3 Proposed Action and Alternatives

3.1 Introduction

As indicated in **Chapter 1, Introduction**, and pursuant to 23 United States Code (USC) 139(f)(4)(E)(ii), the Cape Cod Bridges Program (Program) builds upon and references prior, multi-year foundational studies, including the U.S. Army Corps of Engineers' (USACE's) Major Rehabilitation Evaluation Report/Environmental Assessment (MRER/EA) of the Cape Cod Canal highway bridges.

This chapter identifies the alternatives from the MRER/EA that the Massachusetts Department of Transportation (MassDOT) evaluated, including those considered but dismissed from further evaluation. It describes the alternatives that are retained for detailed study in this Draft Environmental Impact Statement (DEIS), which are a No Build Alternative and a Build Alternative, identified as "Replacement Highway Bridges Built to Modern Design Standards." It also summarizes the extensive analyses MassDOT conducted of multiple bridge design and highway interchange approach options for the Build Alternative, leading to the identification of preferred options and their incorporation into the Preferred Alternative.

MassDOT documented its alternatives assessment process in the following reports, provided in **Appendix 3.1, Alternatives Assessments Technical Report**:

- **Attachment 1, Cape Cod Bridges Program Alternatives Analysis Report** (July 2025), which provides the following:
  - Conceptual-level screening of the USACE's MRER/EA alternatives, resulting in a recommendation for in-kind bridge replacement.
  - Assessments of options and identification of the recommended bridge highway cross-section and shared-used path, bridge vertical and horizontal clearances, main span length and bridge pier location, bridge deck configuration, mainline alignment location, and bridge type, which were conducted at the 5% through 15% design level.
  - Initial assessment of highway interchange approach options, resulting in advancement of 10 options for a more detailed, 15% design-level evaluation.
- **Attachment 2, Cape Cod Bridges Program - Highway Interchange Approaches Detailed Assessment Report** (July 2025), which provides details of the secondary, 15% design-level evaluation of 10 interchange approach options that passed the initial assessment and resulted in a single pairing of options for each replacement bridge crossing.

This chapter also presents MassDOT's Preferred Alternative for the Program, including the preferred bridge design parameters, the preferred highway interchange approach options, and the intersection control recommendations. Additionally, this chapter presents an overview of the construction approach for the Program, which is described in further detail in **Appendix 3.2, Construction Approach Technical Report**.

3.2 Alternatives Screening

The National Environmental Policy Act (NEPA) (42 USC 4321 et. seq.), as amended, requires that Environmental Impact Statements identify and consider a reasonable range of alternatives that are technically and economically feasible and meet the purpose and need of the proposal. As described in 23 CFR 771.105, the Federal Highway Administration's (FHWA) NEPA-implementing regulations, it is the U.S. Department of Transportation's policy to evaluate alternative courses of action and determine the proposed action that is in the "best overall public interest based upon a balanced consideration of the need for safe and efficient transportation; of the social, economic, and environmental effects of the proposed transportation improvement; and of national, State and local environmental protection goals."[1] Alternatives can be rejected as unreasonable based on the inability to meet the purpose and need for a proposed action, in addition to other factors, including environmental effects, engineering, and cost.[2]

In coordination with FHWA, and according to 23 CFR 771, MassDOT conducted an independent conceptual screening of 12 alternatives presented by the USACE in the MRER/EA. These alternatives comprised the USACE's "Universe of Alternatives" for addressing the deteriorating Sagamore and Bourne Bridges. MassDOT reviewed the USACE MRER/EA alternatives relative to the Program's Purpose and Need Statement and NEPA guidance to evaluate the alternatives for reasonableness.

MassDOT screened the alternatives in the USACE's MRER/EA relative to the Program's Purpose and Need Statement and NEPA guidance on reasonable alternatives.

MassDOT determined that replacing both bridges with two new adjacent bridges at each crossing location, each providing two through-traffic lanes and an auxiliary lane in each direction and built to current design standards, would meet the identified Program needs to address the escalating bridge maintenance demands and improve traffic operations and accommodations for pedestrians and bicyclists. Based on its ability to fully meet the Program's needs while minimizing the approach road modifications necessary to connect the replacement bridges to the regional and local transportation system, MassDOT recommended advancing for further consideration the "Four Travel Lanes and Two Auxiliary Lanes Replacement" alternative (referred to as Replacement Highway Bridges Built to Modern Design Standards), the USACE's Preferred Alternative presented in the MRER/EA. MassDOT's recommended alternative, Replacement Highway Bridges Built to Modern Design Standards, was used as the basis for assessing the Program's bridge and highway design parameters (discussed in **Section 3.3.2**).

Table 3-1 summarizes MassDOT's evaluations and determinations of the 11 remaining alternatives from the MRER/EA, including reasons for their dismissal.

[1] https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-771

[2] American Association of State Highway and Transportation Officials' Practitioner's Handbook 07 Defining Purpose and Need and Determining the Range of Alternatives for Transportation Projects

Table 3-1. Summary Evaluation of Other Alternatives Considered

Alternative	MassDOT's Evaluation and Determination
No Build/Base Condition	The No Build Alternative (Major Rehabilitation Evaluation Report/Environmental Assessment Base Condition) would not meet the Cape Cod Bridges Program's (Program) Purpose and Need Statement. The component deficiencies of the bridges and their increasingly frequent maintenance needs would continue to impede mobility and accessibility for road users crossing Cape Cod Canal. Further, the Base Condition would result in unacceptable safety or operational problems. While the Massachusetts Department of Transportation (MassDOT) determined that this alternative is not reasonable, per the National Environmental Policy Act, it is retained as a baseline alternative against which the Build Alternative is evaluated.
Major Rehabilitation of Both Highway Bridges	MassDOT determined that the Major Rehabilitation Alternative is not reasonable, as it would not meet the identified needs of the Program for addressing the underlying structural and roadway design deficiencies of the Sagamore and Bourne Bridges and improving accommodations for pedestrians and bicyclists. The component deficiencies of the bridges, combined with prolonged construction-period bridge closures and ongoing maintenance requirements, would continue to impede mobility and accessibility for road users crossing Cape Cod Canal. Ongoing deterioration would result in unacceptable safety or operational problems, and the extended construction period with partial and/or full closures of the bridges would result in severe disruption to the town of Bourne and surrounding communities on and off Cape Cod.
Replacement of One or Both Highway Bridges with New Bridges, each Limited to Four Through-Traffic Lanes	MassDOT determined that this alternative is not reasonable, as follows: it would not fully meet current Federal Highway Administration (FHWA) and MassDOT highway design standards, it would not meet the Program's needs of addressing the substandard design elements of the bridges or improving vehicular traffic operations, and it would not resolve existing safety and operational problems.
Replacement of One or Both Highway Bridges with New Bridges with Additional (More than Four) Non-Federally Funded Through-Traffic Lanes, and Two Auxiliary Lanes	MassDOT determined that this alternative is not reasonable, as it would not meet the Program's Purpose and Need Statement, which does not include increasing traffic capacity. Providing additional traffic capacity across one or both replacement highway bridges would require considerable traffic capacity upgrades to the regional highway network on both sides of Cape Cod Canal. It is likely these upgrades would have substantial construction costs and extensive environmental, land use, and community effects.

Alternative	MassDOT's Evaluation and Determination
Replacement of Both Highway Bridges with a Single New Bridge	MassDOT determined that this alternative is not reasonable because it would not meet the Program's Purpose and Need Statement to improve cross-canal mobility and accessibility. One mid-canal bridge crossing would decrease road user accessibility for cross-canal trips, as the replacement bridge would be located farther from developed residential and commercial areas on both the Cape Cod and mainland sides of the canal in the town of Bourne. The single replacement highway bridge would require extensive redesign and realignment of the transportation network on both sides of the canal, including utility corridor relocations, resulting in extensive effects to residential and commercial land uses, Joint Base Cape Cod, as well as sensitive environmental resources, including wetlands, open space, and rare species habitat. Further, with a single bridge crossing, this alternative would introduce a level of risk associated with emergency evacuation, access to national defense facilities, and emergency response.
Construction of a New Third Highway Bridge	MassDOT determined that this alternative is not reasonable, in combination with either the Base Condition or Major Rehabilitation, as it would not meet the identified Program need to address the underlying structural and roadway design deficiencies of the existing bridges and would result in unacceptable safety or operational problems. Further, MassDOT determined that this alternative is not reasonable in combination with a bridge replacement alternative, due to its substantial engineering costs and adverse natural resource impacts. MassDOT evaluated the concept of providing a roadway connection from State Route 25 to U.S. Route 6, including a third highway bridge across Cape Cod Canal, in the 2019 Cape Cod Canal Transportation Study. This concept was dismissed from further evaluation in that study because of the potential effects to residential neighborhoods, wetland and drinking water resources, and sensitive tribal areas.
Replacement of One or Both Highway Bridges with a Single Tunnel or Tunnels	MassDOT determined that this alternative is not reasonable, regardless of replacing one or both highway bridges. Replacing one highway bridge with a tunnel would not meet the Program's Purpose and Need Statement to address the underlying structural and roadway design deficiencies of the existing bridges. Replacing both highway bridges with a single tunnel or tunnels would not meet the Program's Purpose and Need Statement to improve accommodations for pedestrians and bicyclists. Pedestrians and bicyclists would need other means to cross the Cape Cod Canal as they would be prohibited from traveling within the tunnel(s) due to air quality and safety concerns. Tunnels also have substantial vertical clearance restrictions, which would impede mobility for oversized commercial vehicles crossing the canal. Further, this alternative would require extensive reconfiguration of the existing approach highways, resulting in extensive effects to wetlands, recreational facilities, residences, businesses, and Joint Base Cape Cod.

Alternative	MassDOT's Evaluation and Determination
Replacement of One or Both Bridges with Low-Level Draw Spans	MassDOT determined that this alternative is not reasonable, as it would not meet the Program's Purpose and Need Statement to improve cross-canal mobility and accessibility between Cape Cod and the mainland for all road users. Low-level draw spans would require frequent draw span openings for passage of marine vessels, which would result in substantial traffic disruptions and delays to road users crossing Cape Cod Canal. These disruptions and delays would be compounded during the summer months and would be overly burdensome to town of Bourne residents who rely on the bridges for their daily activities and livelihood. Replacing one of the existing highway bridges with a low-level span would not meet the Program's need to address the ongoing maintenance requirements of the existing Sagamore and Bourne Bridges. Low-level draw spans require increased maintenance compared to high-level bridges and are susceptible to operational issues as they age, which would be highly disruptive to traffic crossing the canal.
Replacement of One or Both Bridges with Low-Level Causeways	MassDOT determined that this alternative is not reasonable, as it would not meet the Program's Purpose and Need Statement to improve cross-canal mobility and accessibility between Cape Cod and the mainland for all road users. Low-elevation roadways across Cape Cod Canal would require extensive profile modifications to local roads and regional highway connections on the Cape Cod and mainland sides of the canal, which would carry high infrastructure costs as well as major traffic disruptions. Further, Cape Cod Canal and the areas surrounding Bourne Bridge are mapped within high-risk flood zones. Low-level causeways would be increasingly vulnerable to flooding due to fluctuations in relative sea level and coastal storm surge. Flooding issues along these low-elevation causeways would impair mobility and create unsafe conditions for road users, which would threaten efficient and effective responses to public health emergencies and disasters.
Deauthorization and Closure of Cape Cod Canal	MassDOT determined that this alternative is not reasonable based on the high costs, extent of adverse effects to the coastal environment, and anticipated substantial adverse socioeconomic effects. Filling in Cape Cod Canal would severely affect environmental resources protected under other federal statutes, including the Essential Fish Habitat of multiple species protected under the Magnuson Stevens Fishery Conservation and Management Act; the endangered North Atlantic Right Whale, protected under the Endangered Species Act (ESA); and non-ESA listed whales, dolphins, porpoises, and seals protected under the Marine Mammal Protection Act. Additionally, because the Cape Cod Canal is a federally authorized Civil Works Project, the Canal Deauthorization Alternative is not within MassDOT's authorization. Further, this alternative would result in substantial adverse effects to Cape Cod residents and visitors who use the canal facilities for recreation.

3.3 Alternatives Retained for Detailed Study

This section describes the No Build Alternative and Build Alternative (Replacement Highway Bridges Built to Modern Design Standards), which are retained for further evaluation in this DEIS.

3.3.1 No Build Alternative

In the No Build Alternative, Sagamore and Bourne Bridges would retain their current configuration of:

- A single approximately 48-foot, 8-inch-wide highway deck at each crossing, consisting of four 10-foot-wide travel lanes, two in each direction, separated by a double-yellow centerline
- One 6-foot, 8-inch-wide sidewalk
- A 2-foot-wide safety curb (refer to **Figure 1-2** in **Chapter 1**)
- Steep approach grades of 6% (**Figure 3-1**)

The bridges would retain their vertical clearance of 135 feet above mean high water (MHW). The bridge piers, supporting a 616-foot main span, would be located within the waterway and outside the 480-foot authorized navigation channel and 500-foot horizontal clearance at the bridge sites.

The USACE would continue to manage and maintain Sagamore and Bourne Bridges as components of the Cape Cod Canal Federal Navigation Project. The No Build Alternative represents the "Fix as Fails" Base Condition of the USACE's MRER/EA, where the USACE would implement an ongoing program of continued inspections and maintenance and repair of both existing bridges as needed to maintain safety. No major rehabilitation efforts involving extensive repairs and replacement of major bridge components would occur. Structural components would be repaired, and critical elements would be replaced only when inspections indicate unsatisfactory reliability ratings. The MRER/EA indicates that the deteriorated condition of both highway bridges is well beyond the state in which actions and funding from the USACE's operations and maintenance program could correct the deficiencies and restore and sustain reliability. The USACE indicated that as the bridges continue to age, routine maintenance and minor component replacement would result in an unacceptable structural condition. As a result, it is likely that lower vehicle weights, traffic volume restrictions, and speed limits would be required and posted to maintain continued bridge safety.

The No Build Alternative would include recently completed and proposed transportation improvement projects identified in the Federal Fiscal Year (FFY) 2025-2029 Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization.[3] **Table 3-2** identifies the Transportation Improvement Program projects that are part of the No Build Alternative. These projects include Transportation System Management (TSM) improvements such as installation of new traffic signals and/or signal optimization measures, improved roadway markings and signage, installation of shared-use paths, and other projects to maximize the efficiency of the existing system.

[3] The Transportation Improvement Program was endorsed on May 20, 2024, with subsequent amendments on November 18, 2024; December 16, 2024; February 24, 2025; April 28, 2025; and June 16, 2025.

