Memo

Date:	Monday, February 20, 2015
Project:	New Castle-Rye 16127
To:	Victoria Chase - NHDOT, Bob Landry - NHDOT
From:	Marissa Witkowski Birtz - HDR, Jim Murphy - HDR
Subject:	New Castle-Rye Bridge Benefit-Cost Analysis: Fixed and Movable Bridge Replacement Alternatives

The New Castle-Rye Bridge, constructed in 1942, carries Wentworth Road/NH Route 1B over Little Harbor in the towns of New Castle and Rye, New Hampshire. The town of New Castle is an archipelago with only two entry routes. This bridge carries one of these two routes, making it a vital piece of infrastructure for the local community. The New Hampshire Department of Transportation (NHDOT) retained a Design Team, lead by HDR Engineering Inc. (HDR), in conjunction with Hoyle, Tanner & Associates (HTA) and Fitzgerald & Halliday Inc. (FHI) to provide preliminary design services for the New Castle-Rye Bridge. Upon the completion of a Type, Size and Location (TS&L) Study, the NHDOT has decided to replace the existing bridge. The following Benefit-Cost Analysis compares two replacement alternatives: replacement with a fixed structure at existing grade, and replacement with a bascule structure at existing grade.

Typically, a bridge Benefit-Cost Analysis considers the impacts to vehicular traffic, congestion, safety benefits, emissions reductions, and other quantifiable impacts using industry accepted parameters. Based on an initial assessment of the New Castle-Rye Bridge alternatives, which include a bascule and fixed option, there is no clear advantage to one alternative over the other from a roadway benefits perspective. Both options would accommodate vehicular traffic, bicyclists and pedestrians; vehicle speeds and access would remain the same as they are presently. Vehicle congestion would not be reduced and travel time is likely to remain relatively unchanged regardless of the alternative chosen. As a result, quantitative benefits that are typically associated with a bridge investment may not be relevant in this case or useful in determining which bridge alternative is preferable.

While these “typical” road-side benefits may not be useful in differentiating between the bridge alternatives, there are differences on the marine side. The vertical clearance of the bridge will determine marine traffic access to the Back Channel area in the mid- to longer-term.

The focus of this memorandum is to better understand the differences between the two bridge alternatives, identify benefits or disbenefits associated with each alternative, and provide a method to assess the benefits and costs of the alternatives on cost-effectiveness grounds, as well as from a more qualitative perspective.

Methodological Framework
Benefit-Cost Analysis (BCA) is a conceptual framework that quantifies, in monetary terms, as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, or what improves their well-being or welfare.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some members of society are large enough to compensate for the losses of other members of society.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

As is often the case that when choosing between infrastructure alternatives, there are factors beyond those reasonably able to be measured that hold great influence over the ultimate decision in the selection of an alternative. In the case of this analysis, a traditional BCA was particularly difficult to develop due to the lack of measurable and quantifiable differences between the two alternatives. Therefore, two potential benefits have been quantified and monetized, while other benefits are qualitatively discussed. This memorandum will present a combination of both quantitative and qualitative benefits associated with the two bridge alternatives under consideration.

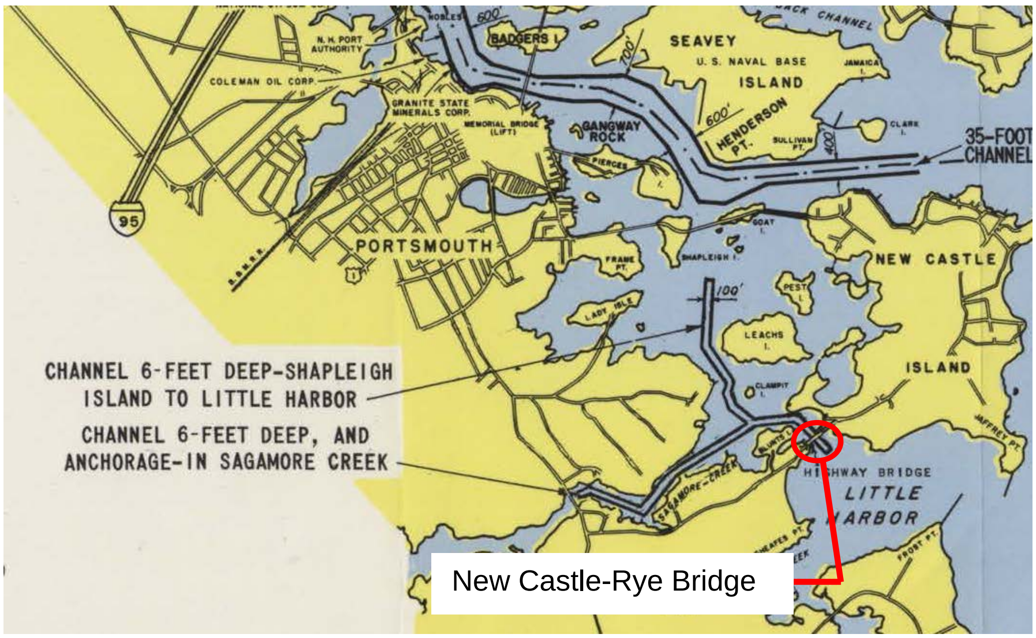
Base Case and Alternatives
A BCA examines the incremental differences between the alternatives under consideration. The existing New Castle-Rye Bridge is in need of replacement, and discussion has been ongoing as to whether the bridge should be replaced with a fixed bridge or a bascule bridge.

