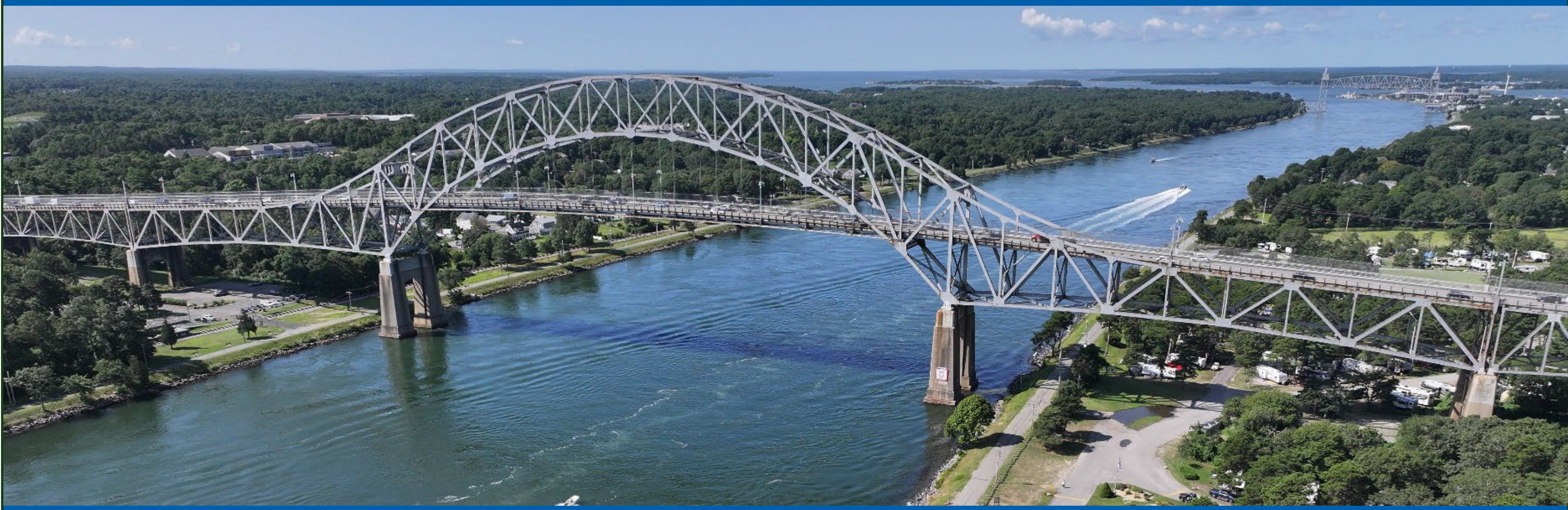


Cape Cod Bridges Program
Bourne, Massachusetts

Appendix 4.13
Air Quality Technical Report

SUBMITTED TO:
Federal Highway Administration
Massachusetts Division
220 Binney Street, 9th Floor
Cambridge, MA 02142

PROPONENT:
The Massachusetts Department of Transportation
Highway Division
10 Park Plaza
Boston, MA 02116

Submitted June 2026

massDOT
Massachusetts Department of Transportation

Table of Contents

Figures

Tables

Acronyms and Abbreviations

Acronym/Abbreviation	Definition
CFR	Code of Federal Regulations
CO	carbon monoxide
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MOVES	Motor Vehicle Emissions Simulator

Acronym/Abbreviation	Definition
MSAT	Mobile Source Air Toxic
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NOx	nitrogen oxides
NO2	nitrogen dioxide
PM	particulate matter
ppm	parts per million
Program	Cape Cod Bridges Program
SO2	sulfur dioxide
SUP	share-use path
USACE	U.S. Army Corps of Engineers
VHT	vehicle hours traveled
VMT	vehicle miles traveled

1 Introduction

This Air Quality Technical Report has been prepared in support of the Final Environmental Impact Statement for the Cape Cod Bridges Program (Program), in accordance with the following federal and state statutes, regulations, and guidance:

- National Environmental Policy Act (NEPA) of 1969, as amended, 42 United States Code (USC) 4321 et seq.
- *Efficient Environmental Reviews for Project Decision-making and One Federal Decision,* 23 USC 139.
- Federal Highway Administration's (FHWA) regulations implementing NEPA, *Environmental Impact and Related Procedures* (23 Code of Federal Regulations [CFR 771]), and corresponding guidance, Technical Advisory (T 6640.8A): *Guidance for Preparing and Processing Environmental and Section 4(f) Documents* (October 30, 1987).

2 Proposed Action and Alternatives

2.1 Purpose and Need

In partnership with FHWA and the New England District of the U.S. Army Corps of Engineers (USACE), MassDOT proposes advancing the Program in the town of Bourne, Barnstable County, Massachusetts.

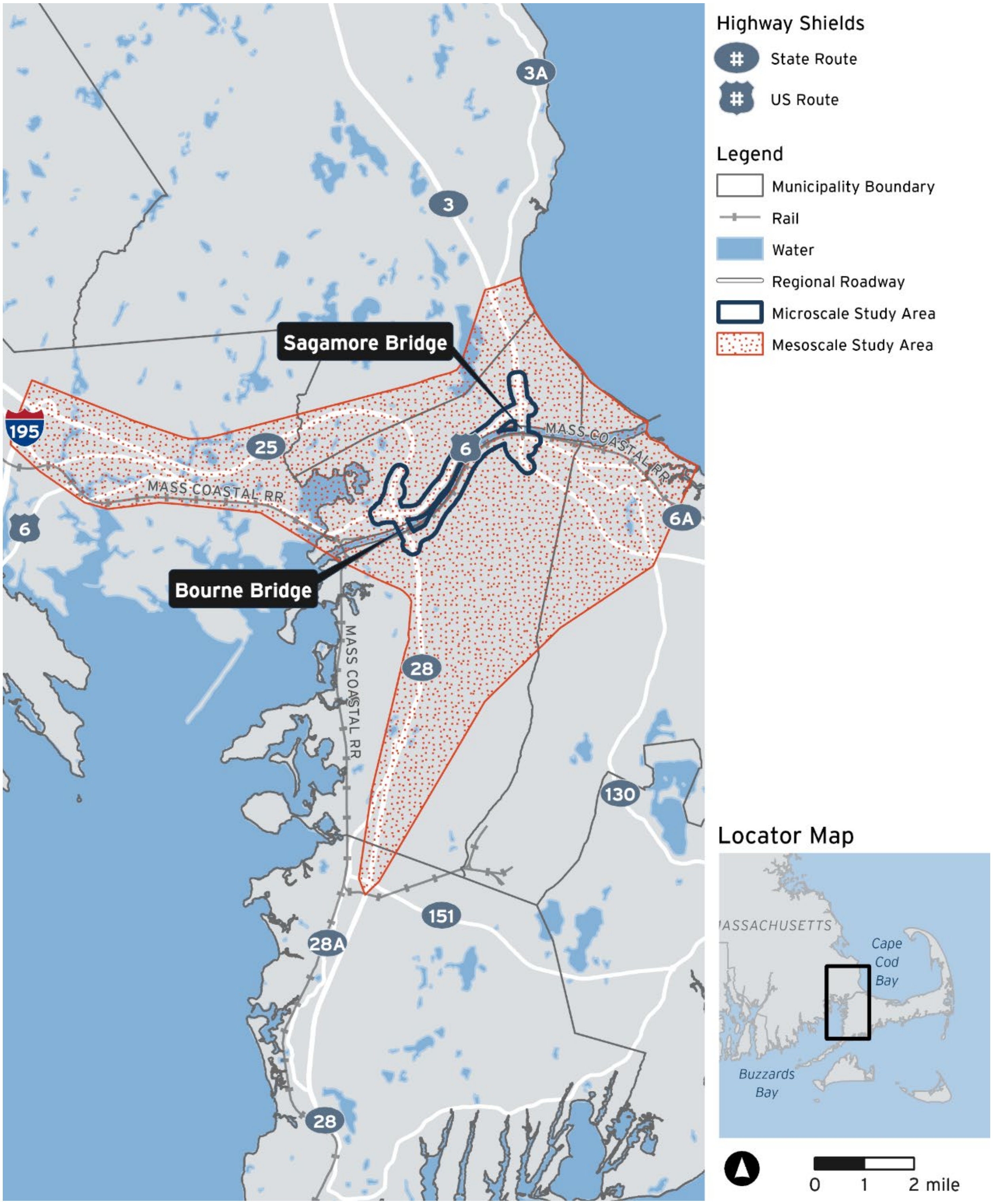
The purpose of the Program is to improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and to address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges. The needs for the Program are as follows:

- Address the deteriorating structural condition and escalating maintenance demands of the Sagamore and Bourne Bridges.
- Address the substandard design elements of the Sagamore and Bourne Bridges, the immediate mainline approaches, and their adjacent interchanges and intersections.
- Improve vehicular traffic operations.
- Improve accommodations for pedestrians and bicyclists.

2.2 Study Area

A Microscale Study Area and a Mesoscale Study Area are defined to assess air quality impacts at both localized roadway locations and across the broader regional transportation network (**Figure 2-1**). These Study Areas correspond to the geographic areas used to assess the Program's effects on traffic operations.

Figure 2-1. Microscale and Mesoscale Air Quality Study Areas



Source: Massachusetts Department of Transportation, 2026

2.3 Build Alternative

The Program's Build Alternative would incorporate USACE's Major Rehabilitation Evaluation Report and Environmental Assessment's (MRER/EA) preferred alternative of replacing both highway bridges with new bridges, each with four through-travel lanes and two auxiliary lanes (in-kind bridge replacement that would be updated to comply with federal and state highway and design safety standards). The Program proposes to replace the Sagamore and Bourne Bridges with parallel, twin tied-arch bridge structures that would be supported on delta frames with an approximate 700-foot mainline span length. At both the Sagamore Bridge and Bourne Bridge crossings, the replacement mainline alignment locations would be offline and inboard of the existing bridges on the side of the canal between the bridges. At both canal crossings, the Program would reconfigure the highway interchange approach networks north and south of Cape Cod Canal to align with the replacement bridges. The replacement bridges and their interchange approaches would accommodate shared-use pedestrian and bicycle paths that would connect to the local roadway network on both sides of Cape Cod Canal in the town of Bourne.

