



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 October 2025

massDOT
Massachusetts Department of Transportation

Table of Contents

1	Introduction	1
2	Summary of Findings	1
2.1	Attainment Status	1
2.2	Microscale Carbon Monoxide (CO) Analysis.....	1
2.3	Mesoscale Analysis	2
2.4	Mobile Source Air Toxics	2
3	Proposed Action and Alternatives	3
3.1	Purpose and Need.....	3
3.2	Study Area.....	3
3.3	Build Alternative	6
3.4	No Build Alternative	10
4	Methods for Effect Evaluation	13
4.1	Regulatory Framework.....	13
4.2	Methodology.....	13
4.2.1	Carbon Monoxide Microscale (Localized) Analysis	13
4.2.2	Mesoscale (Regional) Emission Analysis.....	13
4.2.3	Qualitative Assessment of Mobile Source Air Toxics	14
4.2.4	Construction Emissions	14
5	Affected Environment	15
5.1	National Ambient Air Quality Standards	15
5.2	Air Quality Attainment Status	17
5.3	Ambient Air Quality Data and Trends.....	18
5.3.1	Carbon Monoxide.....	18
5.3.2	Nitrogen Oxides.....	20
5.3.3	Ozone	22
5.3.4	Particulate Matter	22
6	Environmental Consequences	26
6.1	Microscale (Localized) Carbon Monoxide (CO) Analysis.....	27
6.2	Mobile Source Air Toxics	27
6.2.1	Background	27
6.2.2	Motor Vehicle Emissions Simulator (MOVES).....	28
6.2.3	Mobile Source Air Toxics Research.....	28
6.2.4	Incomplete or Unavailable Information for Project-Specific Mobile Source Air Toxics Health Impact Analysis	30
6.2.5	Conclusions	32

6.3	Mesoscale Analysis	32
6.3.1	Construction	33
7	Mitigation Measures	34
7.1	Construction Equipment and Vehicle Exhaust	34
7.2	Fugitive Dust	34
7.3	Lead Abatement Activities	35
8	Glossary of Terms.....	35
9	References	36

Figures

Figure 3-1.	Microscale Study Area	4
Figure 3-2.	Regional 5-mile Mesoscale Study Area	5
Figure 5-1.	National Trends in Ambient Carbon Monoxide Concentrations	19
Figure 5-2.	Carbon Monoxide Trends 2014-2023 8-Hour	19
Figure 5-3.	National Trends in Nitrogen Dioxide Concentrations, 1980–2022	21
Figure 5-4.	Nitrogen Dioxide Trends 2014-2023, 1-hour 98th Percentile Annual Average South of Boston including Central and Western Massachusetts	21
Figure 5-5.	8-hour Ozone Exceedance Trends 2014-2023 South of Boston and Cape & Islands.....	22
Figure 5-6.	Size Comparison of Particulate Matter Particles	23
Figure 5-7.	National Trends in PM2.5 Concentrations (Annual Average)	24
Figure 5-8.	National Trends in PM10 Concentrations (24-hour Average)	24
Figure 5-9.	PM2.5 Annual Trends, 2014-2023, South of Boston.....	25
Figure 5-10.	PM10 Trends, 2014 to 2023 (24-hour Calendar Year Maximum).....	26
Figure 6-1.	Federal Highway Administration Projected National Mobile Source Air Toxics Emission Trends for Vehicles Operating on Roadways, 2020–2060	29

Tables

Table 3-1.	Description of Design Parameters of the Recommended Build Alternative	6
Table 3-2.	Transportation Improvement Program Projects, 2025-2029	11
Table 5-1.	National Ambient Air Quality Standards.....	16
Table 6-1.	2050 Projected Daily Vehicle Miles Traveled, Vehicle Hours Traveled, Daily Trips, Average Vehicle Speeds (Mesoscale Study Area)	32
Table 6-2.	Projected Daily Pollutant Emissions (Tons Per Day) (Mesoscale Study Area)	33
Table 8-1.	Glossary of Terms.....	35

Attachments

Attachment 1 – Traffic Level of Service (LOS)

Attachment 2 – Representative MOVES Runspec

Attachment 3 – Mesoscale Spreadsheets Criteria and Greenhouse Gas (GHG) Pollutants

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
MSAT	Mobile Source Air Toxic
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NOx	oxides of nitrogen
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
VOC	volatile organic compound

1 Introduction

This Air Quality Technical Report has been prepared in support of the Draft 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 Summary of Findings

The proposed improvements were assessed for potential air quality impacts and compliance with all applicable air quality regulations and guidance. All models, methods and assumptions applied in modeling and analyses were made consistent with those provided or specified by the Massachusetts Department of Environmental Protection (MassDEP), the U.S. Environmental Protection Agency (EPA) and the FHWA. Based on the assessment, the Program would meet all applicable federal and state transportation conformity regulatory requirements as well as air quality guidance under NEPA. As such, the Program would not cause or contribute to a new violation of the National Ambient Air Quality Standards (NAAQS) established by the EPA.

2.1 Attainment Status

The Study Areas for this assessment are in Plymouth and Barnstable Counties where the EPA's Green Book shows that these counties are designated as an attainment area for all criteria pollutants with the [EPA NAAQS](https://www3.epa.gov/airquality/greenbook/anayo_ma.html).¹

2.2 Microscale Carbon Monoxide (CO) Analysis

EPA project-level ("hot-spot") transportation conformity requirements for CO do not apply as the project is in a region that is in attainment of the NAAQS. However, a qualitative analysis was conducted to evaluate potential CO impacts from the Build Alternative compared to the No Build Alternative. Consistent with the traffic operations analysis for the project, a comparison of the No Build and Build Alternatives was completed for the peak-hour AM and Fall Weekday PM period travel times to assess

¹ https://www3.epa.gov/airquality/greenbook/anayo_ma.html

changes in delay. In summary, the Build Alternative will result in significant improvements in traffic operations compared to the No Build Condition. Study area intersections and expressway mainline, and merging-diverging segments are expected to operate at improved Level of Service (LOS) during the weekday fall PM design periods. In addition, the study network is anticipated to see significant reductions in vehicle delay and travel times for the Build Alternative compared to the No Build Alternative.

Therefore, based on the overall weight-of-evidence, it may reasonably be concluded that the CO NAAQS will be met given the following:

- Measured CO concentrations are well below the NAAQS.
- Continued implementation of effective emission control technology leading to lower pollutant vehicle emissions.
- Increasingly more stringent motor vehicle emission and fuel quality standards implemented over the past few decades by the EPA.

2.3 Mesoscale Analysis

The Massachusetts Department of Transportation (MassDOT) performed a mesoscale analysis to evaluate the potential regional air quality impact of the Build Alternative from motor vehicles within the mesoscale Traffic Study Area as a measure of the total daily emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM₁₀ and PM_{2.5}), and sulfur dioxides (SO₂). MassDOT performed calculations to compare area-wide emissions for the existing conditions and the No Build Alternative and Build Alternative.

The mesoscale results illustrate the corresponding air quality reductions associated with the Build Alternative compared to the No Build Alternative. Vehicle miles traveled (VMT), vehicle hours traveled (VHT), daily trips, and vehicle speeds are expected to decrease with the Build Alternative when compared to the No Build Alternative due to more efficient flow of traffic expected with the Build Alternative. Correspondingly, emissions are also expected to decrease with fewer VMT and higher speeds for the Build Alternative compared to the No Build Alternative. In summary, VMT, VHT, speeds and emissions are expected to decrease for the Build Alternative compared to the No Build Alternative within the regional mesoscale study area.

2.4 Mobile Source Air Toxics

FHWA updated its guidance for the assessment of mobile source air toxics (MSAT) in the NEPA process for highway projects in 2023, which was reviewed for this Program.² Based on the traffic forecast average annual daily traffic below 140,000 per year, the Build Alternative may therefore be categorized as one with “low potential MSAT effects.”

² https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/fhwa_nepa_msat_memorandum_2023.pdf

3 Proposed Action and Alternatives

3.1 Purpose and Need

In partnership with the 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.