Table 3-2. Transportation Improvement Program Projects, 2025–2029

Project Number	Year	Transportation Project	Project Description	Status
606900	2020	Belmont Circle Traffic and Multimodal Improvements	Traffic and multimodal improvements at Belmont Circle at U.S. Route 6 and State Route 25 and State Route 28	Completed
608422	2022	Trail Improvements – Sandwich	Shared-use path on Service Road (State Route 130 to Chase Road)	Underway
610542	2023	Bourne Rotary Improvements	• Restriping Bourne Rotary to two lanes and adding a channelized right-turn lane from State Route 28 northbound to Sandwich Road eastbound • Adding signs at Bourne Rotary • Installing flashing beacons at the Bourne Rotary approaches	Underway
613195	2024	Bridge Systematic Maintenance	Bridge deck replacement of the Quaker Meetinghouse Road Bridge over U.S. Route 6/Mid-Cape Highway as part of an overall bridge preservation strategy	Programmed
609262	2025	Bourne Rail Trail, Phase 1	First phase of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 1 is approximately one-half mile long within the existing right-of-way of the Old Colony Railroad (Woods Hole branch line) from the Canal Service Road to Monument Neck Road.	Programmed
610673	—	Bourne Rail Trail, Phase 2	Phase 2 of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 2 is approximately 2 miles long from Monument Neck Road to Monk's Park/ Valley Bars Road.	Not Programmed
---	—	Bourne Rail Trail, Phase 3 and Phase 4A	Phase 3 and Phase 4A of four planned phases of the Bourne Rail Trail connection to Shining Sea Bikeway to the south in Falmouth	Not Programmed

Project Number	Year	Transportation Project	Project Description	Status
607394/ 611998	—	Bourne Rail Trail, Phase 4B	Phase 4B of four planned phases of the Bourne Rail Trail connection to the Shining Sea Bikeway to the south in Falmouth and to the Cape Cod Canal path (Canal Service Road) in the town of Bourne; Phase 4B is approximately 1 mile long, extending the Shining Sea Bikeway from its current terminus in North Falmouth into the town of Bourne.	Not Programmed
606082	2025–2028	U.S. Route 6 Scenic Highway Median Installation	• Resurfacing • Safety improvements, including a raised center median and expanded shoulders to separate eastbound and westbound travel lanes • Drainage improvements • Traffic signal improvements at two intersections • Shared-use path	Programmed
612053	2025	Bourne/Sandwich, Resurfacing and Related Work on U.S. Route 6	Improvements to pavement serviceability, condition, and roadway safety on U.S. Route 6 from Sagamore Bridge to the Sandwich town line (8.55 miles)	Programmed
613200	2026	Chase Road over U.S. Route 6 Bridge	Bridge deck replacement of Chase Road over U.S. Route 6 (Mid-Cape Highway) bridge structure in the town of Sandwich	Programmed
612063	2028	State Route 28 Resurfacing and Related Work	Improvements to pavement serviceability, condition, and roadway safety on MacArthur Boulevard (State Route 28) from Bourne Rotary to Otis Rotary	Programmed
613199	2028	U.S. Route 6 over State Route 130 Bridge	Bridge deck replacement of U.S. Route 6 (Mid-Cape Highway) bridge structure over State Route 130 in the town of Sandwich	Programmed
613271	—	Shared-use path, State Route 130 to Canal Service Road	Shared-use path from State Route 130 to Canal Service Road in the town of Sandwich	Not Programmed

Note: **Table 3-2** includes only those projects in the Study Areas that are part of the No Build Alternative. It does not include Project S13144, the replacement of the Sagamore Bridge, which was added to the Federal Fiscal Year (FFY) 2025-2029 Transportation Improvement Program as Amendment #2, December 9, 2024.

— No date available.

As described in **Table 3-1**, the No Build Alternative would not meet any of the Program's needs. However, in accordance with NEPA, the No Build Alternative serves as a baseline against which the Build Alternative is evaluated in this DEIS.

3.3.2 Build Alternative: Replacement Highway Bridges Built to Modern Design Standards

This section describes the Build Alternative, Replacement of the Sagamore and Bourne Bridges with new bridges built to modern design standards, along with the multiple bridge design parameters and highway interchange approach improvements that comprise the Program.

As described in **Chapter 1, Section 1.2**, the Program builds upon its foundational documents and findings, consisting of MassDOT's Cape Cod Canal Transportation Study and the USACE's Preferred Alternative identified in the MRER/EA to replace both highway bridges with new bridges, consisting of four through-traffic lanes and two auxiliary lanes, and updated to comply with current design standards.[4]

In addition to identifying a Preferred Alternative in the MRER/EA, the USACE reviewed bridge design parameters and made recommendations for the bridge highway cross-section, bridge clearances, pier location, bridge deck configuration, and mainline alignment location.

Incorporating the USACE's Preferred Alternative and considering the MRER/EA's additional recommendations for the replacement bridges, MassDOT conducted independent evaluations of the following design parameters for the Build Alternative at the schematic, conceptual (5%), and preliminary (10 through 15%) design levels relative to the Program's purpose and need, as well as other factors including environmental effects, public safety, and cost:

- Highway Bridge Cross-Section and Shared-Use Path
- Bridge Vertical and Horizontal Navigation Clearances
- Main Span Length and Bridge Pier Location
- Bridge Deck Configuration
- Mainline Alignment Location
- Bridge Type
- Highway Interchange Approach Improvements

MassDOT incorporated the MRER/EA's Preferred Alternative and conducted extensive analyses to evaluate the USACE's bridge design recommendations and interchange approaches reconfiguration.

Sections 3.3.2.1 through 3.3.2.6 identify the bridge design parameters and summarize the multiple analyses that resulted in the preferred bridge design options for the Build Alternative. **Sections 3.3.3.1 through 3.3.3.5** identify the highway interchange network improvements and summarize the multiple analyses that resulted in the preferred highway interchange approach options for the Build Alternative.

[4] The Build Alternative incorporates the TIP Projects listed in **Table 3-2**, as well as Project S13144, the replacement of the Sagamore Bridge, which was added to the FFY 2025-2029 TIP as Amendment #2, December 9, 2024. As described in **Section 4.22, Indirect Effects**, the Build Alternative is consistent with the Cape Cod Regional Transportation Plan, including meeting its congestion management goals.

Refer to **Appendix 3.1, Alternatives Assessments Technical Report, Attachments 1 and 2**, for further details, including descriptions of the options that were considered and eliminated from further evaluation.

3.3.2.1 Highway Bridge Cross-Section and Shared Use Path

In accordance with MassDOT and FHWA design criteria, as well as American Association of State Highway and Transportation Officials (AASHTO) guidelines, MassDOT evaluated the proposed highway bridge cross-section and the maximum profile grades relative to the MRER/EA's Preferred Alternative. MassDOT confirmed that each new highway bridge would include the following (consistent with MassDOT and AASHTO design criteria):

- Four 12-foot-wide through travel lanes (two in each direction)
- Two 12-foot-wide auxiliary lanes (one in each direction)
- A shoulder
- A separation median
- Maximum approach grades typical for a limited-access highway

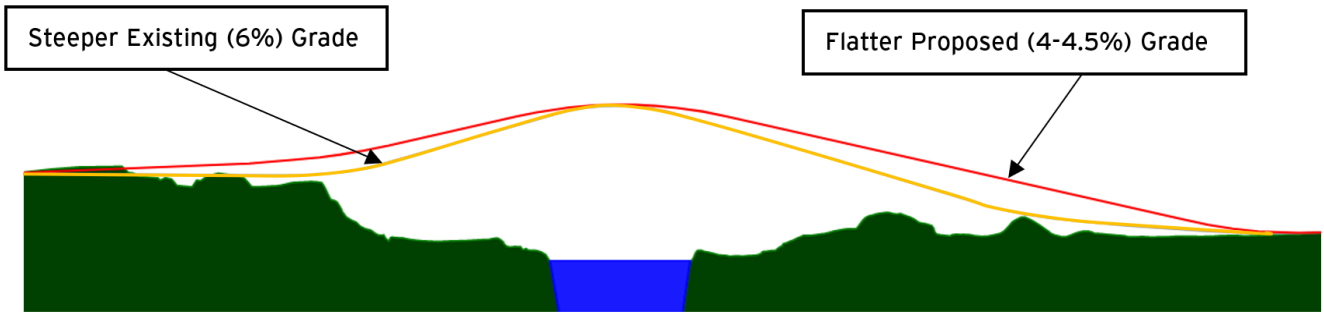
MassDOT developed the highway bridge layout using current FHWA directives and guidance and AASHTO highway design standards.

Additionally, each highway bridge would have one bidirectional shared-use path (SUP) separated from vehicular traffic by a shoulder and barrier.

To confirm the USACE's decision to include auxiliary lanes in the replacement highway bridge roadway design, MassDOT evaluated design criteria that would warrant a continuous auxiliary lane over the bridge structures, including interchange spacing, traffic operations under No Build Alternative conditions, geometric guidelines, and constructability. Per AASHTO highway design standards for adequate acceleration lane, deceleration lane, and taper lengths for interchange access to the bridges north and south of the canal crossings, a continuous auxiliary lane in each direction for the full length of Sagamore Bridge and in the southbound direction for the full length of Bourne Bridge would be required. For the northbound Bourne Bridge crossing, the constructability of the bridge and the need to accommodate users during construction would necessitate the additional structure width for the full length of Bourne Bridge.

Considering the functional classification and the rolling terrain at both bridge sites, MassDOT evaluated the appropriate profile grade for each highway bridge. In contrast to the steep 6% roadway grade, MassDOT proposed a flatter roadway grade, consisting of a 4.5% grade at Bourne Bridge and 4% grade at Sagamore Bridge (**Figure 3-1**). The flatter grades would improve safety by reducing the speed variations due to grade changes, especially for trucks approaching the crest of the bridges; reduce the likelihood of vehicles having difficulties (stalling) during snow and ice events; and be consistent with current design standards.

Figure 3-1. Highway Bridge Roadway Grade



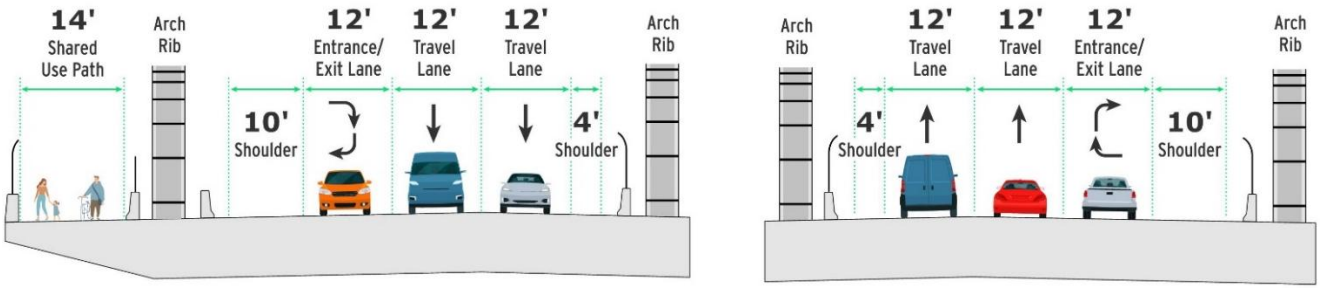
Source: Massachusetts Department of Transportation, 2024

MassDOT evaluated the MRER/EA's decision to include a single, dedicated 10-foot-wide SUP for pedestrians and bicyclists for each crossing. MassDOT determined that the proposed SUP at each canal crossing would be designed in accordance with MassDOT, AASHTO, and FHWA design criteria, as well as the guidance of the Americans with Disabilities Act and the Architectural Access Board. The flatter approach grade would improve the rider experience for cyclists (which would make it easier to cycle uphill to the crest of the bridge) and would increase safety for pedestrians (which would reduce the potential for excessive bicycle speed on the downhill). MassDOT recommended the following for the effective width of the SUP (width from edge of pavement to edge pavement):

- 14 feet wide on the bridge main spans
- 20 feet wide on the interchange approaches
- 12 feet wide on the connecting roadways

Figure 3-2 presents a schematic of the highway bridge cross-section at Sagamore and Bourne Bridges.

Figure 3-2. Replacement Highway Bridge Cross-Section



Source: Massachusetts Department of Transportation, 2024

3.3.2.2 Bridge Vertical and Horizontal Navigation Clearances

MassDOT evaluated the vertical and horizontal clearances for the replacement bridges relative to the recommendations presented in the USACE's MRER/EA. The MRER/EA indicated that to maintain the existing vertical clearance of 135 feet above MHW, the height of the new bridges should be increased to accommodate fluctuations in relative sea level. Additionally, the USACE indicated that horizontal clearance for navigation must be considered with the replacement bridge design.

To accommodate fluctuations in relative sea level, MassDOT recommended an increase in bridge height of 3.3 feet, for a total proposed vertical clearance of 138.3 feet above MHW. Incorporating the USACE's preferences regarding navigation, MassDOT recommended that the replacement bridge structures provide a minimum of 500 feet of horizontal navigational width to be consistent with existing conditions. MassDOT's recommendations were confirmed by the First Coast Guard District in its Preliminary Navigation Determination for the Program, issued on March 11, 2025, as referenced in **Section 4.4, Maritime Transportation, Traffic, and Safety**.

MassDOT incorporated USACE's recommendations and the U.S. Coast Guard's determinations for the proposed bridge vertical and horizontal clearances.

3.3.2.3 Main Span Length and Bridge Pier Location

The bridge piers for the existing Sagamore and Bourne Bridges are within Cape Cod Canal and just outside the 480-foot authorized navigation channel (in-water bridge piers) and support a mainline center span length of 616 feet. MassDOT evaluated the USACE's preference for locating the proposed bridge piers outside of the canal cut, with a longer mainline center span length, to improve navigation, operations, and maintenance, as indicated in the MRER/EA.

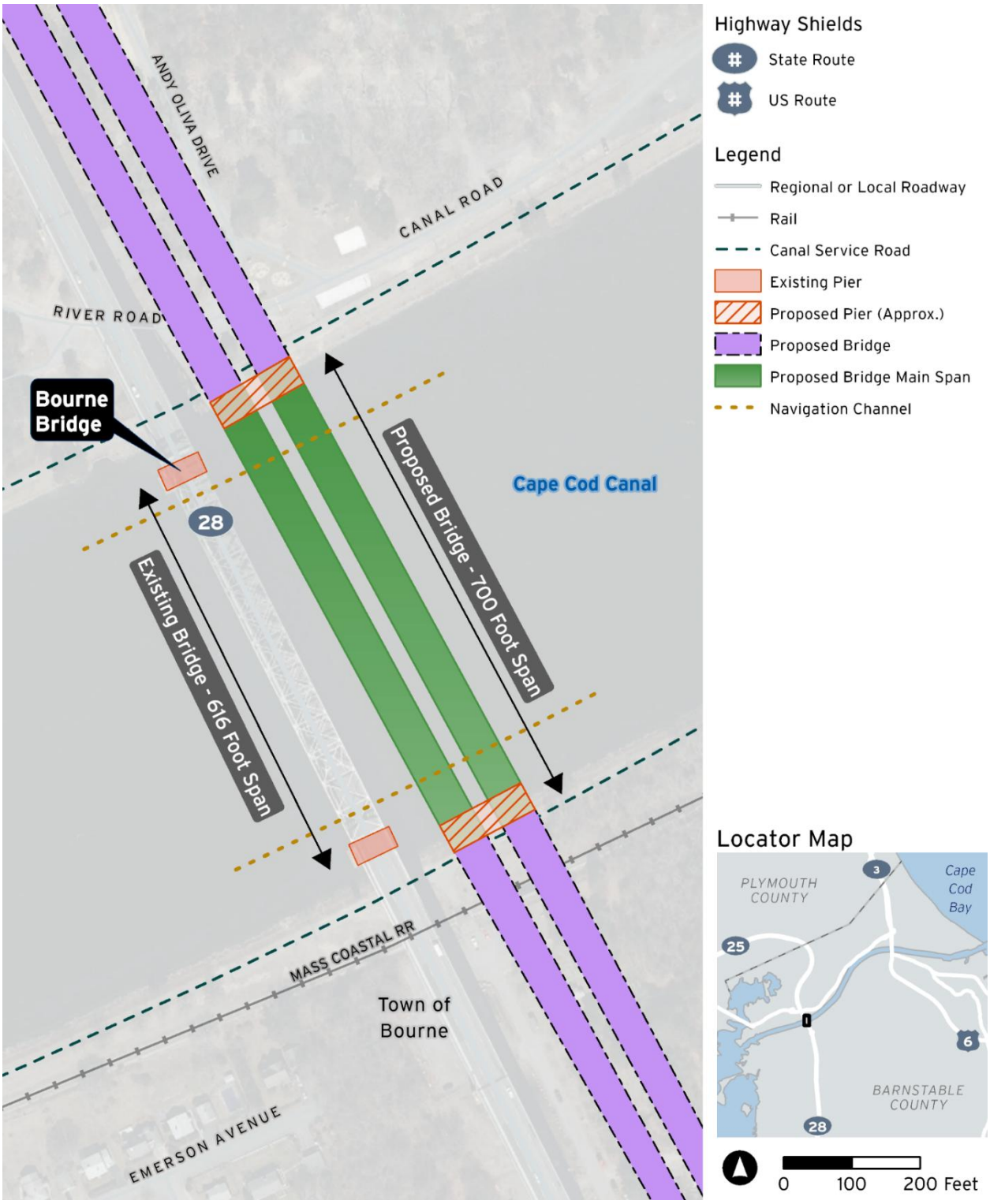
MassDOT identified an out-of-water bridge pier option and conducted an initial assessment of the main span length and bridge pier location options against the applicable bridge design evaluation criteria:

