Interchange Modification Report

I-64 / I-264
PHASE III INTERCHANGE IMPROVEMENTS

City of Norfolk
Commonwealth of Virginia

State Project Number 0264-122-342
UPC 106693

March 20, 2020
Revised: September 16, 2020

Submitted to U.S. Department of Transportation Federal Highway Administration

Prepared for VDOT Virginia Department of Transportation

Prepared by HNTB

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This document satisfies the requirements set forth by Federal statute and policies of the Virginia Department of Transportation for requesting and obtaining approval for changes to Interstate access.

This request for changes to Interstate access is conditionally approved, pending completion of environmental decision documentation for this project.

Thomas L. Nelson, Jr., PE Division Administrator Federal Highway Administration Virginia Division	Barton A. Thrasher, PE Chief Engineer Virginia Department of Transportation
Date of Approval	Date of Approval

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
Alt.	Alternative
AMW	access management waiver
approx.	approximate
Ave.	Avenue
AWDT	average weekday daily traffic
B	billion
Blvd.	Boulevard
BRT	bus rapid transit
C/D	collector/distributor
CLRP	(HRTPO) Constrained Long-Range Plan
Co.	County
Cir.	Circle
Ct.	Court
CTB	(Virginia) Commonwealth Transportation Board
DDI	diverging diamond interchange
DE	design exception
DMV	Virginia Department of Motor Vehicles
Dr.	Drive
DS	design speed
DW	design waiver
Dwy.	Driveway
EA	environmental assessment
EB	eastbound
EBL, EBR	eastbound left-turn movement, eastbound right-turn movement
EBT	eastbound through movement
FHWA	Federal Highway Administration
ft	feet or foot
GP	general-purpose
HCM	Highway Capacity Manual
HGV	heavy goods vehicles (trucks)
HOT	high-occupancy toll
HOV	high-occupancy vehicle
HOV-2 or -3	high-occupancy vehicle, 2-person minimum or 3-person minimum
HRTAC	Hampton Roads Transportation Accountability Commission
HRTPO	Hampton Roads Transportation Planning Organization
Hwy.	Highway
I, I-	Interstate
IMR	Interchange Modification Report
ITS	intelligent transportation system
L/A	Limited Access
L&D	(VDOT) Location & Design Division
LOS	Level of Service
LT	left
LTR	left-through-right shared movement
LRT	light rail transit
LRTP	(HRTPO) Long-Range Transportation Plan
M	million
max.	maximum
min.	minimum
MOE	measure of effectiveness
mph	miles per hour
MUTCD	Manual on Uniform Traffic Control Devices
MVMT	million vehicle-miles traveled
NB	northbound
NBL, NBR	northbound left-turn movement, northbound right-turn movement
NBT	northbound through movement
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NHS	National Highway System
O-D	origin-destination
p	page
pc/mi/ln	passenger cars per mile per lane
PCE	passenger car equivalent
PHF	peak hour factor
pp	pages or page range
Rd.	Road
RT	right
SB	southbound
SBL, SBR	southbound left-turn movement, southbound right-turn movement
SBT	southbound through movement
sec	seconds
sec/veh	seconds per vehicle
SOV	single-occupancy vehicles
SPUI	single-point urban interchange
St.	Street
STARS	Strategically Targeted and Affordable Roadway Solutions (Program or study)
SYIP	(VDOT) Six-Year Improvement Program
TAZ	traffic analysis zone
TIP	(HRTPO) Transportation Improvement Program
TOSAM	(VDOT) Traffic Operations and Safety Analysis Manual
TSM	transportation system management
US	United States
VA	Virginia
v/c ratio	volume-to-capacity ratio
VDOT	Virginia Department of Transportation
veh	vehicle
vpd	vehicles per day
vph	vehicles per hour
vs.	versus
WB	westbound
WBL, WBR	westbound left-turn movement, westbound right-turn movement
WBT	westbound through movement
yr, yrs	year, years

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EXECUTIVE SUMMARY

ES.1 Project Background

Located in the southeastern portion of the City of Norfolk, Virginia, the I-64/I-264 interchange was originally constructed in 1964. Projects undertaken since that time have added capacity through construction of new ramps, ramp modifications, or new HOV lanes. However, much of the infrastructure built with the original project remains in place and is still in service today. Since 1964, the combined population of the Cities of Norfolk and Virginia Beach has increased 60%, and average daily traffic volumes on I-64 have increased from 28,000 to 147,000 vpd - an increase of 425%.

VDOT has performed several studies over the past 20 years to address operational needs, safety, capacity, and asset maintenance in the I-64 and I-264 corridors. The need for improvements at the I-64/I-264 interchange has been well documented through prior studies. In 2011, an Interchange Modification Report (IMR) was approved by FHWA for the Phase I and Phase II improvement projects at the I-64/I-264 interchange, which are currently under construction. These two projects improve the westbound I-64 to eastbound I-264 movement, add a new C/D roadway along eastbound I-264, widen the eastbound I-264 mainline, and reconfigure the south side of the Newtown Road and Witchduck Road interchanges. There continues to be a recognized need to improve traffic operations and safety for the movements at the I-64/I-264 interchange that are not addressed by the Phase I or Phase II projects currently under construction.

Multiple movements at the I-64/I-264 interchange experience recurrent congestion during weekday AM and PM peak periods. These conditions typically occur from 7:00 to 9:00 AM and from 3:45 to 5:45 PM. Several areas within the interchange operate with elevated crash rates that are well above the districtwide crash rate and the statewide crash rate. Phase III improvements at the I-64/I-264 interchange are the subject of this IMR.

ES.2 Purpose and Need

The purpose of the I-64/I-264 Phase III improvements project is to address the following elements of need:

- Relieve the recurring peak period congestion experienced under existing conditions at the I-64/I-264 interchange and adjacent highway segments affecting operations at the interchange. Congestion within the study area is characterized by low travel speeds, high traffic flow densities, and queuing on interstate mainline travelways, C/D roadways, and ramps. Within the study limits, congestion is caused by capacity constraints, merge/weave conditions, and geometric deficiencies.
- Enhance functionality of existing HOV lanes in the I-264 corridor by providing continuous HOV lanes through the I-64/I-264 interchange. Existing HOV lanes are interrupted by the placement of left exit ramps from eastbound and westbound I-264. In both directions, single-occupant vehicles weave across the HOV lane to exit I-264. In the westbound direction, the effects of the weaving movement are worsened by severe queuing upstream of the left exit ramp to eastbound I-64.
- Reduce crash potential at the I-64/I-264 interchange through physical improvements that improve highway geometry and traffic operations. Areas within and adjacent to the interchange have historic crash rates that exceed the statewide and districtwide average crash rates. Crash data indicate that prevalent collision types are susceptible to correction with physical improvements that improve geometry and traffic operations.

ES.3 Screening of Alternatives

Pursuant to guidance set forth by FHWA, the study area was established to include the following interchanges:

- I-64/I-264 interchange
- I-64/Northampton Boulevard interchange
- I-64/Indian River Road interchange
- I-264/Military Highway interchange
- I-264/Newtown Road interchange
- I-264/Witchduck Road interchange

The study area also included the following arterial roadway segments which encompass ramp terminal intersections at interchanges with either I-64 or I-264:

- Northampton Boulevard from USAA Drive/Kempsville Road to Wesleyan Drive/Premium Outlets Boulevard
- Indian River Road, from Reon Drive to Centerville Turnpike/Parkland Lane
- Military Highway, from Corporate Boulevard to Poplar Hall Drive
- Newtown Road, from Kempsville Road/Queen Anne Road to Cleveland Street
- Witchduck Road, from Grayson Road to Cleveland Street

A Study Team was formed to include representatives from VDOT, the City of Norfolk, the City of Virginia Beach, FHWA, and HNTB Corporation. Study Team members met 11 times over a 17-month period to collaboratively develop, evaluate, screen, and select improvement alternatives.

Alternative improvement concepts were evaluated using a three-tier screening process. The no-build scenario was evaluated as part of each screening tier.

During Tier 1 evaluations, multiple improvement concepts at each interchange within the study area were developed to address operational problems as well as known and observed capacity constraints through analyses using long-range traffic volume forecasts available from recent studies. Concepts were evaluated for link capacities, merge conditions, merge-weave conditions, and intersection capacity using the long-range forecasts from prior studies. For each interchange in the study area, three concepts were selected and were combined into network layout alternatives for further evaluation.

Tier 2 screening was performed using projected traffic volumes, which were developed specifically for this study based on current traffic count data. The geometry was refined for each of the three network-wide improvement concepts. Microsimulation analysis was used to assess traffic operations for each alternative using refined 2044 weekday PM peak period traffic volumes. Based on these evaluations, recommended improvements were selected using criteria associated with traffic operations, compliance with standards, right-of-way impacts, cost, constructability, and potential environmental impacts. Selected alternatives at each interchange were combined into a final composite layout for the full roadway network within the study area.

Tier 3 analyses were performed to validate the suitability of the recommended improvements under projected 2044 weekday AM peak period conditions. Where necessary, changes to the network-wide conceptual design were made to address operational requirements for the AM peak period. Those design changes were reflected in updated analyses performed for weekday PM peak period conditions. Finally, analyses were performed to assess operations for projected 2024 AM and PM peak period conditions.

ES.4 Recommended Improvements

The recommended improvements at the I-64/I-264 interchange include new ramps to replace existing ramps that provide insufficient capacity, are configured as left exits, and/or operate with undesirable merge/weave conditions. Specifically, new semi-directional ramps would be constructed for the following movements:

- Eastbound I-264 to westbound I-64
- Westbound I-264 to eastbound I-64

- Eastbound I-64 to eastbound I-264

In addition, a new outer ramp network would be constructed to serve westbound I-264 traffic approaching the I-64/I-264 interchange and address high volumes and weave conditions associated with traffic entering the interstate from the Newtown Road interchange. The entry point to the westbound I-264 C/D roadway would be moved approximately one-half mile east of its current location.

To address capacity constraints on adjacent interstate segments that negatively affect operations at the I-64/I-264 interchange, recommended improvements include the following:

- Widening eastbound I-64 from Northampton Boulevard to I-264;
- Widening westbound I-64 from I-264 to the Northampton Boulevard interchange;
- Operating a shoulder running lane along westbound I-64 during weekday AM peak period from the Northampton Boulevard interchange to the Military Highway/Robin Hood Road interchange;
- Widening eastbound I-64 from I-264 to Indian River Road;
- Widening eastbound I-264 from Newtown Road to east of Witchduck Road; and
- Widening the eastbound I-264 C/D road from Military Highway to I-64.

Capacity improvements to Newtown Road are necessary to ensure that ramps operate without queuing back onto interstate through travel lanes. Ramp improvements are needed at the Military Highway, Newtown Road, and Witchduck Road interchanges.

ES.5 Summary of Findings

Traffic Operational Analysis Findings

Existing 2018 Conditions - Under existing 2018 conditions, the I-64/I-264 interchange experiences heavy demand during both weekday AM and PM peak periods. The following movements operate under fully saturated conditions with high flow densities, low travel speeds, and congested weave areas:

- Eastbound I-64 approaching I-264, including the ramps to eastbound and westbound I-264;
- Westbound I-264 between Newtown Road and I-64;
- Westbound I-64 approaching I-264, including the ramp to eastbound I-264 which was under construction during this study.

Congested conditions are further affected by the following geometric conditions:

- Constrained sight lines from the eastbound I-64 mainline to physical gore at ramps to eastbound and westbound I-264;
- Left exit ramps from westbound I-264 to eastbound I-64, and from eastbound I-264 to westbound I-64 that are contrary to motorist expectations;
- Closely spaced loop ramps along the eastbound and westbound I-264 C/D roadways that constrain merge-weave operations;
- Single-lane ramps that operate over capacity (eastbound I-64 to eastbound I-264, westbound I-264 to eastbound I-64.

2044 No-Build Conditions - With anticipated growth in traffic demand through the 2044 design year, congestion is expected to worsen if improvements are not undertaken. Of the nine travel time routes along interstates studied through the I-64/I-264 interchange, all are expected to have at least one peak hour during which average travel speeds fall below 40 mph. Six travel routes will have travel speeds below 40 mph for three or more hours studied. Eight routes will experience average travel speeds less than 20 mph during one or more hours studied.

Traffic movements at the I-64/I-264 interchange requiring improvements to address congestion and/or geometric conditions include the following:

- Eastbound I-64 to eastbound I-264
- Eastbound I-64 to westbound I-264
- Westbound I-64 approaching the ramp to westbound I-264
- Eastbound I-264 to eastbound I-64
- Eastbound I-264 to westbound I-64
- Westbound I-264 to eastbound I-64
- Westbound I-264 to westbound I-64

In addition, the following interstate segments adjacent to the I-64/I-264 interchange require improvements to address capacity and weaving operations:

- Eastbound I-64, between Northampton Boulevard and I-264
- Westbound I-64, between I-264 and the northern end of the study area toward Military Highway/Robin Hood Road
- Eastbound and westbound I-64, between I-264 and Indian River Road
- Eastbound and westbound I-264, between I-64 and east of Witchduck Road

The following signalized ramp terminal intersections will operate with overall heavy or severe congestion during one or both of the peak periods analyzed:

- Newtown Road at eastbound I-264 exit ramp and Greenwich Road (average delay 497 sec/veh)
- Newtown Road at westbound I-264 exit ramp and Stoney Point South (average delay 507 sec/veh)
- Witchduck Road at eastbound I-264 exit ramp and Grayson Road (average delay 592 sec/veh)
- Northampton Boulevard at eastbound I-64 exit ramp (average delay 252 sec/veh)
- Northampton Boulevard at eastbound I-64 entrance ramp and IKEA Way (average delay 280 sec/veh)

At the first four locations listed above, queuing on the exit ramp will affect traffic operations on the mainline interstate.

2044 Build Conditions - With recommended improvements in place, traffic operations throughout the study area will improve over no-build conditions. Findings regarding key operational metrics include the following:

- Average travel speeds by travel route through the I-64/I-264 interchange range from 47 mph to 61 mph during the weekday AM peak period. Average travel speeds range from 48 mph to 60 mph during the weekday PM peak period.
- Travel times across the nine travel routes studied through the I-64/I-264 interchange are reduced an average of 53% (approximately 4 minutes) during the weekday morning peak period, and 57% (approximately 24 minutes) during the weekday PM peak period.
- All ramp terminal intersections at all six interchanges studied will operate with overall moderate or light congestion during all peak hours studied. Maximum queue lengths on all exit ramps will be contained within available storage, and will not extend back to the respective ramp's physical gore.

These operational improvements are the result of capacity enhancements along interstate segments, ramps, and arterials, as well as modified entrance and exit ramp configurations that alleviate congested merge-weave conditions.

Safety Analysis Findings

Existing Conditions - The following summary points identify safety issues under existing conditions and support the purpose and need for the project:

- The total number of crashes on I-64 within the study area increased by approximately 90 crashes per year during the three-year period studied, representing an increase of 42% from 2015 to 2017. The number of crashes on I-264 within the study area has increased 12% during the same time period.

- The annual crash rate on I-64 exceeds the districtwide and statewide rates over the three-year period studied by an average of 78% and 114%, respectively, and has increased each of the years studied. The annual crash rate on I-264 exceeds the districtwide and statewide rates by 29% and 54%, respectively, and has also increased each of the years studied. The rates at which the crash rates on I-64 and I-264 have increased outpace the trends observed from districtwide or statewide data.
- The annual injury crash rates on I-64 are higher than the districtwide and statewide rates by an average of 100% and 193%, respectively. The annual injury crash rates on I-264 are higher than the districtwide and statewide rates by an average of 44% and 113%, respectively. Injury crash rates by facility and by direction have generally increased on I-64 and I-264 from 2015 to 2017.
- The majority of crashes experienced on I-64 and I-264 within the study area are of types associated with heavy congestion, variable operating speeds, and high-density weave conditions. These crash types can typically be addressed by constructing physical improvements that increase capacity, reduce congestion, reduce speed differentials, and enhance driver expectancy.
- Nearly 45% of the 1,570 reported crashes along both directions of I-64 within the study area occurred on eastbound I-64 between the Northampton Boulevard interchange and the I-64/I-264 interchange.
- Crash data and statistically-established crash "hotspots" correlate to areas observed in the field as experiencing congestion, variable operating speeds, and high densities. Hotspots are located as follows:
  - Westbound I-64 approaching the I-264 interchange, an area that is being addressed by construction of the Phase I I-64/I-264 interchange improvements project (UPC 57048)
  - Eastbound I-264, located 1,500 ft beyond the mainline-C/D road diverge near the Military Highway interchange (crash rate 3 times the districtwide crash rate)
  - Eastbound I-264 C/D road at Newtown Road, an area that is being addressed by construction of the Phase I and Phase II I-64/I-264 interchange improvement projects (UPC 57048 and UPC 17630)
  - Westbound I-264 C/D road, from Newtown Road to I-64 (peak crash rate 3.5 times the districtwide rate)
  - Westbound I-264 mainline at Newtown Road (peak crash rate 3 times the districtwide crash rate)

  Although not technically ranked as hotspots, the following other areas along I-64 and I-264 exhibit high crash rates that correlate to observed and modeled operational problems:
  - Eastbound I-64 general-purpose (GP) lanes, from Northampton Boulevard to I-264 (peak crash rate 6 times the districtwide rate)
  - Eastbound I-64 GP lanes, approaching the Indian River Road interchange (peak crash rate double the districtwide rate)
  - Westbound I-64 GP lanes, north of the entrance ramp from Northampton Boulevard (peak crash rate 3 times the districtwide rate)
  - Westbound I-64 GP lanes, north of the I-64/I-264 interchange (peak crash rate 3.5 times the districtwide rate)
  - Westbound I-64 GP lanes, through the Indian River Road interchange (peak crash rate 3.5 times the districtwide rate)
  - Eastbound I-264 at the mainline-C/D diverge, located west of Military Highway (peak crash rate 1.3 times the districtwide crash rate)
  - Eastbound I-264 C/D road, between loop ramps at the Military Highway interchange (peak crash rate double the districtwide rate)
  - Eastbound I-264 mainline, between I-64 and Newtown Road (peak crash rate double the districtwide rate), an area that is being addressed by construction of the Phase I and Phase II I-64/I-264 interchange improvement projects (UPC 57048 and UPC 17630, respectively)
  - Westbound I-264 at the Witchduck Road interchange (peak crash rate 2.5 times the districtwide rate)
- Crash experience on I-64 and I-264 is generally consistent with statewide experience with respect to environmental factors such as lighting conditions, weather, and road surface conditions. Where differences were noted, they are attributable to differences between the physical setting of the study area and conditions across Virginia. Examples include crash experience in "dark, not lighted" conditions, and crash experience on snowy and icy road surface conditions.

2044 No-Build Conditions - The ISATe tool was used to develop a predicted number of crashes under 2044 no-build conditions. For conditions associated with this study, analytical methods do not allow a direct comparison of historical crash frequency from 2015 to 2017 with predicted crash frequency prepared using the ISATe tool.

The region is expected to continue to grow in population, and is expected to support higher levels of employment, and visitation due to recreation. Roadways not currently being improved under active construction projects are expected to experience growing congestion. Crash potential will continue to increase as the roadway network will serve higher traffic volumes without physical improvements.

2044 Build Conditions - Quantitative analysis indicates a reduction in the number of crashes predicted during the 2044 design year when compared with predicted 2044 no-build conditions. Recommended improvements are predicted to result in approximately 26 fewer injury crashes and 18 fewer property-damage-only crashes in 2044. Predicted crash rates under 2044 build conditions will be reduced as follows, compared with predicted 2044 no-build conditions:

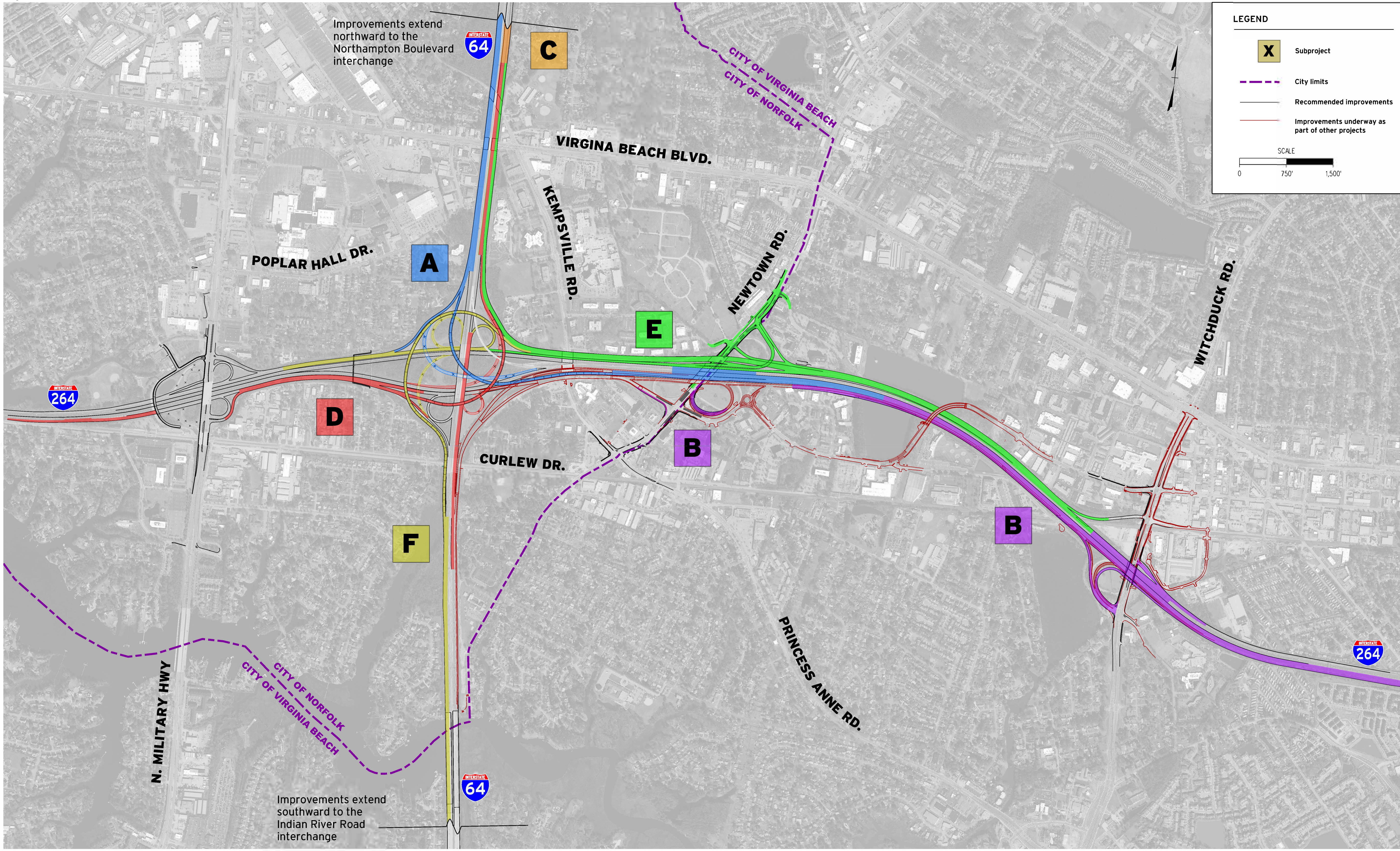
- I-64 mainline - 13% reduction in crash rate
- I-264 mainline - 11% reduction
- I-264 C/D roadways - 38% reduction
- All ramps at the I-64/I-264 interchange - 16% reduction
- Westbound I-264 ramps to/from Newtown Road - 27% reduction
- All ramps at the I-264/Witchduck Road interchange - 5% reduction
- Ramp terminal intersections at arterial roadways, I-264/Newtown Road interchange - 13%-25% reduction
- Ramp terminal intersections at arterial roadways, I-264/Witchduck Road interchange - 15%-48% reduction

Programming Summary

The study identified the improvements that are necessary to provide acceptable traffic operations at the I-64/I-264 interchange through 2044. Given the extent of required improvements, it is reasonable to anticipate that improvements will be constructed through a series of smaller projects ("subprojects") undertaken over several years. Figure ES-1 illustrates the subprojects, which are described as follows (with no significance to the lettering or order):

- **Subproject A** - Improves the movement from eastbound I-64 to eastbound I-264. Improvements begin at the I-64/Northampton Boulevard interchange, and end at the mainline-C/D merge along eastbound I-264 east of the Newtown Road interchange.
- **Subproject B** - Widens eastbound I-264 from the mainline-C/D merge point east of Newtown Road to east of Witchduck Road. This subproject includes replacement of the bridge carrying I-264 over Witchduck Road, and improvements to eastbound ramps between I-264 and Newtown Road.
- **Subproject C** - Widens westbound I-64 from north of the Kempsville Road overpass to the exit ramp to Northampton Boulevard. This subproject also includes minor widening of westbound I-64 to operate a part-time shoulder lane during the weekday AM peak period between the exit ramp to Northampton Boulevard and the entrance ramp from Northampton Boulevard.
- **Subproject D** - Improves the movement from eastbound I-264 to westbound I-64. Improvements begin at the eastbound I-264 mainline-C/D roadway diverge point located west of the Military Highway interchange, and end along westbound I-64 north of the Kempsville Road overpass.

Figure ES-1 - Recommended Subprojects



- **Subproject E** - Improves the movement from the westbound I-264 C/D roadway to westbound I-64. Improvements include widening westbound I-264 west of the Witchduck Road interchange, constructing a new westbound I-264 outer C/D roadway, reconfiguring the north half of the I-264/Newtown Road interchange, and widening along westbound I-64 to provide a part-time shoulder lane north of Northampton Boulevard.
- **Subproject F** - Improves the movement from the westbound I-264 C/D roadway to eastbound I-64. Improvements begin along a new westbound I-264 C/D roadway and end along eastbound I-64 at the Indian River Road interchange.

All subprojects were developed to have logical termini and independent utility with respect to NEPA requirements. The subprojects were submitted to HRTPO for official scoring and prioritization towards inclusion in the 2045 Long Range Transportation Plan.

ES.6 Responses to FHWA Policy Requirements

This report addresses the Federal Highway Administration (FHWA) Interstate access policy requirements pursuant to guidance issued May 22, 2017.

Policy Requirement 1 - Operational and Safety Analysis

(a) An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections.

(b) The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access. The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network.

(c) Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network.

(d) Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative.

(a) Analyses performed for this study demonstrate that recommended improvements at the I-64/I-264 interchange will not have an adverse impact on safety and operations on the interstate network. Improvements on segments of I-64 and I-264 adjacent to the I-64/I-264 interchange have also been identified to support the finding that recommended improvements will not have an adverse impact on safety or traffic operations at adjacent interchanges, including ramps and the local street network. Recommended improvements yield benefits across all measures of effectiveness including travel times, densities, and delay.

(b) The study area for safety and operational analyses performed as part of this IMR satisfies the FHWA and VDOT requirements for roadway network analysis. The study focuses on improvements at the I-64/I-264 interchange, and the study area includes at least the first adjacent interchange in each direction:

- I-64/Northampton Boulevard interchange to the north
- I-64/Indian River Road interchange to the south
- I-264/Military Highway interchange to the west
- I-264/Newtown Road interchange to the east
- I-264/Witchduck Road interchange further east (included as the first adjacent interchange east of the begin/end of the I-264 C/D roadways, which are studied and recommended for improvement)

Analysis of the local street network included at least the first major signalized intersection on both sides of the interchanges identified above.

(c) Microsimulation analyses demonstrate that traffic operations on I-64 and I-264 will fail without improvements before 2044 conditions are realized. Analyses also demonstrate that the recommended improvements provide sufficient capacity at the I-64/I-264 interchange and adjacent interstate segments to address projected demand under 2044 conditions. The recommended improvements include widening of intersecting arterial roadways to provide additional through lanes, turn lanes, and bike/pedestrian enhancements.

Safety analyses demonstrate that the recommended improvements will reduce crash potential at the I-64/I-264 interchange and adjacent segments of I-64 and I-264. Analyses also indicate that these benefits will extend to improved segments of intersecting arterial streets.

(d) A conceptual signing plan has been prepared to demonstrate viability of the recommended improvements with respect to signage for motorist information and directional guidance.

Policy Requirement 2 - Access Connections and Design

The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards. In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.

Recommended improvements at the I-64/I-264 interchange provide full directional access between I-64 and I-264. Recommended improvements also provide full directional access at all other interchanges studied with the exception of the I-64/Northampton Boulevard interchange. At this location, the existing interchange does not provide the movement from eastbound Northampton Boulevard to westbound I-64. This IMR documents VDOT's justification for not constructing new infrastructure to accommodate the missing movement at the I-64/Northampton Boulevard interchange, which is based on cost, right-of-way impacts, environmental impacts, and anticipated utilization.

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CHAPTER 1: INTRODUCTION

1.1 Background

Project Background

This study was undertaken to investigate the need for and extent of required improvements to the I-64/I-264 interchange in Norfolk, Virginia. Based on total average daily traffic served, the interchange is estimated to be the third busiest interchange in Virginia, and is a critical link in the interstate system serving the Hampton Roads region. Under existing conditions, the interchange experiences recurrent congestion, operates with deficient geometry, and experiences high crash rates. Phase I and II improvements at this interchange are underway by VDOT, and focus on increasing ramp capacities and eliminating merge-weave conditions along eastbound I-264 east of I-64. This study focuses on Phase III improvements, which will address operational, geometric, and safety needs at the I-64/I-264 interchange, and improvements at adjacent interchanges as needed to enhance and preserve operations on the interstate system.

Corridor Overview

As shown in Figure 1-1, I-64 provides east-west directional travel through the Midwest and Mid-Atlantic regions of the United States. The I-64 corridor measures approximately 970 miles and crosses portions of Missouri, Illinois, Indiana, Kentucky, West Virginia, and Virginia. In Virginia, I-64 covers a centerline distance of 300 miles, between the West Virginia state line near Covington, Virginia, and the I-64/I-264 interchange in Chesapeake, Virginia. I-64 was constructed between the early 1960s and 1977. In 1995, all interstate highways (including I-64 and I-264) were designated as part of the National Highway System through enactment of the National Highway System Designation Act (PL 104-59).

Figure 1-1: I-64 Corridor Location

Source: "I-64." Wikipedia, en.wikipedia.org/wiki/Interstate_64#/media/File:Interstate_64_map.png

The I-264 corridor is illustrated in Figure 1-2, and provides east-west directional travel through portions of the cities of Chesapeake, Portsmouth, Norfolk, and Virginia Beach, Virginia. The I-264 corridor extends a distance of 26.4 miles, from the I-64/I-664 Bowers Hill interchange on the west to Parks Avenue in the City of Virginia Beach on the east.

Figure 1-2: I-264 Corridor Location

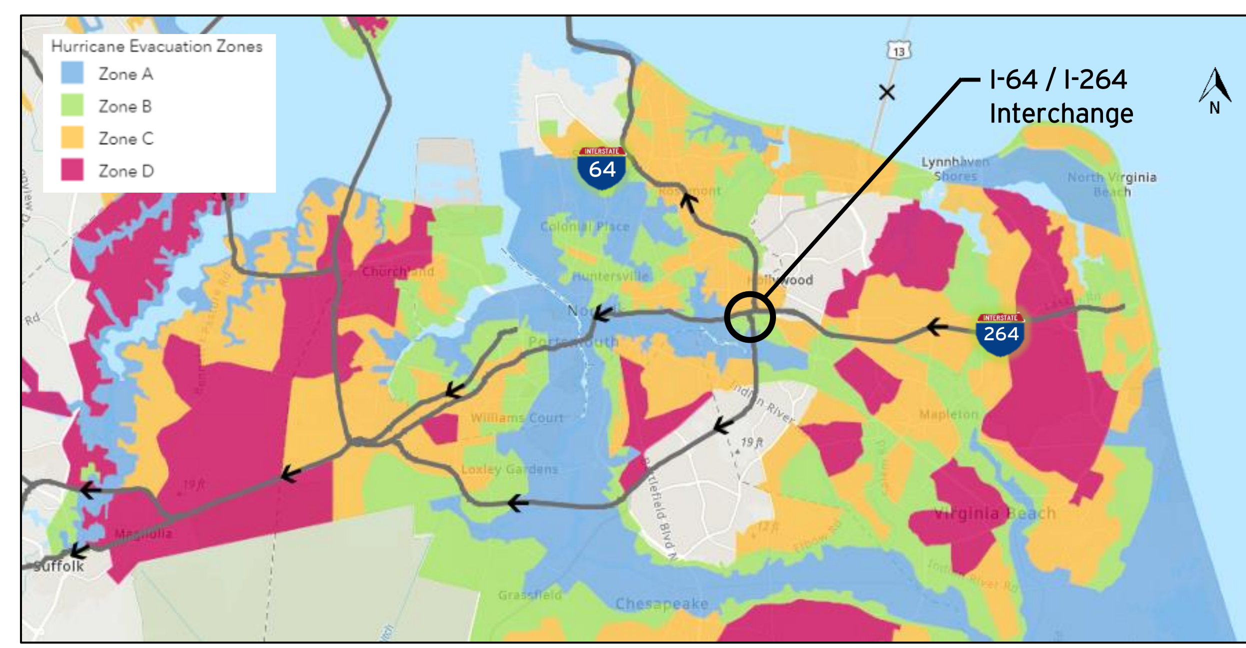
Source: "I-64." Wikipedia, en.wikipedia.org/wiki/Interstate_64-in_Virginia

West of I-64, I-264 was constructed in the mid-1960s. East of I-64, I-264 was constructed in 1967 as the Virginia Beach-Norfolk Expressway and designated Route 44 upon its completion as a toll road. In 1995, the bonds issued to fund construction were retired and tolls were removed from the highway in 1996. In 1999, the highway was renumbered to I-264 as an eastern extension of the original I-264.

Over time, I-64 and I-264 have supported steady economic growth throughout Hampton Roads, and currently serve a diverse mix of residential, commercial, retail, and recreational land uses. The interstates have played key roles in the development and ongoing operation of multiple military bases in the Hampton Roads region, underscoring the highway network's importance to national security.

The interstate system in the Hampton Roads area also serves a vital public safety function as the primary hurricane evacuation route away from the Atlantic Ocean and the Chesapeake Bay. The Virginia Department of Emergency Management identifies all coastal areas in the Hampton Roads region as being within one of four Hurricane Evacuation Zones (A-D) and identifies recommended evacuation routes. As shown in Figure 1-3, coastal evacuation routes from the cities of Norfolk, Chesapeake, and Virginia Beach involve travel within the study area on I-64, I-264, and/or travel through the I-64/I-264 interchange.

Figure 1-3: Hurricane Evacuation Zones and Routes



Source: Virginia Department of Emergency Management. vdemgis.maps.arcgis.com/apps/webappviewer/index.html?id=579752-4b9a58440c8dbc06816e060492

Tourism is a major economic driver for the Hampton Roads region, which provides a broad range of recreational, entertainment, and vacation facilities. These include urban centers, public beaches, multiple state and local parks, an aquarium and science center, amusement parks, golf courses, museums, and convention/conference centers. Based on data available from the Virginia Tourism Corporation, tourism-related visitation and tax revenues reached record levels in 2016 and 2017 for the region. In 2016, the City of Virginia Beach alone hosted more than 15.2M visitors and spending that year by tourists totaled approximately $1.5B. These data underscore the importance of the interstate highway network serving the Hampton Roads region to support tourism and sustain economic growth of the region derived from tourism.