Table 2-1 presents a description of the Program elements/design parameters of the recommended Build Alternative: Replacement Highway Bridges Built to Modern Design Standards.

Table 2-1. Cape Cod Bridges Program Preferred Alternative

Program Element/ Program Design Parameter	Description
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 span would provide two 12-foot-wide through-travel lanes (one in each direction), one 12-foot-wide entrance/exit (auxiliary) lanes, a 6-foot-wide median shoulder, and a 12-foot-wide exterior shoulder. 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 3.3 feet of fluctuations in relative sea level, thereby providing a vertical clearance of 138.3 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.

Program Element/ Program Design Parameter	Description
Main Span Length and Bridge Pier Location	The replacement bridges would have a main span length of 720 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 crossings would be offline inboard. Both spans of the replacement highway bridges would be outside the footprint of the existing bridge, 7 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 steel twin network tied-arch bridges, with delta frames supporting a 720-foot mainline span.
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 Sandwich Road Extension in the Sagamore South quadrant • Bourne Bridge Crossing: Directional Interchange in the Bourne North quadrant and a Diamond Interchange in the Bourne South quadrant

Program Element/ Program Design Parameter	Description
Interchange Approach Network: Sagamore North Quadrant	The selected interchange approach option for the Sagamore North quadrant is: Direct Connection to State Road (Option SN-8A). 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 with geometric adjustments to meet the new mainline location. A double roundabout would replace the signalized intersection of Scenic Highway/Meetinghouse Lane/State Road/Canal Street. Signalized intersections along Scenic Highway would be modified for new lane configurations. The intersection of State Road at State Route 3 northbound on-ramp would be modified to accommodate the addition of the new State Route 3 northbound off-ramp and installation of a traffic signal. Option SN-8A would provide a shared-use path on the U.S. Route 6 eastbound main span that would provide connections to the south side of Scenic Highway, Canal Street, and Canal Service Road. This option would provide shared-use paths along the southern side of Scenic Highway and Meetinghouse Lane and along the eastern side of State Road to Homestead Avenue and Canal Street to Bourne Park and Ride.

Program Element/ Program Design Parameter	Description
Interchange Approach Network: Sagamore South Quadrant	The selected interchange approach option for the Sagamore South quadrant is: Westbound On-Ramp Under U.S. Route 6 with Sandwich Road Extension (Option SS-3.1A). Option SS-3.1A would include Cranberry Highway Extension and would relocate the westbound on-ramp, so that it would share the same entrance point as the eastbound on-ramp off Mid-Cape Connector. Modifications to lane arrangements at the intersections of Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension would accommodate revised traffic patterns resulting from the extension of Cranberry Highway and the relocation of access to U.S. Route 6 (Scenic Highway) eastbound, including modifications to the existing traffic signals. There would be a connection from Cranberry Highway to Sandwich Road east of the mainline bridge (Sandwich Road Connector). A roundabout would be provided at the intersection of the U.S. Route 6 westbound off-ramp with Cranberry Highway. An additional roundabout would be provided along Cranberry Highway providing access to Market Basket (Factory Outlet Road). There would be an access driveway to the former Christmas Tree Shops area. Option SS-3.1A would include a shared-use path 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 also would be included on Cranberry Highway. This option would add a new connection through Cranberry Highway Extension to Mid-Cape Connector.

Program Element/ Program Design Parameter	Description
Interchange Approach Network: Bourne North Quadrant	The selected interchange approach option for the Bourne North quadrant crossing is: Directional Interchange (BN-14.4b). 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 flyover ramp passing over Nightingale Road and merging with the on-ramp from Belmont Circle before meeting up with the State Route 25 mainline. The ramp connecting Scenic Highway eastbound to State Route 25 eastbound would be a flyover ramp passing over Scenic Highway, allowing vehicles to bypass Belmont Circle and eliminating the need for 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 interchange ramp over the State Route 25 bridge would be relocated to widen the bridge to allow for this new southbound to eastbound ramp movement. 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 Scenic Highway/ Nightingale Road/Andy Oliva Drive would be a single-lane roundabout. The new flyover ramp over Scenic Highway would provide a shared-use path and grade-separated crossing for pedestrians and bicyclists. The Scenic Highway lane configuration would be reduced from four lanes to three lanes, which would provide additional space for multimodal accommodations. It would provide one continuous 12-foot-wide shared-use path along the south side of Scenic Highway connecting to Belmont Circle and a 6-foot-wide sidewalk along the north side of Scenic Highway.
Interchange Approach Network: Bourne South Quadrant	The selected interchange approach option for the Bourne South quadrant is: Diamond Interchange (BS-2). Option BS-2 would eliminate Bourne Rotary and replace it with a grade-separated diamond interchange, which would allow through movements on State Route 28 to bypass intersections with the non-mainline roadways. The two intersections within the diamond interchange would be a single-lane dogbone roundabout. Changes to the Trowbridge Road and Sandwich Road underpass in this option would consist of a roundabout at a relocated Upper Cape Cod Regional Technical High School driveway entrance. This option's shared-use path improvements would include providing connections to Trowbridge Road, Canal Service Road, and Bourne Recreation Area.

2.4 No Build Alternative

The Sagamore and Bourne Bridges, as components of the Cape Cod Canal Federal Navigation Project, are federal assets that are managed by USACE's New England District. The Commonwealth of Massachusetts owns the connecting major highway corridors at the bridges, which consist of the State Route 3/U.S. Route 6 corridor at Sagamore Bridge and the State Route 25/State Route 28 corridor at Bourne Bridge.

In the No Build Alternative, the Sagamore and Bourne Bridges would retain their current configuration of four 10-foot-wide travel lanes (two in each direction) with one 6-foot sidewalk and a 2-foot safety curb. USACE would continue to operate and maintain the Sagamore and Bourne Bridges and would implement a maintenance and repair program as needed to maintain bridge operations and public safety. MassDOT would continue to own, operate, and maintain the state highway interchange approach networks at the two bridges.

The No Build Alternative would include recently completed and proposed Commonwealth of Massachusetts-sponsored and local transportation improvements projects in and near the Program as indicated in the Federal Fiscal Year 2026-2030 Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization.[1] **Table 2-2** identifies the Transportation Improvement Program projects within and near the Program to be incorporated in the No Build Alternative.

The No Build Alternative represents the "Fix as Fails" Base Condition of USACE's MRER/EA. In the No Build Alternative, 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 both the Sagamore and Bourne Bridges are in deteriorated condition and well beyond the state in which actions and funding from USACE's operations and maintenance program could correct the deficiencies and restore and sustain reliability. USACE has 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.

[1] The Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization was endorsed on May 19, 2025, and amended on November 17, 2025.

Table 2-2. Transportation Improvement Program Projects, 2026-2030

Project Number	Year	Transportation Project	Project Description	Status[1]
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)	Completed
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	Completed
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	Underway
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

Project Number	Year	Transportation Project	Project Description	Status[1]
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
613864	—	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
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	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	Underway
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

Project Number	Year	Transportation Project	Project Description	Status[1]
613200	—	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	Not Programmed
612063	2030	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	—	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	Not 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 Federal Fiscal Year (FFY) 2026-2030 Transportation Improvement Program (TIP) within the Study Areas that are part of the No Build Alternative.

— No date available.

[1] Status as of October 2025

The No Build Alternative would not meet any of the Program's identified needs:

- It would not address the deteriorating structural condition and escalating maintenance demands of the existing bridges.
- It would not address the substandard design elements of the bridges, the immediate mainline approaches, and their adjacent interchanges and intersections.
- It would not improve vehicular traffic operations.
- It would not improve accommodations for pedestrians and bicyclists.

Per NEPA requirements, the No Build Alternative is included in the Environmental Impact Statement (EIS) as the base condition against which the Build Alternative is compared and evaluated.

3 Methods for Effect Evaluation

3.1 Regulatory Framework

The following provides the regulatory context and guidance for this analysis:

- Federal Clean Air Act of 1970 and Amendments
- Transportation Conformity Rule (40 CFR Parts 51 and 93)
- FHWA Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents, January 18, 2023
- MassDEP Guidelines for Performing Mesoscale Analysis of Indirect Sources, May 1991
- Massachusetts Clean Air Act (Massachusetts General Law [MGL] Chapter 111, Sections 142A-142M) and Air Quality regulations: 310 CMR 6.00: Ambient Air Quality Standards; 310 CMR 7.00: Air Pollution Control, 310 CMR 8.00: Prevention & Abatement of Air Pollution Control Episodes & Emergencies; 310 CMR 60.00: Air Pollution Control for Mobile Sources

3.2 Methodology

3.2.1 Carbon Monoxide Microscale (Localized) Analysis

The U.S. Environmental Protection Agency's (EPA) project-level ("hot-spot") transportation conformity requirements for carbon monoxide (CO) do not apply because the Program is located in a region that is in attainment of the National Ambient Air Quality Standards (NAAQS) for CO. However, a qualitative analysis was conducted to evaluate potential CO impacts from the Build Alternative compared to the No Build Alternative.

3.2.2 Mesoscale (Regional) Emission Analysis

MassDOT performed a mesoscale analysis to evaluate the potential regional air quality impact of the Build Alternative from motor vehicles within the mesoscale study area as a measure of the total daily emissions of volatile organic compounds (VOC), nitrogen oxides (NOx), CO, PM10 and PM2.5, and SO2. MassDOT performed calculations to compare area-wide emissions between the No Build Alternative and Build Alternative.

MassDOT used affected traffic segment links from the larger mesoscale study area, including segment length and average daily traffic, to estimate vehicle miles traveled (VMT) for the No Build Alternative and Build Alternatives. Average vehicle speeds were estimated for the overall study area for each condition to obtain the appropriate emission factors from the EPA Motor Vehicle Emission Simulator (MOVES model version 4). The EPA MOVES4 model is a state of the science emission modeling system that estimates emissions for a variety of vehicle types, including, but not limited to, passenger vehicles, trucks, bulldozers, cranes, etc. The VMT and the average MOVES4 emission factors were used to estimate daily emissions in tons per day over the mesoscale study area. MassDOT estimated daily emissions for No Build Alternative and Build Alternative.