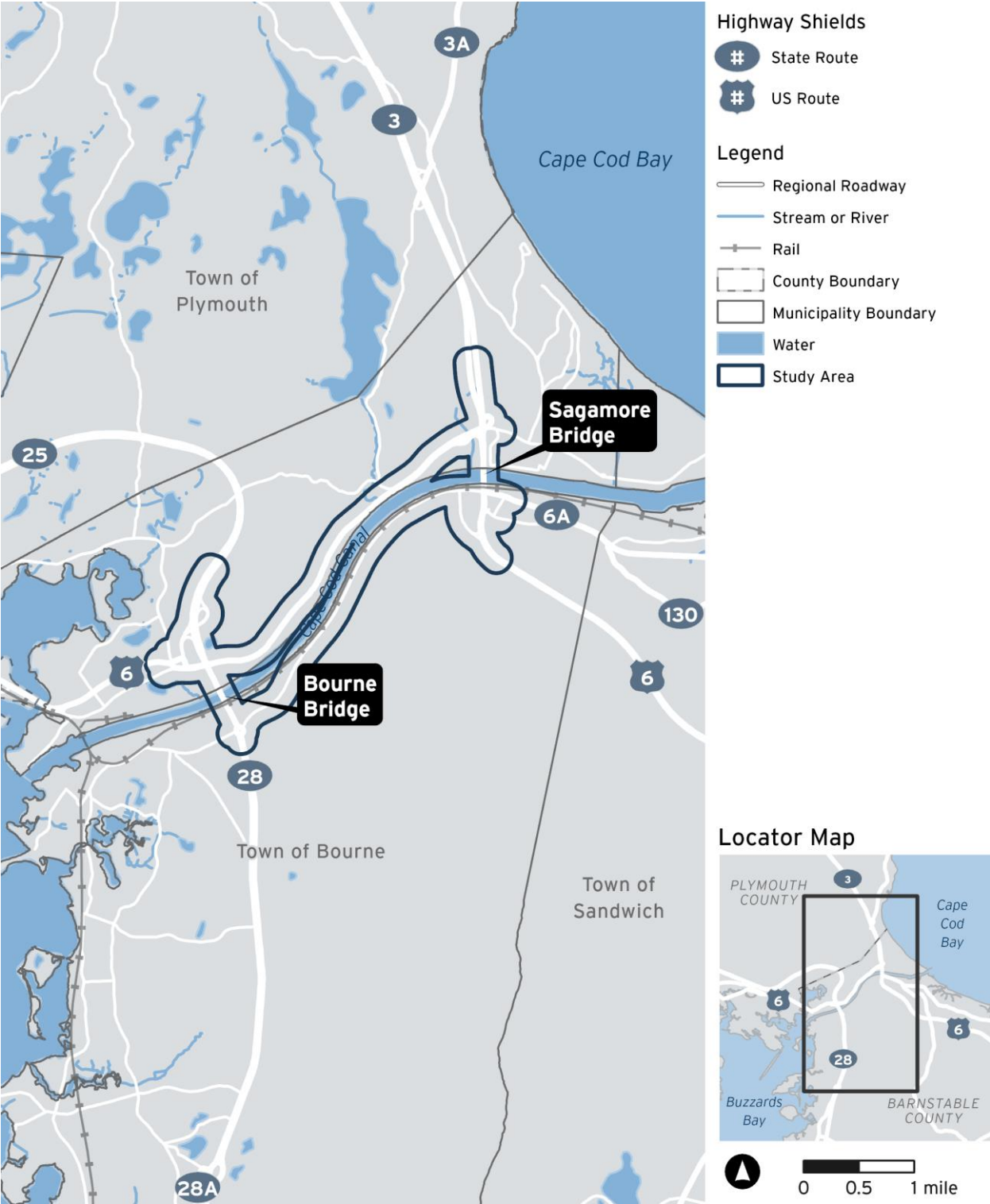
The purpose of the Program is to improve cross-canal mobility and accessibility between Cape Cod and mainland Massachusetts for all road users and to address the increasing maintenance needs and functional obsolescence of the aging Sagamore and Bourne Bridges. The needs for the Program are as follows:

- 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.

3.2 Study Area

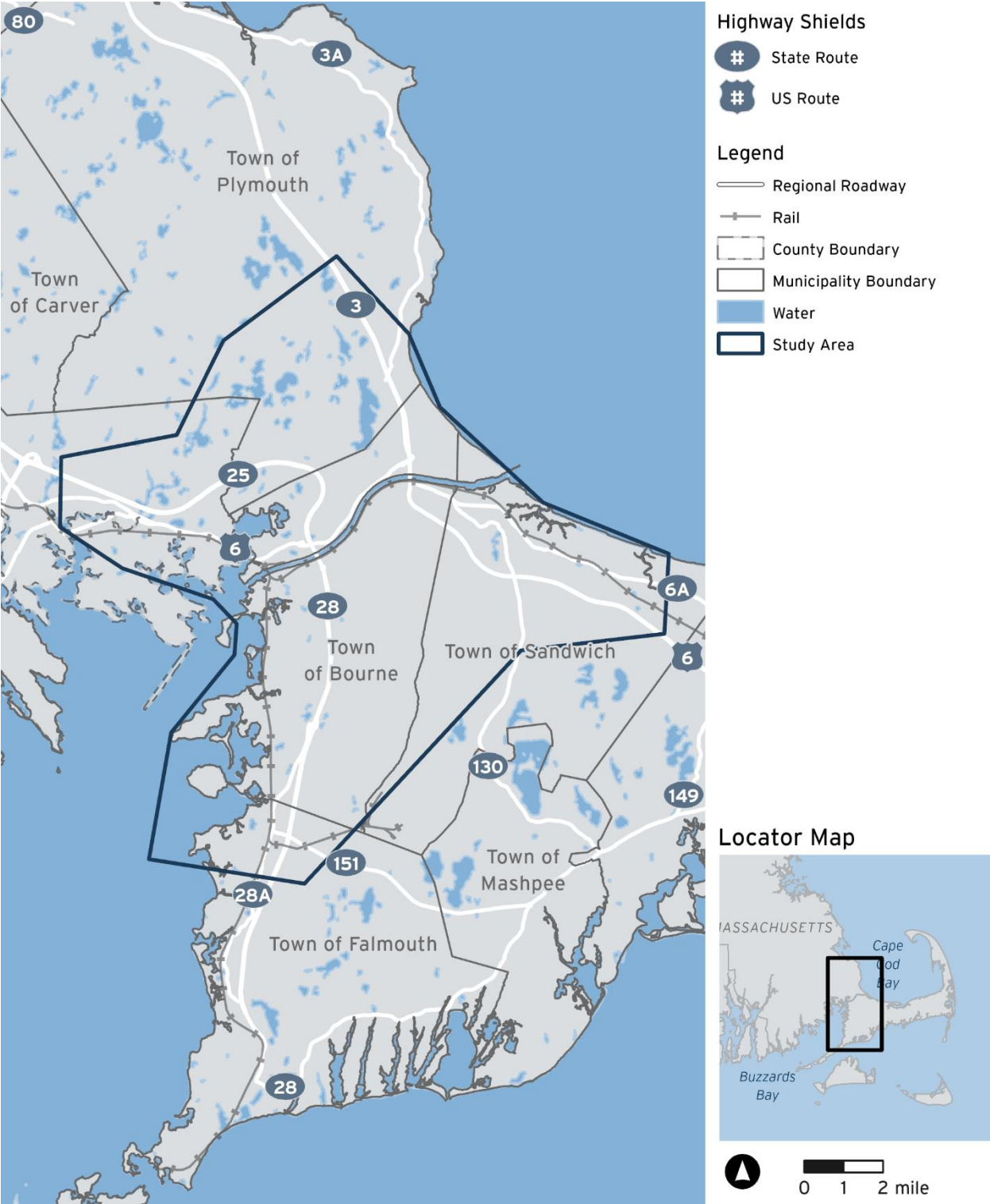
The Air Quality Study Area corresponds to the Transportation and Traffic focus Study Area, which includes a 2-mile area (microscale) centered around the Sagamore and Bourne Bridges, as well as the more regional 5-mile Study Area (mesoscale) radius from the bridges. [Figure 3-1](#) presents the microscale study area, while [Figure 3-2](#) presents the larger regional 5-mile mesoscale study area. Both Study Areas were considered in the analysis and form the basis for the air quality analysis, and they include major regional roadways, interchanges, and intersections in Plymouth, Wareham, Bourne, and Sandwich.

Figure 3-1. Microscale Study Area



Source: Massachusetts Department of Transportation, 2025

Figure 3-2. Regional 5-mile Mesoscale Study Area



Source: Massachusetts Department of Transportation, 2025

3.3 Build Alternative

The Program's Build Alternative would incorporate the 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 3-1 presents a description of the Program elements/design parameters of the recommended Build Alternative: Replacement Highway Bridges Built to Modern Design Standards.