The I-64/I-264 interchange experiences peak hour traffic congestion on a recurring basis during typical weekdays. Weekend traffic congestion is also pronounced, and worsens during the summer when vacation trips are oriented to the beach and other shore points.

Previous Studies by VDOT

In 1997, VDOT completed a study report entitled "*I-264 HOV Feasibility Study*" to evaluate the feasibility of HOV operations on I-264 (then Route 44). The study determined that HOV operations were feasible, and VDOT subsequently advanced HOV operations in the corridor.

VDOT conducted the "*I-264 Corridor Study*" from 2001-2006 focusing on identifying improvements in the I-264 corridor to address congestion and safety issues. The study reflected the assumption that the 21-mile Southeastern Parkway and Greenbelt would be constructed, resulting in some diversion of traffic off of I-264. The study recommended widening I-264 to provide additional through lanes, as well as improvements to interchanges at Newtown Road, Witchduck Road, Independence Boulevard, Rosemont Road, and Lynnhaven Parkway. Two tiers of potential improvements were identified, one estimated to cost $1.5B and a reduced level of improvement estimated to cost $1B.

VDOT prepared the report "*I-64/I-264 Interchange Modification Report*" for Phase I and Phase II improvements to westbound I-64 and eastbound I-264. These included capacity improvements for the westbound-to-eastbound ramp, extension of the eastbound collector-distributor roadway, eastbound ramp improvements at the Newtown Road and Witchduck Road interchanges, and construction of the Cleveland Street overpass of I-264. FHWA approved the IMR on November 14, 2011.

VDOT completed a study to evaluate alternative corrective strategies for bridges at the I-64/Northampton Boulevard interchange. The report "*Alternative Bridge Study, I-64 EB over Northampton Boulevard (US-13) at Exit 282 in the City of Norfolk*" was issued final on May 18, 2015.

On April 13, 2016, a final report entitled "*Interchange Operations Analysis Report, I-64/Northampton Boulevard Interchange*" was issued for an operational study of the I-64/Northampton Boulevard interchange funded through the Strategically Targeted Affordable Roadway Solutions (STARS) Program. The report documents the conceptual layout and evaluation of multiple improvements to the interchange and Northampton Boulevard east of the interchange to remove weave movements and alleviate recurrent congestion.

In July 2016, VDOT completed a study report entitled "*I-264 Corridor Evaluation Study*" which evaluated existing and projected conditions in the I-264 corridor, and developed a framework guidance for future improvements. The study focused on safety, operations, and geometry along I-264 from (and inclusive of) the Military Highway interchange on the west to the east terminus of I-264 at Parks Avenue. Potential improvements were identified at multiple locations along I-264, including interchanges at Military Highway, I-64, Newtown Road, and Witchduck Road.

VDOT completed a Concept of Operations study in 2017 for the conversion of existing HOV lanes to managed HOT lanes along I-64, from I-564 to I-264. This study covered Segment 1 of the I-64 HOV-to-HOT conversion program.

VDOT initiated a Concept of Operations study in 2018 for the conversion of existing HOV lanes to managed HOT lanes along I-64 within corridor Segment 2, which extends from in Norfolk I-264 to the I-664 Bowers Hill interchange.

VDOT initiated a feasibility study in July 2018 to evaluate operation of managed lanes throughout the Hampton Roads region.

Previous Studies by Others

The following transportation studies completed by local agencies were referenced for background information during the conduct of this IMR study:

- Military Circle / Military Highway Urban Development Area: A Vision for the Future, City of Norfolk, January 24, 2017.
- Comprehensive Plan for the Military Highway Corridor District, City of Norfolk, September 18, 2006.
- Study activities undertaken by the City of Norfolk focusing on improvements at the I-64/Military Highway interchange relative to local street connectivity, congestion relief, and enhanced access to the Tide light rail transit (LRT) facilities.
- Newtown Strategic Growth Area Master Plan, City of Virginia Beach, May 2010.
- Centerville Strategic Growth Area Master Plan, City of Virginia Beach, March 2013.
- Draft Update of the Burton Station Strategic Growth Area Master Plan, City of Virginia Beach, June 13, 2018.
- Pembroke Strategic Growth Area 4 Implementation Plan, City of Virginia Beach, November 10, 2009 and amended February 25, 2014.

1.2 Purpose and Need

Purpose

The purpose of this project is to relieve the recurring peak period congestion and reduce crash potential at the I-64/I-264 interchange and adjacent highway segments affecting operations at the interchange.

Need

Improvements are based on the following needs:

- Alleviate recurring daily congestion on interstate segments and ramps created by capacity constraints, merge movements, weave movements, and left exits. These indicate the need for widening of interstate mainline travelways, C/D roadways, and ramps to provide additional capacity, and reconfiguring interchanges to eliminate left exit ramps and eliminate or enhance operation of merge/weave movements. Interstate facilities experiencing severe congestion (flow densities >45 vehicles per lane per mile) during existing 2018 peak periods include the following:
    - Eastbound I-64, from Northampton Boulevard to I-264
    - Ramp from eastbound I-64 to eastbound I-264
    - Left exit ramp from westbound I-264 to eastbound I-64
    - Westbound I-264 mainline approaching I-64
    - Ramp from westbound I-264 C/D roadway to westbound I-64
    - Westbound Northampton Boulevard to eastbound I-64

  The following ramps and arterial segments operate with congestion that affects traffic operations at the I-64/I-264 interchange:
    - Entrance and exit ramps serving westbound I-264 at Newtown Road
    - Newtown Road, north of I-264
    - Entrance ramp from Witchduck Road to westbound I-264
    - Witchduck Road, north of I-264

- Enhance functionality of existing HOV lanes in the I-264 corridor by providing continuous HOV lanes through the I-64/I-264 interchange. Existing HOV lanes are interrupted by the placement of left exit ramps from eastbound and westbound I-264. In both directions, single-occupant vehicles weave across the HOV lane to exit I-264. In the eastbound direction, high-occupancy vehicles are forced to move into the adjacent general-purpose lanes to avoid exiting the highway to westbound I-64. In the westbound direction, the effects of the weaving movement are worsened by severe queuing upstream of the left exit ramp to eastbound I-64.
- Reduce the potential for crashes where historic crash rates are demonstrated to exceed the districtwide and/or statewide crash rates for similar facilities. Based on a detailed analysis of crash data, those locations include the following:
  - Westbound I-64 approaching the I-264 interchange, an area that is being addressed by construction of a current VDOT project (UPC 57048)
  - Eastbound I-264 at the mainline-C/D road diverge (peak crash rate 1.3 times the districtwide crash rate)
  - Westbound I-264 C/D road, between Newtown Road and I-64 (peak crash rate 3.5 times the districtwide rate)
  - Westbound I-264 mainline at Newtown Road (peak crash rate 3 times the districtwide crash rate)
  - Eastbound I-64 general-purpose (GP) lanes, from Northampton Boulevard to I-264 (peak crash rate 6 times the districtwide rate)
  - Westbound I-64 GP lanes, north of the entrance ramp from Northampton Boulevard (peak crash rate 3 times the districtwide rate)
  - Westbound I-64 GP lanes, north of the I-64/I-264 interchange (peak crash rate 3.5 times the districtwide rate)
  - Eastbound I-64 GP lanes, approaching the Indian River Road interchange (peak crash rate double the districtwide rate)
  - Westbound I-64 GP lanes, through the Indian River Road interchange (peak crash rate 3.5 times the districtwide rate)
  - Eastbound I-264 C/D road, between loop ramps at the Military Highway interchange (peak crash rate double the districtwide rate)
  - Westbound I-264 at the Witchduck Road interchange (peak crash rate 2.5 times the districtwide rate)
  - Eastbound I-264 mainline, I-64 to Newtown Road (peak crash rate double the districtwide rate)

1.3 Project Location and Study Area

Project Location

The project focuses on improvements to the I-64/I-264 interchange, which is located within the City of Norfolk. The study area encompasses areas within the City of Norfolk and the City of Virginia Beach, extending along I-64 to the north and south of the interchange, and along I-264 to the west and east of the interchange.

The project is located within the Hampton Roads Transportation Management Area, which is one of four urbanized areas with a population of 200,000 or greater within Virginia and therefore required by federal regulations to fall under the jurisdiction of a metropolitan planning organization.

Study Area Boundaries

FHWA guidelines for conducting IMR studies and preparing documentation to support requests for changes to interstate access are set forth in 23 USC 111, 23 CFR 710 and *Policy on Access to the Interstate System* (FHWA, May 2017). I-64 and I-264 are interstate facilities and designated part of the National Highway System. As a result, this interstate access change request by VDOT (specifically, this IMR document) is subject to review and approval by FHWA.

The study area for this IMR study includes the following roadways, ramps, and intersections:

- I-64, from approximately 1,000 ft north/west of Northampton Boulevard to approximately 1,000 ft west/south of Indian River Road, inclusive of interchanges at Northampton Boulevard, I-264, and Indian River Road;
- I-264, from approximately 1,000 ft west of Military Highway to approximately 1,000 ft east of Witchduck Road, inclusive of interchanges at Military Highway, I-64, Newtown Road, and Witchduck Road;
- All ramps serving the aforementioned interchanges;
- All ramps serving HOV, Express Lanes, or collector/distributor (C/D) roadways within the project limits; and
- Arterials and intersections (inclusive):
  - Indian River Road, from Reon Drive to Centerville Turnpike and Parkland Lane
  - Military Highway, from Corporate Boulevard to Poplar Hall Drive
  - Newtown Road, from Princess Anne Road/Kempsville Road to Cleveland Street
  - Witchduck Road, from Anvers Road to Cleveland Street
  - Northampton Boulevard, from Kempsville Road to Wesleyan Drive

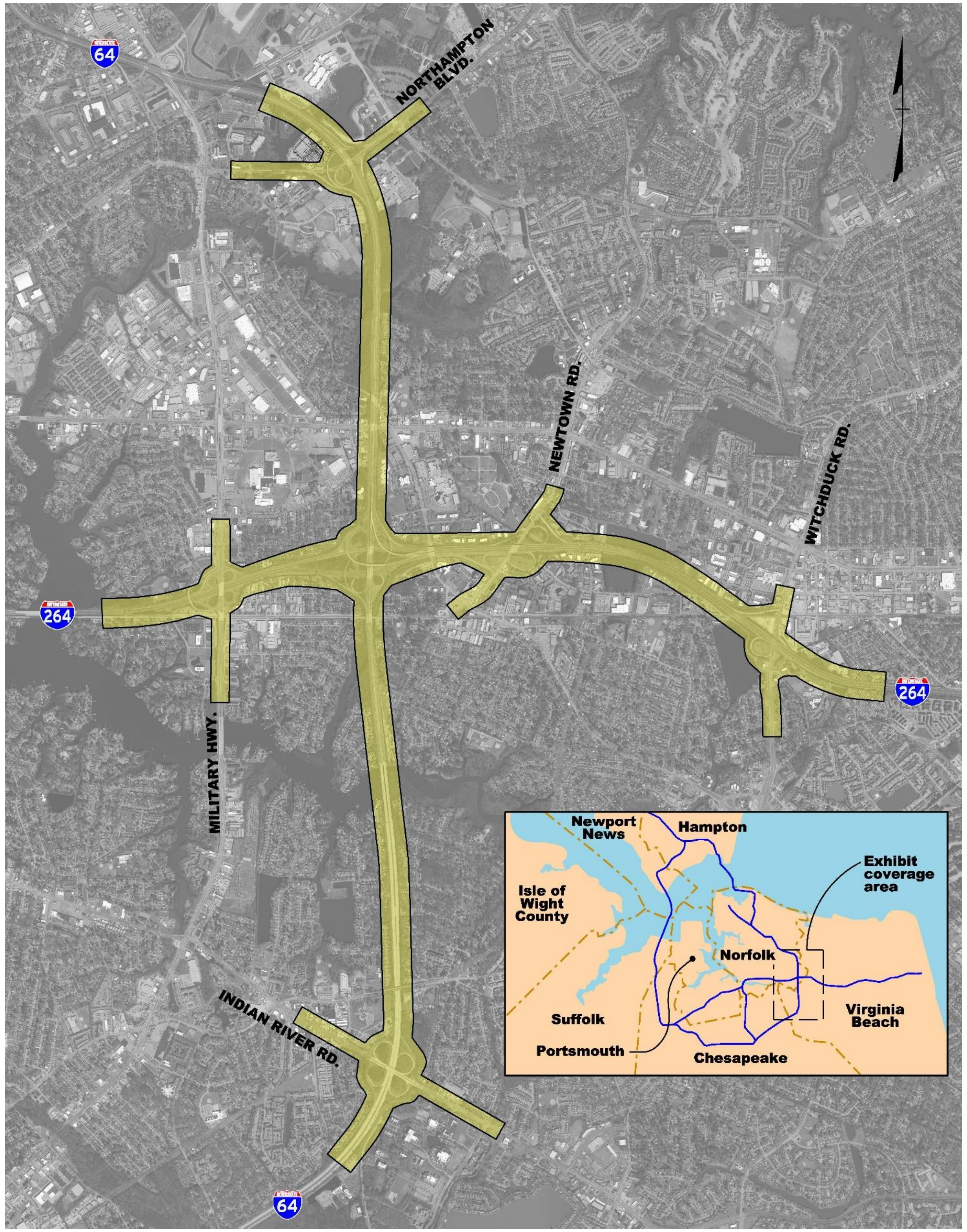
Figure 1-4 illustrates the overall study area. The IMR Framework Document is included in Appendix A.

Relationship to Other Highway Improvement Plans/Projects

The proposed project is near the following recent, ongoing, or programmed improvement projects:

- UPC 57048 - I-264 Interchange Improvements I-64 WB Ramp to I-264 EB (Phase I), VDOT
- UPC 17630 - I-264/Witchduck Road Interchange & Ramp Extension (Phase II), VDOT
- UPC 107044 - I-64/Northampton Boulevard Interchange Modification, VDOT
- UPC 1765, 9783, 84243 - Military Highway Continuous Flow Intersection, City of Norfolk
- UPC 112923 - I-64 Express Lanes Segment 2, VDOT
- CIP #2.409 - Centerville Turnpike Widening Phase 2 (Kempsville Road to Indian River Road), City of Virginia Beach
- CIP #2.135 - Cleveland Street Improvements Phase IV, City of Virginia Beach
- CIP #2.401 - Greenwich Road Crossover & Cleveland Street Improvements, City of Virginia Beach
- CIP #2.025 - Witchduck Road Phase II, City of Virginia Beach
- CIP #2.418 - Indian River Road/Kempsville Road Intersection Improvements, City of Virginia Beach

Figure 1-4: Study Area



1.4 Support and Commitment from Local Jurisdictions

Phase III improvements at the I-64/I-264 interchange (UPC 106693) are included in VDOT's Six-Year Improvement Program for FY2019 with total funding of $10M for Preliminary Engineering activities only.

The project is identified as a Group I Priority Project in the Hampton Roads Transportation Planning Organization (HRTPO) 2040 Long Range Transportation Plan (as approved July 21, 2016 and updated November 1, 2017) for the Hampton Roads region. The project is included in the HRTPO Transportation Improvement Program (UPC 106693) for FY2018-2021.

VDOT has coordinated with local agencies and stakeholders through a series of meetings. Meetings with staff representing the City of Norfolk and the City of Virginia Beach are summarized in Table 1.1.

Table 1.1: Summary of Local Agency Engagement

Activity	Attendees / details	Location	Date
Pre-scoping Meeting	VDOT, City of Norfolk, City of Virginia Beach, HNTB Corp., Seventh Point LLC	VDOT Offices Chesapeake, Virginia	January 30, 2018
Scoping Meeting	VDOT, City of Norfolk	VDOT Offices Chesapeake, Virginia	February 20, 2018
Project Kickoff Meeting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Chesapeake, Virginia	June 1, 2018
Study Team Meeting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Chesapeake, Virginia	July 31, 2018
Interchange Design Workshop #1	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	August 21, 2018
Interchange Design Workshop #2	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	September 18, 2018
Study Team Meeting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	October 11, 2018
Meeting on traffic forecasting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	November 15, 2018
Study Team Meeting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	February 21, 2019
Study Team Meeting	VDOT, FHWA, City of Norfolk, City of Virginia Beach, HNTB Corp.	VDOT Offices Suffolk, Virginia	April 9, 2019
Study Team Meeting	VDOT, City of Norfolk, City of Virginia Beach, HRTPO, HNTB Corp.	VDOT Offices Suffolk, Virginia	June 26, 2019

The proposed improvements are consistent with local and regional transportation plans, including the latest versions of the City of Norfolk General Plan, plaNorfolk2030, as well as the City of Virginia Beach Comprehensive Plan dated May 17, 2016.

CHAPTER 2: STUDY METHODOLOGY

The following summarizes the methodology used to develop and evaluate improvement alternatives for this project.

2.1 Overall Study Approach

The development of this IMR study and report complies with guidance provided by VDOT in a draft of IIM-LD-200.10 entitled "*Access Points to Interstate and Limited Access Highways (IMR / IJR Guidance)*". By included reference, this IMR study complies with the current FHWA/VDOT Stewardship and Oversight Agreement which defines agency oversight responsibilities regarding review and approval of access requests associated with interstate highways in Virginia.

The study evaluated alternative "build" scenarios against the projected future year "no build" scenario that is expected to result if no improvements were made. Alternatives were developed and screened using a three-tiered approach:

- Tier 1 Concept Development and Screening - Through a workshop and subsequent coordination activities, the Study Team developed sketch-level single-line diagram layouts for improvement alternatives. Basic alignments were developed to reflect design considerations associated with highway geometry, lane balance, and required lane count to address projected traffic demand. Concepts underwent an initial level of traffic analysis to identify operational issues associated with merge, diverge, and weave capacities. Tier 1 evaluations were based on these spot analyses of traffic operations, as well as order-of-magnitude right-of-way impacts and a qualitative assessment of relative construction costs. Three concepts were selected for more detailed Tier 2 development and evaluation.
- Tier 2 Concept Development and Screening - Three improvement alternatives were refined to further evaluate geometric requirements and provide more detailed information regarding impacts and construction costs. A microsimulation model was prepared for each improvement alternative to evaluate traffic operations, queuing, and merge/weave areas. Microsimulation analyses were performed only for the weekday PM peak hour under projected 2044 conditions based on the determination that the PM peak period experiences overall higher demand than the AM peak period. Based on the analyses performed and information developed under Tier 2 activities, the Study Team selected a recommended improvement alternative.
- Tier 3 Concept Validation - Additional microsimulation models were prepared for the recommended design alternative to evaluate the effectiveness of proposed improvements on traffic operations during projected 2044 weekday AM peak conditions, as well as 2024 weekday AM and weekday PM peak conditions.

A Study Team was formed to include representatives of VDOT, FHWA, the City of Norfolk, the City of Virginia Beach, and the engineering consultant to advance the project through the study and preliminary design phases. The Study Team met monthly to review interim deliverables; provide input on the development of design alternatives; make decisions regarding study activities; and serve as liaisons with their respective agencies and organizations external to the Study Team.

Alternative improvements were developed to represent a range of possible design solutions within the context of the following basic study objectives:

- Satisfy the purpose and need for the project;
- Comply with long-range transportation plans adopted by VDOT and local agencies; and
- Evaluate a phased implementation of the recommended improvements.

2.2 Traffic Forecasting

A technical memorandum on development of traffic volumes was completed in March 2018. This document is included in Appendix B, and contains detailed information regarding data collection, travel demand modeling, and traffic forecasting activities undertaken for this study. Development of traffic volumes focused on existing conditions, travel demand forecasting, and future traffic volumes.

This study used available traffic data from 2017 and 2018 collected by VDOT, the City of Norfolk, and the City of Virginia Beach. New traffic volume data collected in June 2018 for this study were evaluated to identify the overall peak hour of operations for weekday AM and weekday PM peak periods. Volumes were balanced between adjacent intersections and interchanges to reconcile variances in recorded data between count locations and count years. Data were factored to arrive at average annual conditions, based on monthly variances evidenced from continuous count stations operated by VDOT. With respect to pedestrian and bicycle activity, current year count data were supplemented with historic data collected previously by the City of Norfolk and the City of Virginia Beach. Information on transit was obtained from Hampton Roads Transit.

Travel demand modeling was performed using the current HRTPO regional model, reflecting programmed improvements identified in the HRTPO LRTP. Model runs were conducted to produce data for future 2020 and 2040 conditions. Using these data, an average annual growth rate was derived and applied to the existing 2018 volumes to produce projected 2024 and 2044 directional link traffic volumes for roadways within the study limits.

Model run output was post-processed using methodologies set forth in NCHRP Report 255 to arrive at future year projected turning movement volumes at study area intersections. Future volumes were prepared for the projected opening year (2024) and the 20-year planning horizon (2044).

2.3 Traffic Operational Analyses

Analysis Tools

Merge, weave, and diverge analyses undertaken for Tier 1 evaluation and screening of alternatives were performed using HCS software, Version 7.

For Tier 2 evaluation/screening of alternatives and Tier 3 concept validation, microsimulation analysis was used to evaluate traffic operations and performance of the interchange improvement alternatives. Specifically, VISSIM Version 10.00.08 software was selected as the primary tool to provide a microscopic level of traffic operational analysis because it has the ability to reflect impacts associated with queuing on roadway network components located upstream and downstream of the focus area.

Synchro Version 10 software was used to develop optimized traffic signal timing for all future scenarios. VISSIM was used to analyze and report intersection operations.

Modeling Approach and Assumptions

Application and use of VISSIM microsimulation software followed VDOT guidance set forth in Traffic Operations and Safety Analysis Manual (TOSAM), (v1, VDOT, November 2015), and FHWA guidance set forth in Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, (FHWA, June 2004). Specifically, activities undertaken for this study comply with cited guidance for model calibration, seeding time, determination of the number of simulation runs, simulation resolution, vehicle parameters, car-following models, lane-changing parameters, vehicle fleet, and measure of effectiveness (MOE) output reporting. The modeling approach and assumptions are consistent with the approved IMR Framework Document (refer to Appendix A) and

Calibration Memorandum (see Appendix C). Table 2.1 summarizes the VISSIM model parameters and assumptions.

Table 2.1: VISSIM Model Parameters and Assumptions

	Assumptions
VISSIM Version	Version 10
Entry Volumes (Input)	Two hours in 60-minute increments (peak hour factors greater than 0.95)
Heavy Vehicle Percentages	VDOT guidelines; use existing count data
Arrival Distribution	VDOT guidelines; use "Exact Volume"
Link Length	VDOT guidelines: no limitation on link length. Links should be continuous through areas with consistent lane configuration.
Auxiliary Lane Length	Use field measurements or proposed
Link Speed (Desired Speed Distributions)	VDOT guidelines indicate +/- 5 mph from the posted speed limit. However, past observations of free-flow speeds on the interstates indicate that drivers travel at a higher speed than the posted speed limit in unconstrained flow. Speed profiles will be developed based on INRIX data.
Car Following Model	VDOT guidelines; Wiedemann 99 car following model
Vehicle Parameters	VDOT guidelines
Vehicle Fleet	North America vehicle fleet
Performance Measure Intervals	VDOT guidelines; report in one-hour increments
Simulation Resolution	10 time steps/sec
Seeding Time	Seeding time should be approximately equal to either the actual peak hour travel time (in congested conditions) or twice the off-peak travel time, when traversing from one end of the network to the other. It is anticipated that a 30-minute seeding time will be necessary. Data from the data collection program will be reviewed to confirm duration.
Number of Simulation Runs	VDOT TOSAM guidelines
Random Seeds	Starting seed #1000, seed increment of 100
Vehicle Types	GP car, HOV car, bus, and heavy gross vehicle (truck)
Driver Behavior	Default or adjust for calibration; changes in behavior will be documented in calibration memo
Lane Change Distance	Based on sign locations, otherwise use default (656 ft)
Traffic Signal Timing	Local agency guidelines
Signal Controller Frequency	10

Model Calibration

The existing conditions VISSIM models for weekday AM and weekday PM peak hours were calibrated and validated to ensure the simulation output replicated observed conditions in the field. The following steps were used:

- Capacity calibration - VISSIM model parameters were adjusted to meet the calibration criteria of the throughput volumes. These include car-following and lane-changing parameters, and lane change distances for different facilities.
- System performance calibration - Travel time and speed profiles from VISSIM model results were compared to field measurements. Link free-flow speed and capacity related parameters were further refined to better match field conditions.
- Visual review - VISSIM simulation animation was reviewed to check queuing and congestion conditions between the model and field observations at known bottleneck locations.

The following criteria were used to verify the adequacy of the model calibration:

- Capacity calibration criteria - Throughput volumes served on interstate mainline segments, interchange ramps, and other modeled roadways, including each turning movement at all study intersections.
- System performance calibration criteria - Travel times and travel speeds along interstate mainline segments.

Details of the calibration process, measures of effectiveness, and model calibration results are documented in Appendix C.

Sequencing of Analyses

Table 2.2 summarizes the analysis workflow used to support the screening and evaluation process for design alternatives.

Table 2.2: Analysis Workflow

	Action	Period Studied	Comments
Initial	Evaluate 2018 conditions	weekday AM & PM	Identify existing deficiencies
Tier 1	Evaluate 2044 build conditions - interchange alternatives	weekday AM & PM	Identify future deficiencies
	Develop and evaluate alternative design concepts		
	Select Alternatives for Detailed Evaluation		
Tier 2	Evaluate 2044 build conditions - Alternatives A, B, C	weekday PM only	Weekday PM volumes highest
	Evaluate 2044 no-build conditions	weekday PM only	
	Select Preferred Alternative		
Tier 3	Evaluate 2044 build conditions - Recommended Alt.	weekday AM	Validate operations for recommended alternative during lower-volume periods
	Evaluate 2024 no-build conditions	weekday AM	
	Evaluate 2024 build conditions - Recommended Alt.	weekday AM & PM	

Tier 1 screening evaluated multiple design alternatives, including the preferred alternatives from prior studies. Selected alternatives from Tier 1 screening were carried into Tier 2 screening, which reflected analyses performed for 2044 weekday PM peak hour conditions. For this study area, total traffic volumes entering the study area are highest during the weekday PM peak period, and are projected to remain so through the 2044 planning horizon. Once a recommended alternative was identified, analyses were performed for 2044 weekday AM conditions with the recommended improvements in place. These analyses validated the selection of the recommended Build Alternative by confirming acceptable operations during the other study period having lower traffic volumes. The final series of analyses focused on projected 2024 conditions to reflect operations at opening year with the proposed improvements in place.

2.4 Safety Analysis Methodology

The safety analysis was performed in accordance with the methods identified in VDOT's Traffic Operations and Safety Analysis Manual (v1, VDOT, November 2015). Analysis results are summarized in Chapter 7.

CHAPTER 3: EXISTING CONDITIONS - 2018

This chapter describes existing conditions within the study area related to the roadway network, alternative travel modes, interchanges, and summary findings on traffic operations and crash experience.

3.1 Existing Roadway Network

The following describes the roadways within the study area under existing conditions.

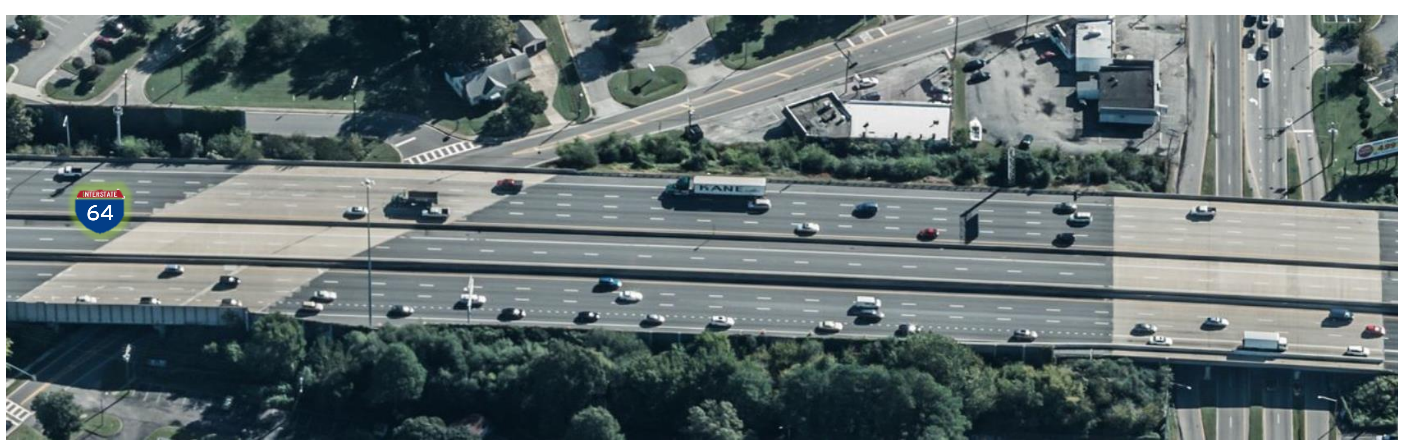
Interstate 64

I-64 and I-664 form the Hampton Roads Beltway. Within the study area, I-64 provides north-south directional travel, although corridor directional travel is established as westbound-eastbound, respectively. (This IMR document refers to corridor directional travel orientations, referring to 'westbound I-64' and 'eastbound I-64'.) Based on information provided through the VDOT website, the facility has a 2014 Federal Functional Classification of Interstate.

The Commonwealth Transportation Board (CTB) designated several Corridors of Statewide Significance, one of which is the East-West Corridor which includes I-64. Other transportation facilities in and near the study area encompassed by this corridor designation include I-664, I-564, I-264, local transit services, private railroad lines, the Port of Virginia, and Norfolk International Airport.

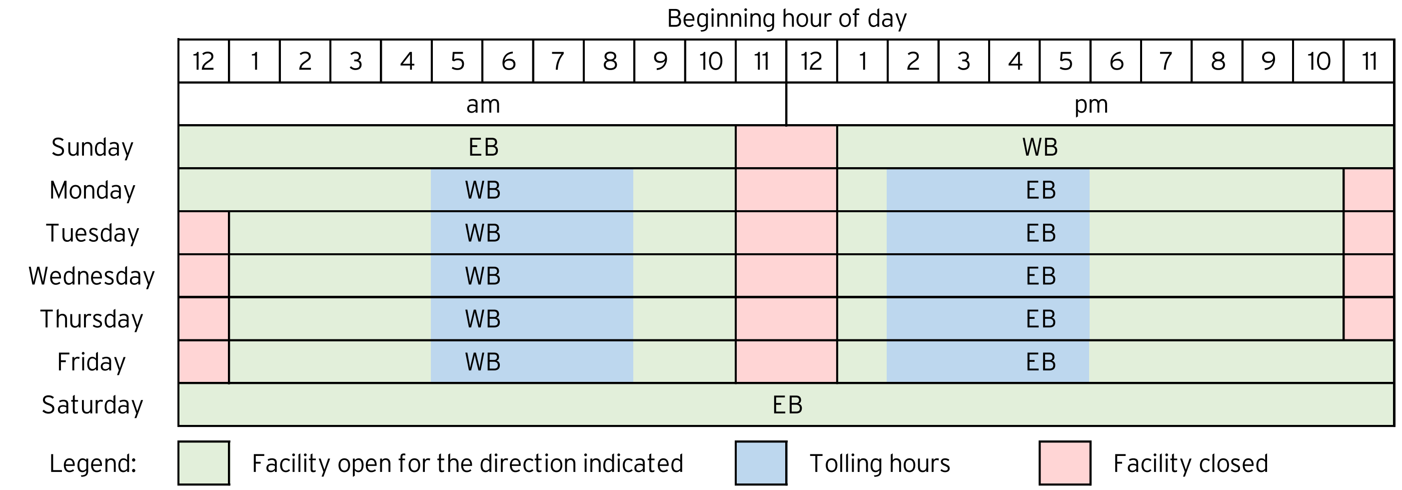
I-64 provides a basic number of three or four general-purpose through travel lanes in each direction within the study area, plus auxiliary lanes for entrance and exit ramps. Travel lanes measure 12 ft wide, and right shoulders generally measure 10-12 ft. Left shoulder widths vary, but typically measure less than the 12 ft required by VDOT design guidelines. Throughout the majority of the study area length, I-64 provides a concrete median barrier; south of the Eastern Branch Elizabeth River crossing at Twin Bridges, a variable-width depressed grass median is provided for a distance of approximately 3,400 ft. I-64 operates with a posted speed limit of 55 mph. Terrain in the I-64 corridor is generally level.

Figure 3-1: I-64, Existing Conditions (shown near crossings of Kempsville Rd. and Virginia Beach Blvd.)



Managed Lanes - The interstate provides a barrier-separated Express Lane (HOT) facility from the I-564 interchange, north of I-264, to approximately 1,100 ft north of the Eastern Branch of the Elizabeth River crossing, south of I-264. Tolls are charged to single-occupancy vehicles (SOV) in the Express Lanes from 5:00 to 9:00 am, and from 2:00 to 6:00 pm. HOV2+ vehicles are not tolled. The Express Lanes are reversible and operate on the schedule summarized in Figure 3-2.

Figure 3-2: I-64 Express Lanes Operating Hours



The remaining segments of the corridor within the study area operate with one HOV lane adjacent to and left of the general-purpose lanes. Operating hours for the HOV lanes are westbound 6:00-8:00 am, and eastbound 4:00-6:00 pm. During off-peak periods, the HOV lanes are open to all vehicles.

Limited Access Lines - I-64 is a limited access highway, consistent with its functional classification as an Interstate. Access limits for all interstates and other defense access highways in Virginia were imposed through resolution by the State Highway Commission of Virginia on October 4, 1958.

Based on a review of survey base mapping prepared by VDOT, the L/A lines along both sides of I-64 are, for the most part, continuous within the project limits. Breaks are not provided at overpasses of Kempsville Road, Virginia Beach Boulevard, and Pleasant Point Drive. L/A lines are continuous along all ramps within the study area.

Available record drawings for the I-64/Indian River Road interchange and the I-64/Northampton Boulevard interchange do not indicate the presence of L/A lines that extend along the arterial roadways, away from the ramp terminals. Additional research is needed to confirm the limits of existing L/A lines at these locations.

Interstate 264

I-264 provides regional travel in an east-west direction between Parks Avenue in Virginia Beach and Bowers Hill in Chesapeake, and provides direct access to downtown Norfolk, west of the study area. I-264 has a 2014 Federal Functional Classification of Interstate. As noted above in the section addressing I-64, I-264 is included in the East-West Corridor as a Corridor of Statewide Significance, as designated by the CTB.

Within the study area, I-264 operates with a through travelway and a barrier-separated C/D roadway in each direction. The C/D system measures approximately 2.5 miles long, with west and east termini located 0.3 miles west of Military Highway and 0.7 miles east of Newtown Road, respectively. The C/D roadway system provides direct access to interchanges at Military Highway, I-64, and Newtown Road. Along the I-264 through facility in each direction, left exits are provided to westbound and eastbound I-64.

I-264 provides a basic number of four through travel lanes in each direction, one of which is a left-side HOV lane that follows the eastbound and westbound through travelways. The HOV lane in each direction is discontinuous within the core of the I-64/I-264 interchange, allowing non-HOV traffic to access the left exits oriented to I-64. Auxiliary lanes are provided at entrance and exit ramp termini, and at the C/D roadway termini.

