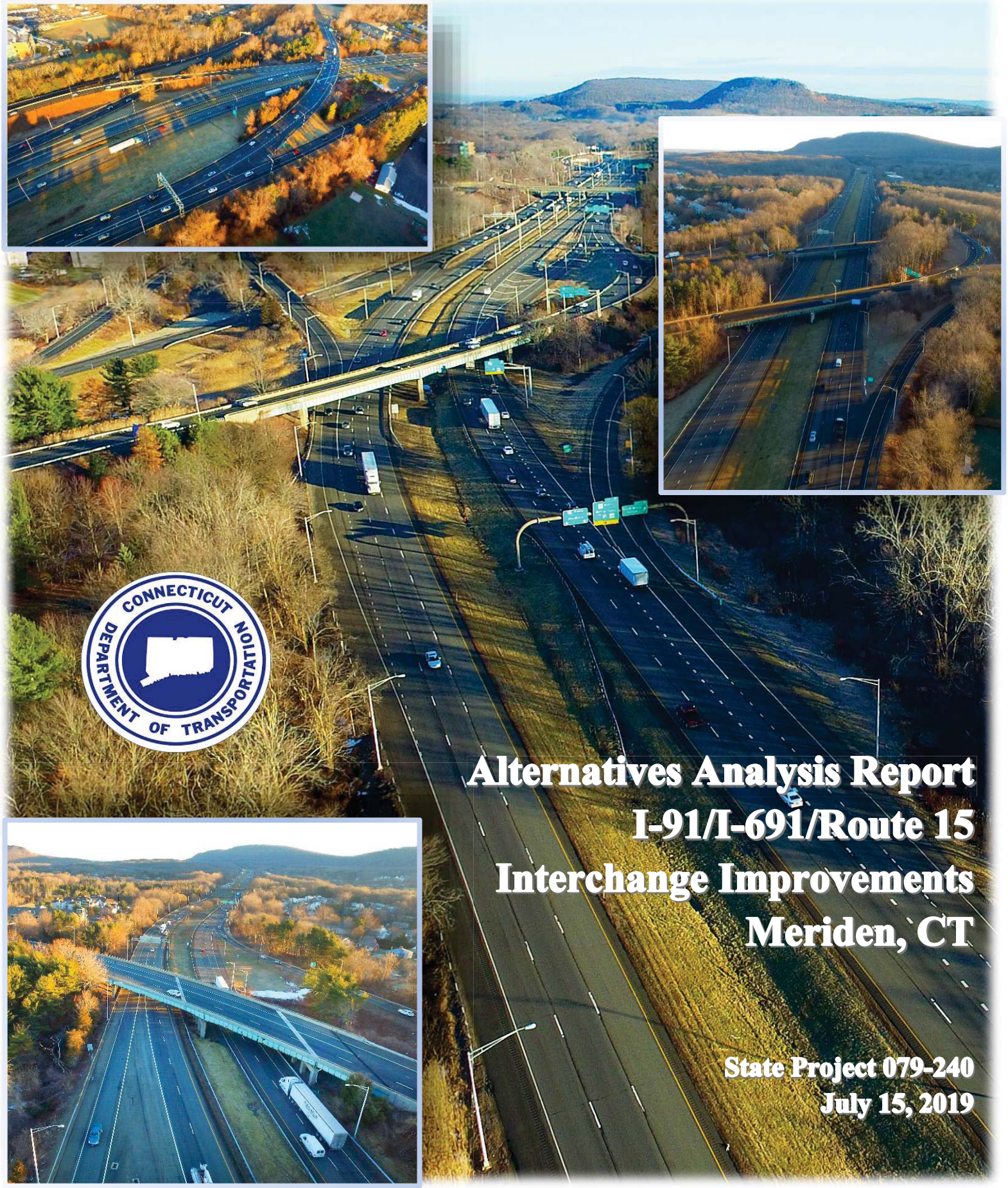


Alternatives Analysis Report
I-91/I-691/Route 15
Interchange Improvements
Meriden, CT

State Project 079-240
July 15, 2019

In association with:

PARSONS

GM2 ASSOCIATES

Terracon

GZA

PARSONS

Table of Contents

Table of Figures

List of Tables

Chapter 1 Introduction

1.1 PROJECT BACKGROUND

The I-91/I-691/Route 15 Interchange Improvement project (the project) was initiated by the Connecticut Department of Transportation (CTDOT) to address operational and safety concerns associated with capacity, congestion and weaving at the I-691 and Route 15 connections with I-91. The project is located in the cities of Meriden and Middletown, communities of approximately 60,000 and 48,000 residents respectively.

The I-91 southbound (SB) off-ramp to Route 15 routinely backs up due to its single-lane configuration and is often operating at or near capacity. The length of back-ups varies but has been observed to extend to as much as approximately one mile. I-91 northbound (NB) in the general area of the East Main Street on/off ramps experiences a notable number of crashes due to the number of on/off ramps and weaving. Route 15 NB experiences delays and crashes due to the weaving that occurs on this section of the highway between the East Main Street off-ramp and the I-91 NB off-ramp. This section of Route 15 carries vehicles entering from I-91 NB, as well as those attempting to access I-691, I-91 and Route 15 from East Main Street.

The Needs and Deficiencies study evaluated and documented both current and future conditions of the overall transportation system, traffic volume and operations, crashes and safety, roadway geometrics, structures, drainage facilities, hydraulics and hydrology and a variety of socioeconomic and environmental resources within and around the project corridor.

The purpose of this document is to describe the concept development process and document the analysis of the efficacy of these concepts to meet the project purpose and need. This report is a component of the on-going National Environmental Policy Act (NEPA) / Connecticut Environmental Policy Act (CEPA) documentation.

1.2 PROJECT STUDY AREA

As shown in Figure 1, the project study area generally encompasses the following corridor elements:

- I-91 between the rest area, just north of Exit 19 (MP 21.41) and Murdock Avenue overpass, just south of Exit 16 (MP 18.07), including Exits 16 through 19 (approximately 3 miles);
- I-691/Route 66 from Exit 8 (Broad Street) to Exit 12 (Preston Avenue) (approximately 2 miles);
- Route 15 between Baldwin Avenue and Miller Avenue, including Exits 67S, 67W, 67N, 68 N-E and 68 W (approximately 3 miles); and
- East Main Street between the on and off ramps from Route 15 and I-91.

1.3 SUMMARY OF EXISTING DEFICIENCIES

The I-91/I-691/Route 15 interchange experiences high traffic volumes and notable operational issues associated with capacity, congestion and weaving, resulting in areas with relatively high crash rates. These operational issues are identified and fully analyzed in the Needs and Deficiencies Report (draft submitted on 12/12/2017) of the project. As result of this analysis, the following Table 1 summarizes the most common and critical deficiencies:

Table 1: Summary of Existing Deficiencies

Criteria	Deficiency
LOS	Congestion on mainline and ramps
Weaving length	Substandard length for traffic weaving sections
Shoulder width	Substandard width of inside and outside shoulder
Stopping sight distance	Substandard length for stopping sight distance
Minimum radius	Substandard horizontal curve radius
Minimum grade	Some road sections do not meet the minimum grade
Vertical clearance	Substandard vertical clearance at bridges
Roadside clear zone	Roadside hazards inside the clear zone
Basic Number of lanes and lane balance	Basic number of lanes criteria not met
Interchange layout	Current interchange layout exhibits missing movements
Decision sight distance	Substandard length for decision sight distance

1.4 PROJECT PURPOSE

The purpose of this project is to reduce congestion and improve safety for all the travel movements within project study area. The two purposes are summarized as follows:

- Reduce traffic congestion to achieve a Level of Service (LOS) of D or better by design year 2051.
- Improve safety associated with crashes caused by congestion and weaving.

Figure 1: Project Study Area

Chapter 2 – Development of Solutions

This chapter details the outreach and development of preliminary solutions for addressing the needs of the I-91/I-691/Route 15 Interchange with the cities of Meriden and Middletown and at interagency meetings.

During the process of development of solutions, the following meetings were conducted with city officials and regulatory agencies to seek their input.

- City of Meriden on May 15, 2017, and April 10, 2018
- Interagency Coordination Meeting on September 21, 2017
- Cities of Meriden and Middletown on June 18, 2019

As the projects move forward, additional meetings, which will include public informational meetings, will be conducted as appropriate.

The project team will continue to identify individuals, groups and organizations potentially impacted by the outcome of these projects as the public outreach process continues. Meetings will be conducted as part of the CEPA scoping process as appropriate and when required.

The design solutions were developed through a series of internal design workshops hosted and attended by the Project Consultant team (Consultant) and discussions among the Consultant and CTDOT staff.

The Consultant conducted several workshops in September and October 2017. Discipline specific teams presented their ideas that served as a basis for developing full-build solutions. These solutions provided comprehensive geometric improvements and effective mitigation of the safety and congestion concerns. Following these workshops, a meeting was held with CTDOT and the Consultant on December 19, 2017 to review the preliminary full-build solutions.

While the full-build solutions were being revised to address CTDOT comments, during early 2018, CTDOT directed the Consultant to explore cost effective solutions that would address the congestion issues within the high priority deficiency location shown in Figure 6. Accordingly, several incremental solutions were developed for each corridor that were specifically tailored to address needs of the individual high priority locations. The solutions were developed to be constructed independent of other solutions and will have independent utility to improve traffic operations. However, these solutions will require design exceptions for existing substandard features, such as shoulder widths, vertical grades, etc., in the build scenario.

The following sections describe no build alternative, preliminary full-build and cost-effective solutions in detail.

2.1 NO BUILD ALTERNATIVE

The no build alternative was included for evaluation as a bench mark for the comparison of future conditions and impacts. The no build alternative would retain the existing roadways and ramps in their current configuration and allow for routine maintenance and safety upgrades.

As detailed in the Needs and Deficiencies Report, the traffic volumes are forecast to increase in the future which will lead to more severe congestion and associated safety concerns on all the roadways and ramps. Therefore, the no build alternative would not address the purpose of the project as identified in Section 1.4 Project Purpose.

2.2 FULL-BUILD SOLUTIONS

Several layouts were generated through workshops and coordination with CTDOT design units that were subsequently consolidated into four full-build solutions. The estimated construction costs of each of the four full-build solutions are between $300 and $500M.

2.2.1 Full-Build Solution #1: I-91 SB Express with Collector-Distributor

Full-build solution #1 consists of a new two lane exit ramp from Route 15 NB to I-91 NB, a collector-distributor road on I-91 SB between Preston Avenue and East Main Street, additional capacity on various ramps and reconstruction of East Main Street bridge over I-91 and Route 15. The construction cost for this concept is estimated to be $300 million. This solution is depicted in Figure 2, and its advantages and disadvantages are listed in the following Table 2:

Table 2: Full-Build Solution #1 - Advantages and Disadvantages

Advantages
• Eliminates weave between Route 15 NB and I-91 NB and I-691 WB
• Eliminates weave between E Main Street destined for I-91 NB and Route 15 NB traffic
• 1 Mile of Collector-Distributor road on I-91 SB to reduce merging/diverging on I-91 SB at exit to Route 15 SB
Disadvantages
• Full-reconstruction, without reusing existing highway elements
• Complex phasing and staging, with traffic impacts during construction
• Requires construction as a large, single project

2.2.2 Full-Build Solution #2: Route 15 & I-91 Separated

Full-build solution #2 consists of relocation of I-91 lanes to the east and Route 15 lanes to the west, relocation of I-691 WB to the north, relocation of East Main Street ramp to Route 15 NB, new two-lane exit ramp from I-91 SB to I-691 WB, new ramp from I-691 EB to I-91 NB, additional capacity on various ramps and reconstruction of the East Main Street bridge over I-91 and Route 15. The construction cost for this concept is estimated to be $400 million. This solution is depicted in Figure 3, and its advantages and disadvantages are listed in the following Table 3:

Table 3: Full-Build Solution #2 - Advantages and Disadvantages

Advantages
• Reconfigures Route 15 to the west and I-91 to the east
• Eliminate left hand entrance from I-691 EB to I-91 NB
• Semi-directional interchange at I-91/I-691
Disadvantages
• Full-reconstruction, without reusing existing highway elements
• Complex phasing and staging, with traffic impacts during construction
• Requires construction as a large, single project

2.2.3 Full-Build Solution #3: Route 15 & I-91 Separated and Collector-Distributor

Full-build solution #3 consists of relocation of I-91 lanes to the east and Route 15 lanes to the west, a new ramp from I-691 WB to I-91 SB, relocation of I-91 SB ramp to I-691 WB, addition of capacity on various ramps and reconstruction of East Main Street bridge over I-91 and Route 15. The construction cost for this concept is estimated to be $400 million. This solution is depicted in Figure 4, and its advantages and disadvantages are listed in the following Table 4:

Table 4: Full-Build Solution #3 - Advantages and Disadvantages

Advantages
• Reconfigures Route 15 to the west and I-91 to the east
• Semi-directional interchange at I-91/691
• C-D roads on I-91 NB & SB and I-691 EB & WB to separate through traffic from weaving traffic
Disadvantages
• Full-reconstruction, without reusing existing highway elements
• Complex phasing and staging, with traffic impacts during construction
• Requires construction as a large, single project

2.2.4 Full-Build Solution #4: Full Interchange

Full-build solution #4 is a fully directional interchange between I-91 and I-691 and it consists of relocation of I-91 lanes to the east and Route 15 lanes to the west, new ramp from I-91 SB to East Main Street and reconstruction of East Main Street bridge over I-91 and Route 15. The construction cost for this concept is estimated to be $500 million. This solution is depicted in Figure 5, and its advantages and disadvantages are listed in the following Table 5:

Table 5: Full-Build Solution #4 - Advantages and Disadvantages

Advantages
• Provides full directional interchanges at I-91/I-691 and Route 15/I-691
• Meets all the design criteria
Disadvantages
• Full-reconstruction, without reusing existing highway elements
• Complex phasing and staging, with traffic impacts during construction
• Requires construction as a large, single project