The first step in the analysis is to determine the differences in cost between the alternatives. Initial capital costs, as well as life-cycle maintenance costs, will be analyzed for each alternative. The bascule structure will have substantially higher capital and maintenance costs, primarily due to the costs of the bascule pier construction, mechanical and electrical systems, maintenance of the systems and operation costs.

This analysis will also examine the benefits of the two alternatives: bascule bridge and fixed bridge. On the land-side, the differences between the alternatives with regards to access for vehicular traffic, bicyclists, and pedestrians; including vehicle speeds and access, is negligible as the bridge currently lifts infrequently, typically between three and four times a year. Even if the number of lifts per year is increased substantially, there would not be a major impact to vehicular traffic, as the Average Daily Traffic on this bridge is only 4,200 vehicles per day.

The primary difference in benefits between the two alternatives is marine-access. The proposed fixed bridge does not offer the option to be raised to increase underclearance for marine vessels when necessary. This would restrict access to the Back Channel, an Army Corp of Engineers maintained water way located between New Castle, Rye, and Portsmouth, NH. The New Castle-Rye Bridge is currently the only means for tall vessels to enter the Back Channel, as fixed bridges currently restrict the other two access points. The existing bridge requires four hours notice to lift, and has only been requested to lift approximately three to four times per year. The benefits discussed in this analysis will be primarily related to marine-access improvements and associated impacts.

Figure 1: Map of Back Channel (Source: USACE)



General Analytical Assumptions

Where possible, the BCA measures benefits against costs for a duration of time that includes the construction period and a fixed number of years of operation. For this analysis, all input prices assume that the first year of analysis is the year in which the bridge is replaced, currently slated for 2017 . A constant four percent real discount rate is assumed throughout the period of analysis, reflecting the time value of money. In other words, it acknowledges that a dollar today can be invested to yield more than a dollar tomorrow.

Project Costs and Schedule

The costs used for this comparison are based on a life-cycle cost analysis for each of the two proposed bridge alternatives. HDR performed order-of-magnitude life-cycle cost estimates which include both the initial capital costs and the long-term maintenance costs over the 75-year useful life of the new bridge.

For the bascule alternative replacement cost, the initial capital costs total $15.8 million and the operating and maintenance costs total $8.5 million in constant dollars ($1.8 million in present-day dollars). The fixed alternative replacement cost is estimated at $7.0 million in construction cost and $3.7 million in long-term maintenance costs in constant dollars ($0.7 million in present-day dollars). The overall difference in cost between the two alternatives is $13.6 million in constant dollars ($9.9 million in present-day dollars) using the 4-percent discount rate.

For purposes of this analysis, it is assumed that all construction costs are incurred in "year zero." Both alternatives are slated to begin construction in late 2017. Accelerated construction techniques will be employed regardless of which alternative is selected; therefore, the differences in construction duration between the two alternatives would only be a matter of weeks, which is negligible for purposes of establishing life-cycle cost periods. The completion of construction marks the beginning of the useful-life of the bridge. For the purposes of this analysis, the useful-life is assumed to be 75-years and the construction duration is assumed to be approximately one-year. The one-year construction duration and 75-year useful life result in a total analysis period of 76 years.

Benefits

There are many benefits that are traditionally measured in a transportation BCA. These include travel-time impacts based on changes in demand or congestion, pavement maintenance impacts, safety impacts, and air emission impacts. In the case of this project, the impacts to these categories do not vary between the two alternatives. These traditional impacts are driven by a change in demand for use of the facility.

