October 15, 2024

2024 NESMEA Conference

I-495 & I-90 Design Build Project

Project Team

massDOT
Massachusetts Department of Transportation

Barletta Engineering Heavy Division

B and G

Aetna Bridge Company

vhb

72 Hours Nondestructive Testing

Michael Baker International

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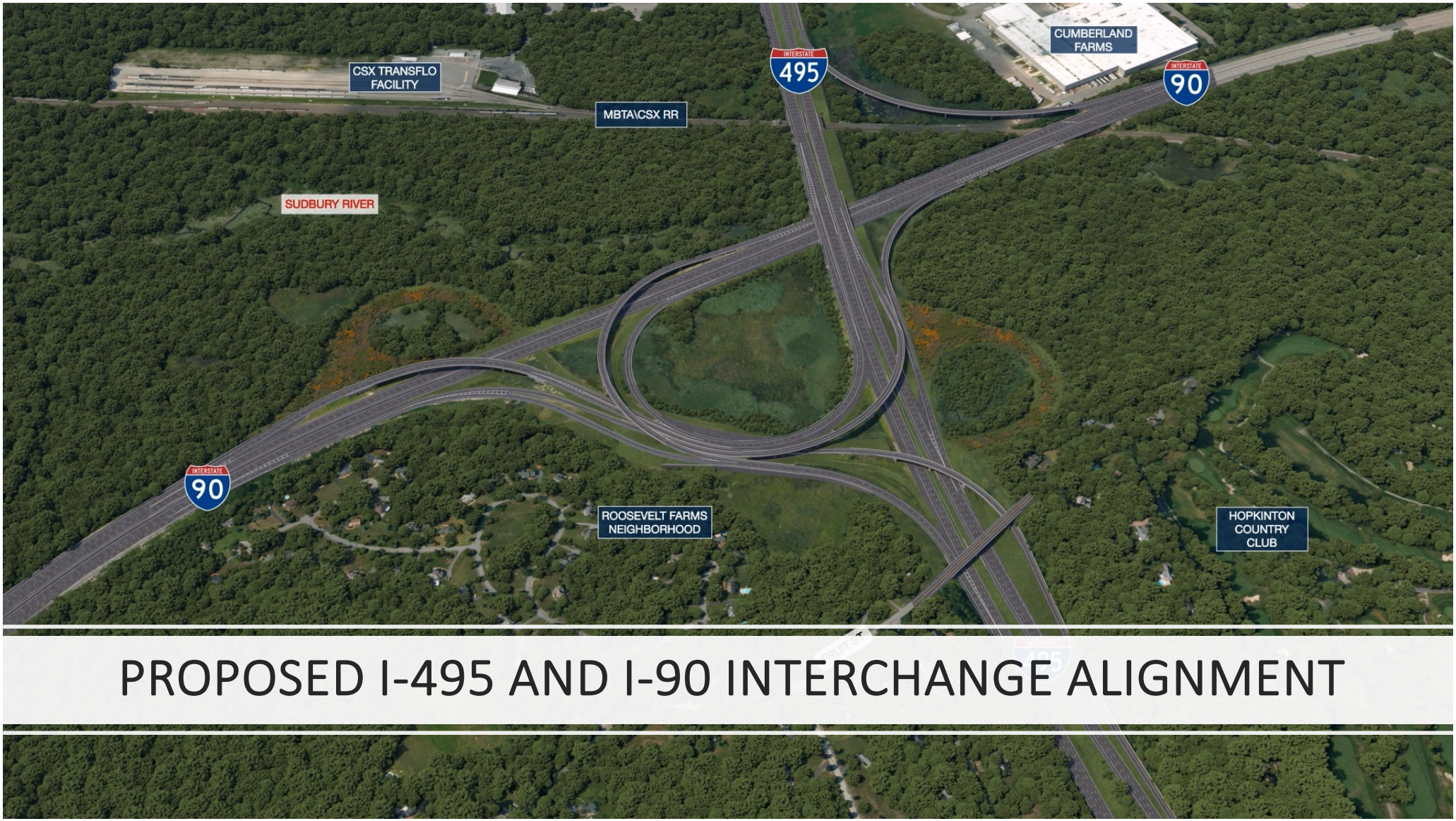
Bryant Associates

City Point Partners

RVA Regina Villa Associates

Lamson Engineering Corp.