- Costs
- Location of main span footings (including potential for vessel effect and scour)
- Construction (including constructability, navigation, and environmental considerations)

This initial assessment resulted in a recommendation for an out-of-water bridge pier option with two potential main span lengths of approximately 700 feet and 820 feet. The out-of-water bridge pier option would minimize the potential for vessel collisions; minimize direct and indirect effects to marine species and habitats; and reduce or eliminate the potential for bridge scour, where fast-moving currents remove sediment from around the piers and potentially compromise their stability. Additionally, by locating the bridge piers farther from the authorized 480-foot navigation channel width, this option would maximize the effective horizontal clearance, which would improve marine traffic conditions. Finally, MassDOT evaluated the bridge pier options relative to bridge construction. With the out-of-water bridge pier location, all construction activity, including construction work platforms and other temporary support work, would be outside of the navigation channel and would not affect canal operations. In contrast, installing the bridge piers at or near the navigation channel (in-water bridge pier option) would be more likely to adversely affect marine traffic during bridge construction.

MassDOT further evaluated the main span lengths as part of a detailed bridge fabrication and erection methodology analysis for the bridge type. The detailed assessment included a review of off-site arch fabrication, float-in operations, and arch lifting operations. Based on a detailed constructability assessment, MassDOT identified the 700-foot main span with the bridge piers located within the riprap slope of the canal and above the low tide line as the preferred option (**Figure 3-3**).

Figure 3-3. Main Span Length and Pier Location (Preferred Option)

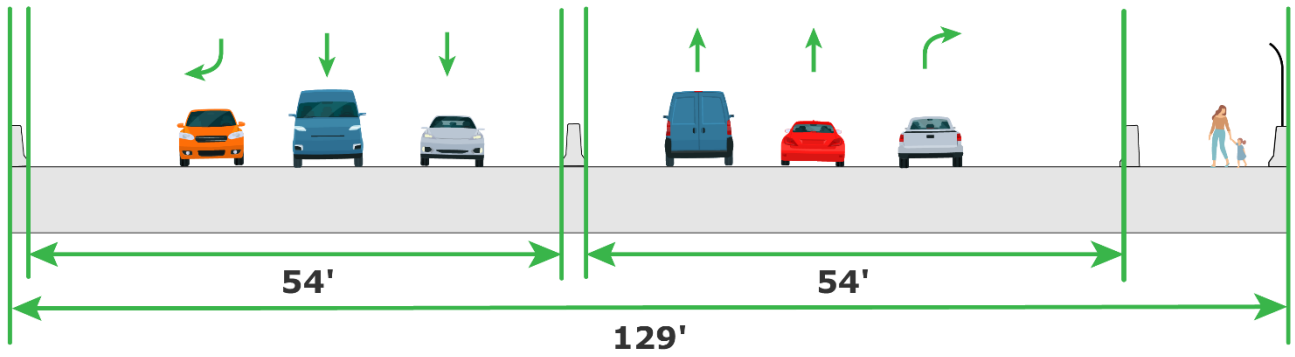


Source: Massachusetts Department of Transportation, 2025

3.3.2.4 Bridge Deck Configuration

The existing Sagamore and Bourne Bridges each provide a single +48-foot-wide highway bridge deck. To update the highway bridges per MassDOT, AASHTO, and FHWA highway design criteria, in the MRER/EA, the USACE proposed an approximate 129-foot-wide single bridge deck at each crossing (**Figure 3-4**).

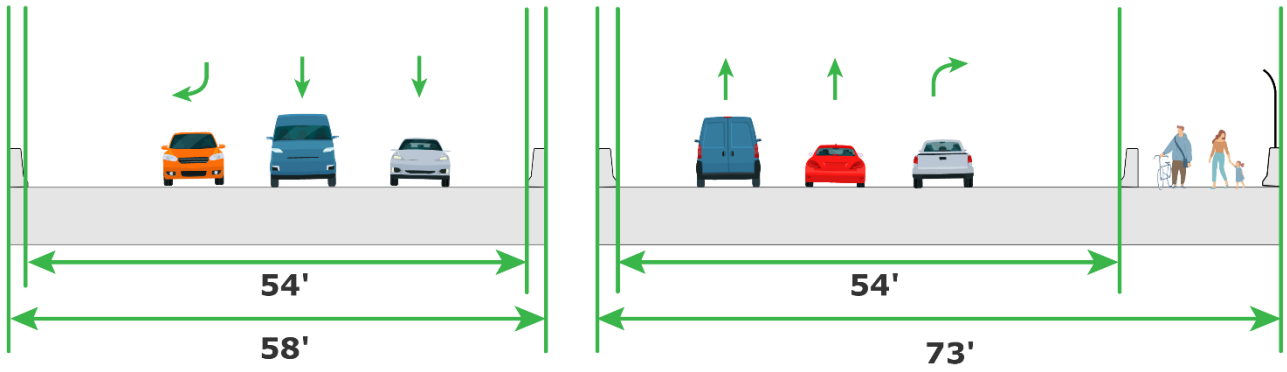
Figure 3-4. Bridge Structure Configuration with a Single Deck



Source: Massachusetts Department of Transportation, 2024

As a variation of the single bridge deck configuration presented in the MRER/EA, MassDOT investigated constructing two separate deck structures for each replacement highway bridge, consisting of two parallel separate decks (main spans) (**Figure 3-5**).

Figure 3-5. Bridge Structure Configuration with Two Separate Decks



Source: Massachusetts Department of Transportation, 2024

MassDOT's investigation consisted of a two-part qualitative assessment. In its initial qualitative assessment, MassDOT focused on the constructability aspects of the bridge deck configuration, including duration of construction, construction complexity, and potential for construction phasing. MassDOT also evaluated the durability and structural redundancy aspects of the two bridge deck configuration options. Based on its initial assessment, MassDOT determined that both bridge deck

configuration designs would be feasible depending on the bridge type and advanced the single deck and two separate deck options for further evaluation as part of the bridge type evaluation.

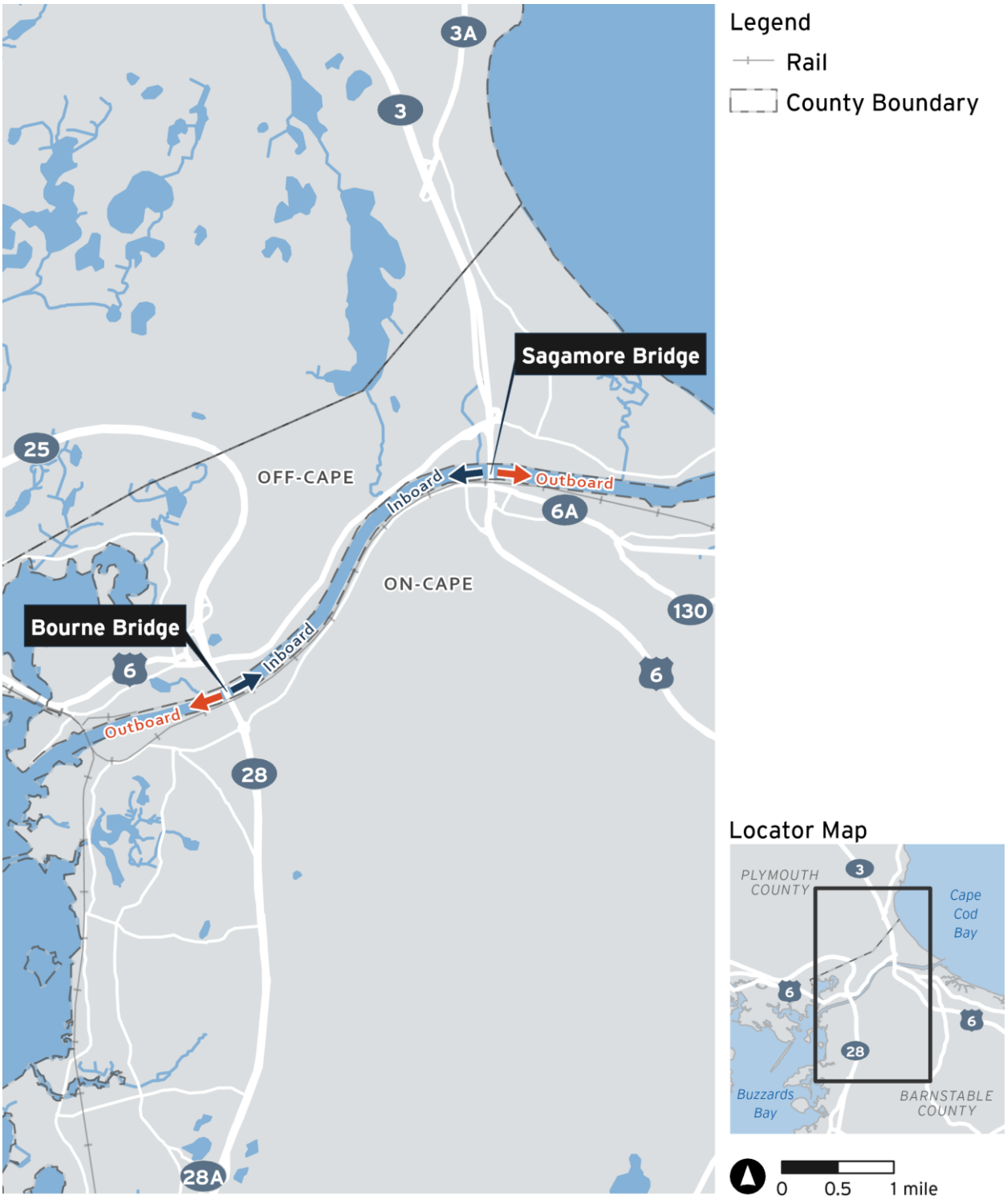
MassDOT's second assessment occurred as part of the detailed bridge type assessment and an advanced constructability review. MassDOT determined that a single bridge deck configuration would present a constructability risk due to the following: the width of the single deck configuration, at approximately 129-feet, would be at the limit of being transportable, being erectable, and maintaining interim stability. Additionally, wide decks would necessitate large floor beams, require increased crane capacity, and increase the complexity of geometry control. In contrast, MassDOT determined that the option with two separate bridge decks would provide maximum flexibility during construction due to smaller member sizes, simplified geometry control, and ability to sequence construction and demolition activities. Further, with two separate bridge decks, MassDOT could accelerate the schedule for shifting traffic from and decommissioning the existing deteriorated highway bridges. As a result, MassDOT recommended advancing the two separate decks configuration option as the preferred option for each replacement bridge.

3.3.2.5 Mainline Alignment Location

MassDOT assessed the MRER/EA's recommendation to construct the two new highway bridges outside the footprint of, parallel to, and inshore of the existing bridges toward the center of the canal (defined as "offline" and "inboard"). MassDOT identified locations for each highway bridge mainline alignment over Cape Cod Canal relative to the location of the existing bridges, consisting of an inboard location versus an outboard location (defined as the bay side of the existing bridge) (**Figure 3-6**), as well as an offline location versus an online location (defined as within the footprint of the existing bridge). From these combinations, MassDOT evaluated five optional locations based on their ability to meet the identified Program needs regarding traffic operations, connectivity, geometrics, safety, and multimodal accommodations (highway design evaluation criteria), while minimizing environmental and right-of-way effects.

MassDOT determined that the offline inboard option for both replacement bridges had an overall higher rating than the other mainline alignment location options in meeting the Program needs, as established through the highway design evaluation criteria. At both crossings, MassDOT could implement phased construction of the replacement main spans. Following construction of the first main span, existing traffic could be relocated from the existing bridge to the first replacement main span. After the initial traffic shift, the existing bridge would be demolished and the second replacement main span would be constructed, following by the final traffic reconfiguration. This construction phasing approach would lessen the risk that major repairs and/or rehabilitation of the existing bridges would need to be performed. Additionally, this option would maintain existing traffic flows and would minimally affect existing traffic patterns. Due to its high constructability ratings, MassDOT recommended the offline inboard option as the preferred option for both canal crossings.

Figure 3-6. Replacement Bridge Mainline Alignment Outboard and Inboard Locations



Source: Massachusetts Department of Transportation, 2024

3.3.2.6 Bridge Type

In collaboration with FHWA and USACE, MassDOT conceptually screened a wide range of bridge types and design parameters to identify feasible bridge types and configurations. MassDOT placed the highest priority on bridge types that would be practical and feasible to construct and maintain; bridge types that would not be practical and feasible were not advanced for further evaluation. Additionally, MassDOT placed high priority on a bridge construction method that would minimize effects to Cape Cod Canal navigation. As a result of this initial assessment, MassDOT recommended advancing the following three bridge types with various configurations for a secondary evaluation:

- Tied-arch bridge
- Cable-stayed bridge
- Box girder bridge

MassDOT's conceptual screening of bridge types focused on identifying the most cost-effective bridge types for crossing Cape Cod Canal.

The detailed analysis incorporated the following:

- Highway geometric assessments
- Additional constructability assessments of the feasible bridge types (including a detailed bridge deck configuration assessment)
- The public's review of the feasible bridge types relative to community considerations and bridge aesthetics

As a result of the detailed bridge type assessment, including public input, MassDOT recommended the following bridge type as the preferred option to be retained for detailed study: parallel, twin tied-arch bridge structures supported on delta frames with an approximate 700-foot main span length. **Figure 3-7** and **Figure 3-8** present renderings of the tied-arch bridge type with delta frame from the viewpoints of Cape Cod Canal and the motor vehicle driver crossing the bridge.

MassDOT determined that the exact span length, arch rib configuration, tie-in with approach ramps, and other parameters for the tied-arch bridge with delta frame would be developed and incorporated into the Program's Bridge Type Studies to be conducted during preliminary design as part of the Program's Base Technical Concept.

Figure 3-7. Rendering of Tied-Arch Bridge with Delta Frame – Cape Cod Canal Viewpoint

Source: Massachusetts Department of Transportation, 2024

Figure 3-8. Rendering of Tied-Arch Bridge with Delta Frame – Driver Viewpoint

Source: Massachusetts Department of Transportation, 2024

3.3.3 Build Alternative Highway Interchange Approach Improvements

Using the alternatives identified in its 2019 Cape Cod Canal Area Transportation Study as a starting point, MassDOT conceptually identified 97 highway interchange approach concepts (the Universe of Concepts) for the highway interchange approaches at the four quadrants of the canal crossings:

- Sagamore North
- Sagamore South
- Bourne North
- Bourne South

MassDOT eliminated concepts that presented significant geometric or safety challenges, did not provide all necessary connections, or posed infeasible constructability issues. MassDOT identified 22 active concepts as viable options to be carried forward for further design and evaluation.

