CHAPTER 2
Alternatives

This section describes the Proposed Action and Alternatives, discusses the methodology used to identify alternatives that meet the Purpose and Need, and presents alternatives that were considered, but did not meet the Purpose and Need and therefore were not carried forward for analysis. FAA Order 1050.1F requires a discussion of alternatives in an EA that the approving official will consider. FAA Order 1050.1F, Chapter 6, Section 6-2.1(d) states the following:

> *"There is no requirement for a specific number of alternatives or a specific range of alternatives to be included in an EA. An EA may limit the range of alternatives to the proposed action and no action when there are no unresolved conflicts concerning alternative uses of available resources. Alternatives are to be considered to the degree commensurate with the nature of the proposed action and agency experience with the environmental issues involved. Generally, the greater the degree of impacts, the wider the range of alternatives that should be considered. The preferred alternative, if one has been identified, should be indicated. For alternatives considered but eliminated from further study, the EA should briefly explain why these were eliminated."*

2.1 Existing Conditions (No Action Alternative)

Boston Logan International Airport (the Airport) is a large commercial service airport in Massachusetts, with more than 20 million enplanements and approximately 427,000 aircraft movements in 2019.[3] It is the primary passenger airport for southern New England as well as the region's busiest passenger service airport. Of the twelve runways available at the Airport, Runway 4L is the only runway that typically handles commercial aircraft arrivals but does not have an IAP available to assist landings. An IAP is a series of predetermined maneuvers that facilitate the orderly transfer of an aircraft under IFR from the beginning of the initial approach to a landing or to a point from which a landing may be made visually. IFR are rules and regulations established by the FAA to govern flight under conditions in which flight by outside visual reference is not safe. When such conditions are present, these are known as IMC. IFR flight depends upon flying by

[3] Boston-Logan International Airport Monthly Airport Traffic Summary – December 2019, http://www.massport.com/media/3927/1219-avstats-airport-traffic-summary.pdf

reference using instruments in the flight deck, and navigation is accomplished by reference to electronic signals.

Currently, while operating in VMC, aircraft approaching Runway 4L to land are expected to maintain visual separation from other traffic at all times. As these aircraft presently lack electronic vertical and lateral guidance to the runway, pilots must “hand-fly” the aircraft and visually judge aircraft altitude and course alignment when arriving Runway 4L, leading to additional cockpit workload during a critical phase of flight. Furthermore, since the runway is not available during periods of IMC, operational flexibility and runway capacity are significantly limited during these times. During periods of significant delay, flights can often land much later than originally scheduled, potentially causing noise impacts to communities during late-night hours. Cancelling flights during periods of significant delay is not uncommon.

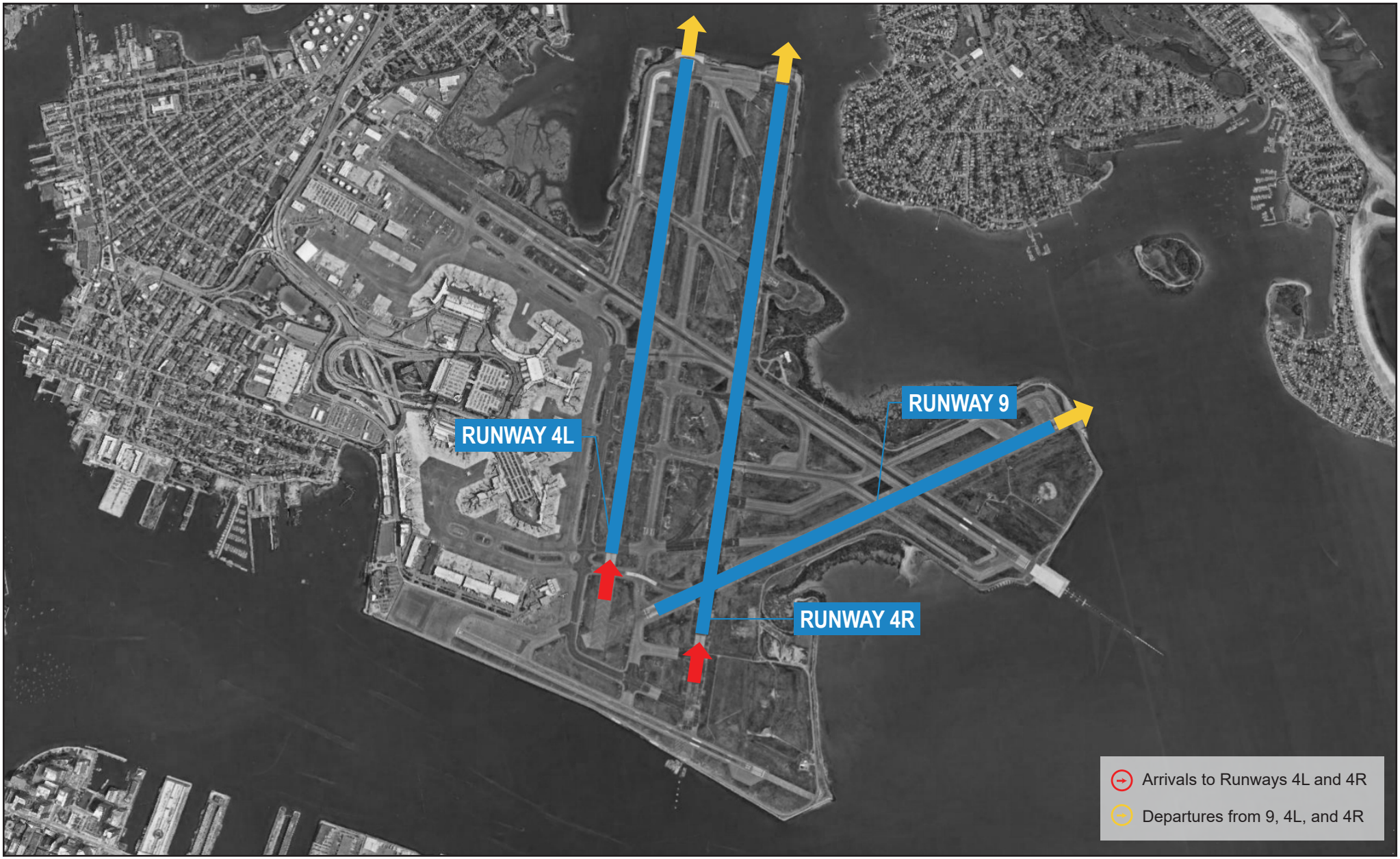
Presently, arrivals to Runway 4L primarily take place in VMC or marginal VMC (when the ceiling is 1,000 to 3,000 feet above field elevation (AFE), and/or visibility is three to five nautical miles (NM)) when the Airport is in the Northeast configuration, which is illustrated in **Figure 2-1**. The Northeast configuration consists of departures using Runways 4L, 4R, and 9, and arrivals using Runways 4L and 4R. As **Figure 2-1** shows, Runways 4L and 4R are oriented in the northeast direction while Runway 9 is oriented to the east. When the Airport is in the Northeast configuration, Runways 4R and 4L are designated as the primary and secondary arrival runways, respectively. Runway 4L is only used in times of heavy demand for Runway 4R, and aircraft are usually only assigned to Runway 4L when the final approach queue for Runway 4R extends beyond 10 NM from the Airport.