Figure 3-3: I-264, Existing Conditions (shown near crossing of Newtown Road)

The C/D roadways provide 2-4 travel lanes, including auxiliary lanes. East of the study area, outer (right) shoulders are used as general-purpose travel lanes during peak hours from the Witchduck Road interchange to 2,000 ft west of the Rosemont Road interchange, a distance of approximately three miles. The westbound shoulder lane operates weekdays from 6:00-8:00 am, and the eastbound shoulder lane is in operation weekdays from 4:00-6:00 pm.

A review of record drawings for Route 44 (now I-264) indicate that the facility was originally constructed to provide 12 ft wide travel lanes. A review of aerial imagery and survey base mapping indicates that average travel lane widths vary from 11.5 to 12 ft throughout most of the study area. Left shoulders on the through travelways measure 6-8 ft wide, and right shoulders measure 10-12 ft wide. Left shoulders on the C/D roadways measure 4-6 ft wide, and right shoulders measure 8-10 ft wide. The eastbound and westbound through travelways on I-264 operate with a posted speed limit of 55 mph. The C/D roadways operate without posted speed limits, and therefore operate with a statutory speed limit of 55 mph. Terrain in the I-264 corridor is generally level.

Limited Access Lines - Like I-64, I-264 is a limited access highway. The L/A line along each side of I-264 provides breaks at Military Highway Frontage Road, Kempsville Road, and Newtown Road. The newly constructed Cleveland Street overpass of I-264 will provide a break in L/A lines along the north and south sides of I-264.

L/A lines are continuous along ramps at all interchanges within the study area. The L/A lines along each side of Military Highway extend from Corporate Boulevard on the south to the Frontage Road intersection on the north.

The west L/A line along Newtown Road extends up to the skewed intersection at Center Drive, but does not meet the AASHTO guidance for urban areas to extend the L/A line for a minimum of 100 ft beyond the interstate ramp terminal. South of the interchange, the L/A line along the west side of Newtown Road extends approximately 200 ft south of the ramp terminal. Along the east side of Newtown Road, the L/A line south of the interchange is established between the loop exit ramp from eastbound I-264 and relocated Greenwich Road. North of the interchange, the L/A line deviates from the right-of-way line and extends approximately 45 ft beyond the curb return at the ramp terminal.

Along the west side of Witchduck Road, the L/A line south of the interchange stops along the turning roadway for the free-right turn movement to southbound Witchduck Road and does not extend beyond the ramp terminal. Along the east side of Witchduck Road, south of I-264, an L/A has been established to begin in the northeast quadrant of the Newtown Road/Grayson Road intersection, extending approximately 110 ft along the north side of Grayson Road.

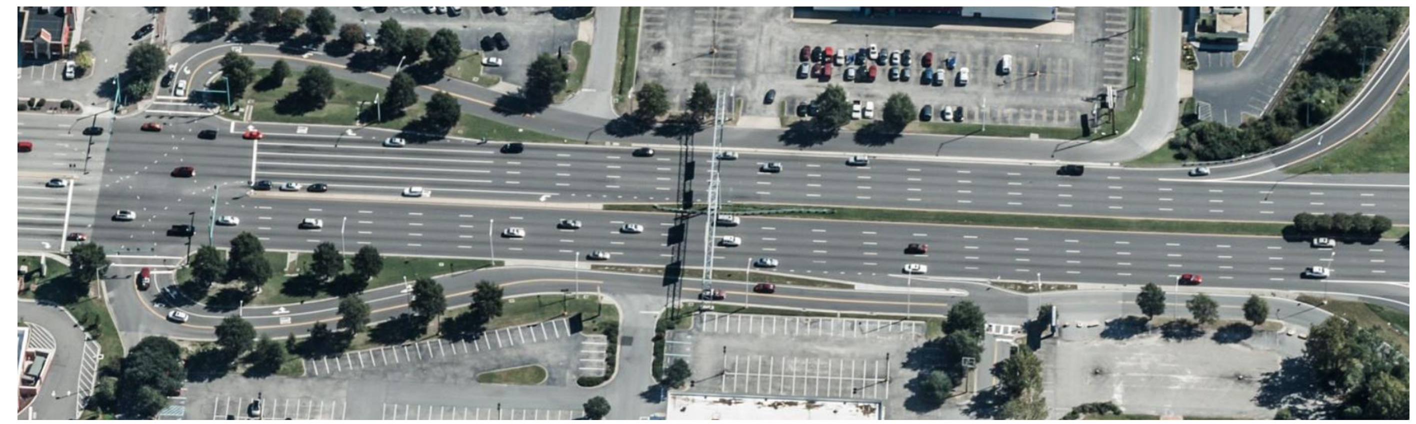
Survey prepared for recent improvement projects to the I-264/Witchduck Road interchange and Witchduck Road north of I-264 were reviewed to identify the location of existing L/A lines. While available survey files do not identify the location of the L/A lines north of the interchange, it is inferred that they are coincident with the existing right-of-way lines. With this assumption, the apparent L/A line along the west side of Witchduck Road does not likely satisfy AASHTO guidance because a commercial driveway is located approximately 55 ft north of the terminal of the entrance ramp to westbound I-264. Similar conditions prevail along the east side of Witchduck Road, north of I-264.

Available survey base mapping identifies existing right-of-way, but does not identify the location or presence of L/A lines. Right-of-way base files prepared for the recent Witchduck Road Phase 2 improvements identify new right-of-way lines and lines of acquisition, but do not identify any adjustments to L/A lines.

Military Highway

Originally constructed in 1942 for exclusive use by US military vehicles, Military Highway now provides travel along an alignment that is generally concentric to the I-64 Hampton Roads Beltway. Military Highway is classified by VDOT as a Principal Arterial. FHWA designates Military Highway as an "Other" NHS route. Virginia's Eastern Shore Corridor (of Statewide Significance) includes Military Highway.

Figure 3-4: Military Highway, Existing Conditions (shown between Hoggard Rd. and I-264 interchange)



Military Highway provides four through lanes in each direction, plus auxiliary and turn lanes at intersections, interchanges, and major commercial access points. A raised landscaped median and continuous roadway lighting are provided within the study area. Travel lanes measure 11-12 ft wide. The roadway operates with a posted speed limit of 40 mph north of I-264, and 45 mph south of I-264. Based on a review of record drawings and base mapping, limited access lines are established along the west and east sides of Military Highway between Hoggard Road and Corporate Boulevard.

Signalized intersections along Military Highway within the study area include those at Poplar Hall Drive and Hoggard Road north of I-264, and the intersection at Corporate Boulevard south of I-264.

Newtown Road

Newtown Road (Virginia Route 403) is a four-lane roadway classified by VDOT as an Urban Minor Arterial. Within the study area, Newtown Road is situated along the City of Norfolk - City of Virginia Beach limits.

Figure 3-5: Newtown Road, Existing Conditions (shown north of I-264 interchange)

The roadway provides a raised grass median and operates with a posted speed limit of 35 mph. Auxiliary and turn lanes are provided at signalized intersections and interchange ramp terminals. Travel lanes measure 11-12 ft wide. The roadway provides continuous roadway lighting and underdeck lighting at the bridge carrying I-264 over Newtown Road. Signalized intersections along Newtown Road within the study area include those at Center Drive, Stoney Point South, and Ethan Allen Lane/Cleveland Street north of I-264; and at Greenwich Road and Princess Anne Road/Kempsville Road south of I-264.

Witchduck Road

Witchduck Road (Virginia Route 190) is classified by VDOT as an Urban Minor Arterial. The roadway operates as a four-lane median-divided roadway with a posted speed limit of 35 mph.

Figure 3-6: Witchduck Road, Existing Conditions (shown from Mac Street to Cleveland Street, north of I-264)

The City of Virginia Beach is reconstructing the roadway between the I-264 overpass and the intersection at Virginia Beach Boulevard to the north. The improvements being made as part of the city's Witchduck Road Phase II improvement project include additional through lanes, additional turn lanes, sidewalks, new traffic signals, and creation of a cul-de-sac on Mac Street with direct access to Witchduck Road eliminated.

South of I-264, Witchduck Road is being reconstructed under a VDOT project to reconfigure the south half of the interchange at I-264. Improvements include additional travel lanes and turn lanes on Witchduck Road, reconfigured ramps to and from eastbound I-264, relocated ramp terminal intersections, new traffic signals, and new pedestrian facilities.

Indian River Road

Indian River Road (Virginia Route 407) is a six-lane median-divided roadway, and operates with a posted speed limit of 45 mph. Turn lanes and auxiliary lanes are provided at intersections and interchange ramp terminals. Lane widths measure 11-12 ft wide. Landscaped medians and continuous roadway lighting are provided. Signalized intersections within the study area are located at Reon Drive west of I-64; and at Regent University Drive and Centerville Turnpike/Parkland Lane east of I-64.

East of the southbound ramps to and from I-64, Indian River Road is classified by VDOT as a Principal Arterial; west of this location, it is classified as a Minor Arterial. Between the interchange at I-64 and Ferrell Parkway east of the study area limits, Indian River Road is designated by FHWA as a MAP-21 NHS Principal Arterial.

Figure 3-7: Indian River Road, Existing Conditions (shown at Strickland Boulevard, east of I-64)

Northampton Boulevard

Northampton Boulevard provides local and regional travel generally in northeast-southwest directions. East of I-64, Northampton Boulevard is designated as part of the Strategic Highway Network (or "STRAHNET" system), and as such, is a part of the NHS. The STRAHNET designation was made in 2002 by the US Department of Defense in consultation with FHWA, VDOT, and port operators, and identifies the roadway as part of the transportation system that is deemed necessary for mobilization of defense assets during peacetime and during defense emergency conditions. West of I-64, Northampton Boulevard is designated as an "Other" NHS route.

Within the study area, VDOT classifies Northampton Boulevard as a Principal Arterial. As a Corridor of Statewide Significance, the Eastern Shore Corridor includes US Route 13, local transit services, private railroad lines, the Port of Virginia, Norfolk International Airport, and Newport News/Williamsburg International Airport.

Northampton Boulevard is a six-lane median-divided roadway west of I-64. East of I-64, four lanes are provided in each direction. The roadway operates with a posted speed limit of 45 mph. Through lanes and auxiliary lanes typically measure 11 ft wide. Continuous roadway lighting is provided, as well as underdeck lighting at the bridge carrying I-64 over Northampton Boulevard. Signalized intersections within the study limits are located at USAA Drive/Kempsville Road, Ikea Way/entrance ramp to eastbound I-64, the exit ramp terminal from eastbound I-64, the exit ramp terminal from westbound I-64, and at Wesleyan Drive/Premium Outlets Boulevard.

Figure 3-8: Northampton Boulevard, Existing Conditions (shown at the I-64 interchange)

The ramp carrying westbound Northampton Boulevard to eastbound I-64 overpasses Northampton Boulevard with a four-span bridge. The bridge is posted for a vertical clearance of 13'-10" above eastbound Northampton Boulevard.

No posting is provided for westbound Northampton Boulevard. The existing bridge carrying I-64 over Northampton Boulevard is not posted for vertical clearance.

Design Constraints

Developed Properties - The project is located in urbanized areas of the Cities of Norfolk and Virginia Beach where most developable land is developed. Properties adjacent to interstates and other roadways within the study area have been developed with buildings, parking lots, and other site features in proximity to highway right-of-way. The location of these constructed features results in the need for alignment shifts, profile adjustments, and retaining walls incorporated into each of the build alternatives considered as part of this study. This applies particularly to the design of new or relocated interchange ramps. Figure 3-9 locates the following areas where developed properties present specific constraints:

- Northeast of the I-64/I-264 interchange - the Barry Robinson Center
- Southwest of the I-64/I-264 interchange - portions of the North Rolleston residential neighborhood
- Northwest of the I-64/I-264 interchange - portions of the Glen Rocks residential neighborhood
- North of I-264 between Newtown Road and I-64 - multiple commercial office buildings and parking lots
- North side of the I-264/Witchduck Road interchange - commercial and light industrial properties located adjacent to westbound I-264, immediately west and east of Witchduck Road
- Northeast of the I-64/Indian River Road interchange - a church and public parking lot along the north side of Indian River Road, east of I-64.
- Along I-64 south of Northampton Boulevard - Lake Taylor High School, Norfolk Academy, and residential development along the east side of I-64; a church located west of I-64 and south of Kempsville Road; and a strip commercial property located west of I-64 and south of Virginia Beach Boulevard.
- Along Northampton Boulevard - a newly constructed IKEA retail store west of I-64; Norfolk Academy, hotel, residential, and planned commercial development east of I-64.

Environmental Resources - The study area includes multiple environmental resources that were considered in the layout of design alternatives, and which must be considered during subsequent stages of project development. Table 3.1 presents a preliminary summary of known and potential resources by location within the study area, based on a Preliminary Environmental Review performed by VDOT in 2018.

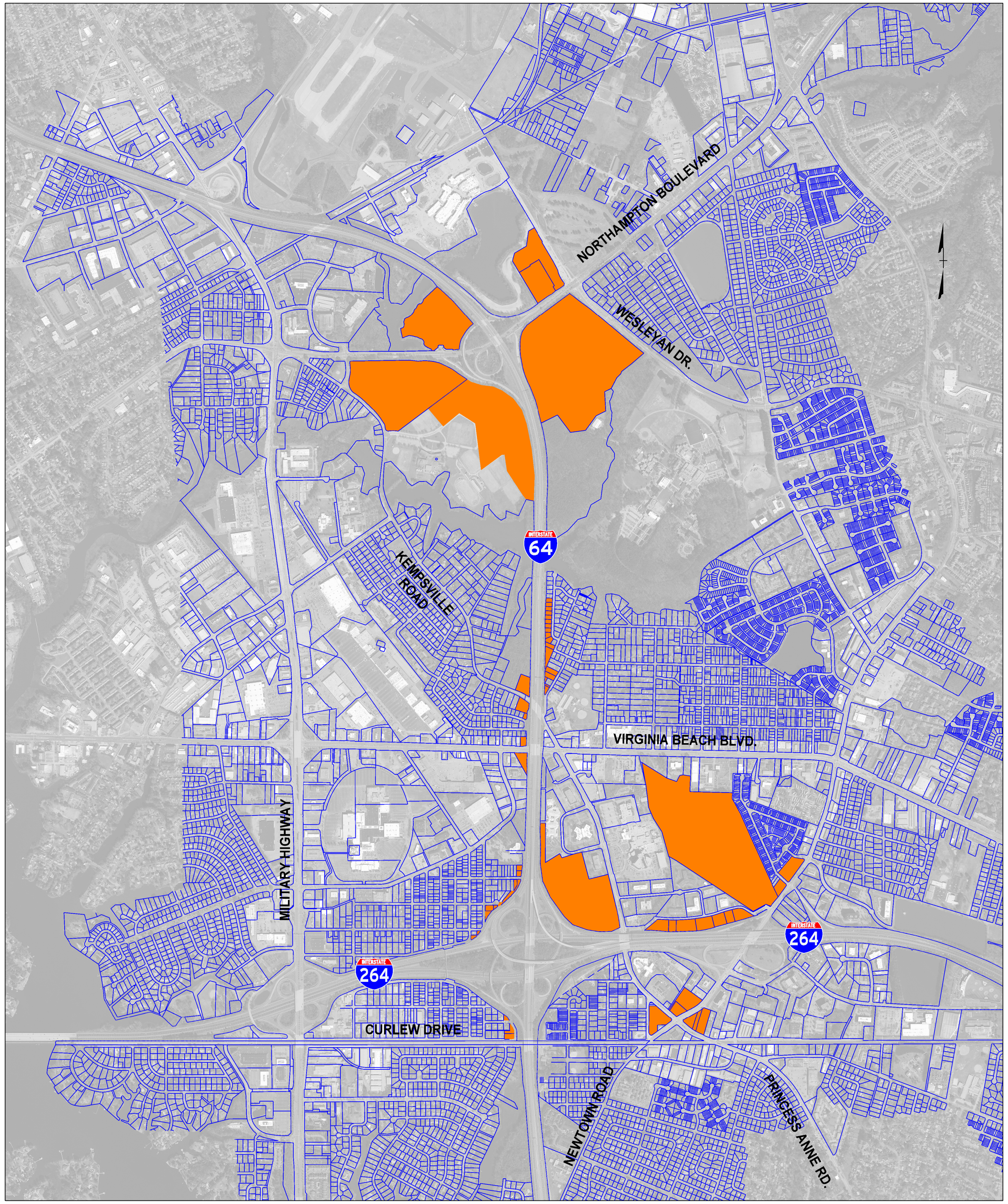
Additional resources may be identified through ongoing environmental investigations undertaken to support environmental documentation prepared for the project. Concept layouts have been prepared to minimize impacts to known and potential resources to the extent practical.

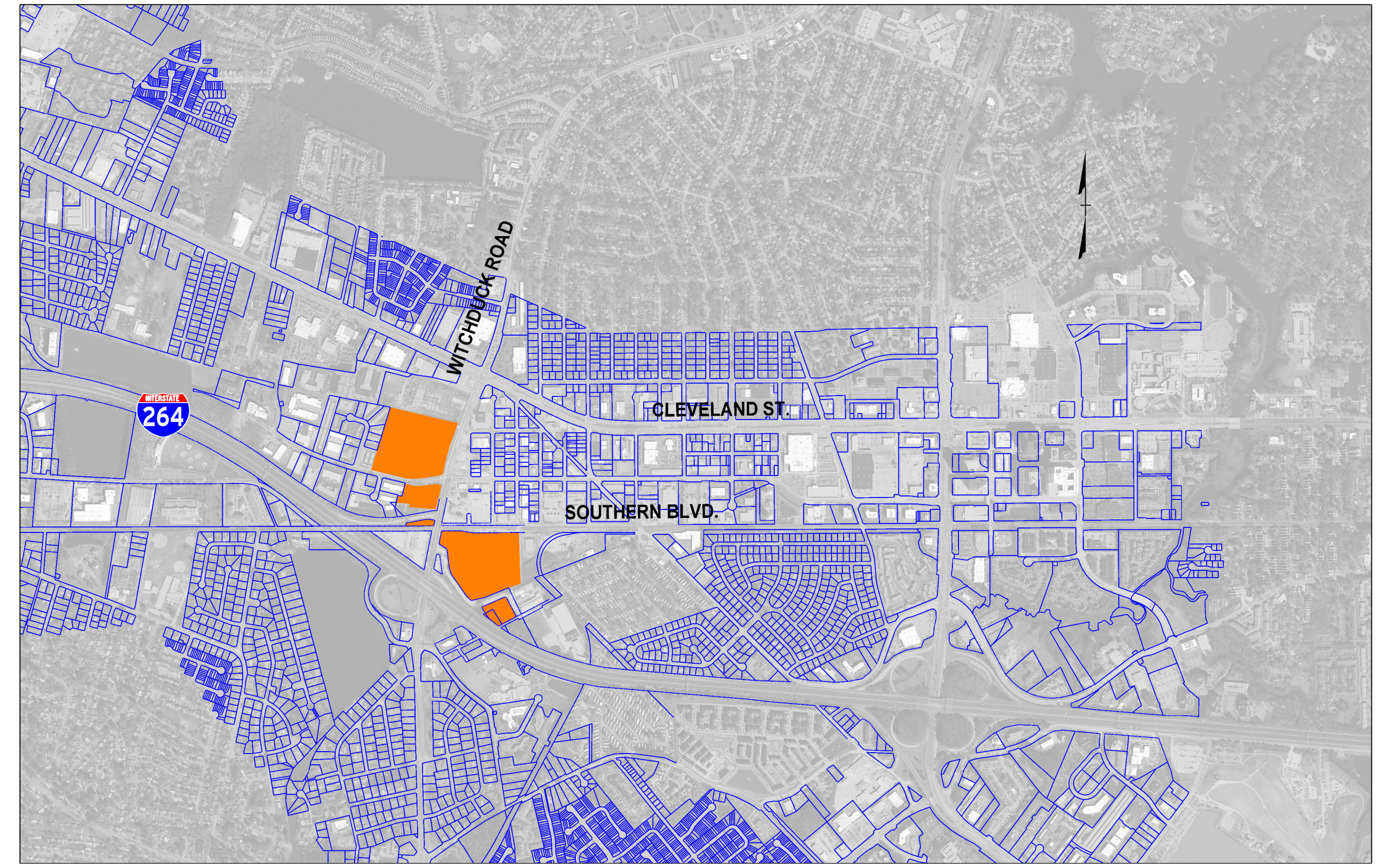
Table 3.1: Known and Potential Environmental Resources in/near Study Area

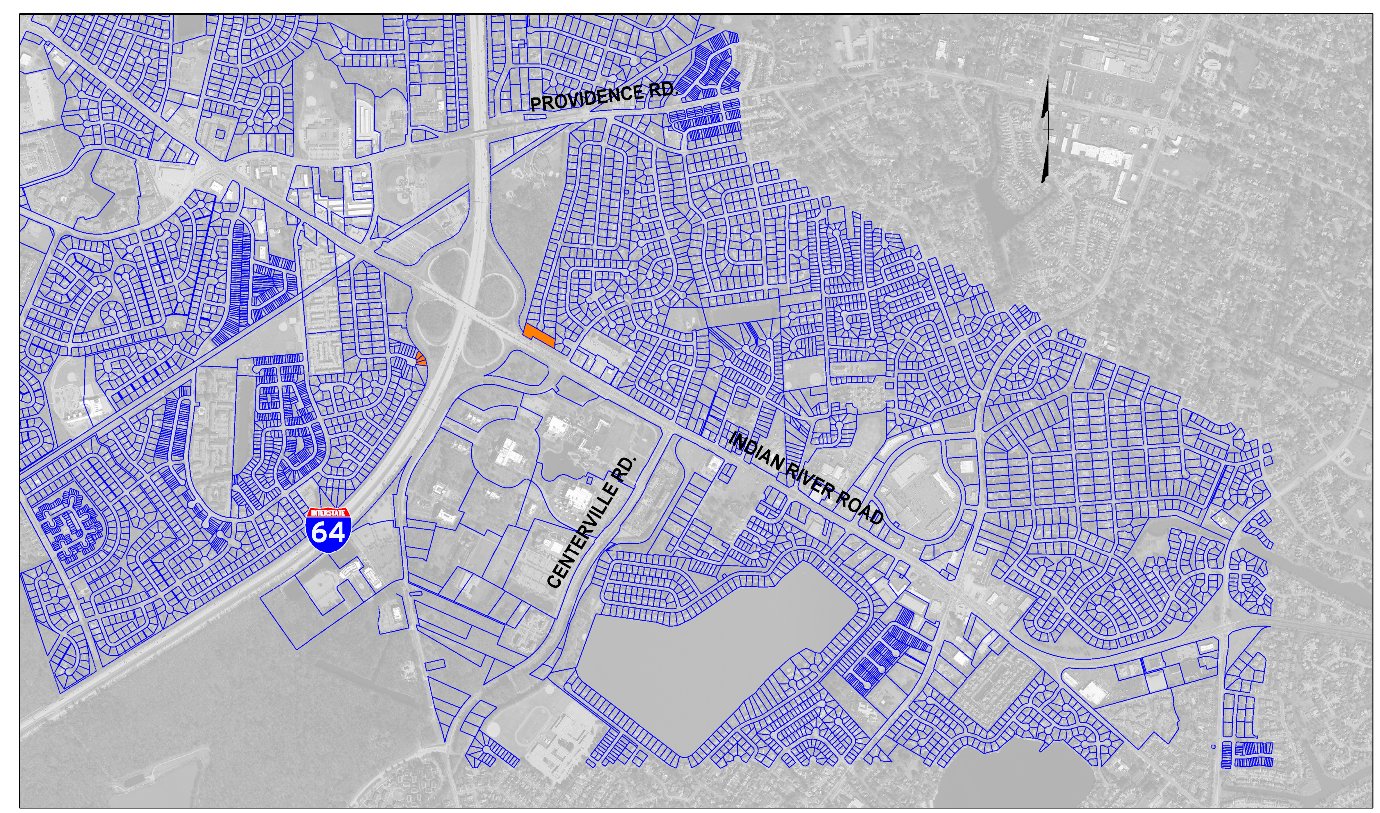
Interchange (vicinity)	Potential Resources
I-64/I-264	▪ Barry Robinson Center (NRHP listed) ▪ Fairlawn Estates neighborhood ▪ Glen Rock neighborhood ▪ North Rolleston neighborhood ▪ Archaeological Site 44NR0013 ▪ Easton School (potential 4(f)) ▪ Bald eagle nest (SE of interchange) ▪ Salt marsh wetlands ▪ Forested wetlands ▪ Channelized streams
I-264/Military Highway	▪ Tidal channels ▪ Stormwater management facilities with tidal influence
I-264/Newtown Road	▪ Lake #1, north of I-264 ▪ Lake #2, south of I-264 ▪ Channelized stream ▪ Stormwater ditches ▪ Stormwater management facilities
I-264/Witchduck Road	▪ Kemps Lake ▪ Stormwater ditches ▪ Channelized stream
I-64/Indian River Road	▪ Woodstock Park (potential 6(f)) ▪ Providence Park (potential 4(f)) ▪ Forested wetlands ▪ Stormwater management facilities ▪ Salt marsh wetlands
I-64/Northampton Boulevard	▪ Lake Taylor H.S. (potential 4(f)) ▪ Norfolk Academy (potential 4(f)) ▪ Lake Taylor ▪ Lake Wright (reservoir) ▪ Forested wetlands ▪ Boat access ramp (Lake Taylor) ▪ Wetlands

Note: Based on information contained in Preliminary Environmental Review, May 2018, VDOT. All data is subject to change.

Figure 3-9: Developed Properties Posing Potential Right-of-Way Constraints







3.2 Interchanges

I-64/I-264 Interchange

This system interchange has a hybrid configuration, consisting of loop, directional, and semi-directional ramps; HOV facilities along both interstates; and local (C/D) and through facilities along I-264. The interchange has three levels, with I-264 at the first level, I-64 at the second level, and the eastbound I-64-to-eastbound I-264 flyover ramp and a reversible HOV ramp at the third level. All ramps at this interchange provide one travel lane, except for two - the eastbound I-64-to-westbound I-264 ramp and the westbound I-264-to-westbound I-64 ramp each provide two travel lanes. High mast lighting and under-deck lighting is provided at most structures.

The interchange operates with consecutive tight-radius entrance and exit loop ramps along the eastbound and westbound I-264 C/D roadways. Merge-weave distances between these paired ramps are approximately 600 ft and 320 ft for westbound and eastbound, respectively. Merge-weave distances between these paired ramps along the I-64 mainline is more generous, at approximately 1,200 ft. The eastbound I-264-to-westbound I-64 loop ramp operates with an advisory posted speed limit of 20 mph; the other three loop ramps have an advisory posted speed limit of 25 mph.

Directional left exit ramps are provided from the westbound and eastbound I-264 through travelways, oriented to eastbound I-64 and westbound I-64, respectively. In the westbound direction, the ramp is located immediately beyond the bridge carrying I-64 over I-264, and the sight line to the ramp gore appears limited by bridge piers and vegetation. The left exits operate with posted advisory speed limits of 40 mph and 45 mph in the westbound and eastbound direction, respectively. Left exit ramps are undesirable for reasons associated with travel speed differentials in the left lane, interruptions to HOV lane continuity, and motorist expectations.

A reversible ramp is provided to connect the I-64 Express Lanes north of the interchange with the nonreversible HOV lanes on I-264 east of the interchange. The HOV lanes on I-264 operate westbound from 6:00 to 8:00 am, and eastbound from 4:00 to 6:00 pm.

The current VDOT project is reconstructing the westbound I-64-to-eastbound I-264 ramp to provide additional capacity and address merge-weave conditions on eastbound I-264 downstream of the interchange.

I-264/Military Highway Interchange

This interchange is a cloverleaf configuration, with tight-radius loop ramps and directional outer connections to both roadways. The loop ramps operate with an advisory posted speed limit of 20 mph. The outer connections also operate with an advisory posted speed limit of 20 mph, except for the northbound-to-eastbound ramp, which has an advisory posted speed limit of 15 mph. The I-264 mainline and ramps at this interchange are provided with continuous roadway lighting.

Merge-weave distances between the loop ramps along the I-264 C/D roadways measure approximately 400 ft. Merge-weave distances along Military Highway measure approximately 500 ft in each direction.

The bridge carrying the North Military Highway frontage road over I-264 constrains the layout of the outer connection ramps to and from southbound Military Highway. The gore for the eastbound I-264 exit ramp is placed immediately beyond the bridge. At this location, eastbound vehicles exiting at this interchange decelerate through a taper ramp having an approximate 5° angle of departure and an approximate deceleration length of 165 ft before the initial horizontal curvature. This value is approximately one-third the distance required to satisfy AASHTO design criteria. Similarly, the entrance ramp to westbound I-264 provides an acceleration distance of approximately 58 ft. This value is approximately 350 ft less than the distance required to satisfy current AASHTO guidelines.

I-264/Newtown Road Interchange

The existing interchange is a partial clover configuration. Loop ramps are provided in three of the four quadrants, each of which operates with an advisory posted speed limit of 25 mph. The directional ramps exiting and entering westbound I-264 each operate with an advisory posted speed limit of 35 mph. All ramps access either the eastbound or westbound C/D roadways along I-264. The current VDOT construction project is reconstructing the south half of the interchange to provide new eastbound exit and entrance ramps that provide additional capacity and address merge-weave conditions on I-264.

The interchange provides two entrance ramps from Newtown Road to westbound I-264 - a loop ramp from northbound Newtown Road, and a directional ramp from southbound Newtown Road. Both ramp terminals are located near the signalized intersection of Newtown Road at Center Drive.

I-264/Witchduck Road Interchange

This interchange is configured as a hybrid half partial clover/half split diamond layout. It is located east of the C/D roadway system serving I-264, and all ramps directly access the I-264 mainline travel lanes. The directional ramps exiting and entering westbound I-264 at this interchange each operate with an advisory posted speed limit of 25 mph. The current VDOT project will reconstruct the south half of the interchange to provide new eastbound exit and entrance ramps that provide additional capacity and address merge-weave conditions on eastbound I-264.

Under existing conditions, the directional ramps to and from westbound I-264 have terminal intersections along Witchduck Road located approximately 700 ft apart. Between these intersections lies a railroad line formerly owned by the Norfolk Southern Railroad, which was purchased by the City of Virginia Beach in 2008. The rail corridor was planned to be used for the eastward extension of The Tide LRT system into Virginia Beach until the system expansion initiative was suspended in 2016. Given its location and intended reuse, the rail corridor constrains the range of improvement alternatives for the westbound ramps at this interchange.

I-64/Indian River Road Interchange

This interchange is configured as a full cloverleaf layout, with loop ramps and outer connections provided in each quadrant of the interchange. Ramps are posted with advisory speed limits as follows:

- Loop exit ramps from eastbound and westbound I-64, and westbound Indian River Road loop ramp - 25 mph
- Eastbound Indian River Road loop ramp - 20 mph
- Outer connection ramps from eastbound and westbound I-64 - 30 mph
- Outer connection from westbound Indian River Road - 20 mph
- Outer connection from eastbound Indian River Road - 35 mph

The outer connection ramp to westbound I-64 provides a two-lane departure from westbound Indian River Road, which reduces to a single lane prior to the merge onto I-64. All other ramps provide one travel lane. All ramp terminals at Indian River Road provide free-flow conditions, and are configured to add or drop one travel lane along Indian River Road.

I-64/Northampton Boulevard Interchange

This interchange has a hybrid configuration, and consists of loop, directional, and semi-directional ramps. The interchange provides all directional movements, except for the eastbound Northampton Boulevard-to-westbound I-64 movement. This missing movement is accommodated at the adjacent interchange along I-64 to the northwest at Military Highway/Robin Hood Road. Conversely, that interchange does not accommodate complementary directional movements provided at the Northampton Boulevard interchange. VDOT recently completed a project to provide the eastbound I-64-to-westbound Northampton Boulevard movement, and increase capacity of the signalized intersection serving the westbound I-64 exit ramp terminal.

Ramps are posted with advisory speed limits as follows:

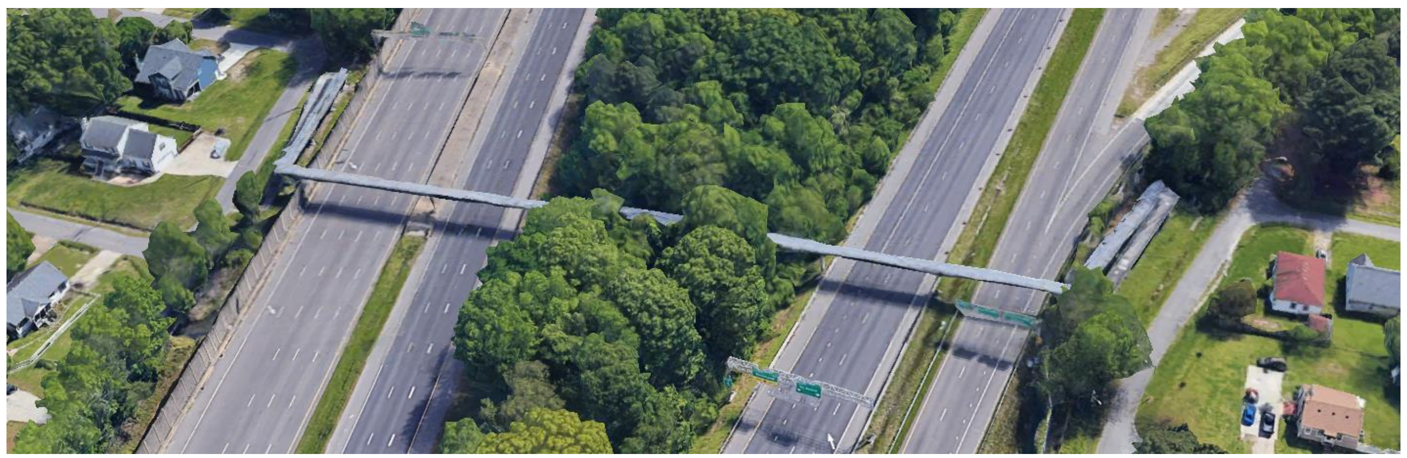
- Westbound I-64 exit ramp - 35 mph
- Eastbound I-64 exit ramp - 30 mph
- Westbound Northampton Boulevard exit ramp to westbound and eastbound I-64 - 25 mph, posted at the diverge point for the directional ramps; it is not clear if the posting applies to one or both ramps.
- Eastbound Northampton Boulevard exit ramp - 45 mph

3.3 Existing Alternative Travel Modes

Pedestrian and Bicycle Facilities

I-64/I-264 Interchange - A bridge is located approximately 1,500 ft west of the I-64/I-264 interchange to allow pedestrians and bicyclists to cross the I-264 corridor. The grade-separated crossing is accessed by ramp approach structures located along Hargrove Street on the south and along Chambers Street on the north. The bridge across I-264 is a six-span structure, with a cast-in-place concrete deck on steel girders. The total structure length is approximately 520 ft, exclusive of ramp structures. Hammerhead piers are used.