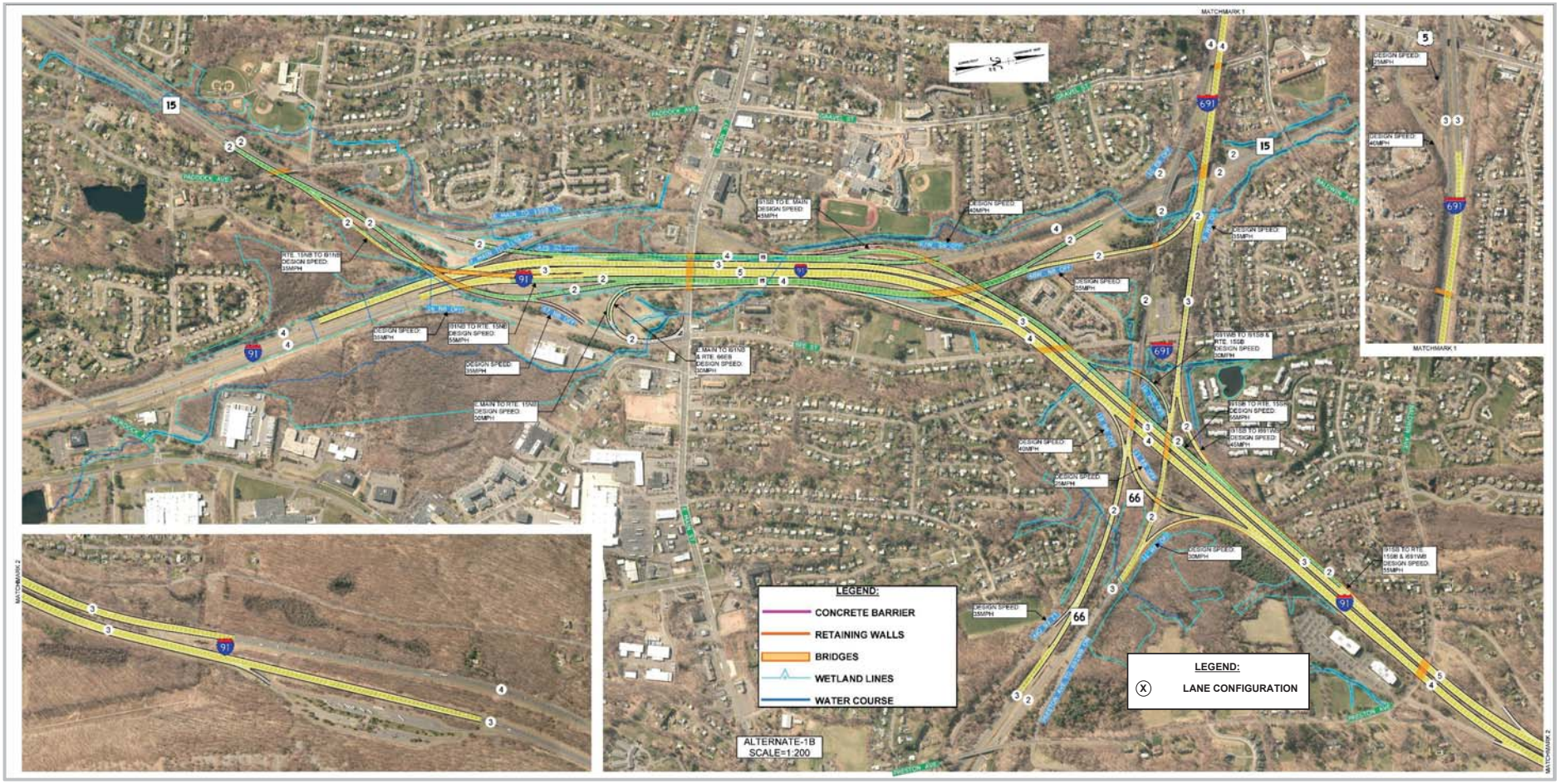


Figure 2: Full-Build Solution #1

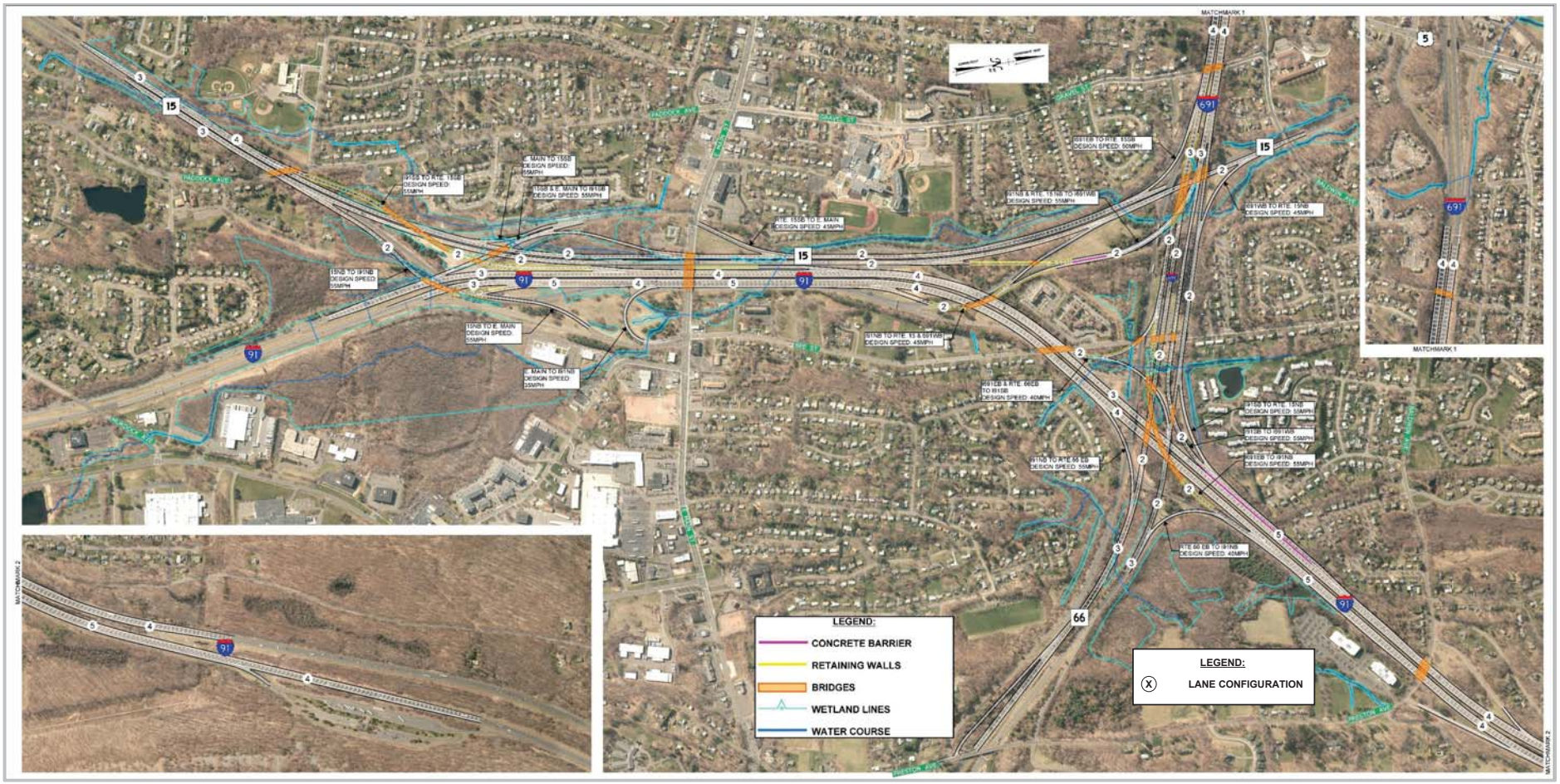


Figure 3: Full-Build Solution #2

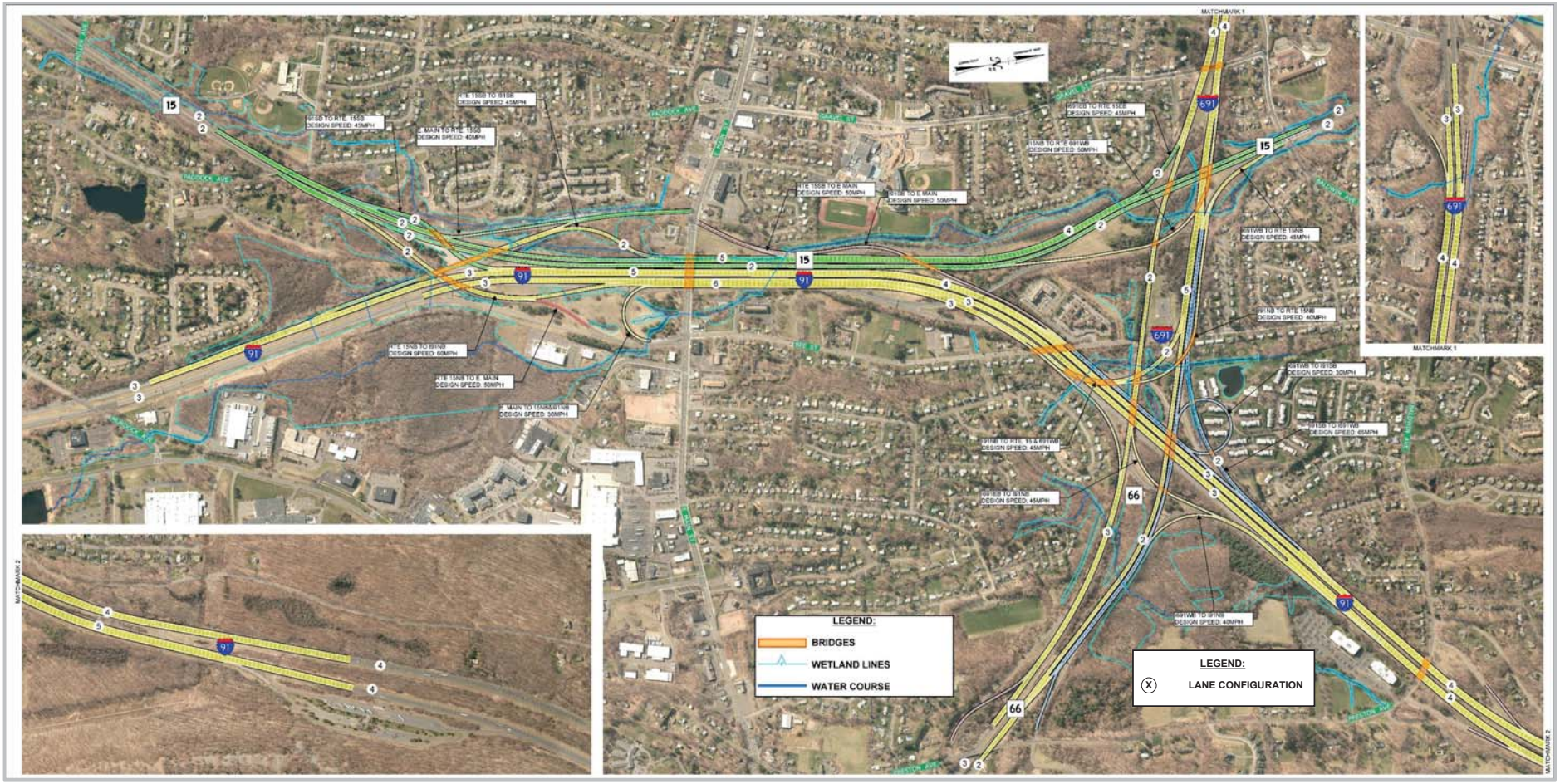


Figure 4: Full-Build Solution #3

Figure 5: Full-Build Solution #4

2.3 COST EFFECTIVE IMPROVEMENTS

In early 2018, due to budgetary constraints, CTDOT directed the Consultant to explore cost effective solutions. Even though each of the previous full-build solutions would address most of the operational and safety issues identified in the Needs and Deficiency Report, they also would have the following characteristics:

- Most of the existing roadways would have to be demolished
- Complex phasing and staging would result in traffic impacts during construction
- Right of way impacts would be required
- Construction as a single project would be necessary
- Estimated costs would exceed the available project budget

Due to these key characteristics, the project team proposed to address the operational and safety issues by dividing the project into critical segments. Solutions were developed with the following goals:

- Preserve existing transportation assets within the project limits to the extent possible
- Maintain existing East Main Street bridge over I-91 and Route 15
- Avoid encroachment on to Gethsemane Cemetery property
- Have independent utility to facilitate short-term or long-term phased construction

As with any project or proposed solution, minimization of traffic impacts during construction and rights-or-way impacts were also prioritized as goals.

Cost effective solutions were developed following the FHWA principles of Performance-Based Practical Design. As the first step to identify the required incremental improvements, five locations and traffic movements with high priority were established based on the crash data. These five segments are listed in Table 6 and depicted in Figure 6. These segments are numbered in order of priority.

Table 6: High Priority Segments

High Priority Deficiency	Location of the Traffic Movement
Traffic Movement #1	Route 15 NB
Traffic Movement #2	I-91 SB
Traffic Movement #3	Route 15 NB to I-691 Westbound (WB)
Traffic Movement #4	I-691 Eastbound (EB) to I-91 NB
Traffic Movement #5	I-691 EB to Route 15 SB

The following sections describe alternative concepts developed for each of the priority movements. The descriptions also include potential savings towards future maintenance costs of the existing facilities. These costs are associated with routine maintenance activities such as pavement rehabilitation, safety improvements, bridge repairs, etc. The intent of including these costs was to highlight the extent of expenses that the Department would have incurred if the proposed improvements were not constructed.

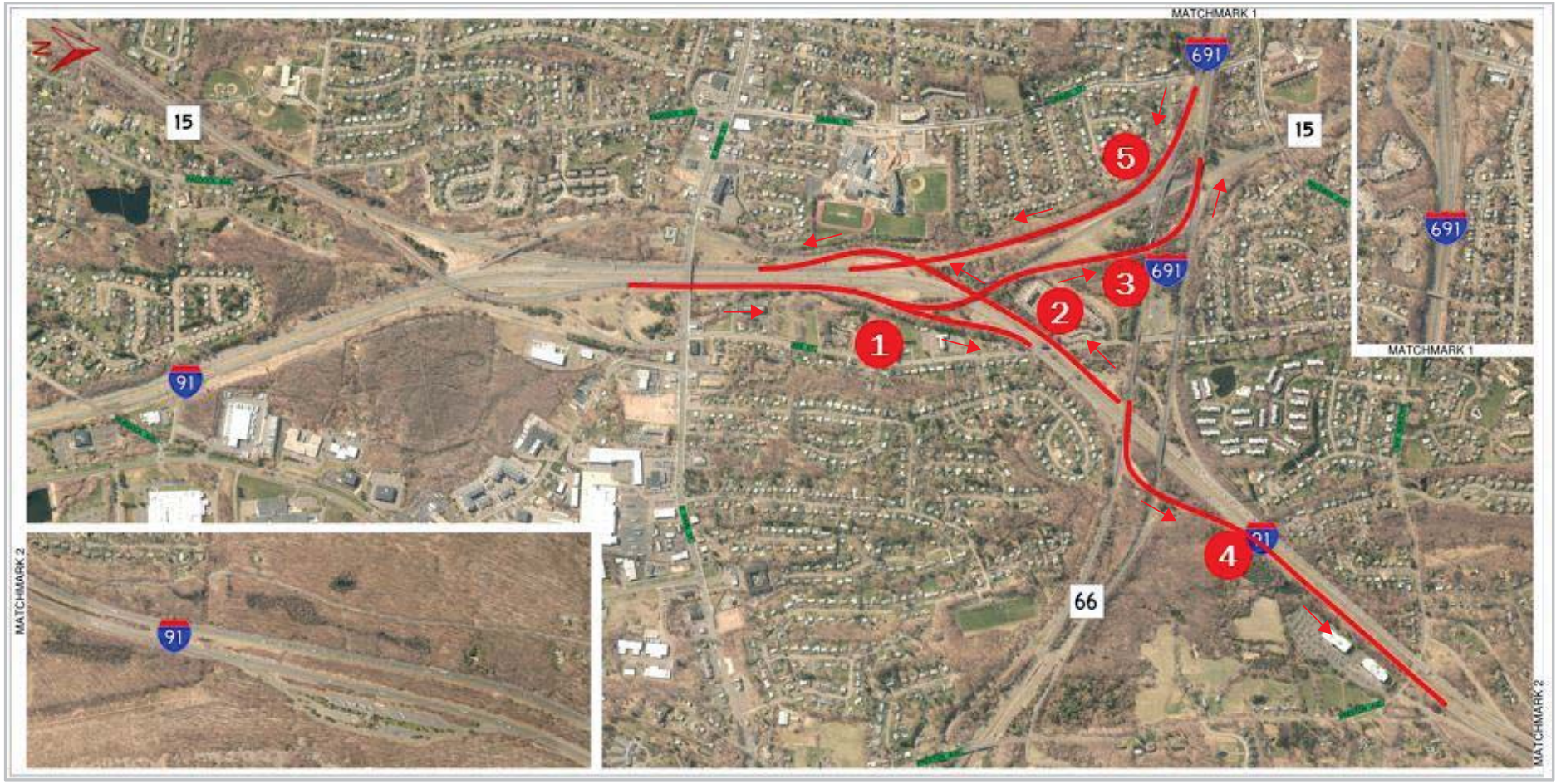


Figure 6: High Priority Deficiency Locations / Traffic Movements

2.3.1 Traffic Movement #1: Route 15 NB

Various solutions were investigated to address operational and safety concerns of this traffic movement and were narrowed down to the following four concepts:

2.3.1.1 Concept 1A

Concept 1A consists of the reconfiguration of the I-91 NB ramp to Route 15 NB, Route 15 NB ramp to I-91 NB and Route 15 NB off-ramp to E Main Street to address current weaving issues. The construction cost for this concept is estimated to be $35 million. This concept will result in estimated savings of $3 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 7 with the color coding classification of the key criteria, and its advantages and disadvantages listed in the following Table 7:

Table 7: Concept 1A - Advantages and Disadvantages

Advantages
• Addresses current weaving issues between Rt 15 NB traffic and E Main Street traffic
• Reconfigures existing Rt 15 NB off-ramp to E Main Street
• No impacts to minority and low income populations
• No impacts to right of way
• Minor impacts to water resources
Disadvantages
• Left merging of Exit 17 NB with Rt 15 NB
• Potential noise and aesthetic impacts
• Unique overhead signage may be required

2.3.1.2 Concept 1B

Concept 1B consists of the addition of one lane for the ramp from Route 15 NB to I-91 NB and addition of one lane on I-91 NB between its gore with the ramp from Route 15 NB and entrance ramp from I-691. The construction cost for this concept is estimated to be $10 million. This concept will result in estimated savings of $2 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 8 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 8:

Table 8: Concept 1B - Advantages and Disadvantages

Advantages
• Provides additional ramp capacity for Rt 15 to I-91 NB
• No impacts to minority and low income populations
• No impacts to right of way
• Minimal impacts to water resources
Disadvantages
• Does not address the weaving issues between Rt 15 NB traffic and E Main Street traffic
• Left merging of Exit 17 NB with Rt 15 NB
• Potential noise and aesthetic impacts

2.3.1.3 Concept 1C

Concept 1C consists of the construction of a new two-lane ramp from Route 15 NB to I-91 NB in the median of I-91 and reconstruction of the East Main Street bridge over I-91 and Route 15. The construction cost for this concept is estimated to be $75 million. This concept will result in estimated savings of $4 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 9 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 9:

Table 9: Concept 1C - Advantages and Disadvantages

Advantages
• Provides new connection for Rt 15 NB to I-91 NB traffic movement in median of I-91
• No impacts to minority and low income populations
• No impacts to right of way
• No impacts to water resources
• Noise abatement is not anticipated
Disadvantages
• Complex phasing and staging, with traffic impacts during construction