2.1.1 Existing Situations for Usage of Runway 4L

The usage of Runway 4L is effectively described by the following three operational scenarios:

Visual 4L Arrivals

When the Airport is in the Northeast configuration and operating in VMC, Runway 4L arrivals are generally vectored to a position southwest of the Airport and west of the Instrument Landing System (ILS) localizer straight-in approach to Runway 4R. Controllers instruct pilots of Runway 4L arrivals to report when they can both visually locate traffic closer to the Airport that is on approach to Runway 4R, and when they have Runway 4L in sight. Once both of these conditions are met, the controller has received the report and the pilot conducting the approach to Runway 4L confirms they are maintaining visual separation from the aircraft landing runway 4R, the controller will then issue a clearance to execute a visual approach to Runway 4L. After the clearance is issued, it continues to be the responsibility of the pilot conducting the approach to maintain visual separation from other aircraft while safely completing the approach to Runway 4L.



SOURCE: Massport, 2020, http://www.massport.com/logan-airport/about-logan/noise-abatement/how-logan-operates/

Boston Logan RNAV (GPS) RWY 4L EA

Figure 2-1
Northeast Flow Operating Configuration

Below is an example of what the communications between an arriving aircraft ('Bostonian 123') and the air traffic control for a visual Runway 4L approach might entail:

> *TRACON: Bostonian 123 fly heading 070, report Runway 4L in sight. Caution Bostonian 456, an Airbus A321 on short final to Runway 4R at your 2 o'clock and four and one-half miles.*
>
> *Bostonian 123: Heading 070 for Bostonian 123 and we have the company A321 in sight.*
>
> *TRACON: Bostonian 123 maintain visual separation from the Airbus A321.*
>
> *Bostonian 123: Wilco.*
>
> *Bostonian 123 (upon visual identification of Runway 4L): Bostonian 123 has Runway 4L in sight.*
>
> *TRACON: Roger Bostonian 123 you are cleared for the visual approach to Runway 4L. Maintain visual separation from traffic landing Runway 4R.*

Visual Change of Runway from ILS Runway 4R to Runway 4L on Final Approach

While the vast majority of aircraft landing on Runway 4L perform a visual approach, there are two additional maneuvers used to land aircraft on Runway 4L after initially following approach procedures to other runways – a change of runway maneuver and a circling maneuver that is limited to small aircraft. The change of runway maneuver allows the controller to approve an aircraft to land on an adjacent parallel runway instead of its initially designated runway. The change of runway maneuver to land on Runway 4L involves aircraft arriving from the south in VMC or marginal VMC. Aircraft that will ultimately arrive on Runway 4L will begin following the ILS straight-in approach procedure to Runway 4R at about 15 NM from the Airport. An ILS is a type of IAP that uses ground-based equipment to provide precision vertical and lateral guidance to arriving aircraft, and is used in this case to align arriving aircraft with the compass heading shared by Runway 4L and Runway 4R. When an arriving aircraft is approximately five NM from the Airport, the controller may issue a clearance to execute a runway change to land on Runway 4L if the Airport and other traffic are visible to the pilot.

It is important to note that the use of the change of runway maneuver to Runway 4L does not change the Airport's arrival rate. All aircraft using this approach are considered to be approaching Runway 4R for ATC separation purposes and are treated as a single arrival stream. Generally, an aircraft will only change runways to land on Runway 4L if an operational constraint to using Runway 4R exists. Examples of potential operational constraints that could result in the runway change maneuver to Runway 4L being used include the clearance of departures from Runway 4R or a tall vessel passing through Boston Harbor and temporarily obstructing the Runway 4R approach path.

Circling Visual Approach to Runway 4L after conducting ILS RWY 15R approach to visual conditions

A circling approach can be used by the pilot to align the aircraft with the runway for landing when a straight-in approach is not possible or desirable. The circling maneuver that is currently used

for aircraft landing on Runway 4L is only available during VMC and marginal VMC. When traffic and weather conditions dictate, small, maneuverable Category A or Category B aircraft (limited to approach speeds of 120 knots or below) are able to follow the ILS straight-in approach to Runway 15R until descent below the cloud ceiling. Once the aircraft is below the cloud ceiling and has the Airport in sight, the pilot can execute a circling approach to land on Runway 4L.

