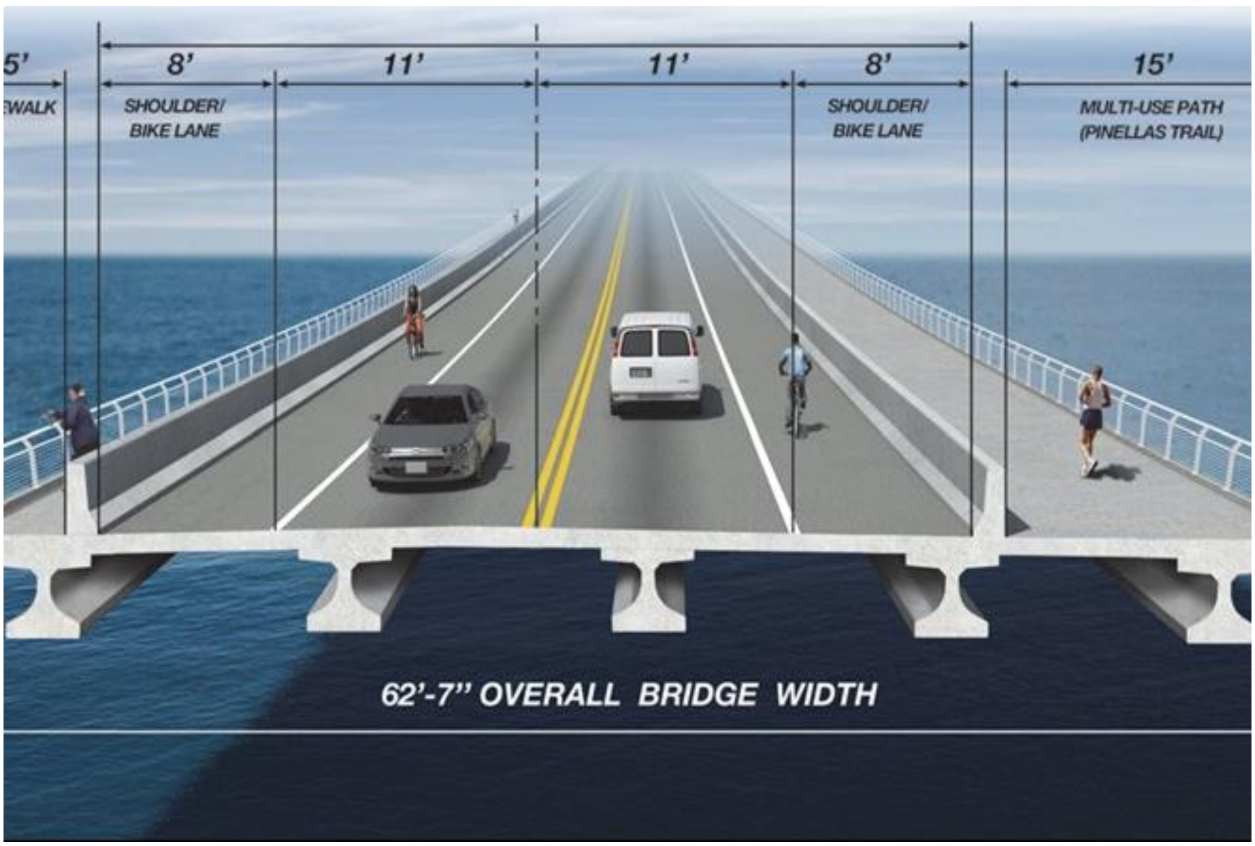
DUNEDIN CAUSEWAY BRIDGE PROJECT DEVELOPMENT

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION



FY2022 BRIDGE INVESTMENT PROGRAM DISCRETIONARY GRANT PROGRAM

PREPARED FOR: PINELLAS COUNTY, FLORIDA
SEPTEMBER 8, 2022

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Executive Summary

A benefit-cost analysis (BCA) was conducted for the Dunedin Causeway Bridge Project (the project) for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the 2022 Bridge Investment Program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in March 2022. The period of analysis corresponds to 36 years and includes 6 years of construction and 30 years of benefits after operations begin in 2029.

The project includes the replacement of a movable bridge in Pinellas County, Florida connecting Dunedin and Honeymoon Island. When the current bridge exceeds its useful life, it will be limited in its service: emergency response vehicles and school buses will be barred from using the bridge, impacting east-west travel in a dense residential community. With more than 1.6 million visitors each year, the lack of emergency response capabilities, will pose a significant issue; the new bridge reconstruction will bring significant benefits to the community by providing emergency medical services (EMS) access to the island. The new bridge will have a design life of 75 years and meet all applicable design standards. It would meet the needs of all traffic, including bike and pedestrian facilities that are not located on the existing bridge. Emergency response times for a select number of cardiac arrest responses will drastically decrease, thereby increasing likelihood of survival.

COSTS

The capital cost for this Project is expected to be $68.7 million in undiscounted 2020 dollars through 2028.[1] At a seven percent real discount rate, these costs are $45.1 million. Table ES-1 shows how these costs are allocated across time and major expense category.

Table ES-1: Project Costs by Category and Year, in Undiscounted millions of 2020 Dollars

Cost Category	2023	2024	2025	2026	2027	2028	Total
Planning and Design	$2.43	$2.37					$4.80
Right of Way							
Construction			$16.57	$16.16	$15.76	$15.37	$63.86
Total	$2.43	$2.37	$16.57	$16.16	$15.76	$15.37	$68.66
Total, Discounted 7%	$1.98	$1.81	$11.82	$10.77	$9.81	$8.94	$45.13

Source: 2020 PD&E

In addition to the upfront capital cost, operations and maintenance (O&M) costs are projected to average $0.225 million per year in the long term. This is an annual reduction of $75,000 compared to the expected $0.3 million per year in annual maintenance for the no-build. However, because the no-build has an end-of life period of 15 remaining years starting in 2020, the build case assumes negative benefits (a higher net difference in O&M between the no-build and build scenarios) for O&M from 2036 until the end of the analysis period in 2058. Over the entire 30-year analysis period these costs accumulate to -$4.7 million in undiscounted 2020 dollars, or -$0.7 million when discounted at seven percent. Assumptions for rehabilitation and replacement (R&R) costs were not specifically calculated, although benefits related to reduced displacement and damage costs associated with the build scenario's climate resilient design were taken into consideration as a resilience benefit.

[1] Note that these costs differ from those reported in the Project Narrative due to the use of 2019 dollars rather than year-of-expenditure dollars.

