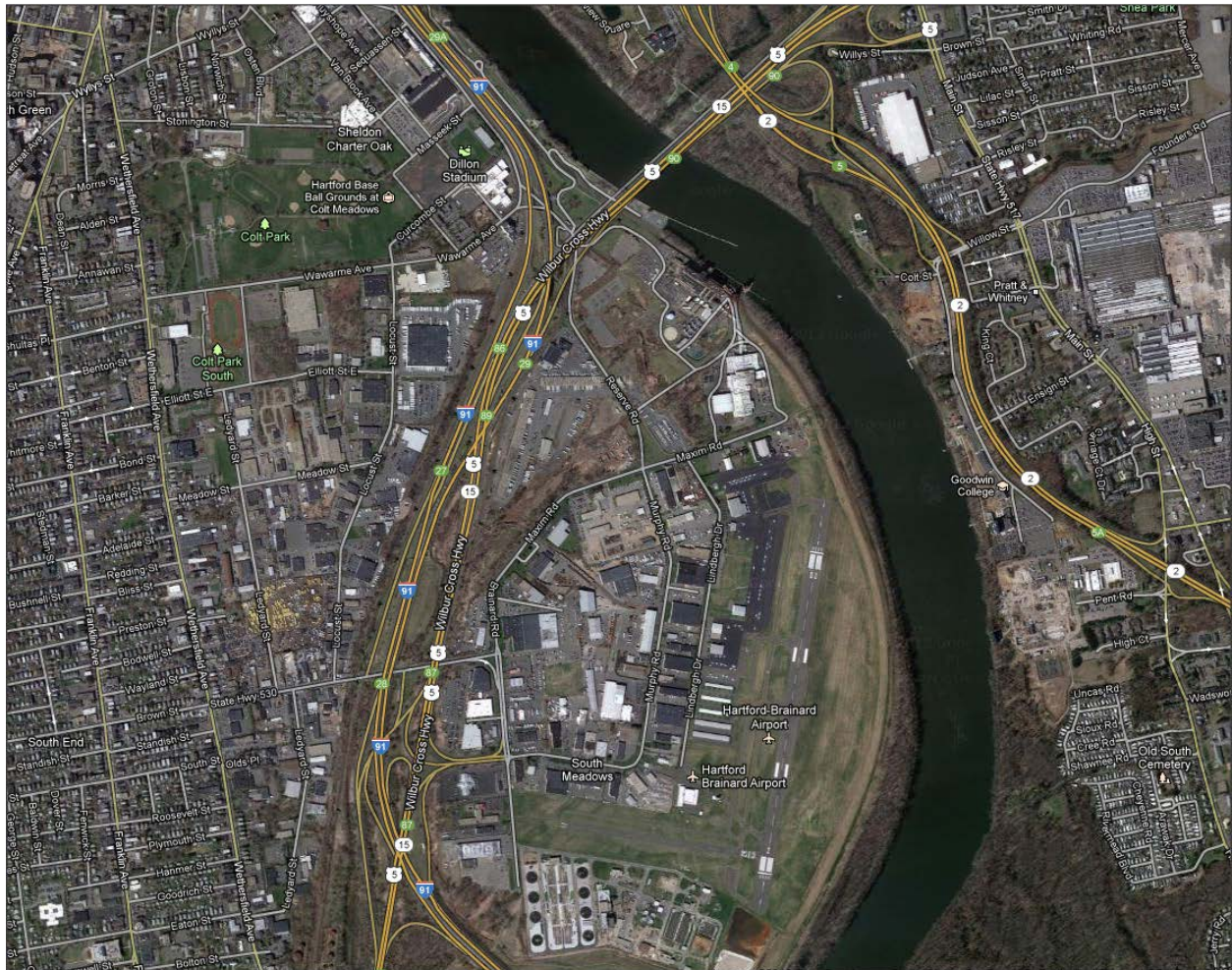


SCOPE REVIEW & RECOMMENDATION INTERCHANGE NO. 29 I-91 NORTH TO ROUTE 15 NORTH & I-84 EAST CITY OF HARTFORD

PURPOSE OF MEETING: The meeting was requested to review existing conditions, evaluate identified improvement alternatives, and select a preferred alternative for advancement. Recommendations on the next steps in the project initiation process are also requested.