A circling approach, in this context, consists of an aircraft executing a turn to the south upon transitioning below the cloud ceiling. While remaining clear of clouds and with the Airport in sight at all times, the aircraft then maneuvers to a visual landing on Runway 4L. Pilots are responsible for maintaining visual separation from other traffic, including traffic landing Runway 4R, at all times when executing this maneuver. As this approach requires significant manual low-altitude maneuvering while maintaining visual separation from other traffic in busy airspace at an airport with multiple intersecting runways, it can be a challenging and potentially hazardous maneuver. Numerous safety-related incidents have occurred with aircraft flying this procedure, including some particularly notable recent incidents as described below:

- In October 2016, a DeHavilland Dash 8 passed directly over an Airbus A320 at low altitude while executing a go-around following an errant approach to Runway 4L's parallel Taxiway Bravo instead of the runway itself.
- In October 2019, a Cessna 414, after receiving clearance to execute a final approach to land Runway 4L, mistakenly lined up with Runway 9 instead, where another aircraft was preparing for takeoff. Once the pilot of the Cessna realized there was another aircraft on the runway, he executed a go-around at low altitude, overflying a third aircraft by an estimated 300 feet.
- In October 2019, a DeHavilland Dash 8, when flying the left downwind leg to Runway 4L after departing the ILS 15R approach course, extended the left downwind more than expected due to excessive airspeed on that leg. This resulted in ATC cancelling the approach clearance and instructing the aircraft to complete a go-around due to the imminent risk of an airspace incursion.

Of the three described methods that pilots can currently follow to land on Runway 4L, the change of runway and circling maneuvers are used far less frequently than visual approaches to the runway.

2.1.2 Current Approach Procedures for Runway 4R

Since Runway 4L is only used concurrently with Runway 4R, any changes to the usage of Runway 4L affect Runway 4R operations. Runway 4R is the primary arrival runway under the Northeast configuration, and has two IAPs available for use: "ILS or LOC RWY 4R", and the "RNAV (GPS) RWY 4R". While there are subtle differences between these two procedures with respect to visibility and ceiling minimums and when they are available, both use the same fixes and produce similar tracks over the ground. A waypoint is a designated geographical location used for route definition or progress-reporting purposes and is defined in terms of latitude/longitude coordinates.

When utilizing these IAPs, aircraft approaching the Airport are vectored to the final approach course within the final approach controller's airspace, to a point that is laterally separated from other aircraft, where a pilot can intercept the glideslope and make a stabilized approach to the

runway. Usually, this results in aircraft intercepting the final approach course near waypoint WINNI, which serves as the Intermediate Fix (IF) for the two procedures. (However, depending on operational factors, the final approach controller will sometimes vector aircraft to the approach inside of WINNI, resulting in a shorter final approach.) From WINNI, aircraft will transition through the fix at or above 4,000 feet above mean sea level (MSL) at a magnetic course of 035 degrees. Aircraft then proceed down the final approach course, crossing over waypoint NABBO at or above 3,000 feet MSL. For the ILS RWY 4R and ILS or LOC RWY 4R procedures, aircraft will proceed to waypoint MILTT and intercept the ILS glideslope at 1,700 feet MSL. In the case of the RNAV (GPS) RWY 4R, aircraft will still proceed to cross MILTT at 1,700 feet MSL, but since this is a non-precision approach (which provides lateral, but not vertical flight path guidance), MILTT functions as a Final Approach Fix (FAF) for this procedure. Instead of intercepting the ILS glideslope at MILTT, aircraft performing the RNAV (GPS) RWY 4R approach will fly to the minimum descent altitude (MDA) or decision altitude (DA) before landing, depending on aircraft equipage.

Aircraft that are equipped for Localizer Performance with Vertical Guidance (LPV) or Lateral Navigation/Vertical Navigation (LNAV/VNAV) can fly to their respective DAs, while aircraft equipped only with LNAV must fly to the MDA instead. The effect of the different minimums on this procedure is that there can be slight differences in altitudes inside of the FAF for aircraft that are equipped with LPV or LNAV/VNAV when compared with aircraft equipped for LNAV only. Additional information on the differences between LPV and LNAV/VNAV systems is also available in Section 2.2.2.3. Approach plates showing graphical representations of these procedures are available in Appendix A.

2.2 Identification of Potential Alternatives

The FAA endeavored to identify reasonable alternatives to meet the Purpose and Need described in Chapter 1. A reasonable alternative is one that would accomplish the Purpose and Need for the Proposed Action while being a feasible action. As the FAA has prioritized the implementation of NextGen, alternatives meriting consideration should emphasize safety and increased efficiency. Safety improvements associated with alternatives might include elements such as improved lateral and vertical guidance in VMC and the ability to use additional runways in IMC. Efficiency improvements could come from reducing arrival delays, potentially reducing the volume of delayed aircraft arriving during late-night and early-morning hours. Such efficiency benefits also lead to environmental benefits via less fuel burn and less aircraft noise during late-night and early-morning hours. Alternatives that involve procedures on other runways, other modes of transportation, use of other airports, or changes in airport use may have the potential to decrease air travel or shift traffic to other airports, but these alternatives do not meet the Purpose and Need for the Proposed Action.