3.2.3 Qualitative Assessment of Mobile Source Air Toxics

FHWA updated its guidance for the assessment of MSATs in the NEPA process for highway projects in 2023. It states the following:

> "…EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and non-cancer hazard contributors from the 2011 National Air Toxics Assessment (NATA).[2] These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter."

It also specifies three possible categories or tiers of analysis:

1. Projects with no meaningful potential MSAT effects, or exempt projects (for which MSAT analyses are not required)
2. Projects with low potential MSAT effects (requiring only qualitative analyses)
3. Projects with higher potential MSAT effects (requiring quantitative analyses)

The forecast average daily traffic (ADT) volumes for the Build Alternative were compared to FHWA criteria to determine the level of analysis for MSATs.

3.2.4 Construction Emissions

MassDOT completed a quantitative assessment of construction-related mobile-source emissions from diesel truck traffic and marine vessels.

3.2.4.1 Diesel Truck Emissions

Diesel vehicle truck trips are required to support material deliveries, equipment transport, and other resources essential to Program implementation. To estimate the reasonable average daily diesel vehicle trips associated with the Program, an analysis was conducted to identify the total quantities of major construction commodities anticipated across all project elements. Assumptions regarding average load sizes were then applied to determine the number of diesel truck trips required to transport these materials to and from the Project Limits.

In addition to material-related trips, the analysis incorporated an allowance for miscellaneous small-part deliveries and diesel-powered work vehicles not otherwise captured in the material transport estimates. This supplemental activity was represented by an average of 20 additional diesel vehicles per bridge per day. The combined trip total was then averaged over the anticipated 10-year construction period, resulting in an average of 103 daily round trips within the Sagamore and Bourne Project Limits.

Daily truck trips were assigned a representative routing distance within the mesoscale study area to quantify daily and annual VMT. A routing distance (14 miles), from State Route 25 eastbound to U.S.

Route 6 eastbound, was selected to represent typical truck movements within the Study Areas and provide a conservative basis for estimating VMT.

Daily and annual VMT were then paired with pollutant-specific emission factors generated using the EPA MOVES2019 model. Annual emissions of criteria pollutants, including nitrogen oxides, particulate matter (PM 10 and PM 2.5), CO, and VOCs were calculated by multiplying VMT by the corresponding emission factors.

3.2.4.2 Marine Vessel Emissions

Marine vessel activity is required to support construction at the Sagamore and Bourne Bridges, including barge positioning, material transport, and in-water construction support. Only powered vessels were included in the emissions analysis, which distinguishes tugs and launches from unpowered barges.

The analysis assumes 7,300 annual trips by tugboats and small launches over the 6-year period during which marine vessels would be operational at both bridges. For emissions quantification, the analysis applies an 8-hour operating day. Total annual operating hours are calculated by multiplying the number of trips by the assumed daily operating duration. These hours are then paired with EPA marine engine emission factors that represent typical emissions from commercial diesel marine engines across various operating modes. Emissions of criteria pollutants are estimated by applying these emission factors to the total annual operating hours.

4 Affected Environment

4.1 National Ambient Air Quality Standards

Pursuant to the Clean Air Act of 1970, EPA established NAAQS for major pollutants known as "criteria pollutants." **Table 4-1** presents the NAAQS established by EPA for criteria air pollutants, namely CO, sulfur dioxide (SO2), ozone, particulate matter, nitrogen dioxide (NO2), and lead (Pb).

There are two types of NAAQS: primary and secondary. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.”[2]

As a requirement of the Clean Air Act, EPA periodically reviews the NAAQS and revises them as needed (for example, to make them more stringent and/or, on occasion, to revoke previous standards that were less stringent).[3] For instance, EPA revoked the 1997 annual primary PM2.5 NAAQS effective

[2] From the preamble to the USEPA NAAQS table: https://www.epa.gov/criteria-air-pollutants/naaqs-table

[3] On January 27, 2023, EPA issued a proposed rule for “Reconsideration of the National Ambient Air Quality Standards for Particulate Matter” (18 Federal Register 5558). At the time of preparation of this report, that rule has not been finalized. The NAAQS table presented here may be updated for particulate matter when the rule is finalized.

October 24, 2016, with the implementation of the more stringent 2012 PM2.5 NAAQS.[4] Most recently in February 2024, EPA strengthened the primary annual PM2.5 standard to 9 microgram per cubic meter from 12 microgram per cubic meter.[5]

Table 4-1. National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		Primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		Primary and Secondary	Rolling 3-month average	0.15 $\mu g/m^3$ [1]	Not to be exceeded
Nitrogen Dioxide (NO2)		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	1 year	53 ppb[2]	Annual Mean
Ozone (O3)		Primary and Secondary	8 hours	0.070 ppm[3]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	PM2.5	Primary[5]	1 year	9.0 $\mu g/m^3$	annual mean, averaged over 3 years
		Secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		Primary and Secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM10	Primary and Secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO2)		Primary	1 hour	75 ppb[4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

4 On August 24, 2016, EPA issued a final rule (81 Federal Register 58010), effective October 24, 2016, on "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" that stated, in part: "Additionally, in this document the EPA is revoking the 1997 primary annual standard for areas designated as attainment for that standard because the EPA revised the primary annual standard in 2012." https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf. Note the revocation of the 1997 annual primary NAAQS for PM2.5 also eliminated the associated conformity requirements. For example, conformity requirements for that NAAQS were eliminated for northern Virginia, which until then had been in attainment (maintenance) for that standard.

5 U.S. Environmental Protection Agency. 2024. Final Reconsideration of the National Ambient Air Quality Standards for Particulate Matter (PM). February. https://www.epa.gov/pm-pollution/final-reconsideration-national-ambient-air-quality-standards-particulate-matter-pm

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: U.S. Environmental Protection Agency. NAAQS Table (https://www.epa.gov/criteria-air-pollutants/naaqs-table (accessed February 2025)

ppm = parts per million by volume; ppb = parts per billion by volume; µg/m^3 = micrograms per cubic meter of air

[1] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m^3 as a calendar quarter average) also remain in effect.

[2] The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[3] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards are not revoked and remain in effect for designated areas. Additionally, some areas may have certain continuing implementation obligations under the prior revoked 1-hour (1979) and 8-hour (1997) O_3 standards.

[4] The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a State Implementation Plan call under the previous SO_2 standards (40 CFR 50.4(3)). A State Implementation Plan call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

[5] On January 27, 2023, EPA issued a proposed rule for "Reconsideration of the National Ambient Air Quality Standards for Particulate Matter" (18 Federal Register 5558). At the time of preparation of this report, that rule has not been finalized. The NAAQS table presented here may be updated for particulate matter when the rule is finalized.

Areas that are not currently designated by EPA as nonattainment for one or more of the NAAQS are classified as attainment areas, while areas that do not meet one or more of the NAAQS may be designated by EPA as nonattainment areas for that or those criteria pollutants. Areas that have failed to meet the NAAQS in the past but have since re-attained them may be re-designated as attainment (maintenance) areas, which are commonly referred to as maintenance areas.

4.2 Air Quality Attainment Status

The microscale and mesoscale study areas are in the counties of Plymouth and Barnstable where EPA's Green Book shows that these counties are designated as an attainment area for all criteria pollutants with EPA NAAQS.[6]

Federal conformity requirements at 40 CFR 93.114[7] and 40 CFR 93.115[8] (as incorporated by reference into the Massachusetts conformity State Implementation Plan) apply because the area in which the Program is located is subject to a federal court decision that affects all former maintenance

6 https://www3.epa.gov/airquality/greenbook/anayo_ma.html
7 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.114
8 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.115

areas nationwide for the 1997 ozone NAAQS.[9] Accordingly, there must be a currently conforming transportation plan (i.e., Long Range Transportation Plan) and Transportation Improvement Program (TIP) at the time of issuance of the NEPA Record of Decision, and the project (Cape Cod Bridges Program) must come from a conforming plan and TIP or otherwise meet the criteria specified in 40 CFR 93.109(b).[10] As of the date of the Record of Decision, the Cape Cod Bridges Program (replacement of Sagamore and Bourne Bridges) is included in the currently conforming Fiscal Year 2026-2030 Transportation Improvement Program - Amendment 3 as developed by the Cape Cod Metropolitan Planning Commission.[11] In addition, as of the date of the Record of Decision, both phases of the Program (replacement of Sagamore and Bourne Bridges) are included in the currently confirming Long Range Regional Transportation Plan.[12]

4.3 Ambient Air Quality Data and Trends

MassDEP issues an annual report summarizing air quality monitoring data collected at monitoring stations across the state for the previous year, covering criteria pollutants (those for which EPA has established NAAQS) and other pollutants, including air toxics.[13] Excerpts of the latest annual air quality monitoring report are presented in the following sections.

4.3.1 Carbon Monoxide

EPA provides the following background information on CO:[14]

> "CO is a colorless, odorless gas that can be harmful when inhaled in large amounts. CO is released when something is burned. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels. A variety of items in your home such as unvented kerosene and gas space heaters, leaking chimneys and furnaces, and gas stoves also release CO and can affect air quality indoors."