BENEFITS

In 2020 dollars, the Project is expected to generate $115.3 million in discounted benefits using a seven percent discount rate. Given that the Dunedin Causeway is the only connection between Honeymoon Island State Park, one of the most-visited state parks in the state, the majority of these benefits stem from visitors' willingness to pay for ecosystem services and recreational value associated with user fees at the park, and the benefit of EMS access to provide medical support for outside hospital cardiac arrest events. Home to over 1,500 residents, the build scenario avoids costs associated with property buyouts for residential property owners on the island, who would have to relocate after 2036 in the no-build scenario due to bridge closure. Additional resilience benefits were calculated based on reduced displacement and damage costs between the build and no-build scenario due to anticipated storm surge impacts exacerbated by climate change. Improvements to cycling and pedestrian infrastructure, as well as time savings for the residential community on the island round out other major monetized benefits. This leads to an overall project Net Present Value of $70.2 million and a Benefit Cost Ratio (BCR) of 2.6[2]. The overall project benefit matrix can be seen in Table ES-2.

Table ES-2: Project Impacts and Benefits Summary, Monetary Values in Millions of 2020 Dollars

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impact	Population Affected by Impact	Economic Benefit	Summary of Results (at 7% discount rate)	Page Reference in BCA Appendix
Current Bridges will be no longer functional in a 15-year period (from 2020)	The replacement of two bridges along the Causeway maintains Honeymoon Island access	Willingness to Pay for Honeymoon Island State Park, which had over 1.6 million visitors in 2020	Recreational users of the park	Facility Amenities, as evaluated by park user fees that would not be collected in no-build	$31.6	11
Current Bridges will be no longer functional in a 15-year period (from 2020)	The replacement of two bridges along the Causeway maintains Honeymoon Island access	Emergency Access is maintained for residents and visitors, avoiding deaths from prolonged emergency service response times	Approx. 1,500 residents on Honeymoon Island plus over 4,000 daily visitors to Honeymoon Island State Park	Avoided deaths from out-of-hospital cardiac arrest	$40.0	10
Current bridges have substandard bike and pedestrian facilities,	New bridges will expand bike/ped facilities including a 15' multi-use path,	Conditions will induce more cycling and biking trips, helping to encourage	Number of annual cyclists/ pedestrians will expand from 34,000	Active Transportation and Heath Benefits	$3.7	10

[2] Per USDOT guidance, operations and maintenance costs are included in the numerator along with other project benefits when calculating the benefit-cost ratio.

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impact	Population Affected by Impact	Economic Benefit	Summary of Results (at 7% discount rate)	Page Reference in BCA Appendix
including a 6' multi-use path and a 3 ½' sidewalk	5' sidewalk, and two 8' shoulder/bike lanes	active transportation and generate associated health benefits	and 12,000, respectively			
No-build scenario shows that current bridge will not have a useful life beyond the analysis period	New bridge will meet design standards that will allow it to serve the community up to 75 years post construction	Accrued benefits beyond the analysis period	Dunedin Causeway users	Residual Value of the new bridge beyond 2058	$2.8	19
No-build scenario do not meet current engineering standards for resisting damage from high waves during significant storms (FDOT, 2020), which would generate economic losses to repair the bridge and limit the accessibility to the island by car.	The height of the new bridges will increase compared to the No-Build case, and the new infrastructure will meet the latest engineering designs to withstand high intensity storm events, reducing significatively the likelihood of infrastructure damage	High intensity storm surge events can generate damages to bridge infrastructure from of deck unseating, scour, debris impact and others.	Dunedin Causeway users	Reduced average annual economic losses from damage to infrastructure and displacement from extensive bridge damage as a result of storm surge events.	$2.0	13
No-build scenario will eliminate accessibility to the island by car in 2035 from bridge closure, indefinitely affecting owners from an estimated 484 apartment units leading to a buyout program	New bridges will ensure continued access to the island through the analysis operation years.	Accessibility loss by car from bridge closures as there is an assumed 15-year remaining service life) until 2035	Owners and residents from apartment units in Honeymoon Island	Avoided costs from buyout program to property owners triggered from inaccessibility to Honeymoon Island	$40.0	13

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impact	Population Affected by Impact	Economic Benefit	Summary of Results (at 7% discount rate)	Page Reference in BCA Appendix
Current bridge is not expected to have a useful life past 2035, reducing its annual O&M costs of $0.3 million to zero	The new bridges are expected to have O&M costs of approximately $0.225 million	Benefits will accrue in the early years as the new bridges costs less to operate, but O&M costs past 2035 will turn to a negative benefit as the no-build has effectively no useful life	Pinellas County	Negative benefit of net O&M costs	($0.7)	19

The overall Project impacts can be seen in Table ES-3, which shows the magnitude of change and direction of the various impact categories.

Table ES-3: Project Impacts for Project, Cumulative 2029-2058

Category	Unit	Quantity	Change
Market Value of residences on Honeymoon Island	2020$	$99,312,846	▲
Willingness to Pay for Honeymoon Island Park	Visitors	31,001,074	▲
Total Bicyclists – Build Case	#	1,894,221	▲
Total Pedestrians – Build Case	#	345,042	▲

In addition to the monetized benefits presented in Table ES-2, the Project is expected to accumulate many benefits not quantified in this analysis

- Beach-goers who may have visited Honeymoon Island State Park may otherwise use beaches further away, increasing VMT and emissions rates.
- It is also expected that there will be other costs to residents of Honeymoon Island beyond a general increase in travel time and emergency response benefits, increasing the benefits of the Build Case.

While these benefits are not easily quantifiable, they do provide real advantages and improvements that will be experienced by individuals and businesses in the region.

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INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the Dunedin Causeway Bridge Project (the project) for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the Bridge Investment Program 2022 program. The following section describes the BCA framework, evaluation metrics, and report contents.

BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative (or alternatives, if applicable). Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or "No Build" Case, which is compared to the "Build" Case, where the grant request is awarded and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project life-cycle. The importance of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the 2022 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.[3] This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case as well as under the Build Case;
- Estimating benefits and costs during project construction and operation, including 30 years of operations beyond the Project completion when benefits accrue;
- Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2020 dollars. In instances where cost estimates and benefits valuations are expressed in historical or future dollar years, using an appropriate inflation factor to adjust the values;
- Discounting future benefits and costs with a real discount rate of seven percent consistent with U.S. DOT guidance.

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[3] U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Applications, March 2022. https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20%28Revised%29.pdf Access March 18, 2022.

REPORT CONTENTS

Section 0 of this report contains a description of the Project, information on the general assumptions made in the analysis, and a description of the base case compared to the build case. Section 0 provides a summary of the anticipated project costs. Section 0 reviews the expected economic benefits the Project would generate, including a review of the assumptions and methodology used to calculate the benefits. Finally, Section 0 reports the high-level results of the benefit-cost analysis.