2.2.1 FAA Proposed Action

The Proposed Action is the implementation of a publicly available (published) RNAV IAP to Runway 4L at the Airport. The proposed RNAV procedure will provide lateral and vertical guidance, enabling continuous descent to the runway and offering a more predictable, consistent, and stabilized approach path, thus improving safety. The proposed procedure will be used in three

specific situations, (1) when the Airport is experiencing IMC, (2) when the Airport is experiencing VMC and a flight is cleared for a visual approach to Runway 4L, and (3) when the Airport is experiencing VMC and a flight is cleared for the new procedure. These use cases are described in more detail below:

Case (1): IMC: During IMC, an aircraft would be cleared by ATC for use of the RNAV (GPS) RWY 4L procedure beginning at the Initial Approach Fix (IAF) AAALL or the IF LVRON. Runway 4L and Runway 4R have a centerline separation of 1,500 feet, well below the threshold of 4,300 feet minimum separation between runways that is required to carry out dual simultaneous independent instrument approaches. As a result, and given that Runway 4L is the secondary runway when Runway 4R is in use, the RNAV (GPS) RWY 4L procedure must be flown as a dependent simultaneous approach with more complex separation requirements from aircraft flying the ILS RWY 4R approach.[4] Due to these factors, utilization of this case is expected to be limited to times when arrival traffic is heaviest.

Case (2): VMC (when receiving a clearance for a visual approach to Runway 4L): During VMC, an aircraft that is cleared for a visual approach to Runway 4L can utilize any available guidance on an advisory basis (i.e., without controller involvement) to improve safety and reduce fuel consumption. As the RNAV (GPS) RWY 4L approach will be the only IAP available for Runway 4L, it will be available for pilot use during VMC. Pilots will fly similar ground tracks as they presently do when flying visual approaches to Runway 4L, but will have guidance available during the final straight-in flight segment.

Case (3): VMC (when receiving a clearance for the RNAV (GPS) RWY 4L approach): During VMC, an aircraft may be cleared by ATC for use of the RNAV (GPS) RWY 4L procedure at the IAP AAALL or the IF LVRON. Generally, this will be used by aircraft approaching from the south that presently utilize the Runway 4R ILS and execute a change of runway maneuver to land on Runway 4L when the Airport is in sight. Essentially, aircraft will use the approach the same way it is used in Case (1), the only differences being in ambient weather conditions.

The proposed procedure includes two charted transitions, as well as two uncharted transitions requiring ATC radar vectors, as described below:

- NUNZO transition – aircraft arriving from the south transition into the approach procedure at the charted fix NUNZO and follow the charted procedure to the runway from that fix.
- WOONS transition – aircraft arriving from the southwest transition into the approach procedure at the charted fix WOONS and follow the charted procedure to the runway from that fix.
- Cape-area transition – aircraft arriving from Cape-area airports such as Nantucket (ACK), Martha's Vineyard (MVY) and Barnstable (HYA), as well as other points east and southeast, will approach the Airport from the southeast and transition into the procedure

[4] FAA JO7110.308C, Appendix A

north of the IAF AAALL and south of the IF LVRON. It will then follow the charted procedure to the runway. This transition is not charted and requires radar vectors.

- Left-downwind transition – aircraft arriving from the west and north will fly a conventional left downwind leg to Runway 4L before making a base-to-final turn north of LVRON and transitioning into the procedure just south of MTAPN. This transition is not charted and requires radar vectors.

The proposed procedure is designated as an RNAV (GPS) IAP, which requires that an aircraft flying the procedure remain within one nautical mile of the procedure centerline 95% of the total flight time. The proposed RNAV (GPS) RWY 4L procedure is illustrated in **Figure 2-2** and **Figure 2-3**.