MassDOT assessed the 22 highway interchange approach options at the 5 to 10% design level based on their performance in meeting the Program's highway design evaluation criteria. The ratings were then compared to identify options for an initial assessment. **Table 3-3** and **Table 3-4** present the 10 highway interchange approach options—two Sagamore North quadrant options, three Sagamore South quadrant options, three Bourne North quadrant options, and two Bourne South quadrant options—that passed the initial assessment and advanced to a secondary, more detailed (15% design level) assessment.

Table 3-3. Initial Assessment of Sagamore Bridge Crossing Interchange Approach Options

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Sagamore North (SN)	SN-1A/ Similar to Existing Configuration	This option is similar to the existing interchange ramp configurations with modifications to support the relocated U.S. Route 6 (Scenic Highway)/State Route 3 alignment.	This option would require fewer modifications than SN-8A to support a relocated U.S. Route 6 (Scenic Highway)/State Route 3 alignment.
	SN-8A/ Direct Connection to State Road	This option is similar to Option SN-1A but would provide a single exit point for westbound/northbound traffic from a relocated U.S. Route 6 (Scenic Highway)/State Route 3 alignment.	This option would present a different approach to handling exiting westbound/northbound traffic from existing conditions (and Option SN-1A). It rated the highest in its performance ratings relative to the highway design evaluation criteria, with primarily favorable ratings and no unfavorable ratings.

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Sagamore South (SS)	SS-1/ Existing Configuration with Cranberry Highway Extension	This option is similar to the existing interchange ramp configurations with modifications to support the relocated U.S. Route 6 (Scenic Highway) alignment. It would extend Cranberry Highway under U.S. Route 6 (Scenic Highway) to provide a connection to Mid-Cape Connector.	This option would largely maintain the existing ramp configurations with an extension of Cranberry Highway that would present an alternative approach to managing traffic.
	SS-1.1/ Similar to Existing Configuration	This option provides the same interchange configuration as Option SS-1 but would eliminate the Cranberry Highway Extension.	This option would mimic the existing interchange configuration without the Cranberry Highway Extension.
	SS-3.1A/ Westbound On-Ramp Under State Route 6 with Cranberry Highway Extension and Sandwich Road Connector	This option is similar to Option SS-1 but would relocate the westbound on-ramp, so it would share the same entrance point as the eastbound on-ramp off the Mid-Cape Connector. This option would include the Cranberry Highway Extension and would also add a connector road between Cranberry Highway and Sandwich Road.	This option received the highest performance ratings relative to the highway design evaluation criteria.

Table 3-4. Initial Assessment of Bourne Bridge Crossing Interchange Approach Options

Study Area Quadrant	Option	Summary Description	Reason for Advancing to Secondary Assessment
Bourne North (BN)	BN-6.1/ Northbound On-Ramp	This option is similar to the existing interchange configuration, modified to meet the offset mainline while adding a new northbound on-ramp directly from Scenic Highway east of the mainline.	This option would largely mimic the existing interchange configuration. It rated the highest among the options in its performance relative to the highway design evaluation criteria.
	BN-13.1/ Single Exit Partial Interchange	This option builds upon Option BN-6.1 and would add a connection from State Route 25 southbound off-ramp directly to Scenic Highway.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria. It would result in medium to fewer environmental and right-of-way effects.
	BN-14.4b/ Directional Interchange	This option is similar to Option BN-13.1 and would provide a combination of direct connection ramps between State Route 25 and Scenic Highway.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria. It would result in medium to less environmental and right-of-way effects.
Bourne South (BS)	BS-2/ Diamond Interchange	This option would replace the existing Bourne Rotary with a grade-separated diamond interchange.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria.
	BS-2.2/ Single-Point Interchange	This option would replace the existing Bourne Rotary with a grade-separated single-point interchange configuration.	This option received favorable and most favorable performance ratings relative to the highway design evaluation criteria.

3.3.3.1 Summary of Detailed Assessment of Highway Interchange Approach Options

MassDOT developed a two-step approach to conduct a more detailed assessment of the 10 highway interchange approach options that passed the initial evaluation. This section summarizes the methodologies and results of the two-step detailed assessment. The results of the two-step evaluation, including further explanations of the methodologies and determinations, are provided in **Appendix 3.1, Interchange Approaches Detailed Assessment Report, Attachment 2**.

Regional Traffic Operations Assessment: Methodology and Results

In the first step, MassDOT conducted a regional traffic operations assessment to determine if there were options in one area of the network[5] that could adversely affect the performance of options in other areas of the network. Options that could adversely affect regional traffic operations would be considered fatally flawed and would be eliminated from further analysis. From an initial identification of 36 possible permutations (pairings) of highway interchange options, MassDOT narrowed the selection to 11 pairings to assess operational trends and effects relative to travel demand. MassDOT's regional traffic operations assessment, which consisted of four different traffic analysis software and simulation models, included the following:

MassDOT used traffic analysis software to eliminate options that would impact the regional network through congestion, vehicle delay, and excessive traffic queues.

- Evaluation of network performance, which measured the number of processed vehicles and average delay per vehicle
- Evaluation of total travel time, which assessed transportation system efficiency, congestions levels, and origin-destination travel times
- Evaluation of queue length within the network

The results of the analyses indicated that option pairings with Option BN-6.1, the Northbound On-Ramp Option, would adversely affect the regional traffic network in the Build Alternative condition. These pairings with Option BN-6.1 would result in the highest levels of congestion, process the fewest number of vehicles through the network, increase average delay per vehicle, and create queue lengths extending to the mainline of State Route 25. Due to its fatal flaws associated with regional traffic operations, MassDOT recommended that Option BN-6.1 not be carried further for additional evaluation in a Step 2 evaluation.

Accordingly, MassDOT advanced nine highway interchange approach options for Step 2 of the detailed assessment.

Program Needs and Goals Assessment: Performance Measures

In the second step, MassDOT identified transportation and contextual performance measures (measures of effectiveness) to evaluate the options in accordance with its Project Development and Design Guide. The guide defines transportation performance measures as the means to

MassDOT identified performance measures and evaluated options according to the Program's needs, goals, and objectives.

[5] The regional network, consisting of the major roadways, interchanges, and intersections within a 2-mile area centered around the Sagamore and Bourne Bridges, is further described and depicted in **Section 4.2, Transportation, Traffic, and Safety**.

evaluate how the transportation facility functions and accommodates its users, and it defines contextual performance measures as the means to evaluate how the transportation facility relates to its physical surroundings and community function.

In coordination with FHWA and stakeholders, MassDOT identified transportation performance measures related to the four identified Program needs (presented in **Chapter 2, Section 2.3, Need for the Program**) to evaluate the interchange options:

- **Operations** – Six evaluation criteria and seven performance measures were used to assess whether the option would improve vehicular traffic operations, focusing on congestion on the mainline highways and ramps, regional and local travel times, cross-canal mobility, traffic (queue) spillback from exit or entrance ramps onto the mainline, and separation of regional and local traffic.
- **Geometrics and Safety** – Seven evaluation criteria and eight performances measures were used to assess whether the option would address the substandard design elements of the bridges and their highway networks, focusing on the compatibility of the exit and entrance ramps with the mainline highways and local roadway network, including weaving, ramp spacing, and speed variances, and the driver's experience within the network, including potential wrong-way driving, complexity of decision points, and overall driving expectation.
- **Multimodal Accommodations** – Eight evaluation criteria and 11 performance measures were used to assess whether the option would improve accommodations for pedestrians and bicyclists, focusing on accessibility regarding local roads, trails, and transit facilities and the overall user experience.
- **Structural/Maintenance** – Two evaluation criteria and two performance measures were used to assess whether the option would address the deteriorating structural condition and escalating maintenance demands of Bourne and Sagamore Bridges, focusing on the ability to minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges, measured by the time required to remove traffic from the existing bridges and discontinue their use and the compatibility of the interchange approaches with the replacement bridge structures.

Incorporating agency and public input, MassDOT identified Program goals and objectives that focused on socioeconomics, natural resources, resiliency and sustainability, constructability, emergency response, and cost effectiveness. **Table 3-5** presents the six Program goals and their related objectives. MassDOT then developed corresponding contextual performance measures to evaluate the ability of the interchange options to meet the Program's goals and objectives.

Table 3-5. Program Goals and Objectives

Goal	Objectives
Maintain and/or improve the socioeconomic fabric of the surrounding community	• Minimize residential and commercial property effects, including acquisitions and displacements. • Improve access to commercial properties. • Maintain or improve neighborhood accessibility to community facilities and services. • Maintain or improve neighborhood cohesion. • Minimize construction period effects upon the traveling public. • Avoid and/or minimize effects to open space and recreational facilities.
Protect and/or enhance the environment, including natural and biological resources	• Minimize effects to Areas of Critical Environmental Concern and wildlife (Natural Heritage and Endangered Species Program) habitats. • Maintain floodplain functions. • Maintain wetlands and surface waters, including protected buffers.
Enhance the resiliency and sustainability of the built environment	• Minimize air quality effects. • Minimize land alteration and tree clearing (urban heat island effect). • Minimize vulnerability to flooding. • Effectively manage stormwater.
Maximize constructability	• Minimize construction duration. • Maintain existing connections during construction.
Facilitate emergency response	• Improve emergency evacuation capabilities off Cape Cod. • Improve emergency response.
Maximize cost effectiveness	• Maximize construction cost effectiveness.

Program Needs and Goals Assessment: Methodology

In Step 2 of the detailed assessment, MassDOT reduced the number of traffic analysis models from 11 pairings to six models, which allowed MassDOT to evaluate the remaining nine options in isolation while also evaluating the options relative to potential network-wide impacts. MassDOT used multiple traffic analysis tools to quantitatively evaluate options based on their performance related to traffic operations and to the network within a 2-mile radius of Sagamore and Bourne Bridges. To arrive at the results for other quantitative and qualitative performance measures, MassDOT used preliminary (approximately 15%) design plans.

MassDOT developed a rating system to evaluate the nine highway interchange approach options based on their performance. Relative to meeting Program needs, an option was rated according to the

benefits it would provide compared to other options or the No Build Alternative condition. Regarding meeting Program goals and objectives, an option was rated based on either the effects that would incur compared to the other options or the opportunities it would provide compared to the other options. Table 3-6 summarizes MassDOT's evaluation system for rating the highway interchange approach options.

Table 3-6. Highway Interchange Detailed Assessment Rating System

How would the option meet Program needs?	How would the Option meet Program Goals and Objectives?		Rating
	Effects	Opportunities	
The option would provide ***Substantial Benefits.***	The option would have ***No, Less, or the Least Effects***.	The option would provide ***More or the Most Opportunity*** to exceed Program objectives.	Highest
The option would provide ***Marginal/Some Benefits***.	The option would have ***Some Effects***.	The option would provide ***Some Opportunity*** to meet minimum Program objectives.	Lower
The option would provide ***Insufficient/Negligible Benefits***.	The option would have more or the ***Most Effects***.	The option would provide ***Less or the Least Opportunity*** to meet Program objectives.	Lowest

All evaluation criteria were equally rated, and no scaling system, weighted average, or grading system was used. Except for the Program's constructability goal, ratings were isolated between Sagamore and Bourne Bridges, and between the two quadrants (north and south) for each bridge. To assess the option's constructability, the Program phasing, construction schedules, and construction sequencing were considered holistically for each crossing, incorporating both the north and south quadrants.

MassDOT determined that the highway interchange options that performed the best and scored the highest ratings would be incorporated into the Build Alternative, further assessed in the DEIS, and developed to preliminary (25%) design.

Program Needs and Goals Assessment: Results

Based upon Step 2 of the detailed assessment—the Program needs and goals assessment—MassDOT recommended that the following Sagamore and Bourne crossing highway interchange approach pairings advance for further evaluation in the DEIS as part of the Build Alternative:

- Sagamore North Quadrant Crossing: Option SN-8A, Direct Connection to State Road
- Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector
- Bourne North Crossing: Option BN-14.4b, Directional Interchange
- Bourne South Crossing: Option BS-2, Diamond Interchange

Sections 3.3.3.2 through 3.3.3.5 present descriptions and figures of the highway interchange approach preferred options that are incorporated into the Build Alternative, including comparison tables of the options that were considered, and MassDOT's conclusions.

Appendix 3.1, Attachment 2, Highway Interchange Approaches Detailed Assessment Report provides details on the transportation and contextual performance measures and additional information on the quantitative and qualitative differences among the highway interchange approach options in meeting the Program's needs, goals, and objectives.

3.3.3.2 Sagamore North Quadrant: Option SN-8A, Direct Connection to State Road

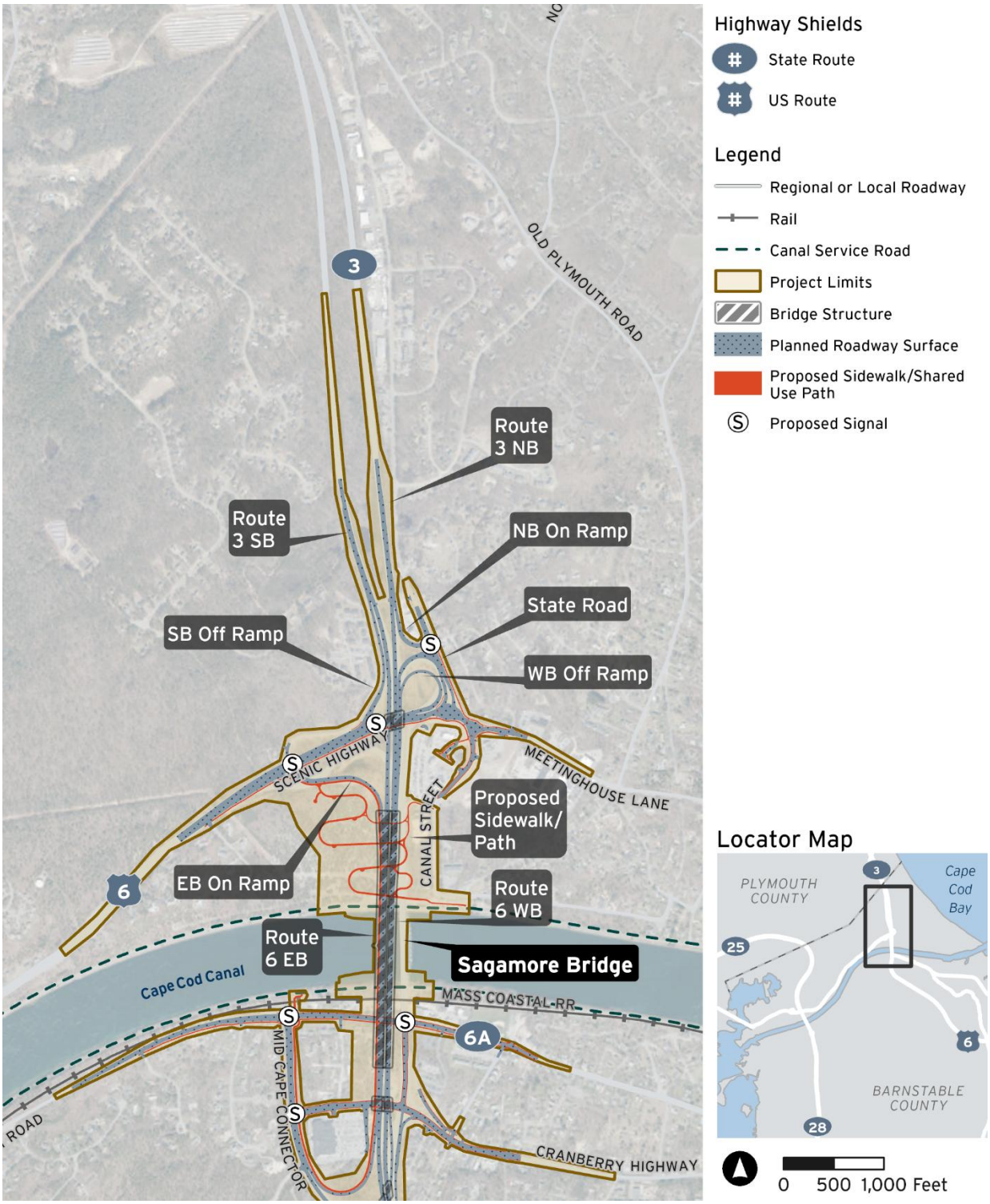
Description of Preferred Option

Of the two Sagamore North quadrant options (Options SN-1A and SN-8A), MassDOT recommended advancing Option SN-8A, Direct Connection to State Road as the Sagamore North quadrant option to be retained for detailed study in the DEIS (**Figure 3-9**).