Figure 3-10: Pedestrian Bridge over I-264, Existing Conditions (shown facing east)



Military Highway - North of Corporate Boulevard, sidewalks are present along the west side of Military Highway, and along the east side of the South Military Highway east frontage road. The west side sidewalk diverges from the highway corridor and terminates in a commercial office park situated south of Curlew Drive. The east sidewalk continues northward to Curlew Drive; from here, pedestrians are provided a sidewalk connection along the North Military Highway frontage road to the north side of the I-264 corridor. This sidewalk stops south of Pebble Lane and provides no connection back to the Military Highway corridor or into the Poplar Hall neighborhood. There are no sidewalk connections along Military Highway through the I-264 interchange area.

A 300 ft-long segment of meandering sidewalk has been constructed along the west side of Military Highway between Poplar Hall Drive and Hoggard Road. Marked and unsignalized crosswalks are provided at the Military Highway/Poplar Hall Drive intersection. The meandering sidewalk terminates on the south at Hoggard Road, with no connections east, west, or south of that point, and with no signal-controlled or marked crosswalks.

There are no bike facilities provided along Military Highway in the study area.

Newtown Road - Under existing conditions, sidewalks are present along both sides of Newtown Road north of the Kempsville Road/Princess Anne Road intersection. The west sidewalk stops 250 ft short of Greenwich Road; the east sidewalk stops 280 ft north of Greenwich Road. From there, pedestrians have worn a path into turf areas extending to the north side of the interchange, up to the westbound I-264 exit ramp. A current VDOT project to improve the south half of the interchange will construct a new continuous sidewalk along the west side of Newtown Road northward to the Center Drive intersection.

The intersection with Kempsville Road/Princess Anne Road provides signalized pedestrian crosswalks on all legs of the intersection. The north leg of the intersection at Ethan Allen Lane/Cleveland Street also has a signalized pedestrian crossing.

There are no bicycle facilities provided along Newtown Road within the study area.

Witchduck Road - A shared-use path exists along each side of Witchduck Road south of the intersection at Greenwich Road/Grayson Road. North of this location, a short segment of sidewalk is provided along the west side of Witchduck Road, with no connections further north. Through the I-264 interchange, pedestrian facilities are not provided. The current VDOT construction project to improve the south half of this interchange will provide a continuous sidewalk along the east side of Witchduck Road between Grayson Road and the south terminus of the Witchduck Road improvement project being undertaken by the City of Virginia Beach.

The east, west, and north legs of the intersection with Cleveland Street operate with signalized pedestrian crossings. The city's current construction project north of I-264 will improve pedestrian facilities and will provide more signalized crosswalks. The south leg at Greenwich Road/Grayson Road intersection has a signalized pedestrian crossing.

The current construction projects being undertaken by VDOT and the City of Virginia Beach along Witchduck Road do not include new bike facilities.

Indian River Road - Within the study area, continuous sidewalks are provided along both sides of Indian River Road. Signalized pedestrian crosswalks crossing Indian River Road are provided at the intersections with Centerville Turnpike and Regent University Drive. Signalized crosswalks are not provided at Reon Drive. There are no bike facilities along Indian River Road within the study area.

Northampton Boulevard - There are no sidewalks provided along Northampton Boulevard within the study area. The only intersection along Northampton Boulevard with signalized pedestrian crossings is at Wesleyan Drive/Premium Outlets Boulevard. An on-street bike lane is provided in each direction along Northampton Boulevard west of I-64.

Transit Service

The study area is served by Hampton Roads Transit (HRT), which operates several transit services within the study area, described in the following sections.

Bus Service - Table 3.2 summarizes information for the bus routes that have stops within the study area.

HRT's bus Route 20 (Downtown Norfolk Transit Center to Virginia Beach Oceanfront) travels along or across roadways within the study area, but does not have designated stops within the study area.

The majority of bus stops along public roads within the study area do not provide any user amenities such as shelters, information kiosks, or benches.

LRT Service - The Tide is a 7.4 mile-long light rail transit system that operates a total of 11 stations. Two stations are located in or near the study area:

- The Military Highway Park & Ride Station is located on Curlew Drive, just west of Military Highway. The park and ride facility has a capacity of 259 spaces, and provides user amenities including a shelter, information kiosks, fare machines, lighting, benches, and a drop-off parking lane along Curlew Drive.
- The Newtown Park & Ride Station is located at the intersection of Curlew Drive and Newtown Road. The station is the easternmost in the system and is situated at the Norfolk-Virginia Beach city line. The park-and-ride facility has a capacity of 260 spaces, and provides user amenities including a shelter, bike racks, information kiosks, fare machines, lighting, and benches.

Table 3.2: Transit Service Information

Route	Stop Locations within Study Area	Direction	Interstate(s) Used	Periods of Operation
Route 12 South Norfolk / TCC-Virginia Beach	Along Indian River Rd.	EB & WB	(none)	Weekdays & Saturdays 5:48 am - 9:35 pm
Route 15 Robert Hall Blvd. / Evelyn T. Butts Ave.	Along Military Hwy., stop at Military Hwy. LRT station	NB & SB	(none)	Weekdays 4:48 am - 1:16 am Saturdays 5:18 am - 12:45 am
Route 22 Newtown Rd. Station / Joint Exp. Base Little Creek	Along Newtown Road, stop at Newtown Rd. LRT station	NB & BB	(none)	Weekdays & Saturdays 6:03 am - 6:56 pm
Route 23 Norfolk General / JANAF / Military Circle	Along Military Hwy., stop at Military Hwy. LRT station	NB & SB	(none)	Weekdays 5:07 am - 1:34 am Saturdays 5:07 am - 1:17 am
Route 25 Military Circle / TCC / Sentara Princess Anne	Along Newtown Rd. and Princess Anne Rd., stop at Newtown Rd. LRT station	SB/EB & WB/NB	(none)	Weekdays 6:02 am - 1:02 am Saturdays 6:07 am - 1:01 am
Route 27 Newtown Rd. Station / Pleasure House Rd.	Along Newtown Rd., stop at Newtown Rd. LRT station	NB & SB	(none)	Weekdays 5:48 am - 12:56 am Saturdays 5:48 am - 1:03 am

Start/end time of routes shown, not stops within study area. Stops are sequenced along a fixed route, but each stop within study area may not be shown on transit schedule.

Regional Bus Service - HRT operates the MAX regional express bus service, which connects commuters to employment centers and cities across the Hampton Roads region. The following MAX routes travel along interstate segments and ramps within the study area:

- Route 922, Greenbrier Mall Park & Ride to Gate 4 - travels along eastbound and westbound I-64 between points north of Northampton Boulevard and south of Indian River Road, with a stop at the Indian River park-and-ride lot in each direction.
- Route 967, Military Highway Station to Newport News Transit Center - travels along eastbound and westbound I-64 south of Indian River Road, with a stop at the Indian River park-and-ride lot in each direction.
- Route 919, Virginia Beach to Joint Forces Staff College Norfolk / Naval Station Norfolk - travels along eastbound and westbound I-64 between a point north of Northampton Boulevard and I-264; and along eastbound and westbound I-264 between I-64 and the Independence Boulevard interchange.
- Route 960, Norfolk to Virginia Beach - travels along eastbound and westbound I-264 between points west of Military Highway and points east of Witchduck Road.

Paratransit Service - HRT offers federally-mandated paratransit service throughout the Hampton Roads region. The service provides point-to-point transportation service through an advance reservation and scheduling program, and serves persons with disabilities who are unable to use the fixed-route system because of their disability.

3.4 Existing 2018 Traffic Data

Data Collection

Data collection activities were undertaken by the Study Team in June 2018, prior to the end of the 2017-2018 school year, and consisted of:

- Intersection turning movement counts at 24 intersections in the study area, collected in 15-minute increments;
- 24-hour volume and classification counts at 30 locations, including mainline I-64 & I-264, and entrance and exit ramps, collected for four hours in 15-minute increments during AM and PM peak periods;
- Travel time runs along I-64, I-264 thru lanes and C/D roads, and three select ramp-to-ramp movements;
- Field observations during the identified weekday AM and PM peak periods to assess queues, traffic patterns, driver behavior, and travel speeds.

Supplemental data from other sources were gathered and used in this IMR study, if the data were less than two-years old at the start of this study. Count data older than two-years old were not used as a primary source, but were used as a reference check for current counts. The supplemental data included:

- Ramp counts from I-64 HOV to HOT Conversion Feasibility Study, dated September 2016, based on traffic volume data from 2015.
- Intersection turn movement counts for intersections along Indian River Road within the study area, provided by the City of Virginia Beach. Data are from September 2017.
- Data from VDOT permanent count station located on I-64 north of Indian River Road. Data are from the days coinciding with the traffic data collection program undertaken for this study.
- VDOT daily classification counts, 2017.
- I-64 and Northampton Boulevard Interchange, Interchange Operations Analysis Report, dated April 2016, based on traffic volume data from 2015.
- Military Highway Continuous Flow Intersection Traffic Operations Technical Report, dated June 2014, based on traffic volume data from 2012.
- Mainline, ramp, arterial and intersection counts from I-264 Corridor Evaluation Study, dated July 2016, based on traffic volume data from 2014.
- Transit ridership data for bus routes having stops within the project limits, provided by Hampton Roads Transit for the period January 2018 to May 2018.
- Crash data for 2015 through 2017, from VDOT Tableau; as well as FR-300 reports for key locations.

Existing 2018 Peak Period Traffic Volumes

Traffic volumes for movements entering the study area were reviewed and analyzed to identify the peak periods during weekday morning and weekday afternoon within the study area. The AM and PM peak periods were calculated to occur from 7:00 to 9:00 AM and from 3:45 to 5:45 PM. Traffic volumes for existing 2018 conditions are illustrated on the following pages in Figures 3-11 through 3-22, which provide data for Hour 1 and Hour 2 during each peak period.

Network traffic volumes were developed for the 2018 existing conditions periods based on the data collected, as described above. Traffic volumes were balanced for the weekday morning and weekday afternoon by following data processing and analytical procedures described in NCHRP Report 765. Data from previous studies were also reviewed to validate volumes within the study area.

Figure 3-11: Traffic Volumes, Existing 2018 AM Conditions, I-64/I-264 Interchange

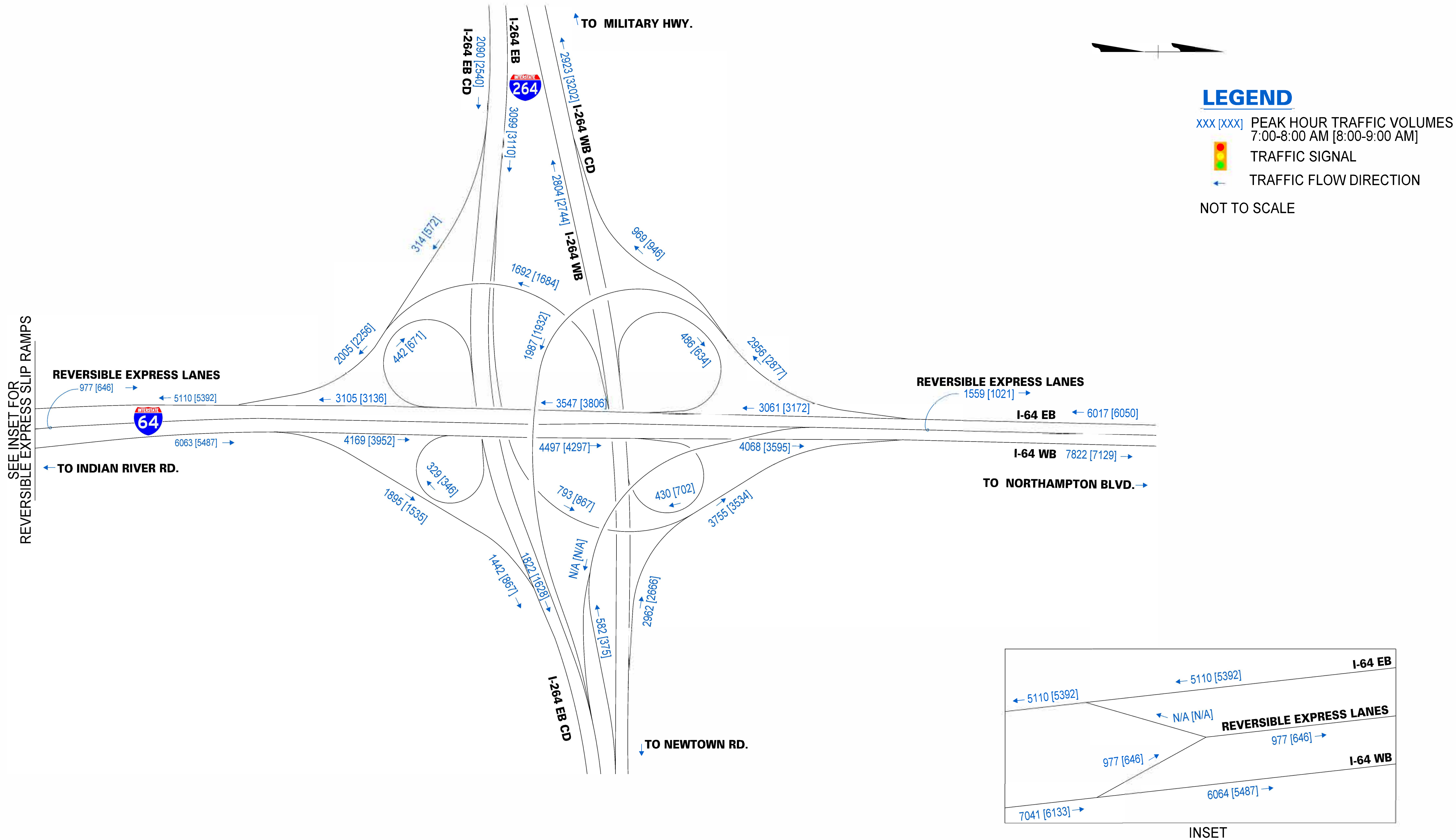


Figure 3-12: Traffic Volumes, Existing 2018 AM Conditions, I-264/Military Highway Interchange

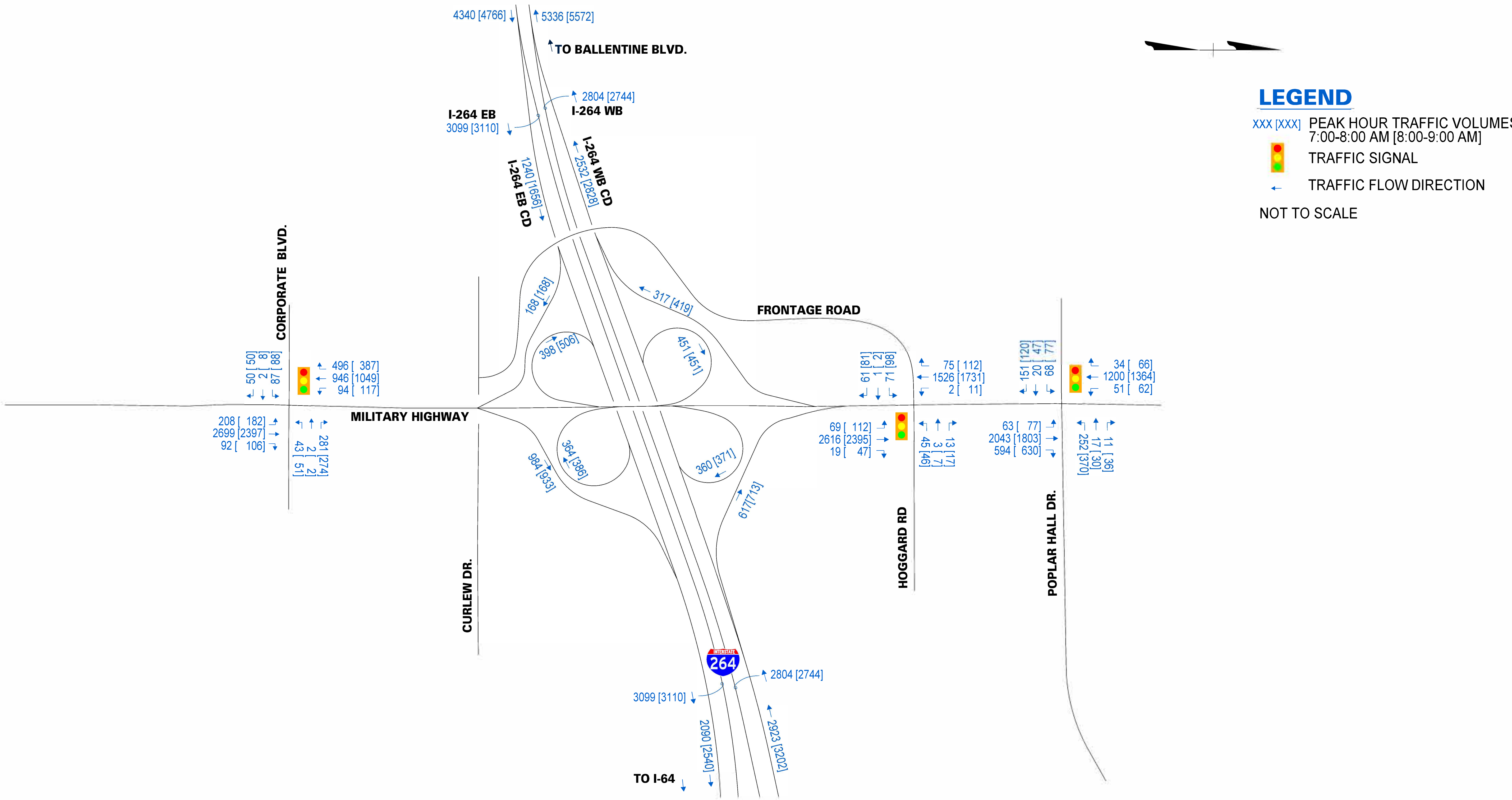


Figure 3-13: Traffic Volumes, Existing 2018 AM Conditions, I-264/Newtown Road Interchange

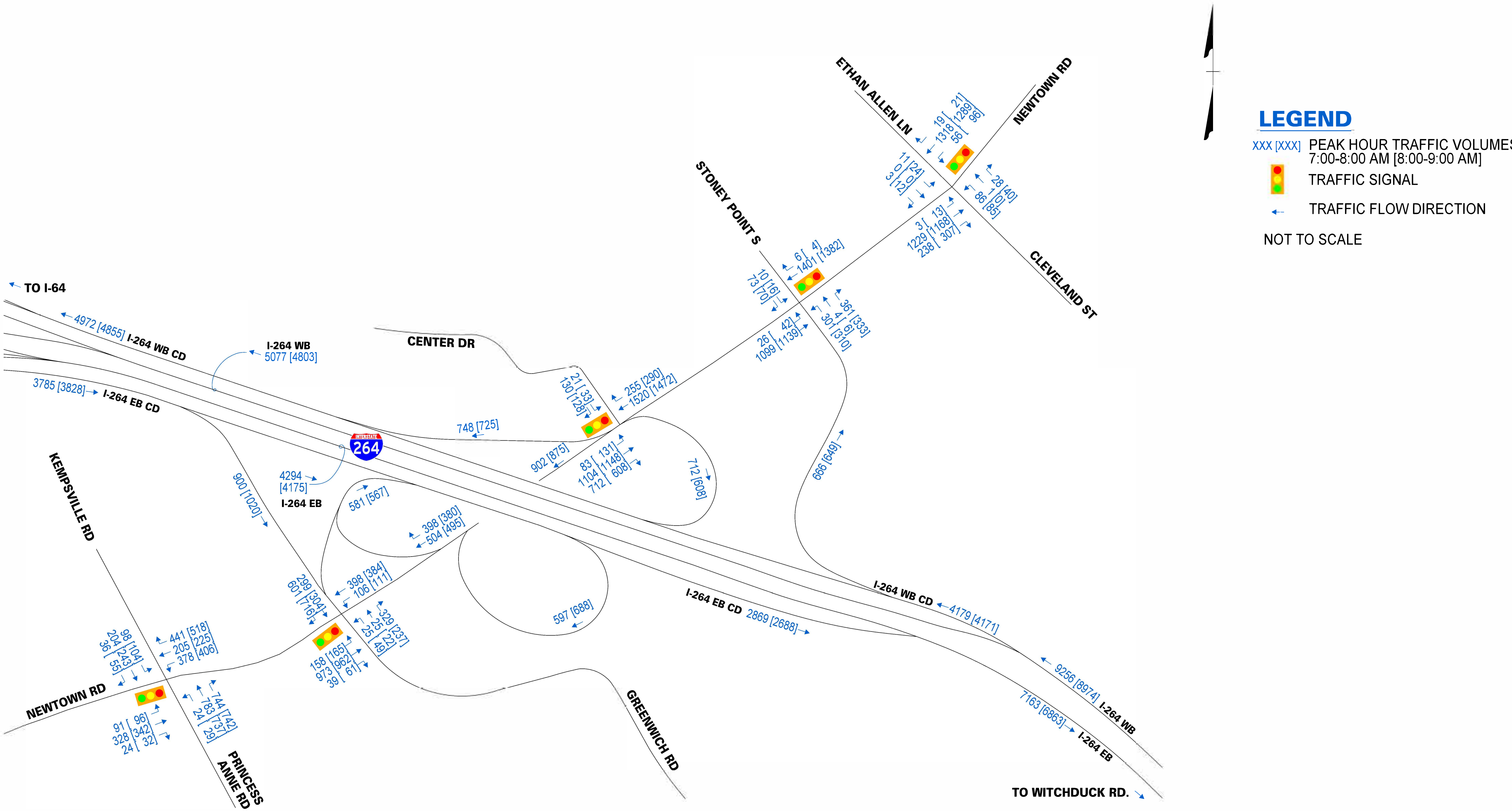


Figure 3-14: Traffic Volumes, Existing 2018 AM Conditions, I-264/Witchduck Road Interchange

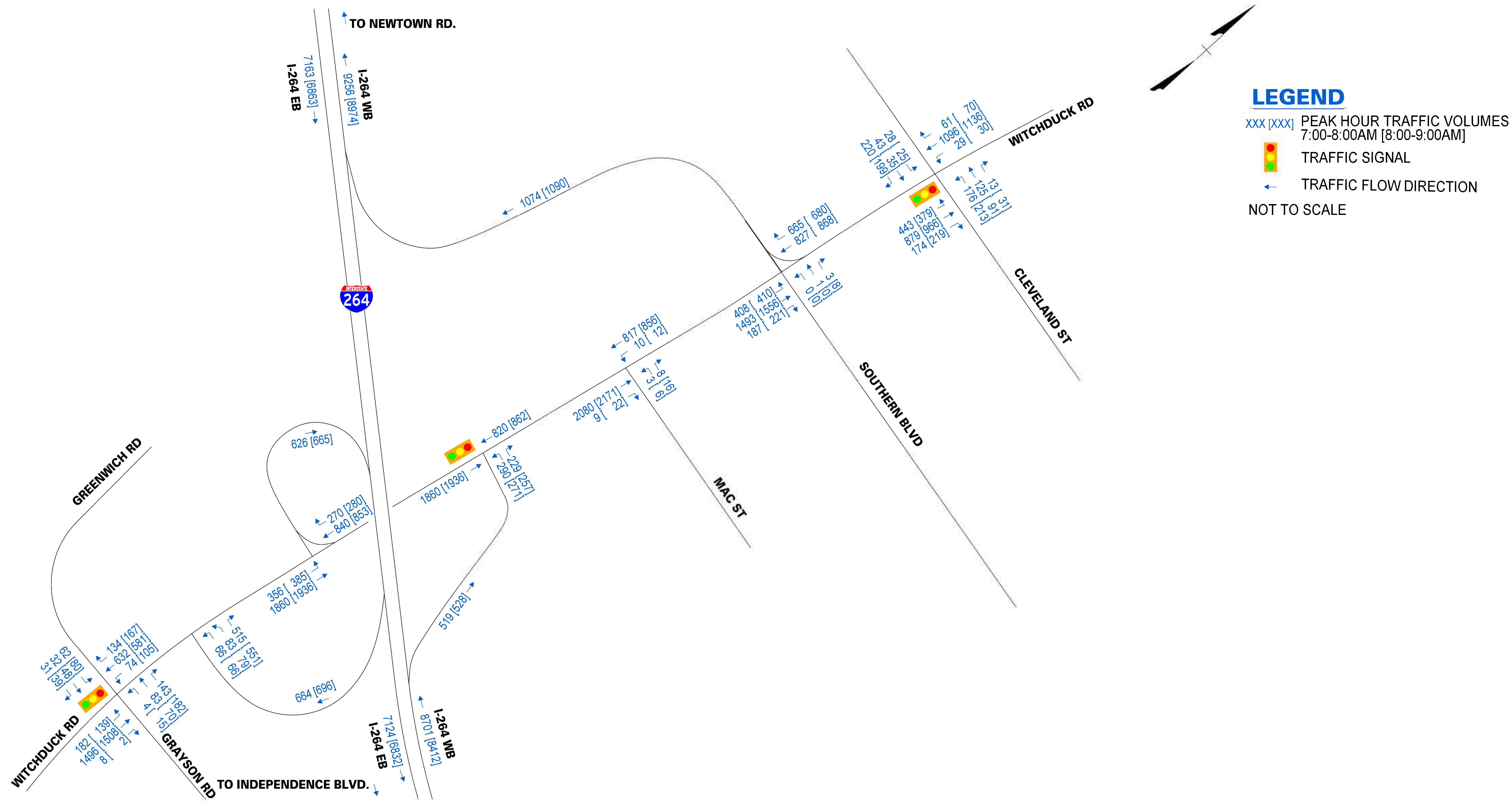


Figure 3-15: Traffic Volumes, Existing 2018 AM Conditions, I-64/Indian River Road Interchange

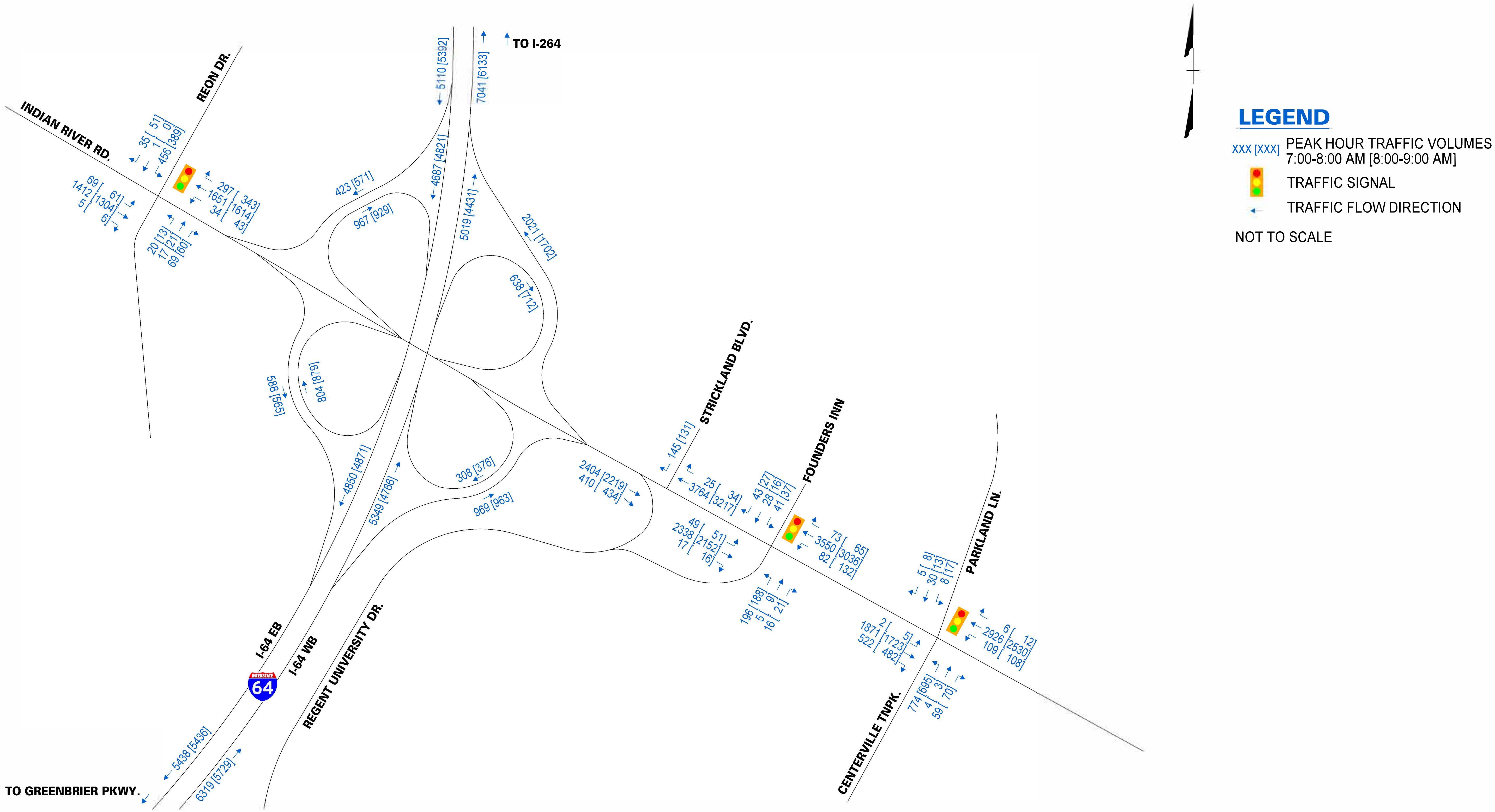


Figure 3-16: Traffic Volumes, Existing 2018 AM Conditions, I-64/Northampton Blvd. Interchange

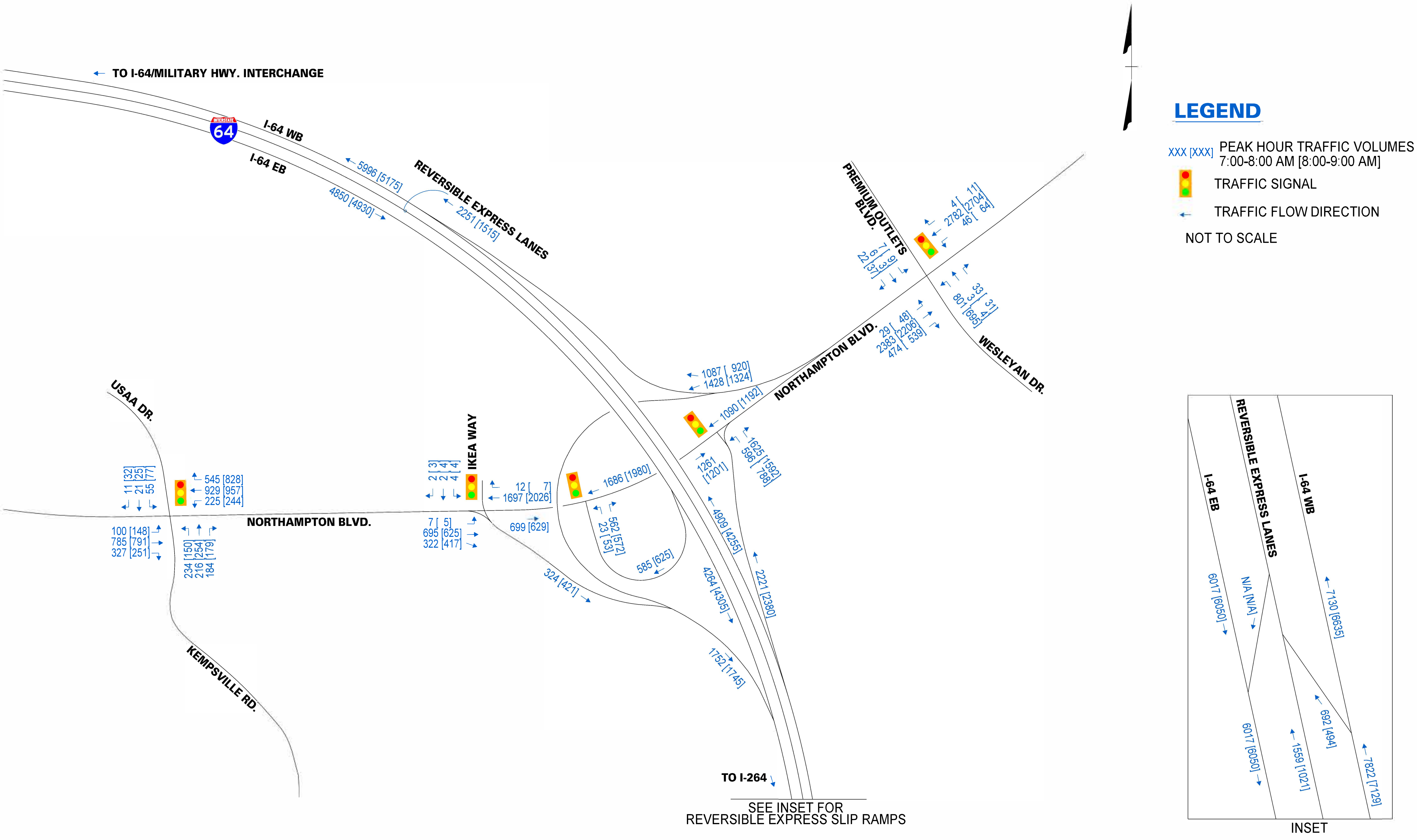


Figure 3-17: Traffic Volumes, Existing 2018 PM Conditions, I-64/I-264 Interchange

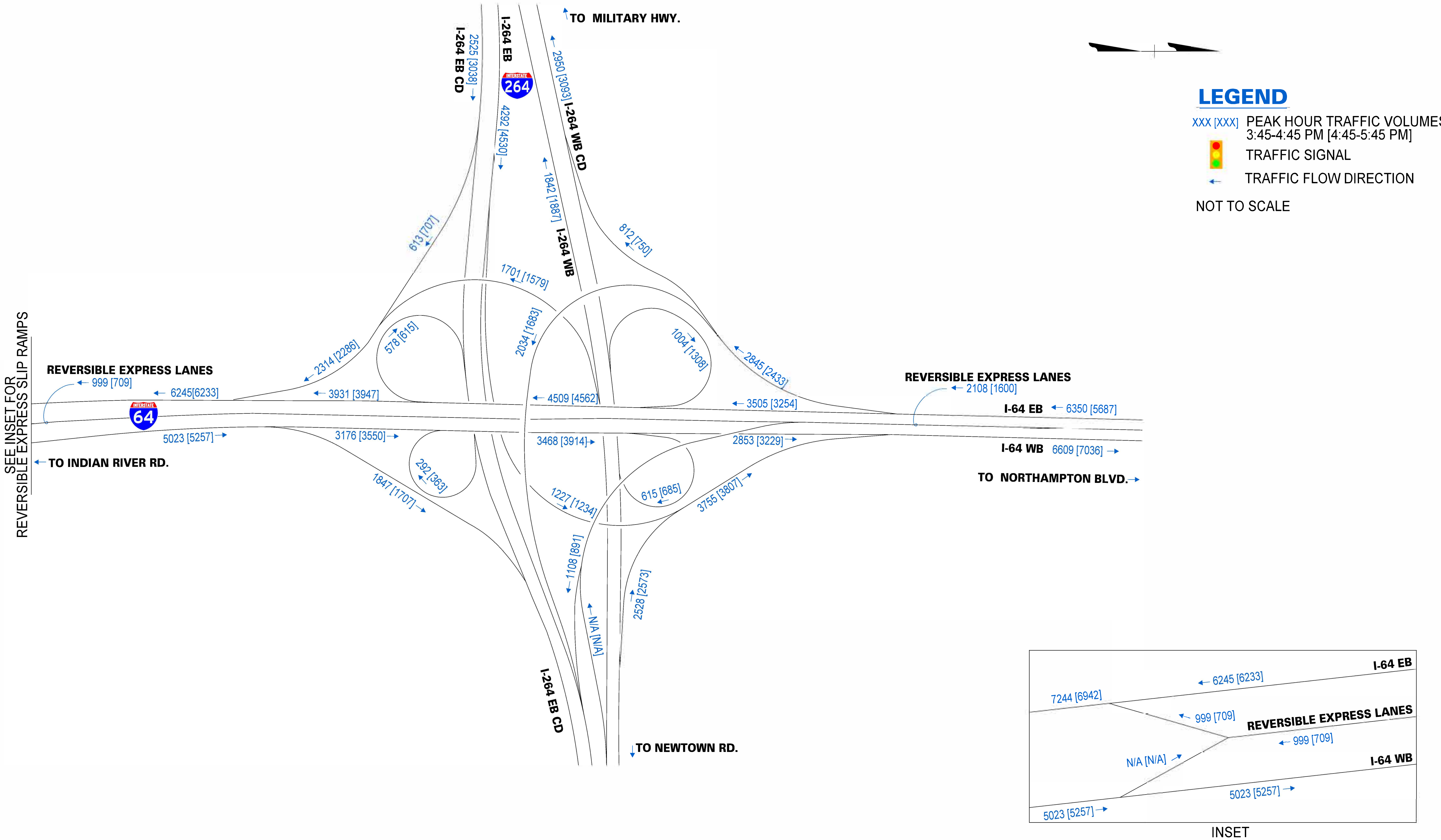


Figure 3-18: Traffic Volumes, Existing 2018 PM Conditions, I-264/Military Highway Interchange