PURPOSE & NEED OF PROJECT: The purpose of this project is to address safety concerns associated with capacity and operational failures at Interchange No. 29 on Northbound I-91, which connects to Route 15 North and I-84 East.

PROJECT LOCATION MAP:



EXISTING CONDITIONS:

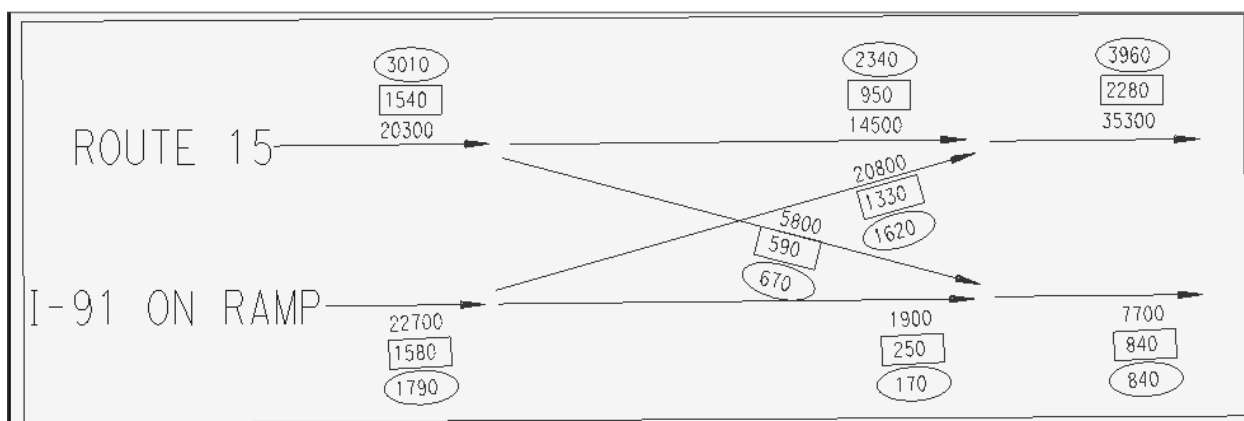
As an overview, three of the four connections for the I-91 and I-84 interchange are located proximate to the physical crossing of the interstates in downtown Hartford. The subject interchange, which is located approximately 1.6 miles to the south of I-84, provides the I-91 North to I-84 East connection, via Route 15.

Due to a combination of the factors identified below, there are significant traffic delays on I-91 North, which result in an above average crash frequency on I-91. A graphic depiction of the level of service analysis (LOS) has been attached to quantify delays on I-91 NB and on RTE 15 NB. In actual operation, traffic routinely backs up from Exit 29 onto the I-91 NB mainline, taking up the right-most lane of the three-lane facility. The length of the back-ups varies, but has been observed extending approximately 1.4 miles to the vicinity of the Wethersfield Cove. The condition is made far worse by the tendency of drivers to cut into the right lane queue from the center lane, drastically reducing the capacity of that center lane also.

The following factors are listed in approximate order of significance:

- **Exit 29 Off-Ramp Vertical Geometry:** The exit ramp has a 5% vertical grade with a 1,000-foot critical length of grade and an overall 1,660-foot total upgrade. Due to the vertical geometry, heavy vehicles slow approximately 12 MPH as they enter onto the Charter Oak Bridge. Assuming a ramp entering speed of 52 MPH (consistent with a mainline speed of 60 MPH) heavy trucks will slow to roughly 39 MPH. When other slow moving heavy vehicles are already in the traffic queue, heavy trucks that follow them enter the ramp at far lower initial speeds and then slow an additional 12 MPH until the entire queue is moving at stop-and-go speeds. Since the percentage of heavy vehicles is approximately 10.7% (assumed at 4% during peak periods), the speed reduction of heavy vehicles due to the vertical grade on the ramp plays a significant role in creating traffic congestion on I-91 south of exit ramp. Due to sporadic frequency of heavy vehicles, traffic queues can form and dissipate quickly, which can also contribute to the frequency of crashes in this area.
- **Exit 29 Off-Ramp at Capacity:** The northbound exit ramp at Interchange 29 has a one-lane configuration with more than half of its length on Bridge 6000C, which is 923 feet in length and 26 feet wide. The 2011 ADT on this ramp was recorded at 21,600 VPD which is considered at full capacity. The 2011 ADT on Northbound I-91 was recorded at 55,800 VPD prior to the subject exit ramp and 34,200 VPD after the ramp (i.e. 39% of the mainline volume uses Exit 29).
- **Mainline Volumes At or Near Capacity:** –There are four northbound travel lanes on I-91, from Interchange 22 (Route 9) in Cromwell to Interchange 27 (Brainard Road) in Hartford. However, there is a lane-drop at the Brainard Road exit ramp, just north of Wethersfield Cove. The 2011 Average Daily Traffic (ADT) on Northbound I-91 was recorded at 64,000 vehicles per day (VPD) south of the lane-drop and 57,000 north of the lane-drop (approximately 11% volume reduction). During the AM and PM peak hours, traffic volumes north of Interchange 27 were recorded at 6,230 (exceeds capacity) and 4,520 VPH, respectively. Northbound Route 15, east of the Charter Oak Bridge, has two travel lanes with a 2011 ADT of 33,600 VPD and with AM and PM peak volumes of 2,170 and 3,770 VPH (near capacity), respectively.