As shown in **Figure 4-1** and **Figure 4-2,** and due primarily to the implementation of more stringent vehicle emission and fuel quality standards, the national trend in ambient concentrations of CO over

9 Per a 2/16/2018 court decision (South Coast Air Quality Management District v. EPA), all areas in the country that were in nonattainment or maintenance for the 1997 eight-hour ozone NAAQS before its revocation by EPA in 2015 were again made subject to conformity for that standard. This decision in part affects "orphan areas" (as defined in the ruling), which in Virginia include Fredericksburg, Richmond/Tri-Cities, and Hampton Roads. https://law.justia.com/cases/federal/appellate-courts/cadc/15-1115/15-1115-2018-02-16.html

10 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.109

11 https://acrobat.adobe.com/id/urn:aaid:sc:US:a8dfff78-a1c1-4d6d-8820-5629d867e5d0

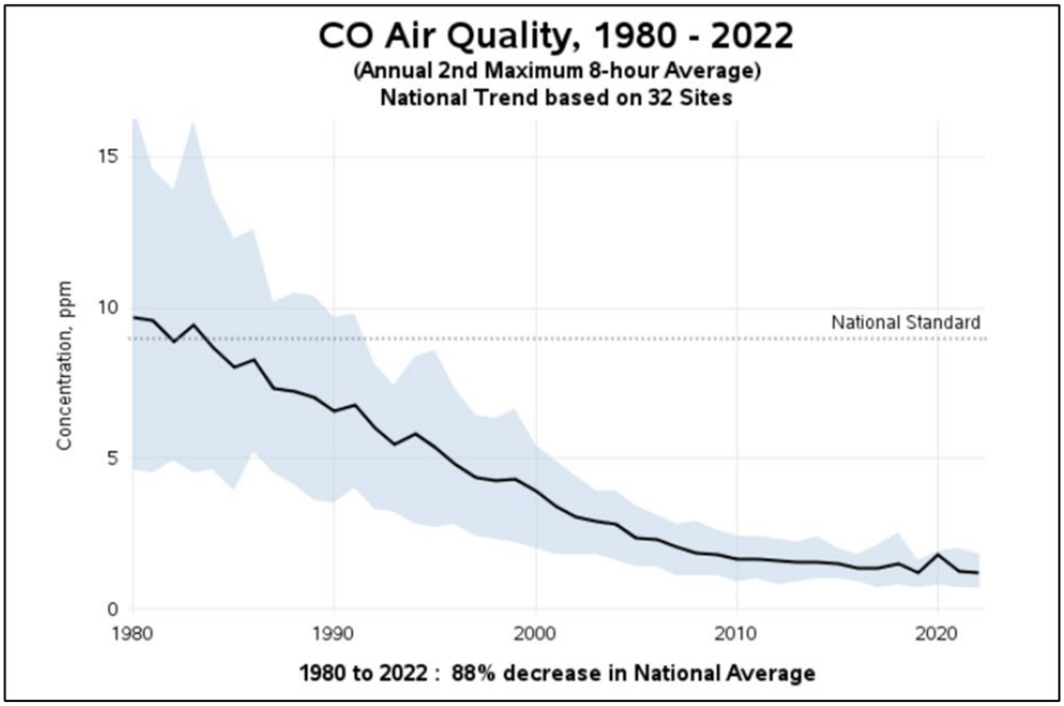
12 https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/Transportation%20Plans/RTP/2024_RTP/Report/FINAL%20PDF/Cape%20Cod%202024%20Regional%20Transportation%20Plan_Endorsed%2007242023%20With%20Appendix.pdf

13 Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

14 U.S. Environmental Protection Agency. Basic Information about Carbon Monoxide (CO) Outdoor Air Pollution. https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#What%20is%20CO

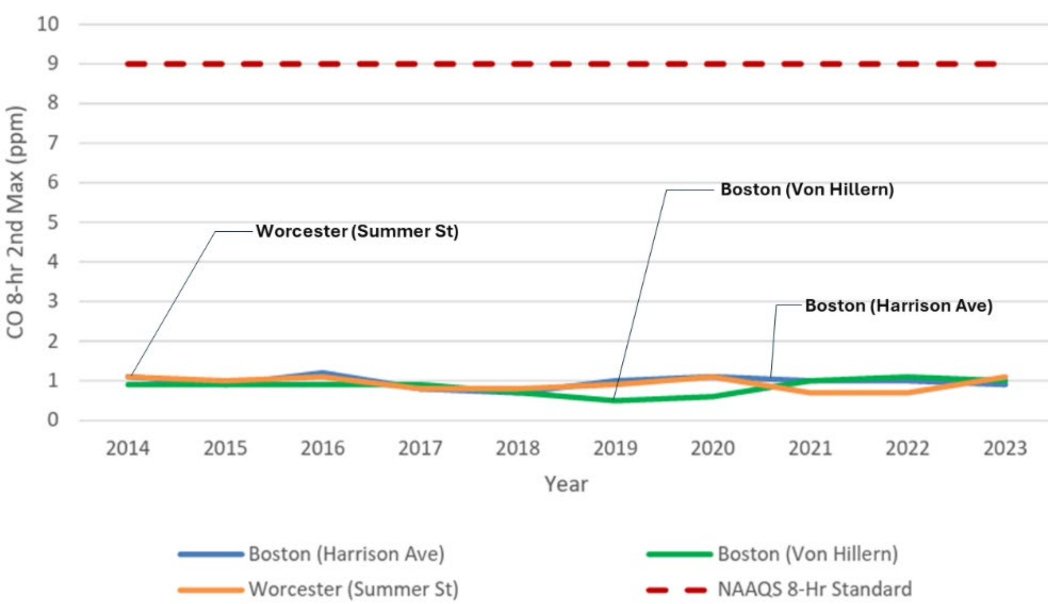
the past few decades has decreased to a level substantially below the current eight-hour NAAQS of 9 parts per million (ppm). The national trend is reflected in the very low ambient CO concentrations.

Figure 4-1. National Trends in Ambient Carbon Monoxide Concentrations



Source: U.S. Environmental Protection Agency. Carbon Monoxide Trends. https://www.epa.gov/air-trends/carbon-monoxide-trends

Figure 4-2. Carbon Monoxide Trends 2014-2023 8-Hour



Source: Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

4.3.2 Nitrogen Oxides

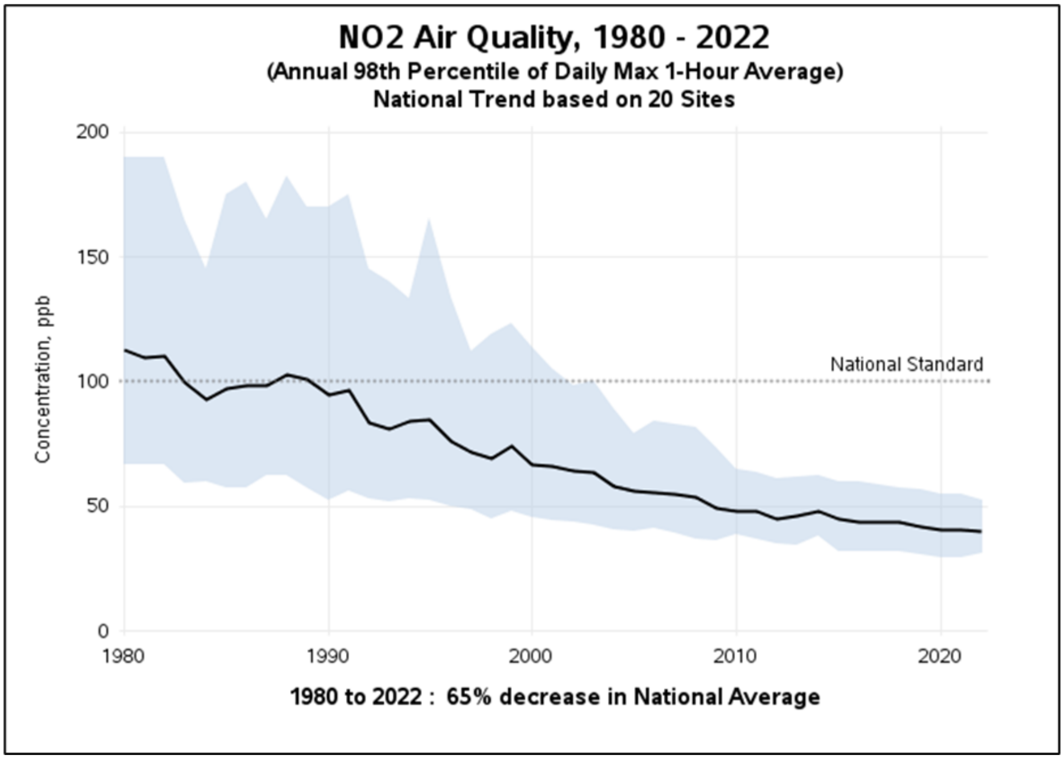
EPA provides the following background information on NO_2:[15]

> "Nitrogen Dioxide (NO_2) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NOx). Other nitrogen oxides include nitrous acid and nitric acid. NO_2 is used as the indicator for the larger group of nitrogen oxides.
>
> NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment."
>
> and
>
> "Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2. NO_2 along with other NOx reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system."

Figure 4-3 and **Figure 4-4** present the trend in levels of NO_2 on a national level and for the region south of Boston, including Central and Western Massachusetts, respectively. Monitored levels of NO_2 in Massachusetts meet the NO_2 standards.

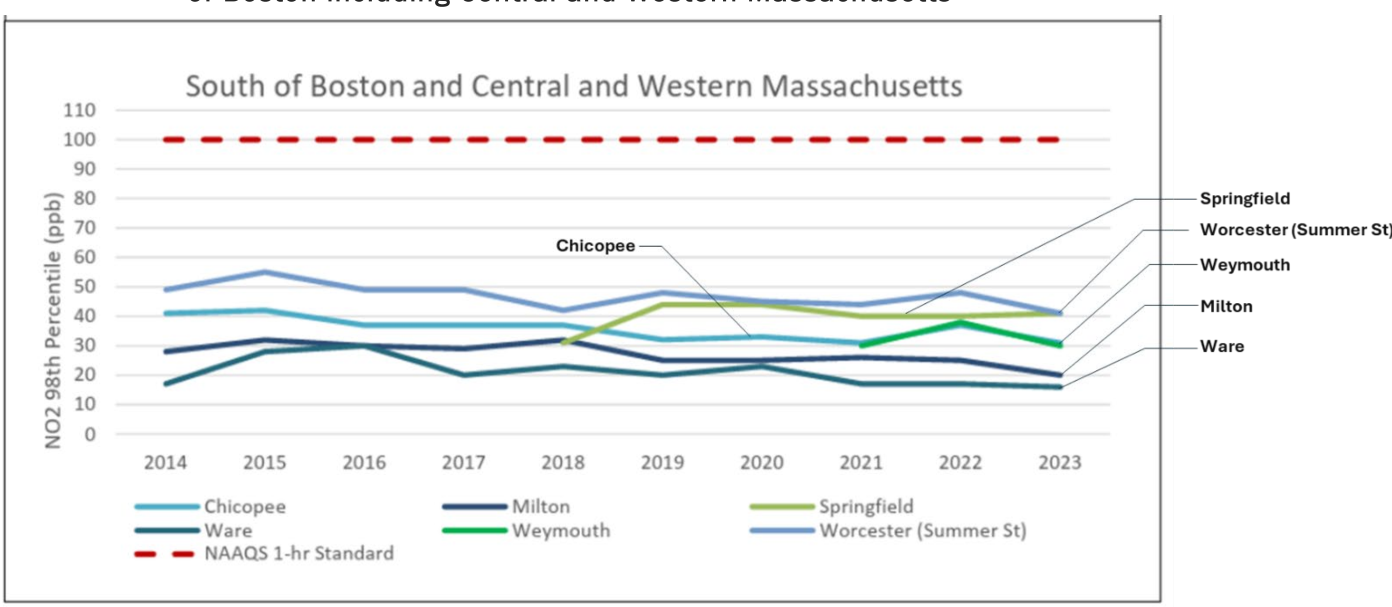
[15] U.S. Environmental Protection Agency. Basic Information about NO2. https://www.epa.gov/no2-pollution/basic-information-about-no2#What%20is%20NO2

Figure 4-3. National Trends in Nitrogen Dioxide Concentrations, 1980–2022



Source: U.S. Environmental Protection Agency. Nitrogen Dioxide Trends. https://www.epa.gov/air-trends/nitrogen-dioxide-trends.