Table 3-1. Description of Design Parameters of the Recommended Build Alternative

Program Element/ Program Design Parameter	Description
Highway Bridges	Both the Sagamore and Bourne Bridges would be replaced with new bridges, with each comprising four through-travel lanes and two auxiliary lanes (i.e., an in-kind bridge replacement that would comply with federal and state highway and design safety standards).
Bridge Highway Cross-Section and Shared-Use Path	Each replacement bridge would provide four 12-foot-wide through-traffic lanes (two in each direction), two 12-foot-wide entrance/exit (auxiliary) lanes, a 4-foot-wide left shoulder, and a 10-foot-wide right shoulder. Right and left barriers would be offset an additional 2 feet beyond the limits of the shoulders. Each crossing location would include one bidirectional pedestrian and bicycle shared-use path (SUP), separated from vehicular traffic by the shoulder and barrier. The usable width of the SUP would be 14 feet wide on the bridge main span, 20 feet wide on the interchange approaches, and 12 feet wide on the connecting roadways.
Bridge Clearances	The replacement bridges would maintain the existing vertical clearance of 135 feet above mean high water and account for 3 feet of fluctuations in relative sea level, for a total vertical clearance of 138 feet above mean high water. The replacement bridges would provide a minimum 500 feet of horizontal channel width to be consistent with 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 approximately 700 feet, which would locate the bridge piers at the waterline adjacent to the service road (shoreline piers) into the riprap slope but above the low tide line.
Bridge Deck Configuration	Each replacement bridge would have two separate decks (twin structures).
Mainline Alignment	The mainline alignment locations at both crossings would be offline inboard: the main spans of each replacement bridge would be located outside the footprint of the existing bridge, approximately 10 feet apart and parallel to each other and on the side of the canal between the existing Bourne Bridge and Sagamore Bridge. At the Bourne crossing, both main spans would be located east of the existing Bourne Bridge toward Cape Cod Bay. At the Sagamore crossing, both main spans would be located west of the existing Sagamore Bridge toward Buzzards Bay.
Bridge Type	The replacement bridges would be twin tied-arch bridges with delta frames supporting an approximate 700-foot mainline span.
Interchange Approach Network: Sagamore North	The Sagamore North interchange approach network would follow the “Direct Connection to State Road (Option SN-8A)” configuration. This design would provide a single exit point from a relocated U.S. Route 6/State Route 3 and eliminate the existing Sagamore Bridge northbound off-ramp connection to Scenic Highway/Meetinghouse Lane eastbound. Instead, the new connection would tie into State Road, north of Scenic Highway/Meetinghouse Lane. The remaining ramp connections would remain similar to existing conditions. Intersections along Scenic Highway and Meetinghouse Lane would be modified to accommodate new lane configurations. The intersection of State Road at State Route 3 northbound would also be reconfigured to support the addition of the new northbound off-ramp. The design includes a SUP on the U.S. Route 6 eastbound main span, providing connections to the south side of Scenic Highway, Canal Street, and Canal Service Road. Additional SUPs would be constructed along the southern side of Scenic Highway and Meetinghouse Lane, as well as along the eastern side of State Road to Homestead Avenue.

Program Element/ Program Design Parameter	Description
Interchange Approach Network: Sagamore South	The Sagamore South interchange approach network would follow the “Westbound On-Ramp Under U.S. Route 6 with Sandwich Road Extension (Option SS-3.1A)” configuration. This design includes the Cranberry Highway Extension and relocates the westbound on-ramp to share the same entrance point as the eastbound on-ramp from the Mid-Cape Connector. The existing westbound ramp from Cranberry Highway to the Sagamore Bridge would be removed and replaced with a new westbound on-ramp connection from the Mid-Cape Connector. Lane arrangements at the intersections of the Mid-Cape Connector with Sandwich Road and Cranberry Highway Extension would be modified to accommodate revised traffic patterns resulting from the new Cranberry Highway Extension and changes to U.S. Route 6 access. A new connection from Cranberry Highway Extension to Sandwich Road would be provided east of the new mainline bridge structure, forming the Sandwich Road Extension. Access to Market Basket via Factory Outlet Road would be modified, and a new driveway would be added to serve the former Christmas Tree Shops property. A SUP would be constructed along the U.S. Route 6 eastbound main span, providing connections to Factory Outlet Road, Sandwich Road, and Canal Service Road. Additional bicycle and pedestrian improvements would be included along Cranberry Highway. A new connection would also be established through the Cranberry Highway Extension to the Mid-Cape Connector.

Program Element/ Program Design Parameter	Description
Interchange Approach Network: Bourne North	The Bourne North interchange approach would follow the “Directional Interchange (Option BN-14.4b)” configuration. This design includes a combination of direct connection ramps between State Route 25 and U.S. Route 6. The ramp connecting State Route 25 eastbound to Scenic Highway would be a direct connection, providing access to Scenic Highway eastbound only. A new flyover ramp from Scenic Highway to State Route 25 would allow vehicles to bypass Belmont Circle, improving traffic flow without the need for additional intersection control. This ramp would repurpose one of the existing travel lanes on Scenic Highway and provide a free-flowing movement to reduce congestion. To accommodate this new southbound-to-eastbound movement, the existing State Route 28 bridge over State Route 25 would be relocated and widened. The existing southbound off-ramp would be reconfigured as an option lane, improving geometry and decision sight distance for drivers. Intersection control at U.S. Route 6/Nightingale Road/Andy Oliva Drive is being evaluated, with a single-lane roundabout previously considered. MassDOT continues to assess appropriate control types through the Intersection Control Evaluation (ICE) process. The design also includes a SUP and a grade-separated crossing for pedestrians and bicyclists via the new flyover ramp over Scenic Highway. U.S. Route 6 would be reduced from four lanes to three, creating space for multimodal accommodations. A continuous 12-foot-wide SUP would be provided along the south side of U.S. Route 6, connecting to Belmont Circle, with a 6-foot-wide sidewalk along the north side.
Interchange Approach Network: Bourne South	The Bourne South interchange approach network would follow the “Diamond Interchange (Option BS-2)” configuration. This design would eliminate the existing Bourne Rotary and replace it with a grade-separated diamond interchange, allowing through movements on State Route 28 to bypass intersections with local roadways. Both intersections within the diamond interchange would include appropriate intersection controls to manage traffic flow and improve safety. Changes to the Trowbridge Road and Sandwich Road underpass would include a reconfigured entrance to Upper Cape Cod Regional Technical High School, relocated to improve access and circulation. The design would also provide SUP connections to Trowbridge Road, the Cape Cod Canal Service Road, and the Bourne Recreation Area, enhancing multimodal connectivity throughout the corridor.

3.4 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 the 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. The USACE would continue to own 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 2025-2029 Transportation Improvement Program for the Cape Cod Metropolitan Planning Organization.³ **Table 3-2** 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 the USACE's MRER/EA. In the No Build Alternative, the USACE would implement an ongoing program of continued inspections and maintenance and repair of both existing bridges as needed to maintain safety. No major rehabilitation efforts involving extensive repairs and replacement of major bridge components would occur. Structural components would be repaired, and critical elements would be replaced only when inspections indicate unsatisfactory reliability ratings. The MRER/EA indicates that both the Sagamore and Bourne Bridges are in deteriorated condition and well beyond the state in which actions and funding from the USACE's operations and maintenance program could correct the deficiencies and restore and sustain reliability. The USACE 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.

³ The TIP was endorsed on May 20, 2024, with subsequent amendments on November 18, 2024; December 16, 2024; February 24, 2025; and an adjustment on March 24, 2025.

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

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

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

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

— No date available.

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 Draft Environmental Impact Statement as the base condition against which the Build Alternative is compared and evaluated.

4 Methods for Effect Evaluation

4.1 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

4.2 Methodology

4.2.1 Carbon Monoxide Microscale (Localized) Analysis

Consistent with the traffic operations analysis for the Program, a comparison of the No Build and Build Alternatives was completed for the peak-hour AM and Fall Weekday PM period travel times to assess changes in delay. Key travel routes within the study area were evaluated to qualitatively assess air quality impacts within the microscale study area.

4.2.2 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 VOCs, NO_x, CO, PM₁₀ and PM_{2.5}, 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.

4.2.3 Qualitative Assessment of Mobile Source Air Toxics

FHWA most recently 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 the FHWA criteria to determine the level of analysis for MSATs.

4.2.4 Construction Emissions

MassDOT conducted a qualitative assessment of the potential adverse construction-period effects of the Build Alternative on local air quality, including the identification of measures to mitigate those effects.

5 Affected Environment

5.1 National Ambient Air Quality Standards

Pursuant to the Clean Air Act of 1970, the EPA established NAAQS for major pollutants known as "criteria pollutants." **Table 5-1** presents the NAAQS established by the 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."⁴

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).⁵ For instance, EPA revoked the 1997 annual primary PM_{2.5} NAAQS effective October 24, 2016, with the implementation of the more stringent 2012 PM_{2.5} NAAQS.⁶ Most recently in February 2024, the EPA strengthened the primary annual PM_{2.5} standard to 9 microgram per cubic meter from 12 microgram per cubic meter.⁷

⁴ From the [preamble to the USEPA NAAQS table](https://www.epa.gov/criteria-air-pollutants/naaqs-table): <https://www.epa.gov/criteria-air-pollutants/naaqs-table>

⁵ On January 27, 2023, the 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.

⁶ 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 PM_{2.5} 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.