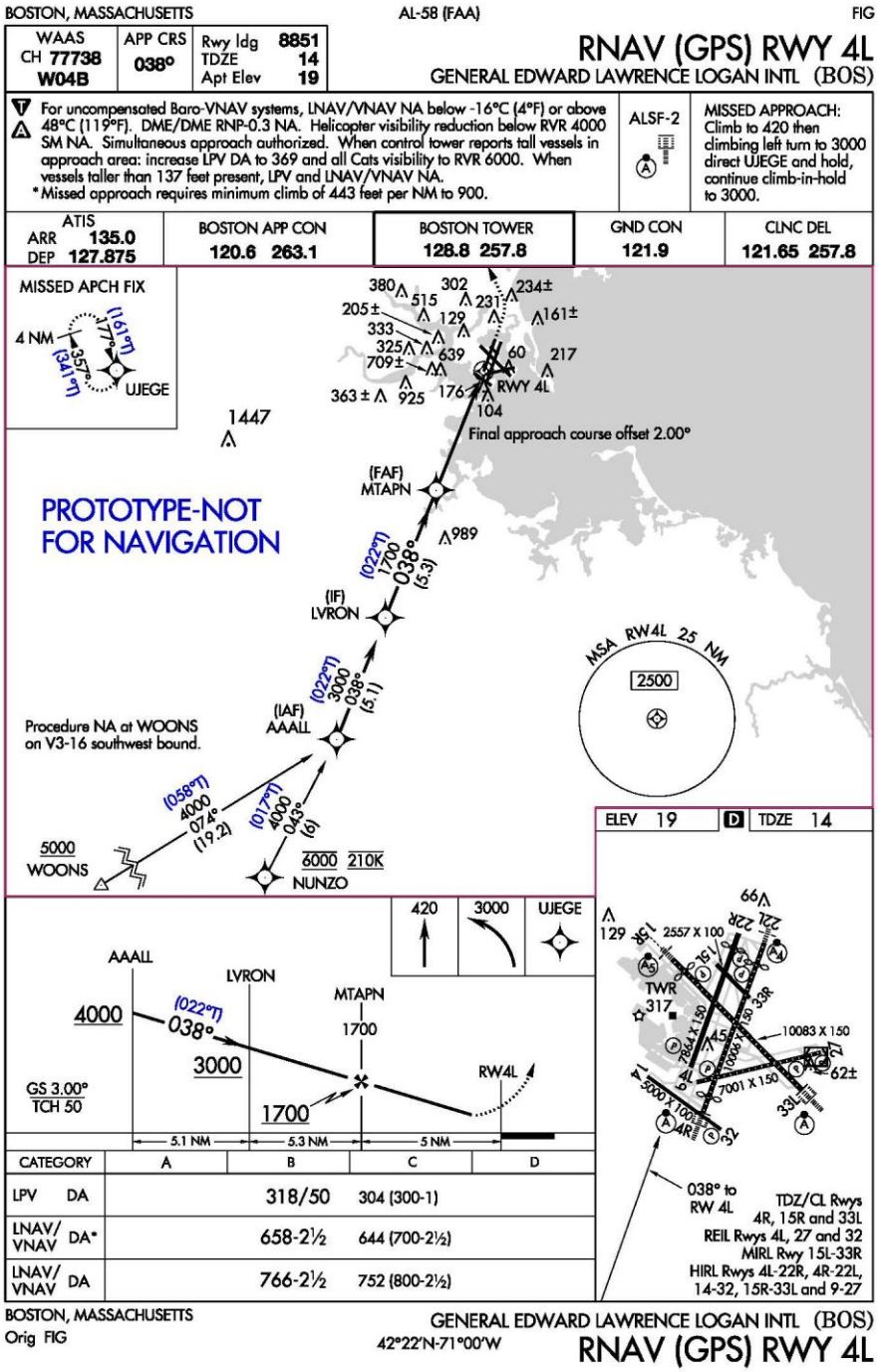
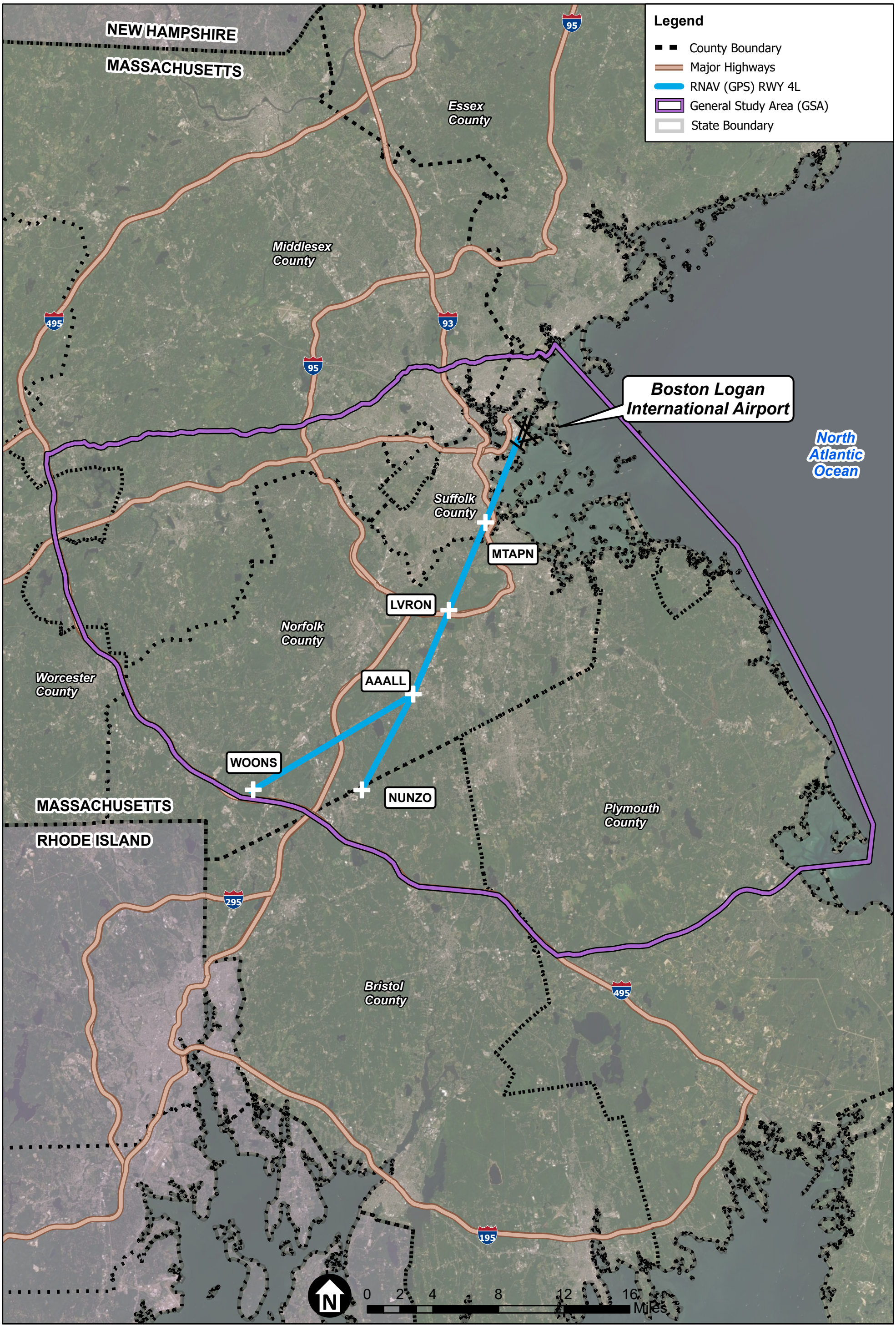