The two bridge alternatives have a similar surface composition. They both: maintain the existing 11' wide roadway lanes; replace the open-grate deck surface with a solid surfaced deck; widen the sidewalk and shoulders for improved pedestrian/bicycle access; and have the same roadway vehicular capacity. It is possible that the bascule bridge may have a marginal impact on traffic if it is raised and lowered with greater frequency. This impact was not measured for this analysis, as it would require projections for future use of the bascule bridge which could vary widely. There are currently three to four lifts per year, which minimally impacts traffic. The road served an average of 4,200 vehicles per day in 2010. Traffic impacts would depend on the timing and duration of the lifts with the new bascule bridge. A lift currently takes 10 minutes, which would be substantially reduced by a new bascule bridge, as the span locks are currently operated manually. The manual span lock operation requires operators to walk to the far end of the bascule span to unlock the bascule span, and walk back prior to lifting the bridge. If increased marine activity led to a substantial increase in the number of bridge lifts, the potential for negative impacts to traffic does exist, though they are negligible for this analysis.

When assessed based on traditional bridge-related benefits, neither of the two alternatives will be significantly more or less appealing to roadway users, and thus the differences between these two alternatives are negligible. As a result, any value of these traditional benefits would essentially net to zero when comparing the two alternatives for the New Castle-Rye Bridge replacement. Due to the lack of ability to quantify a difference in traditional benefits, the study was expanded to include impacts to property values, local utilities and a number of marine-related benefits.

The potential for an increase in property values was investigated. The United States Department of Transportation (USDOT) recognizes property value increases associated with transportation investments as a societal benefit that improves the public's quality of life in the longer term. In fact, it allows the incorporation of some property value increases in the BCA required as part of its Transportation Investment Generating Economic Recovery (TIGER) grant program.[1] It is the net increase in land value due to the presence of a transportation improvement that is considered a benefit by USDOT. But after review of sources, it was found that there is no precedent or study found indicating an actualized increase in property value strictly associated with improved movable bridge access, and therefore increases in property values cannot be dependably considered a benefit. For informational purposes only, a simplified review was performed to determine the amount which property values would have to increase in order to offset the difference in costs between the two alternatives, which is discussed later in this report.

The City of Portsmouth is undergoing an effort to improve its water system, a utility that provides water to New Castle and portions of Rye. The city is planning to potentially install a new water line at the bridge site. The bridge type selected will affect how the water line is installed, as a bascule bridge would require that the water line be installed under the channel with directional drilling, where as a fixed bridge would allow for the waterline to be connected to the bridge. The cost impacts of each alternative on local utilities will be reviewed in this document.

In addition to "land-side" benefits, the study reviewed potential marine-related benefits. These benefits include marine accessibility, resiliency to climate change and rising sea levels, boat-related economic activity, as well as affects replacement alternatives may have on the logistics and costs associated with dredging the Back Channel in the future. Unfortunately, many of these benefits are not easily quantified or monetized, and thus are not included in a quantitative analysis. However, these factors should still be given consideration in the overall decision making process. This highlights the reality that for some transportation investments it is difficult to quantify all of the factors that should be considered when evaluating project alternatives.

This report discusses the qualitative benefits identified with each bridge alternative, as well as quantifies the costs associated with dredging and utilities.

Quantified and Monetized Benefits

As noted previously, the road condition and overall demand on the roadway will not be different between the two bridge alternatives. Consequently, land-side benefits traditionally incorporated into a bridge alternatives selection process may not be suitable for this project, as the difference between alternatives will be negligible. Two benefits were considered in the quantitative analysis. One category of land-side benefits (potential property value impact), as well as one category of marine-side benefits (dredging), were considered.

<u>Potential Property Values</u>

It is widely accepted that water access impacts the value of nearby properties. Research was performed to determine whether values are affected by improved water access due to a movable bridge. No studies were found to address the change in property values driven by

[1] "Benefit-Cost Analysis Analyses Guidance for TIGER Grant Applicants," US DOT, http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Guidance%202014.pdf

movable or fixed bridge types. Thus, there was no precedent to indicate definitive changes in property values as a direct result of bridge related access.