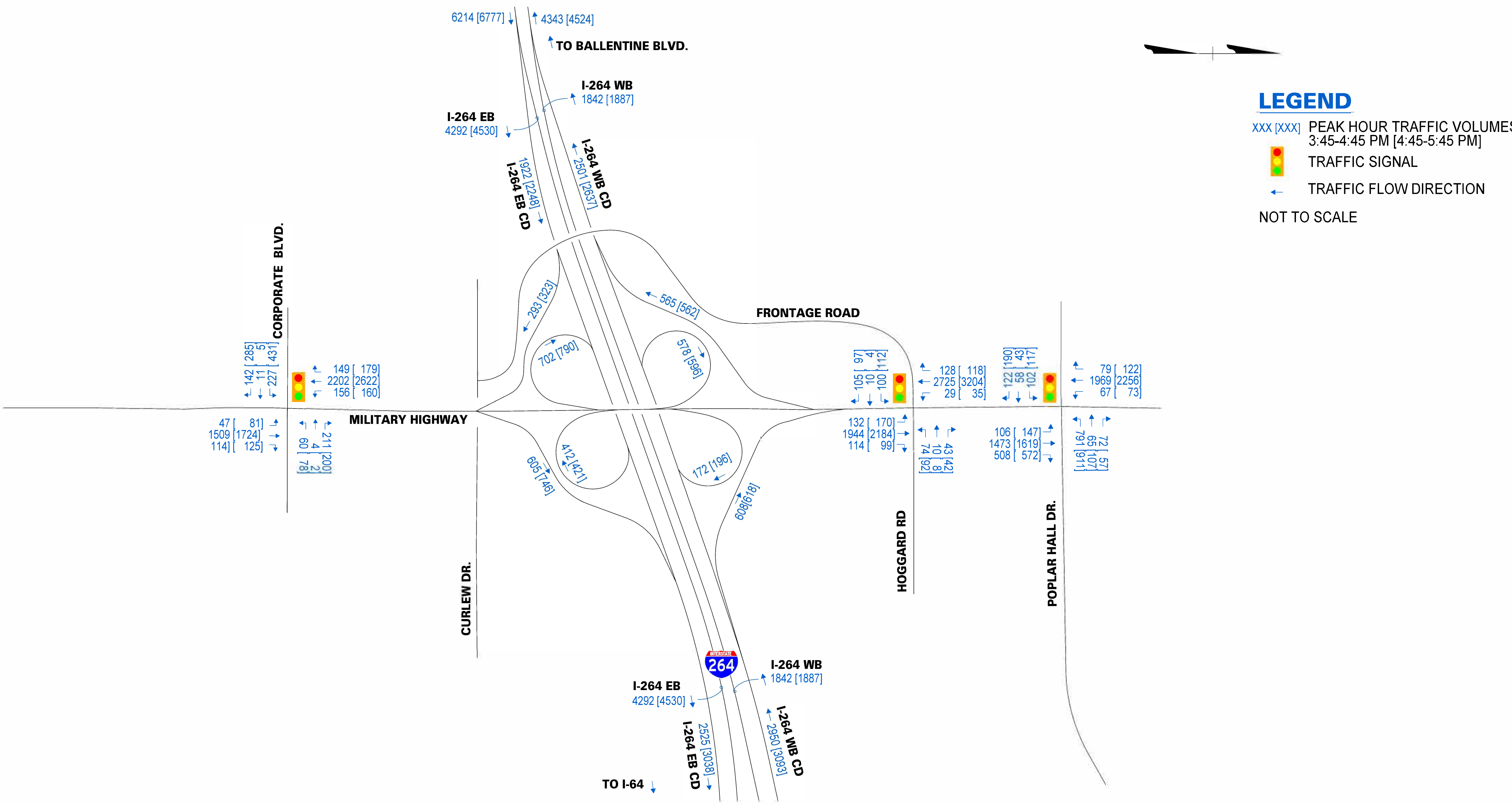


Figure 3-19: Traffic Volumes, Existing 2018 PM Conditions, I-264/Newtown Road Interchange

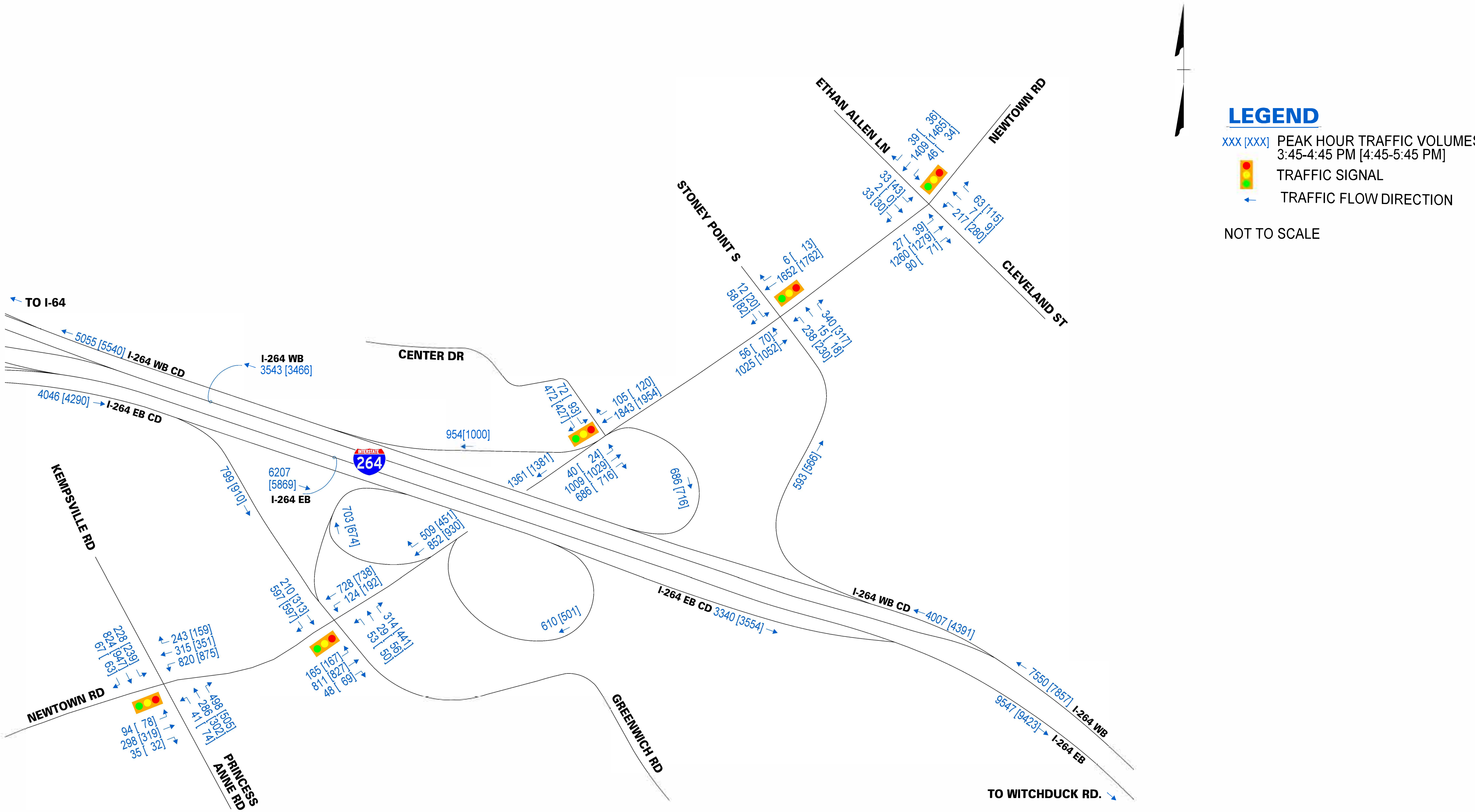


Figure 3-20: Traffic Volumes, Existing 2018 PM Conditions, I-264/Witchduck Road Interchange

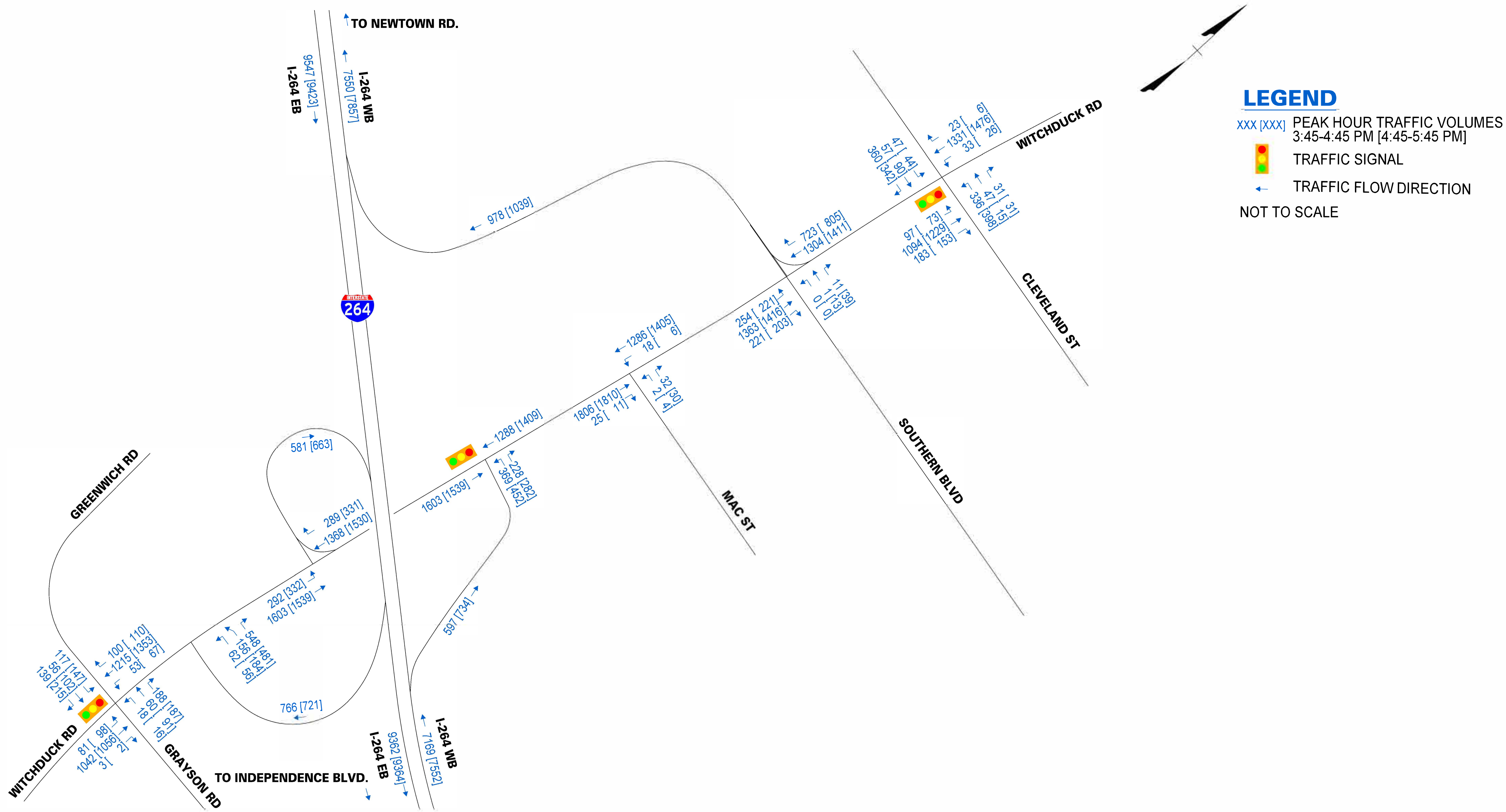


Figure 3-21: Traffic Volumes, Existing 2018 PM Conditions, I-64/Indian River Road Interchange

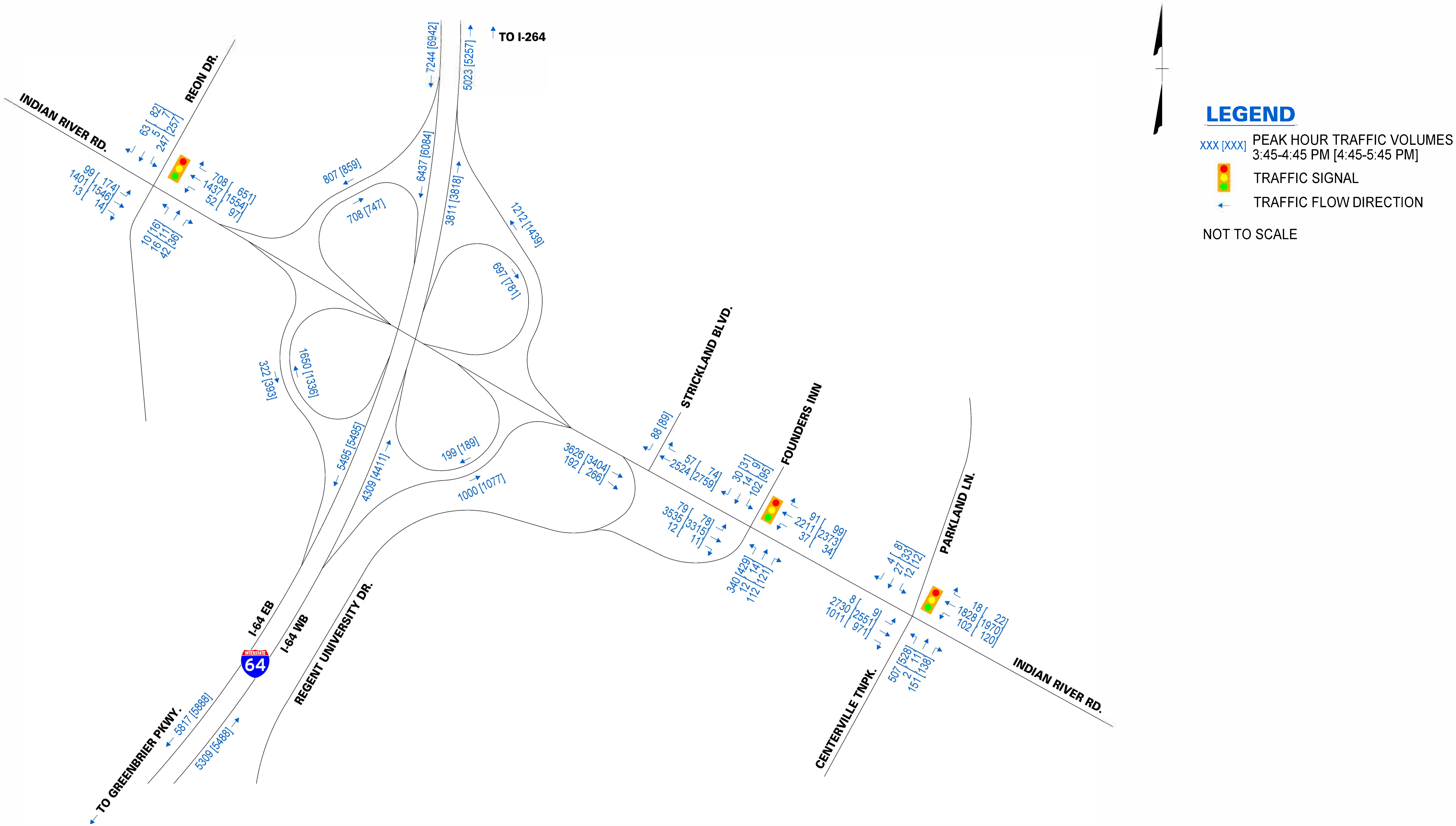
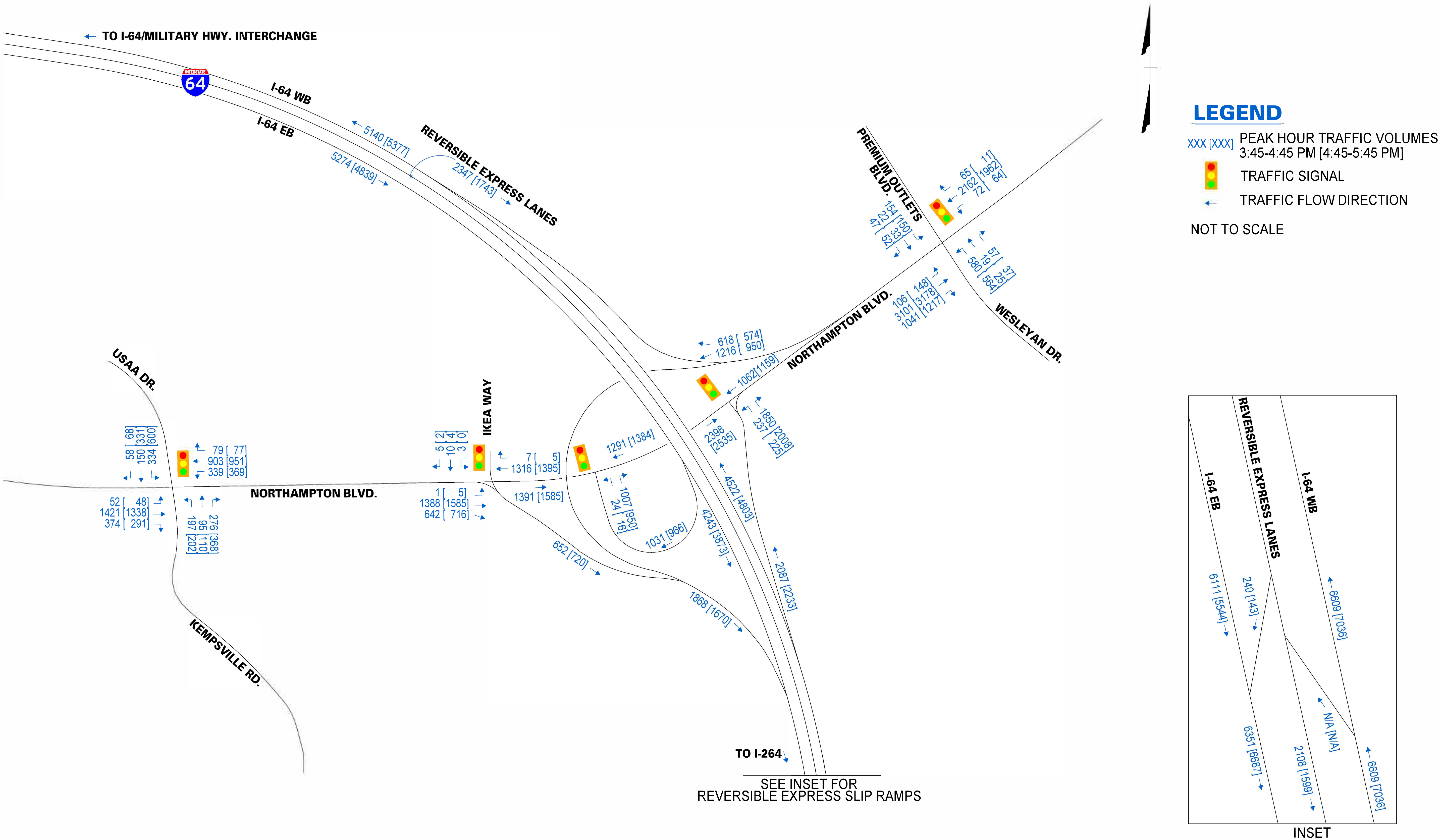


Figure 3-22: Traffic Volumes, Existing 2018 PM Conditions, I-64/Northampton Blvd. Interchange



At the time of the traffic data collection program undertaken for this IMR study, the Military Highway/Northampton Boulevard intersection was under reconstruction. In comparing 2018 data to prior counts, it was concluded that the construction project resulted in a diversion of through trips along Northampton Boulevard to other routes. To account for this effect, the through trip volumes along Northampton Boulevard were increased above the counted volumes to match prior recent counts. A similar approach was used to adjust volumes for elements of I-64 and I-264 affected by ongoing construction of the I-64/I-264 Phase I and Phase II improvement projects.

Diagrams for balanced existing traffic volumes were prepared to reflect adjustments made to account for the effects of capacity constraints and resultant queuing. Where capacity constraints exist in the roadway network, resulting queue lengths observed during the first hour of the peak period were equated to a number of vehicles representing unserved volume. Estimated unserved volumes were added to the counted volumes to arrive at estimated demand volumes. Examples are the ramps exiting eastbound and westbound I-64 oriented to eastbound I-264, where the demand exceeds the capacity of each of these single-lane ramps. The demand volumes reflect the volumes with all capacity constraints removed. For these ramps, unserved volumes were pushed downstream in the first hour and removed from the second hour.

Average Weekday Daily Traffic Volumes

Table 3.3 summarizes existing 2018 average weekday daily traffic (AWDT) volumes for select roadway segments within the study limits.

Table 3.3: 2018 AWDT Volumes for Select Roadway Links, Existing and Future Build Conditions

Roadway	Segment Location	Facility	AWDT Volume (vpd)
I-64	Between Indian River Rd. and I-264	EB GP	79,100
		Express Lanes	11,600
		WB GP	83,700
	Between I-264 and Northampton Blvd.	EB GP	87,700
		Express Lanes	20,300
		WB GP	101,800
I-264	Between Military Hwy. and I-64	EB C/D	34,900
		EB thru	48,500
		WB thru	32,900
		WB C/D	45,200
	Between I-64 and Newtown Rd.	EB outer C/D	57,200
		EB thru	66,700
		WB thru	56,800
		WB C/D	70,700
	Between Newtown Rd. and Witchduck Rd.	EB C/D	46,600
		EB thru	66,700
		WB thru	56,800
		WB C/D	58,400
	East of Witchduck Rd.	EB	110,900
		WB	108,500
Indian River Road	West of I-64	EB & WB	34,200
	East of I-64	EB & WB	79,000
Military Highway	South of I-264	NB & SB	53,000
	North of I-264	NB & SB	62,200
Newtown Road	South of I-264	NB & SB	11,600
	North of I-264	NB & SB	37,500
Witchduck Road	South of I-264	NB & SB	20,500
	North of I-264	NB & SB	30,500
Northampton Boulevard	West of I-64	EB & WB	36,000
	East of I-64	EB & WB	83,000

3.5 Existing 2018 Traffic Operations

Data presented in this section are based on VISSIM output for freeway elements and intersections. As prescribed by VDOT's "Traffic Operations and Safety Analysis Manual" (TOSAM) Version 1.0, intersection delay is used as the operational metric rather than Level of Service (LOS). Density is used as the operational metric for freeway operations. Table 3.4 and Table 3.5 summarize thresholds for flow conditions for freeways and intersections, respectively. The traffic analysis follows procedures outlined in the study's Framework Document, provided in Appendix A. The technical memorandum addressing calibration of the existing conditions VISSIM models is presented in Appendix C. Detailed VISSIM analysis results are presented in Appendix G for existing 2018, no-build 2024, no-build 2044, build 2024, and build 2044 conditions.

Table 3.4: Traffic Flow Rating Threshold Values for Freeways

Traffic Flow Condition	Flow Density (vehicles per lane per mile)	
	Freeway	Weave/Ramp
Light traffic conditions	0-26	0-28
Moderate traffic conditions	26-35	28-35
Heavily congested conditions	35-45	35-43
Severely congested conditions	45 and above	43 and above

Table 3.5: Traffic Flow Rating Threshold Values for Intersections

Traffic Flow Condition	Delay (seconds per vehicle)	
	Signalized	Unsignalized
Light traffic conditions	0-35	0-25
Moderate traffic conditions	35-55	25-35
Heavily congested conditions	55-80	35-55
Severely congested conditions	80 and above	55 and above

Analysis Results - Existing 2018 Conditions

The prevalent direction of flow on both I-64 and I-264 is westbound during the AM peak period and eastbound during the PM peak period. The reversible I-64 Express Lanes and I-264 HOV lanes flow in the prevalent direction.

Freeway Link Densities - Table 3.6 presents the I-64 freeway link densities during the two AM peak hours and the two PM peak hours (AM1, AM2, PM1, and PM2), including traffic flow condition levels for the existing 2018 conditions. Table 3.7 presents the same information for I-264. Density information for 2018 existing conditions is presented in graphical format in Appendix G. Several segments operate under heavily to severely congested conditions in the AM and/or PM peak period. Along I-64, the right mainline travel lanes at some locations operate under congested conditions, while the left mainline lanes operate under more free-flow conditions. This is due to the congestion on downstream ramps that is caused by ramp capacity constraints.

Table 3.6: Traffic Analysis Results for I-64, Flow Density, 2018 Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
WB I-64	Freeway entry to study area and diverge at Indian River Road	26.9	24.3	22.5	24.2
	Exit ramp to EB Indian River Road	26.2	26.9	30.4	45.8
	Freeway between Indian River Road ramps	22.9	20.4	18.3	18.9
	Entrance ramp from EB Indian River Road	11.2	14.3	7.3	7.2
	Weave at Indian River Road	21.1	19.1	16.6	17.0
	Exit ramp to WB Indian River Road	19.6	21.9	21.8	25.8
	Freeway between Indian River Road ramps	21.5	19.3	16.1	16.3
	Entrance ramp from WB Indian River Road	65.6	56.1	37.5	45.4
	Merge at WB Indian River Road	27.6	31.7	18.9	20.1
	Freeway, entrance from Indian River Road to Express Lanes slip	36.4	52.5	21.9	28.8
	Express Lanes slip ramp (south of I-264)	21.7	14.9	N/A	N/A
	Diverge at EB I-264	43.1	44.3	36.7	41.0
	Exit ramp to EB I-264	42.2	40.7	41.5	43.1
	Freeway, EB I-264 exit ramp to EB I-264 entrance loop ramp	36.9	39.2	27.5	32.2
	Entrance ramp from EB I-264 C/D	12.9	14.6	11.6	15.3
	Weave between I-264 entrance and exit loop ramps	32.4	32.2	23.1	27.4
	Exit ramp to WB I-264	14.4	24.3	20.5	24.3
	Freeway between weave and I-264 major merge	35.3	32.9	24.0	28.1
	Entrance ramp from EB I-264	17.6	18.9	27.5	27.4
	Entrance ramp from WB I-264	30.0	26.9	25.5	25.7
	Major merge at I-264	32.5	30.2	27.1	29.1
	Freeway, I-264 to Express Lanes slip	33.7	31.6	28.1	30.3
	Express Lanes slip ramp (north of I-264)	14.7	10.5	N/A	N/A
	Freeway, Express Lanes slip to exit ramp to Northampton Blvd.	31.3	30.2	28.6	31.0
	Diverge at Northampton Boulevard	25.2	24.6	23.1	31.5
	Exit ramp to Northampton Boulevard	28.8	39.2	29.5	71.6
	Freeway between Northampton Boulevard ramps	29.0	25.5	25.9	27.7
	Entrance ramp from Northampton Boulevard	38.8	32.7	21.2	20.1
	Merge at Northampton Boulevard	40.8	33.2	30.4	32.2
	Freeway mainline exit from study area	34.9	31.1	29.6	31.1
EB I-64	Freeway entry to study area	27.9	28.4	30.6	28.0
	Diverge at Northampton Boulevard	23.3	23.8	25.6	23.5
	Exit ramp to Northampton Boulevard	13.9	15.0	28.3	25.0
	Freeway between Northampton Boulevard ramps	24.4	24.8	24.5	22.5
	Entrance ramp from WB Northampton Boulevard	56.2	52.7	62.8	41.4
	Entrance ramp from EB Northampton Boulevard	10.2	13.4	25.9	25.8
	Merge at Northampton Boulevard	31.4	31.8	34.6	30.0
	Freeway, Northampton Blvd. entrance ramp to Express Lanes slip	35.6	36.2	37.3	33.5
	Express Lanes slip ramp (north of I-264)	N/A	N/A	4.8	3.1
	Freeway, Express Lanes slip to dedicated lanes to I-264	25.8	26.2	27.4	24.7
	Major diverge at I-264	25.7	26.0	28.9	27.8
	Exit ramp to WB I-264	8.4	8.1	7.0	6.7
	Exit ramp to EB I-264	47.0	46.1	57.5	43.4
	Freeway segment in vicinity of double white lines	21.5	22.0	26.9	23.5
	Freeway before weave at I-264	17.0	18.0	19.9	18.7

Table 3.6 (continued): Traffic Analysis Results for I-64, Flow Density, 2018 Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
EB I-64	Entrance ramp from WB I-264 C/D road	16.5	22.6	37.6	51.4
	Weave between I-264 entrance and exit loop ramps	16.1	17.3	20.7	20.9
	Exit ramp to EB I-264 C/D road	14.8	23.4	19.9	22.2
	Freeway after weave at I-264 loop ramps	17.3	17.8	22.5	22.7
	EB entrance ramp from WB I-264	41.5	75.2	80.8	105.8
	EB entrance ramp from EB I-264	7.8	14.6	16.4	18.9
	Merge at I-264	26.3	28.3	33.8	34.0
	Freeway between I-264 merge and Express Lanes slip	28.9	30.8	36.0	36.2
	Express Lanes slip ramp (south of I-264)	N/A	N/A	22.2	16.5
	Freeway, Express Lanes slip to exit ramp to Indian River Road	21.5	23.1	32.1	30.9
	Diverge at WB Indian River Road	19.6	21.0	30.0	28.3
	Exit ramp to WB Indian River Road	10.9	14.9	22.3	23.4
	Freeway after diverge at WB Indian River Road ramp	19.6	20.5	27.5	26.4
	Entrance ramp from WB Indian River Road	40.6	40.0	28.7	30.2
	Weave at Indian River Road	19.9	20.7	25.4	24.9
	Exit ramp to EB Indian River Road	13.7	15.4	29.3	25.2
	Freeway after weave	20.1	20.6	23.2	23.5
	Entrance ramp from EB Indian River Road	14.9	14.5	8.2	10.0
	Merge at Indian River Road	20.4	20.8	22.1	22.7
	Freeway exit from study area	22.8	23.2	24.8	25.3
I-64 Reversible Express Lanes	WB Freeway after diverge from general-purpose lanes	16.9	11.7	N/A	N/A
	WB I-264 flyover entrance ramp to WB Express Lanes	16.3	10.5	N/A	N/A
	WB freeway after merge at I-264 ramp	12.0	8.2	N/A	N/A
	First slip ramp to WB Express Lanes (north of I-264)	14.7	10.5	N/A	N/A
	WB merge at Express Lanes slip ramp (north of I-264)	17.8	12.2	N/A	N/A
	WB Freeway exit from study area	17.3	12.2	N/A	N/A
	EB Freeway entry to study area	N/A	N/A	18.4	13.7
	EB Diverge at Express Lanes slip north of I-264	N/A	N/A	17.1	12.9
	Express Lanes slip ramp to EB I-64 (north of I-264)	N/A	N/A	4.8	3.1
	EB freeway between Express Lanes slip and I-264	N/A	N/A	16.5	12.8
	Exit ramp to I-264 flyover	N/A	N/A	17.0	13.0
	EB I-64 flyover to EB I-264	N/A	N/A	31.6	25.5
	EB freeway, I-264 to Express Lanes slip	N/A	N/A	17.1	12.7

Table 3.7: Traffic Analysis Results for I-264, Flow Density, 2018 Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
EB I-264 Mainline	Freeway entry to study area and diverge at C/D road	18.0	19.9	26.5	30.3
	Ramp to C/D road	10.3	13.8	16.0	18.8
	Freeway segment with HOV lane	13.2	13.3	18.7	19.7
	Freeway segment between end of HOV lane and exit for WB I-64	13.2	13.3	18.6	19.5
	Diverge at WB I-64	13.2	13.4	18.8	19.6
	Exit ramp to WB I-64	17.6	18.9	27.5	27.4

Table 3.7 (continued): Traffic Analysis Results for I-264, Flow Density, 2018 Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
	Freeway between exit for WB I-64 and merge at EB I-64	19.0	18.8	26.0	27.8
	Entrance ramp from EB I-64 Express Lanes flyover	N/A	N/A	31.6	25.5
	Ramp from EB I-64 general-purpose lanes flyover	47.0	46.1	57.5	43.4
	Merge at EB I-64	18.2	18.0	26.6	26.1
	Freeway between flyover merges and merge at C/D road	18.0	17.9	26.4	25.9
	Entrance ramp from C/D road	23.8	24.5	29.7	52.2
	Merge at C/D road	20.1	20.3	27.8	29.6
	Freeway between merge at C/D road and Witchduck Road	28.3	28.7	32.7	33.9
	Entrance ramp from Witchduck Road	21.3	22.9	19.5	22.4
	Weave at Witchduck Road ramps	22.9	23.5	32.4	34.9
	Exit ramp to Witchduck Road	13.0	14.3	15.9	16.6
	Freeway exit from study area	29.6	30.0	31.9	33.3
EB I-264 C/D Road	Freeway start of EB C/D road and diverge at Military Highway	10.4	14.0	16.4	19.3
	Exit ramp to SB Military Highway	5.2	5.1	8.9	9.8
	Freeway between Military Highway ramps	9.0	12.6	13.9	16.7
	Entrance ramp from SB Military Highway	15.5	20.5	28.1	31.5
	Weave at Military Highway	9.4	13.7	19.0	24.4
	Exit ramp to NB Military Highway	11.6	12.3	15.5	16.4
	Freeway between Military Highway ramps	9.6	14.5	19.2	24.0
	Entrance ramp from NB Military Highway	53.5	54.1	30.3	38.9
	Weave between Military Highway entrance and EB I-64 exit ramps	18.4	25.2	22.6	29.1
	Exit ramp to EB I-64	7.8	14.6	16.4	18.9
	Freeway between I-64 ramps	15.2	17.6	16.7	20.9
	Entrance ramp from EB I-64	14.8	23.4	19.9	22.2
	Weave at I-64 entrance and exit loop ramps	16.3	21.4	18.8	24.3
	Exit ramp to WB I-64	12.9	14.6	11.6	15.3
	Freeway between I-64 ramps	16.1	20.4	19.0	23.8
	Entrance ramp from WB I-64	42.2	40.7	41.5	43.1
	Weave between WB I-64 and Newtown Road	21.3	23.7	23.1	31.1
	Exit ramp to SB Newtown Road	20.1	24.1	17.9	21.2
	Freeway between Newtown ramps	23.6	25.7	27.0	40.8
	Entrance ramp from Newtown Road	19.8	19.4	25.1	23.1
	Weave at Newtown ramps	21.7	23.1	26.6	44.5
	Exit ramp to NB Newtown Road	17.7	22.6	19.2	16.9
	Freeway between Newtown exit ramp and EB I-264 mainline	24.9	25.9	32.5	54.5
WB I-264 Mainline	Freeway entry to study area and diverge at Witchduck Road	30.0	29.0	24.5	26.4
	Exit ramp to Witchduck Road	10.9	10.8	12.2	33.1
	Freeway between Witchduck ramps	28.5	27.4	22.7	23.6
	Entrance ramp from Witchduck Road SB	38.6	39.3	35.1	36.1
	Weave between Witchduck entrance ramp and diverge at C/D road	27.2	26.3	22.1	22.9
	Ramp to C/D road	24.1	24.1	23.2	25.4
	Freeway between C/D road and Express Lanes flyover	29.2	27.7	20.2	19.6
	Freeway at exit ramp to Express Lanes	30.4	28.7	20.9	26.6
	Exit ramp to flyover to EB I-64 Express Lanes	16.3	10.5	N/A	N/A

Table 3.7 (continued): Traffic Analysis Results for I-264, Flow Density, 2018 Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
WB I-264 Mainline	Freeway diverge at left exit to EB I-64	20.1	26.4	24.4	51.8
	Left exit ramp to EB I-64	41.5	75.2	80.8	105.8
	Freeway between left exit ramp to EB I-64 and merge at C/D road	15.7	15.6	10.5	10.4
	Ramp from C/D road	23.1	26.9	21.4	23.4
	WB I-264 at merge at C/D road	20.8	21.9	16.9	18.1
	Freeway exit from study area	22.7	23.7	18.3	19.2
WB I-264 C/D	Start of C/D road	24.1	24.1	23.2	25.4
	Diverge at Newtown Road	24.0	24.1	23.2	25.8
	Exit ramp to Newtown Road	12.5	12.4	13.4	12.6
	Freeway between Newtown ramps	32.0	31.8	30.7	36.0
	Entrance ramp from NB Newtown Road	24.8	21.3	23.6	25.1
	Freeway between Newtown entrance ramps	25.7	24.9	24.7	28.9
	Entrance ramp from SB Newtown Road	20.8	19.7	25.9	27.6
	Weave between Newtown Road and I-64	21.3	21.0	22.1	26.6
	Exit ramp to WB I-64	30.0	26.9	25.5	25.7
	Freeway between I-64 ramps	11.3	12.5	14.4	17.1
	Entrance ramp from WB I-64	14.4	24.3	20.5	24.3
	Weave at I-64 entrance and exit loop ramps	11.3	13.4	14.2	16.8
	Exit ramp to EB I-64	16.5	22.6	37.6	51.4
	Freeway between I-64 ramps	11.0	12.8	12.0	13.3
	Entrance ramp from EB I-64	8.4	8.1	7.0	6.7
	Weave between I-64 and Military Highway	11.6	12.6	11.5	12.4
	Exit ramp to NB Military Highway	21.0	24.8	21.0	21.7
	Freeway between Military Highway ramps	13.2	14.1	13.1	14.2
	Entrance ramp from NB Military Highway	14.0	14.4	6.4	6.8
	Weave at Military Highway ramps	12.9	13.8	12.1	13.2
	Exit ramp to SB Military Highway	14.8	14.7	19.7	21.7
	Freeway between Military Highway ramps	12.9	13.9	11.1	12.2
	Entrance ramp from SB Military Highway	10.6	13.9	19.3	19.2
	Merge at SB Military Highway	15.8	18.1	15.5	16.8
	C/D road ramp to WB I-264	23.1	26.9	21.4	23.4

The southeast quadrant of the I-64/I-264 interchange is currently under construction to widen the westbound I-64 to eastbound I-264 ramp, construct a new eastbound I-264 C/D roadway from the I-64/I-264 interchange to beyond the Newtown Road interchange, and improve capacity along the I-264 mainline through the Witchduck Road interchange. The current construction projects are expected to alleviate recurring congestion along westbound I-64 approaching the exit ramp to eastbound I-264, and improve flow on the eastbound I-264 mainline and C/D roadway.