EXISTING I-495 AND I-90 INTERCHANGE ALIGNMENT



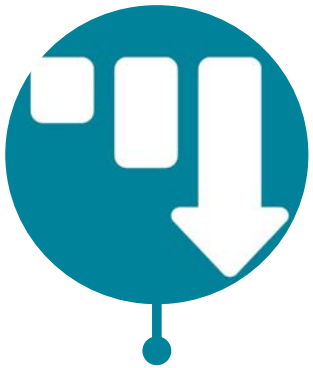
PROPOSED I-495 AND I-90 INTERCHANGE ALIGNMENT

Project Overview

Project Goals

Reduce crashes
in the project area for all movements

Reduce recurring congestion
within the interchange



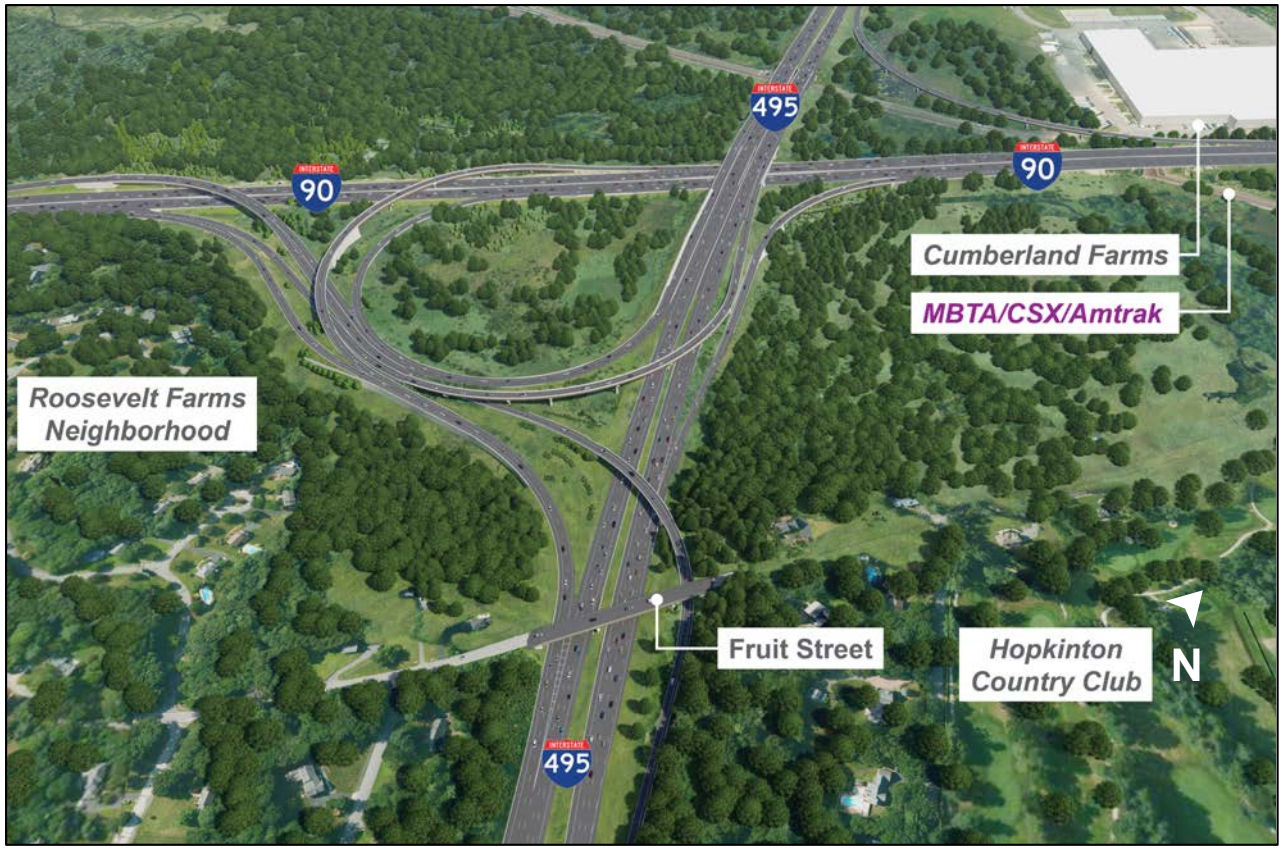
Reduce queuing
that currently extends from the interchange onto the mainlines of I-90 and I-495