SECTION 2 - PROJECT OVERVIEW

DESCRIPTION

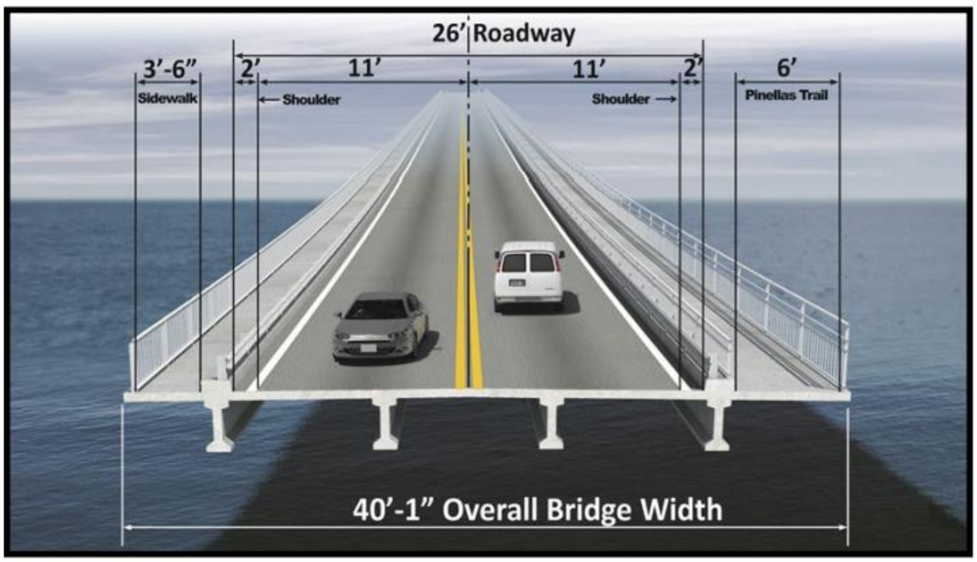
A benefit-cost analysis (BCA) was conducted for the Dunedin Causeway Bridge Project (the project) for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the 2022 Bridge Investment Program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in March 2022. The period of analysis corresponds to 36 years and includes 6 years of construction and 30 years of benefits after operations begin in 2029.

The Project consists of the reconstruction of two bridges in Pinellas County, Florida. Constructed in 1963, the first bridge (Main Bridge) is a one-lane-per direction, 1,200' long bascule bridge, while the second bridge (Tide Relief Bridge) is a one-lane-per direction, 400' fixed-structure bridge. Both are part of the 1.5 mile long Dunedin Causeway which links mainland Pinellas County with Honeymoon Island, a Gulf Coast barrier island home to one of Florida's largest state parks (Honeymoon Island State Park), a ferry terminal to Caladesi Island State Park, and a group of apartment complexes with approximately 1,500 residents. The causeway is the only connection between Honeymoon Island and the mainland. The bridges have an annual average daily traffic (AADT) of approximately 9,100 according to Florida Department of Transportation (FDOT) and sports bicycle and pedestrian facilities, including an extension of the Pinellas Trail. The Main Bridge has a clearance of 19.5' when closed and unlimited clearance when open, with a navigational width of 90'. The Tide Relief Bridge consists of eight 48' spans, with a maximum vertical clearance of 15 feet.

Figure 1. Project Location Map

The conditions of the deck, superstructure, and substructure of the existing bridges range from fair to satisfactory, consistent with its age, severe environmental exposure, and heavy use. Both bridges are beyond their 50-year life span and have been rehabilitated and maintained to expand life for approximately another 15 years (based on the 2020 preliminary engineering report). While there are currently no load restrictions, saltwater exposure is expected to continually deteriorate bridge conditions, and neither bridge meets current engineering standards for resisting damage from high waves during significant storms and vessel impact. Due to the narrow width of the bridges, both are considered "functionally obsolete."

Figure 2. Existing Typical Section (Main and Tide Relief Bridges)



Due to these conditions, Pinellas County sought out engineering and environmental analyses to determine alternatives. Through a comprehensive planning process, the Pinellas County Board of County Commissioners (BCC) approved the preferred alternative: the ***Mid-level Movable Bridge Alternative*** (Preferred Alternative Main Bridge) and ***Low-Level Fixed Bridge Alternative*** (Preferred Alternative Tide Relief Bridge). The Preferred Alternative Main Bridge will feature a wider overall bridge width, incorporating wider sidewalks and shoulders, as well as an improved 15' multi-use trail path. The Preferred Alternative Main Bridge will be a bascule bridge with 35' of vertical clearance when closed and 100' navigational width. The Preferred Alternative Tide Relief Bridge will feature similar width and road-deck uses as the Preferred Alternative Main Bridge, with an 18' vertical clearance and 115' navigational width. Both spans will be built to current design standards to mitigate the impacts of storms and erosion and be designed for a 75-year lifespan.

Figure 3. Preferred Alternative Bridge Section

The Preferred Alternative will maintain the critical connection between Honeymoon Island and the mainland for 75 years, or 69 years longer than the presumed period of useful life for the no-build case. This connection is important to the region, as Honeymoon Island State Park is one of the most visited parks in Florida, attracting over 1.6 million annual visitors and providing over $222 million in direct economic impact in 2020.[4] The bridge also maintains connection to the ferry terminal for connections to Caladesi Island State Park, which is only assessable via ferry or private watercraft. It will also maintain a connection between a complex of apartment buildings on Honeymoon Island and mainland Pinellas County, where jobs, schools, emergency services, and regional connections are located. Finally, the preferred alternative expands existing bike and pedestrian connections, including a more than double-widening of the Pinellas Trail, which is expected to generate new users.

GENERAL ASSUMPTIONS

The evaluation period for this project includes a 6-year design and construction period, from 2023-2028, during which capital expenditures are undertaken, plus 30 years of operations beyond Project completion within which to accrue benefits, through 2058.

Dollar figures in this analysis are expressed in constant 2020 dollars (2020$). Capital costs, which were provided in year-of-expenditure terms, were converted to 2020 dollars using federal reserve guidance for years 2020-2022 and then an annual inflation rate of 2.48% for years 2023 and beyond, which reflect a blended average of inflation rates from 2010-2022.[5]

[4] Florida Department of Environmental Protection, Fiscal Year 2020-2021 Florida State Park System – Economic Impact Assessment https://floridadep.gov/parks/parks-office-park-planning/documents/economic-impact-assessment-report-2021 **Note:** This economic impact value is illustrative of the park's value to the region and state overall; it is *not* an input into the BCA quantifications, which rely on willingness to pay by park visitors, consistent with the 2022 USDOT guidance.