- Heavy Weaving of Route 15's Through Traffic with I-91's Entering Traffic:** The single lane exiting from northbound I-91 merges with two NB Route 15 travel lanes on the Charter Oak Bridge with the entering traffic from I-91 on the right. The three lane section was recently extended with pavement marking revisions to 1,458 feet (Project #63-679) until Interchange No. 90 on Route 15 for access to Route 2 and Route 5. After review of the traffic data (ADT) in the merge/diverge area, approximately 92% of vehicles from the I-91 entrance ramp continue on Route 15 (to I-84 East) and approximately 71% of vehicles from Route 15 continue on Route 15, which results in 29% of traffic from Route 15 weaving with 92% of traffic from I-91. As expected, traffic speeds are reduced through this weave area, which may further reduce vehicular speed on the I-91 ramp. However, the lower speeds of the heavy vehicles do allow for larger gaps for vehicles accessing the exit ramp for Routes 2 & 5.



CRASH HISTORY:

Most of Interstate 91 from the Wethersfield/Hartford town line to Interchange 29 has been included on the most recent SLOSSS List (2007-2009). The two sections include from the city limits to Interchange 28 (Sequence No. 1267) and from Interchange 28 to Interchange 29 (Sequence No. 656).

During 2008 through 2010, there were 529 crashes recorded on I-91 northbound from just north of the Wethersfield Cove to exit ramp on Interchange 29. Of the 529 recorded crashes, 136 were injury crashes with a total of 205 injuries (2 type "A" and 40 type "B" injuries). The crash types were 75% "rear-end", 12% "sideswipe – same direction" and 11% "fixed object".

Camera observations in the section south of Exit 29, shows that frequent queue-jumping occurs in the middle travel lane adding to the crash frequency and causing additional congestion for through vehicles.

At the approach to Interchange 27 (MP 35.40 to MP 35.6), crash data shows 81 crashes with 22 injury crashes and 29 total injuries. The higher than normal crash frequency appears to be related to congestion due to the lane drop.

A plan (PDF) summarizing the crash history in 0.1 mile increments will accompany this report. As is evident from the summaries, the accident frequency increases dramatically as we approach the Exit 29 ramp.

OTHER AREA OF CONCERN:

During the review of the project area, the following area of concern was identified but not addressed in the study:

- The I-84 and Route 15 merge in East Hartford
 - I-84 (3 travel lanes) merges to the south of Route 15 (2 travel lanes) to form a 5-lane expressway for approximately 1.5 miles until the I-84 and I-384 diverge with I-84 to the north of I-384. As a result, approximately 60% of vehicles are required to change lanes.

PROPOSED IMPROVEMENTS:

Widening of I-91 North from Interchange 27 to Interchange 29

In Alternatives 6C, 6D & 8A, the widening I-91 for approximately 4,300 feet to extend the four lane travel lane section from Interchange 27 to Interchange 29 will be required to relieve congestion, address significant safety concerns and provide an efficient I-91 to I-84 connection.