Option SN-8A would provide a single exit point from a relocated U.S. Route 6/State Route 3. It would remove the Sagamore Bridge northbound off-ramp connection to Scenic Highway/Meetinghouse Lane eastbound, and instead would connect to State Road, north of Scenic Highway/Meetinghouse Lane. The remaining ramp connections would remain similar to existing conditions. MassDOT would modify the signalized intersections along Scenic Highway and Meetinghouse Lane with two roundabouts to accommodate through-travel and turning movements. The intersection of State Road at State Route 3 northbound would be modified to accommodate the addition of the new State Route 3 northbound off-ramp with the installation of a traffic signal.

Option SN-8A, Direct Connection to State Road, would include a SUP on the U.S. Route 6 eastbound main span that would provide connections to the south side of the Scenic Highway, Canal Street, and the Canal Service Road. This option would provide SUPs along the southern side of Scenic Highway and Meetinghouse Lane and along the eastern side of State Road to Homestead Avenue.

Figure 3-9. Sagamore North Quadrant Crossing: Option SN-8A, Direct Connection to State Road (Preferred Option)



Source: Massachusetts Department of Transportation, 2024

EB = eastbound, NB = northbound, SB = southbound, WB = westbound

Comparison of Options

Table 3-7 identifies the Program needs evaluation criteria that were differentiators between Option SN-8A and Option SN-1A in the Step 2 detailed assessment. MassDOT determined that Option SN-8A, the Direct Connection to State Road Option, would provide more benefits in meeting the Program needs than would Option SN-1A, Similar to Existing Configuration Option. In particular, Option SN-8A would perform better than Option SN-1A in its ability to remove traffic from the existing bridge and avoid or minimize the potential for a disruptive maintenance program or rehabilitation of the existing Sagamore Bridge. The differences in benefits provided by the two Sagamore North quadrant options were directly attributable to the ability to meet the Program's Purpose and Need.

Table 3-7. Sagamore North Quadrant Interchange Options: Program Needs Differentiators

Program Need/Total # Evaluation Criteria	Differentiating Evaluation Criteria	SN-1A	SN-8A (Preferred)	Comparison of Options
Operations (6 Evaluation Criteria)	Would the option separate local and regional traffic?	**Insufficient/ Negligible Benefits**	**Marginal/ Some Benefits**	• SN-8A would remove Sagamore Bridge westbound traffic from a local intersection. • SN-1A would maintain existing conditions.
Geometrics and Safety (7 Evaluation Criteria)	Would the option minimize weaving movements?	**Marginal/ Some Benefits**	**Substantial Benefits**	For bridge westbound off-ramp traffic: • SN-8A would have one exit, minimizing merging and weaving. • SN-1A would have two exits, increasing merging and weaving.
	Would the option minimize wrong-way driving risk?	**Substantial Benefits**	**Marginal/ Some Benefits**	• SN-1A would geometrically restrict wrong-way driving. • SN-8A would have a high potential for wrong-way driving, requiring mitigation.
	Would the option minimize deceleration lane speed variances between ramps and mainline?	**Marginal/ Some Benefits**	**Substantial Benefits**	• SN-8A would have two mainline locations with higher speed differentials. • SN-1A would have three mainline locations with higher speed differentials.

Program Need/Total # Evaluation Criteria	Differentiating Evaluation Criteria	SN-1A	SN-8A (Preferred)	Comparison of Options
Multimodal Accommodations (8 Evaluation Criteria)	Would the option improve pedestrian/bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	At Scenic Highway ramp crossings: • SN-8A would have one shared-use path (SUP) crossing. • SN-1A would have two SUP crossings.
	Would the option enhance the pedestrian/bicycle experience?	**Marginal/ Some Benefits**	**Substantial Benefits**	On the Scenic Highway east to west movement: • SN-8A would have four intersection/ramp crossings. • SN-1A would have five intersection/ramp crossings.
Maintenance/ Structural (2 Evaluation Criteria)	Would the option minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges?	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	Traffic could be shifted off the existing bridge: • For SN-8A, after construction of one main span without ramp closings. • For SN-1A, after construction of two main spans with long duration ramp closings.

Table 3-8 identifies the Program goals and objectives that were differentiators between Option SN-8A and Option SN-1A. MassDOT determined that the two Sagamore North quadrant options scored fairly evenly in meeting the Program's goals and objectives related to natural resource protection, resiliency and sustainability, emergency response, and cost. The differences between the two Sagamore North quadrant options were due to construction-period effects, including construction duration, and effects to the traveling public.

Table 3-8. Sagamore North Quadrant Interchange Options: Program Goals Differentiators

Program Goal/Total # Objectives	Program Objectives	SN-1A	SN-8A (Preferred)	Comparison of Options
Socioeconomics (8 Objectives)	Would the option minimize construction period effects upon the traveling public?	**Some Effects**	**Less Effects**	• SN-8A would not require vehicular construction detours. • SN-1A would require a long duration, complicated vehicular construction detour.
Constructability (2 Objectives)	Would the option minimize the construction duration, measured by opening of second main span?	**More Opportunity**	**Some Opportunity**	• In opening of second main span, SN-1A would have a time savings of 12 to 18 months over SN-8A.
	Would the option maintain existing connections during construction?	**Some Opportunity**	**More Opportunity**	• SN-8A would maintain existing connections during construction without detours. • SN-1A would require an extensive detour during construction.

MassDOT's Conclusions and Recommendation

MassDOT determined that both Sagamore North quadrant options would address the Program's needs to substantially improve operations, geometrics and safety, multimodal accommodations, and maintenance and structural issues relative to the Future No Build Alternative. In comparing the two options, MassDOT determined that Option SN-8A would provide more opportunities to meet the Program's needs than Option SN-1A. Option SN-8A would provide some separation between local and regional traffic, whereas Option SN-1A would maintain existing traffic patterns. The three geometrics and safety differentiators between Options SN-1A and SN-8A, consisting of weaving movements, wrong-way driving risk, and acceleration and deceleration speed variances between the ramps and mainline, weigh in favor of Option SN-8A. Further, in Option SN-8A, traffic could be shifted off the structurally deficient Sagamore Bridge in an optimal time frame, following the completion of the first main span. In contrast, in Option SN-1A, both main spans would need to be constructed before traffic could be shifted off the existing bridge; this option would prolong use of the existing bridge by approximately 12 to 18 months. As a result, Option SN-8A rated substantially higher than Option SN-1A regarding the option's ability to avoid or minimize the potential for a disruptive maintenance program

and/or rehabilitation of the existing Sagamore Bridge.

Relative to meeting the Program's goals, MassDOT determined that the two Sagamore North quadrant options scored fairly evenly, and of the four objectives where the two options received different results, the differences canceled each other out. Option SN-8A scored higher than Option SN-1A in minimizing effects to the traveling public during construction, which was deemed to be particularly important to MassDOT due to the Program's relatively long construction period.

Regarding anticipated environmental effects, MassDOT determined that, in general, the preliminary effects of the options were not differentiating factors in determining the preferred option.

3.3.3.3 Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector

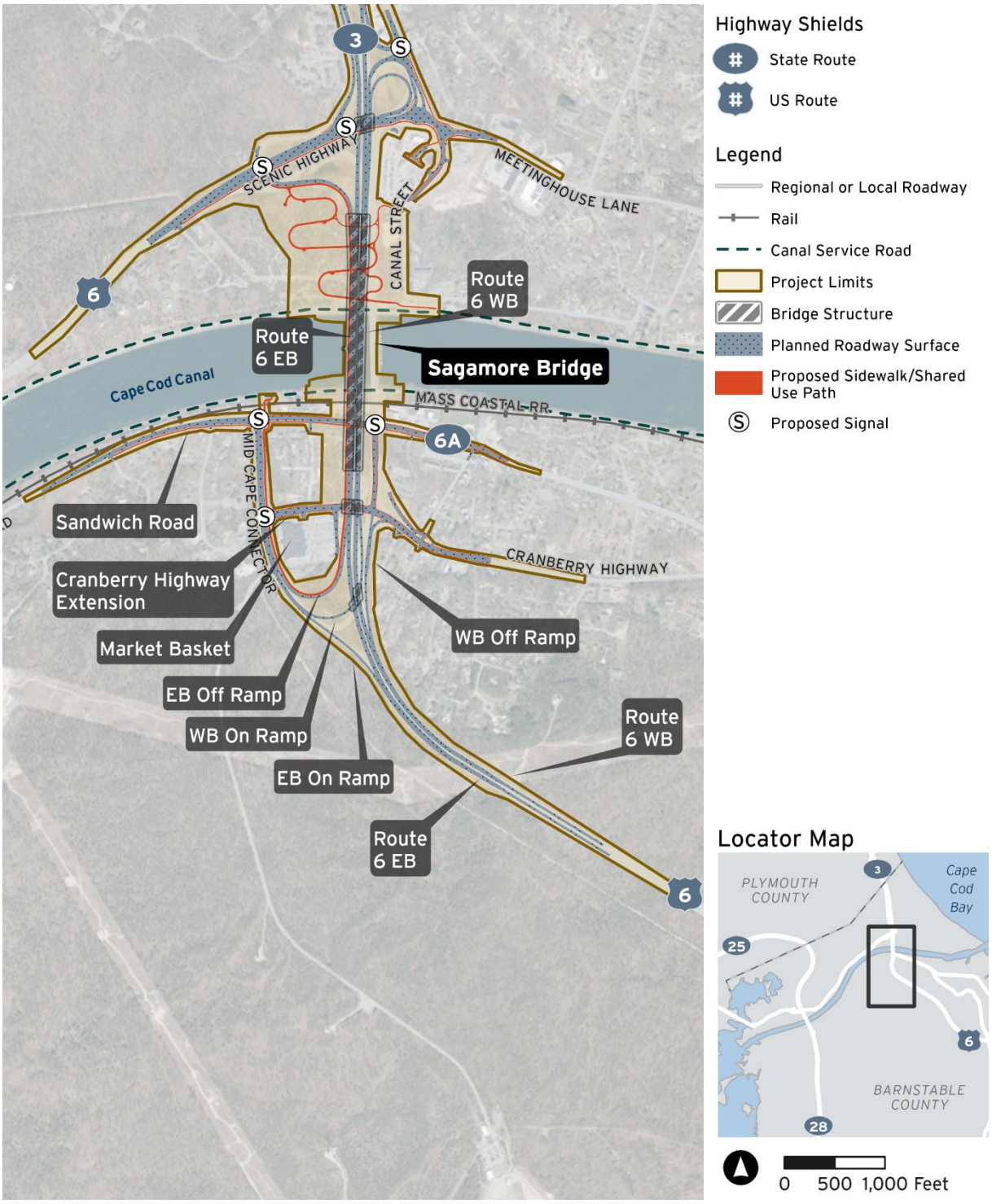
Description of Preferred Option

Of the three Sagamore South quadrant options (Options SS-1, SS-1.1, and SS-3.1A), MassDOT recommended advancing Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector as the Sagamore South quadrant option to be retained for detailed study in the DEIS (**Figure 3-10**).

Option SS-3.1A would relocate the westbound on-ramp, so it would share the same entrance point as the eastbound on-ramp off Mid-Cape Connector. It would remove the Cranberry Highway to Sagamore Bridge westbound ramp, and it would provide a new westbound on-ramp connection from Mid-Cape Connector to Sagamore Bridge westbound. Modifications to lane arrangements at the intersections of Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension would accommodate the revised traffic patterns resulting from the extension of Cranberry Highway and relocation of access to U.S. Route 6 eastbound, including modifications to the existing traffic signals. In addition, there would be a connection from Cranberry Road Extension to Sandwich Road east of the new mainline bridge structure (Sandwich Road Connector). A single lane roundabout would be the intersection control at this location. Additionally, west of the new mainline bridge, a single lane roundabout would be provided at the eastern-bound entrance of the existing Market Basket parking lot. Additional improvements would include modified access to Market Basket (Factory Outlet Road) and an access driveway to the former Christmas Tree Shops area.

Option SS-3.1A would include a SUP on the U.S. Route 6 eastbound main span that would provide connections to Factory Outlet Road, Sandwich Road, and Canal Service Road. Bicycle and pedestrian improvements would also be included on Cranberry Highway. This option would add a new connection through Cranberry Highway Extension to Mid-Cape Connector. This new connection would improve multimodal connectivity by providing access between local neighborhoods and businesses that currently do not exist.

Figure 3-10. Sagamore South Quadrant Crossing: Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector (Preferred Option)



Source: Massachusetts Department of Transportation, 2024

EB = eastbound, WB = westbound

Comparison of Options

Table 3-9 identifies the Program needs evaluation criteria that were differentiators among Options SS-1, SS-1.1, and SS-3.1A. MassDOT determined that while the three Sagamore South quadrant options performed comparably in addressing the Program's needs related to geometrics and safety and multimodal accommodations, Option SS-3.1A, Westbound On-Ramp Under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector, would provide the most opportunities to meet the Program's needs, particularly regarding the ability to remove traffic from the existing bridge and avoid and/or minimize the potential for disruptive maintenance and/or rehabilitation of the existing Sagamore Bridge. The differences in benefits among the three options were directly attributable to the ability of an option to meet the Program's Purpose and Need Statement.

Table 3-9. Sagamore South Quadrant Crossing: Program Needs Differentiators

Program Need	Needs Evaluation Criteria	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Operations	Would the option reduce local travel times, measured by vehicle hours traveled on local roads, compared to the 2050 No Build Alternative?	**Substantial Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	Vehicle hours traveled would be approximately 69.67 for SS-3.1A, 82.9 for SS-1, and 97.2 for SS-1.1, compared to 115.15 for the No Build Alternative.
	Would the option improve cross-canal mobility, measured by vehicle hours traveled from local roads to bridge mid-point, compared to the 2050 No Build Alternative?	**Substantial Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	Vehicle hours traveled would be approximately 38.13 for SS-3.1A, 42.86 for SS-1, and 56.67 for SS-1.1, compared to 86.39 for the No Build Alternative.