[5] 2022 USDOT BCA Guidance for historic inflation rate, CPI estimates for 2022, and Minneapolis Fed historic

The real discount rate used for this analysis was 7.0 percent, consistent with USDOT guidance for 2022 RAISE grants and OMB Circular A-94.[6]

BASE CASE AND BUILD CASE

- One base case (or no-build case) and one build case have been evaluated for the Project.
- The no-build case assumes that only standard O&M costs will be continued, maintaining practical use of the bridge through 2035, the designated end of useful life as defined by the preliminary engineering of the bridge. To account for continued degradation of the no-build bridges, it is assumed that service will be continually restricted from project opening until 2035, when it is assumed the no-build would no longer be able to carry traffic of any kind, and there would be no access to Honeymoon Island.
- The Build Case assumes two new bridges replace the existing facilities starting in 2029. The new facilities maintain the current levels of visitation and travel supported by the existing facilities. The new facilities also include expanded pedestrian and bicycle facilities, as explained in Section 2.1, which increase the capacity and expected demand for these users.

[6] White House Office of Management and Budget, Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. October 29, 1992. https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/a94/a094.pdf. Accessed March 18, 2022.

SECTION 3 - PROJECT COSTS

CAPITAL COSTS

- Costs are related to the full design and construction of two bridges: the Preferred Alternative Main Bridge and the Preferred Alternative Tide Relief Bridge.
- Design costs are applied in 2023 and 2024, while construction costs are equally divided between 2025 and 2028.
- Costs provided to WSP were in year-of-expenditure terms. WSP converted these to 2020$ consistent with estimated inflation rates.

Table 1: Project Costs by Category and Year, in Undiscounted Millions of 2020 Dollars

Cost Category	2023	2024	2025	2026	2027	2028	Total
Planning and Design	$2.43	$2.37					$4.80
Right of Way							
Construction			$16.57	$16.16	$15.76	$15.37	$63.86
Total	$2.43	$2.37	$16.57	$16.16	$15.76	$15.37	$68.66
Total, Discounted 7%	$1.98	$1.81	$11.82	$10.77	$9.81	$8.94	$45.13

Source: Pinellas County, 2020

OPERATIONS AND MAINTENANCE COSTS

- Preliminary engineering documents outline expected O&M costs for both the no-build case and the build case. The expected no-build O&M costs are estimated to be $0.3 million per year in undiscounted 2020 dollars. The expected build O&M costs are estimated at $0.225 million per year.
- Because the useful life of the no-build is expected to end in 2035, accrual of no-build O&M costs ends at this horizon year as well. Between project opening in 2029 and the no-build horizon year of 2035, it is expected that the build case will save $0.075 million per year Past 2035, it is assumed that the no-build O&M costs will be zero, thus generating $0.225 million per year in O&M disbenefits.
- The total disbenefit from increased O&M costs over the operations period is expected to be -$4.7 million in 2020$, or -$0.7 million in discounted terms. This disbenefit is included in the numerator of the BCR equation.

SECTION 4 - PROJECT BENEFITS

Benefits of the project are related to the build-case meeting the current levels of demand associated with visitation at Honeymoon Island State Park and travel time savings associated with residents of the apartment complex on Honeymoon Island. These benefits begin to accrue during project opening, when it is assumed that the no-build case would only be able to serve less than 50% of its current traffic (quantified through a reduction in visitation and in travel time savings for residents in the no-build case).

- The reduction in capacity in the no-build case is linearly extended from 2020 (the preliminary engineering study year when the no-build case was assumed to have a 15-year remaining service life) until 2035. The benefits of the build-case continue to growth through 2035, when capacity of the no-build case is assumed to be 1/15 of its 2020 levels, while the build case assumes full capacity. For years 2036 – 2058, it is assumed there is no connection from the no-build case, though O&M costs are reduced to zero.
- Benefits are monetized based on data provided by the client or through relevant sources. A number of benefits that are supplementary to the key benefit categories of recreational value, improved bike/ped growth, and travel time savings have been identified qualitatively but have not been quantified or included in the BCR/NPV calculations.

Table 2: Project Benefits

Benefit (Disbenefit) Category	Description	Monetized	Quantified	Qualitative
Health & Quality of Life Benefits		√		√
Recreational Benefits			√	
Buyout Cost Avoidance		√		
Displacement Avoidance		√		
Bridge Damages Due to Storm Surge (Resilience)		√		
ADA Access				√

Source: WSP 2022

DEMAND PROJECTIONS

The benefits of the Project rely on maintaining current levels of demand on the Dunedin Causeway. As such, 2020 levels of demand including AADT, Honeymoon Island State Park Visitation, bike and pedestrian users, and the population of residents on the island are maintained throughout the project. Growth in these estimates was only assumed for bike and pedestrians, whose usage rates are expected to rise with the inclusion of improved and widened facilities in the Build Case. Though regional traffic impacts from a lack of connection to Honeymoon Island can reasonably expected in the no-build case, no traffic analysis has been conducted outlining these impacts.

Table 3: Demand Projection Assumptions and Sources

Variable	Unit	Value	Source
Honeymoon Island State Park Visitation	People	1,482,075	2020-2021 Fiscal Year Economic Impact[7]
Honeymoon Island State Park User Fee per HOV vehicle	$/visit	8	Florida State Parks[8]
Honeymoon Island Residents	People	1,560	US Census Bureau (Block Group Estimation)
Average Resident Trips per day	Annual Person Trips	2.9	2017 NHTS
Calculated Travel time – Dunedin Causeway	Minutes/Trip	3	Google Maps
2021 Pinellas Trail User Count – Dunedin Counter	Annual Person Trips	488,569	2021 Pinellas Trail User Count[9]

Source: WSP review of various sources

The resulting demand projections are presented in the following table. Note that no-build estimates for the project opening year assume a reduction in capacity of 56%, consistent with 9 years of linear reduction of capacity between 2020-2035.

Table 4: No Build and Build Demand Projections

Variable	Project Opening Year		Final Year of Analysis	
	No Build	Build	No Build	Build
Honeymoon Island State Park Visitation	648,408	1,610,871	0	1,610,871
Annual Increase in Travel Time	46,442 hours	0 hours	82,563 hours	0 hours
Annual Cyclists	26,719	61,992	0	71,639
Annual Pedestrians	5,344	12,214	0	12,214

Source: WSP, 2022

SAFETY

The build case will include new bicycle and pedestrian facilities that provide wider and safer right-of-way for both users. Given previously minimal safety concerns for these users, safety benefits for cyclists and pedestrians were not quantified. However, these benefits are still likely to be accrued as more non-

[7] Florida Department of Environmental Protection, Fiscal Year 2020-2021 Florida State Park System – Economic Impact Assessment https://floridadep.gov/parks/parks-office-park-planning/documents/economic-impact-assessment-report-2021

[8] Florida State Parks https://www.floridastateparks.org/parks-and-trails/honeymoon-island-state-park/hours-fees. NOTE: WSP accounted for lower fees for other users and estimated a blended fee of $6.19 per vehicle *or* cyclist/walker.