Congested areas include the following:

- Mainline segments:
  - Westbound I-64 from Indian River Road to the I-64/I-264 interchange (AM and PM peaks).
  - Eastbound I-64 from Northampton Boulevard to the I-64/I-264 interchange (AM and PM peaks).
  - Eastbound I-264 C/D road in vicinity of Newtown Road, including merge onto EB I-264 mainline (PM peak).
- Ramps:
  - Westbound I-264 to westbound I-64 (AM peak)
  - Westbound I-264 to eastbound I-64 (PM peak)
  - Westbound I-64 to eastbound I-264 (AM and PM peaks)
  - Eastbound I-64 to eastbound I-264 (AM and PM peaks)
  - Westbound Indian River Road ramp to westbound I-64 (AM peak)
  - Westbound Northampton Boulevard ramp to eastbound I-64 (AM and PM peaks)

The reversible I-64 Express Lanes operate under light traffic conditions.

Queuing Beyond Ramp Storage Capacity - Under existing 2018 conditions, there are several locations where queues on ramps spill back onto the interstate mainline:

- The westbound I-64 exit ramp to Northampton Boulevard experiences queues longer than the storage length for this ramp. Queues in the second hour of the PM peak period routinely exceed one quarter mile long and spill back onto westbound I-64. While this appears to have a nominal effect on travel speeds for the overall through movement on the interstate, the queuing condition poses safety concerns related to speed differentials in adjacent lanes and high-speed traffic approaching stopped vehicles from the rear.
- During the PM peak period, eastbound Indian River Road is congested downstream of the I-64 interchange, and queues can extend back onto the eastbound and westbound I-64 mainline. However, field observations indicated that such queues had no apparent effect on the operating speed of interstate through traffic.
- The westbound I-264 left exit ramp to eastbound I-64 operates near capacity during the AM peak hours and over capacity during PM peak hour 2, resulting in queueing on the westbound I-264 mainline. This is caused by (a) the demand exceeding the capacity of the ramp, and (b) the ramp merging with the eastbound I-264 to eastbound I-64 ramp to form a single-lane merge onto eastbound I-64, a movement that is also over capacity.

Travel Times and Travel Speeds - Travel time segments and routes were selected for detailed evaluation through consultation with the Study Team. Routes through the study area were selected to represent primary travel patterns that are known to operate with heavy demand and congestion during peak periods, and which are therefore of primary interest in the study. Table 3.8 summarizes travel times and average speeds for selected routes under existing 2018 conditions during the two AM peak hours and the two PM peak hours studied.

Average travel speeds less than 40 mph are highlighted. Drops in travel speeds within each travel route correspond with locations that operate under heavily to severely congested conditions, as described above in the previous section entitled "Freeway Link Densities". Speeds can drop within individual segments without a corresponding increase of density. This can occur on short weave and merge areas where drivers slow down to perform a particular merge, weave, or diverge maneuver.

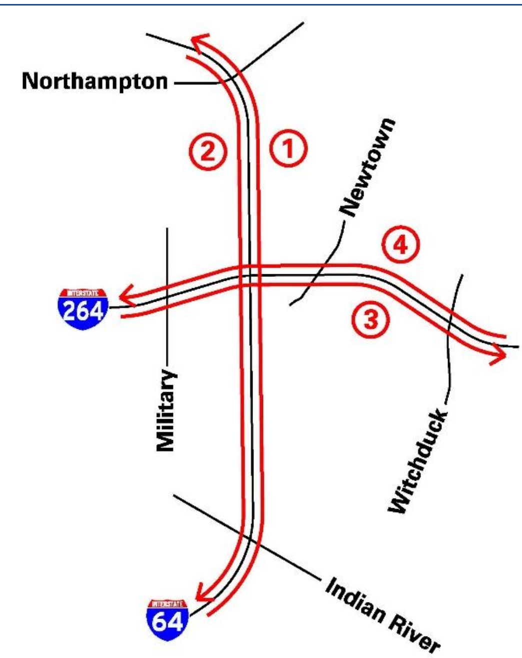
Low travel speeds in the following areas are of particular note:

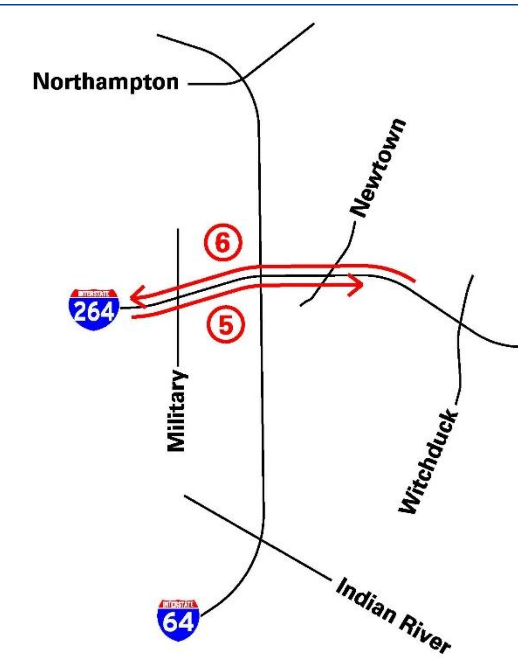
- During the AM and PM peak periods, westbound I-64 experiences reduced travel speeds upstream of the exit ramp to eastbound I-264. This location is an active construction zone, and was observed to operate with heavy delay and reduced speeds.
- The westbound I-264 C/D roadway operates with low travel speeds between the Newtown Road interchange and the I-64 interchange due to vehicles slowing down to weave between closely spaced ramps with heavy volumes.
- The ramp from westbound I-264 to eastbound I-64 operates with low travel speeds during both PM peak hours due to congestion at the downstream ramp terminal at the merge onto eastbound I-64.
- Eastbound I-64 slows from Northampton Boulevard to the exit to eastbound/westbound I-264. Once beyond this diverge, travel speeds increase.

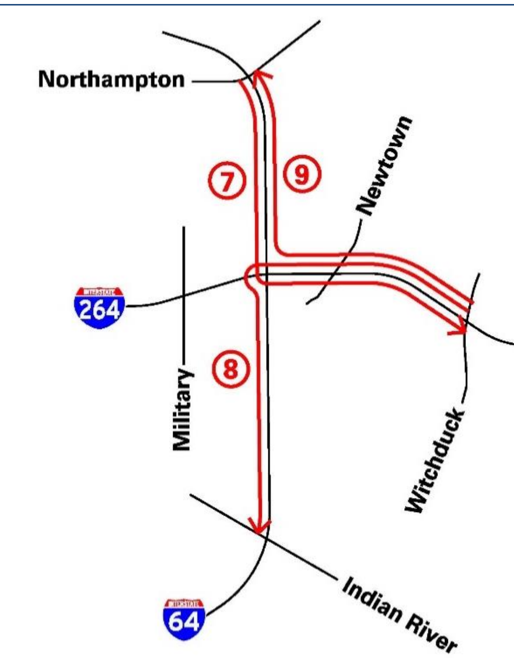
Table 3.8: Travel Time and Speed Data for Existing 2018 Conditions

	Travel Time Route No.	1	2	3	4	5	6	7	8	9
	Route Start Point	WB I-64, south of Indian River Road	EB I-64, north of Northampton Blvd.	EB I-264 mainline at diverge to C/D	WB I-264 mainline, east of Witchduck Rd.	EB I-264 C/D, at diverge with mainline	WB I-264 C/D, at diverge with mainline	EB I-64, on ramp from Northampton Blvd.	WB I-264, on ramp from Witchduck Rd.	WB I-264, on ramp from Witchduck Rd.
	Route End Point	WB I-64, north of Northampton Blvd.	EB I-64, south of Indian River Road	EB I-264 mainline east of Witchduck Rd.	WB I-264 mainline, at merge with C/D	EB I-264 C/D, at merge with mainline	WB I-264 C/D, at merge with mainline	EB I-264, exit ramp to Witchduck Rd.	EB I-64, exit ramp to Indian River Rd.	WB I-64, exit ramp to Northampton Blvd.
	Route Length (mi)	5.91	6.01	4.34	4.33	2.40	2.36	4.02	4.28	3.72
AM Peak Hr. 1	Travel time (min)	6.6	6.2	4.5	4.5	2.4	2.6	4.8	4.8	3.9
AM Peak Hr. 1	Avg. speed (mph)	53.7	57.7	57.9	57.6	60.0	54.5	50.3	54.0	57.2
AM Peak Hr. 2	Travel time (min)	7.6	6.3	4.5	4.6	2.5	2.6	4.8	5.3	4.0
AM Peak Hr. 2	Avg. speed (mph)	46.7	57.6	57.9	56.5	57.6	54.5	50.3	48.8	55.8
PM Peak Hr. 1	Travel time (min)	6.2	6.4	4.5	4.6	2.5	2.6	5.3	5.4	3.9
PM Peak Hr. 1	Avg. speed (mph)	56.8	56.3	57.9	56.5	57.6	54.5	45.5	47.6	57.2
PM Peak Hr. 2	Travel time (min)	6.7	6.4	4.6	5.3	3.0	2.7	5.3	6.4	4.0
PM Peak Hr. 2	Avg. speed (mph)	53.1	56.3	56.6	49.3	47.4	52.6	45.5	39.9	55.8

Orientation of Numbered Travel Time Routes







Intersections - Table 3.9 summarizes the results of traffic analyses conducted for intersections under existing 2018 conditions. Most intersections currently operate with light or moderate congestion, with the exception of Witchduck Road at Cleveland Street. Witchduck Road is currently being reconstructed and the improvements are expected to address existing operational deficiencies in this corridor under existing and near-term conditions. The Northampton Boulevard/USAA Drive/Kempsville Road intersection operates with heavy delay during the weekday PM peak hour 2.

Table 3.9: Traffic Analysis Results for Intersections, 2018 Conditions

Roadway	Intersection at	Control	Average Delay (seconds per vehicle)			
			AM1	AM2	PM1	PM2
S. Military Highway	Corporate Blvd.	S	19.2	21.5	23.4	32.7
	Hoggard Rd.	S	16.5	20.3	16.7	20.4
	Poplar Hall Dr.	S	20.8	28.7	33.1	39.4
Newtown Road	Kempsville Rd. / Princess Anne Rd.	S	30.5	33.0	41.4	53.5
	Greenwich Rd. / I-264 EB ramp	S	37.6	43.9	42.6	46.8
	Center Dr.	S	10.3	10.5	16.3	14.5
	Stoney Point S. / I-264 WB exit ramp	S	15.3	16.0	17.0	17.6
	Cleveland St. / Ethan Allen Ln.	S	7.3	8.2	14.1	17.3
Witchduck Road	Grayson Rd. / I-264 EB exit ramp	S	28.9	32.0	27.4	40.1
	I-264 EB on-ramp	U	10.0	11.5	20.0	32.2
	I-264 WB exit ramp	S	20.4	22.7	18.8	31.9
	Mac St.	U	6.6	7.1	4.0	8.9
	I-264 WB on-ramp / Southern Blvd.	U	7.8	7.6	6.8	13.0
	Cleveland St.	S	53.6	55.8	57.7	91.6
Indian River Road	Reon Dr.	S	26.5	22.8	22.2	26.8
	Strickland Blvd.	U	4.1	2.3	1.7	2.1
	Regent University Drive	S	21.0	19.5	35.6	42.5
	Centerville Turnpike / Parkland Lane	S	41.2	25.3	40.0	41.1
Northampton Boulevard	USAA Dr. / Kempsville Rd.	S	24.8	27.5	39.3	56.3
	I-64 EB entrance ramp / IKEA Way	S	1.5	1.9	2.8	2.5
	I-64 EB exit ramp	S	6.9	7.2	12.9	12.1
	I-64 WB exit ramp	S	24.1	27.8	21.6	34.0
	Wesleyan Dr./Premium Outlets Blvd.	S	22.4	21.6	49.0	49.9

Control: S – Signalized, U – Unsignalized
Orange shading refers to heavily congested conditions, Red shading refers to severely congested conditions.

3.6 Summary of Existing Traffic Operations

The following are general findings regarding existing traffic conditions within the study area:

- While certain individual movements have higher volumes during the weekday AM peak period, aggregate traffic volumes on a system-wide basis are higher during the weekday PM peak period.
- Traffic flow patterns appear to be heavily influenced by operation of the Norfolk Naval Base, located northwest of the study area. Prevalent traffic flow directions within the study area are as follows:
  - During the AM peak period, traffic flow is heavier westbound on I-64 and westbound on I-264
  - During the PM peak period, traffic flow is heavier eastbound on I-64 and eastbound on I-264
- Traffic operations on the westbound I-64 approach to I-264 are impacted by heavy demand and construction activities in the southeast quadrant of the interchange. The current widening of the ramp from westbound I-64 to eastbound I-264 from one to two lanes will address current and projected volumes.
- The segment of eastbound I-64 from Northampton Boulevard to I-264 experiences recurrent congestion. Contributing factors are heavy volumes entering I-64 from westbound Northampton Boulevard, and heavy exiting traffic to I-264. These movements create a weaving condition on eastbound I-64, which is complicated by the operation of the slip exit ramp from the reversible Express Lanes.
- Within the I-64/I-264 interchange, heavy traffic movements include:
  - Westbound I-264 to westbound I-64 (AM peak)
  - Westbound I-264 to eastbound I-64 (PM peak)
  - Westbound I-64 to eastbound I-264 (AM and PM peaks)
  - Eastbound I-64 to eastbound I-264 (AM and PM peaks)
- Other heavy movements within the study area include
  - Westbound Indian River Road ramp to westbound I-64 (AM peak)
  - Westbound Northampton Boulevard ramp to eastbound I-64 (AM and PM peaks)
- Most intersections within the study area operate at an acceptable level of service, except for the following:
  - The Indian River Road/Centerville Turnpike intersection experiences heavy northbound and westbound volumes during the AM peak period. The eastbound approach serves heavy volumes during the PM peak.
  - The intersection of Witchduck Road and Cleveland Street operates with severe congestion during the AM and PM peak hours. However, the current Witchduck Road Phase II improvement project will increase the number of through and turn lanes in the Witchduck Road corridor north of I-264.

3.7 Crash Data

Three years of crash data, from January 1, 2015 to December 31, 2017, were obtained from VDOT through the online Tableau database. The data included crash-specific information regarding location, travel direction, date, time of day, crash type, and crash severity. Crash location information was used to prepare crash location maps by type and severity. FR-300 reports provided by VDOT were also used to differentiate crash locations between the I-64 mainline and reversible lanes, and the I-264 mainline and C/D facilities. Crash analyses aggregated data in three ways:

- Mainline interstate segments, including the merge/diverge and weave areas, for the following:
  - I-64 from milepoint 281.5 (1 mile north of Northampton Boulevard) to milepoint 287.75 (0.7 miles south of Indian River Road)
  - I-264 from milepoint 11.5 (0.5 miles west of North Military Highway) to milepoint 15.5 (0.5 miles east of Witchduck Road)
- Individual interchange areas, including mainline interstate segments, merge/diverge and weave areas, crossing arterials, and ramps. The following interchanges were evaluated:
  - I-64 at I-264
  - I-64 at Northampton Boulevard
  - I-64 at Indian River Road
  - I-264 at Military Highway
  - I-264 at Newtown Road (excluding the eastbound ramps and mainline)
  - I-264 at Witchduck Road (excluding the eastbound ramps and mainline)
- Signalized intersections along the crossing arterial, including the ramp terminal intersections.

Crash experience was not analyzed for the I-264 eastbound ramps at Newtown Road, the I-264 eastbound ramps at Witchduck Road, or the Witchduck Road corridor. At the time of the analysis, these facilities were being improved under active construction projects that were developed to address congestion and safety. Post-improvement crash data were not available at the time of the study.

Figures 3-23 through 3-26 on the following pages illustrate crash locations and crash types within the study area. Starting on page 3-31, Figures 3-27 through 3-31 illustrate crash density, severity, and type within the study area.