2.3.1.4 Concept 1D

Concept 1D consists of a new two-lane ramp from Route 15 NB to I-91 NB, reconfiguration of I-91 NB ramp to Route 15 NB and East Main Street, and reconstruction of Paddock Avenue bridge over Route 15. The construction cost for this concept is estimated to be $50 million. This concept will result in estimated savings of $6 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 10 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 10:

Table 10: Concept 1D - Advantages and Disadvantages

Advantages
• Addresses current weaving issues between Rt 15 NB traffic and E Main Street traffic
• Existing Rt 15 NB becomes an on-ramp to I-91 NB
• No impacts to minority and low income populations
• No impacts to right of way
• Minor impacts to water resources
Disadvantages
• Potential noise and aesthetic impacts

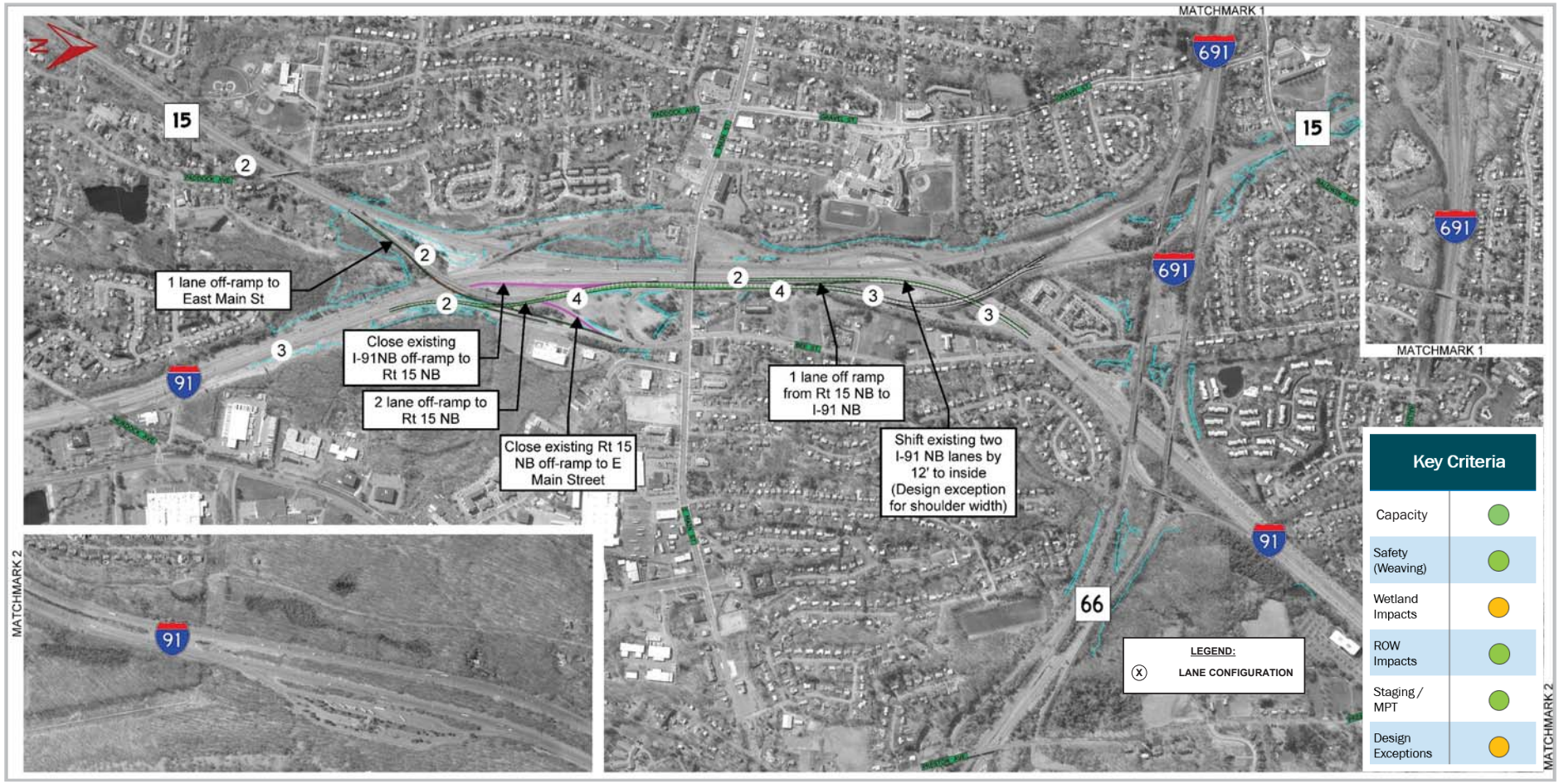


Figure 7: Concept 1A

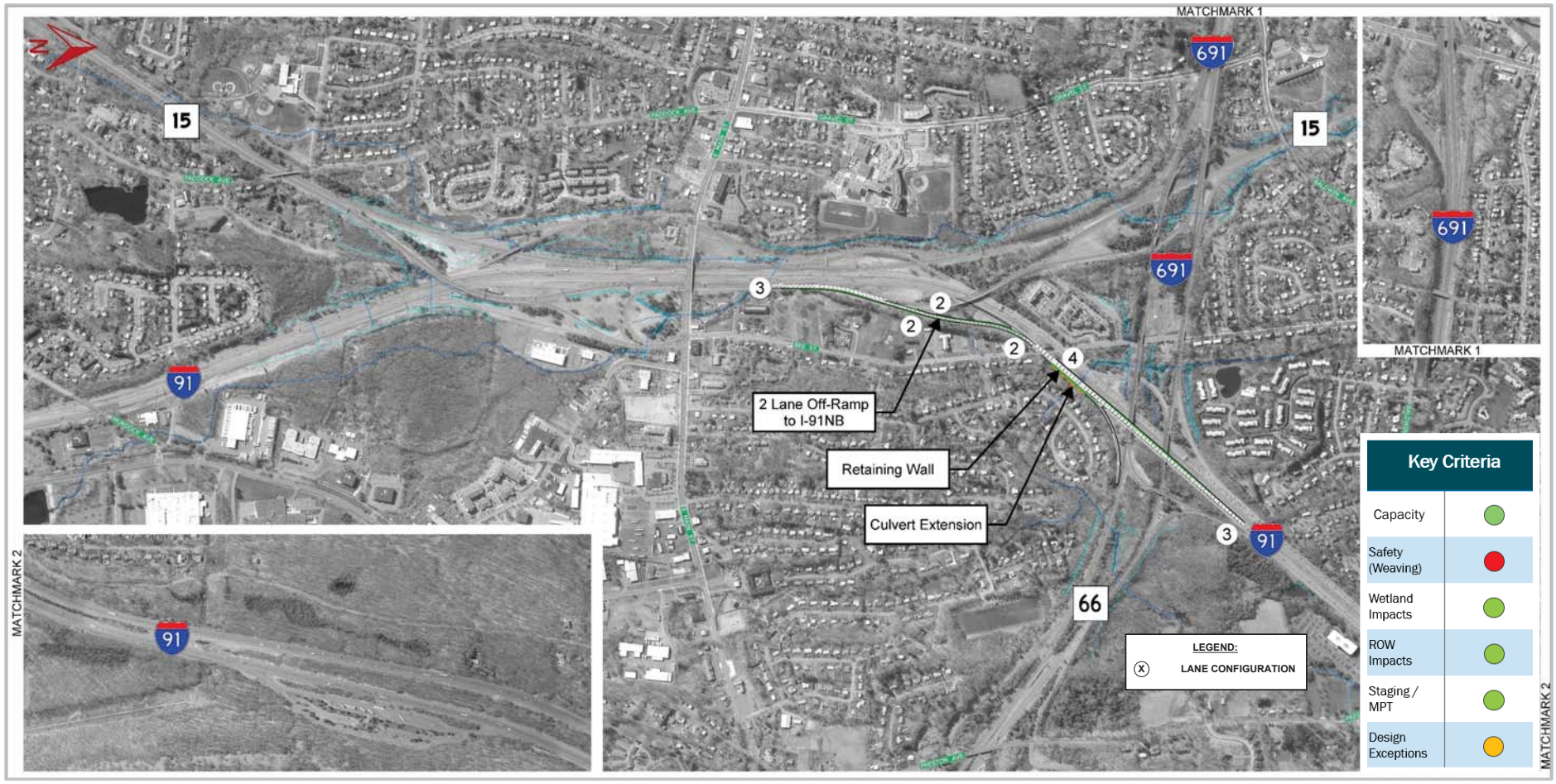


Figure 8: Concept 1B

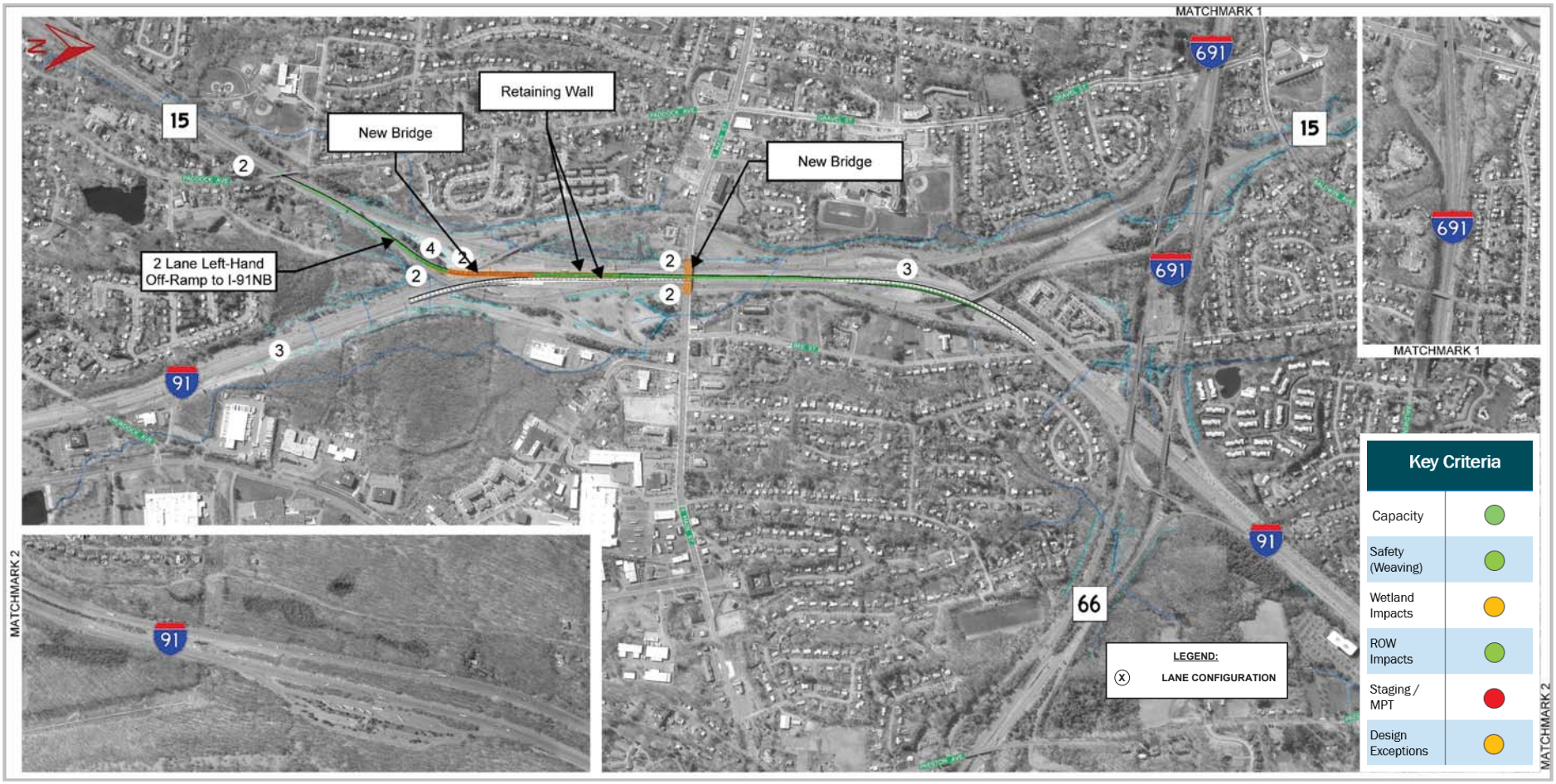


Figure 9: Concept 1C

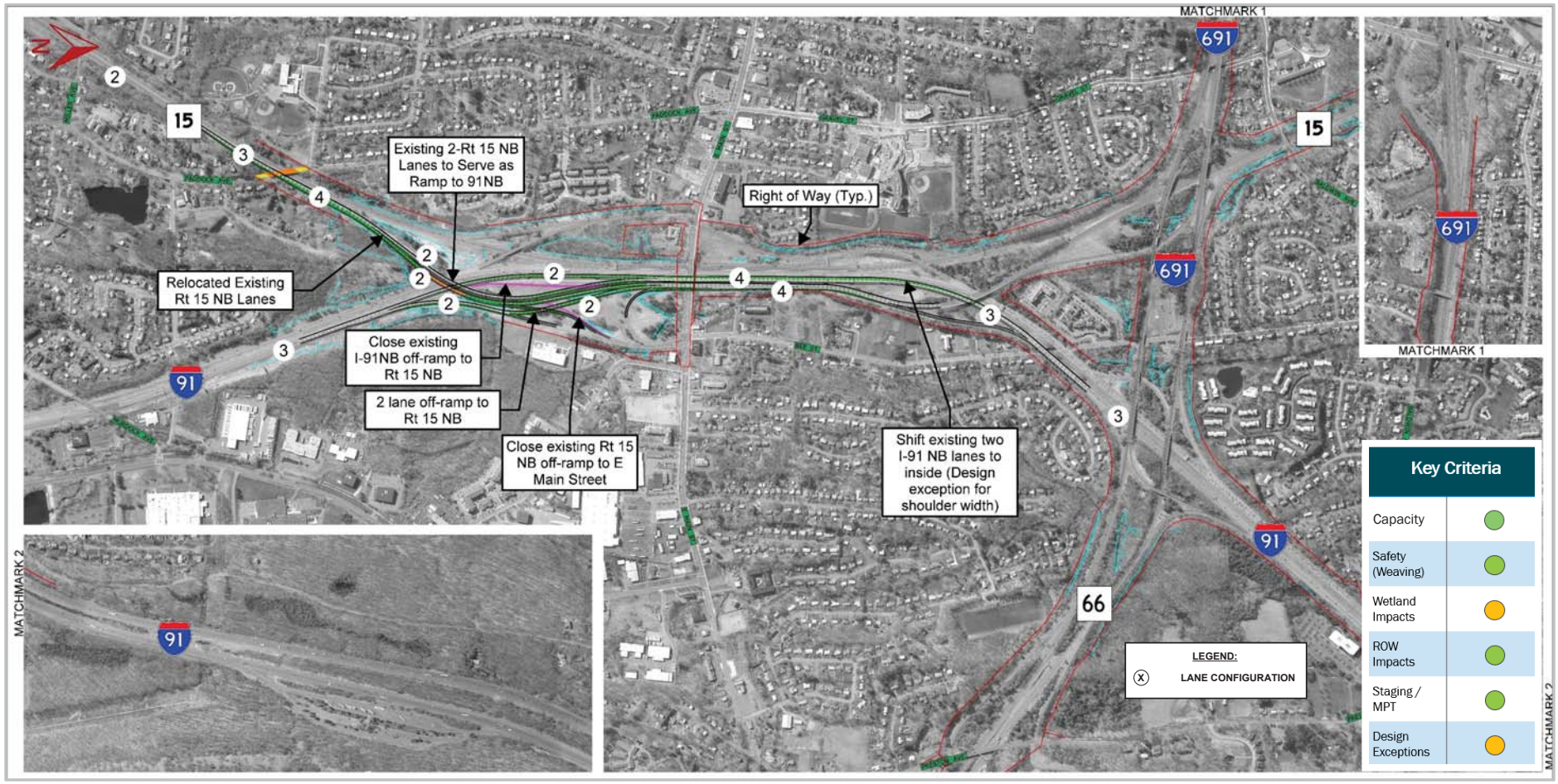


Figure 10: Concept 1D

2.3.2 Traffic Movement #2: I-91 SB

Various solutions were investigated to address operational and safety concerns of this traffic movement and were narrowed down to the following three concepts:

2.3.2.1 Concept 2A

Concept 2A consists of the addition of one lane on I-91 SB in the median, relocation of the ramp from I-91 SB to Route 15 SB, relocation of the ramp from Route 15 SB to I-91 SB and reconstruction of Paddock Avenue bridge over Route 15. The construction cost for this concept is estimated to be $50 million. This concept will result in estimated savings of $6 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 11 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 11:

Table 11: Concept 2A - Advantages and Disadvantages

Advantages
• No impacts to minority and low income populations
• Addresses current weaving issues between I-91 SB through traffic and traffic exiting to Rt 15 SB
Disadvantages
• Major impacts to water resources
• Minor impacts to right of way
• Potential noise and aesthetic impacts

2.3.2.2 Concept 2B

Concept 2B consists of the reconfiguration of I-91 SB to separate through traffic from merging and diverging traffic at its connections with I-691 EB/WB and Route 15 SB roadways. The construction cost for this concept is estimated to be $50 million. This concept will result in estimated savings of $8 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 12 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 12:

Table 12: Concept 2B - Advantages and Disadvantages

Advantages
• Separates I-91 SB through traffic from weaving traffic at I-691 and Rt 15 SB connections
• No impacts to minority and low income populations
• No impacts to right of way
• Minimal impacts to water resources
Disadvantages
• Snow removal and maintenance challenges for Express lanes
• Potential noise and aesthetic impacts

2.3.2.3 Concept 2C

Concept 2C is essentially an upgraded version of Concept 2A and it consists of the addition of one lane on I-91 SB in the median, addition of one lane on I-91 SB ramp to I-691 WB, relocation of the I-91 SB ramps to East Main Street and Route 15 SB and the ramp from Route 15 SB to I-91 SB which will potentially impact up to four acres of a forested wetland classified as a red maple swamp which may require a structure for impact minimization and reconstruction of Paddock Avenue bridge over Route 15. The construction cost for this concept is estimated to be $75 million. This concept will result in estimated savings of $8 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 13 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 13:

Table 13: Concept 2C – Advantages and Disadvantages

Advantages
• Revised concept 2A with new ramp from I-91 SB to E Main and addition of one lane on I-91 SB ramp to I-691 WB
• No impacts to minority and low income populations
• Estimated cost includes cost of Br. 01824 ($10 M) previously in #5A
• Adequate weave distance on I-91 SB between on-ramp from I-691 WB and off-ramp to E Main St
Disadvantages
• Minor impact to right of way
• Construction cost of this concept is higher than 2A and 2B.
• Potential impact to a palustrine forested wetland classified as a red maple swamp requiring mitigation.