Figure 4-4. Nitrogen Dioxide Trends 2014-2023, 1-hour 98th Percentile Annual Average South of Boston including Central and Western Massachusetts

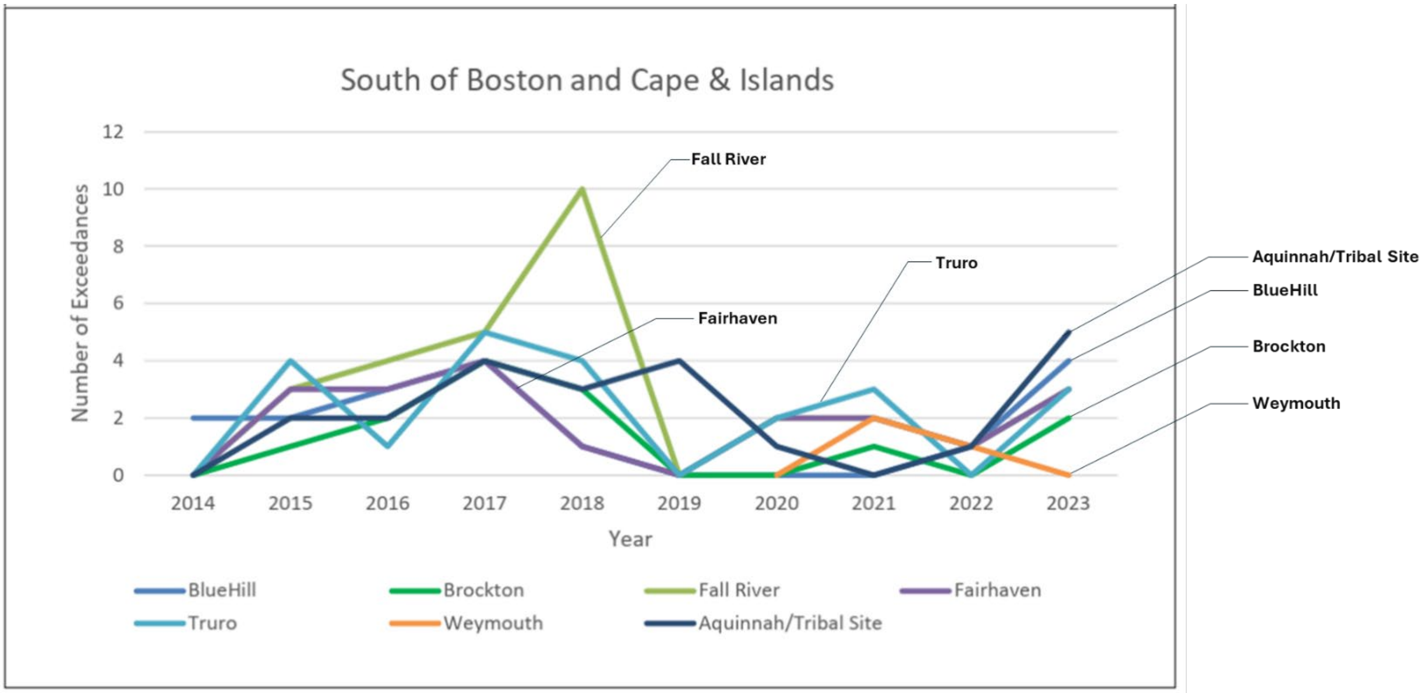


Source: Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

4.3.3 Ozone

Figure 4-5 presents the 8-hour ozone exceedance trends south of Boston and Cape & Islands. Based on the most recent three years of data (2021–2023), no monitoring locations violated the 0.070 ppm standard.

Figure 4-5. 8-hour Ozone Exceedance Trends 2014-2023 South of Boston and Cape & Islands



Source: Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

4.3.4 Particulate Matter

EPA provides the following background information on particulate matter:[16]

> "PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope."

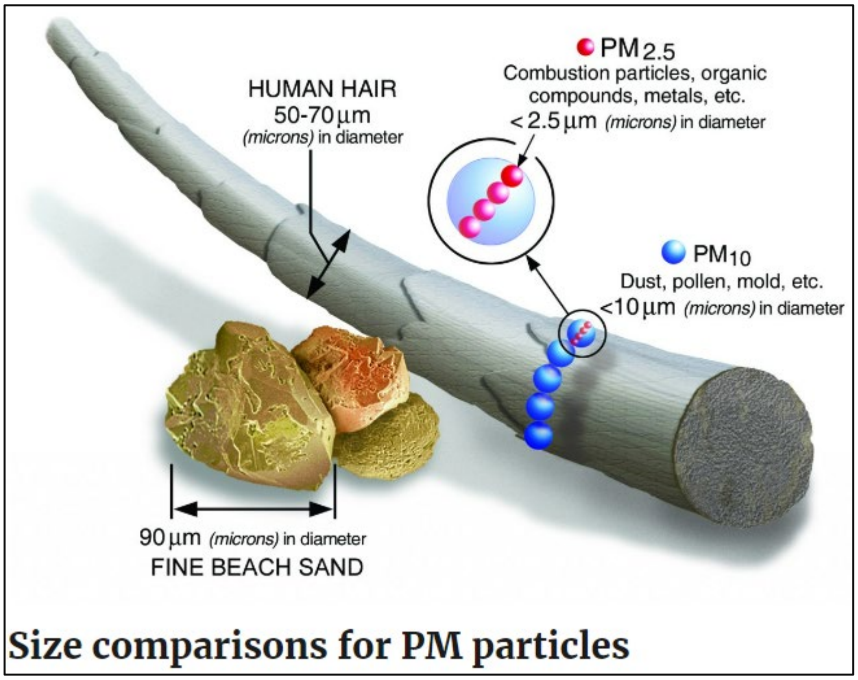
Particle pollution includes:

- PM10: inhalable particles, with diameters that are generally 10 micrometers and smaller
- PM2.5: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller

[16] U.S. Environmental Protection Agency. Particulate Matter (PM) Basics. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

Figure 4-6 from EPA shows the size of PM2.5 and PM10 particles relative to a human hair and to fine beach sand.

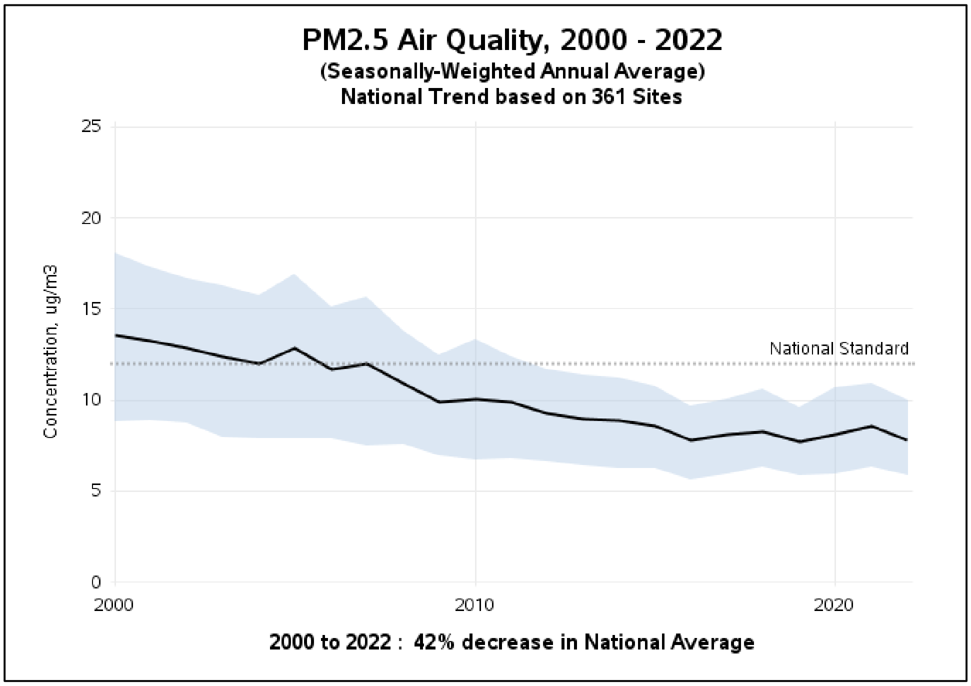
Figure 4-6. Size Comparison of Particulate Matter Particles



Source: U.S. Environmental Protection Agency. [Particulate Matter (PM) Basics](https://www.epa.gov/pm-pollution/particulate-matter-pm-basics). https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