[9] Forward Pinellas, 2021. https://forwardpinellas.org/document-portal/pinellas-trail-usage-reports/?wpdmdl=48446&refresh=62f6bdcc6fbb61660337612&ind=16440023146711&filename=Pinellas%20Trail%20Annual%20Report%202021.pdf

motorized users are assumed to use the causeway to access Honeymoon Island as a result of these new facilities.

ENVIRONMENTAL SUSTAINABILITY

Honeymoon Island State Park is one of the most visited state park facilities with over 1.6 million users. Given that Honeymoon Island is one of the largest public-access beaches north of Clearwater, it can reasonably be assumed that a reduction in access will divert beachgoers to other locations, many of which would be a further drive than Honeymoon Island. This is especially true for visitors coming from the north of Honeymoon Island and north of Pinellas County, where few beach facilities exist on the Gulf Coast south of the Florida panhandle.

Given that no detailed traffic analysis was conducted for this project, environmental benefits related to a reduction in overall VMT was not conducted. However, it is clear that the elimination of access to Honeymoon Island would divert beach goers to other locations, most likely increasing VMT and associated emissions as recreationists travel further for beach amenities.

QUALITY OF LIFE

This project will create quality of life / livability benefits which include:

- Health benefits from increased biking/walking
- Inherent Mobility/Connectivity Benefits of Cycling/Pedestrian Facility Improvements
- Emergency Response Services

As demonstrated from existing datasets, cyclists and pedestrians use the existing facilities on the Dunedin Causeway to access the island. With the no-build case, bike and pedestrian access would be constricted until 2035, when the bridge would no longer function, and all access would cease. The build case maintains these connections, while increasing the rates of cycling on the causeway as an improved Pinellas Trail pathway would induce more trips than in the no-build case.

Overall, it is estimated that about 71,000 annual cyclists will use the bridges in the build case by the final operations analysis year (2058), and another 12,000 pedestrians will use the facilities. This generates about $3.2 million in total discounted benefits related to the health benefits of walking and cycling, and another $0.5 million in inherent benefits of active transportation, both in 2020$ discounted terms.

Finally, the estimated benefit of emergency response was calculated for the build scenario. In this case, it is assumed that the build scenario maintains access for emergency vehicles to Honeymoon Island post-2036. Because it is assumed emergency vehicles would receive priority and not be affected by capacity restrictions, this estimate was only calculated for years in which the bridges in the no-build scenario would be past their useful life and have zero utilization. Emergency response access was monetized based on the value of avoided out-of-hospital cardiac arrest deaths. A cardiac arrest rate of 58.5 people per a population of 100,000 was used to estimate the number of potential cardiac arrest incidents. This rate was applied to the residential population of Honeymoon Island (1,560), as well as the daily visitation rate of Honeymoon Island State Park (estimated at 4,413 based on an annual visitation rate of 1.61 million). This estimate results in approximately 3 cardiac arrest events per year.

American Heart Association estimates on emergency services response times and survival rates was used to estimate the number of avoided deaths per year between the No-Build and Build case. In the no-build case, it is assumed that response time would be greater than 19 minutes, associated with a 0.83% survival rate.[10] The build-case maintains an average response time of about 8.5 minutes, consistent with a survival rate of 14%. The estimate of avoided deaths between the no-build and build cases is estimated at approximately 0.84 deaths per year. This equates to an annual benefit of approximately $3.3 million in discounted benefits in 2036, the first year of accrual of this benefit. The total build benefit of access for emergency service vehicles is assumed to be $40.0 million in $2020 discounted terms.

Table 5: Quality of Life Benefits, millions of 2020 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Mortality Reduction Benefit – Walking and Cycling	$0.27	$0.15	$14.4	$3.2
Active Transportation – Sidewalk and Cycling Facility Improvements	$0.06	$0.03	$2.0	$0.5
Emergency Response	$0.0	$0.0	$225.1	$40.0

ECONOMIC COMPETITIVENESS AND OPPORTUNITY

HONEYMOON ISLAND STATE PARK – WILLINGNESS TO PAY

The majority of traffic that frequents the existing Dunedin Causeway is workers and visitors of Honeymoon Island State Park. The state park includes four miles of beach, picnic pavilions, bathhouses, a concession stand, nature trails and a nature center, bird observations areas, and other facilities for swimming, fishing, shelling, and bicycling. The park is currently one of the most utilized in the Florida State Park system, with over 1.61 million users reported in the 2020 fiscal year. Park-goers may access the park via walking, cycling, or vehicle. Currently, park fees are charged for access, including $2 for a cyclist or pedestrian, $4 for a single-occupant vehicle (or sunset fee), and $8 per vehicles of 2 people or more.

Because of the park's high usage and the critical connection the Dunedin Causeway holds for park-goers, an estimate of the willingness to pay for recreational services at Honeymoon Island State Park was developed using current visitation estimates and fees. Shares of bike/ped and single occupancy vehicles were conservatively estimated using NHTS data and experience in analyzing beach-going traffic. After accounting for higher occupancy for beach-going traffic than normal traffic, it is assumed that the approximately 1.61 million visitors is divided into approximately 73,000 ped/cyclists per year, 241,000 SOVs or Sunset users, and 479,000 2+ occupant vehicles. The blended fee per visit is estimated to be $6.23 per vehicle/auto/ped visit.

[10] American Heart Association. "Shortening Ambulance Response Time Increases Survival in Out-of-Hospital Cardiac Arrest". Oct 2020. https://www.ahajournals.org/doi/10.1161/JAHA.120.017048

Table 6: Recreational Value of Honeymoon Island Assumptions and Sources

Variable	Unit	Value	Source
2020-2021 Visitation	Factor	1,610,871	Florida DEP Visitation Data[11]
Park Entrance Fee - Multiple passenger vehicle	2020$	8	Florida State Parks[12]
Estimated Vehicle Occupancy	Factor	1.8	NHTS (recreational occupancy in Tampa-St. Pete CSA)
Estimated Beach-going occupancy factor	Factor	50%	Conservative estimate – assumes a 2.7 occupancy for non-SOV and non-bike/ped vehicles.
Estimated Single Occupancy Vehicle/Sunset	Factor	0.15	Conservative Estimate
Bike/Ped Fee	2020$	2	Florida State Parks
SOV/Sunset Fee	2020$	4	Florida State Parks

As with other benefits, the opening year benefit accounts for a 56% reduction in no-build capacity compared to the build, growing to a 100% reduction by 2036. In the project opening year, this leads to $1.5 million in discounted benefits. By 2036, the annualized benefit is estimated to be $1.6 million in annualized benefits. Overall, it is expected that $31.6 million in discounted benefits will accrue from maintained access to Honeymoon Island State Park. This estimate is duly conservative compared to economic impact analysis of the Park, which estimates an annual direct impact of over $200 million due to park visitation.