Reduce travel time
the interchange, especially for high-volume movements

Key Project Elements and Proposed Modifications

- Project limits extend approximately 3/4 mile in each direction
- Complete replacement of the Interchange
- Elimination of old toll booth area and weaving areas
- Extremely sensitive environmental resource area

Project website:
https://www.mass.gov/i-495i-90-interchange-improvements



I-90

- 3 lanes in each direction
- Minor widening and minimal changes to profile
- Bridges over MBTA/CSX/Amtrak and Whitehall Brook to be replaced

I-495

- 3 lanes in each direction
- 4th lane to Route 9
- Future I-495 NB will be within the previous median area
- Future I-495 SB will be in its existing location
- Bridges over MBTA/CSX/Amtrak and I-90 to be replaced

Interchange Ramps

- New direct, semi-direct and loop ramp configurations
- Support up to 40-50 mph design speed
- Single or two-lane ramps based on traffic demand

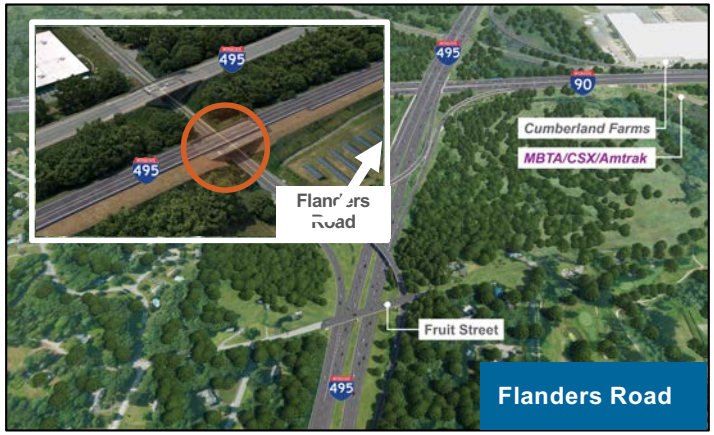
*Ramp Designations indicate directionality—i.e., **Ramp WN** connects I-90W to I-495N

Fruit Street

- Will be completed in 2 major stages
- 2-way, 1-lane alternating traffic (under signal control) during major stages

Flanders Road

- Replacement of I-495 NB bridge superstructure over Flanders Road
- Constructed with an overbuild to maintain 3-lanes of travel
- Utility work on Flanders Road below I-495