⁷ U.S. Environmental Protection Agency. 2024. [Final Reconsideration of the National Ambient Air Quality Standards for Particulate Matter \(PM\)](https://www.epa.gov/pm-pollution/final-reconsideration-national-ambient-air-quality-standards-particulate-matter-pm). February. <https://www.epa.gov/pm-pollution/final-reconsideration-national-ambient-air-quality-standards-particulate-matter-pm>

Table 5-1. 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-mon average	0.15 µg/m ³ ^[1]	Not to be exceeded
Nitrogen Dioxide (NO ₂)		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 (O ₃)		Primary and Secondary	8 hours	0.070 ppm ^[3]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	PM _{2.5}	Primary ^[5]	1 year	9.0 µg/m ³	annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m ³	annual mean, averaged over 3 years
		Primary and Secondary	24 hours	35 µg/m ³	98th percentile, averaged over 3 years
	PM ₁₀	Primary and Secondary	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO ₂)		Primary	1 hour	75 ppb ^[4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		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) (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/m³ = 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/m³ as a calendar quarter average) also remain in effect.

^[2] The level of the annual NO₂ 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) O₃ 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) O₃ standards.

^[4] The previous SO₂ 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 SO₂ standards or is not meeting the requirements of a State Implementation Plan call under the previous SO₂ 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, the 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.

5.2 Air Quality Attainment Status

The microscale and mesoscale study areas are in the counties of Plymouth and Barnstable where the EPA’s Green Book shows that these counties are designated as an attainment area for all criteria pollutants with the EPA NAAQS.⁸

Federal conformity requirements at [40 CFR 93.114](#)⁹ and [40 CFR 93.115](#)¹⁰ (as incorporated by reference into the Massachusetts conformity State Implementation Plan) apply because the area where the Program is located is under a federal court decision affecting former maintenance areas nationwide for the 1997 ozone NAAQS.¹¹ Accordingly, there must be a currently conforming transportation plan (i.e., Transportation Improvement Plan and a Long Range Transportation Plan) at the time of issuance of the NEPA Record of Decision, and the Program must come from a conforming plan or otherwise meet the criteria specified in [40 CFR 93.109\(b\)](#).¹² As of the date of preparation of this analysis, Phase 1 of the Program (Replacement of Sagamore Bridge) is currently included in the [Fiscal Year 2025-2029 Transportation Improvement Program Amendment 2](#).¹³ The Program is also included in the [Draft Fiscal Year 2026-2030 Transportation Improvement Program](#) currently being reviewed by the Cape Cod Metropolitan Planning Organization as of April 2025.¹⁴ The Program is also included in the Regional Air

⁸ https://www3.epa.gov/airquality/greenbook/anayo_ma.html

⁹ <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.114>

¹⁰ <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.115>

¹¹ 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>

¹² <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93#93.109>

¹³ <https://www.capecod.gov/2024/11/19/public-review-notice-transportation-improvement-program/>

¹⁴ https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/tr/ccmpo/Outreach/OUTREACH%202025/Documents%20for%20Public%20Review/Cape_Cod_2026%202030_Transportation_Improvement_Program_draft%20for%20CCMPO%20review.pdf

Conformity Assessment for the [Cape Cod 2024 Regional Transportation Plan 2024-2044](#), which received approval by the Cape Cod Metropolitan Planning Organization dated July 24, 2023.¹⁵

5.3 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 the EPA has established NAAQS) and other pollutants, including air toxics.¹⁶ Excerpts of the latest annual air quality monitoring report are presented in the following sections.

5.3.1 Carbon Monoxide

The EPA provides the following background information on CO:¹⁷

“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.”

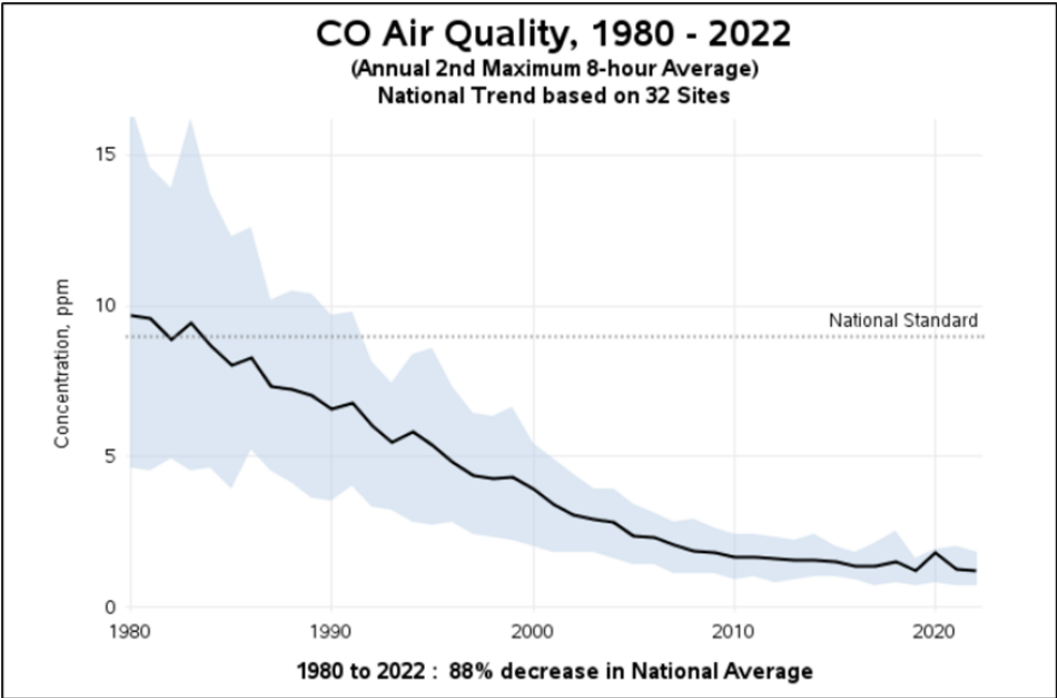
As shown in [Figure 5-1](#), and due primarily to the implementation of more stringent vehicle emission and fuel quality standards, the national trend in ambient concentrations of CO over the past few decades has decreased to a level substantially below the current eight-hour NAAQS of 9 parts per million (ppm). The national trend is reflected in the very low ambient CO concentrations.

¹⁵ 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

¹⁶ Massachusetts Department of Environmental Protection. 2024. [Massachusetts 2023 Air Quality Report](#). September. <https://www.mass.gov/doc/2023-annual-air-quality-report/download>

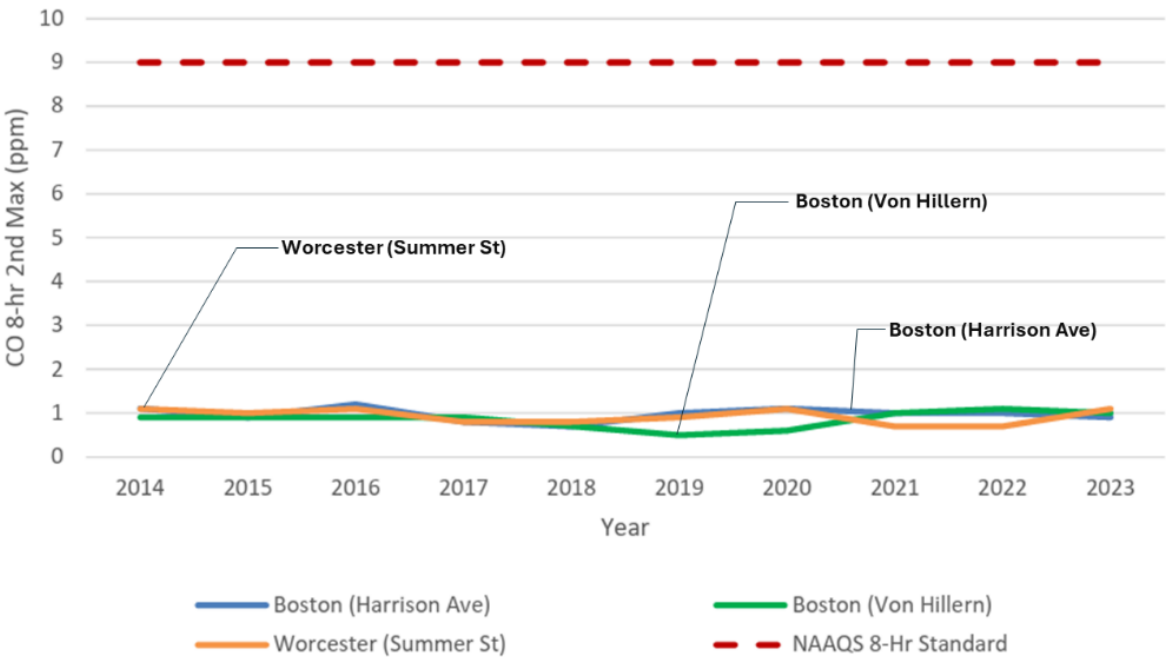
¹⁷ U.S. Environmental Protection Agency. [Basic Information about Carbon Monoxide \(CO\) Outdoor Air Pollution](#). <https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#What%20is%20CO>

Figure 5-1. 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). <https://www.epa.gov/air-trends/carbon-monoxide-trends>

Figure 5-2. Carbon Monoxide Trends 2014-2023 8-Hour



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

5.3.2 Nitrogen Oxides

EPA provides the following background information on NO₂:¹⁸

“Nitrogen Dioxide (NO₂) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NO_x). Other nitrogen oxides include nitrous acid and nitric acid. NO₂ is used as the indicator for the larger group of nitrogen oxides.