Table 7: Recreational Value of Honeymoon Island Savings, Millions of 2020 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Willingness to Pay for Recreational Value – Honeymoon Island State Park Visitors	$2.8	$1.5	$139.9	$31.6

[11] https://www.floridamuseum.ufl.edu/wp-content/uploads/sites/85/2020/09/FRE_StateParksFactsheet.Print_.pdf
[12] https://www.floridastateparks.org/parks-and-trails/honeymoon-island-state-park/hours-fees

AVOIDED BUYOUT COSTS

This section estimates the avoided costs from buyout to the residential units located in Honeymoon Island, which would be potentially incurred in the No-Build Case. According to the Preliminary Engineering Report (FDOT, 2020), the bridges are past their original designed service life of 50 years and their structural components were found to be in fair to satisfactory condition, which is expected to continue worsening in the upcoming years.

It is foreseen that the bridges will be closed by 2035 if the project is not implemented, eliminating accessibility to the island by car and indefinitely affecting owners from an estimated 484 apartment units presented in Figure 4. As a response, triggering the development of a buyout program aimed to alleviate the impact to owners.

Figure 4: Potentially affected residences from bridge closure

Under the assumption that the bridges remain fully functional until that year, buyout costs are estimated from market value of the apartment units located in the island which were found in (*Pinellas County Property Appraiser*, 2022). Usually, buyout programs consider demolition and site restoration after acquisition; however, considering that the accessibility to the island would be lost, these additional costs were not included in the analysis.

The total market value estimated for the 484 apartment units in Honeymoon Island totals $99.3 million in undiscounted 2020$. Assuming that the costs associated to the buyout would be incurred in 2035, the avoided costs are estimated at $36.0 million 2020$.

RESILIENCE BENEFITS

The project site is exposed to coastal events such as storm surge. Specifically, bridge infrastructure is susceptible to deck unseating, being the predominant damage observed in historical events, scour, pavement rattling from inundation, and others, as a consequence of storm surge events (Stearns and Padgett, 2011).

The resilience benefits are quantified and monetized in this study as the net reduction in average annual losses between the Build case and No-Build case in performing repairs to the damages arising from storm surge events and displacement costs triggered from accessibility loss for the residential units located at the project site.

Storm surge hazard models developed by (WSP, 2020) for Pinellas County were used to obtain storm surge values exacerbated by anticipated sea level rise at the locations of the Main Bridge and Tide Relief Bridge for the scenarios presented in Table 8.

Table 8: Probabilistic Storm Surge Hazard Scenarios (NOAA, 2017)

Return periods	25, 50, 100, 250, 500
Sea-level Rise Scenario	Intermediate
Horizon years	2018, 2040, 2070

The assumptions and limitations in the estimation of the resilience benefits include:

- The losses only consider bridge damage from deck unseating; it is therefore acknowledged that the losses and consequences could potentially be higher than presented in this study.
- The deck unseating analysis only consider the height of the bridges; the structural performance of the existing (No-Build Case) and new infrastructure (Build Case) is not considered in the analysis.
- Losses were linearly interpolated between selected horizon years to obtain the annualized values through the analysis period of this study (i.e., 2029 after project opening to 2058 analysis end year).

The following steps were undertaken in the analysis:

1. Estimate the critical elevations of the existing (No-Build Case) and new bridges (Build Case)
2. Obtain storm surge elevations along the bridges
3. Estimate the probability of deck unseating from storm surge for the No-Build Case and the Build Case based on anticipated storm surge impact at critical elevations
4. Estimate the damage-related costs from deck unseating and triggered displacement costs for the No-Build Case and the Build Case
5. Estimate the annualized losses through the analysis period for the No-Build Case and the Build Case
6. Estimate the benefit from project implementation by subtracting the losses of the Build Case from the No-Build Case.

The bridge critical elevation is estimated as the elevation at the base of the deck. For the existing infrastructure the critical elevations were extracted from the Digital Surface Model (DSM) obtained from the County. For the new infrastructure, critical elevations were obtained from drawings with bridge profiles for the Main and Tide Relief bridges (FDOT, 2020). Table 9 shows the minimum and maximum elevations found for the No-Build and Build cases throughout the length of the deck. The maximum critical elevations were used in the analysis as a conservative approach.

Table 9: Bridge Critical Elevation Estimates (NAVD88)

	No-Build Case		Build Case	
	Min. (ft)	**Max. (ft)**	**Min. (ft)**	**Max. (ft)**
Main bridge	16.65	27.22	20.50	43.50
Tide Relief bridge	16.31	18.66	16.50	21.20

Storm surge values were obtained along the bridges from the hazard models developed by (WSP, 2020). Table 10 summarizes the maximum storm surge values impacting the Main and Tide Relief Bridges for the various scenarios.

Table 10: Maximum Storm Surge Elevations at the Project Site (ft, NAVD88)

Main bridge			
Return Period	**Year 2018**	**Year 2040**	**Year 2070**
25	14.041	15.252	16.574
50	15.522	16.754	18.078
100	17.745	18.997	20.319
250	20.422	21.694	23.015
500	22.259	23.546	24.881
Tide Relief bridge			
Return Period	**Year 2018**	**Year 2040**	**Year 2070**
25	12.348	13.551	14.868
50	13.709	14.931	16.420
100	15.995	17.237	18.555
250	18.543	19.804	21.120
500	20.248	21.523	22.853

As presented in Equation 1 and Equation 2, the probability of deck unseating is a function of the storm surge elevation (S), the critical elevation of the bridge defined as the bottom of the deck (Hb), and the wave height (H) (Gidaris *et al.*, 2017). The hazard models used in this study did not include wave height values. Therefore, losses are estimated for a range of wave heights from 0 to 5 m to consider the variability from this parameter. Figure 5 represents the variation in the probability from deck unseating from different wave heights.