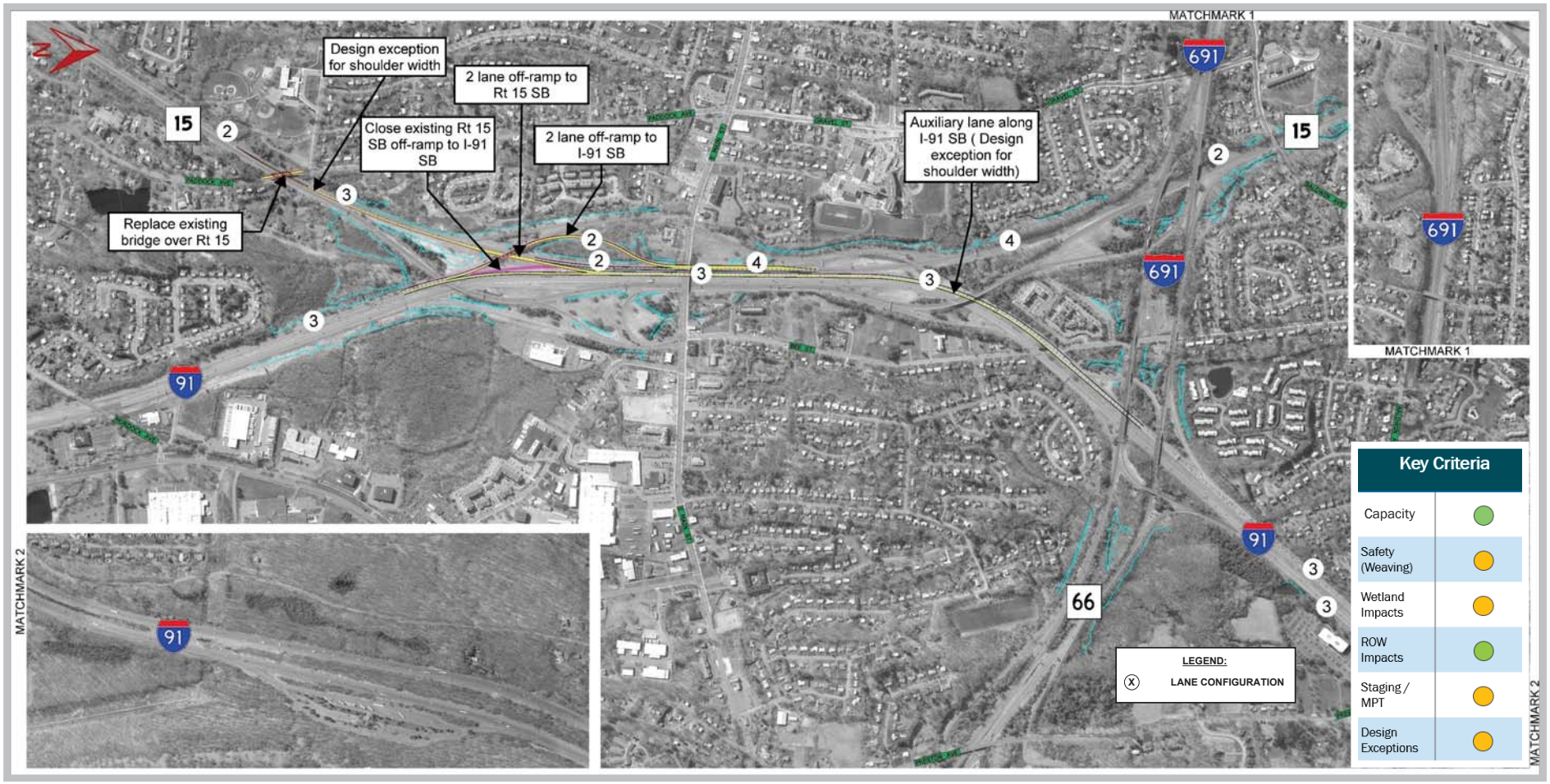


Figure 11: Concept 2A

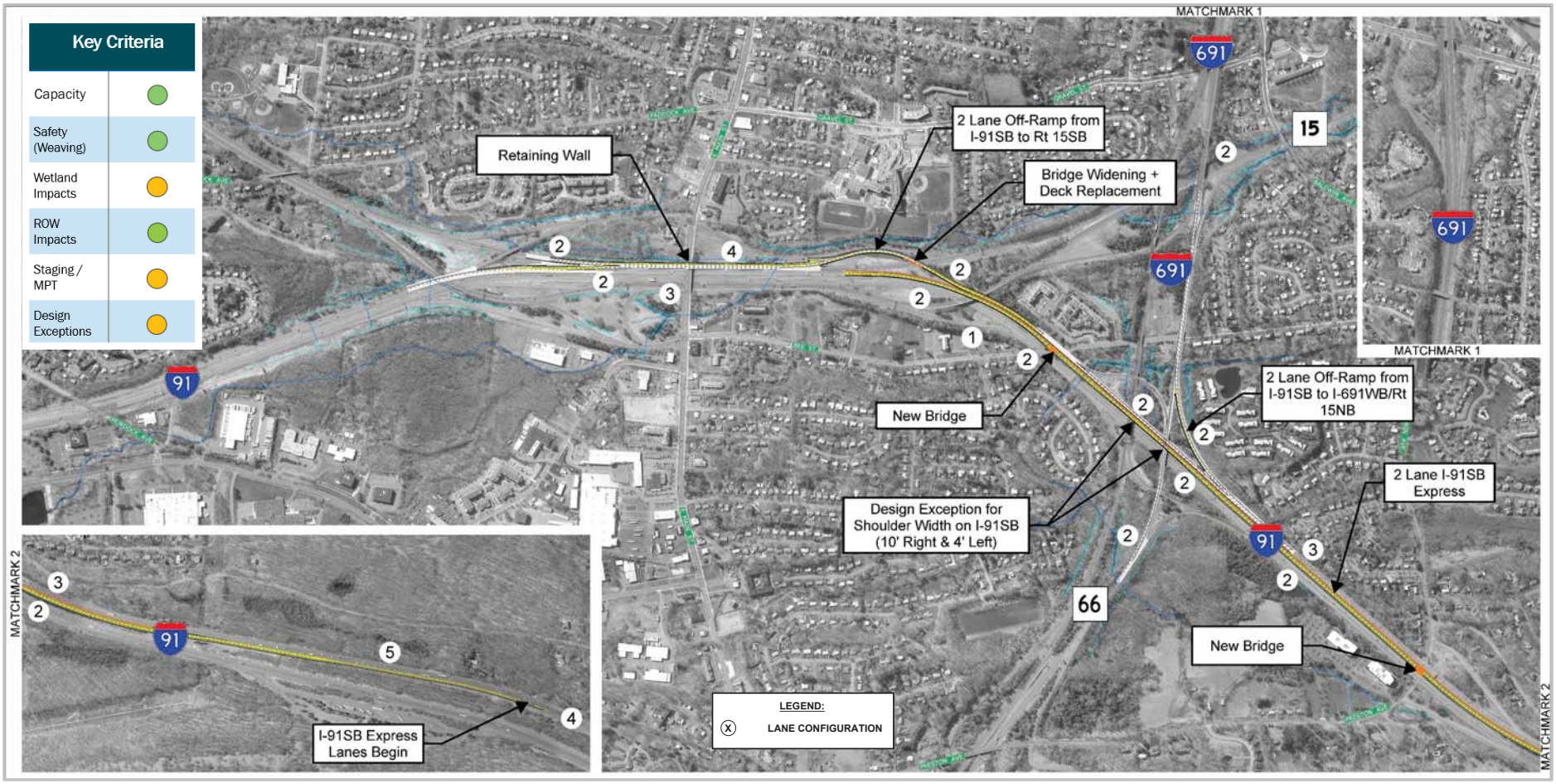


Figure 12: Concept 2B

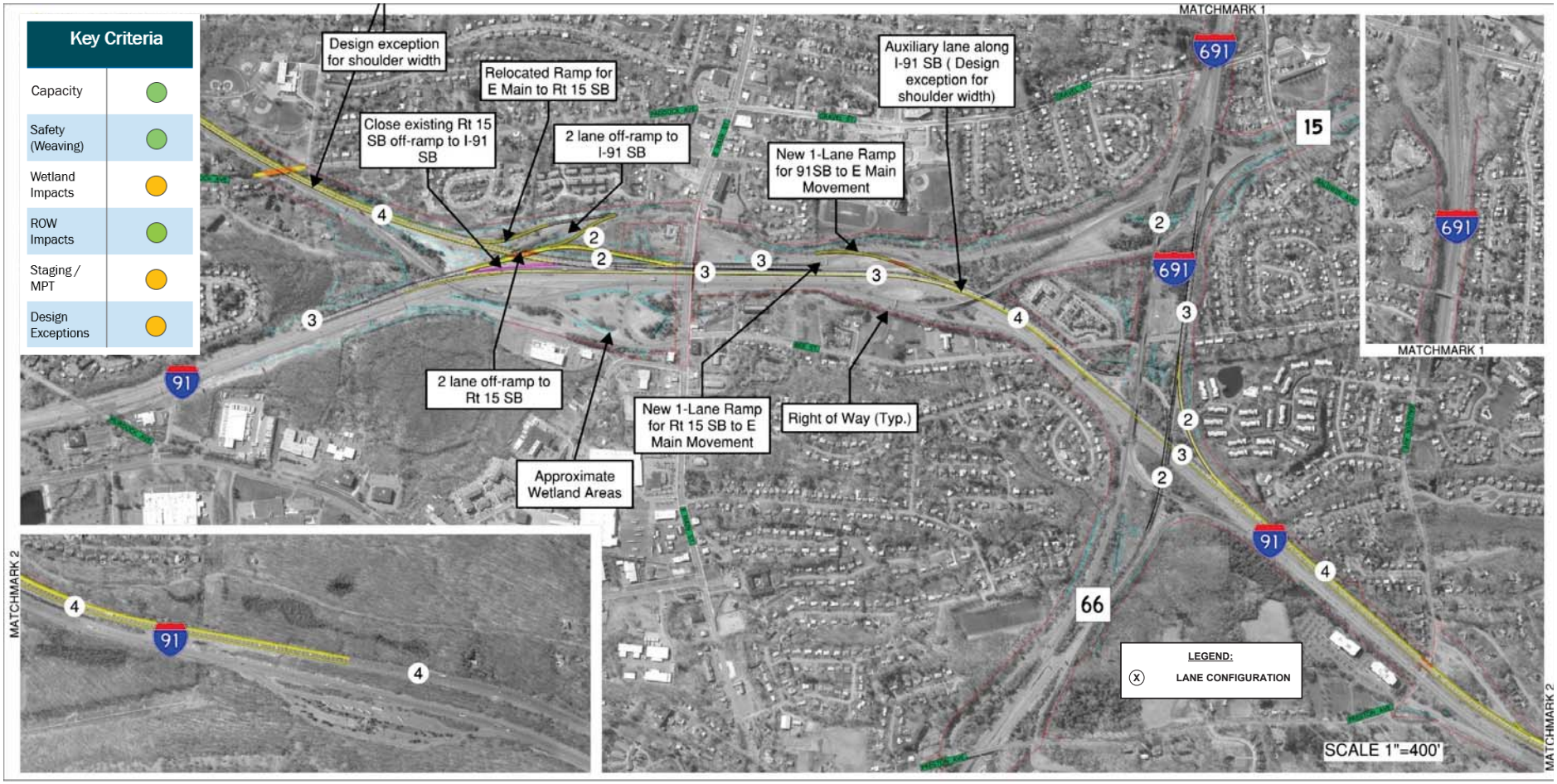


Figure 13: Concept 2C

2.3.3 Traffic Movement #3: Route 15 NB to I-691 WB

Various solutions were investigated to address operational and safety concerns of this traffic movement and were narrowed down to the following concept:

2.3.3.1 Concept 3

Concept 3 consists of the addition of one lane to the ramp from Route 15 NB to I-691 WB and widening of I-691 WB bridge over Route 15 and Gravel Street. The construction cost for this concept is estimated to be $20 million. This concept will result in estimated savings of $1 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 14 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 14:

Table 14: Concept 3 – Advantages and Disadvantages

Advantages
• Addresses current weaving issues on Rt 15 SB between off-ramp to I-91 NB and off-ramp to I-691 WB
• No impacts to minority and low income populations
• No impacts to right of way
Disadvantages
• Minor impact to water resources
• Potential noise and aesthetic impacts

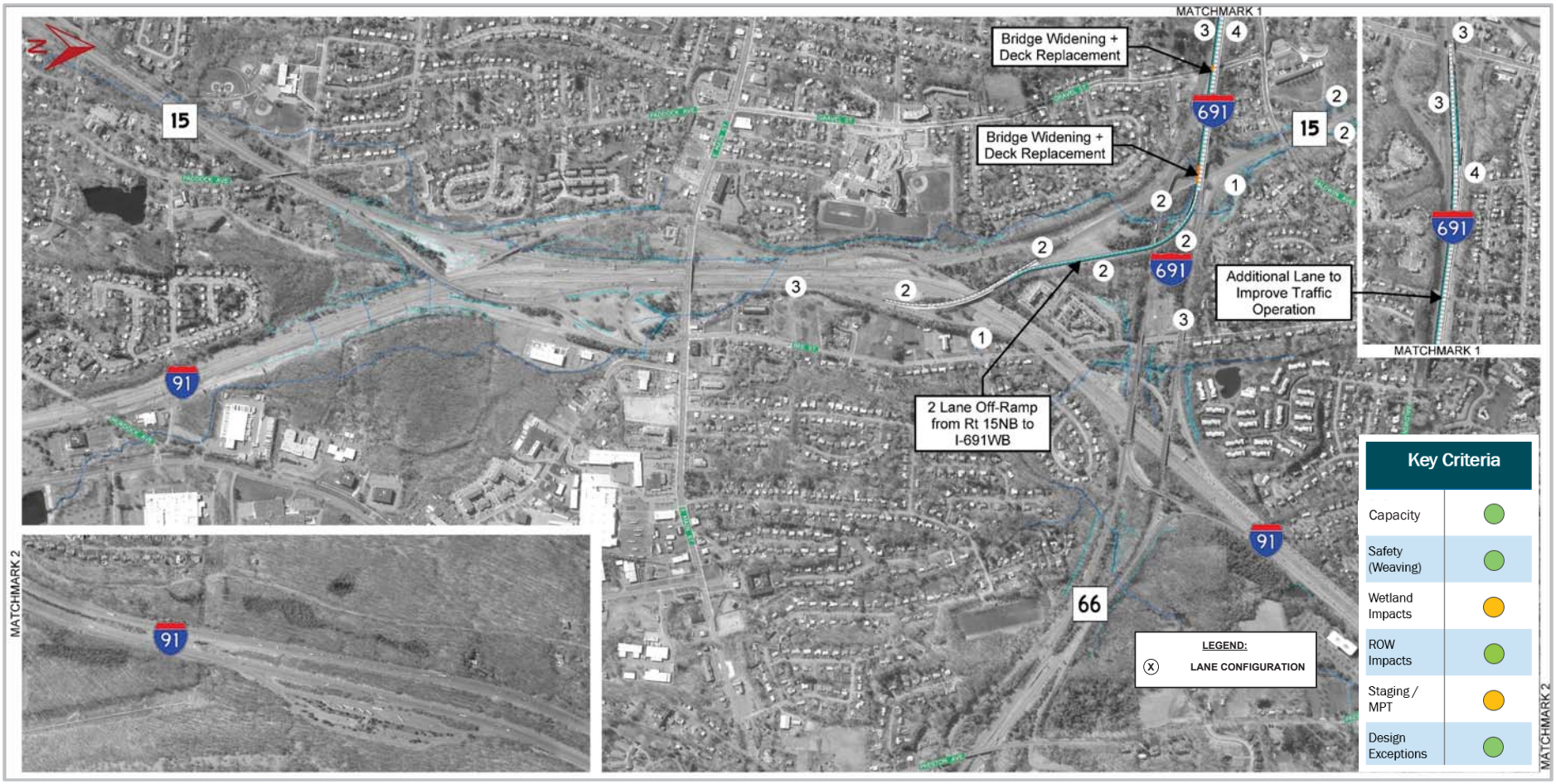


Figure 14: Concept 3

2.3.4 Traffic Movement #4: I-691 EB to I-91 NB

Various solutions were investigated to address operational and safety concerns of this traffic movement and were narrowed down to the following concepts:

2.3.4.1 Concept 4A

Concept 4A consists of the construction of a 2-lane off-ramp from I-691 EB to I-91 NB to provide additional ramp capacity and additional lane on I-91 to improve traffic operations. The construction cost for this concept is estimated to be $30 million. This concept will result in estimated savings of $7 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 15 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 15:

Table 15: Concept 4A – Advantages and Disadvantages

Advantages
• Addresses capacity concerns on I-91 NB from I-691 interchange to rest area
• No impacts to minority and low income populations
• No impacts to right of way
Disadvantages
• Minor impact to water resources
• Potential noise and aesthetic impacts

2.3.4.2 Concept 4B

Concept 4B consists of essentially the same elements of Concept 4A, except that the I-691 eastbound ramp to I-91 northbound is proposed to be re-aligned in this concept in order to fix an existing deficient curve radius. The bridge carrying the ramp will also have to be relocated. The construction cost for this concept is estimated to be approximately $36 million. This concept will result in estimated savings of approximately $7 million towards maintenance cost over the next 20 years. This concept is depicted in Figure 16 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 16:

Table 16: Concept 4B – Advantages and Disadvantages

Advantages
• Addresses capacity concerns on I-91 NB from I-691 interchange to rest area
• No impacts to minority and low income populations
• Addresses geometric deficiency of the existing ramp
• No impacts to right of way
Disadvantages
• Minor impact to water resources
• Potential noise and aesthetic impacts

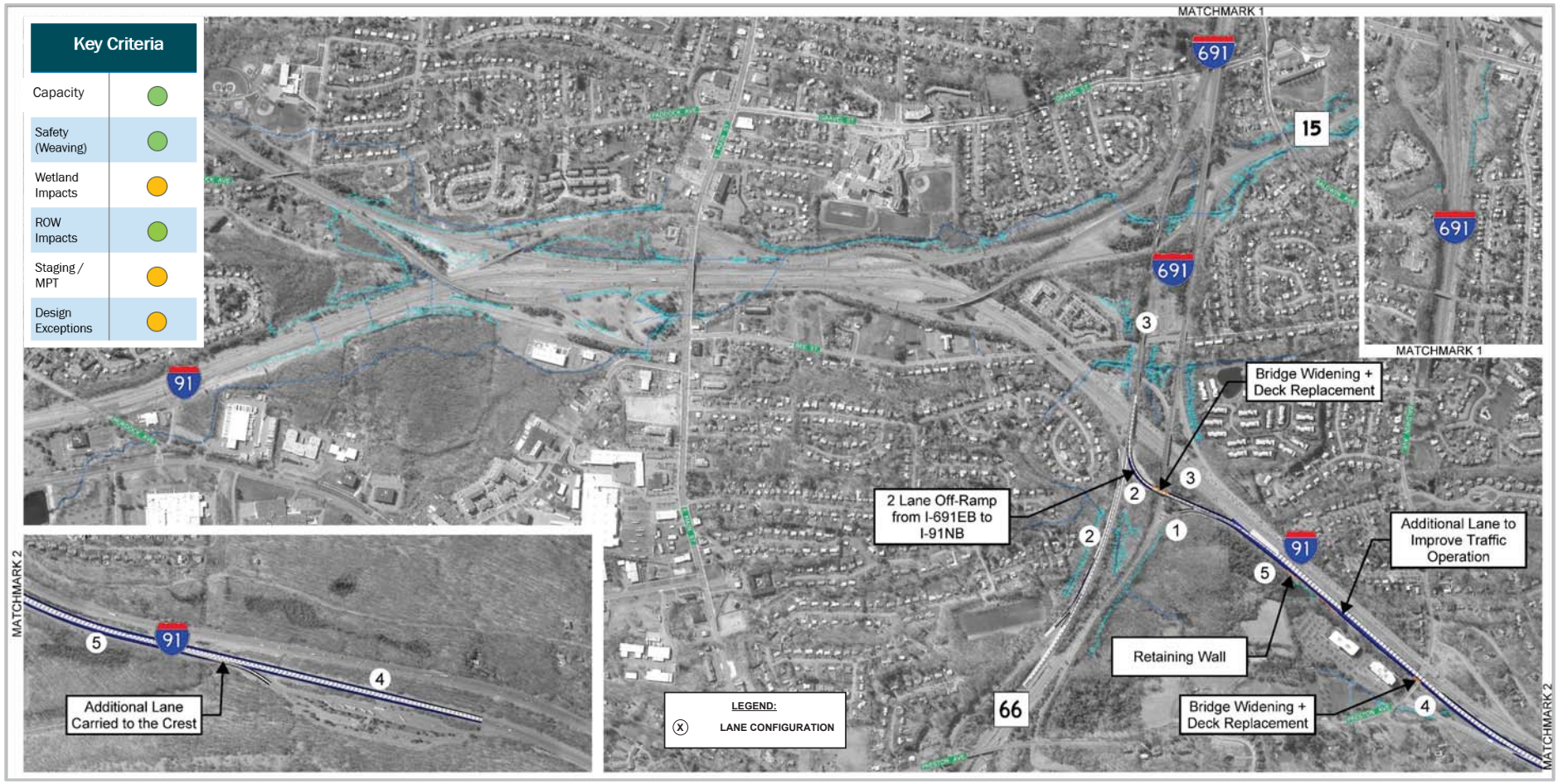


Figure 15: Concept 4A

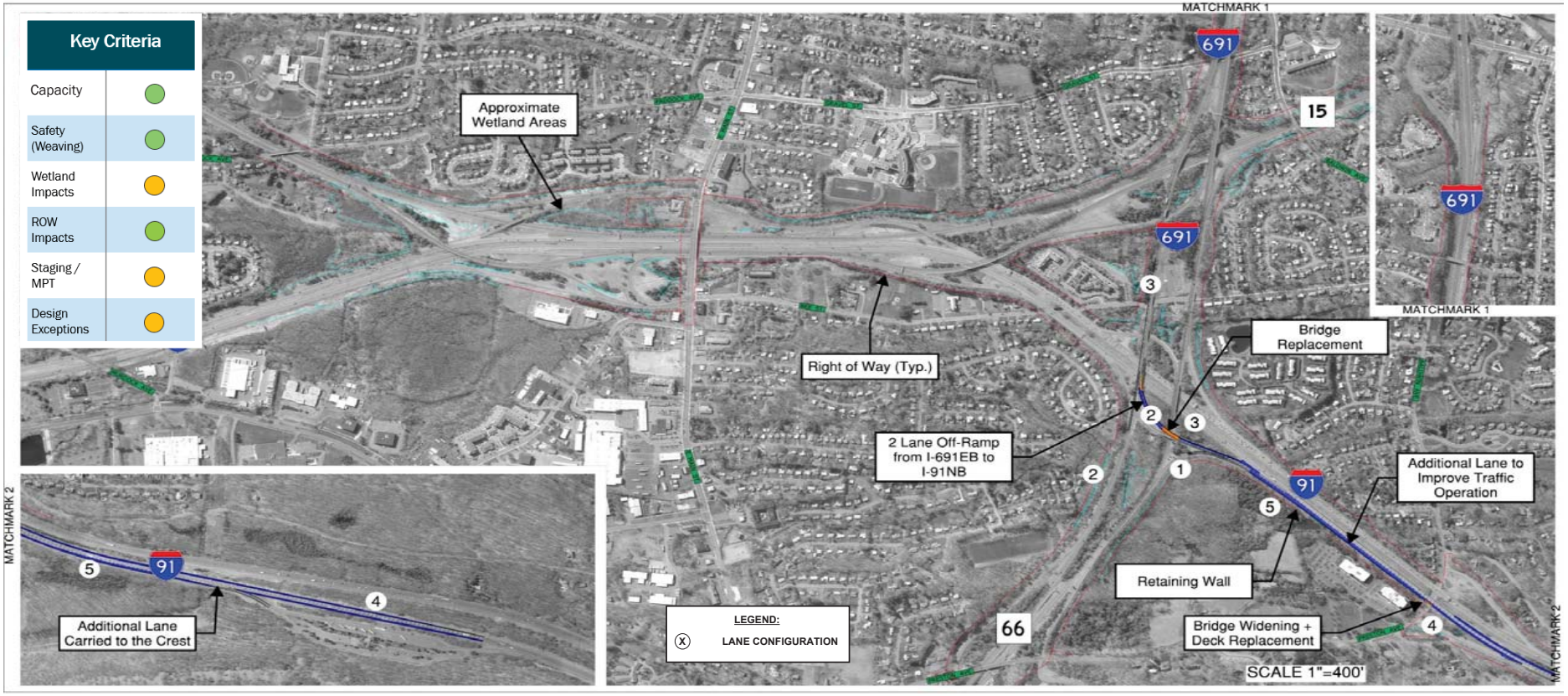


Figure 16: Concept 4B

2.3.5 Traffic Movement #5: I-691 EB to Route 15 SB

Various solutions were investigated to address operational and safety concerns of this traffic movement and were narrowed down to the following two concepts:

2.3.5.1 Concept 5A

Concept 5A consists of the addition of one lane to the ramp from I-691 EB to Route 15 SB, relocation of Route 15 SB ramp to East Main Street and reconstruction of the bridge carrying the exit ramp from I-91 SB to East Main Street over Route 15. The construction cost for this concept is estimated to be $10 million. This concept will result in estimated savings of $3 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 17 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 17:

Table 17: Concept 5A – Advantages and Disadvantages

Advantages
• This solution will function better when implemented in conjunction
• No impacts to minority and low income populations
• No impacts to right of way
Disadvantages
• Minor impact to water resources
• Potential noise and aesthetic impacts

2.3.5.2 Concept 5B

Concept 5B consists of the addition of one lane to the ramp from I-691 EB to Route 15 SB and reduction of one lane on Route 15 SB immediately north of its gore with the ramp from I-691 EB. The construction cost for this concept is estimated to be $5 million. This concept will result in estimated savings of $0.5 million towards maintenance costs over the next 20 years. This concept is depicted in Figure 18 with the color coding classification of the key criteria, and its advantages and disadvantages are listed in the following Table 18:

Table 18: Concept 5B – Advantages and Disadvantages

Advantages
• Rt 15 SB is reduced to one lane section at I-691 interchange
• No impacts to minority and low income populations
• No impacts to right of way
• No impact to water resources
Disadvantages
• Potential noise and aesthetic impacts

2.4 ANALYSIS OF CONCEPTS

As the concepts were developed at a preliminary level, the Highway Capacity Software (HCS) program was used to conduct a high level traffic analysis at the priority locations deemed as necessary. This information was used to refine preliminary concepts, so that limitations identified by the HCS analysis can be addressed to the extent possible.