Program Need	Needs Evaluation Criteria	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
	Would the option separate local and regional traffic?	**Marginal/ Some Benefits**	**Insufficient /Negligible Benefits**	**Substantial Benefits**	• SS-3.1A would remove regional traffic from Cranberry Highway Extension. • SS-1 would separate some local and regional traffic. • SS-1.1 would maintain existing traffic patterns.
Geometrics and Safety	Would the option minimize weaving movements on mainline highways?	**Marginal/ Some Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	SS-3.1A design improvements would minimize weaving movements over SS-1 and SS-1.1.
Multimodal Accommodations	Would the option improve pedestrian/bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	**Substantial Benefits**	• SS-1.1 and SS-3.1A would require one sidewalk crossing. • SS-1 would require two sidewalk crossings at ramp terminals.
	Would the option enhance the pedestrian/bicycle experience?	**Marginal/ Some Benefits**	**Marginal/ Some Benefits**	**Substantial Benefits**	SS-3.1A would provide the highest level of shared-use path and neighborhood connectivity among the three options.
Maintenance/ Structural	Would the option minimize the risk of disruptive maintenance and/or rehabilitation on the existing bridges?	**Insufficient/ Negligible Benefits**	**Insufficient /Negligible Benefits**	**Substantial Benefits**	• SS-1 and SS-1.1 would prolong use of the existing bridge. • SS-3.1A would accelerate discontinued use of the existing bridge.

Program Need	Needs Evaluation Criteria	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
	Would the option allow for the most efficient and simplest structural system to accommodate the interchange ramps?	**Insufficient/ Negligible Benefits**	**Insufficient /Negligible Benefits**	**Substantial Benefits**	• SS-3.1A would have a compatible ramp framing and tie-in with the bridge mainline. • SS-1 and SS-1.1 would have a complex bridge framing system due to the configuration of ramps.

Table 3-10 identifies the Program goals and objectives that were differentiators among Options SS-1, SS-1.1, and SS-3.1A. MassDOT determined that the three Sagamore South quadrant options scored fairly evenly for most of the performance measures. Where the three options received different results, the differences were due to the construction period effects and constructability issues.

Table 3-10. Sagamore South Quadrant Crossing: Program Goals Differentiators

Program Goal	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Socioeconomics	Would the option minimize commercial property effects, regarding the number of easements on occupied parcels?	**Some Effects**	**Least Effects**	**Some Effects**	• SS-1 and SS-3.1A would require 7 and 6 easements, respectively, on occupied commercial parcels. • SS-1.1 would require 3 easements on occupied commercial parcels.
	Would the option improve access to commercial properties?	**Some Opportunity**	**Least Opportunity**	**Some Opportunity**	• SS-1.1 would not improve access. • SS-1 and SS-3.1A would improve accessibility to Market Basket and to neighborhoods via Cranberry Highway Extension.

Program Goa	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
	Would the option maintain or improve neighborhood accessibility to community facilities and services?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve accessibility via the Cranberry Highway Extension. • S-1.1 would not improve accessibility via the Cranberry Highway Extension.
	Would the option maintain or improve neighborhood cohesion?	**Some Opportunity**	**Least Opportunity**	**Most Opportunity**	• SS-1.1 would mimic existing conditions. • SS-1 and SS-3.1A would reduce the regional traffic volume on local roads. • SS-3.1A would also include the Sandwich Road extension.
	Would the option minimize construction period effects upon the travelin public?	**Some Effects**	**Some Effects**	**Least Effects**	• SS-1 and SS-1.1 would require detours for the bridge construction. • SS-3.1A would not require detours for the bridge construction.
Resiliency and Sustainability	Would the option effectively manage stormwater, regarding an increase in impervious area from the 2050 No Build condition?	**Some Opportunity**	**Most Opportunity**	**Some Opportunity**	• SS-1.1 would increase impervious area by 19%. • SS-1 and SS-3.1A would increase impervious area by 30%.

Program Goal	Program Objectives	SS-1	SS-1.1	SS-3.1A (Preferred)	Comparison of Options
Constructability	Would the option minimize the construction duration, measured by opening of second main span?	**Most Opportunity**	**Most Opportunity**	**Some Opportunity**	SS-1 and SS-1.1 would be completed up to 12 months sooner than SS-3.1A due to advance construction work and fewer traffic shifts.
	Would the option maintain existing connections during construction?	**Some Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-3.1A would maintain connections without detours. • SS-1 and SS-1.1 would require detours to maintain existing conditions.
Emergency Response	Would the option improve emergency evacuation capabilities off Cape Cod?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve capabilities via the Cranberry Highway Extension. • SS-1 would minimally improve capabilities.
	Would the option improve emergency response?	**Most Opportunity**	**Some Opportunity**	**Most Opportunity**	• SS-1 and SS-3.1A would improve access to and from Sandwich Road west and the Mid-Cape Connector via the Cranberry Highway Extension. • SS-1.1 would maintain the existing configuration.

MassDOT's Conclusions and Recommendation

Except for three evaluation criteria, the three Sagamore South options performed comparably in addressing the Program needs related to geometrics and safety and multimodal accommodations. The three options varied considerably in addressing the Program needs related to operations and the maintenance and structural needs of the existing Sagamore Bridge. Based on the constructability

assessment, Options SS-1 and SS-1.1 would require extensive preparation work, consisting of long-term and potentially complicated detours to maintain connections during construction. As a result, these options would prolong use of the Sagamore Bridge, taking 12 to 18 months longer to remove traffic from the existing bridge than would Option SS-3.1A. Of the eight total evaluation criteria differentiators, Option SS-3.1A consistently received the highest rating of *substantial benefits*. As a result, MassDOT determined that Option SS-3.1A would provide the most opportunities to meet the Program's needs, particularly regarding the option's ability to avoid and/or minimize the potential for a disruptive maintenance program and/or rehabilitation of the existing Sagamore Bridge.

Relative to meeting the Program's goals, MassDOT determined that the three Sagamore South options scored fairly evenly. To maintain vehicular travel connections during bridge construction, Options SS-1 and SS-1.1 would require detours, whereas Option SS-3.1A would not. Option SS-3.1A scored highest among the options in maintaining existing connections during Program construction, which was deemed to be particularly important to MassDOT due to the Program's relatively long construction period.

MassDOT determined that the anticipated environmental effects of the options were not differentiating factors in determining the preferred option.

3.3.3.4 Bourne North Quadrant Crossing: BN-14.4b, Directional Interchange Option

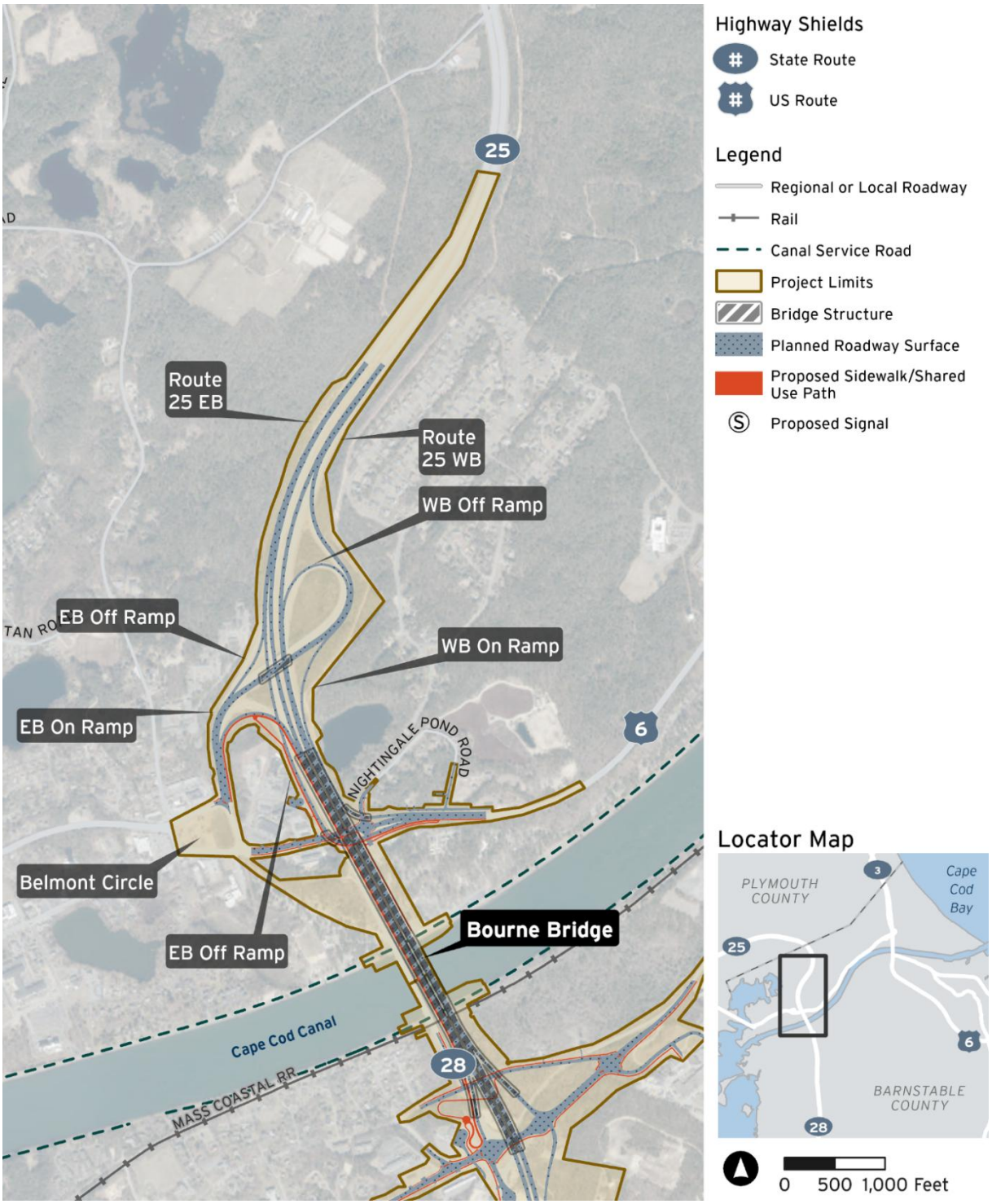
Description of Preferred Option

Of the remaining two interchange approach options for the Bourne North quadrant crossing (Options BN-13.1 and BN-14.4b), MassDOT recommended advancing Option BN-14.4b, Directional Interchange, as the Bourne North quadrant option to be retained for detailed study in the DEIS (**Figure 3-11**).

Option BN-14.4b would provide a combination of direct connection ramps between State Route 25 and U.S. Route 6 (Scenic Highway). The ramp connecting State Route 25 eastbound to Scenic Highway would be a direct connect ramp, allowing access to Scenic Highway eastbound only. The new flyover ramp connecting Scenic Highway to State Route 25 would allow vehicles to bypass Belmont Circle and would not require an additional traffic signal. This ramp would use one of the travel lanes on Scenic Highway and would be a free-flowing movement to reduce congestion. The existing State Route 28 over the State Route 25 bridge would be relocated to widen the bridge to allow for this new southbound to eastbound ramp movement. Additionally, the existing southbound off-ramp would be revised to be an option lane, improving the geometry and decision sight distance for drivers. The intersection control at U.S. Route 6/Nightingale Road/Andy Oliva Drive would be a single-lane roundabout.

In Option BN-14.4b, Directional Interchange, the new flyover ramp over Scenic Highway would provide a SUP and grade-separated crossing for pedestrians and bicyclists. Since the flyover ramp would remove traffic from Belmont Circle, the lane configuration of Scenic Highway would be reduced from four lanes to three lanes, which would provide additional space for multimodal accommodations. Additionally, this option would provide one continuous 12-foot-wide SUP along the south side of Scenic Highway connecting to Belmont Circle and a 6-foot-wide sidewalk along the north side of Scenic Highway.

Figure 3-11. Bourne North Quadrant Crossing: Option BN-14.4b, Directional Interchange (Preferred)



Source: Massachusetts Department of Transportation, 2024

EB = eastbound, WB = westbound

Comparison of Options

Table 3-11 identifies the Program needs evaluation criteria that were differentiators between Option BN-13.1 and Option BN-14.4b. MassDOT determined that Option BN-14.4b, Directional Interchange, would provide more benefits in meeting the Program's Purpose and Need Statement than Option BN-13.1, Single Exit Partial Interchange, particularly regarding multimodal accommodations. The substantial benefits that would be provided by Option BN-14.4b versus the marginal or lower benefits that would be provided by Option BN-13.1 are directly attributable to design.

Table 3-11. Bourne North Quadrant Crossing: Program Needs Differentiators

Program Need	Evaluation Criteria	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
Operations	Would the option separate local and regional traffic?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would use flyover ramps, allowing for free-flow traffic. • BN-13.1 would use signalized intersections.
Geometrics and Safety	Would the option minimize wrong-way driving risk?	**Marginal/ Some Benefits**	**Substantial Benefits**	At the southbound off-ramp to Scenic Highway: • BN-14.4b would geometrically restrict wrong-way driving. • BN-13.1 would use wrong-way detection systems to reduce the risk of wrong-way driving.
Multimodal Accommodations	Would the option improve pedestrian/ bicycle access adjacent to local roads?	**Insufficient/ Negligible Benefits**	**Substantial Benefits**	• BN-14.4b would meet MassDOT's Healthy Transportation Policy Directive. • BN-13.1 would not meet the Healthy Transportation Policy Directive.
	Would the option improve pedestrian/ bicycle access to existing trail facilities?	**Marginal/ Some Benefits**	**Substantial Benefits**	Between the bridge mid-point and first Canal Service Road connection: • BN-14.4b would provide a grade-separated crossing. • BN-13.1 would include several at-grade crossings.

Program Need	Evaluation Criteria	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
	Would the option improve pedestrian/ bicycle connections at ramp terminals?	**Marginal/ Some Benefits**	**Substantial Benefits**	• BN-14.4b would avoid the high-speed ramp through a diversion. • BN-13.1 would provide signalized control at ramps.
	Would the option enhance the pedestrian/ bicycle experience?	**Marginal/ Some Benefits**	**Substantial Benefits**	On the Scenic Highway east to west movement: • BN-14.4b would require two intersection/ramp crossings. • BN-13.1 would require six intersection/ramp crossings.

Table 3-12 identifies the Program goals and objectives that were differentiators between Option BN-13.1 and Option BN-14.4b. MassDOT determined that the two Bourne North quadrant options scored fairly evenly across many of the Program's goals and objectives.