A simplified review was performed to determine the amount which property values would have to increase in order to offset the difference in costs between the two alternatives, for reference purposes only. Details of the exercise undertaken to determine the potential change in property values and the varying level of impacts to the properties in the area of the Back Channel can be found in the Appendix. The general results highlight the range of potential benefits at varying percentage value increases. For example, a 5.0 percent property value premium results in a total lifetime benefit of $2.99 million dollars. A 16.6 percent increase for properties in the area would lead to an additional $9.9 million and offset the additional costs of the on-demand movable bascule bridge as compared to the fixed bridge. A variety of property value premiums were tested and they are shown in the table below. Again, it should be noted that there is no precedent indicating that this premium in property value would be guaranteed, and thus this information is solely provided for reference.

Table 1: Property Value Increases (4% discount rate)

Lifetime Property Premium	Total Benefits
20%	$ 11,932,000
16.6%	$ 9,903,000
15%	$ 8,949,000
13%	$ 7,756,000
10%	$ 5,966,000
7%	$ 4,176,000
5%	$ 2,983,000
3%	$ 1,790,000

<u>Dredging Benefits</u>

Dredging of the Back Channel would allow for larger vessels to enter the Back Channel, as the depth and width of the navigable channel would be increased. Currently, the depth of the channel limits some vessels from travelling into the Back Channel. Dredging of the Back Channel is planned as part of the congressionally authorized Federal Navigation Project, but funding has not yet been authorized. The 2013 Annual Dredge Report by the Pease Development Authority Division of Ports & Harbors states that the United States Army Corp of Engineers (USACE) estimates the dredging would cost approximately $750,000. This estimate assumes the current bridge will be in place. Correspondence with the USACE indicates that both a fixed and bascule bridge would improve access for dredging, as both alternatives widen the horizontal clearances of the waterway. The USACE has also indicated in a letter dated September 24, 2014 that the bascule alternative would be favored, as it would not limit vertical clearances for dredging equipment. Regardless of which alternative is selected, the Back Channel would not be removed from the Federal Navigation Project unless done so through a Congressional vote on legislation addressing the project.

It is unknown when dredging would occur, and therefore, the value of dredging in present-day dollars cannot be known, as the cost would be discounted based on time of expenditure. The following table shows the present-day cost of dredging at various years of expenditure.

Table 2: Cost of Dredging in Present-Day Dollars (4% discount rate)

Year of Dredging	Cost
0	$ 750,000
10	$ 519,400
20	$ 345,314
30	$ 229,576
50	$ 101,473

While the bascule span will provide increased cost savings over a fixed bridge, these cost savings can vary based on a number of factors: year of dredging, equipment used, and increased sediment buildup in the channel. Even if the cost savings between the alternatives were an order-of-magnitude savings, the dollar values would be orders-of-magnitude smaller than the cost differential associated with bridge construction and maintenance.

Qualitative Benefits

As noted previously, most of the benefits of the two bridge alternatives are not easily quantified or monetized. This section will discuss the qualitative benefits to consider when selecting between the bascule and fixed bridge alternatives.

<u>Safe Harbor</u>

Under current conditions, the Back Channel area is considered a safe harbor that can be used for refuge during extreme weather events. Any restriction to the vertical clearance under the bridge has the potential to limit this access for use as a safe harbor.

The benefit associated with the safe harbor is difficult to quantify as these storms are not predictable, but the possibility of saving lives due to availability of access to the harbor over the open ocean provides respite and peace of mind for ocean-going vessels in the area.

Maintaining the area as a safe harbor may also provide the potential to reduce impacts on the Coast Guard due to the reduced need to rescue vessels during these events as they have access to the safe harbor on their own. Without this safe harbor, it would be expected that the marine vessels would remain exposed on the open ocean.

<u>Commercial Fishing</u>

The Back Channel area is currently home to multiple small commercial lobsterman and other fishermen. The boats that currently fish there do not require the existing bridge to be lifted for access to the Back Channel, though the availability of on-demand access to the Back Channel, which requires less coordination with the tides to ensure clearances or advanced notice, would provide the opportunity to maintain the existing commercial fishing industry, as well as potentially increase the commercial fishing output of the area. While information on revenue from local fishing industry is available, no data is available that isolates product in the Back Channel from product caught elsewhere.

Tourist Revenue

There are several boat tours that leave downtown Portsmouth near the Market Street Marine Terminal and tour the Portsmouth harbor and the area around New Castle. Ships that would require the bridge to lift do not currently enter the Back Channel. The Back Channel area offers views of beautiful homes and uninhabited islands, and provides the potential for increased tourist revenue due to new or expanded tours into this area. A bascule bridge allows for the possibility of boat tours accessing the Back Channel, if on-demand bridge mobility were utilized and dredging of the Back Channel was completed. A fixed bridge would reduce the vertical clearance for access into the Back Channel area and would limit the opportunity for expanded tours, if dredging of the Back Channel was completed.