Equation 1: (Gidaris *et al.*, 2017)

$$g(S,H,H_B) = -2.71 - 3.47(H_B - S) + 1.59H + 0.17(H_B - S)^2 + 0.05H^2$$

Equation 2: (Gidaris *et al.*, 2017)

$$P_{Deck\ Unseating} = \frac{e^{g(S,H,H_B)}}{1 + e^{g(S,H,H_B)}}$$

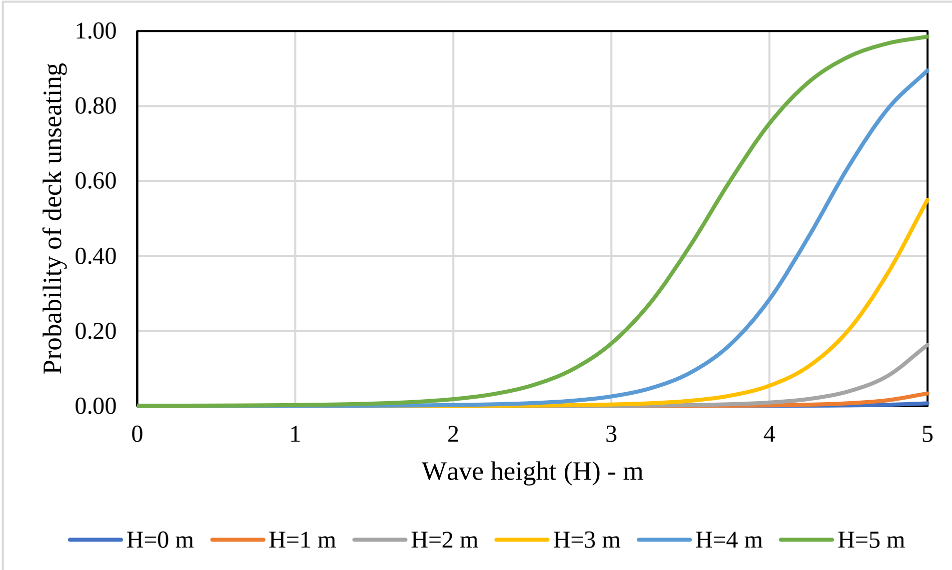


Figure 5: Example of probability of deck unseating for wave heights considered in the study for Tide Relief bridge

Given that bridge deck failure would result in loss of bridge functionality and repair works needed to restore functionality would result in significant costs, it is assumed that bridge deck failure would trigger bridge reconstruction consequences. These consequences are summarized in Table 11.

Table 11: Bridge Reconstruction Costs and Times (FDOT, 2020)

Bridge replacement cost	Main bridge	$77,220,988
	Tide Relief bridge	$10,064,224
Reconstruction time (months)	Main bridge	48
	Tide Relief bridge	18

The displacement expenses are estimated as described in section 14.2.8 of the HAZUS Technical Manual (FEMA, 2006). The values are updated to 2020$ as presented in Table 12 which are used in combination with the reconstruction times presented in Table 11 and residential unit floor areas obtained from (*Pinellas County Property Appraiser*, 2022). Equation 3 is implemented to estimate displacement losses.

Equation 3: modified from (FEMA, 2006)

$$Relocation\ costs = Fa * (1 - \%OO) * (DC) + \%OO * (DC + Rent * RT)$$

Where:

- Fa: Is floor area of the apartment units assessed
- %OO: Is percent owner occupied parameter (see Table 12)
- DC: Is the disruption costs (see Table 12)
- Rent: Rental costs (see Table 12)
- RT: Recovery time equivalent to the bridge reconstruction times (see Table 11)

Table 12: Displacement costs updated to 2020$; modified from (FEMA, 2006)

Occupancy class	FEMA use	Rental costs ($/ft^2/month)	Disruption costs ($/ft^2)	Percent owner occupied
High Density Residential	Multi-family	$0.799	$1.074	35

The final displacement costs triggered from bride deck unseating for each of the bridges are summarized in Table 13.

Table 13: Bridge displacement costs

Displacement costs	**Main bridge**	$6,626,025
	Tide Relief bridge	$2,484,760

For each of the horizon years, wave height and project scenario analyzed, the associated probabilistic return period and economic losses are used to compute an annualized loss estimate (i.e., average annual loss) using the HAZUS methodology (FEMA, 2017), which considers:

- The annual exceedance probabilities of hazard events, equivalent to the inverse of the corresponding return periods, and
- The losses associated with such events (the resulting loss curve is illustrated in Figure 6, where the average annual loss is represented by the area under the curve).

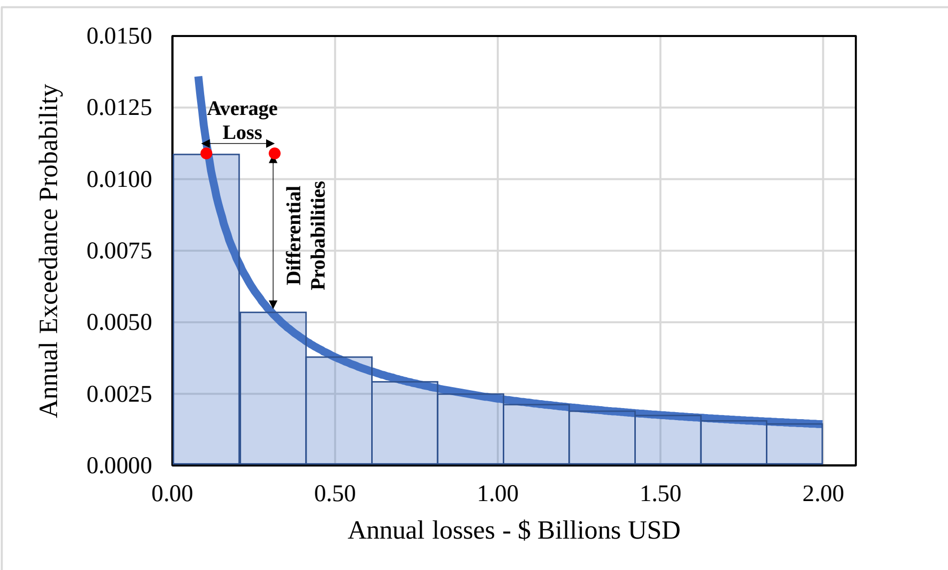


Figure 6: Loss Curve

Table 14 to Table 16 summarize the annual average losses of the No-Build Case and No-Build Case from storm surge events for each combination of wave heights.

Table 14: Annual Average Displacement Costs

Wave Height (m)	Displacement costs					
	No-Build Case			Build Case		
	2018	2040	2070	2018	2040	2070
0	$3,244	$8,185	$15,642	$285	$1,002	$3,415
1	$9,414	$16,736	$26,281	$1,360	$4,054	$9,692
2	$19,503	$29,204	$44,714	$5,586	$11,579	$19,843
3	$35,628	$51,227	$77,127	$15,194	$23,772	$36,413
4	$64,631	$91,193	$119,620	$31,354	$45,236	$66,390
5	$112,286	$133,025	$147,844	$61,699	$81,491	$101,699
Average	$40,784	$54,928	$71,871	$19,246	$27,856	$39,576

Table 15: Annual Average Damage Costs

Wave Height (m)	Displacement costs					
	No-Build Case			Build Case		
	2018	2040	2070	2018	2040	2070
0	$10,991	$27,840	$54,025	$950	$3,343	$11,401
1	$32,263	$58,516	$96,876	$4,541	$13,534	$32,354
2	$69,842	$112,112	$196,054	$18,648	$38,651	$66,240
3	$147,061	$248,391	$436,953	$50,722	$79,358	$121,555
4	$359,036	$568,345	$829,234	$104,679	$151,025	$221,653
5	$788,461	$1,055,404	$1,397,369	$206,075	$272,194	$339,754
Average	$234,609	$345,101	$501,752	$64,269	$93,018	$132,160