Table 3-12. Bourne North Quadrant Crossing: Program Goals Differentiators

Program Goal	Program Objectives	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
Socioeconomics	Would the option improve neighborhood access to community facilities and services, specifically, schools, hospitals, and emergency services (police and fire)?	**Some Opportunity**	**More Opportunity**	Along Scenic Highway: • BN-14.4b would add a shared-use path. • BN-13.1 would add sidewalks.
	Would the option maintain or improve neighborhood cohesion?	**Some Opportunity**	**More Opportunity**	From the local roadway network: • BN-14.4b would fully remove State Routes 28/25 traffic. • BN-13.1 would partially remove State Routes 28/25 traffic.
	Would the option avoid and/or minimize effects to	**Some Effects**	**More Effects**	At Bourne Scenic Park:

Program Goal	Program Objectives	BN-13.1	BN-14.4b (Preferred)	Comparison of Options
	parks, open space, and recreational facilities?			• BN-13.1 would affect 14.2 acres. • BN-14.4b would affect 14.8 acres.
Resiliency and Sustainability	Would the option effectively manage stormwater, demonstrated by change in 2-year peak discharge rate compared to a minimum goal of 0%?	**Some Opportunity**	**More Opportunity**	For the 2-year peak discharge rate: • BN-14.4b would have a 14% decrease. • BN-13.1 would have a 4% increase.
Emergency Response	Would the option improve emergency evacuation capabilities off Cape Cod?	**Some Opportunity**	**More Opportunity**	For westbound Cape Cod departures: • BN-14.4b would provide free-flow traffic conditions. • BN-13.1 would have a signalized intersection.
Cost Effectiveness	Would the option maximize construction cost effectiveness?	**More Opportunity**	**Some Opportunity**	Approximate costs would be: • BN-13.1 = $178 million • BN-14.4b = $211 million

MassDOT's Conclusions and Recommendation

Both Bourne North quadrant options would address the Program's needs to provide *substantial benefits* in operations, geometrics and safety, multimodal accommodations, and maintenance and structural issues. MassDOT determined that Option BN-14.b would provide more opportunities to meet the Program's needs than Option BN-13.1, including separating regional and local traffic and geometrically restricting wrong-way driving risk. In particular, Option BN-14.4b rated higher than Option BN-13.1 regarding multimodal accommodations, including providing grade separation over Scenic Highway for pedestrians and bicyclists and meeting the pedestrian and bicycle requirements of MassDOT's Healthy Transportation Policy Directive.

Relative to meeting the Program's goals, MassDOT determined that the two Bourne North options scored fairly evenly across many of the Program's goals and objectives. Of the six differentiating Program objectives, Option BN-14.4b scored higher than Option BN-13.1 in four objectives and scored lower than Option BN-13.1 in two objectives.

MassDOT compared the environmental effects of the two options and determined that, except for four objectives, the environmental ratings of the two options were comparable and were not differentiating factors in determining the preferred option. Regarding the proposed effects to parks and recreation areas, Option BN-14.4b would result in more temporary effects to Bourne Scenic Park than Option BN-13.1. **Chapter 5, Draft Section 4(f) Evaluation**, describes how MassDOT is coordinating with the USACE and Bourne Recreation Authority, the owners of Bourne Scenic Park, to minimize effects during construction and to enhance the park's facilities in the permanent condition as mitigation for anticipated construction period effects.

3.3.3.5 Bourne South Quadrant Crossing: Option BS-2, Diamond Interchange

Description of Preferred Option

Of the two Bourne South quadrant options (Options BS-2 and BS-2.2), MassDOT recommended advancing Option BS-2, Diamond Interchange, as the Bourne South quadrant option to be retained for detailed study in the DEIS (**Figure 3-12**).

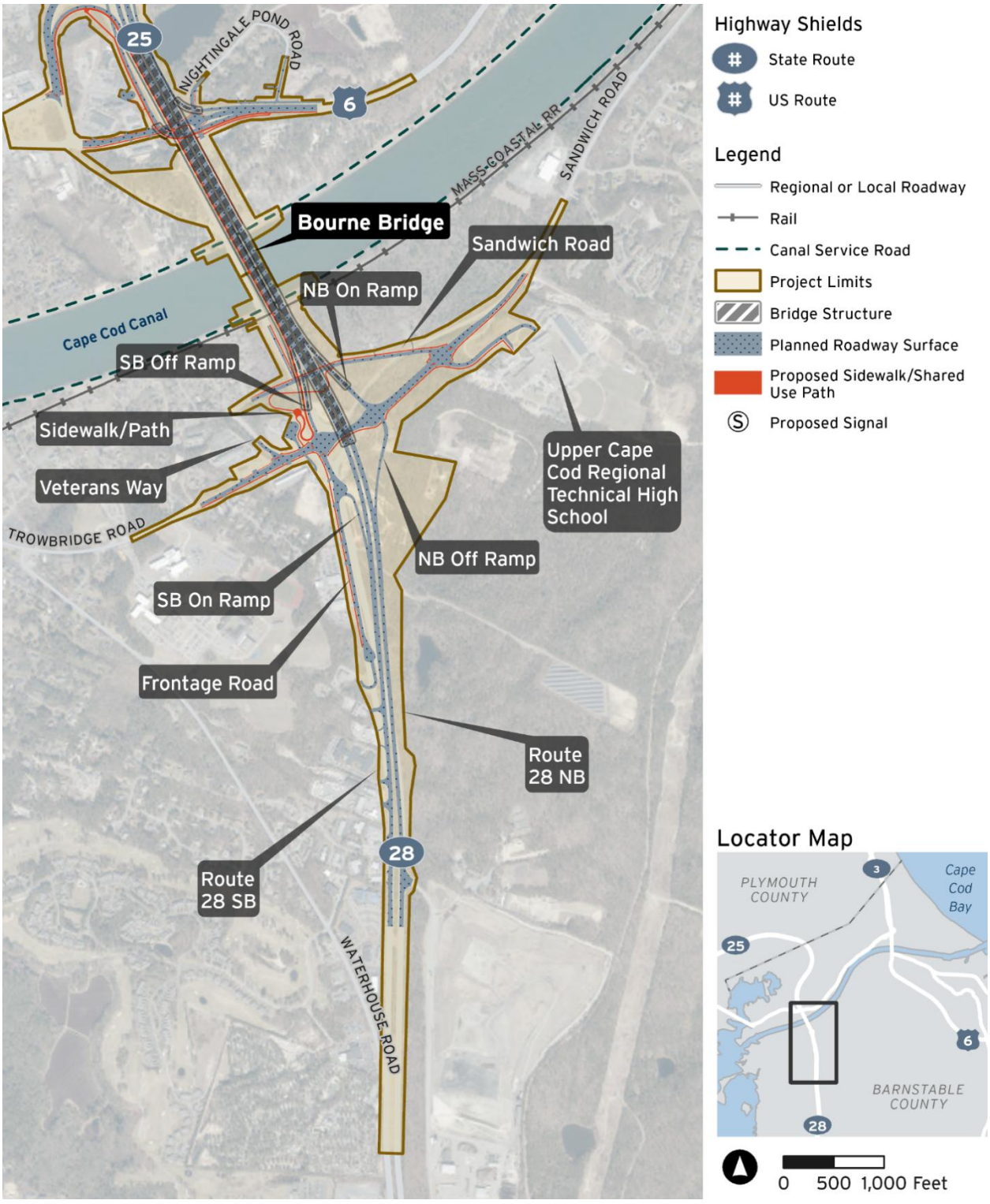
Option BS-2, Diamond Interchange, would eliminate the Bourne Rotary and replace the existing rotary with a grade-separated diamond interchange. This option would allow through movements on State Route 28 to bypass the intersections with the non-mainline roadways. Both intersections within the diamond interchange would require a roundabout for intersection control.

Based on the traffic analysis, a single-lane dog-bone roundabout[6] would maximize the operations of the diamond interchange. A dog-bone roundabout processes more vehicles per hour than a typical roundabout or signalized intersection, resulting in shorter queues and delays. Additionally, a dog-bone roundabout eliminates the inside lane of each roundabout, resulting in a reduced number of conflict points at each intersection and improved safety and operations. Replacing the traditional signalized intersection with a dog-bone roundabout in Option BS-2 would allow better movement and access to the frontage road users from Trowbridge Road and the southbound off-ramp. Additionally, traffic from the frontage road would have direct access to the State Route 28 southbound on-ramp. The dog-bone roundabout would use Pedestrian Hybrid Beacons at each intersection leg for visual enhancements to protect pedestrians and bicyclists and increase driver awareness.

Additionally, changes to the Trowbridge Road and Sandwich Road underpass in the Diamond Interchange Option would consist of a multi-lane roundabout at a relocated Upper Cape Cod Regional Technical High School Driveway entrance. This option's SUP improvements would include providing connections to Trowbridge Road, the Cape Cod Canal Service Road, and the Bourne Recreation Area.

[6] A dog-bone interchange (a variation of the dumbbell interchange) references its aerial resemblance to a real or toy dog-bone; it is a double roundabout interchange where the roundabouts do not form a complete circle but instead are connected by parallel traffic lanes.

Figure 3-12. Bourne South Quadrant Crossing: Option BS-2, Diamond Interchange (Preferred)



Source: Massachusetts Department of Transportation, 2024

NB = northbound, SB = southbound

Comparison of Options

Table 3-13 identifies the Program needs evaluation criteria that were differentiators between Option BS-2 and Option BS-2.2. MassDOT determined that Option BS-2, Diamond Interchange, received much higher ratings than Option BS-2.2, Single-Point Interchange, in three evaluation criteria addressing the Program needs related to operations, geometrics and safety, and multimodal accommodations. The substantial benefits provided by Option BS-2 versus the marginal benefits provided by Option BS-2.2 are directly attributable the option's ability to meet the Program's Purpose and Need Statement.

Table 3-13. Bourne South Quadrant Crossing: Program Goals Differentiators

Program Need	Evaluation Criteria	BS-2 (Preferred)	BS-2.2	Comparison of Options
Operations	Would the option improve cross-canal mobility, measured by vehicle hours traveled from local roads to bridge mid-point, compared to the 2050 No Build condition?	**Substantial Benefits**	**Marginal/ Some Benefits**	BS-2 would reduce vehicle hours traveled by 20% over BS-2.2.
Geometrics and Safety	Would the option minimize wrong-way driving risk?	**Substantial Benefits**	**Marginal/ Some Benefits**	• BS-2's diamond interchange configuration would geometrically restrict wrong-way driving. • BS-2.2's single point interchange would have an inherent risk of wrong-way driving, reduced through signage.
Multimodal Accommodations	Would the option improve pedestrian/ bicycle connections at ramp terminals?	**Substantial Benefits**	**Marginal/ Some Benefits**	• BS-2 would provide rapid flashing beacons for the single-lane crossings. • BS-2.2 would provide signalized crossings but would require complicated lane crossings.

MassDOT did not identify any Program goals and objectives that were differentiators between the two Bourne South options. MassDOT determined that the two Bourne South quadrant options scored fairly evenly across the Program's goals and objectives.

MassDOT's Conclusions and Recommendation

In addressing the Program needs, both Bourne South quadrants options would substantially improve operations compared to the No Build Alternative. Compared to each other, the Bourne South quadrant options received almost identical scores, except for three evaluation criteria addressing operations, geometrics, and safety, and multimodal accommodations, where Option BS-2 received higher ratings than Option BS-2.2. In contrast to Options BS-2.2, which received marginal/some benefits ratings, Option BS-2 received substantial benefits ratings for improving cross-canal mobility via an approximate 20% reduction in vehicle-hours traveled, geometrically restricting wrong-way driving risk, and simplified pedestrian/bicyclist crossings at ramp terminals.

Relative to meeting the Program's goals, MassDOT determined that the two Bourne South quadrant options scored fairly evenly.

MassDOT compared the environmental effects of the two options and determined that the two Bourne South quadrant options scored fairly evenly, with no substantial qualitative or quantifiable differences between the two options.

3.4 Description of the Preferred Alternative

This section describes the Program's Preferred Alternative, including an assessment of the Preferred Alternative relative to the Program's needs and a summary preferred bridge and highway design parameters that resulted from the multiple assessments discussed in **Sections 3.3.2.1 through 3.3.2.6** and **Sections 3.3.3.1 through 3.3.3.5**.

3.4.1 Assessment of Preferred Alternative and Program Needs

MassDOT determined that the Preferred Alternative—incorporating the preferred bridge design options identified in **Sections 3.3.2.1 through 3.3.2.6**, and the preferred highway interchange approach options identified in **Sections 3.3.3.2 through 3.3.3.5**—would fully meet the Program's needs, as listed in **Table 3-14**. The table also identifies the operational benefits of the Preferred Alternative.

Table 3-14. Evaluation of the Preferred Alternative Relative to Program Needs

Program Need	Evaluation of the Preferred Alternative
Address the deteriorating structural condition and escalating maintenance demands of the Cape Cod Canal highway bridges.	**This need would be met.** With both replacement highway bridges, MassDOT would implement the optimal construction sequence of removing all traffic from the existing bridge and discontinuing its use following construction of the first replacement main span, thereby minimizing the risk of disruptive maintenance and/or rehabilitation of the existing bridges. **Additional operational benefits** would include compatible ramp framing and mainline framing systems at both crossings, allowing for the most efficient and simplest structural system to accommodate the interchange ramps. In particular, the preferred highway interchange network options in the Sagamore quadrants would accelerate the removal of traffic and discontinue use of the existing Sagamore Bridge, minimizing the potential for a disruptive maintenance program and/or rehabilitation of the existing bridge.
Address the substandard design elements of the Cape Cod Canal highway bridges, the immediate mainline approaches and their adjacent interchanges and intersections.	**This need would be met.** The highway bridges and approaches would comply with AASHTO highway and bridge design specifications and MassDOT design standards. **Additional operational benefits** would include geometric improvements and safety features. For example, the preferred highway interchange network would minimize weaving movements; improve merge/weave distances on the mainline; geometrically restrict the potential for wrong-way driving, such as through replacement of Bourne Rotary with a diamond interchange and a direct connection from State Route 25 to Scenic Highway eastbound; and minimize deceleration speed variances between ramps and the mainline.
Improve vehicular traffic operations.	**This need would be met.** The Preferred Alternative would substantially improve vehicular traffic operations compared to the No Build Alternative, including reduced regional and local travel times and improved cross-canal mobility. **Additional operational benefits** would include interchange improvements designed to separate local and regional traffic. For example, with the preferred highway interchange network, Sagamore Bridge westbound traffic destined for State Road would be removed from the Meetinghouse Lane/Canal Street intersection, a new Cranberry Road extension and new connection between Sandwich Road and Cranberry Highway would improve local traffic conditions with more direct access between neighborhoods and Market Basket, and regional drivers traveling to and from mid-Cape via Scenic Highway could bypass Belmont Circle, thereby reducing traffic at Belmont Circle.

Program Need	Evaluation of the Preferred Alternative
Improve accommodations for pedestrians and bicyclists.	**This need would be met.** Each crossing location would include one bidirectional pedestrian and bicycle shared-use path. **Additional operational benefits** would include substantially improved pedestrian and bicycle access adjacent to local roads, existing trail facilities, and at ramp terminals, resulting in an overall enhanced pedestrian/bicycle experience. For example, the preferred highway interchange network would provide grade separation for pedestrians and bicyclists over Scenic Highway, increase access and connectivity to neighborhoods through shared-use paths, and minimize the number of ramp and intersection crossings for pedestrians and bicyclists.

3.4.2 Preferred Alternative Design Parameters

The Preferred Alternative would replace Sagamore and Bourne Bridges with parallel, twin tied-arch bridge structures supported on delta frames with an approximate 700-foot mainline span length. The replacement bridges would maintain the existing vertical clearance of 135 feet above MHW and would provide a minimum of 500 feet of horizontal clearance consistent with the authorized 480-foot navigational channel and existing conditions. The bridge piers would be located at the waterline adjacent to the Canal Service Roads, within the riprap slope but above the low tide line. At both Sagamore and Bourne Bridges, the replacement bridge mainline alignment location would be offline (outside of the footprint of the existing bridge) and inboard of the existing highway bridges, on the side of the canal between the existing Bourne Bridge and Sagamore Bridge. The twin-deck structures would be approximately 10 feet apart and parallel to each other; each main span would include two through-traffic lanes, one auxiliary lane, and shoulders and barriers in compliance with current MassDOT and FHWA standards and guidelines for highway and bridge design. Each crossing location would include one bidirectional pedestrian and bicycle SUP, separated from vehicular traffic by the shoulder and barrier. Additionally, each crossing location would include reconfiguration of the highway interchange approach networks on both sides of Cape Cod Canal to align with the replacement bridges. **Figure 3-13** and **Figure 3-14** present two views of the replacement bridge based on preliminary design. **Table 3-15** summarizes the Program based on analyses of design parameters conducted for the Preferred Alternative, as described in **Sections 3.3.2.1 through Section 3.3.2.6**. Phase 1 of the Program—which would replace Sagamore Bridge, including the replacement of State Route 3 over U.S. Route 6—is listed in the FFY 2025-2029 Transportation Improvement Program as Project S13144.[7]

It is important to note that the identification of the Preferred Alternative does not represent a final decision. The final selection of an alternative will be made only after full consideration of the environmental impacts and public and agency comments received on the DEIS, in accordance with NEPA requirements.