The 2011 Average Daily Traffic (ADT) on Northbound I-91 was recorded at 64,000 vehicles per day (VPD) prior to the lane-drop at Interchange 27 and 57,000 north of the lane-drop (approximately 11% volume reduction). The 2011 ADT on Northbound I-91 was recorded at 55,800 VPD prior to Interchange 29's exit ramp and 34,200 VPD after the ramp (approximately 39% volume reduction). Currently, the Level of Service (LOS) on I-91 drops from "D" to "E" at the lane drop at Interchange 27. In 2035, the LOS on I-91 north of Interchange 27 drops to "F" with vehicles exceeding 90 PC/lane/mile. At the approach to Interchange 27 (MP 35.40 to MP 35.6), crash data shows 81 crashes with 22 injury crashes and 29 total injuries (2007-2009 SLOSS Sequence No.1267). The higher than normal crash frequency may be related to merge difficulties and intermittent congestion.

Widening Route 15 North from the Charter Oak Bridge to the Silver Lane Underpass

In the subsequent section of this report, all alternatives provide an additional lane for exiting traffic from I-91 to Route 15. In Alternatives 6C, 6D and 8A, Route 15 will have 4 travel lanes on the eastbound approach to the Charter Oak Bridge. Due to the proximity of the 4 lane merge, alternatives 6C, 6D and 8A include widening Route 15 to three travel lanes from east of the Charter Oak Bridge to the Silver Lane underpass, then providing a lane-drop prior to its merge with I-84 East. With the lane drop at Interchange 90 (Routes 2 & 5), the remaining 3 travel lanes will need to be reduced to two prior to Route 15's merge with I-84. This proposed widening addresses capacity concerns on Route 15 and allows a more desirable distance from Interchange 29 on I-91 to merge from three travel lanes to two prior to its merge with I-84 East.

Currently this section of Route 15 has a "E" LOS in PM peak period. The existing cross-section on Route 15 east of the Charter Oak Bridge is approximately 50' wide. The length of the proposed widening of Route 15 is approximately 1 mile and the width of the proposed widening is approximately 6 feet, which allows for three 12-foot travel lanes and two 10-foot shoulders.

In Alternative 4, this section of Route 15 will not require widening.

ALTERNATIVES:

Alternative 1 – No Build

Alternative 4 – Ramp Relocation to Interchange 27

- Removes the existing Exit 29 ramp and relocates it approximately 1.4 miles to the south by combining it with Exit 27 ramp (Brainard Road) to form a two-lane exit.
- Provides a two-lane flyover connection to Route 15 North (without impacting Route 15 SB). This connection results in a 5-lane configuration for approximately 3,000 feet to its existing diverge for the I-91 northbound entrance ramp with 3 travel lanes on Route 15 to the left and the 2-lane I-91 entrance ramp to the right while maintaining the existing profiles of both. Existing three lanes on the Charter Oak Bridge is maintained.
- To accommodate this new 5-lane expressway section, four bridges would require replacement; Bridge #813 (I-91 over Route 15), Bridge #1466 (SB Route 15 ramp to Brainard Road over I-91), Bridge #480 (SR 530 – Airport Road – over I-91) and Bridge #815 (I-91 over Route 5/15). Northbound Route 5/15 would require realignment to accommodate the flyover section for the new ramp.
- The existing 2-lane entrance ramp from Brainard Road would merge to one lane prior to its merge with Route 5/15.
- This alternative would also require the removal of the existing Interchange 29 exit ramp which includes Bridge No. 6000C.
- A new SB exit ramp from I-91S to Airport Road could be considered during the development of the project's scope.
- Estimated cost range is between \$310 and \$330 Million.

Positives:

- Addresses congestion concerns on I-91, Route 15 and exit ramp from I-91 to Route 15.
- Addresses safety concerns on the subject section of I-91.
- Eliminates the vertical grade issues associated with the existing ramp.
- Minimizes weave on Route 15 (Charter Oak Bridge).

Negatives:

- Relatively high impacts to existing infrastructure and high costs
 - most expensive alternative

Anticipated Design Exceptions: None anticipated



Alternative 6C – Widen Existing Ramp and Eliminate the Route 2 Expressway Connection