FIGURE 2-2 – RNAV (GPS) RWY 4L APPROACH PLATE



SOURCE: Esri; Prepared by Jacobsen Daniels, 2020

Boston Logan RNAV (GPS) RWY 4L EA

Figure 2-3

RNAV (GPS) RWY 4L Procedure

2.2.2 Alternatives Considered but Eliminated from Further Study

2.2.2.1 Memorandum of Understanding between FAA and Massachusetts Port Authority

In September 2016, the FAA and the Massachusetts Port Authority (Massport) signed a Memorandum of Understanding (MOU) detailing how they will work together to address aviation noise from flights at the Airport. The agencies agreed that Massport is responsible for recommending flight procedure changes to the FAA. Massport engages with the Massachusetts Community Advisory Committee (MCAC) to coordinate recommendations. These efforts produced two sets of recommendations for implementation of revised procedures, known as the Block 1 and Block 2 recommendations. Procedures associated with Block 1 were characterized by clear predicted noise benefits, limited operational and technical barriers, and a lack of adverse environmental justice impacts. Procedures associated with Block 2 exhibit greater complexity due to potential operational barriers, technical barriers, or environmental justice impacts.

Block 1 technical recommendations were released by Massport and the Massachusetts Institute of Technology (MIT) in December 2017.[5] A subset of these recommendations were deemed to be preliminarily feasible, but had not been validated or flight checked by the FAA at the time of the publishing of this EA. It is also important to note that since meeting the Purpose and Need involves obtaining safety and efficiency gains associated with implementing lateral and vertical guidance for traffic landing on Runway 4L at the Airport, the Block 1 technical recommendations do not meet the Purpose and Need for this EA. Block 2 technical recommendations have not been released at the time of the publishing of this EA. Because this alternative would not meet the Purpose and Need, it was determined not to be reasonable and eliminated from further study.

2.2.2.2 Install an Instrument Landing System for Runway 4L

Although the fundamental objective of the Proposed Action is to improve safety and reduce delays through implementation of an RNAV (GPS) procedure and to bring the Runway 4L approach procedures into conformance with national policy, multiple alternatives were considered and evaluated to determine feasibility. An early alternative considered was the installation of an ILS for Runway 4L. An ILS is a very common method of providing precision lateral and vertical guidance to landing aircraft and is extremely reliable and well understood. However, the land upon which an ILS would have to be installed is expensive, would involve the purchase of approximately 25 to 30 residential units and lots, and would require the closing of a portion of a local street. Additionally, construction, testing, and implementation of the ILS itself are activities that carry additional costs and complexities. As such, this alternative was eliminated early in the evaluation process as unreasonable.[6]

[5] The Report summarizing the Block 1 Technical Recommendations can be found at https://dspace.mit.edu/bitstream/handle/1721.1/114038/Jensen%20et%20al_Block_1%20Report.pdf?sequence=1
[6] Air Traffic Initial Environmental Review, RWY 4L RNAV (GPS) IAP, Federal Aviation Administration, March 2016.

2.2.2.3 RNAV (GPS) RWY 4L Alternative Designs

After the elimination of the ILS option, focus turned to an RNAV (GPS) procedure, which was the only realistic option for a procedure type that would be able to provide the necessary level of precision to facilitate safe, efficient, simultaneous dependent approaches to Runway 4L and Runway 4R. With respect to the design of the RNAV (GPS) RWY 4L IAP, alternatives considered for an RNAV (GPS) RWY 4L IAP must adhere to two requirements:

(1) Mitigation of wake encounters pursuant to FAA Order 7110.308C – *Simultaneous Dependent Approaches to Closely Spaced Parallel Runways* due to the proximity of Runway 4R approaches.
(2) Conformance with Performance Based Navigation (PBN) design parameters established by FAA Order 8260.58A – *United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design* – Including Change 1 and 2.

Accordingly, the implementation of an RNAV (GPS) IAP for Runway 4L requires consideration of the following[7]:

- A survey of obstacles along the approach path
- Ensuring Runway 4L is properly marked for an IAP
- Selection of an appropriate approach course relative to Runway 4R
- Selection of an appropriate glide path angle (GPA), DA, and minimum visibility for the IAP
- Coordination with both Boston Terminal Radar Approach Control Facility (TRACON) and Airport Air Traffic Control Tower (ATCT) personnel

As described in Section 2.2.1, the RNAV (GPS) RWY 4L IAP will be flown as a simultaneous offset instrument approach (SOIA) in conjunction with aircraft flying the ILS RWY 4R due to the lack of horizontal separation between the two runways as well as the designation of Runway 4R as the primary runway when the Airport is in the Northeast configuration. A major concern when running dual simultaneous approaches to runways that do not have at least 4,300 feet of separation between runway centerlines is the propensity for wake turbulence encounters. Wake turbulence involves atmospheric disturbances that form behind an aircraft as it moves through the air. Other aircraft encountering these disturbances can experience significant turbulence and, in some cases, loss of control. While loss of control is usually a recoverable event at high altitudes, a wake turbulence encounter at low altitudes can be extremely hazardous for any aircraft and could potentially result in an accident.

In order to mitigate wake encounters associated with operations approaching Runway 4R, three methods may be employed:

(1) Arrival operations on the two runways should be dependent with aircraft grouped in leader-trailer pairs with the lead aircraft approaching Runway 4R and the trailing aircraft approaching Runway 4L. In this situation, limiting the size and weight of the lead aircraft

[7] Air Traffic Initial Environmental Review, RWY 4L RNAV (GPS) IAP, Federal Aviation Administration, March 2016.

of the pair would also limit the magnitude of the wake potentially encountered by the trailing aircraft. Analysis of this wake mitigation measure indicated additional mitigation measures would need to be implemented. See **Figure 2-4** for an example of dependent runway operations.

(2) Ensuring the glide path of the trailing aircraft on Runway 4L is higher than that of the leading aircraft on Runway 4R could reduce the magnitude of wake encountered.