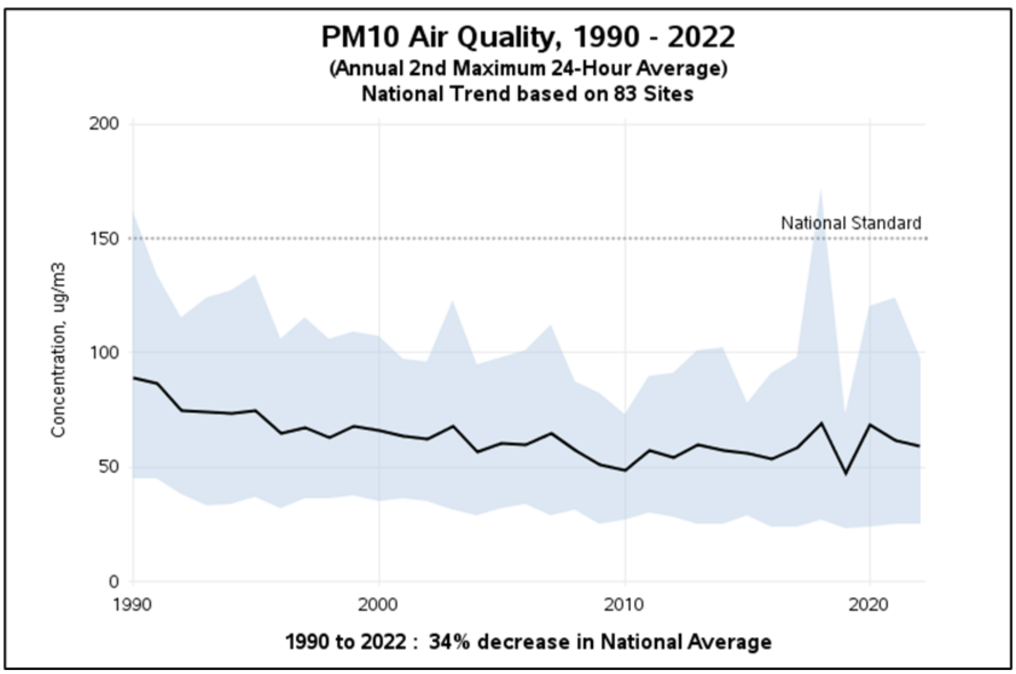
Figure 4-7 and **Figure 4-8** present the national trends in PM2.5 and PM10 levels, respectively.

Figure 4-7. National Trends in PM2.5 Concentrations (Annual Average)



Source: U.S. Environmental Protection Agency. [Particulate Matter (PM2.5) Trends](https://www.epa.gov/air-trends/particulate-matter-pm25-trends). https://www.epa.gov/air-trends/particulate-matter-pm25-trends.

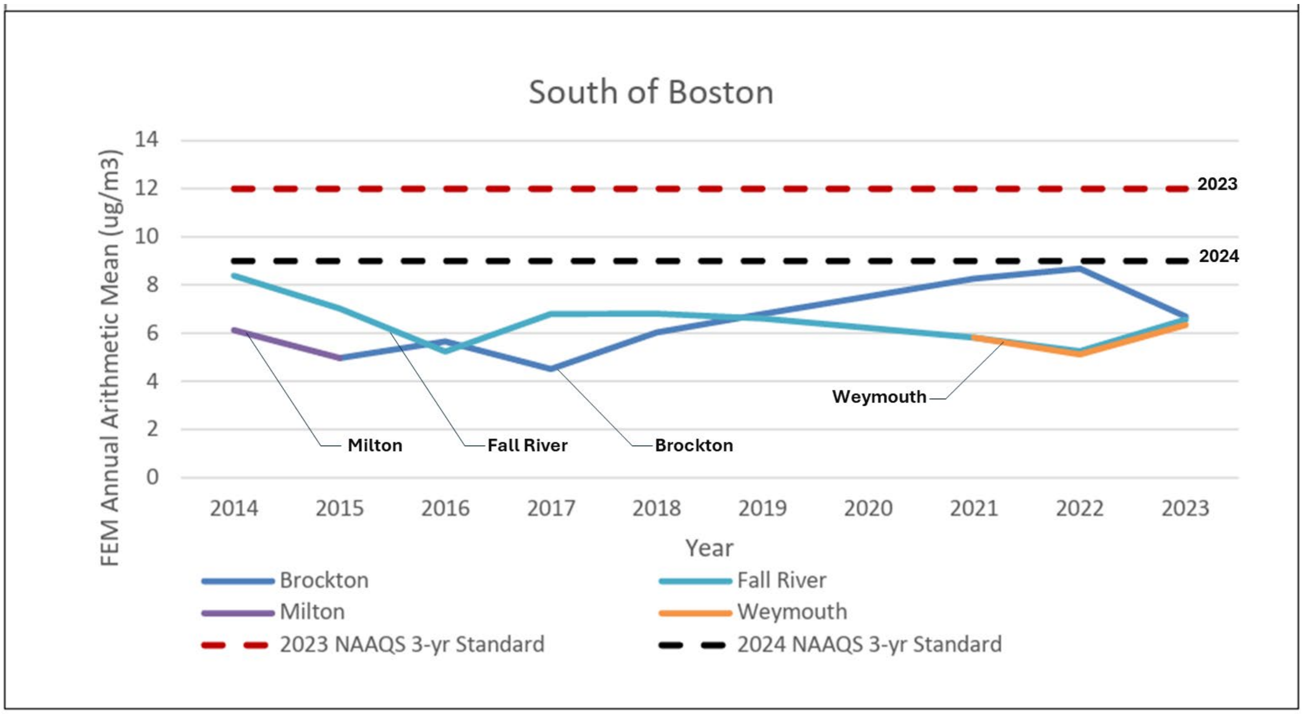
Figure 4-8. National Trends in PM10 Concentrations (24-hour Average)



Source. U.S. Environmental Protection Agency. [Particulate Matter (PM10) Trends](https://www.epa.gov/air-trends/particulate-matter-pm10-trends). https://www.epa.gov/air-trends/particulate-matter-pm10-trends.

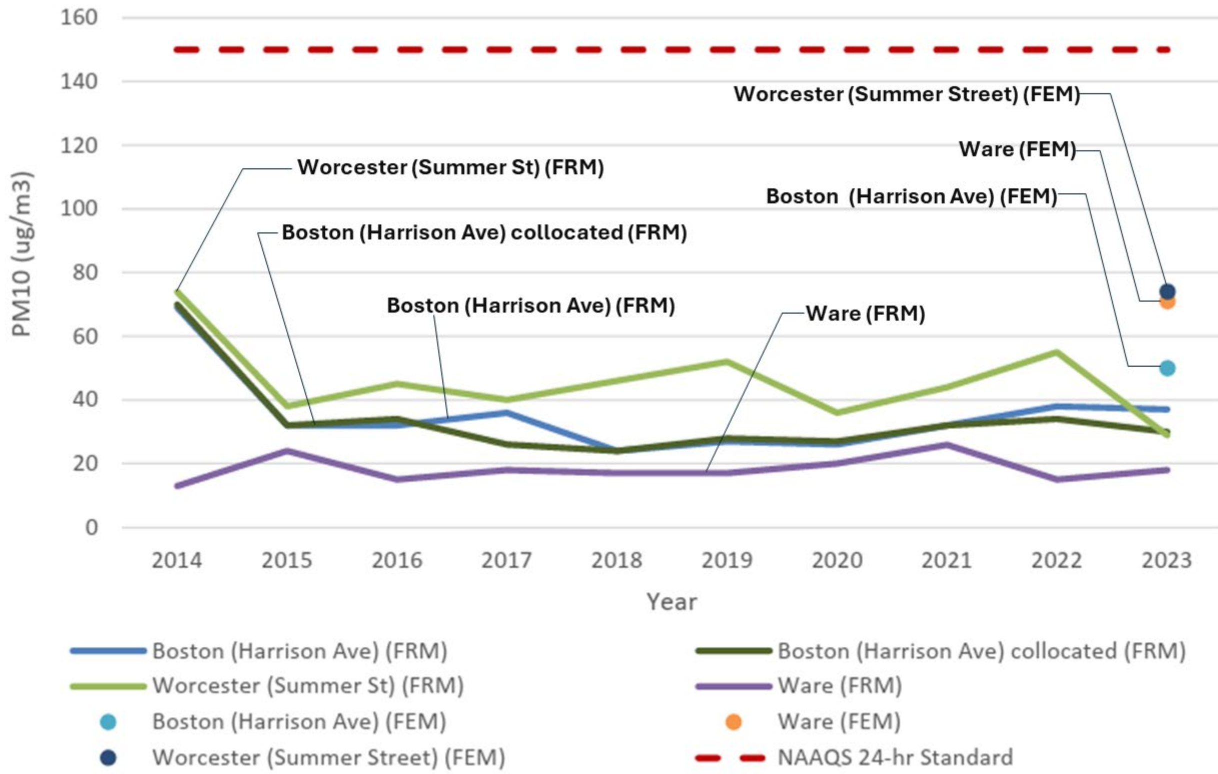
Figure 4-9 and **Figure 4-10** present tabulations of PM2.5 (annual trends) South of Boston and PM10 (24-hour standard) concentrations, which were excerpted from the referenced MassDEP annual air quality monitoring report. As noted above, all of Massachusetts is in attainment of the NAAQS for both pollutants.

Figure 4-9. PM2.5 Annual Trends, 2014-2023, South of Boston



Source: Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

Figure 4-10. PM10 Trends, 2014 to 2023 (24-hour Calendar Year Maximum)



Source: Massachusetts Department of Environmental Protection. 2024. Massachusetts 2023 Air Quality Report. September. https://www.mass.gov/doc/2023-annual-air-quality-report/download

5 Environmental Consequences

The assessments presented in this section were conducted for purposes of the NEPA analysis. FHWA posts guidance for NEPA on its website for project development,[17] and provides guidance specific to air quality (focusing on carbon monoxide) in its 1987 Technical Advisory 6640.8A, "*Guidance for Preparing and Processing Environmental and Section 4(f) Documents.*"[18] FHWA posts separate guidance for MSATs along with responses to "Frequently Asked Questions" on its air quality webpage.[19]

[17] Federal Highway Administration. NEPA and Project Development. https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx

[18] Federal Highway Administration. NEPA Implementation, Guidance for Preparing and Processing Environmental and Section 4(f) Documents. https://www.environment.fhwa.dot.gov/projdev/impTA6640.asp

[19] Federal Highway Administration. Air Quality: Transportation & Toxic Air Pollutants. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/

5.1 Microscale (Localized) Carbon Monoxide (CO) Analysis

Based upon the design year 2050 traffic analysis, the Build Alternative is expected to substantially improve traffic operations compared to the No Build Alternative. Study Area intersections, expressway mainline, and merging-diverging segments are expected to operate at improved levels of service during the fall weekday PM peak hour. Travel times between major origin-destination points along major routes within the study area are also estimated to improve for the Build Condition compared to the No Build Condition. Despite processing more vehicles, the Build Conditions model recorded less total travel time (2,126 hours) in the network roadway than the No Build Condition (2,879). Improved traffic operations and mobility within the Study Area for the 2050 Build Alternative is anticipated to reduce CO emission rates compared to the 2050 No Build Alternative. Refer to **Section 4.2, Transportation, Traffic, and Safety,** and the supporting **Traffic Engineering Technical Report (Appendix 4.2**) for detailed information on the traffic analyses conducted for the 2019 Base Year and 2050 Design Year.