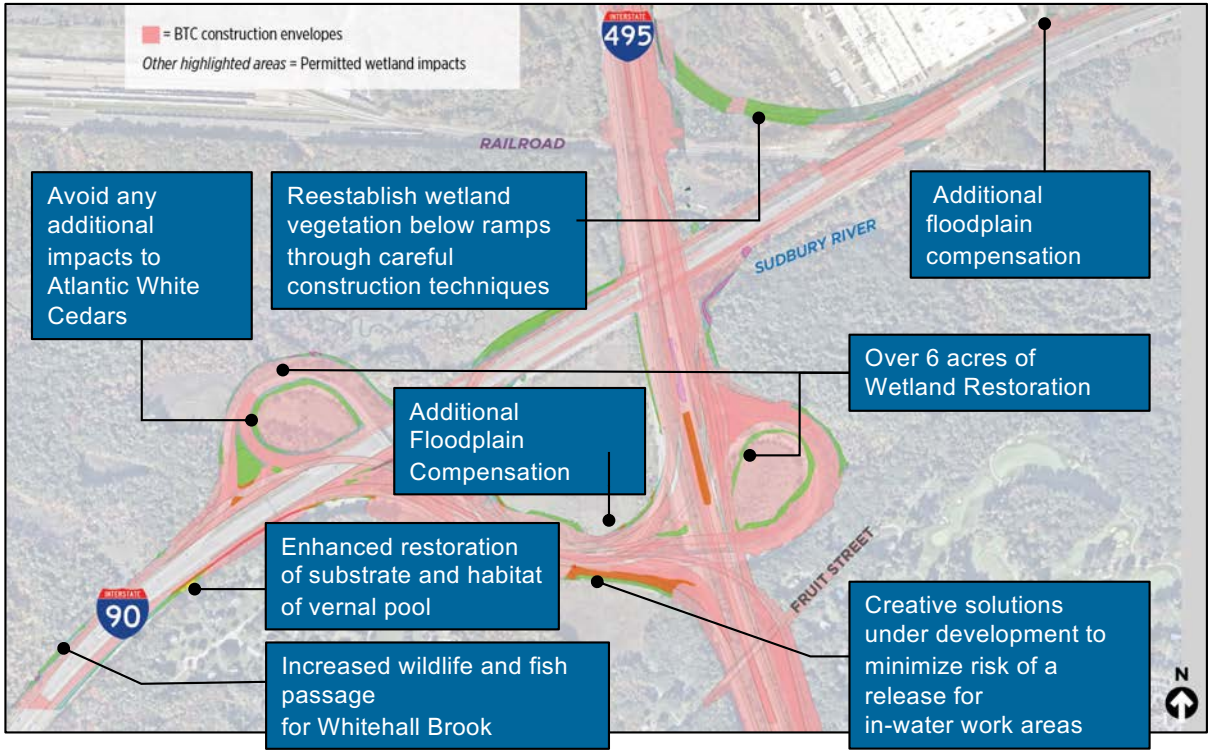
Environmental Considerations

Interchange is located near sensitive natural resources

- Cedar Swamp ACEC
- Sudbury River
- Whitehall Brook
- Surrounding wetlands and floodplains

Permits

- Issued during preliminary design
- Require continued agency involvement as designs advance
- Require construction and post-construction oversight



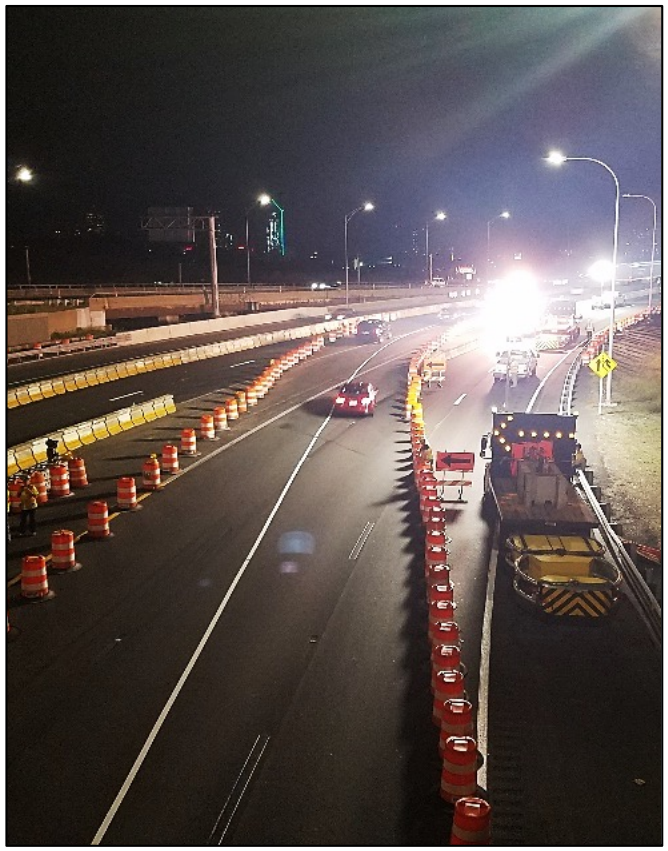
Traffic and Staging Considerations

I-90 and I-495

- Maintain 3 lanes on mainlines, except for short-term closures during approved off-peak hours
- Maintain all ramp connections between I-90 and I-495, including along temporary alignments
- Maintain proper signage and markings
- Provide temporary roadway lighting along ramps
- Provision of safe construction access/egress