(3) Ensuring adequate separation between the flight tracks traveled over the ground by the leading and trailing aircraft would also mitigate the impact of wake encounters.

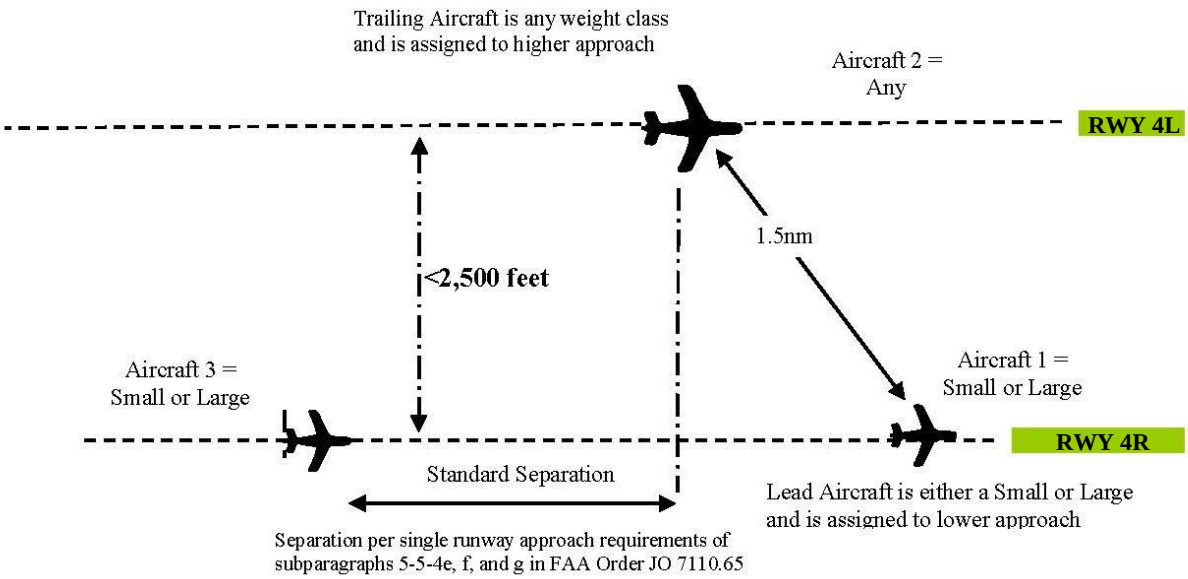


FIGURE 2-4 – EXAMPLE OF STAGGERED DEPENDENT PARALLEL RUNWAY OPERATIONS

For RNAV (GPS) procedures that offer both horizontal and vertical guidance, two approach types are offered – LPV and LNAV/VNAV. LPV approaches use the Wide Area Augmentation System (WAAS) to provide sensitivities very similar to that of a Category 1 ILS. LNAV/VNAV approaches utilize an internally generated glideslope based on either WAAS or a barometric VNAV system. Generally, an LPV approach will have a lower DA than an LNAV/VNAV approach due to the greater precision offered by WAAS lateral and vertical guidance.

To ensure the GPA of the leading aircraft on Runway 4R would be lower than that of the trailing aircraft on Runway 4L, consideration was given to lowering the established GPA for Runway 4R as well as raising the Runway 4L glideslope. A modeled alternative lowering the Runway 4R GPA was found to result in a reduction of the landing distance available and determined to be infeasible. Conversely, alternatives raising the Runway 4L GPA were found to result in fewer wake encounters experienced by aircraft executing LPV approaches when compared with wake encounters experienced by aircraft approaching Runway 4R with standard in-trail separation.

For aircraft on Runway 4L executing LNAV/VNAV approaches, the wake encounters experienced varied according to outside temperature. Aircraft traveling in temperatures that vary from the International Standard Atmosphere value of 59 degrees Fahrenheit (°F) fly either slightly lower or higher GPAs than indicated by aircraft altimeters due to the manner in which atmospheric physics

and barometric altimeters interact. Temperatures lower than 59°F result in altimeter readings slightly lower than the actual glide path, while warmer temperatures result in altimeter readings higher than the actual glide path being flown. Accordingly, cooler temperatures resulted in lower GPAs flown on approach to Runway 4L and an increase in wake encounters experienced, and warmer temperatures resulted in higher GPAs flown and a decrease in wake encounters experienced.

In order to address variation in the effects of wake encounters associated with temperature on aircraft using the LNAV/VNAV procedure, four alternatives were evaluated, three of which were rejected from further consideration. The rejected alternatives were considered unsuitable due to accessibility, safety, and complexity reasons. The idea of limiting the RNAV (GPS) RWY 4L IAP to an LPV-only approach was eliminated from consideration due to the fact that many aircraft are not equipped with WAAS and are limited to flying GPS approaches in LNAV/VNAV mode, limiting the usability of an LPV-only procedure. The other two alternatives, which both centered on modifying the GPA to be generally steeper than the standard 3.1° were not accepted by pilots and controllers. For pilots, a steeper GPA results in higher descent rates on approach, which erodes safety margin by decreasing the time that pilots have to react to unexpected circumstances on approach. Controllers viewed publishing multiple GPAs as a complicated alternative to mitigate potential wake turbulence encounters. Additionally, no criteria exist to support multiple published GPAs based on air temperature. The accepted alternative of a standard 3.1° GPA combined with a 2.0 degree westward offset approach course was carried forward as part of the Proposed Action These four potential enhancements to the Proposed Action are summarized further in **Table 2.2-1**.