Table 16: Annual Average Losses

Wave Height (m)	Displacement costs					
	No-Build Case			Build Case		
	2018	2040	2070	2018	2040	2070
0	$14,234	$36,025	$69,667	$1,235	$4,345	$14,816
1	$41,677	$75,252	$123,157	$5,901	$17,588	$42,046
2	$89,345	$141,316	$240,767	$24,234	$50,230	$86,083
3	$182,689	$299,617	$514,080	$65,916	$103,130	$157,968
4	$423,667	$659,538	$948,854	$136,034	$196,261	$288,044
5	$900,747	$1,188,429	$1,545,213	$267,774	$353,685	$441,453
Average	$275,393	$400,030	$573,623	$83,516	$120,873	$171,735

These values were projected from project opening through the analysis period timeframe using linear interpolation between the horizon years to estimate the present value of the benefit (i.e., difference in terms of losses between the build case and the no-build case) as a result of project implementation. The average avoided losses are estimated to be $8.8 million in undiscounted $2020, and at 7% discount rate $2.0 million across the analysis period.

STATE OF GOOD REPAIR

The state of good repair condition benefits assessed in this analysis include changes to operations and maintenance. According to preliminary engineering estimates, the annual O&M expenditures is expected to decrease from the No-Build Case to the Build Case from $0.3 million to $0.225 million. However, in line with other benefit categories, it is assumed that the no-build case will cease O&M expenditures when the bridge passes its useful life in 2035. Thus, from 2036 until the end of the analysis period in 2058, it is assumed that the Build Case will have an O&M disbenefit of -$0.225 million per year. It is assumed that between 2029-2035, the $0.3 million will be still used in the no-build to maintain limited access.

Table 17: State of Good Repair Benefits Assumptions and Sources

Variable	Unit	Value	Source
No-build O&M Costs	Annual Cost (2020$)	$0.3 million	2020 PD&E
Build O&M Costs	Annual Cost (2020$)	$0.225 million	2020 PD&E

In the Project Opening Year, when the No-Build Case still accrues an O&M cost, net benefits are expected to be $0.04 million in discounted 2020$ dollars. However, over the course of the project lifecycle, the Build Case's O&M costs will turn into a disbenefit of approximately -$0.7 million in discounted terms.

The project also generates residual benefits, which consider the remaining value of the project past the analysis period. Applied during the final year in the analysis period, the discounted residual value is $2.8 million.

Table 18: State of Good Repair Benefits, Millions of 2020 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Change in O&M costs	$0.075	$0.04	-$4.7	-$0.7
Residual Value	0	0	$36.5	$2.8

SECTION 5 - SUMMARY OF RESULTS

EVALUATION MEASURES

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCA:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- Benefit Cost Ratio (BCR): The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.
- Internal Rate of Return (IRR): The IRR is the discount rate which makes the NPV from the Project equal to zero. In other words, it is the discount rate at which the Project breaks even. Generally, the greater the IRR, the more desirable the Project.
- Payback Period: The payback period refers to the period of time required to recover the funds expended on a Project. When calculating the payback period, the time value of money (discounting) is not taken into account.

BCA RESULTS

The table below presents the evaluation results for the project. Results are presented in undiscounted, discounted at seven percent as prescribed by the U.S. DOT. All benefits and costs were estimated in constant 2020 dollars over an evaluation period extending 30 years beyond system completion in 2028.

- Total benefits in 2020$ discounted terms amount to $86.8 million. This compares favorably to an estimated $45.1 million in 2020$ discounted costs, for a Project BCR of 1.92.
- The net present value of the project is estimated to be $41.6 million in $2020 discounted terms. The project is expected to achieve a payback of its cost in 14 years after construction.
- Because this Project exceeds a BCR above 1.0, the project's benefits are expected to exceed its costs and can be considered cost-effective and valuable.

Table 19: Benefit Cost Analysis Results, millions of 2020 Dollars

BCA Metric	Undiscounted	Discounted (7%)
Total Benefits	**$521.2**	**$115.3**
Active Transportation	$1.9	$0.5
Health	$239.5	$43.2
Recreational Access – Willingness to Pay	$139.9	$31.6
Avoided Buyout Costs	$99.3	$36.0
Climate Resilience – Reduced Displacement and Damage Costs	$8.7	$2.0
Residual Value	$36.5	$2.8

BCA Metric	Undiscounted	Discounted (7%)
Change in O&M / R&R Costs	($4.7)	($0.7)
Total Costs	**$68.7**	**$45.1**
Net Present Value (NPV)	**$452.6**	**$70.2**
Benefit Cost Ratio (BCR)	**7.6**	**2.6**
Internal Rate of Return (IRR)	**15%**	
Payback Period (Years)	**12**	

SENSITIVITY TESTING

This analysis relies on many assumptions that, while based on the best available knowledge, are uncertain. This sensitivity analysis evaluates the impact of adjusting key assumptions on the BCR and NPV. Specifically, assumptions that generate key benefits categories are important to test to confirm that even with further conservative assumptions, the project remains cost-effective. For this case, a reduction in expected benefits for recreational willingness to pay and a reduction in avoided property buyout costs were calculated. This sensitivity test assumes a 50% reduction in those visitation numbers to estimate the benefits of visitors' willingness to pay. This estimate may account for the fact that visitors would still be willing to pay for beaches elsewhere, albeit conservatively not assuming the added travel time and emissions costs of those trips. The estimated project benefits for the willingness to pay category drop from $31.6 million in discounted dollars to $15.6 million. The corresponding BCR from the project drops to 1.87, indicating the project still is cost-effective even with this reduction.

A second sensitivity test was run that assumes a 50% reduction in home values that would be bought back. This benefit decrease may result if people decide to move in the no-build case, or a potential reduction in property values compared to 2020 market rates. In this case, the benefits of avoided buyout costs reduce from $36.0 million in discounted 2020 dollars to $18.0 million. The corresponding BCR reduces to 2.16, again showing that the project is cost-effective, even when major assumptions are reduced.

Table 20: Benefit Cost Analysis Sensitivity Analysis

Sensitivity Variable	Sensitivity Value	New BCR	New NPV	% Change in NPV	Source / Notes
Base results	Build (7% Discount Rate)	2.56	$70.2 million	-	No Change to the Model
-50% visitors in no-build	Willingness to Pay	1.87	$36.9 million	-43%	
-50% market value of Honeymoon Island private property in no-build	Avoided Buyout Costs	2.16	$52.2 million	-25%	

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