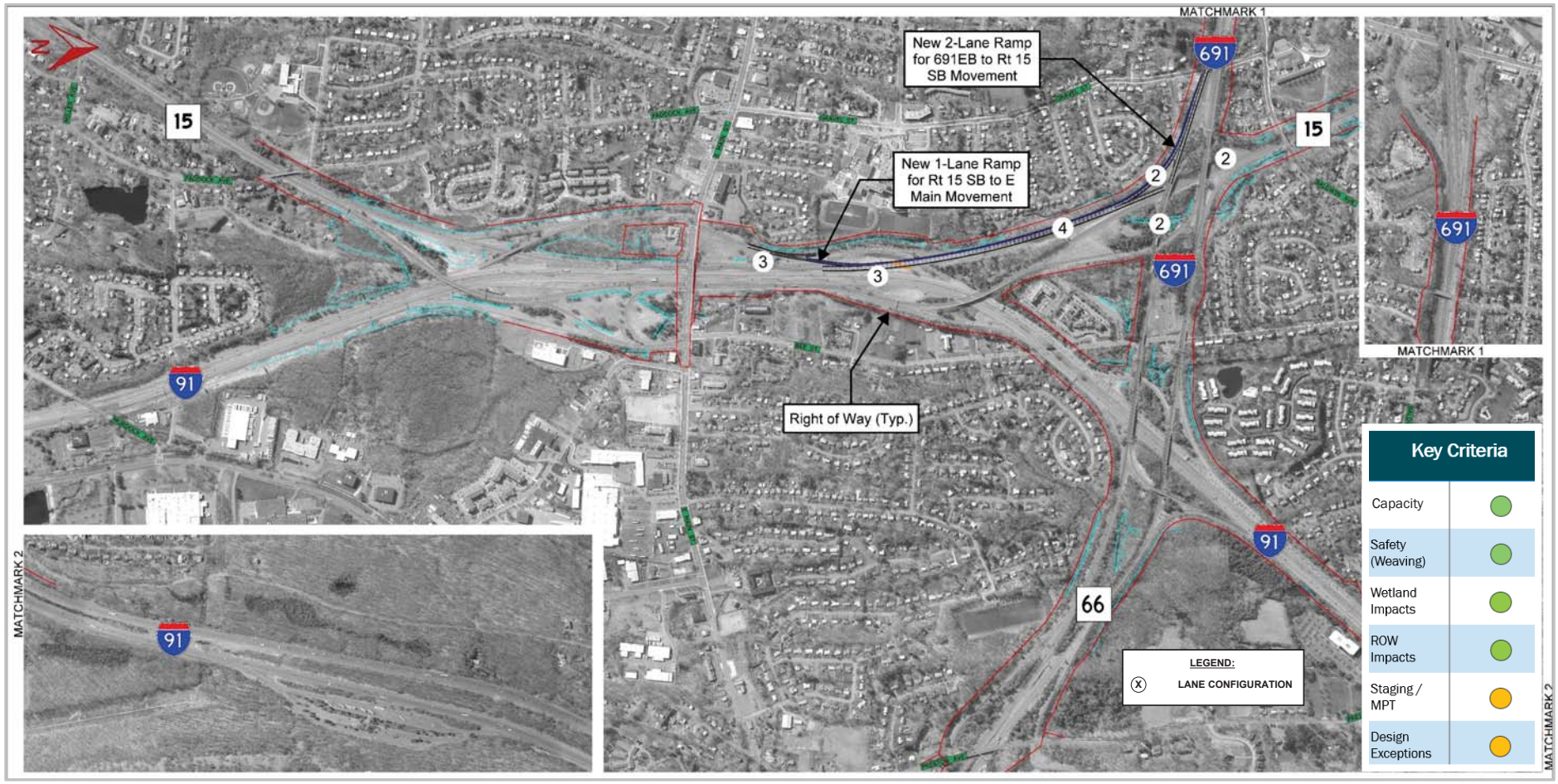


Figure 17: Concept 5A

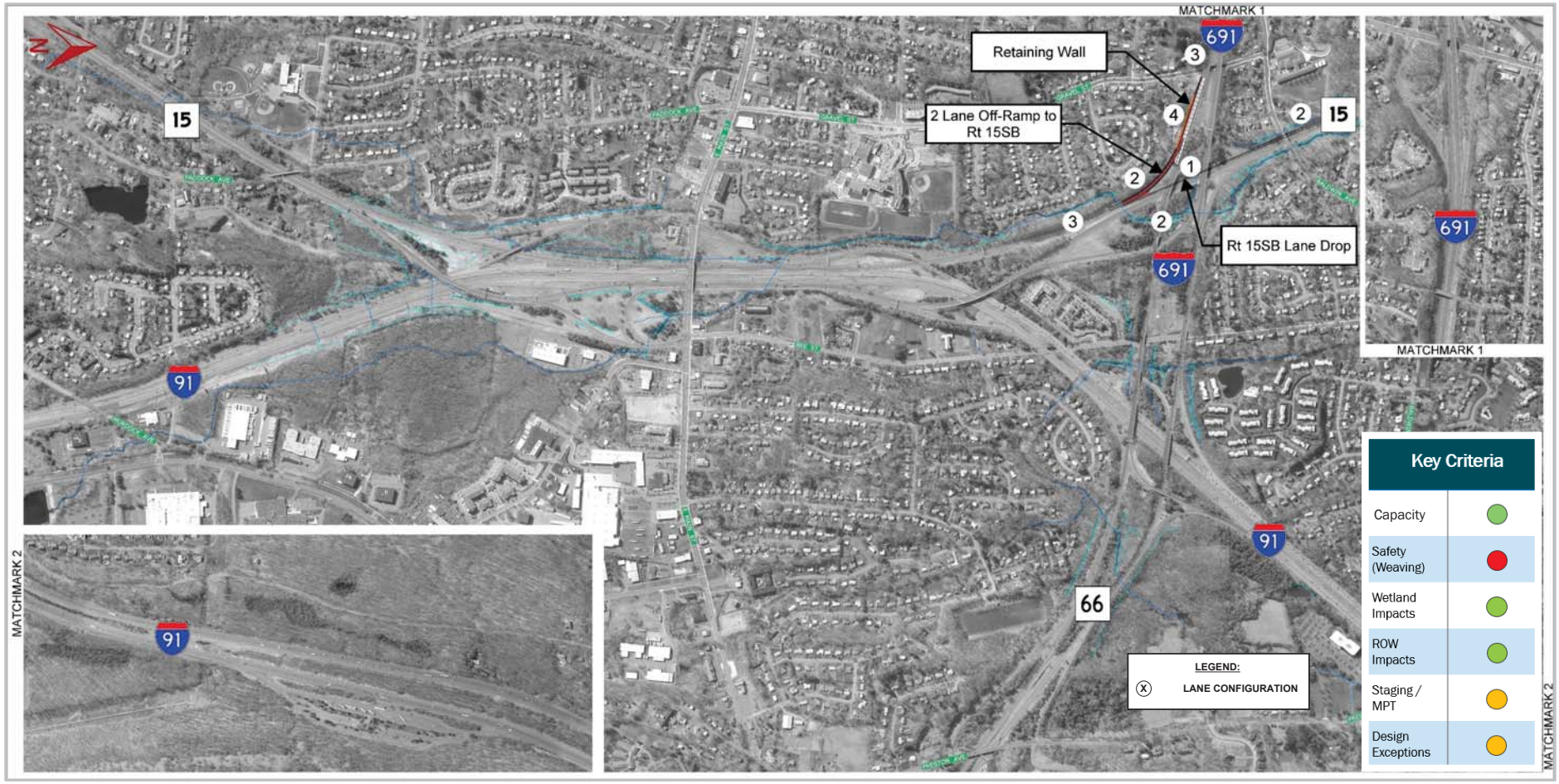


Figure 18: Concept 5B

Chapter 3 – Recommendations

Comparison of the results of various analyses indicate that the following solutions would best satisfy the two primary purposes of this project:

- Reduce traffic congestion to achieve LOS of D or better by 2051
- Improve safety associated with crashes caused by congestion and weaving

These solutions preserve the existing transportation assets to the extent possible and can be constructed with minimal disruption to traffic and minimal right of way impacts.

Depending upon the traffic movement served, the solutions were classified into three groups, as shown in Table 19:

Table 19: Projects Improvements

#	Projects	Selected Alternative	
1	Northbound Improvements	Concept 1	Route 15 NB
		Concept 3	Route 15 NB to I-691 WB
2	Southbound Improvements	Concept 2	I-91 SB
		Concept 5	I-691 EB to Route 15 SB
3	I-691 EB to I-91 NB Improvements	Concept 4	I-691 EB to I-91 NB

3.1 PROPOSED IMPROVEMENTS BY CORRIDOR

3.1.1 Northbound Improvements

After the evaluation of the advantages and disadvantages described in the Section 2.3 Cost Effective Improvements, the concepts providing optimal benefits have been designated to be the selected concepts for the Northbound Improvements, as selected in Table 20, and depicted in Figure 19.

Table 20: Northbound Improvements

	Traffic Movement	Concept	Selected Concept	Name of Selected Concept	Project
1	Route 15 NB to I-91 NB	1A		Concept 1	Northbound Improvements
		1B			
		1C			
		1D	*		
3	Route 15 NB to I-691 WB	3	*	Concept 3	

* Selected Concept

Concept 1D was selected because it separates the Route 15 NB through traffic from Route 15 NB to I-91 NB traffic. The estimated construction duration of the Northbound Improvements is 26 months.

3.1.2 Southbound Improvements

After the evaluation of the advantages and disadvantages described in the Section 2.3 Cost Effective Improvements, the concepts providing optimal benefits have been designated to be the selected concepts for the Southbound Improvements, as selected in Table 21, and depicted in Figure 20.

Table 21: Southbound Improvements

Traffic Movement		Concept	Selected Concept	Name of Selected Concept	Project
2	I-91 SB to Route 15 SB	2A		Concept 2	Southbound Improvements
		2B			
		2C	*		
5	I-691 EB to Route 15 SB	5A	*	Concept 5	
		5B			

* Selected Concept

Concept 2C was selected because it addresses the weave distance between entrance ramp from Route 66 WB and exit ramp to East Main Street and it separates the I-91 SB traffic destined for East Main Street and Route 15 SB, also includes the addition of one lane on I-691 WB from I-91 SB ramp to Gravel Street. Concept 5A was selected because it functions better with Concept 2C. The estimated construction duration of the Southbound Improvements is 30 months.

3.1.3 I-691 EB to I-91 NB Improvements

After the evaluation of the advantages and disadvantages described in the Section 2.3 Cost Effective Improvements, the Concept providing optimal benefits has been designated to be the selected Concepts for the I-691 EB to I-91 NB Improvements, as selected in Table 22, and depicted in Figure 21.

Figure 21: I-691 EB to I-91 NB Improvements

Table 22: I-691 EB to I-91 NB Improvements

Traffic Movement		Concept	Selected Concept	Name of Selected Concept	Project
4	I-691 EB to I-91 NB	4A	*	Concept 4	I-691 EB to I-91 NB Improvements
		4B			

* Selected Concept

Concept 4A was selected because it addresses capacity concerns on I-91 NB from I-691 interchange to the rest area and its cost is lower than Concept 4B. The estimated construction duration of the I-691 EB to I-91 NB Improvements is 30 months.

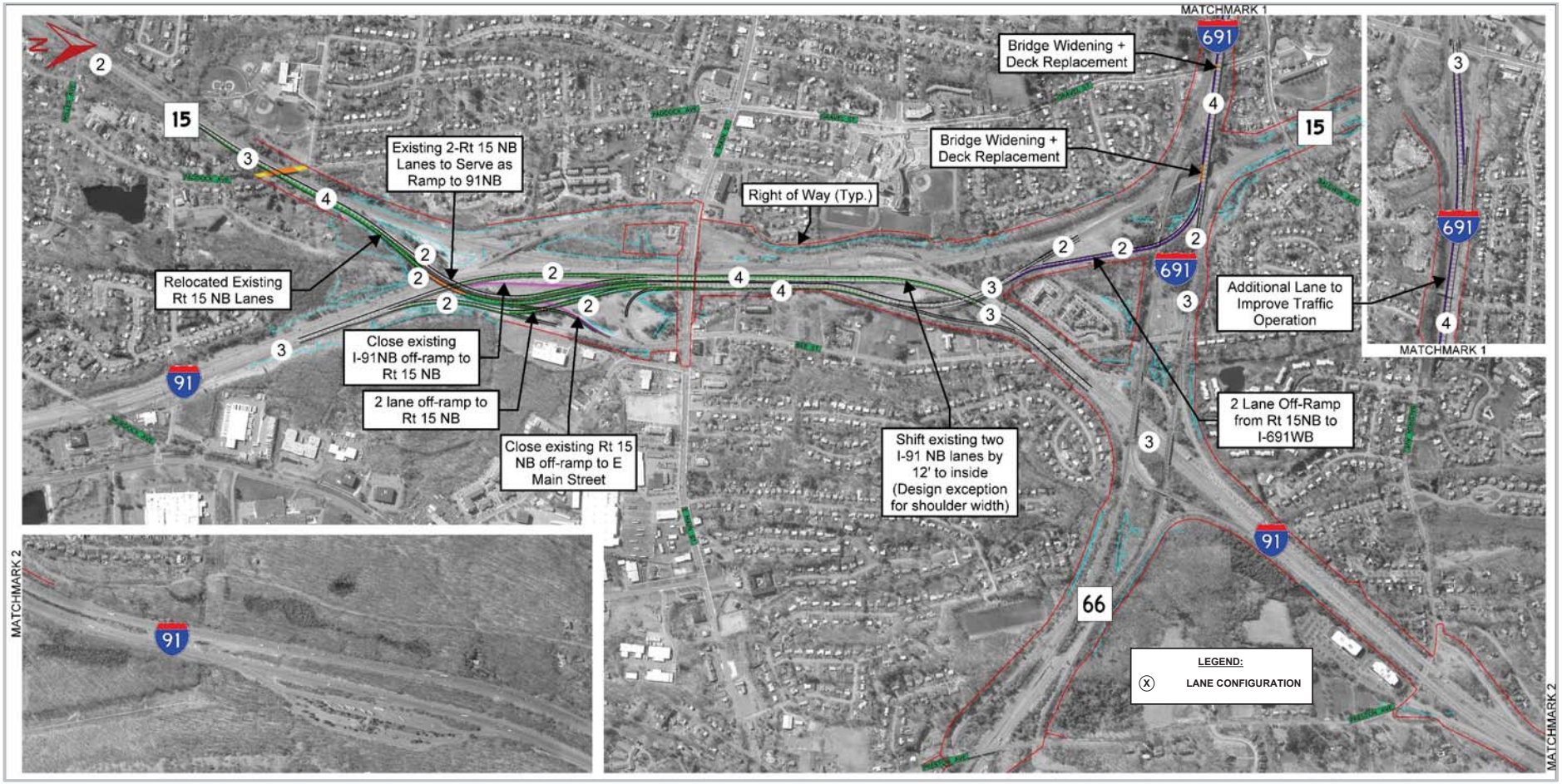


Figure 19: Northbound Improvements

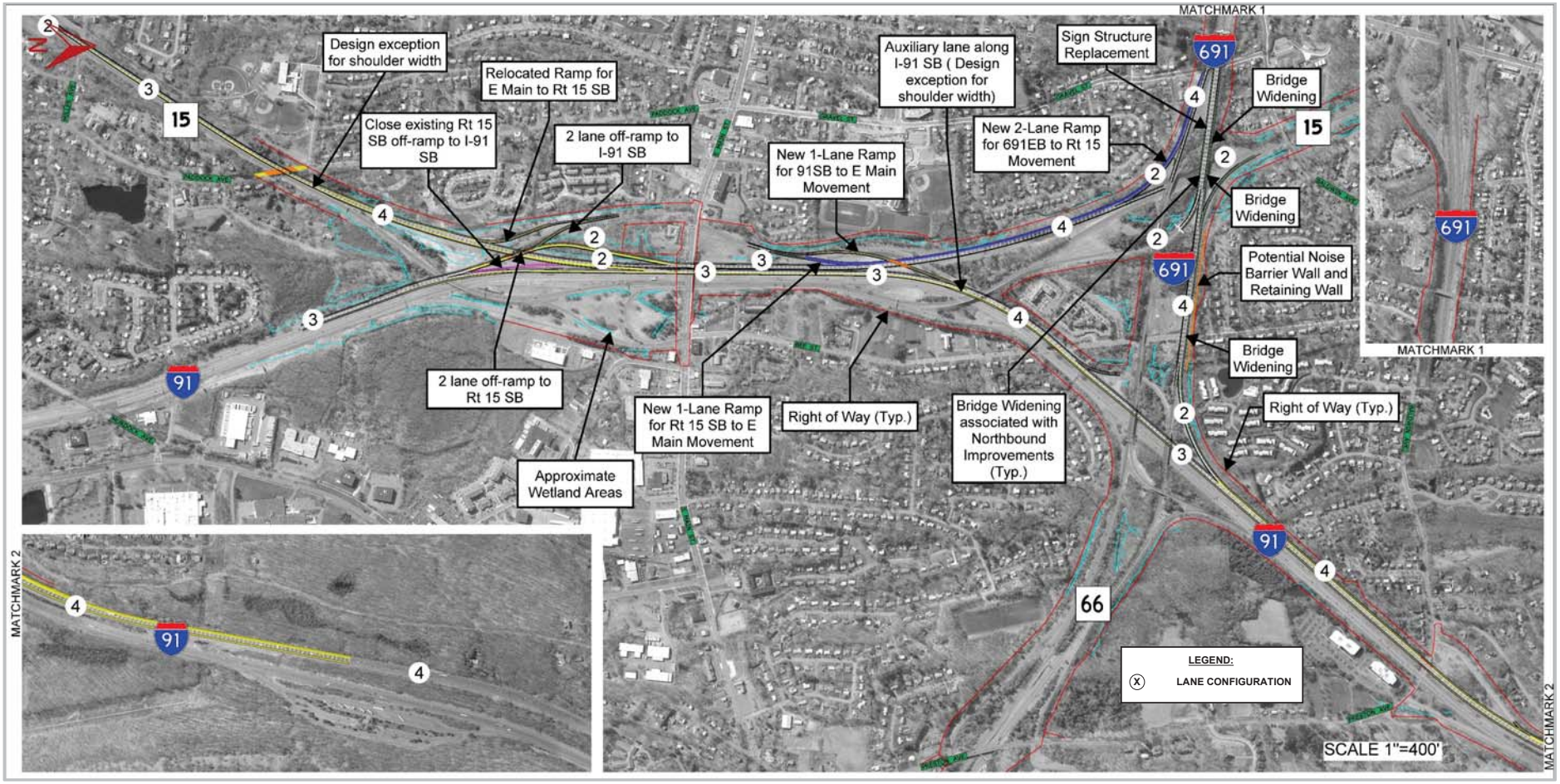


Figure 20: Southbound Improvements

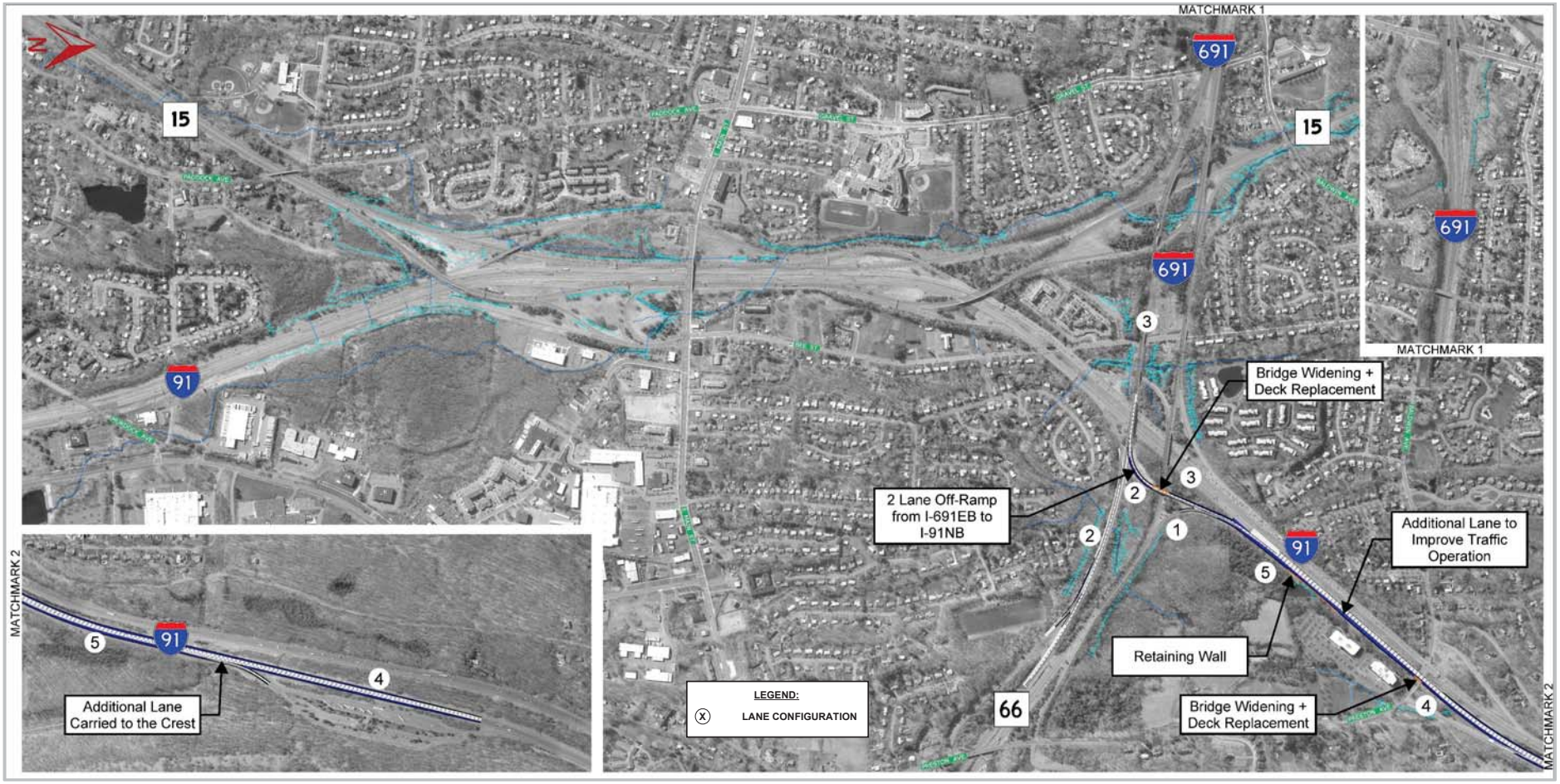


Figure 21: I-691 EB to I-91 NB Improvements

3.2 COMBINED IMPROVEMENTS

The three projects recommended, the northbound improvements, the southbound improvements and the I-691 eastbound to I-91 northbound improvements are designed to operate individually with independent utility and provide transportation improvements to each of these movements.