Figure 3-23: Crash Location and Types, I-64 Corridor, 2015-2017

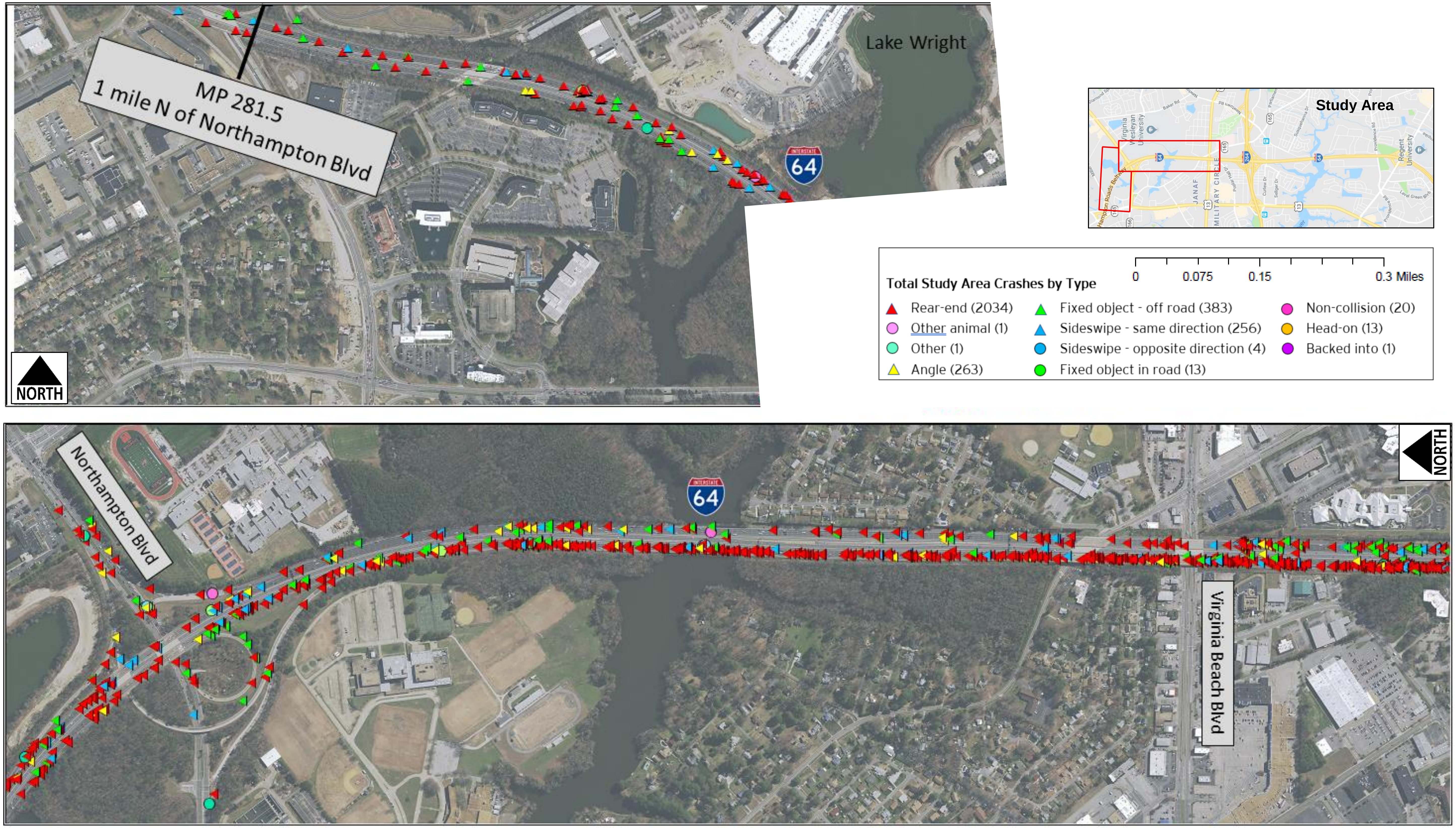


Figure 3-24: Crash Location and Types, I-64 Corridor, 2015-2017

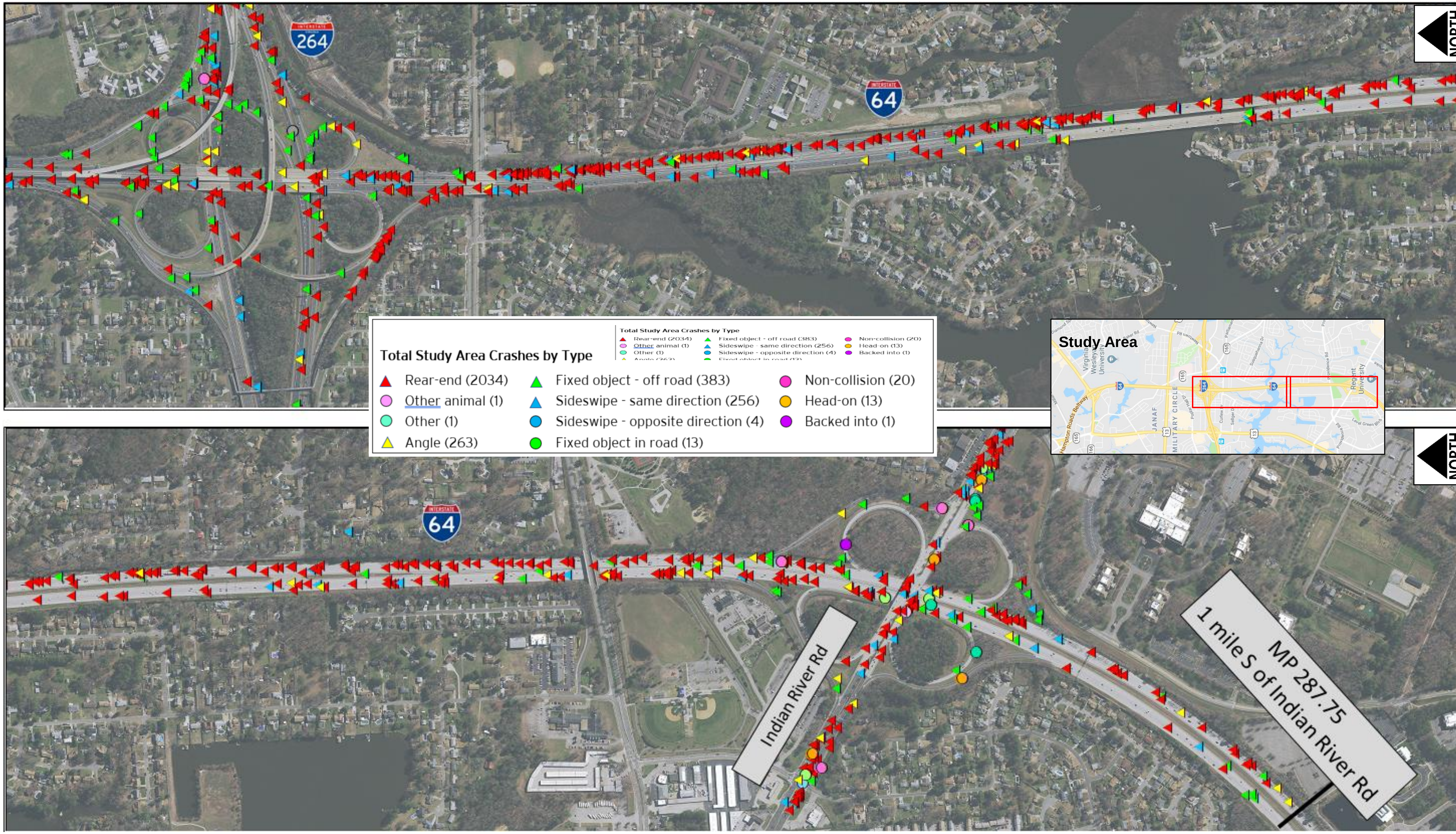


Figure 3-25: Crash Location and Types, I-264 Corridor, 2015-2017

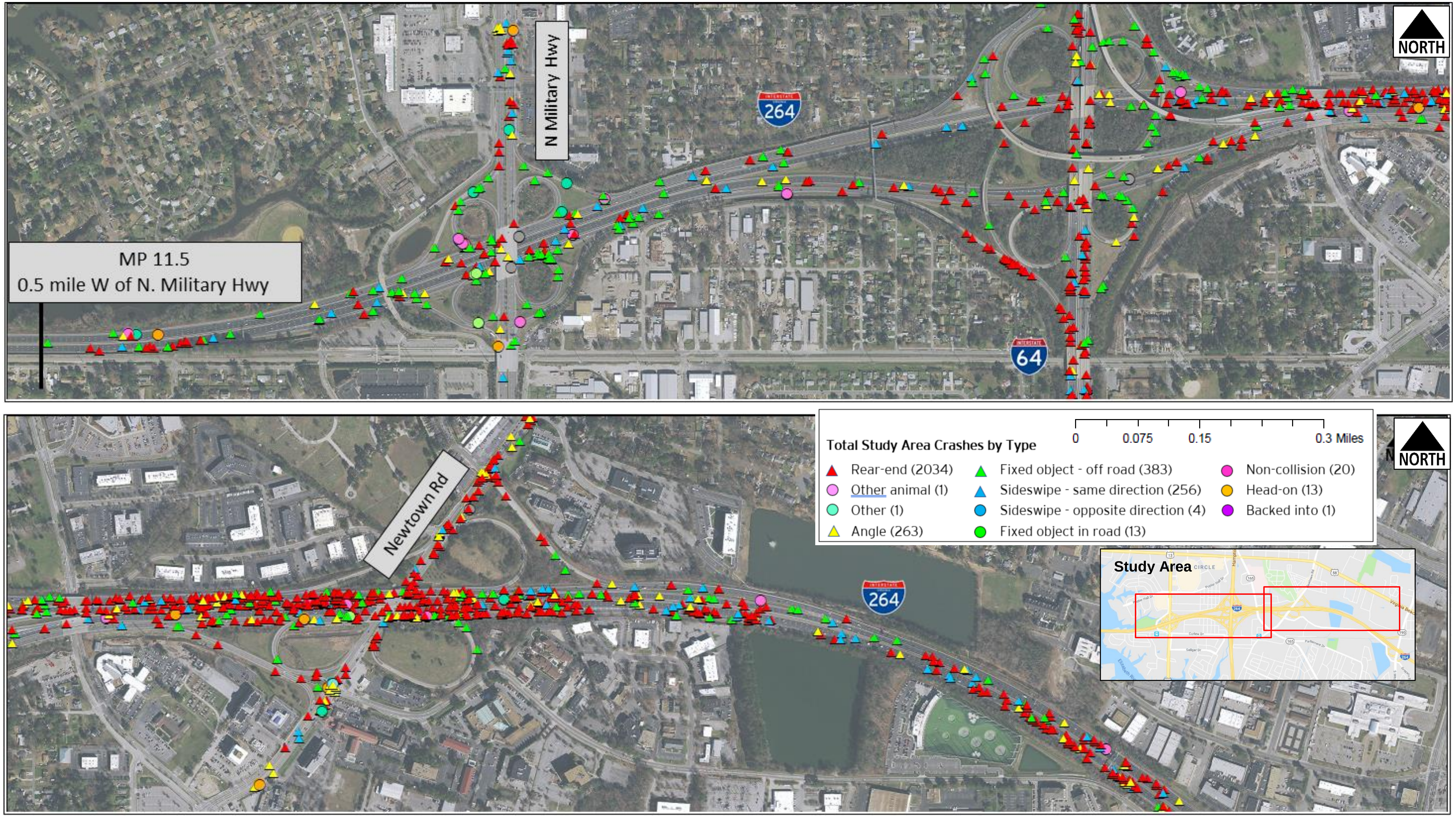


Figure 3-26: Crash Location and Types, I-264 Corridor, 2015-2017

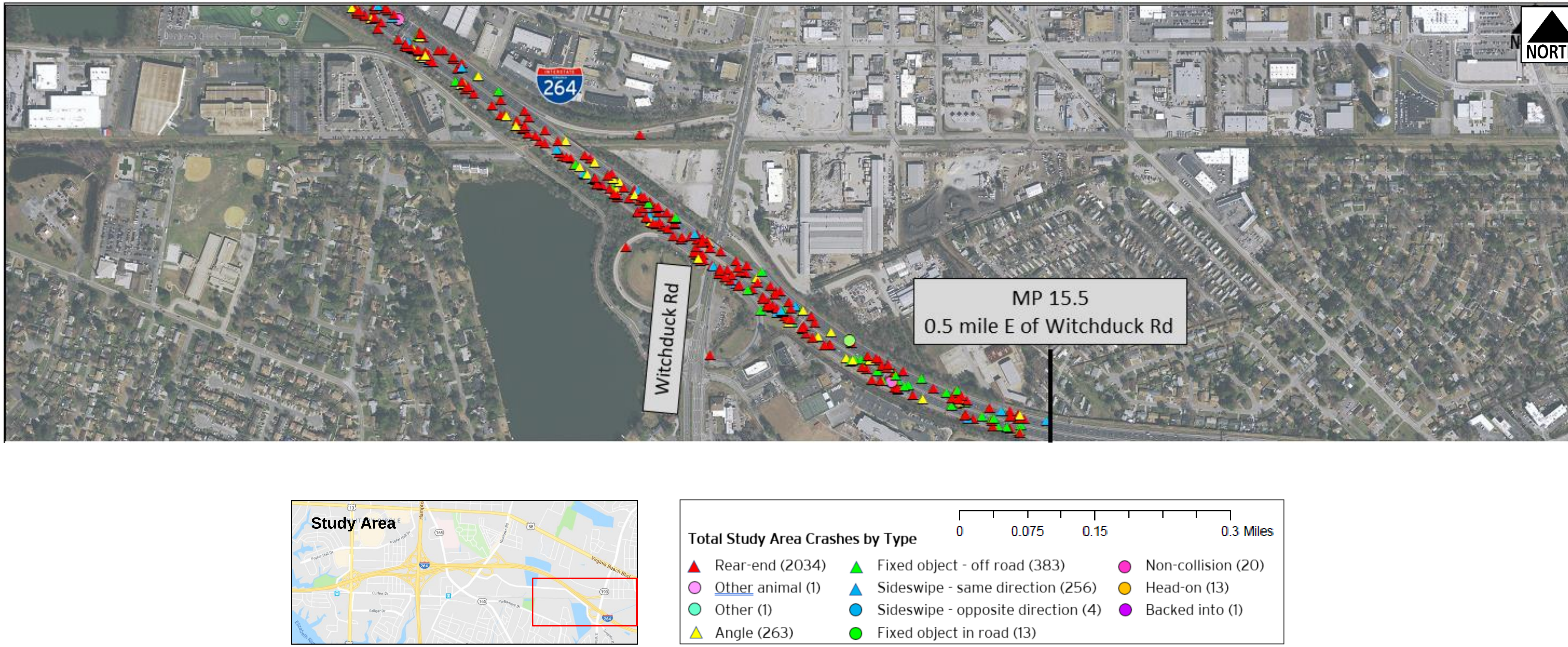


Figure 3-27: Crash Density, Severity, and Type, I-64 Corridor, 2015-2017

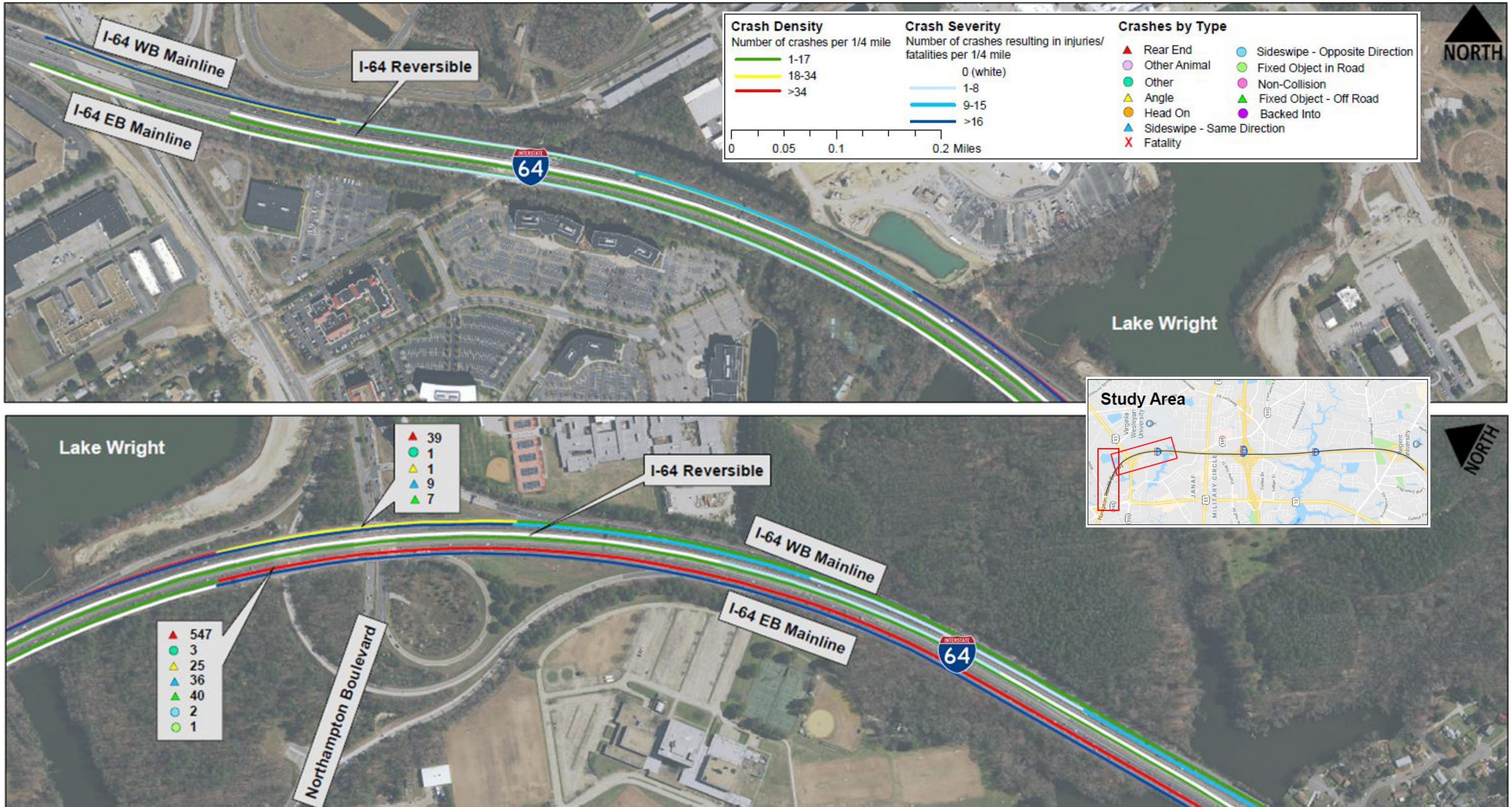


Figure 3-28: Crash Density, Severity, and Type, I-64 Corridor, 2015-2017

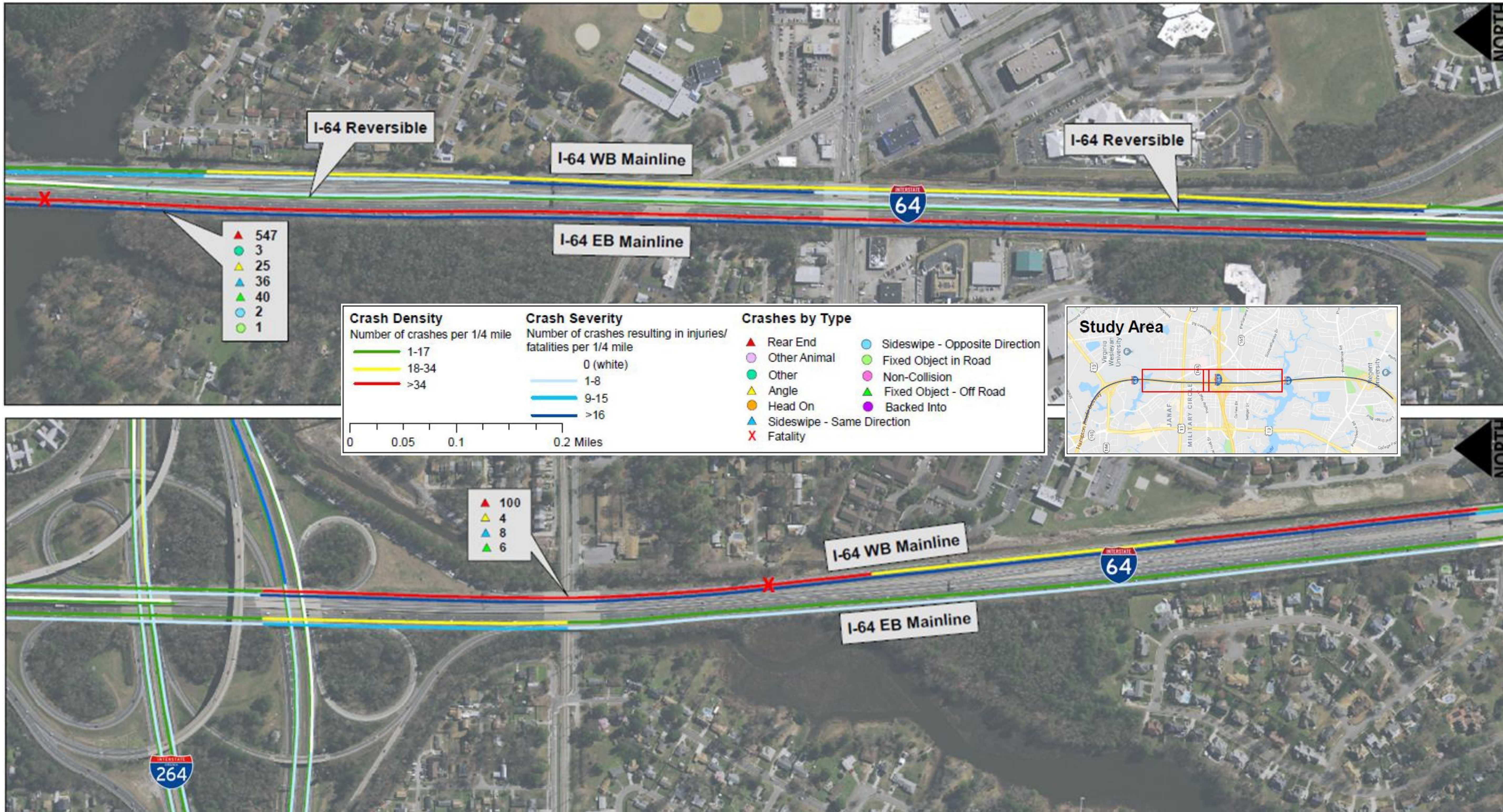


Figure 3-29: Crash Density, Severity, and Type, I-64 Corridor, 2015-2017

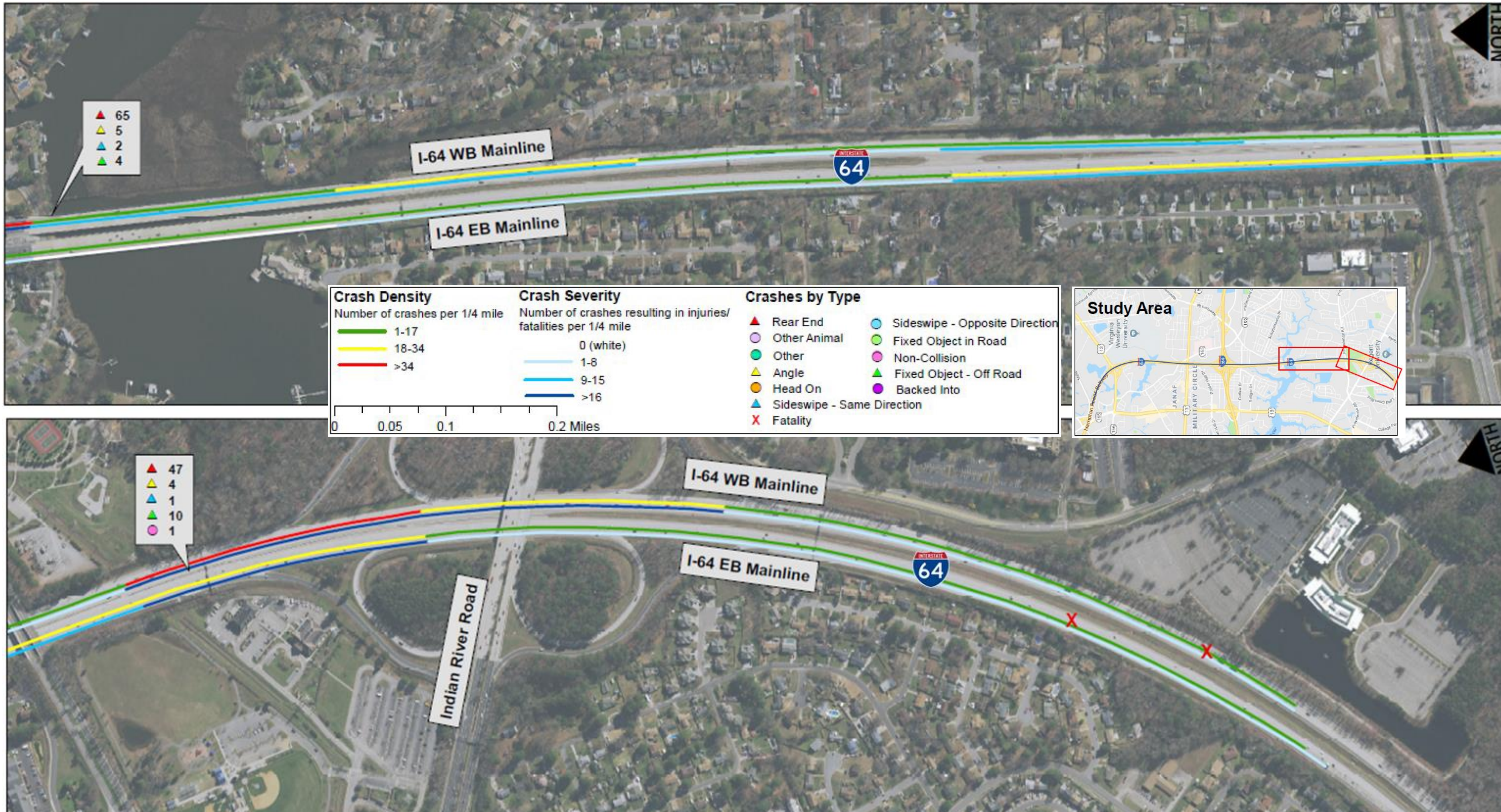


Figure 3-30: Crash Density, Severity, and Type, I-264 Corridor, 2015-2017

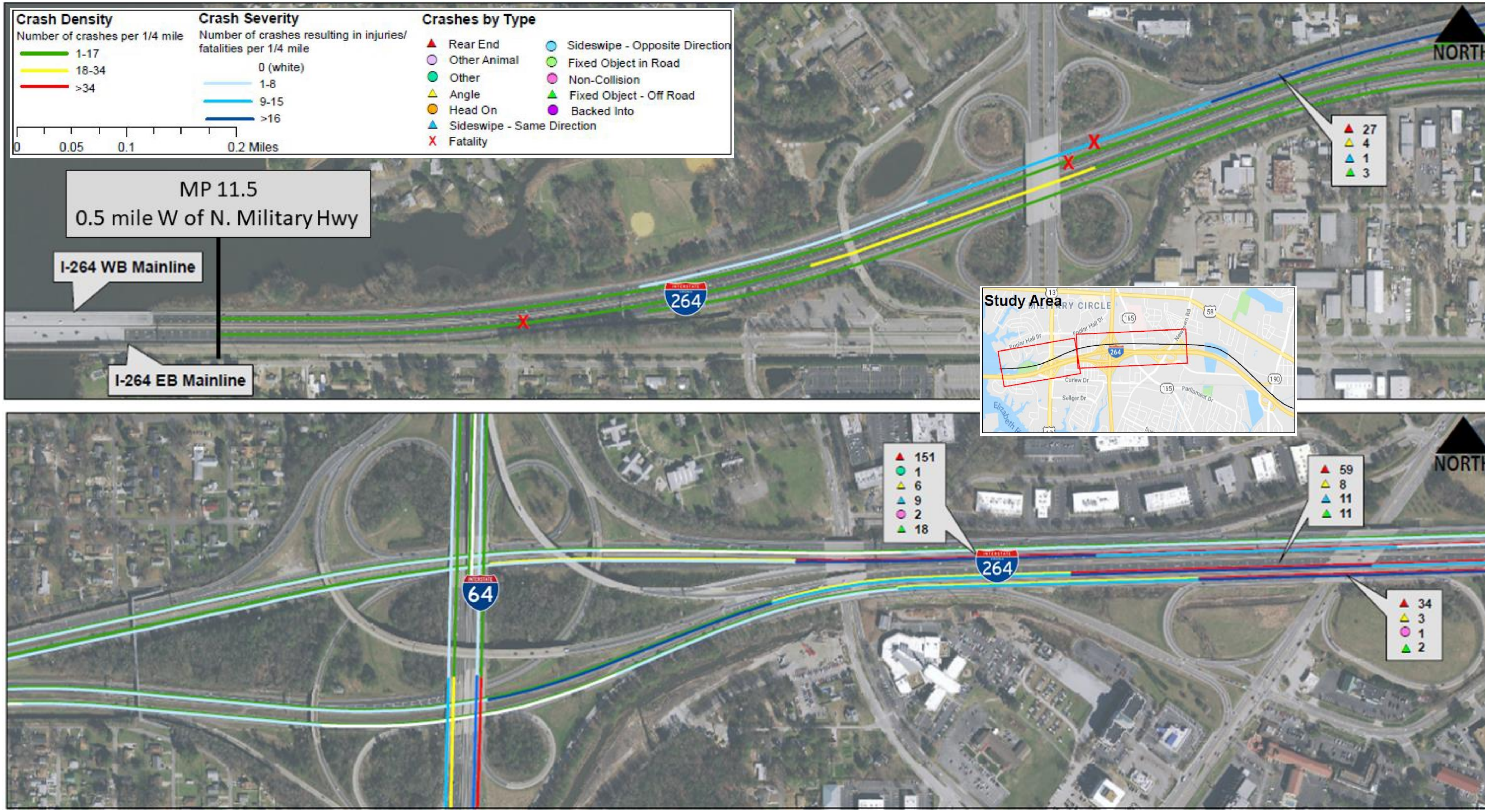
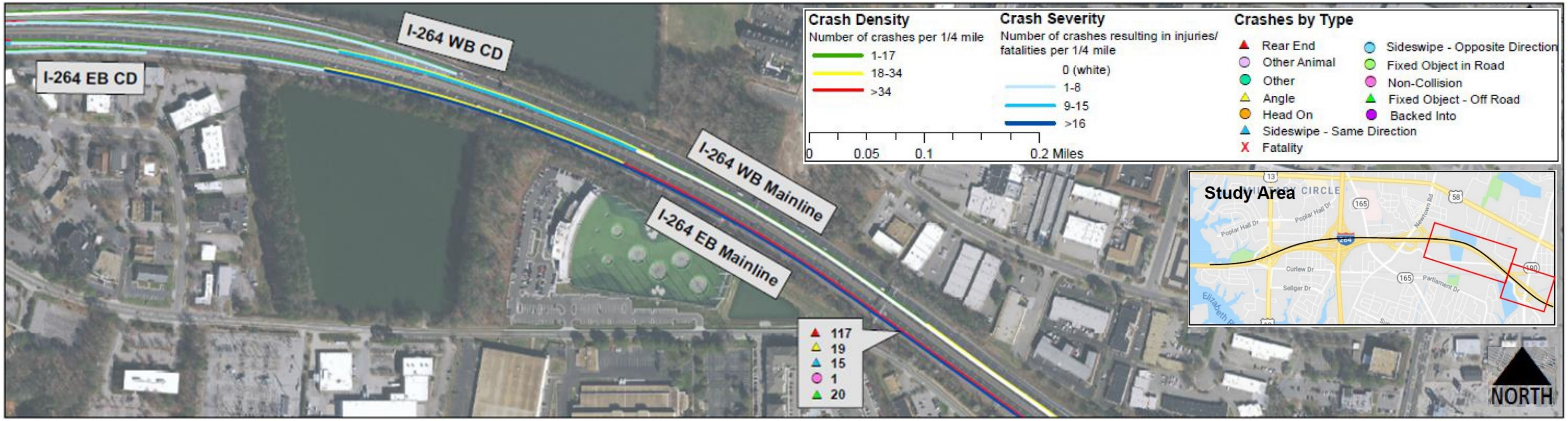
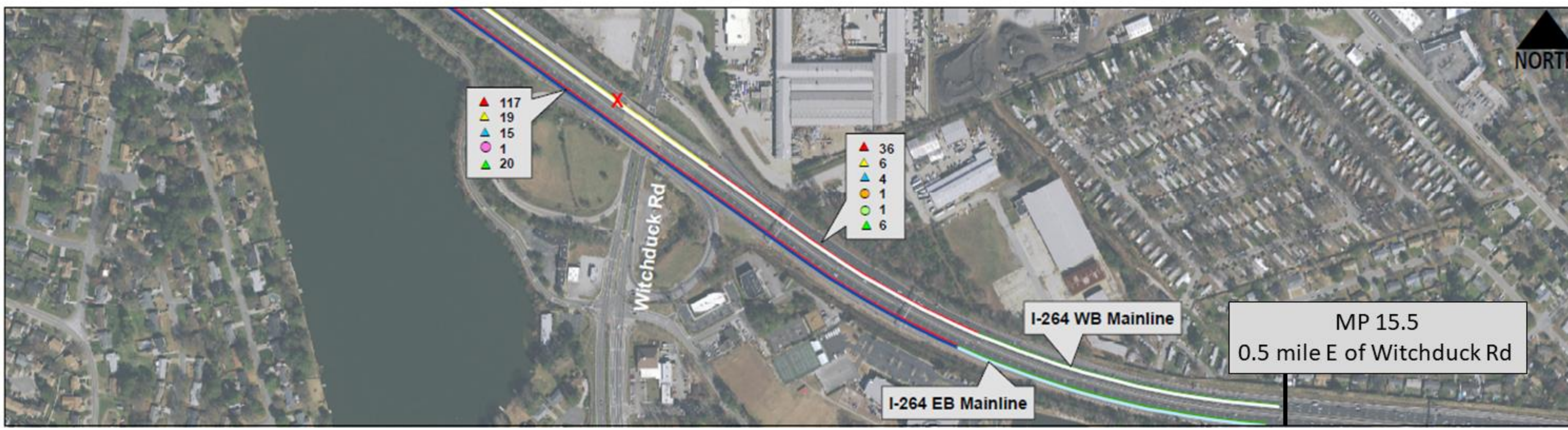


Figure 3-31: Crash Density, Severity, and Type, I-264 Corridor, 2015-2017





3.8 Crash Analysis - I-64 Corridor

As summarized in Table 3.10, a total of 866 crashes were reported along eastbound I-64, and 693 crashes were reported along westbound I-64 within the study area. Eastbound I-64 has consistently experienced a greater number of crashes than westbound I-64 on an annual basis. Total crashes increased each year during the three-year period studied, and increased 42% from 2015 to 2017.

Table 3.10: Number of Crashes on I-64 by Year, 2015-2017

Roadway Segment		2015	2016	2017	Subtotal
EB I-64	Mainline	225	281	349	855
	Work-Zone Related Crashes	7	1	3	11
	EB I-64 Directional Subtotal	**232**	**282**	**352**	**866**
WB I-64	Mainline	193	235	234	662
	Work-Zone Related Crashes	5	2	24	31
	WB I-64 Directional Subtotal	**198**	**237**	**258**	**693**
I-64 Reversible		2	7	2	11
Total		**432**	**526**	**612**	**1,570**

Work-zone crashes typically accounted for 1% to 3% of the annualized total crashes by direction. The exception is westbound I-64 during 2017, when 9% of crashes occurred in a work zone. This may be associated with the I-64/I-264 Phase I improvement project which started in mid-2016. A total of 11 crashes occurred on the reversible managed-lane facility during the three years studied. Annual totals for this facility evidence no consistent trend of increasing or decreasing crash experience.

Table 3.11 summarizes crash severity on I-64 for the three-year reporting period. Of the 1,570 crashes reported, 64% involved only property damage, and 36% involved injuries. The 562 reported injury crashes resulted in injuries to a total of 890 persons.

Table 3.11: Crash Severity for I-64, 2015-2017

I-64 Segment	Crash Severity (number of crashes)		
	Property Damage Only	Injury	Fatality
EB mainline	562	302	2
WB mainline	435	256	2
Reversible	7	4	0
Total	**1,004**	**562**	**4**

During the three-year period studied, there were four fatalities along I-64 which are described as follows:

- A crash occurred on eastbound I-64 at milepoint 287.78 (0.5 miles south of Indian River Road) on April 7, 2015. The crash involved a fixed-object off-road collision with a concrete barrier. This occurred during daylight and dry surface conditions, and the driver was not wearing a seatbelt at the time of the crash.
- A fatality occurred on eastbound I-64 at milepoint 283.16 (0.7 miles east of Northampton Boulevard) on October 1, 2017. The crash was reported as an angle collision resulting from an unsafe lane change at approximately 4:30 PM, which is within the peak traffic period studied. The crash occurred during daylight and dry surface conditions.
- A third fatality occurred on westbound I-64 at milepoint 287.45 (0.6 miles south of Indian River Road) on January 23, 2016. The crash involved an angle collision caused by an eastbound vehicle crossing the median, and striking another vehicle traveling on westbound I-64. The crash occurred during daylight and wet surface conditions. At the time of crash, the driver of the eastbound vehicle was unbelted and was determined to be intoxicated.
- The fourth fatality occurred on westbound I-64 at milepoint 284.98, at the I-64/I-264 interchange, on April 15, 2015. The crash involved a sideswipe collision when a vehicle traveling in the general-purpose lanes made an unsafe lane change into the HOV lane to avoid traffic congestion and struck a motorcycle, resulting in the death of the motorcyclist. The crash occurred during daylight and dry roadway surface conditions.

Table 3.12 summarizes the percentage of crashes occurring on I-64 during the morning (6:00 - 9:00 AM) and afternoon (3:00 - 6:00 PM) peak periods for the years 2015-2017. Approximately half of all crashes occur during either the morning or afternoon peak periods, a trend that has remained fairly consistent over the three years studied. I-64 within the study area is below the districtwide average for percent of daily crashes occurring during the AM and PM peak periods. However, it is above the statewide average for percent of daily crashes occurring during the peak periods.

Table 3.12: Percentage of Crashes on I-64 by Peak Period, 2015-2017

Period of Day	2015	2016	2017	Corridor Average 2015-2017	Districtwide Average 2015 - 2017	Statewide Average 2015 - 2017
6:00 - 9:00 AM	19.17%	21.14%	17.97%	19.43%	25.92%	16.10%
3:00 - 6:00 PM	31.64%	30.86%	33.01%	31.84%	40.48%	24.14%
Off-peak Periods	49.19%	48.00%	49.02%	48.74%	33.60%	59.76%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 3.13 summarizes crash types along I-64 within the study area during the three-year study period. The four most prevalent crash types accounted for 98.9% of all crashes. These involved rear-end, fixed-object off-road, sideswipe same-direction, and angle collisions. Rear-end, sideswipe and angle collisions are attributed to heavy traffic volumes operating under congested conditions. These often include stop-and-go conditions and abrupt lane changes made to avoid collision with a slow or stopped vehicle. Clusters of fixed object off-road crashes are noted to have occurred on ramps, specifically along segments with curvilinear alignments. It is possible these are caused by motorists exceeding the posted advisory speed limits for these ramps. The majority of sideswipe crashes occurred in areas operating with merge or weave movements, which is expected.

Table 3.13: Crash Types for I-64, 2015-2017

I-64 Segment	Crash Type (number of crashes)							
	Rear End	Sideswipe, Same Direction	Fixed Object Off-Road	Angle	Fixed Object in Road	Non-Collision	Sideswipe, Opposite Direction	Other
EB mainline	691	58	61	48	2	0	2	4
WB mainline	492	65	78	49	3	5	0	1
Reversible	7	1	1	1	0	0	0	1
Total	**1,190**	**124**	**140**	**98**	**5**	**5**	**2**	**6**
% of total	75.9%	7.9%	8.9%	6.2%	0.3%	0.3%	0.1%	0.4%

Table 3.14 compares crash, injury, and fatality rates along eastbound and westbound I-64 with the 2017 statewide and districtwide rates for similar facilities. With respect to crash and injury crash rates, the rates evidenced on I-64 within the study area during each of the years studied are higher than either the statewide rates or the districtwide rates. The fatality rates in both directions evidence high variability because the number of fatalities is low in any given year, but are comparable to the statewide rate, and lower than the districtwide rate.

Table 3.14: Crash, Injury and Fatality Rates on I-64, 2015-2017

Facility	Crash Rates (crashes per 100 million vehicle-miles)											
	2015				2016				2017			
	Crash Severity	Observed Rate	Statewide	Districtwide	Crash Severity	Observed Rate	Statewide	Districtwide	Crash Severity	Observed Rate	Statewide	Districtwide
EB I-64	Crash	143.98	70.88	81.13	Crash	168.82	70.48	86.00	Crash	206.02	71.60	87.98
WB I-64		115.16				134.64				142.18		
EB I-64	Injury	69.51	28.70	39.02	Injury	102.97	29.27	44.82	Injury	119.40	28.50	43.14
WB I-64		57.00				85.22				80.46		
EB I-64	Fatality	0.62	0.38	0.42	Fatality	0.00	0.41	0.45	Fatality	0.59	0.41	0.58
WB I-64		0.58				0.57				0.00		

The crash rate on I-64 has increased each year from 2015 to 2017 in both directions of travel. While this trend is also evident on a districtwide basis (8% increase in crash rate from 2015 to 2017), the increase in crash rate on I-64 is more pronounced (43% increase from 2015 to 2017). The same is true for the injury rate on eastbound I-64, where the corridor rate increased 72% from 2015 to 2017 with a districtwide rate increase of only 10%. The injury rate on westbound I-64 peaked in 2016, and has remained approximately 1.5 to 2 times the districtwide rate in any given year. The fatality rate by direction (in years having a fatality recorded) is consistent across all years studied.

To identify crash hotspots and contributing factors along the eastbound and westbound I-64 mainline, three-year crash data was aggregated by 0.25-mile segments and plotted by crash type. Figure 3-32 presents a crash occurrence graph along I-64 within the study area. Figure 3-33 summarizes the same data using calculated crash rates per quarter mile along I-64.

> A crash "hotspot" is defined by VDOT as a quarter-mile segment with a crash rate higher than the 95th percentile confidence interval (statistical mean plus two standard deviations), also referred to as the critical crash rate.

Crash location data, crash density, and crash rates identify the following high crash locations in the I-64 corridor:

- Eastbound I-64 general-purpose (GP) lanes, from Northampton Boulevard to I-264 - Plotted crashes on this 1.5-mile segment of highway appear as a dense, linear cluster of incidents. Resulting crash densities are >34 crashes per quarter mile. Crash rates vary from 250-500 crashes per 100M vehicle-miles traveled, or approximately 3-6 times the districtwide crash rate for interstates. Rear-end collisions predominate, with a significant number of sideswipe/same-direction collisions and fixed-object/off-road collisions.

  The high crash experience at this location may be associated with the following causes:

  - Severe congestion on the ramp from eastbound I-64 to eastbound I-264, which results in the extensive queuing on eastbound I-64 in the two right GP lanes. Motorists are required to decelerate and/or stop at the back of queue, which is an unexpected maneuver on an interstate. Motorists attempting to enter the middle of the queue decelerate and often stop in the second lane. Once in the queue, traffic moves at variable speeds, increasing the potential for rear-end collisions. Field observations of traffic flow during peak periods and visual evidence of tire skid marks in the outer two travel lanes support this analysis.
  - This entire highway segment is provided with either guardrail or concrete barrier on both sides of the eastbound I-64 travelway. The fixed-object/off-road collisions are therefore believed to be impacts with either guardrail or barrier. It is possible that motorists attempting to avoid a rear-end collision leave their travel lane and instead impact guardrail or barrier.
  - The horizontal and vertical geometry of the exit ramp from eastbound I-64 to eastbound and westbound I-264 limits decision sight distance for motorists. This likely has the effect of reducing travel speeds and increasing congestion on the upstream travelway.
  - The sideswipe collisions may be the result of multiple lane changes by vehicles exiting the eastbound Express Lanes approximately one mile in advance of the exit ramp to eastbound and westbound I-264. In addition, collisions may also be the result of late lane changes into the vehicle queue upstream of the exit ramp.
  - Traffic volumes entering eastbound I-64 from Northampton Boulevard are in the range of 1,700-1,800 vehicles per hour during AM and PM peak periods. The single-lane ramp operates at capacity. The ramp lane terminates 800 ft beyond the merge point with the mainline travel lanes, which themselves are congested with traffic queued for the downstream exit to eastbound and westbound I-264.
- Westbound I-64 GP lanes, north of the entrance ramp from Northampton Boulevard - The crash density approaching the entrance ramp is between 18 and 34 crashes per quarter mile, and >34 crashes per quarter mile at the entrance ramp. Sideswipe and read-end collisions predominate in this area. The computed crash rates in this area range from 150 to 335 crashes per 100M vehicle-miles traveled, or approximately 2-3 times the districtwide crash rate.

  The recorded crash data reflect substandard geometric conditions at this entrance ramp terminal prior to completion of recent improvements to extend the acceleration distance. Prior to the improvements, the ramp did not provide sufficient acceleration length, and conditions resulted in an undesirable speed differential between ramp and mainline traffic. Slow-moving vehicles entering higher-speed travel lanes typically result in sideswipe collisions, or sudden deceleration in the mainline traffic stream which results in rear-end collisions.
- Westbound I-64 GP lanes, north of the I-64/I-264 interchange - This is the terminal area for the ramps from eastbound and westbound I-264 to westbound I-64. Primary collision types are rear-end, sideswipe/same-direction, and fixed-object/off-road. Crash densities along this segment of the westbound I-64 GP lanes ranges from 18-34 crashes per quarter mile. Computed crash rates vary from 200-300 crashes per 100M vehicle-miles traveled, or approximately 2.5-3.5 times the districtwide crash rate.

  Downstream of the ramp merge point, the right lane of this three-lane ramp terminates with a taper measuring approximately 200 ft. This lane drop taper is shorter than the 300 ft minimum prescribed by VDOT and AASHTO design guidance. In addition, the length of the three-lane speed change area measures 300 ft, which is 700 ft shorter than the minimum length recommended by AASHTO guidance. Crash experience in this terminal area is likely attributable to the ramp terminal configuration, which forces lower-speed ramp traffic to merge into higher-speed mainline traffic prematurely. These conditions typically result in sideswipe crashes.