Local Roadways

- Maintain resident and local business access/egress
- Traffic management to maintain access/egress on Fruit Street & Flanders Road



Schedule

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Design

Design **90%** Complete

May 2022–December 2024

Construction

Stage 0

October 2022–April 2023

Enabling work including fiber relocation and temp Ramp ES

Stage 1

December 2022–September 2024

Complete future I-495 NB in Median, and Fruit Street, Stage 1

Stage 2

June 2024–May 2026

Complete future I-495 SB, Ramps WN, WS, ES and SE, Fruit Street, Stage 2

Stage 3/3b

April 2025–April 2027

Complete Ramp NE, NW, SW and EN

Stage 4

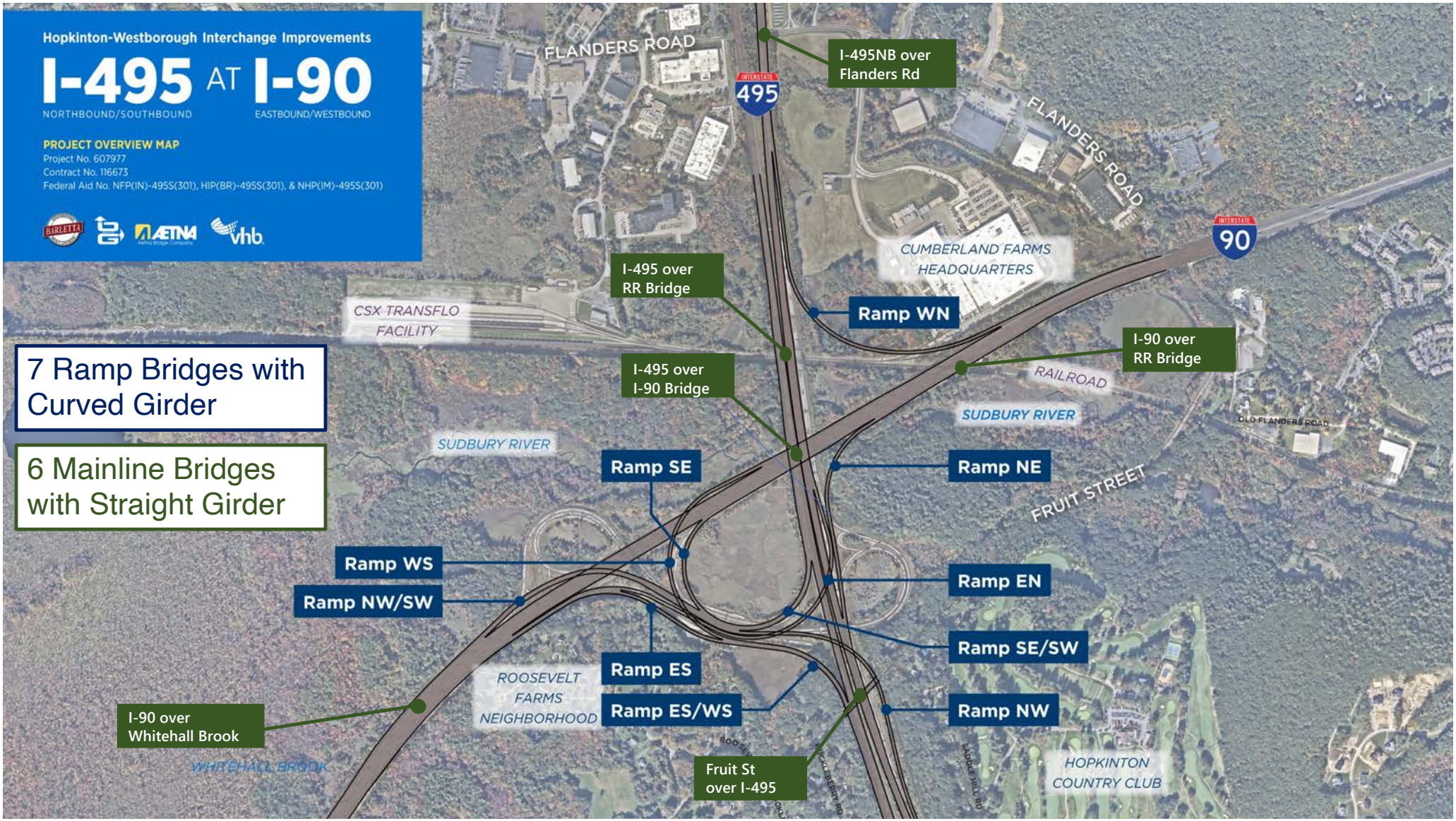
August 2026–June 2027

Complete I-90 widening, remove former loop ramps and complete environmental mitigation areas

Construction Materials

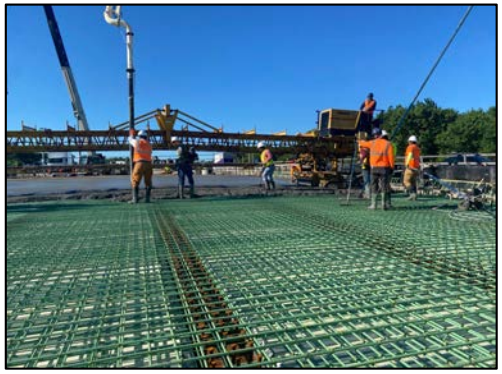
Construction Material Project Highlights

- Project Structures
- Concrete Placements
- Concrete Mixes on the Project
- Material Challenges & Recommendations


Hopkinton-Westborough Interchange Improvements
I-495 AT I-90
NORTHBOUND/SOUTHBOUND
EASTBOUND/WESTBOUND
PROJECT OVERVIEW MAP
Project No. 607977
Contract No. 116673
Federal Aid No. NFP(IN)-495S(301), HIP(BR)-495S(301), & NHP(IM)-495S(301)
7 Ramp Bridges with Curved Girder
6 Mainline Bridges with Straight Girder
FLANDERS ROAD
I-495NB over Flanders Rd
FLANDERS ROAD
CUMBERLAND FARMS HEADQUARTERS
I-495 over RR Bridge
Ramp WN