Livability Improvements

Under current conditions, tall boats can access the Back Channel area, but require a 4-hour notice to open the bridge. A new bascule bridge allows for the potential of improving access to the Back Channel for recreational benefits to both local and non-local users, should on-demand bridge lifts and dredging of the channel be implemented.

In addition to recreational boating access considerations, improvement of currently underutilized parcels not considered in the property-value analysis are possible with changes in use of the Back Channel area. These improvements could reflect a change in land uses and value of developments associated with increased attention to the area.

Boat Related Economic Activity

Currently, only boats under a certain height can access the Back Channel area without at least 4-hours notice. There are currently only thirteen commercial vessels moored inside of the Back Channel; a bascule alternative allows for the possibility of increasing the number of commercial vessels through increased access, since it does not restrict vertical underclearance. This presents an opportunity for commercial activities dependent upon the possibility of channel dredging and increased accessibility through on-demand bridge lifts.

Climate Change Resiliency

Though there are no consensus predictions regarding timing of climate change, rising sea levels have been an issue of importance in coastal areas. The timing of this climate change is unclear, and thus creates difficulty in attempting to measure benefits associated with its impacts. However, in this instance, the assumption is that the bridge will exist for 75 years. During this time, reasonable expectations include a rising sea level. While direct impacts associated with changes in coast line and reduction in land masses will not be affected by bridge type, the alternatives differ in how navigational clearances will be affected. The vertical clearance under a fixed bridge alternative would be reduced as sea levels rise, where a movable bridge can lift, maintaining accessibility for vessels even with rises in sea levels. The potential change in vertical clearance from the water should be considered due to its impact on existing private and commercial vessels.

<u>Noise</u>
The existing bridge has an open grate deck, which generates a great deal of noise as vehicles cross the bridge. Both alternatives replace this with a closed deck. The bascule bridge may generate a small amount of noise upon opening and closing that could potentially disturb anyone occupying or using adjacent properties.

<u>Utilities</u>
The City of Portsmouth Public Works Department is currently reviewing scenarios to improve water service to New Castle. One alternative under consideration calls for the installation a new water line running across the Back Channel at the location of the New Castle-Rye Bridge. With a bascule bridge, this potential scenario would require the water line to run under the channel at the bridge location, installed by directional drilling. Under a fixed bridge alternative, the water line would be affixed to the bridge. The 2013 Portsmouth Master Plan programs the total cost of this new water line at $1.1 million. The City of Portsmouth Water Division has estimated that the ability to connect the water line to a fixed bridge would cost approximately $600,000 less than running the water line under the channel with a bascule bridge. This project is in the design phase, and commenced in the summer of 2014.

Results and Summary
Many of the benefits typically analyzed in a traditional BCA, such as traffic and noise impacts, are not applicable to this bridge replacement, as the two alternatives have negligible differences for these benefits. That being said, three categories of benefits – benefits associated with utilities, property values and dredging benefits – were able to be quantified. It should be noted that there was no precedent found during this study that would suggest the increased water a moveable bridge provides would increase property values, and that calculations associated with property values are not meant to imply an expectation of such increase.

Quantitative analysis highlights the monetizable benefits to society, but often other considerations cannot be quantified or monetized. These qualitative benefits are given consideration in the overall decision making process. In the case of the New Castle-Rye Bridge replacement, many of the qualitative benefits lay in the fact that a bascule bridge allows for greater possibility of improvements and benefits to local economy and properties in the Back Channel.

Table 3 highlights the benefits, both quantitative and qualitative, that can be attributed to each of the two alternatives. A rating system is applied to each benefit, which weights the benefit with up to three check marks using the following classification:

- ✓: Provides a greater potential for benefit than the alternative bridge type
- ✓✓: Provides a greater potential for a benefit than the alternative bridge type that would also have either a widely affecting impact on the local population or a significant impact on a portion of the local population should that benefit be realized
- ✓✓✓: Meets the criteria of ✓✓, and has a benefit that is definitively known or probable to occur.

It should be noted that expenditure of public money for dredging and utilities is considered a widely affecting impact in this table.