NO₂ primarily gets in the air from the burning of fuel. NO₂ forms from emissions from cars, trucks and buses, power plants, and off-road equipment.”

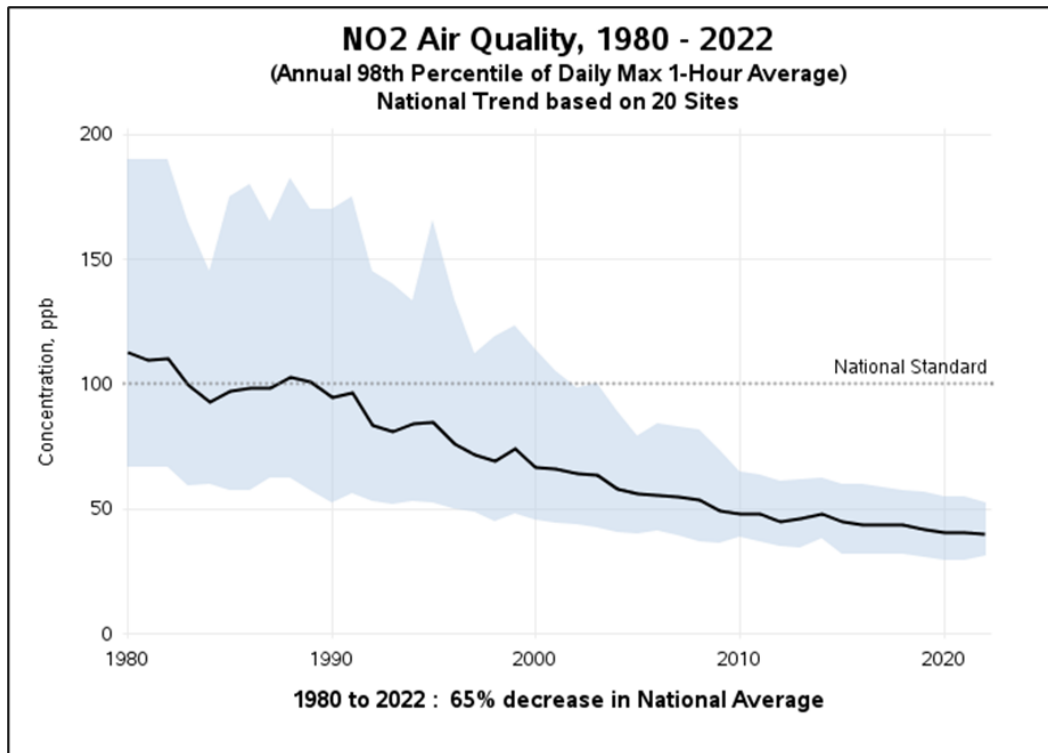
and

“Breathing air with a high concentration of NO₂ 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 NO₂ 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 NO₂. NO₂ along with other NO_x 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 5-3 and **Figure 5-4** present the trend in levels of NO₂ on a national level and for the region south of Boston, including Central and Western Massachusetts, respectively. Monitored levels of NO₂ in Massachusetts meet the NO₂ standards.

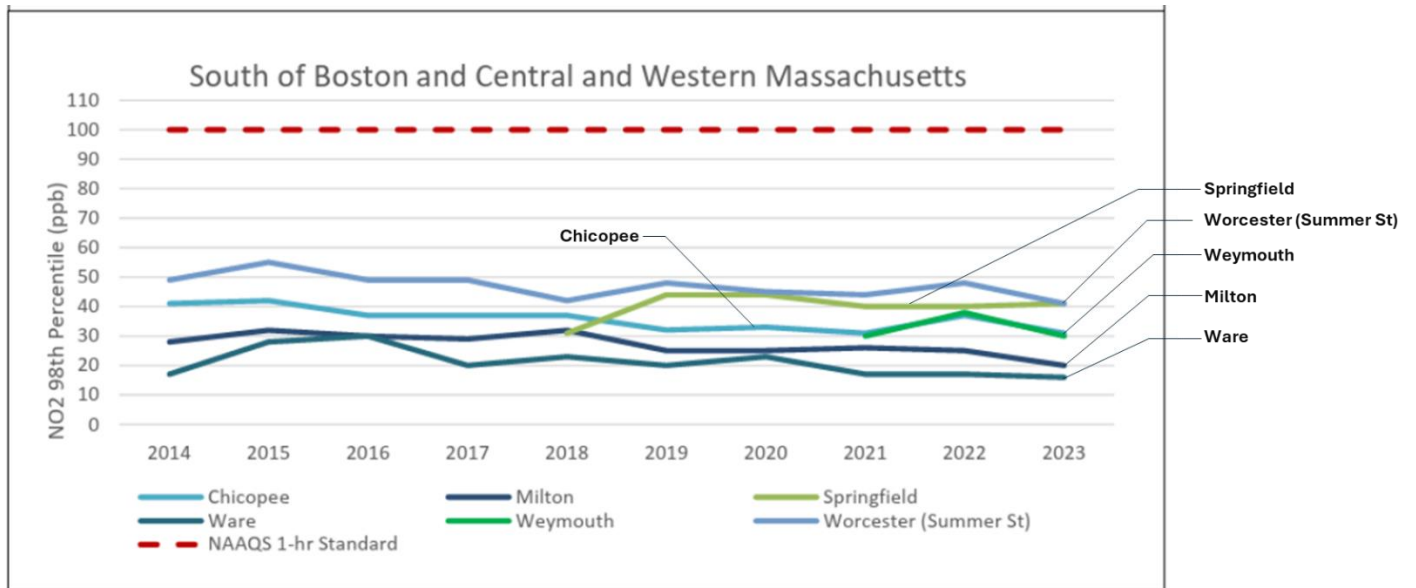
¹⁸ U.S. Environmental Protection Agency. [Basic Information about NO₂](https://www.epa.gov/no2-pollution/basic-information-about-no2#What%20is%20NO2). <https://www.epa.gov/no2-pollution/basic-information-about-no2#What%20is%20NO2>

Figure 5-3. 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). <https://www.epa.gov/air-trends/nitrogen-dioxide-trends>.

Figure 5-4. Nitrogen Dioxide Trends 2014-2023, 1-hour 98th Percentile Annual Average South of Boston including Central and Western Massachusetts

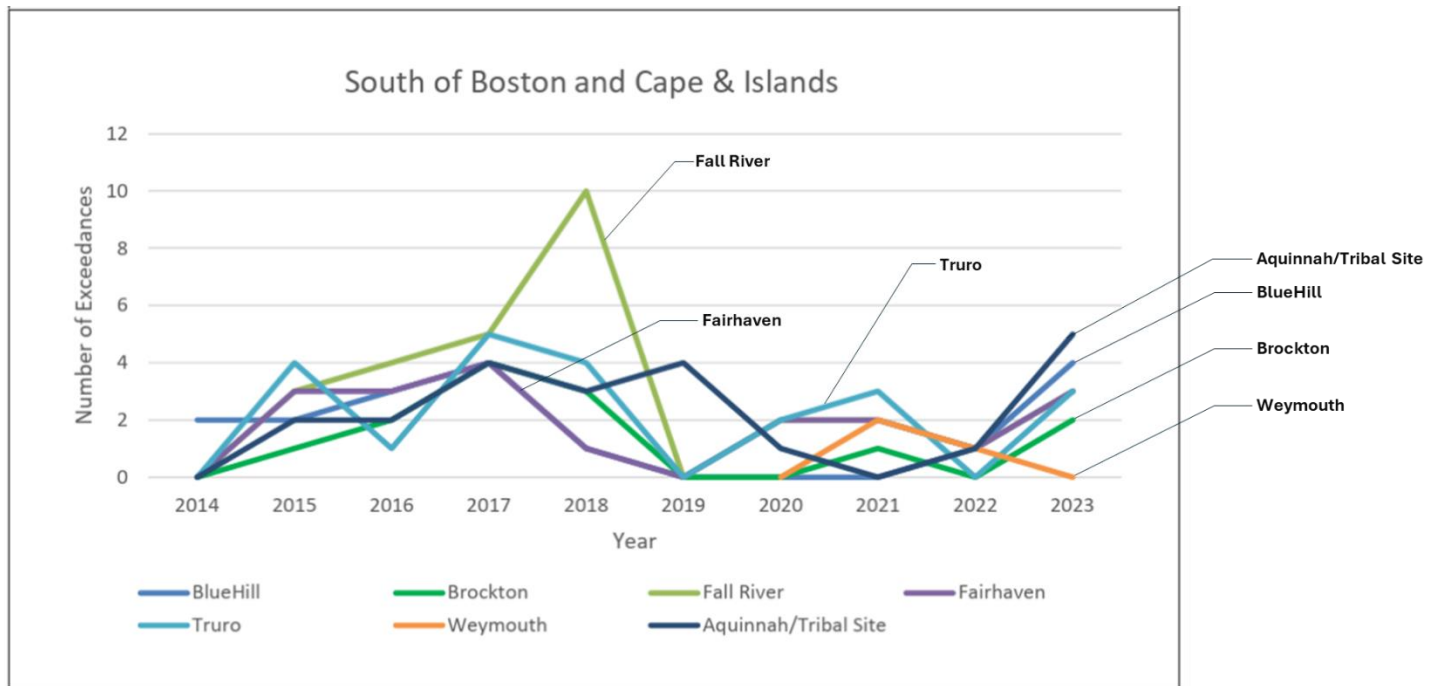


Source: Massachusetts Department of Environmental Protection. 2024. [Massachusetts 2023 Air Quality Report](https://www.mass.gov/doc/2023-annual-air-quality-report/download). September. <https://www.mass.gov/doc/2023-annual-air-quality-report/download>

5.3.3 Ozone

Figure 5-5 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 5-5. 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](https://www.mass.gov/doc/2023-annual-air-quality-report/download). September. <https://www.mass.gov/doc/2023-annual-air-quality-report/download>

5.3.4 Particulate Matter

EPA provides the following background information on particulate matter:¹⁹

“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.”