CSX TRANSFLO FACILITY
I-90 over RR Bridge
I-495 over I-90 Bridge
RAILROAD
SUDBURY RIVER
SUDBURY RIVER
OLD FLANDERS ROAD
Ramp SE
Ramp NE
FRUIT STREET
Ramp WS
Ramp EN
Ramp NW/SW
Ramp SE/SW
Ramp ES
ROOSEVELT FARMS NEIGHBORHOOD
Ramp ES/WS
Ramp NW
I-90 over Whitehall Brook
WHITEHALL BROOK
Fruit St over I-495
HOPKINTON COUNTRY CLUB

Overview

- All bridges consist of concrete deck on steel girders
  - Ramp WN is composed of curved steel box girders
- Concrete substructures throughout the project (some staged construction)
- Abutments are mostly conventional cantilever abutments (some with H-piles)
- Two integral abutment bridges
- Piers are either multi-column style or hammerhead
- One hammerhead pier with a concrete integral pier cap



Mass Concrete on a Massive Project

- 500+ structural concrete pours
- 33 Pier Footing Pours
- 30 Abutment Footing Pours
- 34 Pier Column Pours
- 33 Pier Cap Pours
- 38 Integral Abutment Pours
- 49 Cantilever Abutment Pours
- 123 of these concrete pours are considered Mass Concrete

Mass Concrete Mix Designs

- Per 901.65, Section B, Section 1 MassDOT considers mass concrete to be any pour equal to or greater than 4ft x 4ft x 4ft
- Temperature differential between internal and external is limited to 38°F
- Maximum temperature limited to 154°F
- Thermal Control Plan is required and includes mix design, heat of hydration analysis, plan to meet the temperature limits, method of recording temperatures, and plan of corrective action