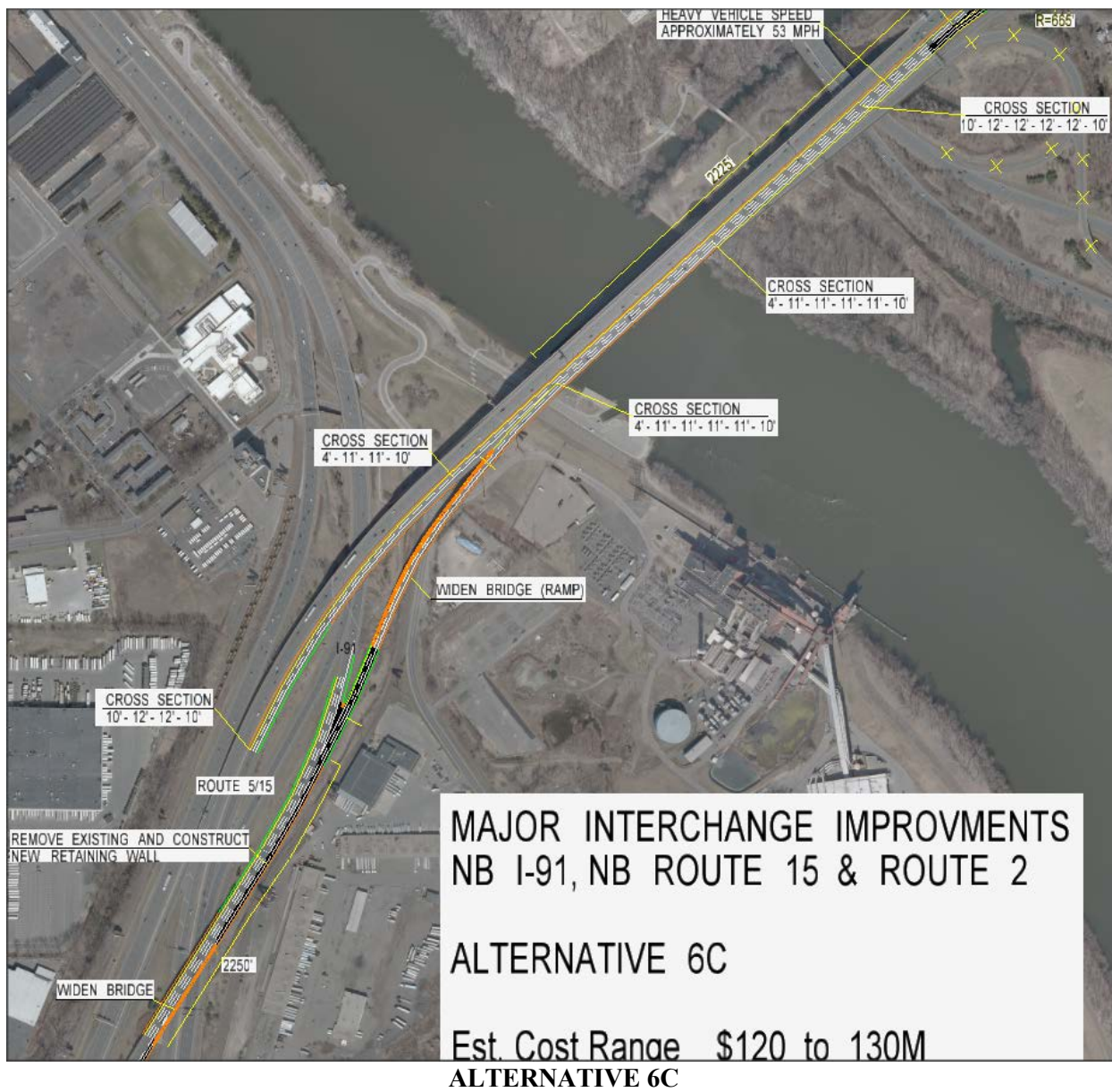
- Widens existing ramp to allow for a two-lane connection from I-91 North to Route 15 North.
 - Widening of Bridge No. 6000C required.
 - Widening of Bridge No. 375, (I-91 NB over RTE 5/15) for an auxiliary lane, which would start approximately 1,100 feet south of the Bridge No. 375 for a distance of approximately 2,500 feet.

- To avoid widening the Charter Oak Bridge, pavement markings modifications would be required from the entrance ramp gore for approximately 850 feet to allow a cross-section of a 4-foot shoulder (left), four 11-foot travel lanes and a 10-foot shoulder (right). The cross-section would transition to 10-foot shoulders (left & right) and 12-foot travel lanes on the remaining section of Charter Oak Bridge.

- To address concerns with the length of the ‘merge-diverge’ zone, the expressway to expressway connection to Route 2 would be severed and the exit ramp to Main Street/Route 5 (Interchange 90) would be realigned to extend the operational lane to 2,225 feet (extended to 1,458’ under Project No. 63-679).