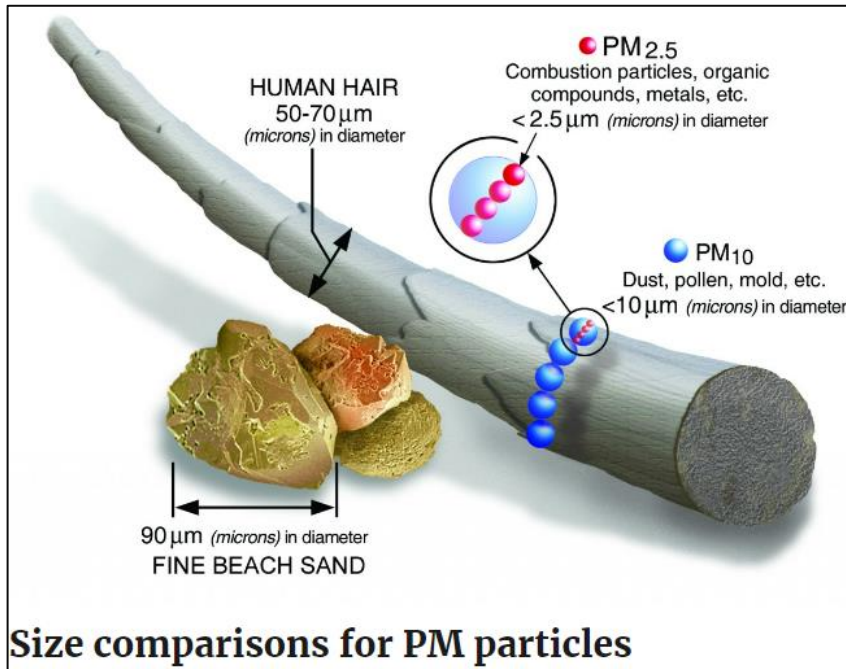
Particle pollution includes:

- PM₁₀: inhalable particles, with diameters that are generally 10 micrometers and smaller
- PM_{2.5}: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller

¹⁹ 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 5-6 from EPA shows the size of PM_{2.5} and PM₁₀ particles relative to a human hair and to fine beach sand.

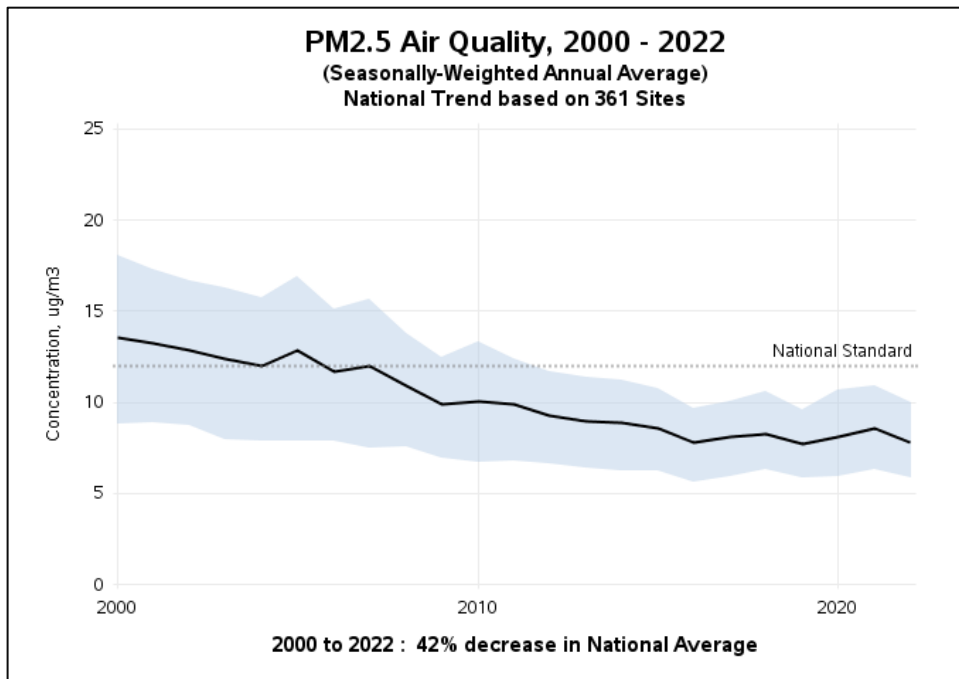
Figure 5-6. Size Comparison of Particulate Matter Particles



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>

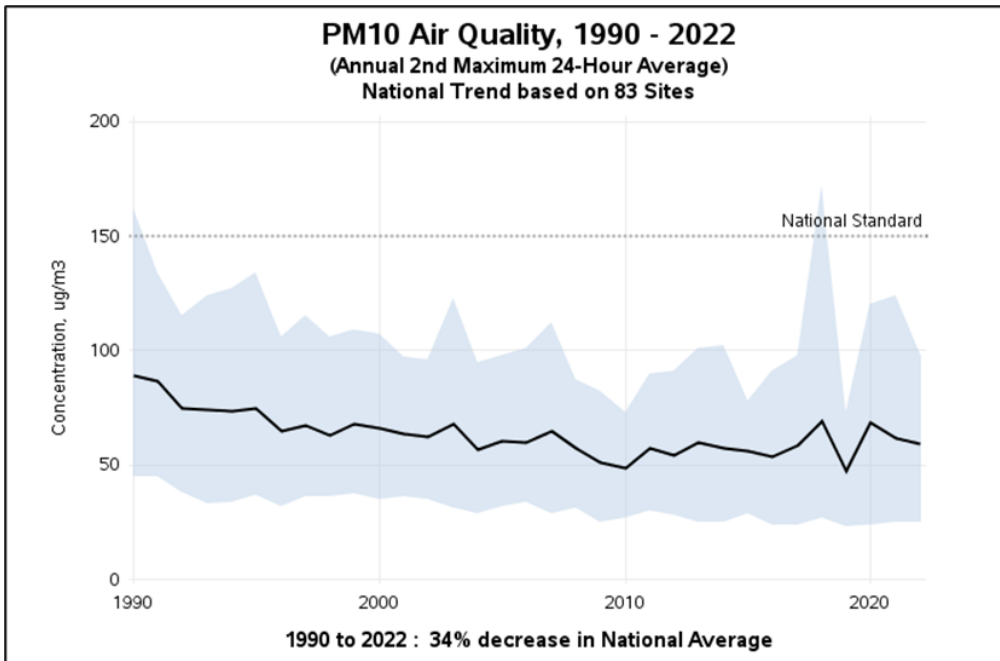
Figure 5-7 and **Figure 5-8** present the national trends in PM_{2.5} and PM₁₀ levels, respectively.

Figure 5-7. 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>.