In addition to the proposed traffic improvements with the Build Alternative, continued implementation of effective emission control technology, increasingly more stringent motor vehicle emissions and fuel quality standards implemented over the past few decades by EPA strategies have had the combined effect of substantially reducing CO emission rates nationwide, resulting in long-term downward trends in emissions and near-road ambient concentrations of CO despite increasing VMT. As presented in **Figure 4-2**, the MassDEP measured air pollution for CO in the state is well below the NAAQS, and the 10-year historical 8-hour concentrations have remained steady and trended down and have been well below the standards for over 20 years.

5.2 Mobile Source Air Toxics

5.2.1 Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments of 1990, whereby Congress mandated that EPA regulate 188 air toxics, also known as hazardous air pollutants. EPA assessed this expansive list in its rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are part of EPA's Integrated Risk Information System.[20] In addition, EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and non-cancer hazard contributors from the 2011 National Air Toxics Assessment.[21] These are 1,3-butadiene, acetaldehyde, acrolein, benzene, DPM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

[20] https://www.epa.gov/iris
[21] https://www.epa.gov/national-air-toxics-assessment

5.2.2 Motor Vehicle Emissions Simulator (MOVES)

According to EPA, MOVES3[22] is a major revision to MOVES2014 and improves upon it in many respects. MOVES3 includes new data, new emissions standards, and new functional improvements and features. It incorporates substantial new data for emissions, fleet, and activity developed since the release of MOVES2014. These new emissions data are for light- and heavy-duty vehicles, exhaust and evaporative emissions, and fuel effects. MOVES3 also adds updated vehicle sales, population, age distribution, and VMT data. MOVES3 incorporates the effects of three new federal emissions standard rules not included in MOVES2014. These new standards are all expected to impact MSAT emissions and include Tier 3 emissions and fuel standards starting in 2017.

In November 2020, EPA issued MOVES3 Mobile Source Emissions Model Questions and Answers.[23] EPA states that for on-road emissions, MOVES3 updated heavy-duty diesel and compressed natural gas emission running rates and updated heavy-duty gasoline emission rates. They updated light-duty emission rates for hydrocarbon, CO, and NOx and updated light-duty PM rates, incorporating new data on Gasoline Direct Injection vehicles.

Using EPA's MOVES3 model, as shown in , FHWA estimates that even if VMT increases by 31% at a national level from 2020 to 2060 as forecast, a combined reduction of 76% in the total annual emissions for the priority MSAT is projected for the same time period. Diesel PM is the dominant component of MSAT emissions, making up 36% to 56% of all priority MSAT pollutants by mass, depending on calendar year. Users of MOVES3 will notice some differences in emissions compared with MOVES2014. MOVES3 is based on updated data on some emissions and pollutant processes compared to MOVES2014 and reflects the latest federal emissions standards in place at the time of its release. In addition, MOVES3 emissions forecasts are based on slightly higher VMT projections than MOVES2014, consistent with nationwide VMT trends.

5.2.3 Mobile Source Air Toxics Research

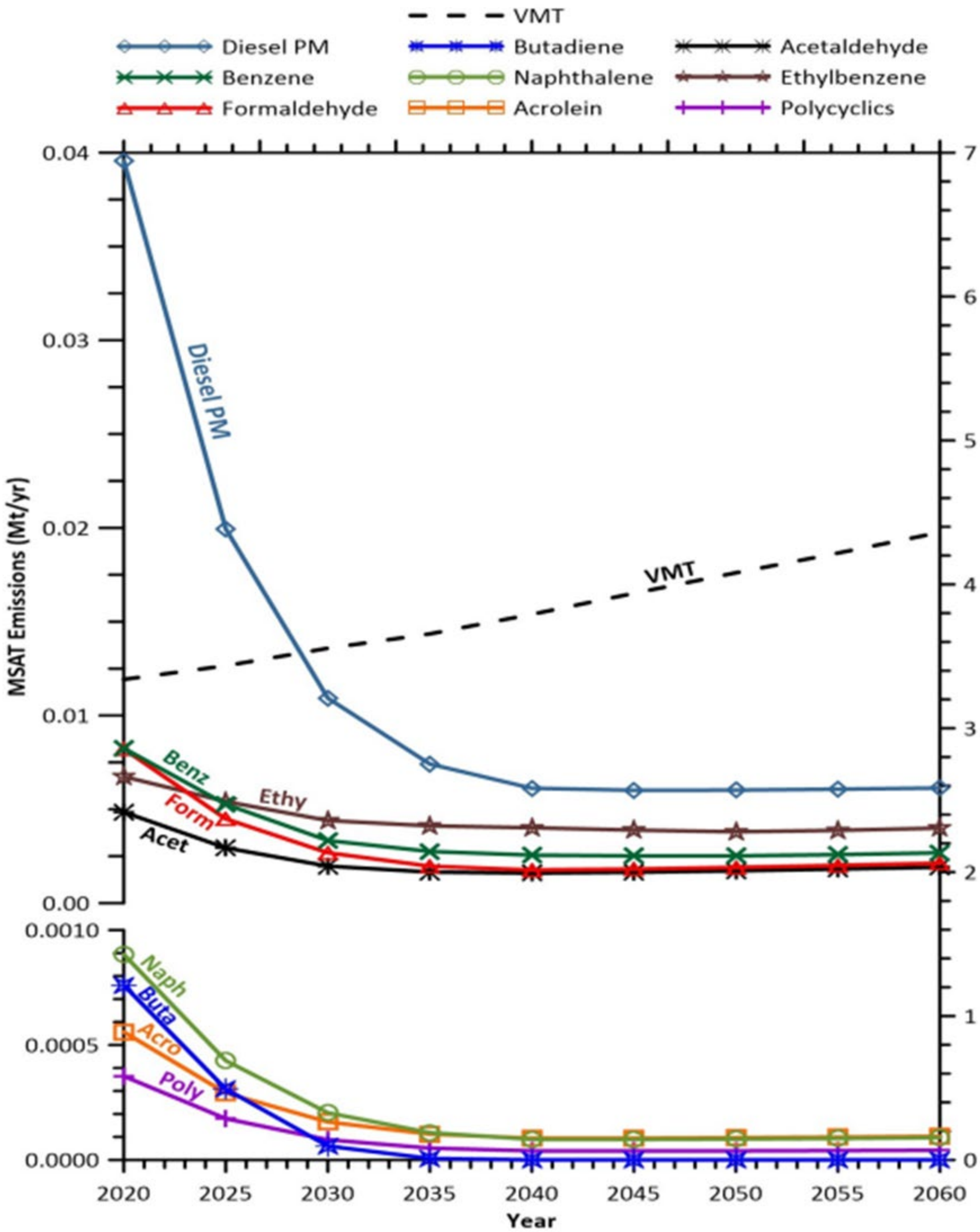
Air toxics analysis is a continuing area of research. While much work has been done to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes as a result of lifetime MSAT exposure remain limited. These limitations impede the ability to evaluate how potential public health risks posed by MSAT exposure should be factored into project-level decision-making within the context of NEPA.

---

[22] The FHWA national-level analysis summarized here for context was based on MOVES3.The analysis conducted for this project was based on an updated version of the model, namely MOVES4.

[23] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010M06.pdf

Figure 5-1. Federal Highway Administration Projected National Mobile Source Air Toxics Emission Trends for Vehicles Operating on Roadways, 2020–2060



Source: U.S. Environmental Protection Agency Motor Vehicle Emissions Simulator (MOVES3) model runs conducted by the Federal Highway Administration, March 2021.

Note: Trends for specific locations may be different, depending on locally derived information representing vehicle miles traveled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors.

Nonetheless, air toxics concerns continue to arise on highway projects during the NEPA process. Even as the science emerges, the public and other agencies expect FHWA to address MSAT impacts in its environmental documents. FHWA, EPA, the Health Effects Institute, and others have funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. FHWA will continue to monitor the developing research in this field.

5.2.4 Incomplete or Unavailable Information for Project-Specific Mobile Source Air Toxics Health Impact Analysis

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the Clean Air Act and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the Integrated Risk Information System, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects."[24] Each report contains assessments of non-cancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the Health Effects Institute (HEI). A number of HEI studies are summarized in Appendix D of FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. Among the adverse health effects linked to MSAT compounds at high exposures are cancer in humans in occupational settings, cancer in animals, and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations[25] or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include emissions modeling, dispersion modeling, exposure modeling, and then final determination of health impacts; each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel

[24] U.S. Environmental Impact Statement. Integrated Risk Information System. https://www.epa.gov/iris/

[25] Health Effects Institute. 2007. Special Report 16: Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects. November. https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects

patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways, to determine the portion of time that people are actually exposed at a specific location, and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI.[26] As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds and in particular for DPM. EPA states that with respect to diesel engine exhaust, "[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk."[27]

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by EPA as provided by the Clean Air Act to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than 1 in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than 1 in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two-step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable.[28]

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project

---

[26] Health Effects Institute. 2007. Special Report 16: Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects. November. https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects

[27] U.S. Environmental Protection Agency. Integrated Risk Information system (IRIS) Chemical Assessment Summary, Diesel engine exhaust; CASRN N.A. https://iris.epa.gov/static/pdfs/0642_summary.pdf

[28] U.S. Court of Appeals for the District of Columbia Circuit, June 2028.

benefits, such as reducing traffic congestion, accident rates, and fatalities while improving access for emergency response, which are better suited for quantitative analysis.