- *It should be noted that the two-lane entrance ramp will require drivers on Route 15 to cross two lanes to access the exit ramp on Interchange 90 against higher entering speeds.* By severing the expressway access to Route 2, the demand for the exit ramp on Interchange 90 would be reduced by approximately 30%. Drivers could still access Route 2 via Interchange 90 by traveling north on Main Street then west on East River Drive Extension, approximately .7 mile. Drivers on Route 15 that prefer an expressway to expressway connection to Route 2 could access I-91 South at Interchange 86 to Route 3 (Putnam Bridge) to Route 2.

- The estimated cost for this alternative ranges between \$120 to \$130 million for the construction phase.



Positives:

- Addresses safety concerns on the subject section of I-91.
- Addresses congestion concerns on I-91, Route 15 and exit ramp from I-91 to Route 15.
- The widened 2-lane exit ramp allows for additional capacity and a climbing lane for heavy vehicles.
- Extends ‘merge-diverge’ zone on the Charter Oak Bridge to 2,225 feet (+ 767 feet)
 - Lowers the demand for Interchange 90 from Route 15 by 5% in the AM peak and 7% in the PM peak.
 - Allows heavy vehicles the distance required to merge into traffic at an acceptable speed (53+/- MPH).
- Eliminates safety concerns with left-entering ramp on Route 2.

Negatives

- The grade of the existing ramp significantly reduces the speed of heavy vehicles.
- Approximately 30%/AM Peak & 17% /PM Peak of NB Route 15 vehicles, which destined for Interchange 90 (Route 2/Route 5), are required to cross *two* lanes to access Route 2 exit ramp *against higher entering speeds from I-91*.
- Difficult political decision to close ramp to Route 2
- Increased traffic volumes on Main Street (Route 5) to access Route 2.

Anticipated Design Exceptions: Travel Lane & Shoulder Width

- To avoid widening the Charter Oak Bridge, a cross-section of 4' left shoulder, four 11-foot travel lanes and 10-foot shoulders are proposed for approximately 850 feet.

Alternative 6D – Widen Existing Ramp & Maintains the Route 2 Expressway Connection



ALTERNATIVE 6D

- This alternative mirrors Alternative 6C but maintains the expressway to expressway connection to Route 2.

Positives:

- Addresses safety concerns on the subject section of I-91.
- Addresses congestion concerns on I-91, Route 15 and exit ramp from I-91 to Route 15.
- Widened 2-lane exit ramp provides additional capacity and a climbing lane for heavy vehicles.

Negatives

- The grade of the existing ramp significantly reduces the speed of heavy vehicles.
- The length of the weave, from the entrance ramp from I-91 to the exit ramp to Route 2 and Main Street (Route 5), would remain at its existing length of 1,458 feet.
- Heavy vehicles merge into through traffic on Route 15 at a reduced speed (current condition).
- The current volume of weaving traffic will be maintained.
 - Approximately thirty percent of Route 15 traffic which is destined for Interchange 90 (Routes 2 & 5) has to cross ninety two percent (92%) of traffic entering from I-91 destined for I-84 Eastbound via Route 15.
- **Safety concern** - approximately 37% of AM Peak and 22% of PM Peak volumes on NB Route 15 vehicles destined for to Route 2 or Route 5 are required to cross *two* lanes within 1,458 feet to access Route 2 exit ramp **against higher entering speeds from I-91**. Gaps will be more difficult to find with the higher volumes and higher speeds.

Anticipated Design Exceptions: Travel Lane & Shoulder Width

- To avoid widening the Charter Oak Bridge, a cross-section of 4' left shoulder, four 11-foot travel lanes and 10-foot shoulders are proposed for approximately 850 feet.

Alternative 8A – Replace Exit Ramp with Major Diverge Configuration

- This preferred alternative eliminates the existing exit ramp and provides a major diverge on I-91 North just south of Bridge No. 815 (I-91 over Route 15). The four travel lanes would split into five lanes with three lanes to the right maintaining I-91 traffic over Bridge No. 815 (existing condition) and two lanes to the left via a new bridge over Southbound Route 15. The proposed location of the fork takes advantage of the crest vertical curve on I-91 which allows a 60 MPH Design Speed onto Route 15. The two entering lanes from I-91 would displace the two existing northbound lanes on Route 15. The existing lanes would be realigned to the east. Modification to the westerly terminus of the Charter Oak Bridge would be required to accommodate the four travel lanes.
- To avoid widening the Charter Oak Bridge, pavement markings modifications would be required for approximately 850 feet to allow a cross-section of a 4-foot shoulder (left), four 11-foot travel lanes and a 10-foot shoulder (right). The cross-section would transition to 10-foot shoulders (left & right) and 12-foot travel lanes on the remaining section of Charter Oak Bridge.
- Estimated cost range is from \$150 to 170 Million.