[7] Project #S131144 was added to the Federal Fiscal Year (FFY) 2025-2029 Transportation Improvement Program as Amendment #2, December 9, 2024.

Figure 3-13. Proposed Replacement Bridge: Cape Cod Canal Viewpoint

Source: Massachusetts Department of Transportation, 2024

Figure 3-14. Proposed Replacement Bridge: Driver Viewpoint

Source: Massachusetts Department of Transportation, 2024

Table 3-15. Cape Cod Bridges Program Preferred Alternative

Program Element/ Program Design Parameter	Description of Program
Highway Bridges	Replacement of Both Highway Bridges with New Bridges with Four Through-Traffic Lanes and Two Auxiliary Lanes (In-Kind Bridge Replacement) (updated to comply with federal and state highway and design safety standards).
Highway Bridge Cross-Section and Shared-Use Path	Each replacement highway bridge would provide four 12-foot-wide through-travel lanes (two in each direction), two 12-foot-wide entrance/exit (auxiliary) lanes, a 4-foot-wide left shoulder, and a 10-foot-wide right shoulder. Right and left barriers would be offset an additional 2 feet beyond the limits of the shoulders. Each crossing location would include one bidirectional pedestrian and bicycle shared-use path, separated from vehicular traffic by the shoulder and barrier. The usable width of the shared-use path would be 14 feet wide on the bridge main spans, 20 feet wide on the interchange approaches, and 12 feet wide on the connecting roadways.
Bridge Vertical and Horizontal Clearances	The replacement bridges would maintain the existing vertical clearance of 135 feet above mean high water and account for 3 feet of fluctuations in relative sea level, for a total vertical clearance of 138 feet above mean high water. The replacement bridges would provide a minimum of 500 feet of horizontal channel width consistent with the authorized navigational channel width and existing conditions.
Main Span Length and Bridge Pier Location	The replacement bridges would have a main span length of approximately 700 feet, which would locate the bridge piers at the waterline adjacent to the service road (shoreline piers) into the riprap slope but above the low tide line.
Bridge Deck Configuration	Each bridge (Sagamore and Bourne) would have two separate decks (twin structures).
Mainline Alignment	The mainline alignment locations at both bridges would be offline inboard. Both spans of the replacement highway bridges would be outside the footprint of the existing bridge, approximately 10 feet apart and parallel to each other (offline), and on the side of Cape Cod Canal between the existing bridges (inboard). The replacement main spans at the Sagamore crossing would be west of existing Sagamore Bridge toward Buzzards Bay. The replacement main spans at the Bourne crossing would be east of existing Bourne Bridge toward Cape Cod Bay.
Bridge Type	The replacement bridges would be twin tied-arch bridges, with delta frames supporting an approximate 600-foot arch and 700-foot mainline span.

Program Element/ Program Design Parameter	Description of Program
Interchange Approach Network	Interchange approach improvements at each bridge would be as follows: • Sagamore Bridge Crossing: Direct connection to State Road in the Sagamore North quadrant and westbound on-ramp under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector in the Sagamore South quadrant • Bourne Bridge Crossing: Directional Interchange in the Bourne North quadrant and a Diamond Interchange in the Bourne South quadrant

3.4.3 Intersection Control Preliminary Recommendations

This section identifies the intersection control preliminary recommendations for each Program quadrant based on MassDOT's Intersection Control Evaluation (ICE) process. These are preliminary recommendations and are subject to modification as final design proceeds, as described in **Section 3.5.1**.

3.4.3.1 Sagamore North Quadrant: Direct Connection to State Road

MassDOT would modify the signalized intersections along Scenic Highway and Meetinghouse Lane with two roundabouts to accommodate through-travel and turning movements. The intersection of State Road at State Route 3 northbound would be modified to accommodate the addition of the new State Route 3 northbound off-ramp with installation of a traffic signal.

3.4.3.2 Sagamore South Quadrant: Westbound On-Ramp under U.S. Route 6 with Cranberry Highway Extension and Sandwich Road Connector

MassDOT would modify the lane arrangements at the intersections of Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension to accommodate the revised traffic patterns resulting from the extension of Cranberry Highway and relocation of access to U.S. Route 6 eastbound, including modifications to the existing traffic signals. In addition, there would be a connection from Cranberry Road Extension to Sandwich Road east of the new mainline bridge structure (Sandwich Road Connector). A single lane roundabout would be the intersection control at this location. Additionally, west of the new mainline bridge, a single lane roundabout would be provided at the eastern-bound entrance of the existing Market Basket parking lot.

3.4.3.3 Bourne North Quadrant: Directional Interchange

MassDOT would modify the U.S. Route 6/Nightingale Road/Andy Oliva Drive intersection with a single-lane roundabout.

3.4.3.4 Bourne South Quadrant: Diamond Interchange

To accommodate the need for intersection control at both intersections within the diamond interchange, MassDOT would provide a single-lane-dog-bone-shaped roundabout, which would allow better movement and access to the frontage road users from Trowbridge Road and the southbound off-ramp. Additionally, traffic from the frontage road would have direct access to the State Route 28 southbound on-ramp. The dog-bone roundabout would use Pedestrian Hybrid Beacons at each intersection leg for visual enhancements to protect pedestrians and bicyclists and increase driver awareness.

Additionally, MassDOT would change the Trowbridge Road and Sandwich Road underpass by providing a multi-lane roundabout at a relocated Upper Cape Cod Regional Technical High School Driveway entrance.

3.5 Construction Proposed Action

3.5.1 Construction Method

MassDOT proposes to use a "best value" design-build (D-B) procurement method for the construction of the Cape Cod Bridges Program, pursuant to Chapter 149A of the Massachusetts General Law. A D-B process is a construction delivery system that combines design and construction services within a single contract. A "best value" method is one that provides the highest overall value to MassDOT, in both cost and quality.[8]

MassDOT will design the Build Alternative to a Base Technical Concept—defined as 25% design—to establish the minimum baseline requirements for the design-build team.

The D-B construction method can "fast-track" the overall construction process. By awarding one contract under the D-B procurement method, there is no bidding phase, or delay, between the final design and construction phases that is typical of the more traditional design-bid-build approach. In addition to accelerating project delivery by integrating the design and construction phases, the D-B method can result in the following:

- Greater cost and schedule control
- Innovative design and construction methodologies through close collaboration between designer and contractor
- Reduced overall project risk

[8] Per Section 15 of Massachusetts General Law Chapter 149A, quality is defined as the basis on which the Massachusetts Department of Transportation will evaluate the elements of the project that it has determined are most important to the project, including, for example, quality of design, innovative approach, constructability, life-cycle and other long-term maintenance costs, maintenance-of-traffic, aesthetics, environmental impacts, local impacts, traveler and other user costs, service life, and time to construct.

Under the D-B procurement method, MassDOT's advertised construction contract will provide the Base Technical Concept, defined as approximately 25% level of design, to establish the minimum baseline requirements the D-B team must equal or exceed. Additionally, MassDOT will secure all necessary environmental approvals and clearances based on the Program's Base Technical Concept.

MassDOT proposes to use a Best Value design-build construction method to accelerate project delivery, control costs and schedule, promote innovation, and reduce overall risk.

The awarded D-B entity will complete final design and construct the Program in compliance with regulatory permits and approvals and within the timeframe of the Program schedule. They must also be in accordance with the Project Management Plan, Quality Management Plan, Site Control Plan, Construction Staging Plan, Noise and Dust Control Plans, Health and Safety Plan and all other applicable laws, regulations, ordinances, and other requirements, taking into account right-of-way and other physical constraints affecting the Program.

Also refer to **Appendix 3.2, Construction Approach Technical Report**, for information on the D-B construction method for the Program.

3.5.2 Construction Schedule and Estimated Construction Costs

3.5.2.1 Schedule

Pending the completion of the NEPA environmental review and receipt of federal and state permits and approvals, anticipated in spring 2026, MassDOT proposes to initiate the Program's design-build procurement and construction process in fall 2026. Construction activities for the replacement Sagamore and Bourne Bridges are expected to occur over eight to ten years, respectively. Construction of the replacement Sagamore Bridge would begin first, followed by the replacement Bourne Bridge once funding is secured. Bourne Bridge construction would commence one year following the commencement of Sagamore Bridge construction. However, the timing of construction sequencing depends on funding.

3.5.2.2 Estimated Construction Costs

In May 2023, MassDOT conducted a Cost and Schedule Risk Assessment workshop for the Program, in coordination with the FHWA. The workshop produced a risk-based cost estimate distribution based on inputs from MassDOT's Program Risk Register and output from FHWA's Monte Carlo simulation program. The estimated construction costs—including replacement of the bridge and interchange improvements, rights-of-way, utilities, preliminary engineering, and escalation and contingencies—are $2.14 billion for Sagamore Bridge and $2.4 billion for Bourne Bridge. The Program's total estimated construction cost is $4.54 billion. The Sagamore Bridge project will be funded with $1.37 billion from federal grants, $350 million from the USACE, and approximately $430 million from the Commonwealth of Massachusetts. MassDOT and the USACE are actively involved in identifying funding for the Bourne Bridge project.

3.5.3 Overview of Construction Approach

This section provides an overview of the construction approach based on preliminary design. MassDOT evaluated construction scenarios in consultation with a construction specialist. MassDOT expects to contract the Program as a D-B. However, the D-B team could propose different construction means and methods. **Appendix 3.2, Construction Approach Technical Report**, provides details on the construction approach, including descriptions and schematics of land- and water-based construction activities and conceptual construction plans.

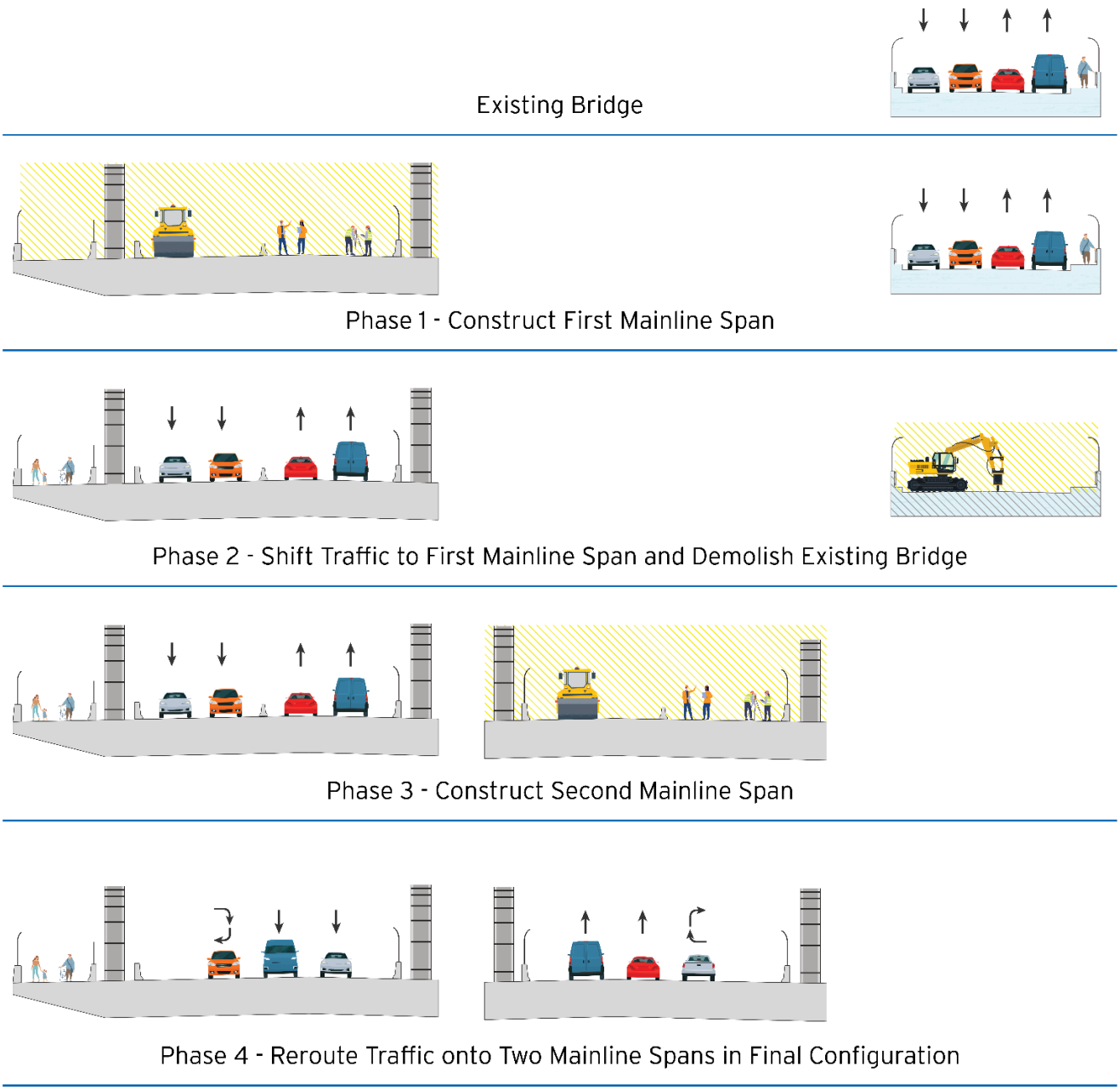
Figure 3-15 presents a simplified schematic of the Program's bridge construction sequencing approach, which involves four key phases. The replacement bridges would be constructed offline (outside of the existing footprint) and a maximum of 250 feet inboard of the existing highway bridges. Sagamore Bridge would be replaced first, followed by Bourne Bridge. At each site, the inboard main span (inboard bridge) would be constructed first. At the Sagamore Bridge site, this would be the westernmost bridge, which would ultimately carry traffic onto Cape Cod. For the Bourne Bridge site, this would be the easternmost bridge, which would ultimately carry traffic off Cape Cod. After construction of the first new span, all traffic would be shifted onto it so the existing bridge could be demolished, and the second main span (bridge) could be constructed.

Section 4.2, Transportation, Traffic, and Safety, further describes the Program's construction staging and sequencing. The Program's construction sequencing approach is a critical element for the design of the highway bridges, interchanges, and surrounding local roadway network. The construction sequencing goals for the Program include the following:

- Remove traffic from the existing bridge as quickly as possible.
- Maintain existing roadway and ramp connections through construction duration.
- Avoid the need for construction detours.
- Reduce or minimize traffic shifts.
- Maintain pedestrian and bicycle connectivity access equal to or better than existing conditions through construction duration.

Appendix 3.2, Construction Approach Technical Report, provides summaries of the interchange approach network construction phases in the four Program quadrants.

Figure 3-15. Proposed Bridge Construction Sequencing Approach



Source: Massachusetts Department of Transportation, 2024