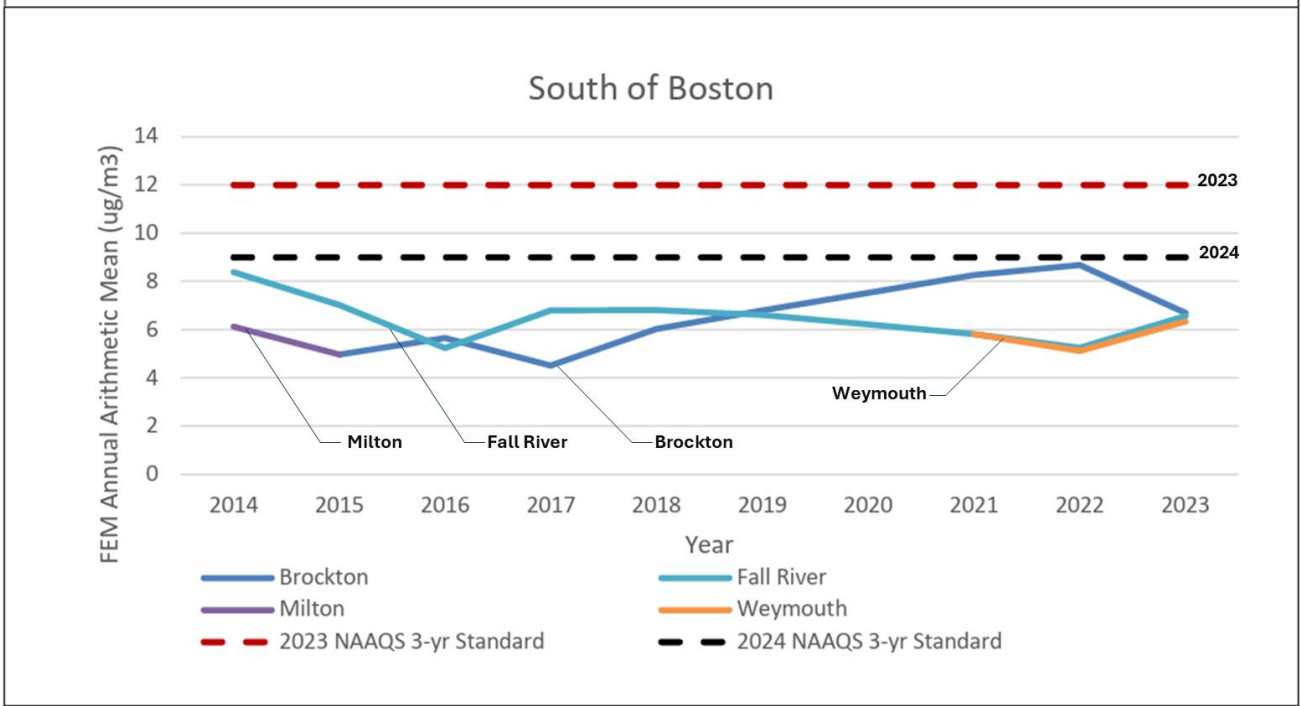
Figure 5-8. National Trends in PM10 Concentrations (24-hour Average)



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>.

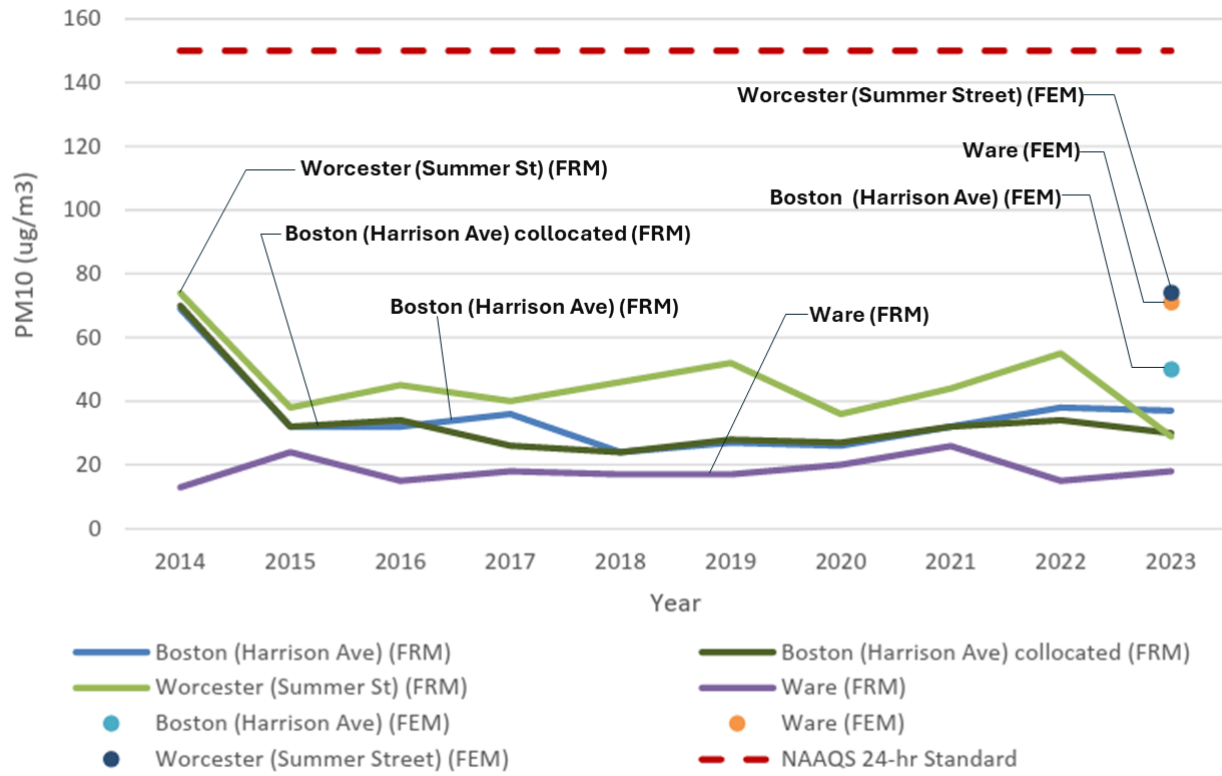
Figure 5-9 and Figure 5-10 present tabulations of PM2.5 (annual trends) South of Boston and PM10 (24-hour standard) concentrations, which were excerpted from the referenced MassDEP annual air quality monitoring report. As noted above, all of Massachusetts is in attainment of the NAAQS for both pollutants.

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



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

Figure 5-10. PM10 Trends, 2014 to 2023 (24-hour Calendar Year Maximum)



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

6 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,²⁰ 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*.”²¹ FHWA posts separate guidance for MSATs along with responses to “Frequently Asked Questions” on its air quality webpage.²²

²⁰ Federal Highway Administration. [NEPA and Project Development](https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx). https://www.environment.fhwa.dot.gov/nepa/nepa_projDev.aspx

²¹ 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). <https://www.environment.fhwa.dot.gov/projdev/impTA6640.asp>

²² Federal Highway Administration. [Air Quality: Transportation & Toxic Air Pollutants](https://www.fhwa.dot.gov/environment/air_quality/air_toxics/). https://www.fhwa.dot.gov/environment/air_quality/air_toxics/

6.1 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 Level of Service (LOS) during the weekday fall PM design periods. 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 (2,240 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 the 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 5-2**, the MassDEP measured air pollution for CO in the state is well below the NAAQS and the 10-year historical 8-hour concentrations have remain steady and trended down and have been well below the standards for over 20 years.

6.2 Mobile Source Air Toxics

6.2.1 Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments of 1990, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. The 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 the [EPA's Integrated Risk Information System](#).²³ 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](#).²⁴ 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.

²³ <https://www.epa.gov/iris>

²⁴ <https://www.epa.gov/national-air-toxics-assessment>

6.2.2 Motor Vehicle Emissions Simulator (MOVES)

According to the EPA, MOVES3²⁵ 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 (79 Federal Register 60344), heavy-duty greenhouse gas regulations that phase in during model years 2014-2018 (79 Federal Register 60344), and the second phase of light-duty GHG regulations that phase in during model years 2017-2025 (79 Federal Register 60344).

In November 2020, the EPA issued [MOVES3 Mobile Source Emissions Model Questions and Answers](#).²⁶ The 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 [Figure 6-1](#), 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.