**ALTERNATIVE 8A
(PREFERRED ALTERNATIVE)**

Positives:

- Addresses safety concerns on the subject section of I-91.
- Addresses congestion concerns on I-91, Route 15 and exit ramp from I-91 to Route 15.
 - Eliminates reduced speeds of heavy vehicles due to steep vertical grades from I-91 onto the Charter Oak Bridge
 - Provides two lanes to provide for adequate capacity.
- Minimizes weaving traffic on Route 15 prior to Interchange 90 (Route 2/Route 5).
 - Entering traffic from I-91 is to the left of Route 15 traffic.
 - Only approximately 8% (170 PM Peak) of traffic from I-91 is destined for Interchange 90 as compared to 30% (670 PM peak) of traffic from Route 15.
- Extends ‘merge-diverge’ zone on the Charter Oak Bridge to 1,900 feet (+ 442 feet)
- Avoids modifications to Route 2 expressway connection.

Negatives:

- Traffic bound for I-84 via Route 15 is diverging left from I-91.

Anticipated Design Exceptions: Travel Lane & Shoulder Width

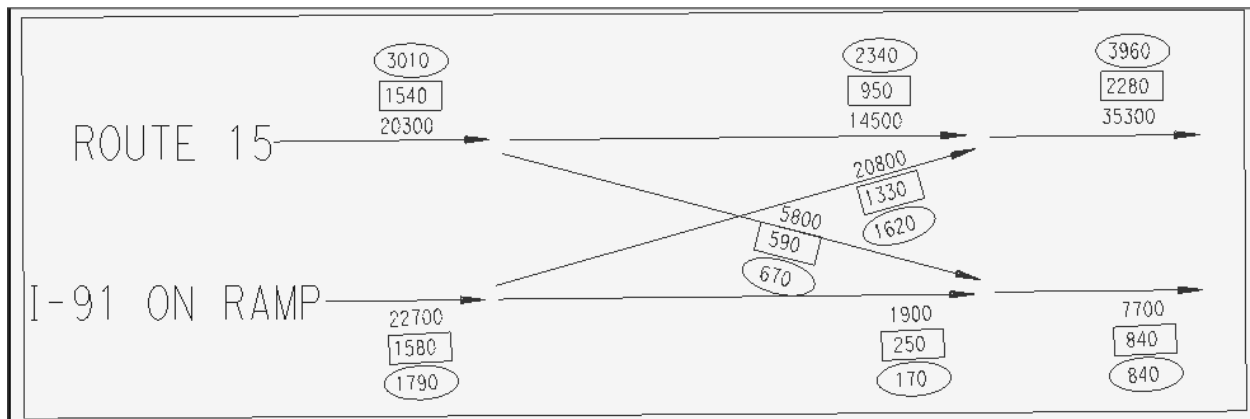
- To avoid widening the Charter Oak Bridge, a cross-section of 4’ left shoulder, four 11-foot travel lanes and 10-foot shoulders are proposed for approximately 850 feet.