Table 3: Potential Benefits of Fixed and Bascule Bridge Alternatives

Benefit	Bascule	Fixed
Increased Property Value	✓	
Traffic Impacts		✓
Safe Harbor	✓✓✓	
Increased Commercial Fishing	✓✓	
Tourist Revenue	✓	
Boat Related Economic Impacts	✓✓	
Climate Change Resiliency	✓✓✓	
Dredging Costs	✓✓✓	
Utilities		✓✓✓
Noise		✓

An analysis of costs was also performed, which found that the fixed bridge alternative has significantly lower capital and maintenance costs. The fixed bridge has an estimated capital costs that is approximately $8.8 million less than the bascule bridge ($7.0 million versus $15.8 million). The life-cycle costs of the fixed bridge were found to be $1.1 million less than the bascule bridge in present-day dollars ($0.7 million versus $1.8 million). The higher costs of the bascule bridge alternative are largely associated with the construction of the bascule pier, the construction and maintenance of the mechanical and electrical systems, as well as the greater operational costs required for a movable bridge. See Table 4 for a summary of costs associated with each alternative.

Table 4: Costs of Fixed and Bascule Bridge Alternatives (Present Day Dollars)

Alternative	Capital Cost (2014 dollars)	Maintenance Cost (2014 Dollars)	Total Cost (2014 Dollars)
Bascule	$15.8 million	$1.8 million	$17.6 million
Fixed	$7.0 million	$0.7 million	$7.7 million
Cost Differential	$8.8 million	$1.1 million	$9.9 million

While the fixed alternative does not provide as much potential for benefit as a bascule bridge, the costs of the fixed alternative are significantly lower. Additionally, many of the potential for benefits a bascule provides only reflect opportunity for quality-of-life and economic growth. These benefits may not be realized because the majority of the benefits examined would be dependent upon future dredging of the channel, and the possibility of having bridge lifts with notice times much less than the current 4-hour required notice, which are planned for, but not guaranteed to occur. Even if these two events were to occur, related economic growth is not guaranteed. Additionally, the proposed fixed bridge provides improved navigable clearances over the existing bascule bridge in the down position, which is the condition that serves the vast majority of vessels currently entering the Back Channel, as the current bridge only lifts three to four times per year. Since these benefits only allow for potential growth in the economy and quality of life, and since the impact from benefits is inconclusive, one should examine the overall life-cycle costs. In this case, the fixed bridge provides a lower life-cycle cost than the bascule bridge and is the recommended alternative.

Appendix: Potential Property Value Impacts

Research has found that deep-water lots have increased property value over cove lots in South Carolina[2] and there is a generally held view that properties with a water view are appraised at a higher value than their non-coastline equivalents.[3] This observation is reflected in the data that have been assembled for the New Castle-Rye Bridge area. Properties that have open water access in and around New Castle, Portsmouth, and Rye, NH, are valued 258 percent higher per-acre than medium-access properties, according to tax assessor data. As a result, property value differences were reviewed as part of this BCA, as a bascule bridge offers the potential for increased open water access, while a fixed bridge is far more limiting.

In addition to USDOT's acknowledgement that property value increases may be appropriate for inclusion in a BCA, a 2010 Texas Transportation Institute Workshop suggested that real estate benefits can occasionally be included in Benefit-Cost Analyses if the associated improvements provide value over and above what would have occurred in the absence of the project.[4] This typically applies to improvements in transportation and transit infrastructure, but the land-side improvement of a movable bridge may be argued to improve the water access, and thus the value of properties just to the inside of the bridge. However, during research performed for this Benefit-Cost Analysis, no studies were found that address property value impacts as they relate specifically to water access changes driven by movable or fixed bridge types. Therefore, there was no precedent found indicating property values are changed as a direct result of access through a movable or fixed bridge, nor to what extent values may change as a result of a change in water access caused by the presence or lack of a movable bridge.

Due to the difficulty in isolating the increase in property value associated with water access, a detailed analysis was unable to be completed. However, for purposes of illustrating the range of monetary benefits that could be associated with property value increases, a simplistic analysis investigates the average increase in property value that would be required to offset the higher costs of the bascule alternative. This analysis examines the average property value of properties with full water access as compared to medium water access and limited water access, which are considered to be properties that have access permanently restricted by obstructions such as shallow water depths or fixed bridges. Currently, the ability to access the open ocean from the Back Channel is limited due to the operational windows available to have the bridge lift. The new bascule bridge may allow marine traffic to more freely travel between the ocean and the Back Channel if two conditions were met: remotely controlled lifts allowing for shorter notice by vessels than the current four-hour notice, and dredging of the Back Channel, allowing larger vessels to navigate through that area. Both of these conditions are under consideration, but nether are currently slated to have funding for completion. This analysis will assume that both of these conditions are met, for purposes of illustrating the possible benefits associated with increased marine access.