Material and Quantity (lb/cu yd)	Mass Concrete Mix
Cement (lbs/cu yd)	303
Slag (lbs/cu yd)	303
3/4 in. Stone (lbs/cu yd)	500
1/2 in. Stone (lbs/cu yd)	500
1-1/2 in. Stone (lbs/cu yd)	900
Sand (lbs/cu yd)	1,168
Water (gal/cu yd)	33.0
GCP ADVA 140M (oz/cu yd)	42.0
GCP Darex II AEA (oz/cu yd)	2.5

Mass Concrete Work Plan

Workplan	Allowable Mean Ambient Temperature Range	Work Plan
1 – Warm Weather Placements	100° to 50°F	1. Maximum concrete placement temperature is **80°F.**[1] 2. Immediately after the concrete placement, tightly cover and wrap the **top surface with one layer of R1.5 insulation blankets**, wrapping and securing the blankets against the top of the formwork to prevent wind from getting underneath the blankets. 3. Remove all of the formwork after the embedded thermocouples indicate that thermal control measures can be stopped.[2,3,4]
2 – Moderate Weather Placements	90° to 35°F	1. Maximum concrete placement temperature is **75°F.**[1] 2. Immediately after the concrete placement, tightly cover and wrap the **top surface with one layer of R1.5 insulation blankets**, wrapping and securing the blankets against the formwork to prevent wind from getting underneath the blankets. 3. Remove all of the covers and formwork after the embedded thermocouples indicate that thermal control measures can be stopped.[2,3,4]
3 – Cool Weather Placements	70° to 15°F	1. Maximum concrete placement temperature is **65°F.**[1] 2. Immediately after the concrete placement, tightly cover and wrap the **top and side surfaces with one layer of R1.5 insulation blankets**, wrapping and securing the blankets against the formwork to prevent wind from getting underneath the blankets. 3. Remove all of the covers and formwork after the embedded thermocouples indicate that thermal control measures can be stopped.[2,3,4]

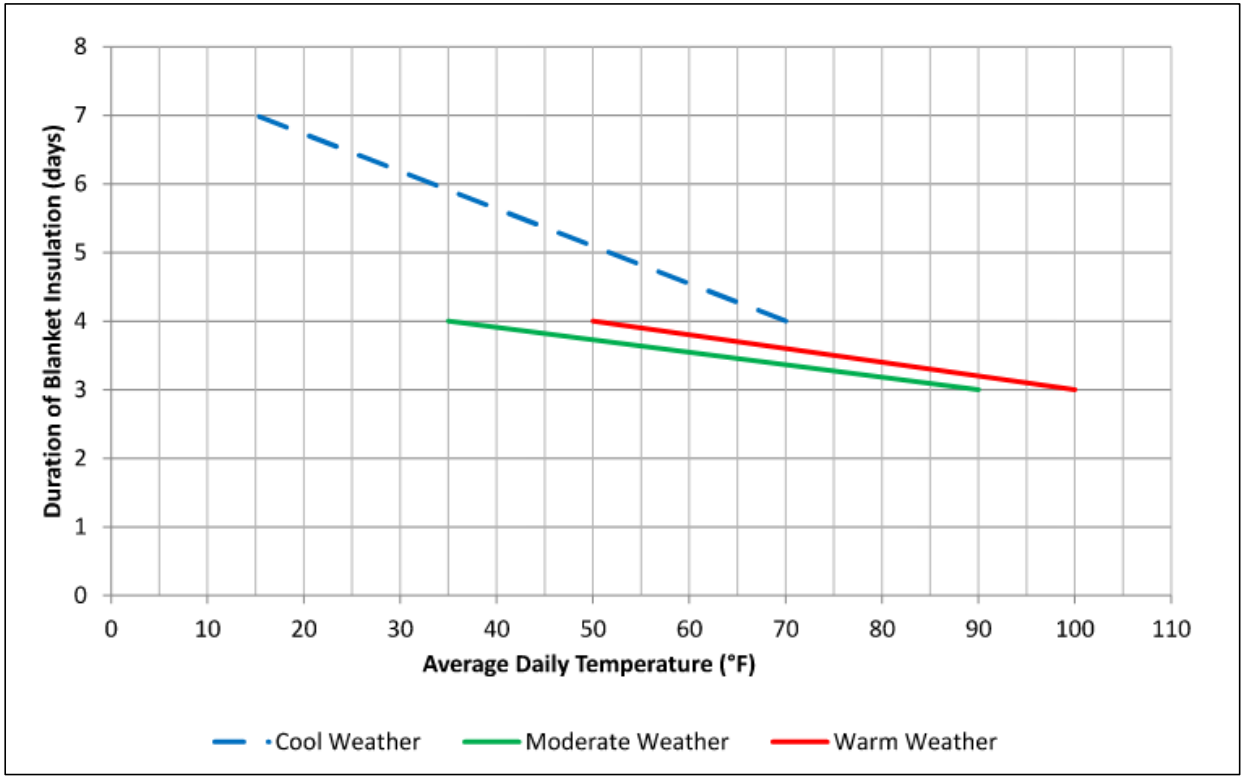
[1] ACI 306R-16 Guide to Cold Weather Concreting recommends a minimum concrete temperature as placed and maintained of 45°F for elements between 3 and 6 ft thick.