However, in order to provide optimal improvements in the entire interchange, the above improvements, can be taken together and designated as proposed "combined improvements". A comprehensive traffic simulation model using VISSIM software was undertaken in order to investigate the efficacy of these improvements and compare the projected traffic operating conditions with the No-Build alternative.

Table 23 illustrates the change in vehicle hours of delay (VHD) for the entire interchange network. As expected, the "combined improvements" scenario exhibit a reduction in total VHD to the tune of approximately 41% in the AM Peak hour and 65% in the PM peak hour and Table 24 demonstrates the impacts, benefits and costs of the individual projects and the combination of all three.

Table 23: Vehicle Hours of Delay (VHD)

Scenario	Horizon Year	AM	PM
No-Build	2051 (ETC*+20)	925	2072
Combined improvements	2051(ETC+20)	545	723
% Difference Combined Improvements to No-Build		-41%	-65%

*ETC – Estimated Time for Construction Completion

Table 24: Impacts Based on Key Criteria

Key Criteria	Project 1		Project 2		Project 3	Combined
	Concept 1D	Concept 3	Concept 2C	Concept 5A	Concept 4A	
Capacity						
Safety (Weaving)						
Wetland Impacts						
ROW Impacts						
Staging / MPT						
Design Exceptions						
Estimated Cost	$50 M	$20 M	$75 M	$10 M	$30 M	$185 M

Nominal Improvements/Major Negative Impacts

Nominal Improvements/Major Negative Impacts

Nominal Improvements/Major Negative Impacts

Figures 22 through 27 depict comparison of Measures of Effectiveness (MOEs) between the 2051 No-Build scenario and 2051 Combined Improvements scenario, as obtained from respective traffic simulation models.

Generally, density and speed are considered to be appropriate MOEs for freeways. The density values were compared with the freeway Levels of Service ranges published in the latest (6th) edition of the Highway Capacity Manual and the results are presented in Figures 21 through 26. It is to be noted that VISSIM being a macroscopic simulation model reports the density of vehicles, while the density used in the HCM level of service for uninterrupted flow facilities is the passenger car equivalent in passenger car units (pcu) of the actual vehicles in the facility.

Figures 22 through 27 reveal that under the Combined Improvements scenario, all the freeway mainline sections, weaving areas, ramp merge/diverge areas of the three corridors in the project area, i.e. I-91, Route 15 and I-691 show improved operating conditions when compared to the No-Build scenario.