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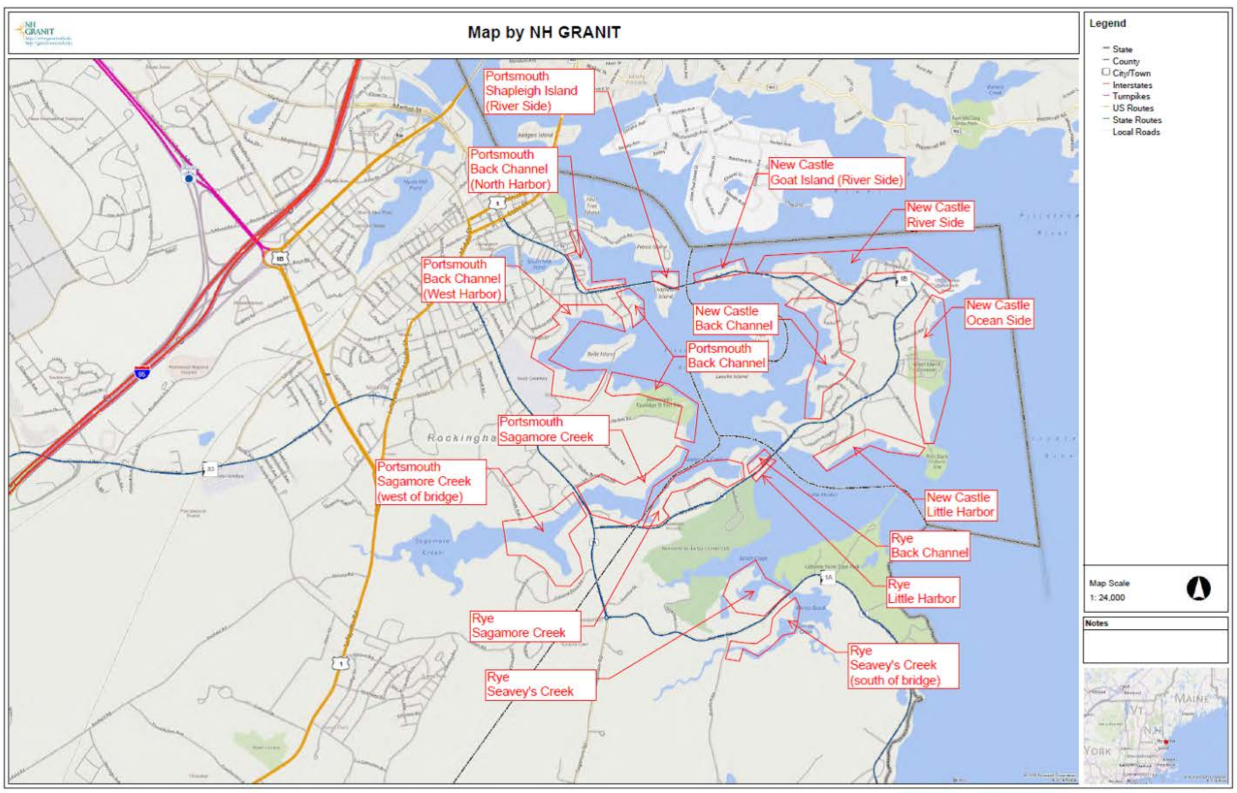
[2] Brown and McCabe; "Current Issues Concerning View Attributes in the Appraisal of Real Estate"
[3] Restore America's Estuaries; "The Economic and Market Value of Coasts and Estuaries: What's at Stake?"
[4] TTI Workshop Proceedings; "Benefit/Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop"; May 17, 2010.

The first step in conducting the analysis was to identify the various parcels to include. Existing parcels and property values for waterfront properties in Portsmouth, New Castle, and Rye were extracted from the Tax Assessor database. These parcels come from 15 different areas, as indicated in the map below. Waterfront properties in these areas were then sorted into one of three categories (full access, medium access, or limited access) based on their access to open and deep water. Parcels on the outside of the Back Channel and Sagamore Creek areas with ocean access without the restriction of a bridge were considered full access. Those parcels on the dredged portion of Sagamore Creek and the Back Channel but inside the bridge are considered medium access. Those waterfront parcels that require boating through undredged areas after entering the Back Channel are considered limited access.