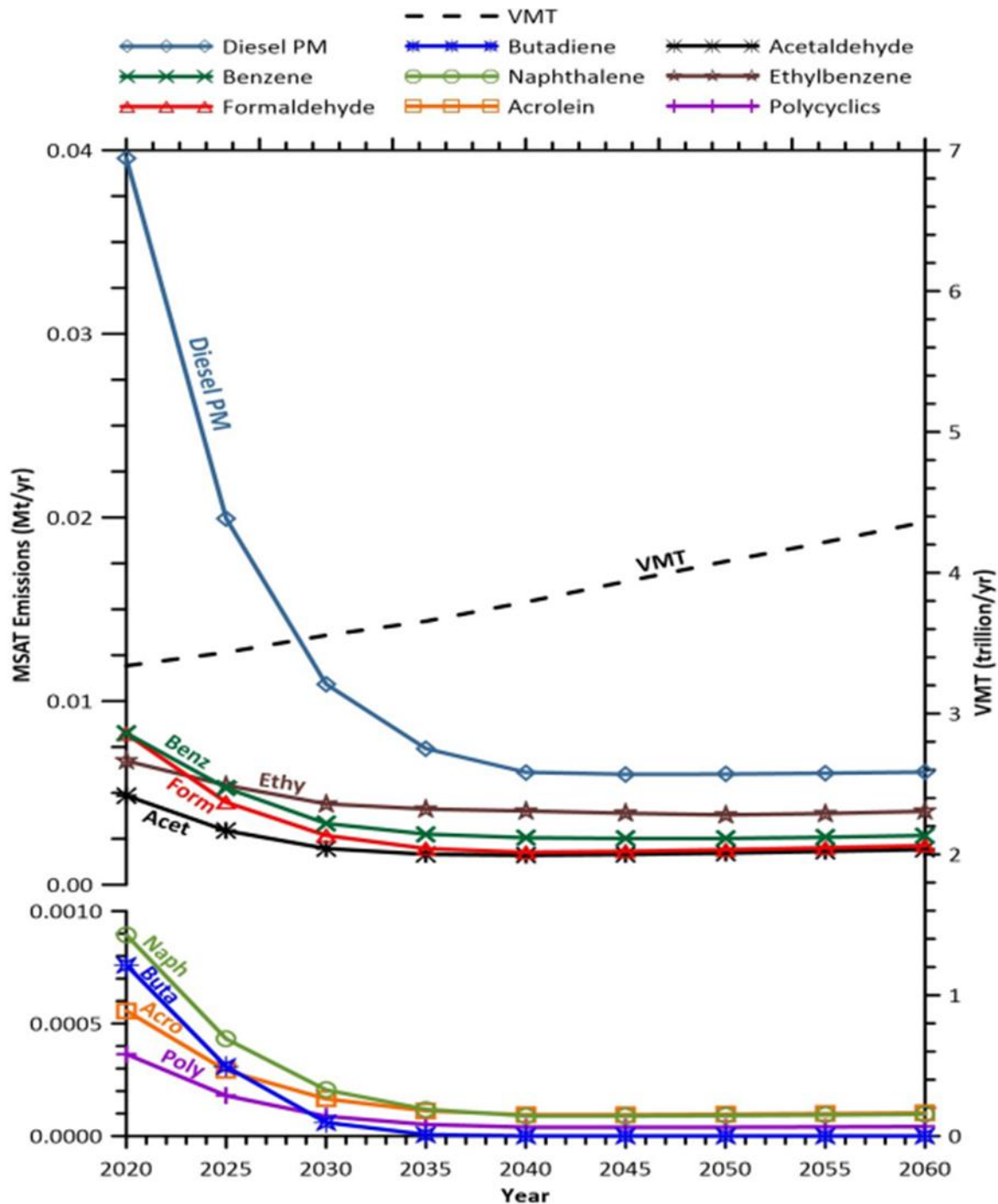
6.2.3 Mobile Source Air Toxics Research

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.

²⁵ 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.

²⁶ <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010M06.pdf>

Figure 6-1. 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. The 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. The FHWA will continue to monitor the developing research in this field.

6.2.4 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.

The 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. The 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."²⁷ 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 concentrations²⁸ 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,

²⁷ U.S. Environmental Impact Statement. [Integrated Risk Information System](https://www.epa.gov/iris/). <https://www.epa.gov/iris/>

²⁸ Health Effects Institute. 2007. [Special Report 16: Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects](https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects). November. <https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects>

particularly because unsupportable assumptions would have to be made regarding changes in travel 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.²⁹ 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. The 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.”³⁰

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the 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.³¹

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

²⁹ Health Effects Institute. 2007. [Special Report 16: Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects](https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects). November. <https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects>

³⁰ 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) https://iris.epa.gov/static/pdfs/0642_summary.pdf

³¹ U.S. Court of Appeals for the District of Columbia Circuit, June 2008.

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

6.2.5 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 the 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.

6.3 Mesoscale Analysis

Table 6-1 presents the 2050 forecast VMT, VHT, Daily Trips and average vehicle speeds for the No Build and Build Alternative within the mesoscale study area. **Table 6-2** presents the corresponding air quality reductions associated with the Build Alternative compared to the No Build Alternative. A reduction in VMT, VHT, daily trips, and vehicle speeds is expected with the Build Alternative when compared to the No Build Alternative due to more efficient traffic flow within the study area. Correspondingly, emissions are also expected to decrease with fewer VMT and higher speeds for the Build Alternative compared to the No Build Alternative.

Table 6-1. 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
Daily Trips	421,866	421,686	0
Average Speed (miles per hour)	37	39	+2

Table 6-2. 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)
Vehicle Miles Traveled (millions of miles per year)	2.653	3.476	3.416	-0.06
Carbon Monoxide	6.37	3.24	2.99	-0.25
Volatile Organic Compounds	0.11	0.07	0.07	-0.01
Nitrogen Oxide	0.71	0.11	0.10	-0.01
Sulfur Dioxide	0.02	0.004	0.004	-0.0020
PM10 ^[1]	0.10	0.18	0.14	-0.04
PM2.5 ^[2]	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.

^[2] Totals may not exactly match due to rounding.

6.3.1 Construction

During construction, there is potential for short-term increases in particulate matter emissions (airborne dust) due to site preparation and roadway reconstruction activities, including land clearing, demolition, excavation, grading, compaction, removing or improving existing roadways, and paving roadway surfaces. In addition to airborne dust, the operation of diesel-fueled off-road equipment and heavy-duty trucks has the potential to adversely affect air quality due to direct emissions of CO, NO_x, and VOCs. MassDOT's Standard Specifications for Road and Bridge Construction include construction-related specifications and contract special provisions for dust control, use of cleaner diesel fuel, idling reduction requirements, and installation of emission control devices on contractor vehicles. MassDOT's contractors will comply with all air quality contract specifications to minimize impacts of fugitive dust and construction equipment and vehicle exhaust, including ozone precursors VOCs and NO_x. [Section 7](#) outlines specific measures that will be implemented to reduce air quality impacts during construction.

Demolition of the Sagamore and Bourne Bridges would involve lead paint disturbance, which can generate airborne lead dust and fumes. The contractor will be required to comply with MassDOT specifications for the proper removal of bridge components coated with lead-based paint. These specifications will require the contractor(s) to develop a Lead Abatement Plan—including containment measures, lead paint removal methods, worker protection measures, waste disposal procedures, and post-abatement protocols—for review and approval by MassDOT. Any demolition activities with the potential to disturb identified or suspected lead-based paint would be performed in accordance with the [Occupational Safety and Health Administration Lead in Construction Standard](#).³²

³² <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.62>

7 Mitigation Measures

7.1 Construction Equipment and Vehicle Exhaust

The following best management practices (BMP) and mitigation measures will be employed to control the impacts of construction equipment and vehicle exhaust emissions, including criteria pollutants and ozone precursors. Such measures include, but are not limited to:

- Use of low-emitting diesel-fueled equipment or retrofitting of heavy-duty diesel-fueled construction equipment with diesel oxidation catalysts or diesel particulate filters to meet either the Environmental Protection Agency (EPA) particulate matter emission standards or emission control technology verified by the U.S. Environmental Protection Agency (U.S. EPA) or the California Air Resources Board. This will mitigate sulfur oxides and particulates.
- Installation of on-site anti-idling signage at various loading and drop-off/pick-up/waiting areas to prohibit trucks from engine idling more than five minutes in compliance with Massachusetts General Law (MGL) Chapter 90, Section 16A and MassDEP idling reduction regulation (310 CMR 7.11(1)(b)). This will mitigate criteria pollutant and ozone precursors.
- Ensuring construction equipment is maintained in proper working order to minimize exhaust emissions, including odors. This will mitigate criteria pollutants and ozone precursors.

Use of alternative-fueled or electric equipment where feasible. This will mitigate criteria pollutants and ozone precursors.

7.2 Fugitive Dust

The following BMPs and mitigation measures will be employed to control the impacts of fugitive dust emissions and mitigate particulate matter during construction. Such measures include, but are not limited to:

- Seeding, paving, covering, wetting, or otherwise treating disturbed soil surfaces.
- Covering of active stockpiles with plastic tarps or other suitable containment measures.
- Covering of dust-producing materials (e.g., dirt or demolition debris) before transport on public roadways.
- Route and schedule construction traffic through areas that would cause the least disturbance to nearby sensitive receptors.
- Locating aggregate storage piles away from sensitive receptors and environmental resources.
- Modifying work schedules when weather conditions, such as dry soil or high wind speeds, could lead to adverse impacts.

7.3 Lead Abatement Activities

The following BMPs will be employed to prevent public exposure to lead-based paint hazards during construction and demolition. Such measures include, but are not limited to:

- Developing a Lead Abatement Plan.
- Establishing containment enclosure areas around work zones.
- Wet-misting or vacuuming to control lead dust and paint chips during removal.
- Avoiding abatement activities during precipitation events or periods of high sustained wind speeds.

8 Glossary of Terms

Table 8-1. 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 measure that describes how well a roadway operates based on factors like speed, maneuverability, and delay.
Maintenance	Areas that were formally designated by EPA as attainment that are now currently meeting the NAAQS.
Mesoscale Analysis	Estimate of mobile source emissions generated by the project within the study network for the Build and No Build conditions.

Term	Definition
Mobile Source Air Toxics (MSAT)	The 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 the 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.

9 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.

Federal Register. "National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change," February 16, 2023, p. 1196. <https://www.federalregister.gov/documents/2023/02/16/2023-03257/national-environmental-policy-act-guidance-on-consideration-of-greenhouse-gas-emissions-and-climate>.

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.