5.2.5 Conclusions

As discussed above, technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of this project at this time. While it is possible that localized increases in MSAT emissions may occur as a result of this project, emissions will likely be lower than present levels in the design year of this project as a result of EPA's national control programs that are projected in FHWA guidance (2023) to reduce annual MSAT emissions by 76% between 2020 and 2060, even as VMT increases nationally by 31%. Although local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures, the magnitude of EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

5.3 Mesoscale Analysis

Table 5-1 presents the 2050 forecast VMT and VHT for the No Build and Build Alternatives within the Mesoscale Study Area. **Table 5-2** presents the corresponding air quality reductions associated with the Build Alternative compared to the No Build Alternative. The 2050 Build Alternative is expected to decrease daily VMT and VHT compared to the 2050 No Build Alternative, leading to reduced daily pollutant emissions of CO, NOx, and particulates (PM10 and PM2.5) in the Mesoscale Study Area.

Table 5-1. 2050 Projected Daily Vehicle Miles Traveled, Vehicle Hours Traveled, Daily Trips, Average Vehicle Speeds (Mesoscale Study Area)

Category	2050 No Build	2050 Build	Change
Daily Vehicle Miles Traveled	3,476,000	3,416,153	-59,847
Daily Vehicle Hours Traveled	94,715	86,788	-7,927

Table 5-2. Projected Daily Pollutant Emissions (Tons Per Day) (Mesoscale Study Area)

Category	2019 Existing	2050 No Build Alternative	2050 Build Alternative	Change (No Build to Build)
Carbon Monoxide	6.37	3.24	2.99	**-0.25**
Volatile Organic Compounds	0.11	0.07	0.07	**0**
Nitrogen Oxide	0.71	0.11	0.10	**-0.01**
Sulfur Dioxide	0.02	0.004	0.004	**0**
PM10[1]	0.10	0.18	0.14	**-0.04**
PM2.5[1]	0.03	0.03	0.02	**-0.01**

[1] PM10 and PM2.5 include primary exhaust as well as brake wear and tire wear emissions.

5.3.1 Construction

5.3.1.1 Construction Mobile Source Emissions

Table 5-3 presents annual diesel truck emissions, using 529,980 annual VMT as the basis for estimation.

Table 5-3. Projected Annual Diesel Truck Emissions (Tons Per Year)

Pollutant	Annual Emissions (tons/year)
Carbon Monoxide	1.50
Volatile Organic Compounds	0.11
Nitrogen Oxides	2.89
Sulfur Dioxide	0.004
PM10	0.14
PM2.5	0.08

Source: HMMH, 2026

Table 5-4 presents annual criteria pollutant emissions estimates for marine transport vessels expected to operate within Cape Cod Canal during the construction period.

Table 5-4. Projected Annual Pollutant Emissions (Tons Per Year) for the Marine Vessel Trips

Activity	Trips Per Year	Carbon Monoxide	Volatile Organic Compounds	Nitrogen Oxides	Sulfur Dioxide	PM10	PM2.5
Tugs	4,380	2.24	0.30	3.16	0.01	0.07	0.07
Launches	2,920	1.07	0.41	2.52	0.41	0.17	0.16
Total Emissions		3.30	0.71	5.68	0.42	0.25	0.24

Source: HMMH, 2026

Table 5-5 presents the projected annual combined emissions from construction-related diesel truck trips and marine vessel activity. These annual emissions were compared to EPA *de minimis* thresholds to evaluate the potential for significant air quality impacts. **Table 5-5** identifies that annual emissions for all evaluated pollutants remain well below EPA *de minimis* thresholds for each pollutant, demonstrating that construction-related diesel truck traffic and marine vessel activity are not expected to result in significant air quality impacts.

Table 5-5. Projected Annual Construction Mobile Source Emissions Compared to EPA Thresholds

Pollutant	Annual Emissions (tons/year)	EPA *de minimis* Threshold (tons/year)[1]	Below Threshold?
Carbon Monoxide	4.80	100	Yes
Volatile Organic Compounds	0.82	100	Yes
Nitrogen Oxides	8.57	100	Yes
Sulfur Dioxide	0.42	100	Yes
PM10	0.39	50	Yes
PM2.5	0.32	100	Yes

Source: HMMH, 2026

[1] EPA de minimis thresholds represent emission quantities of a NAAQS-regulated pollutant or its applicable precursors that, if exceeded, may cause or contribute to a new or continued violation of the NAAQS in a nonattainment or maintenance area. EPA de minimis tables accessed on January 15, 2026. https://www.epa.gov/general-conformity/de-minimis-tables

5.3.1.2 Other Sources of Construction-Period Emissions

During construction, short-term increases in particulate matter emissions (fugitive dust) may occur as a result of site preparation and roadway reconstruction activities, including land clearing, demolition, excavation, grading, compaction, removing or improving existing roadways, and paving. In addition to airborne dust, the operation of diesel-fueled off-road equipment and heavy-duty trucks has the potential to affect air quality through direct emissions of CO, NOx, and VOCs.

Demolition of the Sagamore and Bourne Bridges would involve lead paint disturbance, which can generate airborne lead dust and fumes if not properly controlled. Appropriate mitigation measures would be implemented to minimize these emissions and protect worker and public health.

6 Mitigation Measures

A comprehensive suite of emission and dust control measures will be implemented during construction to protect workers, nearby communities, and the surrounding environment. These measures address diesel equipment emissions, fugitive dust generation, and airborne contaminants associated with demolition activities, including work involving painted steel. Diesel emissions will be minimized in accordance with MassDOT's Diesel Emission Control Specification, which requires the use of cleaner fuels, verified emission-control technologies, and strict idling limits for construction equipment. An Environmental Health and Safety Plan will also be developed to identify, evaluate, and control potential exposure to onsite chemical contaminants in air or other media, and to establish appropriate emergency response procedures. Fugitive dust will be controlled under MassDOT's Dust Control

Specification, which mandates proactive measures, such as regular watering of exposed soils, covering haul loads, cleaning paved surfaces, and implementing an approved Dust Control Plan.

For demolition and work involving painted steel, the Design-Builder must comply with MassDOT's Standard Specification, including preparation of a site-specific plan to protect workers and nearby receptors from airborne contaminants. This plan must include air quality monitoring requirements, such as baseline monitoring, high-volume ambient sampling, and targeted monitoring of lead in total suspended particulates. If monitoring indicates exceedances of established thresholds, work must be suspended until containment measures are improved and verified. The Design-Builder is required to maintain all monitoring records, inspection logs, and compliance documentation, and make them available to the Town of Bourne Health Department and other authorities upon request.

7 Glossary of Terms

Table 7-1. Glossary of Terms

Term	Definition
Ambient Air Quality Data	Massachusetts Department of Environmental Protection (MassDEP) collection of representative samples of ambient air for several pollutants at monitoring stations located across the Commonwealth. These results are summarized annually in an Air Quality Report.
Attainment	Areas designated by the U.S. Environmental Protection Agency (EPA) that meet the National Ambient Air Quality Standards (NAAQS).
Average daily traffic (ADT)	The average number of vehicles that travel through a specific area over a period of time.
Criteria Pollutants	EPA sets NAAQS for six commonly found air pollutants known as criteria air pollutants.
EPA Motor Vehicle Emissions Simulator (MOVES) Model	EPA MOVES model is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, and air toxics.
Federal Highway Administration (FHWA) Mobile-Source Air Toxics (MSAT) Guidance	This FHWA interim guidance Memorandum provides a tiered approach for analyzing MSAT in National Environmental Policy Act (NEPA) documents.
Level of Service (LOS)	A qualitative measurement that describes the operating conditions within a traffic stream. LOS is represented using letter grades "A" through "F", with LOS A representing very low delays and free-flow conditions and LOS F representing conditions in which vehicle demand generally exceeds roadway capacity.
Maintenance	Areas that were formally designated by EPA as attainment that are now currently meeting the NAAQS.

Term	Definition
Mesoscale Analysis	An assessment that evaluates the total regional or area-wide emissions of pollutants generated by motor vehicle traffic within a specific geographic area.
Mobile Source Air Toxics (MSAT)	EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and non-cancer hazard contributors from the 2011 National Air Toxics Assessment. These nine compounds are referred to as MSATs and are considered priority mobile source air toxics.
National Ambient Air Quality Standards (NAAQS)	Standards developed by EPA for criteria pollutants which can be harmful to the public health and environment. They are standards designed to protect public health and welfare.
Nonattainment	Areas designated by EPA that do not meet the NAAQS.
Regional Transportation Plans	Usually developed by metropolitan planning organizations for a five-year period that identifies the transportation needs of the region.
Transportation Conformity	Transportation conformity is the process that is used in a nonattainment or maintenance area to review the current transportation plan and program in a region to ensure they conform to the state's air quality plan or State Implementation Plan.
Vehicle Miles Traveled	Measurement of how many miles vehicles travel within a specific area based on a set period of time.

8 References

Clean Air Act. 42 U.S.C. § 7401 et seq. (1970).

Commonwealth of Massachusetts. *Massachusetts Clean Air Act*. M.G.L. Chapter 111, Sections 142A-142.

Determining Conformity of Federal Actions to State or Federal Implementation Plans. 40 CFR § 93 (1993).

Federal Highway Administration. *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. Report, January 18, 2023. https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat//fhwa_nepa_msat_memorandum_2023.pdf.

Massachusetts Department of Environmental Protection (MassDEP). "Air Pollution Control," 310 CMR § 7.00 (2024).

MassDEP. "Air pollution control for mobile sources," 310 CMR § 60.00 (2021).

MassDEP. “Ambient air quality standards for the Commonwealth of Massachusetts,” 310 CMR § 6.00 (2019).

MassDEP. 1991. *Guidelines for Performing Mesoscale Analysis of Indirect Sources*. May. https://www.mass.gov/doc/guidelines-for-performing-mesoscale-analysis-of-indirect-sources/download

MassDEP. “Prevention & Abatement of Air Pollution Episodes & Emergencies,” 310 CMR § 8.00 (1990).

Requirements for Preparation, Adoption, and Submittal of Implementation Plans. 40 C.F.R. § 51 (1971).

U.S. Environmental Protection Agency (EPA). 2018. *Transportation Conformity Guidance for South Coast II Court Decision*. November.