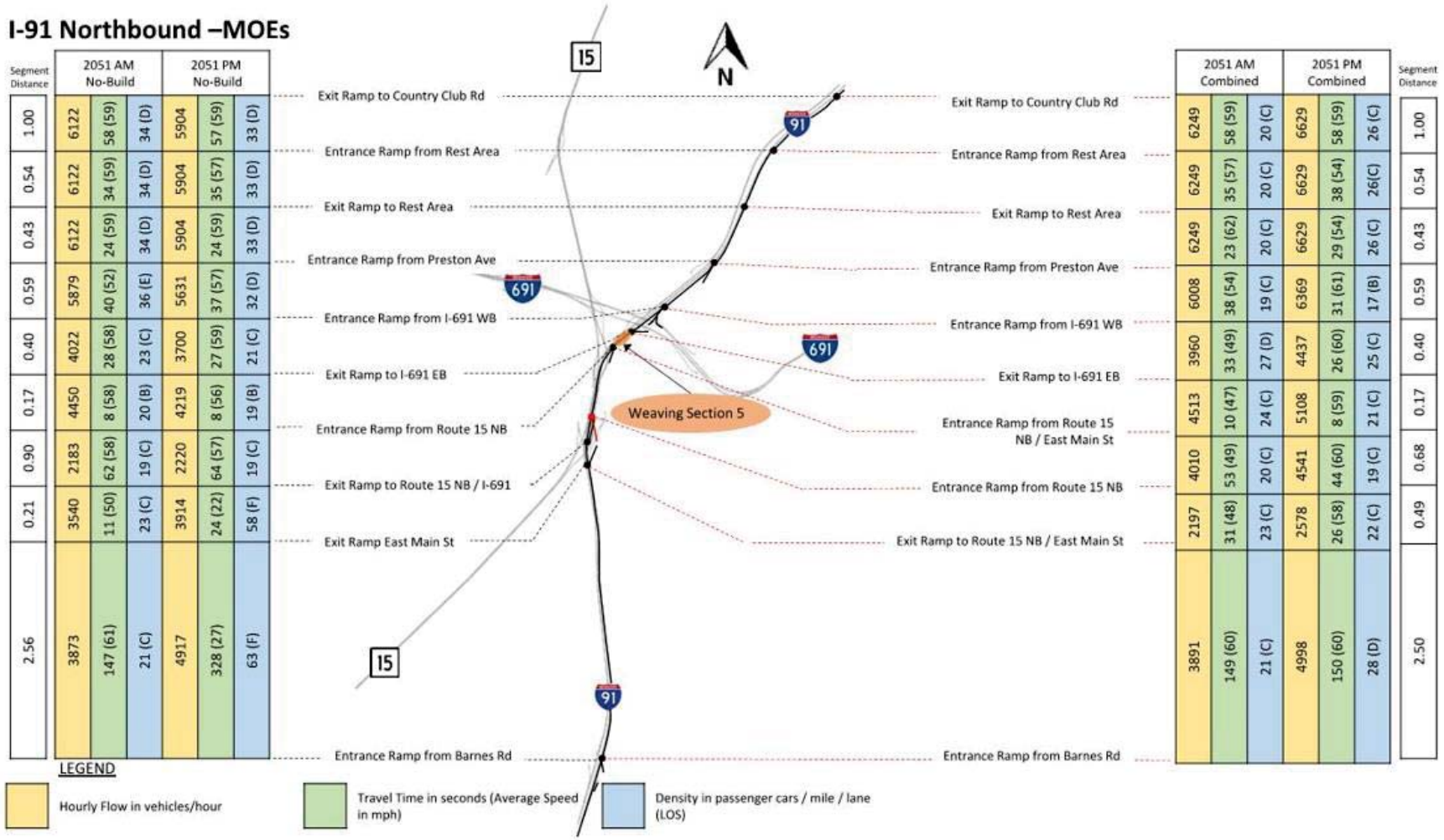


Figure 22: I-91 Northbound MOEs

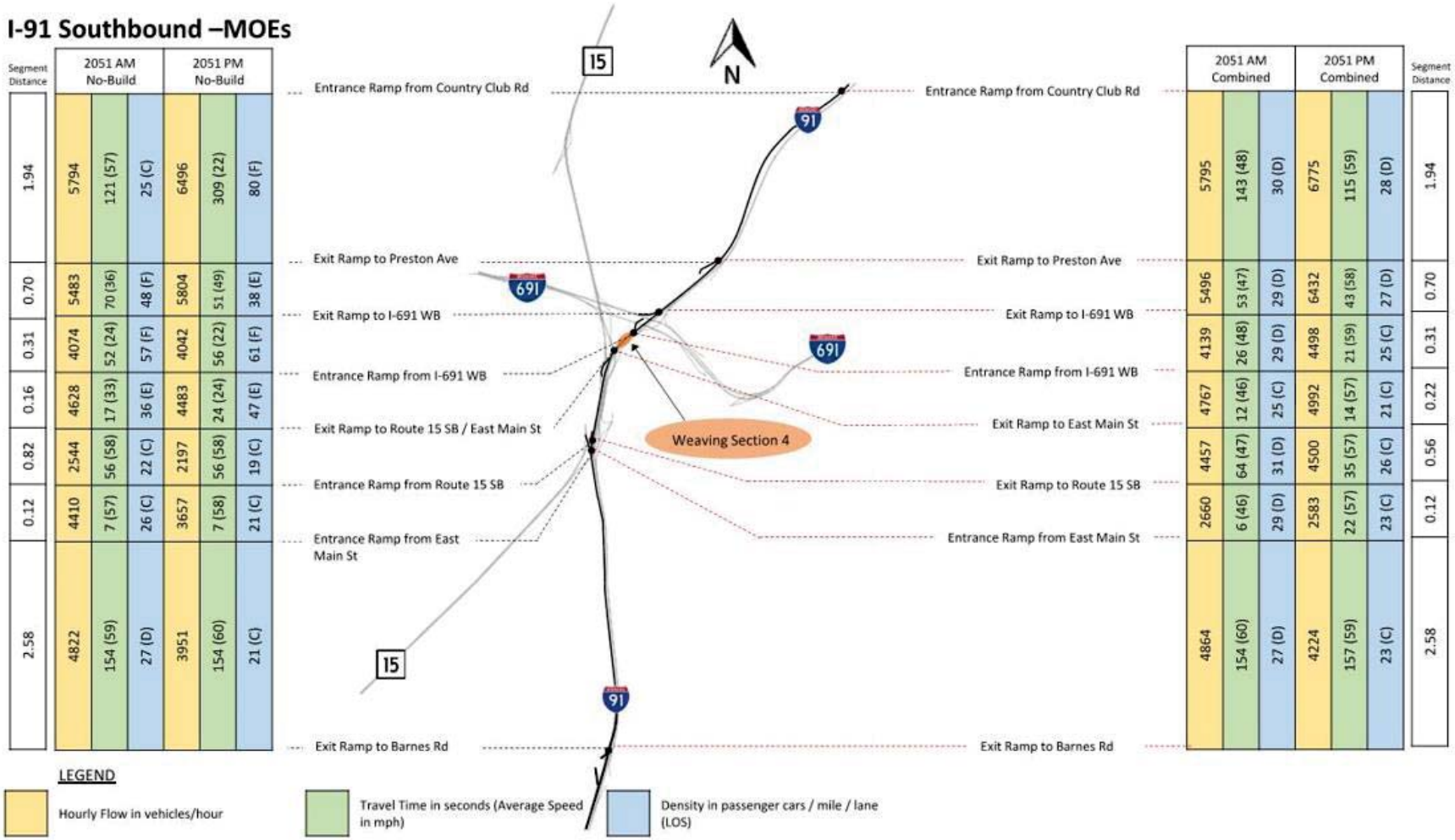


Figure 23: I-91 Southbound MOEs

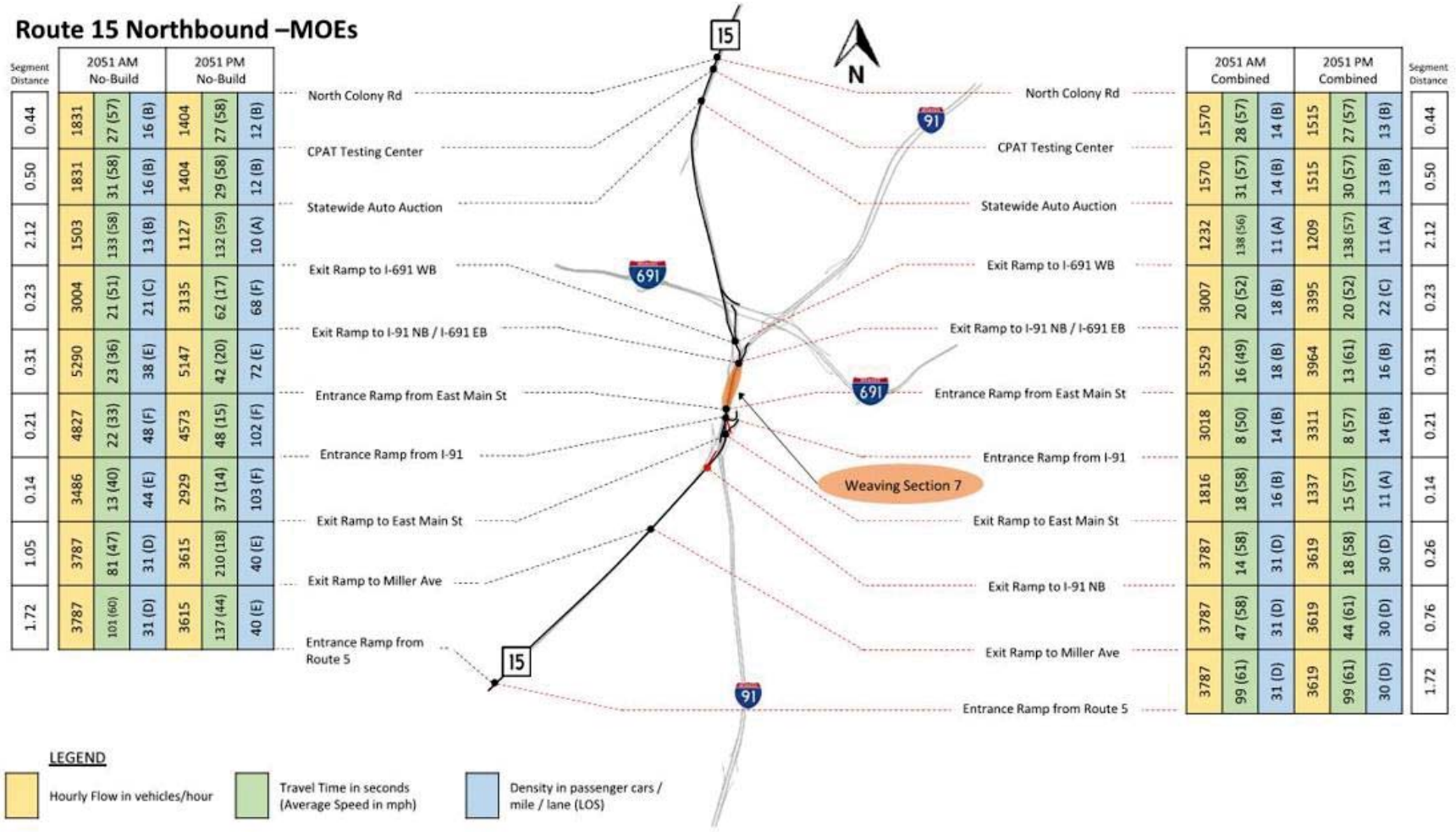


Figure 24: Route 15 Northbound MOEs

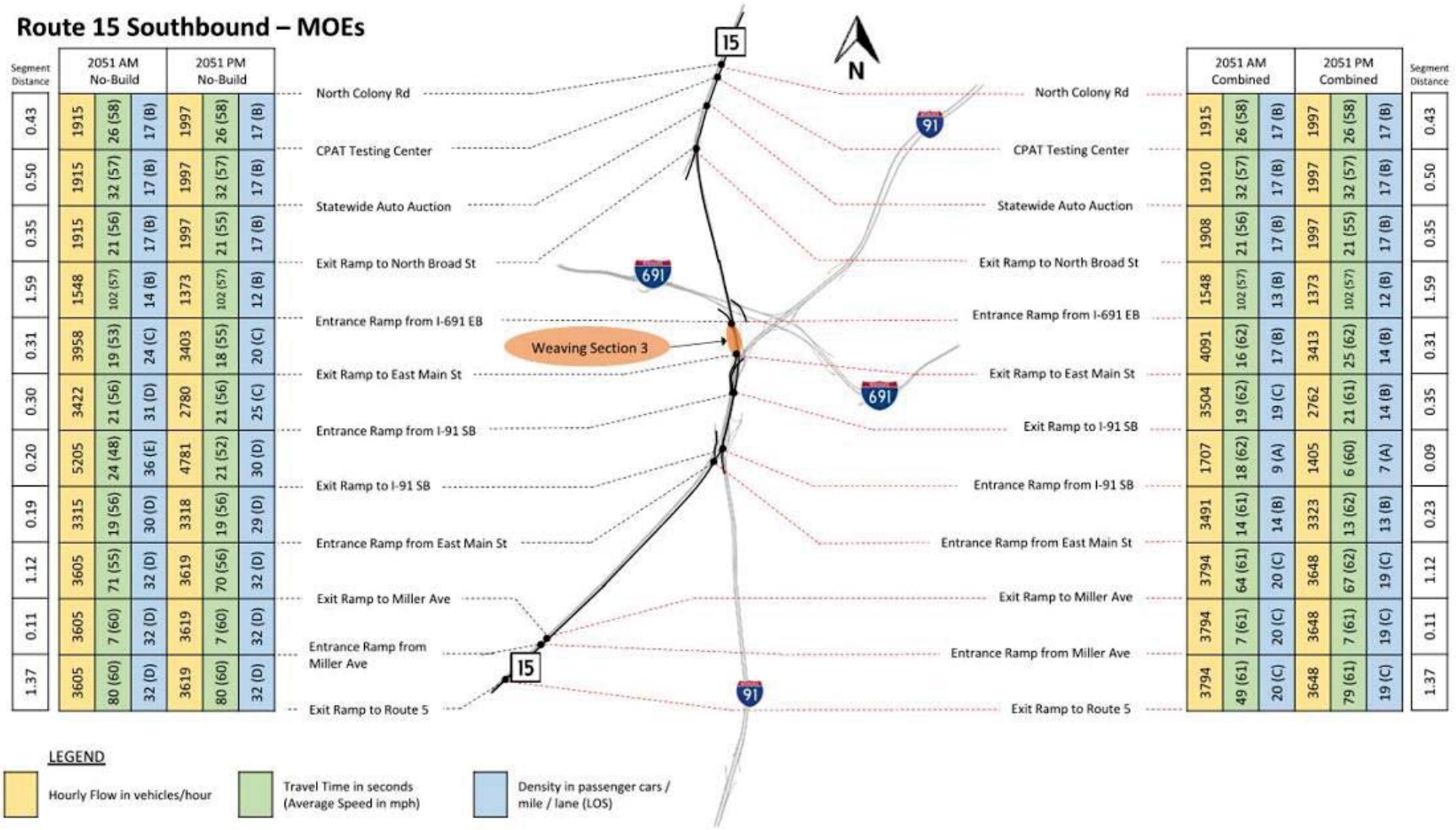


Figure 25: Route 15 Southbound MOEs

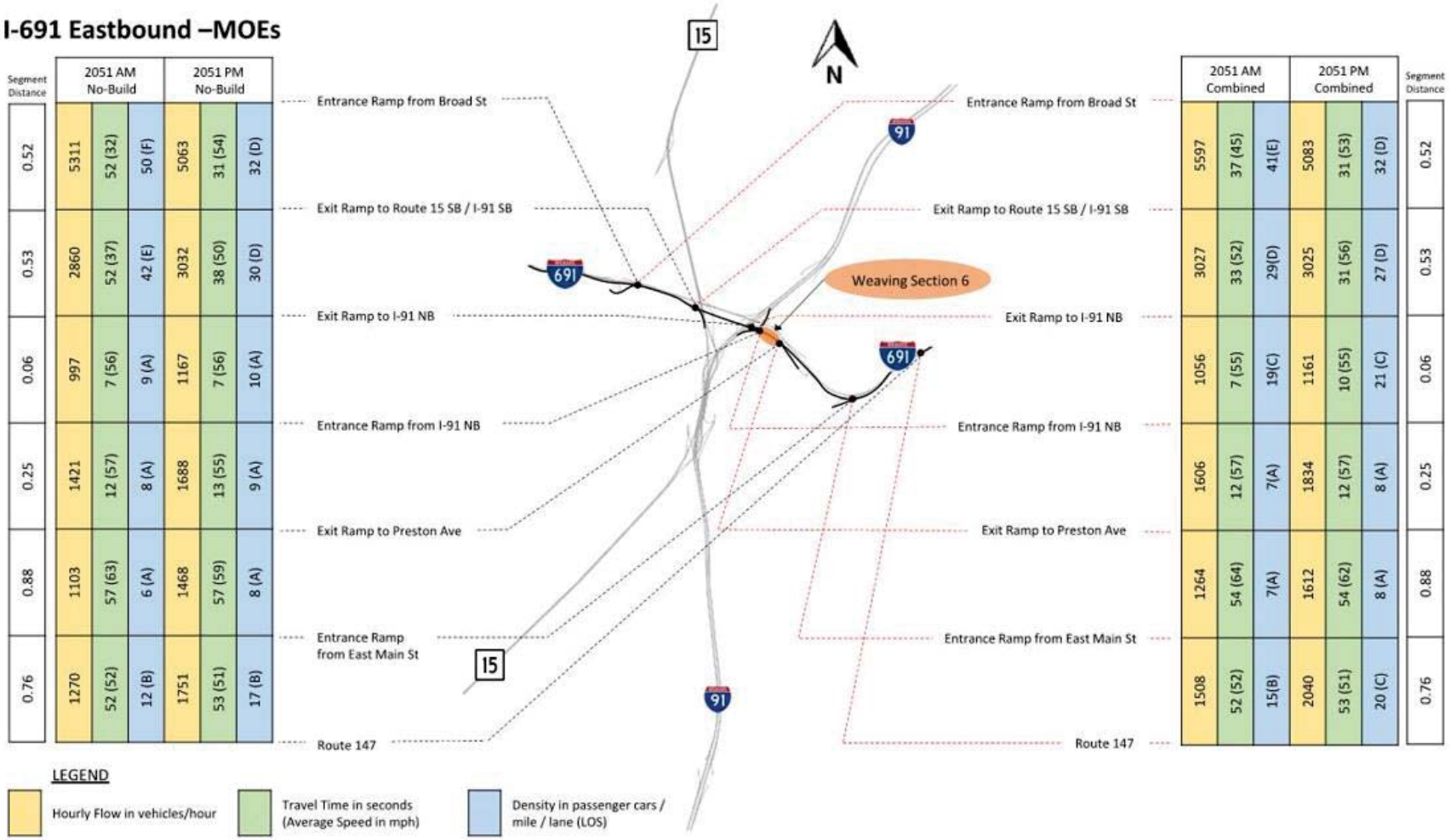
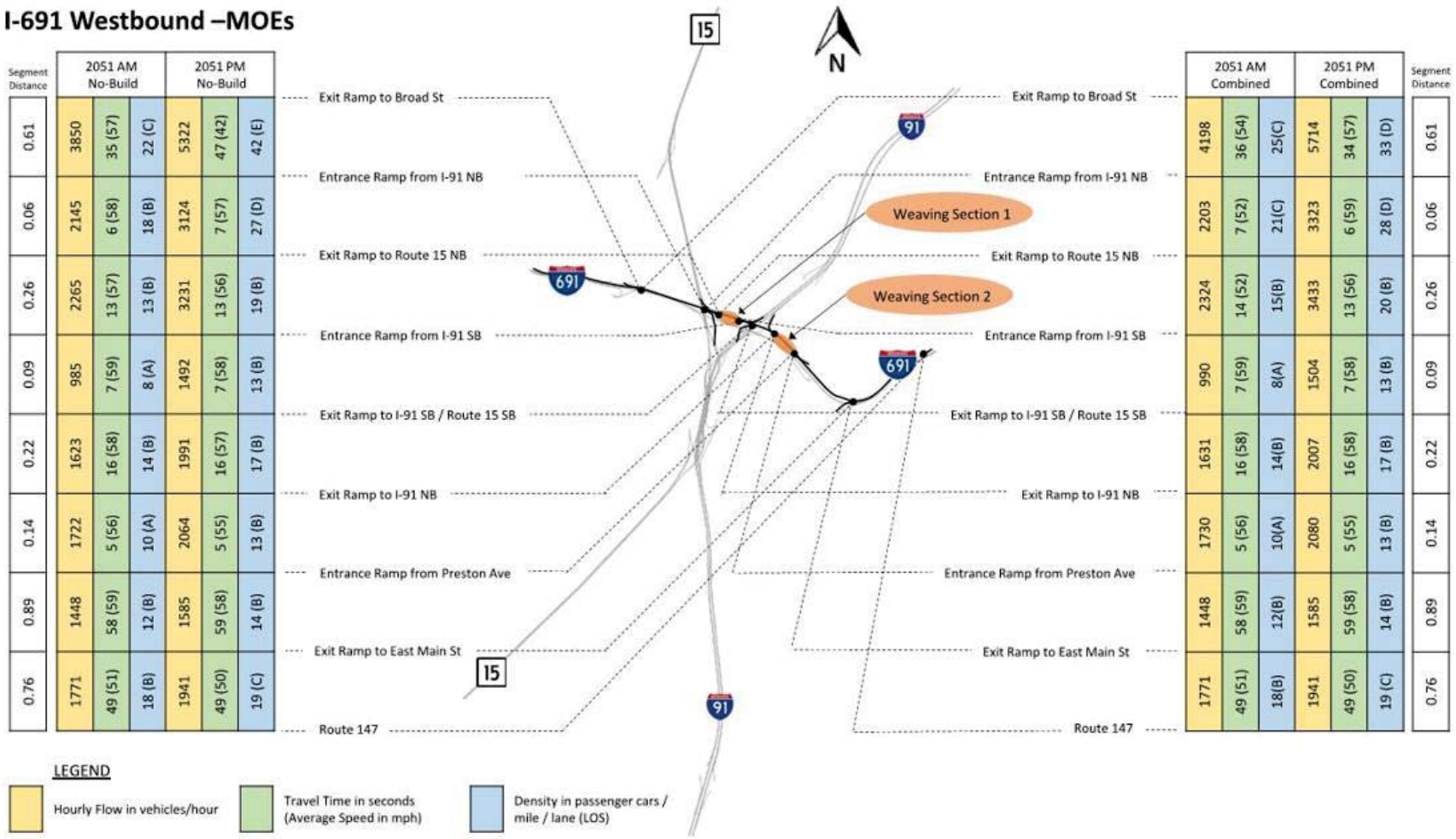


Figure 26: I-691 Eastbound MOEs



Segment Distance	2051 AM No-Build			2051 PM No-Build			2051 AM Combined			2051 PM Combined			Segment Distance
0.61	3850	35 (57)	22 (C)	5322	47 (42)	42 (E)	4198	36 (54)	25(C)	5714	34 (57)	33 (D)	0.61
0.06	2145	6 (58)	18 (B)	3124	7 (57)	27 (D)	2203	7 (52)	21(C)	3323	6 (59)	28 (D)	0.06
0.26	2265	13 (57)	13 (B)	3231	13 (56)	19 (B)	2324	14 (52)	15(B)	3433	13 (56)	20 (B)	0.26
0.09	985	7 (59)	8 (A)	1492	7 (58)	13 (B)	990	7 (59)	8(A)	1504	7 (58)	13 (B)	0.09
0.22	1623	16 (58)	14 (B)	1991	16 (57)	17 (B)	1631	16 (58)	14(B)	2007	16 (58)	17 (B)	0.22
0.14	1722	5 (56)	10 (A)	2064	5 (55)	13 (B)	1730	5 (56)	10(A)	2080	5 (55)	13 (B)	0.14
0.89	1448	58 (59)	12 (B)	1585	59 (58)	14 (B)	1448	58 (59)	12(B)	1585	59 (58)	14 (B)	0.89
0.76	1771	49 (51)	18 (B)	1941	49 (50)	19 (C)	1771	49 (51)	18(B)	1941	49 (50)	19 (C)	0.76

Figure 27: I-691 Westbound MOEs

3.3 ASSESMENT OF INDEPENDENT UTILITY AND LOGICAL TERMINI

It is expected that the projects will be constructed by corridor and will likely be eligible for Federal funds. Per Federal regulations (23 C.F.R. § 771.111(f)), to ensure meaningful evaluation of alternatives and to avoid commitments to transportation improvements before they are evaluated i.e. to avoid segmentation, each proposed action shall:

1. Connect logical termini and be of sufficient length to address environmental matters on a broad scope.
2. Have independent utility or independent significance i.e. be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made.
3. Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements.

A separate analysis was conducted to ascertain whether the limits of the corridor wise improvements represent logical termini and whether the projects themselves have independent utility.

By definition, logical termini are rational beginning and end points for a project (23 CFR 771.111(f)(1)) for the purposes of assessment of environmental impacts and they do not preclude phasing of construction within a single NEPA action. A project is said to have independent utility if it is able to provide transportation benefit even if no other project is built in the area (23 CFR 771.111(f)(2)). Also, that project must be a reasonable expenditure of federal funds even if no other transportation improvements are made in the area.

The northbound improvements taken separately provide transportation benefits in terms of reduction in delays to the traveling public and addressing existing safety issues in the corridors. Traffic analyses of these corridors (I-91 and Route 15 northbound) demonstrate no residual capacity concerns following the proposed improvements and no further need to construct additional improvements. In light of the above, it can be concluded that this project has independent utility and meets the purpose and need by reducing traffic congestion to achieve level of service D or better by design year 2051 and improves safety by reducing crashes caused by congestion and weaving

The southbound improvements taken separately provide notable transportation benefits in terms of reduction in delays to the traveling public and addressing existing safety issues in the corridors. Traffic analyses of these corridors (I-91 and Route 15 southbound and I-691 westbound) demonstrates no residual capacity concerns following the proposed improvements and no further need to construct additional improvements. In light of the above, it can be concluded that this project have independent utility and meets the purpose and need.by reducing traffic congestion to achieve level of service D or better by design year 2051 and improve safety by reducing crashes caused by congestion and weaving

The I-691 eastbound to I-91 northbound improvement project, by itself also provides notable transportation benefits in terms of reducing back-ups on mainline I-691 eastbound and providing additional ramp capacity and an improved geometry. Traffic analysis has demonstrated no residual capacity concerns following the proposed improvements and no further need to construct additional improvements. In light of the above, it can be concluded that this project has independent utility and meets the purpose and need.by reducing traffic congestion to achieve level of service D or better by design year2051 and improve safety by reducing crashes caused by congestion and weaving.

The southbound improvement project limits on I-91 southbound are proposed to be prior to the Murdock Avenue overpass (eastern limit) and prior to the Preston Avenue off-ramp (northern limit). The western limit of the project is proposed to be at the beginning of the I-691 eastbound ramp to Route 15 southbound and the southern limit is proposed to be beyond the Paddock Avenue overpass. Traffic analyses have indicated that the proposed improvements do not affect operating conditions beyond these limits and hence the project can be considered to have logical termini.

The northbound improvement project limits on I-91 northbound are proposed to be in close proximity of Interchange 18 (northern limit) and north of the Murdock Avenue interchange (southern limit). The western limit of the project is proposed to be in close proximity to Interchange 8 of I-691 westbound. This project, due to its close proximity with the I-691 eastbound on-ramp was examined more closely with regard to its traffic impact on the later. An analysis conducted using VISSIM microsimulation model demonstrated that both in the AM and PM peak hours, completion of

the northbound improvements will not affect the traffic operating conditions of the existing I-691 eastbound on-ramp, as defined by Level of Service.

In light of the above, it can be concluded that the northbound improvements have logical termini.

The southern limit of the I-691 eastbound to I-91 northbound project is proposed to be on mainline I-691 eastbound, immediately prior to the on-ramp. The northern limit of the project is proposed to be on mainline I-91 northbound, immediately prior to the on-ramp from Middletown Rest Area. Traffic analyses have indicated that the proposed improvements do not affect operating conditions beyond these limits and hence the project can be considered to have logical termini

3.4 CONCLUSION

We recommend proceeding with the design and construction of this project accordingly:

Northbound improvements that includes Concept 1 and Concept Three. Of the four alternatives studied for Concept 1, Concept 1D was selected as the preferred course of action because it most efficiently moves traffic by separating the Route 15 NB through traffic from Route 15 NB to I-91 NB traffic. Only one concept was studied for Concept 3 because it adequately addresses current weaving issues on RT 15 SB between the off-ramp to I-91 NB and the off-ramp to I-691 WB. It also has no impacts to minority and low income populations and has no impacts to right of way,

Southbound improvements that include Concept 2 and Concept Five. Of the three alternatives studied for Concept 2, Concept 2C was selected as the preferred course of action because it addresses the weave distance between entrance ramp from Route 66 WB and exit ramp to East Main Street and it separates the I-91 SB traffic destined for East Main Street and Route 15 SB, also includes the addition of one lane on I-691 WB from I-91 SB ramp to Gravel Street. Concept 2C also addresses congestion and capacity issues on I-91 SB upstream of the ramp to I-691 WB. Of the two alternatives studied for Concept 5, Concept 5A was selected because it functions better with the preferred Concept 2C.

I-691 EB to I-91 NB Improvements that include Concept Four. Of the two alternatives studied for Concept 4, Concept 4A was selected as the preferred course of action because it addresses capacity concerns on I-91 NB from the I-691 interchange to the rest area and its cost is lower than Concept 4B.

These concepts are further defined in Chapter Three Sections 3.1 and 3.2.

In regards to assure compliance with the National Environmental Policy Act, pursuant to Section 23CFR 771.117, each of these projects will be processed as three individual Categorical Exclusions in coordination with the Federal Highway Administration to satisfy requirements set forth by the National Environmental Policy Act.

Also, pursuant to Section 22a-1a-12, inclusive, each of these projects will be published in the Connecticut Environmental Monitor to determine, through the scoping process, to satisfy all requirements set forth by the Connecticut Environmental Policy Act.