Figure A1: New Castle-Rye, NH, Study Area Properties



The study area contained a total of 273 properties that were included in this analysis, 101 properties of which were considered to have full water access, 87 properties with medium access, and 85 properties with limited access. The breakdown of areas by access type is as follows:

- Full access
  - New Castle – Goat Island, River Side; Little Harbor, South; Ocean Side, East; River Side, North
  - Rye – Concord Point; Little Harbor; Rye Harbor
- Medium access
  - New Castle – Back Channel, West

  - Portsmouth – Back Channel; Back Channel, West Harbor; Shapleigh Island, River Side
  - Rye – Back Channel; Sesavehy's Creek, North of Bridge
- Limited access
  - Portsmouth – Back Channel, North Harbor; Sagamore Creek
  - Rye – Sagamore Creek; Seavey's Creek, South of Bridge

The table below depicts the total, average, and median property values per parcel for each of the three categories. The 101 properties with full water access have a substantially higher property value than the medium access properties, which have a higher average property value than the limited access properties. The average and median value of the full-water access properties are greater than the average and median value of all properties considered, as shown in the table below.

Table A1: Number of Properties and Value by Water Access Type

	Number Properties	Total Property Value	Average Property Value	Median Property Value
Full Access	101	$147,480,800	$1,460,206	$1,251,200
Medium Access	87	$69,529,400	$799,189	$794,200
Limited Access	85	$45,398,600	$534,101	$486,800
Total	273	$262,408,800	$961,204	$826,300

In addition to these existing residential properties, a commercial marina and a bait and tackle shop are located within the Back Channel area, and are two of the only commercial properties in this area. The marina is currently valued at $1.33 million, though this 3.07 acre property has the potential to increase in value due to the increased water access associated with the on-demand movable bridge.

It should be noted that for purposes of this analysis, the residential parcels were only examined at a high level, and not in detail. If further study were to be done, greater analysis of the various parcels, including any attributes that would potentially alter the value of the property beyond water access, would be considered. This detailed analysis has the potential to greatly alter the outputs of the preliminary property analysis.

The higher property values of the full access parcels may not be exclusively due to deep water boating access. Other factors, including view and potential beach or seashore access, may influence property values. As a result, only a partial premium can be added to the medium access properties associated with the improved water access due to the on-demand movable bridge. This premium reflects the increase in property value over-and-above the increase in value that would be expected over time, absent the improved water access.

As this is the only easily quantifiable benefit associated with the two alternatives, the analysis sought to identify the magnitude of the property value increase required to offset the incremental cost difference between the two bridge alternatives. Using the current average assessed values for the medium access properties, the necessary increase in both residential and commercial properties[5] would be approximately 16.6 percent. This property value increase isolates growth associated with increased access, and is independent of other factors, such as appreciation and market demand. It should be noted that this is strictly a high level estimate and should not be used to estimate additional property tax revenue that could be generated. This calculation is also not an indication of expected property value increase, but solely reflects the increase that corresponds to the cost differential between the two bridge alternatives.

The 16.6 percent premium equates to an average of $109,730 per residential property. This reflects the total property value increase over the useful life of the bridge, 75 years, and equates to approximately $1,540 in additional property value per property per year. For purposes of this analysis, it is assumed that 25 percent of the annual increase will accrue in the first year, and it will take 10 years to reach the full value of the increase due to increasing certainty and realization of the availability of this resource (water access). These assumptions result in a total residential property value increase of $9.9 million over the time horizon.

Using similar assumptions to the residential properties, the commercial marina site also has the potential to increase in value due to the improved access afforded by the on-demand movable bridge. Using the same growth assumptions and 16.6 percent increase for the marina, property values over the 75-year horizon could increase $357,000, an average annual increase of $5,010.

The combination of a 16.6 percent increase in property value for both the residential and commercial marina properties would offset the additional cost of an on-demand movable bascule bridge, with a total value increase of approximately $9.9 million. As there is no precedent indicating the anticipated property value increase associated with movable bridges, sensitivity calculations were also done assuming various other property premiums. The results indicating the total dollar increase in property values based on percentage increases are shown in the table below.

Table A2: Property Value Increases (4% discount rate)

Lifetime Property Premium	Total Benefits
20%	$ 11,932,000
16.6%	$ 9,903,000
15%	$ 8,949,000
13%	$ 7,756,000
10%	$ 5,966,000
7%	$ 4,176,000
5%	$ 2,983,000
3%	$ 1,790,000

[5] This includes the marina in the Back Channel.

It is possible that this increase in property value could be composed differently – with a greater increase in commercial property value than residential, or vice versa. For the purposes of this analysis, the property value increase was assumed to be the same regardless of land use.