[2] During the first 48 hrs after placement, monitor the thermocouples at least twice a day. If the differential temperatures approach the limits discussed below in Section 4.3, place an additional layer of insulation blankets on the side and top surfaces.

[3] The forms and any insulation should be stripped near the middle of the day. The cooling rate on the removal of insulation should also be kept below 30°F/day in the first 24 hrs after thermal protection is terminated, as specified in ACI 301.

[4] Refer to Section 4.2 for information on how to determine when thermal control measures can be stopped. Refer to Fig. 1 for an estimate of how long thermal control measures will be required for the selected work plan and ambient conditions.

Mass Concrete Temperature Monitoring



Material Challenges and Recommendations

- Mass Placements
- Cold Weather Concrete
- Concrete Consolidation
- High Performance Concrete Mix Design

Mass Placements

- Recommend early assessment of mass concrete pours on the project
  - Test block "hot box" takes time (28-day strength)
  - Development of thermal control plan for a new mix takes time
- Recommend early indication of mix performance for mass placements
- High Performance Concrete Mixes run hot (4000 psi conventional vs HP)
- Large aggregate (1-½") is a key element to developing low heat concrete mixes
- LRFD Bridge Design require more reinforcement in substructures (particularly pier caps and columns) presenting constructability challenges

Cold Weather Concrete

- Deck Placements in Cold Weather
  - Temperature control during placement
    - Pre-heat the forms for the deck
    - Ensure warm water temperature
  - Temperature control during curing
    - Maintaining heaters during construction
    - Laying out the heaters and hoses to optimize heating during curing
- Mass Placements in Cold Weather
  - Balancing the internal heat with the cold external temperatures
  - Maintaining the differential limit and the internal limit over the 3-day range

Concrete Consolidation

- LRFD Bridge Design Code results in significant reinforcement in pier caps and columns
- Typically pier column requires pumping
- Pumping within tight rebar spacing requires a reduced pump outlet
- Taller columns are more difficult to ensure effective pumping within tight rebar spacing
- Recommend ensuring that the pump and vibrators can fully access the range of the column when working with a tall pier column

High Performance Concrete Mixes

- New HP concrete mix specification after construction began
- Concrete producers needed to maintain production of the current 4000 psi HP mixes while beginning production of the new mixes
- Project was able to utilize the new 5000 psi HP mixes instead of old 5000 psi HP mixes

Table M4.06.1-1: Classifications of HP Concrete

28 Day Compressive Strength	Nominal Maximum Coarse Aggregate Size (in.)	Maximum Total Cementitious Content (lb per yd³)
5,000 psi	¾	685
5,000 psi	⅜	710
6,500 psi	⅜, ½, ¾	–
8,000 psi	⅜, ½, ¾	–

KICK-OFF MEETING

May 2, 2022