TABLE 2.2-1
ALTERNATIVES TO MITIGATE WAKE ENCOUNTERS DUE TO TEMPERATURE VARIATIONS

Alternative Description	Determination
Limit the Runway 4L RNAV (GPS) IAP to the LPV procedure.	• Several Airlines serving BOS objected because their aircraft are not equipped for the LPV procedure. **ELIMINATED**
Increase the Runway 4L GPA to a value larger than 3.1° reducing the wake encounter probability to an acceptable level at lower temperatures.	• Some pilots objected to such a steep glide path angle during warm temperatures as less safe (due to the associated increase in descent rate). • FAA Order 8260.3C (2-6-1) states that the Category D (aircraft with approach speeds of 141 knots to 165 knots) aircraft 3.1° slope is the maximum allowable glide path angle. **ELIMINATED**
Publish multiple GPAs based on the temperature (e.g., 3.4° GPA for 0ºF to 35ºF; 3.2° GPA for 36ºF to 72ºF; and 3.0° GPA for 73ºF to 105ºF).	• Controllers objected to this alternative as being complicated, thus more error-prone and a safety risk. • There are no criteria established that would allow multiple approach descent angles to be published for an instrument approach predicated on air temperature. • FAA Order 8260.3C (2-6-1) states that the Category D (aircraft with approach speeds of 141 knots to 165 knots) aircraft 3.1° slope is the maximum allowable glide path angle. **ELIMINATED**
Combination of 3.1 degree GPA and 2.0 degree westward offset approach course, retaining LNAV/VNAV approach as an option	• Selected after investigating alternative offset angles • Provides the required wake mitigation • Is compliant with Order 8260.58 and was acceptable to controllers, pilots, and airlines **CARRIED FORWARD**

Source: Air Traffic Initial Environmental Review, RWY 4L RNAV (GPS) IAP, Federal Aviation Administration, March 2016.

2.2.2.4 Enhance Arrival Rates on Alternative Runways

From a theoretical perspective, increased aircraft arrival rates (AAR) on other IAP runways could reduce delays, but this would not meet the Purpose and Need because this action would not fundamentally increase safety. Rather, increasing AAR on other runways would have a neutral effect on safety at best (assuming sufficient capacity), and at worst a detrimental one as ATC must handle more aircraft in the same time and space. Furthermore, given that the Northeast configuration currently only uses Runway 4L and Runway 4R for arrivals under normal circumstances, the Airport would have to determine a method of utilizing Runway 9 and/or Runway 15R for a significant number of landings given that the AAR to Runway 4R cannot be increased further. Both of these options would involve the development of an entirely new operating configuration at the Airport. Neither of these options is operationally feasible, and FAA air traffic specialists have been unable to identify other specific enhancements that increase arrival rates that are compatible with existing safety criteria. Thus, the idea of enhancing arrival rates on other runways is not a feasible alternative to meeting the Purpose and Need.

2.2.2.5 Other Alternatives

In addition to the alternatives discussed above, other alternatives were suggested during the Proposed Action Initial Environmental Review public comment period that took place from May 18, 2015 to June 30, 2015. Alternatives were suggested by various public officials as well as members of the general public. The suggested alternatives received during the public comment period that were deemed reasonable generally fell into three categories, summarized in **Table 2.2-2**. Although the suggested alternatives were considered, all were found to be infeasible as none were consistent with FAA Order 8260.58 – *United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design* – Including Change 1 and 2.

TABLE 2.2-2
ALTERNATIVES RECEIVED DURING THE PUBLIC COMMENT PERIOD FOR THE INITIAL ENVIRONMENTAL REVIEW

Recommended Alternative	Determination
Utilize a curved approach from Boston Harbor to Runway 4L to reduce overflight of homes.	Not feasible for safety reasons since this requires that Runway 4L arrival traffic cross through the paths of aircraft approaching Runway 4R along its extended centerline while using ILS guidance. Also requires significant low altitude maneuvering in busy airspace.
Utilize a 4° GPA.	Not permitted by Order 8260.58 governing design of RNAV approach procedures. Extremely steep GPAs cannot be flown with electronic guidance in most commercial aircraft, and are uncomfortable and potentially hazardous to fly manually, particularly in aircraft without a dedicated steep approach mode.
Aircraft approach the runway at different azimuth angles to reduce concentration of flight paths.	While the FAA is authorized to consider implementing procedures featuring multiple dispersal headings in some instances, a fanning approach to the runway would increase pilot workload and/or controller workload during a critical phase of flight in busy airspace, thus introducing a potential safety risk. As a result, this alternative does not meet the Purpose and Need of the action.

Source: Air Traffic Initial Environmental Review, RWY 4L RNAV (GPS) IAP, Federal Aviation Administration, March 2016.

2.3 Alternatives Carried Forward for Detailed Evaluation

This section provides descriptions of the alternatives selected for analysis in the EA, including the No Action and Proposed Action Alternatives.

2.3.1 No Action Alternative (Maintain Current Operations)

The No Action Alternative would maintain the current suite of procedures available at the Airport, and would not result in the implementation of a new IAP for Runway 4L. As a result, the current general lack of availability of Runway 4L during IMC would remain, and all arrivals to Runway 4L would continue to operate without vertical or lateral guidance. Although it does not meet the

Purpose and Need, the No Action Alternative is carried forward for further environmental analysis in accordance with Council on Environmental Quality (CEQ) regulations implementing NEPA.

2.3.2 FAA Proposed Action

As described in **Section 2.2.1**, the FAA developed an RNAV (GPS) arrival procedure in order to provide an IAP to Runway 4L and increase safety and efficiency at the Airport. This alternative, which was refined and technically evaluated to meet RNAV performance criteria and evaluated for noise impacts, has been carried forward for further environmental analysis.

Because all of the other alternatives considered were determined to be unreasonable, the FAA has determined that the No Action and Proposed Action Alternatives represent a reasonable range of alternatives to be evaluated in this EA.