Summary of Alternatives

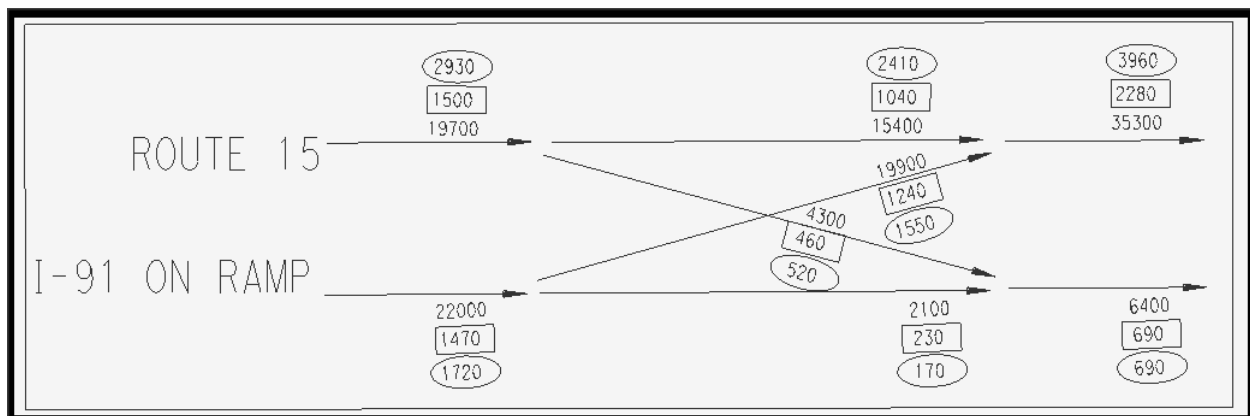
	ALT 4	ALT 6C	ALT 6D	ALT 8A
ADVANTAGES	Addressing all safety & capacity concerns	Addresses safety, capacity concerns on I-91 only.	Addresses safety, capacity concerns on I-91 only.	Addresses all safety & capacity concerns
DISADVANTAGES	Significant impacts to existing infrastructure. M&P challenges	Increased safety concerns in weave area on Route 15. Slow speeds of heavy vehicles.	Increased safety concerns in weave area on Route 15. Slow speeds of heavy vehicles	Left-handed diverge for RTE 15/I-84 traffic
EST COST RANGE	\$310 - 330 Million	\$120 - 130 Million	\$118 - 128 Million	\$150 - 170 Million

Comparison of Weave Section on the Charter Oak Bridge:

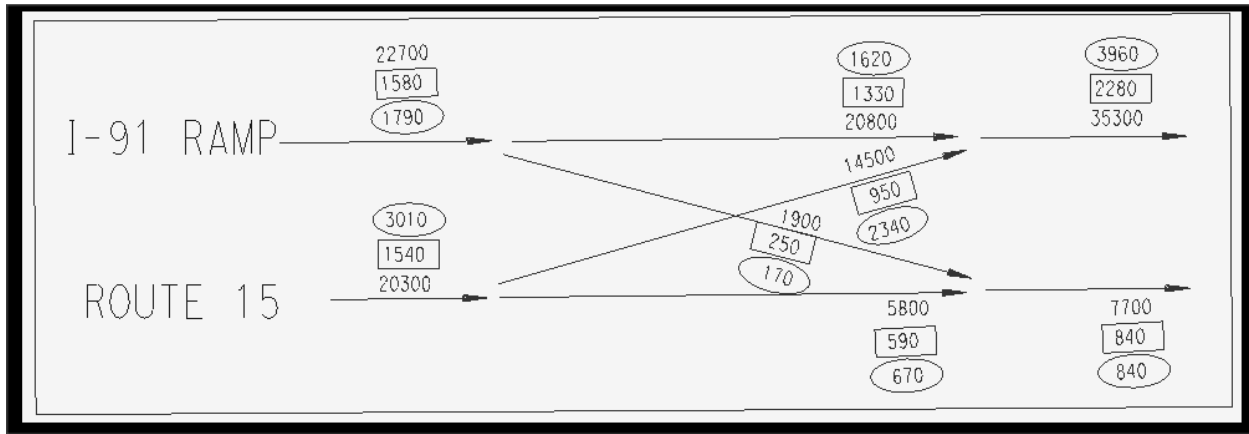
The following diagrams compare the various alternatives with their traffic volumes through the merge-diverge area on the Charter Oak Bridge.



EXISTING & ALTERNATE 6D



ALTERNATE 6C



ALTERNATES 4 & 8A

Recommended Alternative

After compiling data and developing the various alternatives, we recommend that Alternative 8A be the basis for improvements at Interchange No. 29. Although all alternatives address the congestion and related safety concerns on I-91, Alternative 8A minimizes the volume of weaving vehicles on the Charter Oak Bridge since traffic from I-91 enters Route 15 on the left. In addition, this alternative also minimizes speed reductions of heavy vehicles due to vertical grade. With Alternative 8A, the diverge is located just south of Bridge No. 815, I-91 over Route 15 and takes advantage of I-91's elevation to minimize the elevation difference to the Charter Oak Bridge. Including both the widening of I-91 from Interchange 27 to Interchange 29 and Route 15 to the Silver Lane underpass are natural conclusion limits for the proposed improvements.