Figure 3-32: I-64 EB and WB Mainline Crash Location Graph, 2015-2017

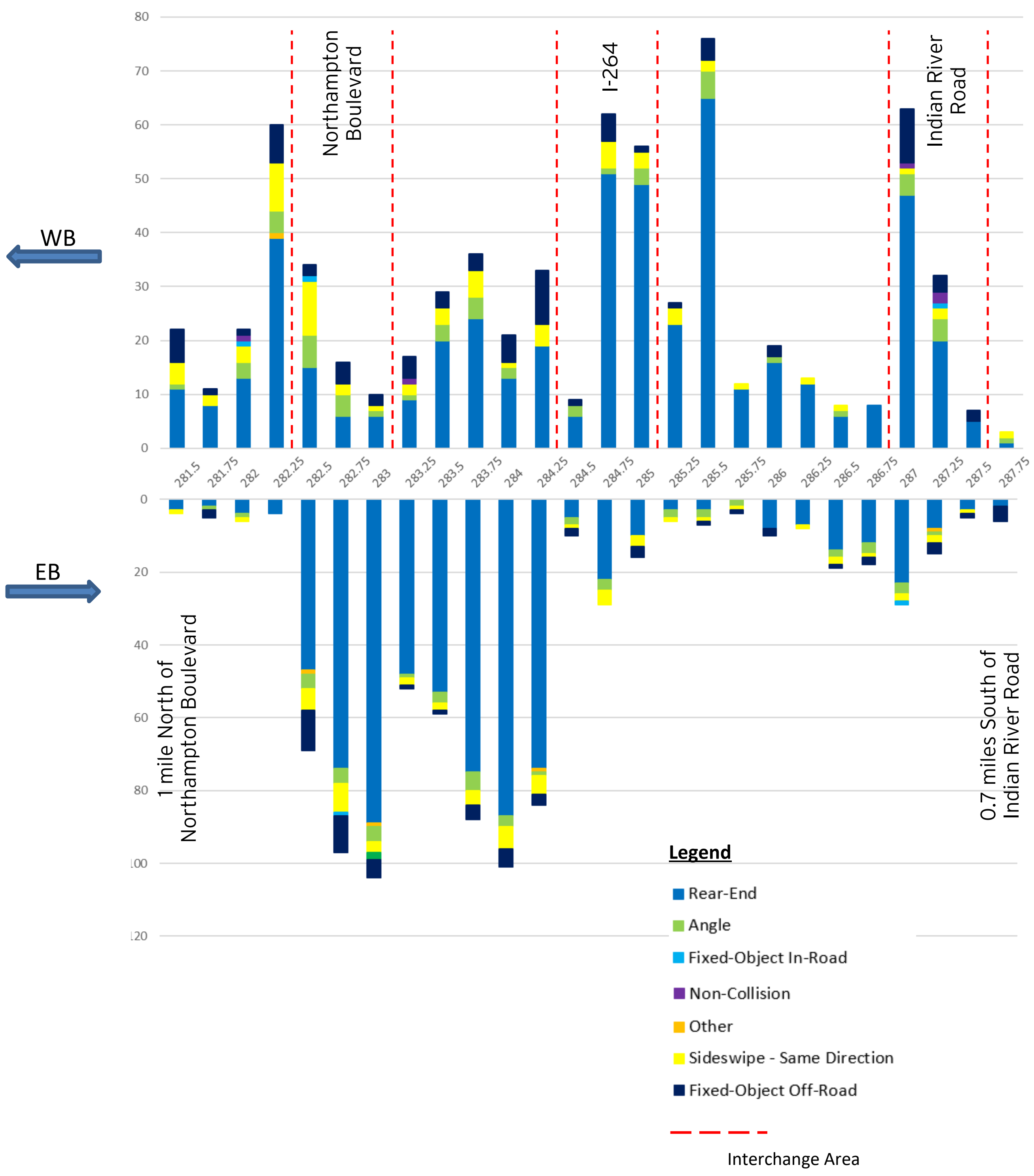
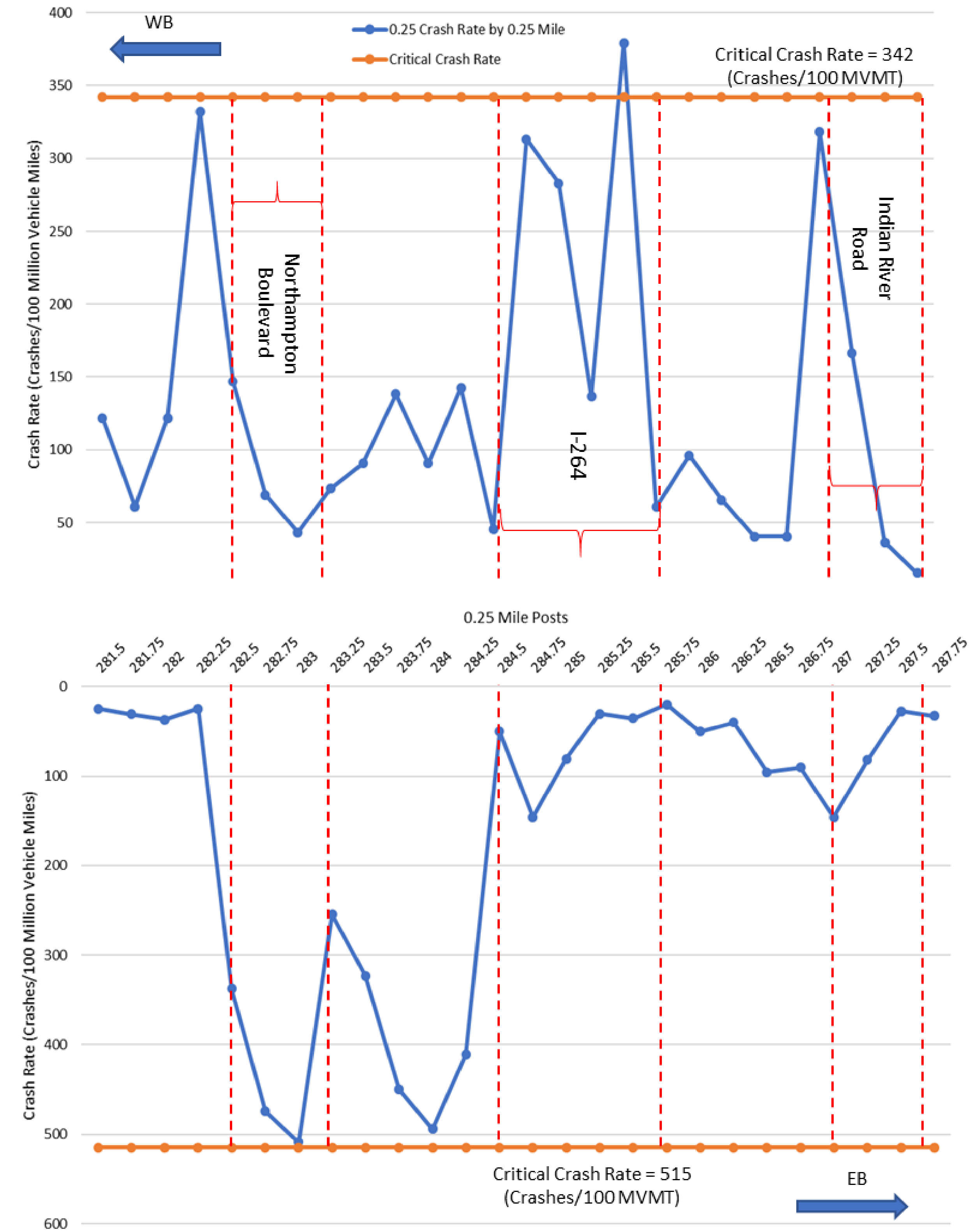


Figure 3-33: Crash Rate Analysis for I-64 per 1/4 Mile



The ramp lane reduction has the effect of increasing flow densities, further reducing ramp travel speeds and increasing congestion. Those conditions increase the potential for read-end collisions, and fixed-object/off-road collisions when motorists take evasive maneuvers. Tire skid marks and guardrail impacts are visible in the area.

- Westbound I-64 GP lanes, approaching the exit ramp to eastbound I-264 - This ramp is currently being reconstructed under the I-64/I-264 Phase I improvement project to provide additional capacity and reduce crash potential. Crash experience at this location qualifies the area as a crash hot spot, with a peak crash rate of 380 crashes per 100M vehicle-miles traveled which is approximately 4.5 times the districtwide crash rate.
- Eastbound I-64 GP lanes, approaching the Indian River Road interchange - This area experiences crash densities of 18-34 crashes per quarter mile, and a peak crash rate of 150 crashes per 100M vehicle-miles traveled or approximately double the districtwide crash rate. Crash experience involves primarily rear-end collisions, in addition to several angle collisions.

  The loop ramp from eastbound I-64 to eastbound Indian River Road operates with heavy congestion and extensive queuing during the weekday PM peak period. The queuing on the loop exit ramp is attributable to congestion on eastbound Indian River Road at signalized intersections east of the interchange. The rear-end collisions on eastbound I-64 upstream of the interchange are associated with peak period queuing, which extends back through the merge-weave area between the loop exit and entrance ramps at the interchange.

  The angle collisions are located along eastbound I-64 upstream of the loop exit ramp. These may be caused by through motorists trapped in the loop ramp queue pulling out into the adjacent through travel lane and being struck by another through vehicle.
- Westbound I-64 GP lanes, through the Indian River Road interchange - The crash density approaching the entrance ramp from westbound Indian River Road is between 18 and 34 crashes per quarter mile, and >34 crashes per quarter mile at the entrance ramp. Sideswipe and read-end collisions predominate in this area. The computed crash rates in this area range from 200 to 300 crashes per 100M vehicle-miles traveled, or approximately 2.5-3.5 times the districtwide crash rate.

  Upstream portions of the entrance ramp provide two travel lanes. The ramp tapers to a single lane prior to merging with the westbound I-64 GP lanes. Volumes during the weekday AM peak hour period exceed 2,000 vph, resulting in reduced travel speeds and high flow densities at the mainline merge. High levels of congestion, unstable travel speeds, and lane changes in areas with high speed differentials increase the potential for rear-end and sideswipe collisions.

Tables 3.15 through 3.18 summarize crash experience on I-64 associated with various lighting conditions, weather conditions, road surface conditions, and truck involvement for the 2015-2017 period. Each table also provides a comparison of corridor-specific and statewide data by percent distribution of environmental factors.

Table 3.15: Crash Data for I-64 by Light Conditions

Location		Dawn	Daylight	Dusk	Dark, Road Lighted	Dark, Road Not Lighted	Unknown	Total
I-64 EB Mainline	Northampton Boulevard to I-264	16	555	21	90	12	0	694
	I-264 to Indian River Road	6	124	8	32	1	1	172
	Subtotal	22	679	29	122	13	1	866
I-64 Reversible		0	5	1	5	0	0	11
I-64 WB Mainline	Indian River Road to I-264	5	313	14	51	2	0	385
	I-264 to Northampton Boulevard	11	204	6	80	7	0	308
	Subtotal	16	517	20	131	9	0	693
Total		**38**	**1,201**	**50**	**258**	**22**	**1**	**1,570**
Percent in Corridor		2.4%	76.5%	3.2%	16.4%	1.4%	0.1%	100.0%
Statewide trend		2.8%	66.6%	2.0%	12.7%	15.8%	0.1%	100.0%

With respect to lighting conditions, crash data generally follows statewide trends with the exception of crashes occurring under "dark, road not lighted" conditions. The majority length of I-64 within the study area is lighted whereas this is not the case for interstates across Virginia. Therefore, the crash experience for the corridor tends more toward lighted conditions than the statewide data.

Table 3.16: Crash Data for I-64 by Weather Conditions

Location		Clear	Fog	Mist	Rain	Snow	Sleet / Hail	Other	Total
I-64 EB Mainline	Northampton Boulevard to I-264	600	0	5	83	5	0	1	694
	I-264 to Indian River Road	156	0	0	14	2	0	0	172
	Subtotal	756	0	5	97	7	0	1	866
I-64 Reversible		8	0	0	2	1	0	0	11
I-64 WB Mainline	Indian River Road to I-264	347	0	1	31	6	0	0	385
	I-264 to Northampton Boulevard	264	1	5	32	5	1	0	308
	Subtotal	611	1	6	63	11	1	0	693
Total		**1,375**	**1**	**11**	**162**	**19**	**1**	**1**	**1,570**
Percent in Corridor		87.6%	0.1%	0.7%	10.3%	1.2%	0.1%	0.1%	100.0%
Statewide trend		77.0%	0.4%	1.4%	16.1%	3.9%	1.1%	0.1%	100.0%

Table 3.17: Crash Data for I-64 by Road Surface Conditions

Location		Dry	Slush	Wet	Snow	Ice	Water	Other	Total
I-64 EB Mainline	Northampton Boulevard to I-264	591	0	98	4	1	0	0	694
	I-264 to Indian River Road	155	1	15	1	0	0	0	172
	Subtotal	746	1	113	5	1	0	0	866
I-64 Reversible		8	1	1	1	0	0	0	11
I-64 WB Mainline	Indian River Road to I-264	335	0	46	4	0	0	0	385
	I-264 to Northampton Boulevard	259	3	41	5	0	0	0	308
	Subtotal	594	3	87	9	0	0	0	693
Total		1,348	5	201	15	1	0	0	1,570
Percent in Corridor		85.9%	0.3%	12.8%	1.0%	0.1%	0.0%	0.0%	100.0%
Statewide trend		75.2%	0.0%	19.1%	3.0%	2.2%	0.2%	0.3%	100.0%

Crash data relative to weather conditions is generally consistent with statewide data, noting that the Hampton Roads area receives less snow and ice than other areas of the state. Corridor-specific crash data shows a slight increase in occurrences during clear conditions relative to statewide data, and slightly lower during rain. This same relationship between corridor and statewide trends is evident relative to dry and wet pavement conditions.

Table 3.18: Truck Involvement in Crashes on I-64

Location		Truck(s) Involved	Truck(s) Not Involved	Total
I-64 EB Mainline	Northampton Boulevard to I-264	27	667	694
	I-264 to Indian River Road	12	160	172
	Subtotal	39	827	866
I-64 Reversible		1	10	11
I-64 WB Mainline	Indian River Road to I-264	15	370	385
	I-264 to Northampton Boulevard	20	288	308
	Subtotal	35	658	693
Total		75	1,495	1,570
Percent in Corridor		4.8%	95.2%	100.0%
Statewide trend		2.1%	97.9%	100.0%

Trucks are involved in crashes along I-64 at twice the rate as is evidenced statewide. Within the study area, trucks comprise approximately 4% of total traffic on I-64, which is approximately the same as the statewide value of 4.7% for major urbanized areas. Within the data set presented in Table 3.18, crashes involving trucks are overrepresented along eastbound I-64 south of I-264, and westbound I-64 north of I-264. These do not appear to correlate to specific geometric or operating conditions. As discussed later in this chapter, this trend is not evidenced for crashes along I-264 within the study area. Consequently, data for the 2015-2017 period may therefore be anomalous.

3.9 Crash Analysis - I-264 Corridor

During the three-year period studied, a total of 513 crashes were reported along eastbound I-264, and 486 crashes were reported along westbound I-264 within the study area. The number of crashes increased from 2015 to 2016 but then declined nominally in 2017 in both directions. Crashes on the C/D roadways accounted for 26% of the total crashes. Work-zone crashes did not increase from 2016 to 2017 with the ongoing construction activities associated with the I-64/I-264 Phase I and Phase II improvement projects. Table 3.19 presents the number of crashes on I-264 within the study area over the three-year period studied, by year and by direction.

Table 3.19: Number of Crashes on I-264 by Year, 2015-2017

Roadway Segment		2015	2016	2017	Total
EB I-264	Mainline	123	146	146	415
	C/D Road	28	36	29	93
	Work-Zone Related Crashes	2	1	2	5
	EB I-264 Directional Subtotal	**153**	**183**	**177**	**513**
WB I-264	Mainline	88	100	116	304
	C/D Road	54	67	46	167
	Work-Zone Related Crashes	10	2	3	15
	WB I-264 Directional Subtotal	**152**	**169**	**165**	**486**
Total		305	352	342	999

Table 3.20 summarizes crash severity along I-264. Of the 999 total crashes reported on I-264, 63% involved property damage only. Injury crashes accounted for 37% of all crashes, resulting in a total of 410 injuries.

Table 3.20: Crash Severity for I-264, 2015-2017

I-264 Segment	Crash Severity (number of crashes)		
	Property Damage Only	Injury	Fatality
EB mainline	264	152	1
EB C/D Road	59	37	0
WB mainline	199	116	2
WB C/D Road	104	64	1
Total	626	369	4

During the three-year period studied, there were four crashes involving fatalities along I-264 which are described as follows:

- A fatal crash occurred on eastbound I-264 at milepoint 11.72 (0.5 miles west of Military Highway) on July 7, 2017. The crash involved a fixed object off-road collision with a concrete barrier. It occurred in daylight with dry surface conditions, and the driver was not wearing a seatbelt at the time of the crash.
- A fatality occurred on westbound I-264 at milepoint 11.94 (at the Military Highway interchange) on September 6, 2015. The subject vehicle overturned. It was dark at the time and the roadway surface was dry.
- A fatality occurred when a pedestrian was struck on westbound I-264 at milepoint 12.29 (at the merge of the entrance ramp from northbound Military Highway) on September 21, 2017. It was dark at the time and the roadway surface was dry.
- A fatality occurred as the result of a rear-end collision on westbound I-264 at milepoint 15.18 (at the Witchduck Road interchange) on March 5, 2017. It was dark at the time and the roadway surface was dry. The driver of the rear vehicle was intoxicated.

Table 3.21 summarizes the percentage of crashes occurring on I-264 during the morning (6:00 - 9:00 AM) and afternoon (3:00 - 6:00 PM) peak periods for the years 2015-2017. Like the I-64 corridor, approximately half of all crashes on I-264 occurred during either the morning or afternoon peak periods, a trend that has remained fairly consistent over the three years studied. I-264 within the study area is below the districtwide average for percent of daily crashes occurring during the AM and PM peak periods. However, it is above the statewide average for percent of daily crashes occurring during peak periods.

Table 3.21: Percentage of Crashes on I-264 by Peak Period, 2015-2017

Period of Day	2015	2016	2017	Corridor Average 2015 - 2017	Districtwide Average 2015 - 2017	Statewide Average 2015 - 2017
6:00 - 9:00 AM	18.03%	19.77%	22.06%	19.95%	25.92%	16.10%
3:00 - 6:00 PM	30.82%	36.13%	30.29%	32.41%	40.48%	24.14%
Off-peak Periods	51.15%	44.10%	47.65%	47.63%	33.60%	59.76%
Total	100%	100%	100%	100%	100%	100%

Table 3.22 summarizes crash types for the three-year period studied. The four most prevalent crash types accounted for 97.4% of all crashes. These involved rear-end, fixed-object in-road, angle, and sideswipe same-direction. Like conditions on I-64, these crash types are typically attributed to heavy traffic volumes operating under congested conditions.

Table 3.22: Crash Types for I-264, 2015-2017

I-264 Segment	Crash Type (number of crashes)							
	Rear End	Fixed Object in Road	Angle	Sideswipe, Same Direction	Fixed Object Off-Road	Sideswipe, Opposite Direction	Head-on	Other
EB mainline	260	60	44	46	4	1	1	1
EB C/D Road	49	35	9	7	2	3	1	0
WB mainline	211	40	27	29	3	1	2	4
WB C/D Road	114	22	16	14	2	0	0	1
Total	634	147	96	96	11	5	4	6
% of total	63.5%	14.7%	9.6%	9.6%	1.1%	0.5%	0.4%	0.6%

Table 3.23 presents a comparison of crash, injury, and fatality rates along eastbound and westbound I-264 with the 2017 statewide and districtwide rates for similar facilities. The overall crash and injury crash rates evidenced on I-264 within the study area during each of the years studied are higher than either the statewide rates or the districtwide rates. The fatality rates in both directions evidence high variability because the number of fatalities is low in any given year. Where a fatality crash rate has not been zero, it has been approximately double either the statewide rate or the districtwide rate for a given year.

The crash rate on I-264 has increased each year from 2015 to 2017 in both directions of travel. As mentioned earlier, this trend is evident on a districtwide basis, with data indicating an 8% increase in crash rate from 2015 to 2017. The crash rate on eastbound I-264 has increased 19% from 2015 to 2017. The injury rates on eastbound and westbound I-264 increase 43% and 74% from 2015 to 2017, during which time the districtwide rate increased 10%. The fatality rate by direction (in years having a fatality recorded) is consistent within the period studied.

Table 3.23: Crash, Injury and Fatality Rates on I-264, 2015-2017

Facility	Crash Rates (crashes per 100 million vehicle-miles)											
	2015				2016				2017			
	Crash Severity	Observed Rate	Statewide	Districtwide	Crash Severity	Observed Rate	Statewide	Districtwide	Crash Severity	Observed Rate	Statewide	Districtwide
EB I-264	Crash	106.75	70.88	81.13	Crash	124.90	70.48	86.00	Crash	126.85	71.60	87.98
WB I-264		94.37				103.35				104.41		
EB I-264	Injury	45.63	28.70	39.02	Injury	79.56	29.27	44.82	Injury	67.31	28.50	43.14
WB I-264		40.86				63.44				71.07		
EB I-264	Fatality	0.00	0.38	0.42	Fatality	0.00	0.41	0.45	Fatality	0.86	0.41	0.58
WB I-264		0.97				0.00				0.88		

To identify crash hotspots and contributing factors along the eastbound and westbound I-264 mainline roadways, three-year crash data were aggregated by 0.25-mile segments and plotted by location and type. Figure 3-34 illustrates the number of crashes by location within the study area. Figure 3-35 presents the crash location graph for the eastbound and westbound I-264 C/D roadways. Crash rates per quarter mile and critical crash rates along I-264 mainline and C/D roads are presented in Figures 3-36 and 3-37 on page 3-44.

Crash data indicate the following high crash locations in the I-264 corridor:

- Eastbound I-264 at the mainline-C/D road diverge - While the crash density in this area is relatively low, the crash rate is computed to be approximately 110 crashes per 100M vehicle-miles traveled, or approximately 30% higher than the districtwide crash rate. Rear-end, sideswipe/same-direction, and fixed-object/off-road collision types predominate in this area.

  Crashes at this location may be attributable to irregular roadway geometry at the diverge which may cause unexpected speed reductions. Based on a review of existing lane striping, the widening of the C/D roadway from one to two lanes is coincident with the development of the initial taper-type diverge from the mainline. The resulting lane geometry does not satisfy either VDOT or AASHTO guidance, and may be confusing to motorists. Motorists may also be confused by overhead directional signage that fails to provide advanced lane use guidance relative to the immediate downstream exit ramp to Military Highway.
- Eastbound I-264, 1,500 ft east of the mainline-C/D diverge - This area has a calculated crash rate of 255 crashes per 100M vehicle-miles traveled, or approximately three times the districtwide crash rate. This location is a crash hotspot. Crashes involved rear-end, sideswipe/same-direction, and fixed-object/off-road collisions.

  Crashes at this location may be associated with lane change maneuvers at the end of the marked HOV lane along eastbound I-264, or motorist positioning in advance of the downstream right lane drop or left exit ramp to westbound I-64.
- Eastbound I-264 C/D road, between loop ramps at the Military Highway interchange - The cluster of crashes at this location involves rear-end, sideswipe/same-direction, fixed-object/in-road, fixed-object/off-road, and angle collisions. While this area has a relatively low crash density, the computed crash rate is approximately 165 crashes per 100M vehicle-miles traveled, or approximately double the districtwide crash rate.

  The rear-end and sideswipe collisions experienced at this location could be associated with acceleration and deceleration maneuvers over short distances. Motorists may be traveling on the tight-radius loop ramps at speeds greater than the advisory speed limits, resulting in angle and fixed-object collisions.
- Westbound I-264 C/D road, between Newtown Road and I-64 - On the westbound C/D roadway, a crash hotspot is located near the entrance ramp from Newtown Road and extending one quarter mile west, approaching the I-64/I-264 interchange. This area experiences a crash rate ranging from 150 to 310 crashes per 100M vehicle-miles traveled, which is approximately 2-3.5 times the districtwide crash rate.

  The majority of these crashes are rear-end collisions, which are typically associated with congested operating conditions and unstable operating speeds, which were observed in this area under peak period conditions. This area also operates with complex weave movements between the entrance ramps from Newtown Road and the exit ramps to westbound and eastbound I-64. Heavy traffic volumes in this weave area contribute to an elevated crash potential, and are likely associated with the rear-end and sideswipe crashes experienced.
- Westbound I-264 mainline at Newtown Road - A crash hotspot is identified on the westbound I-264 mainline approaching the I-64 interchange. Crash rates in the area range from 150-260 crashes per 100M vehicle-miles traveled, which is approximately 2-3 times the districtwide crash rate. Most crashes in this area are rear-end collisions.

  The location of this crash hotspot correlates to field observations and traffic modeling results that reveal reduced speeds along this segment. Crashes are likely attributable to congestion on the downstream left exit ramp to eastbound I-64, which operates with queuing that extends back onto the westbound I-264 mainline and reaches the overpass of Newtown Road. Rear-end collisions are concentrated at the approximate end of the queue. Crash experience may be exacerbated by a concentration of lane changes in this area associated with end-of-queue avoidance maneuvers, the entrance ramp to the westbound I-64 Express Lanes, and/or the marked end of the westbound HOV lane at this location.
- Westbound I-264 at the Witchduck Road interchange - The terminal area of the westbound I-264 exit ramp to Witchduck Road has a high crash density of >34 crashes per quarter mile. The crash rate at this location ranges from 150 to 200 crashes per 100M vehicle-miles traveled, or 2-2.5 times the districtwide crash rate. Rear-end collisions are the predominant crash type.

  The crash experience at this location may be attributable to substandard decision sight distance around the horizontal curve located immediately east of the westbound exit ramp to Witchduck Road. With reduced time to make decisions regarding exit maneuvers, motorists may be decelerating suddenly. Crashes may also be caused by exiting motorists decelerating as they change lanes through the westbound shoulder running lane.
- Eastbound I-264 mainline, I-64 to Newtown Road - In this area, crashes primarily involve rear-end and sideswipe/same-direction collisions. Crash densities at this location range from 18 to >34 crashes per quarter mile. Crash rates range from 125 to 160 crashes per 100M vehicle-miles traveled, or approximately 1.5-2 times the districtwide crash rate.

  This location is a complex merge-weave area for vehicles from eastbound I-264, the ramp from eastbound I-64, and the ramp from the I-64 managed lanes when they are operating in the eastbound direction. Sideswipe crashes in this area are likely caused by speed changes and weaves associated with entry and exit maneuvers between the general-purpose lanes and the eastbound I-264 HOV lane. Rear-end collisions may be caused by congestion at the merge of the eastbound I-264 mainline and C/D roadway further east, with motorists impacting slower or stopped vehicles.

Figure 3-34: I-264 EB and WB Mainline Crash Location Graph, 2015-2017

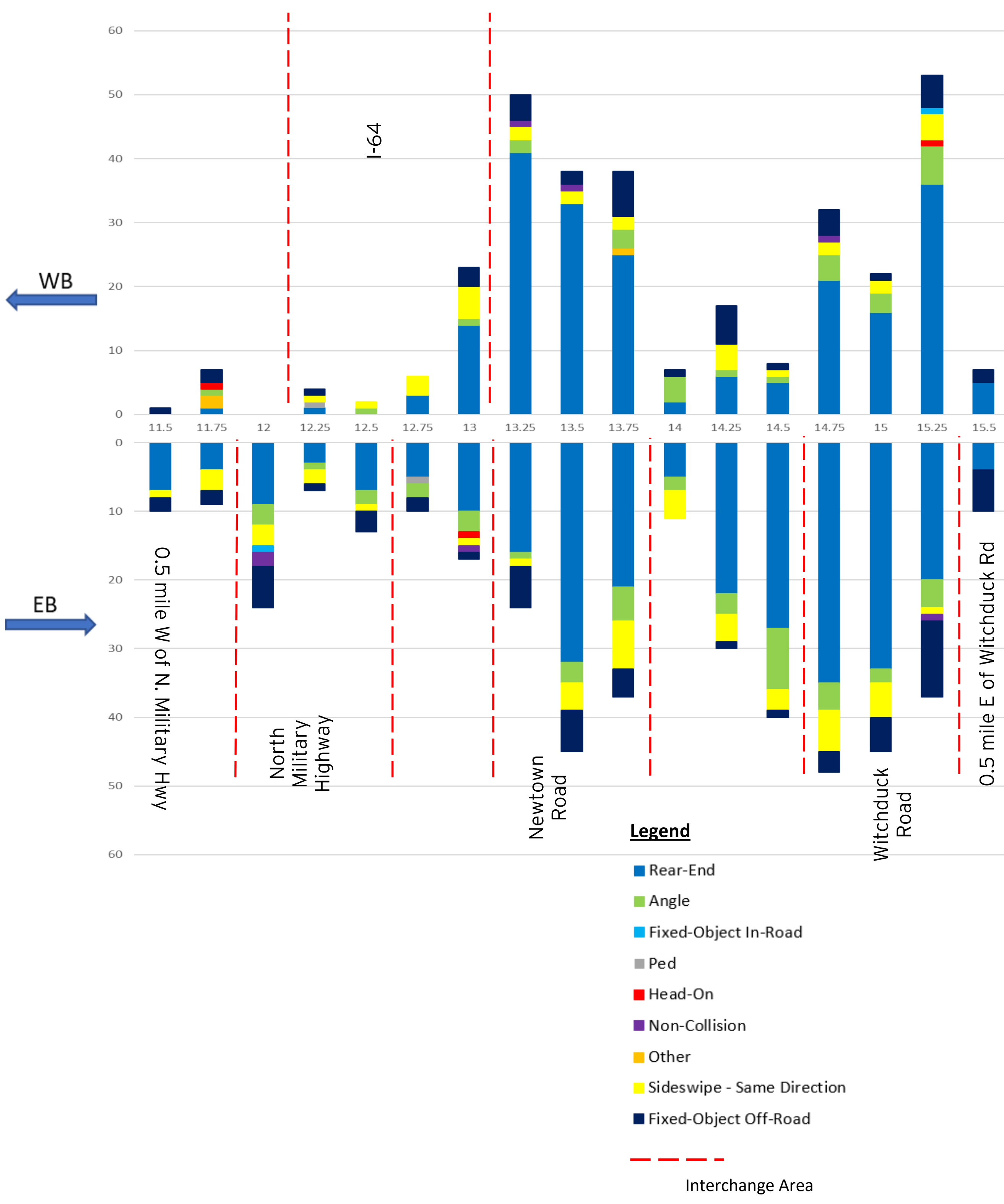


Figure 3-35: I-264 EB and WB C/D Roadway Crash Location Graph, 2015-2017

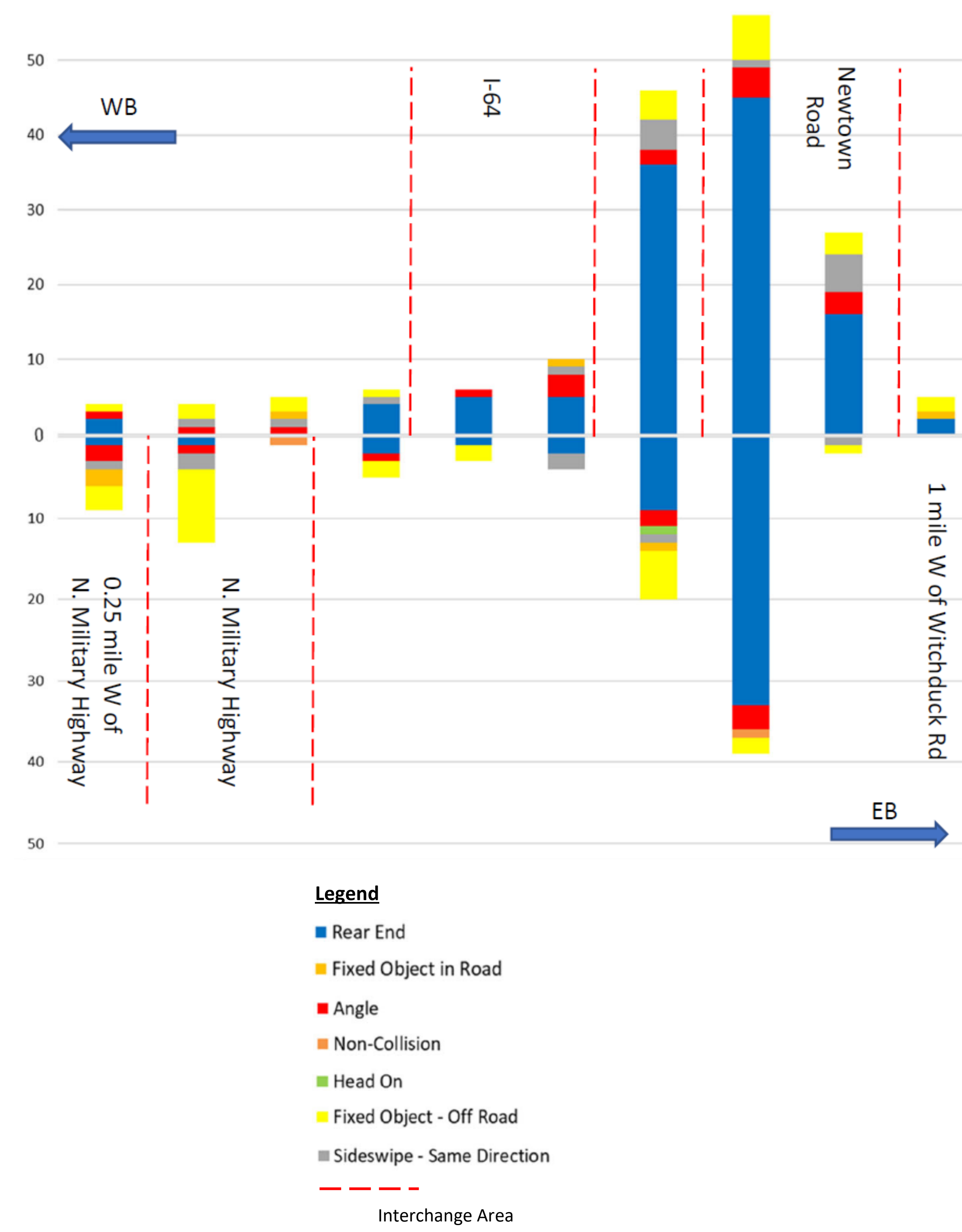


Figure 3-36: Crash Rate Analysis for I-264 Mainline per 1/4 Mile

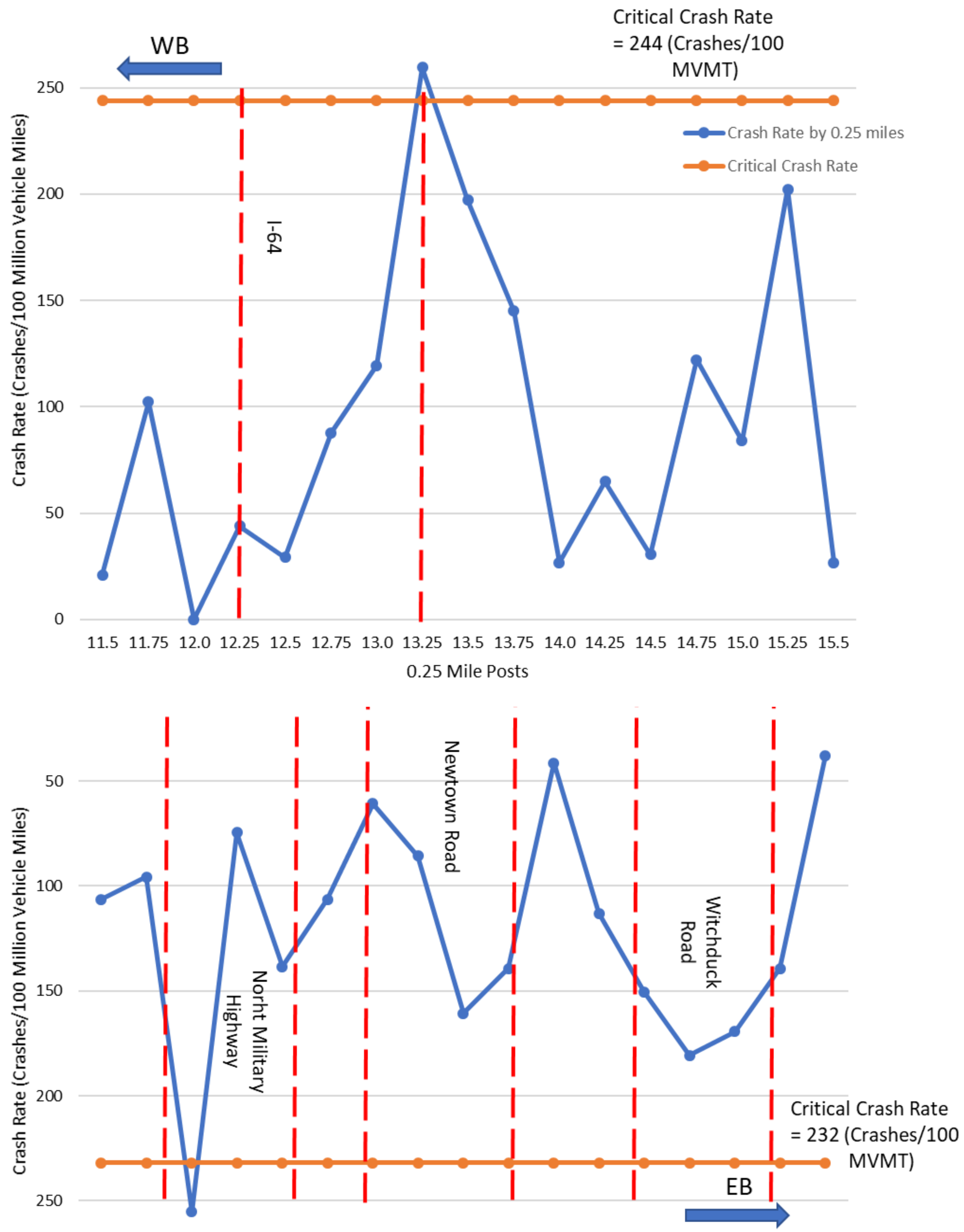
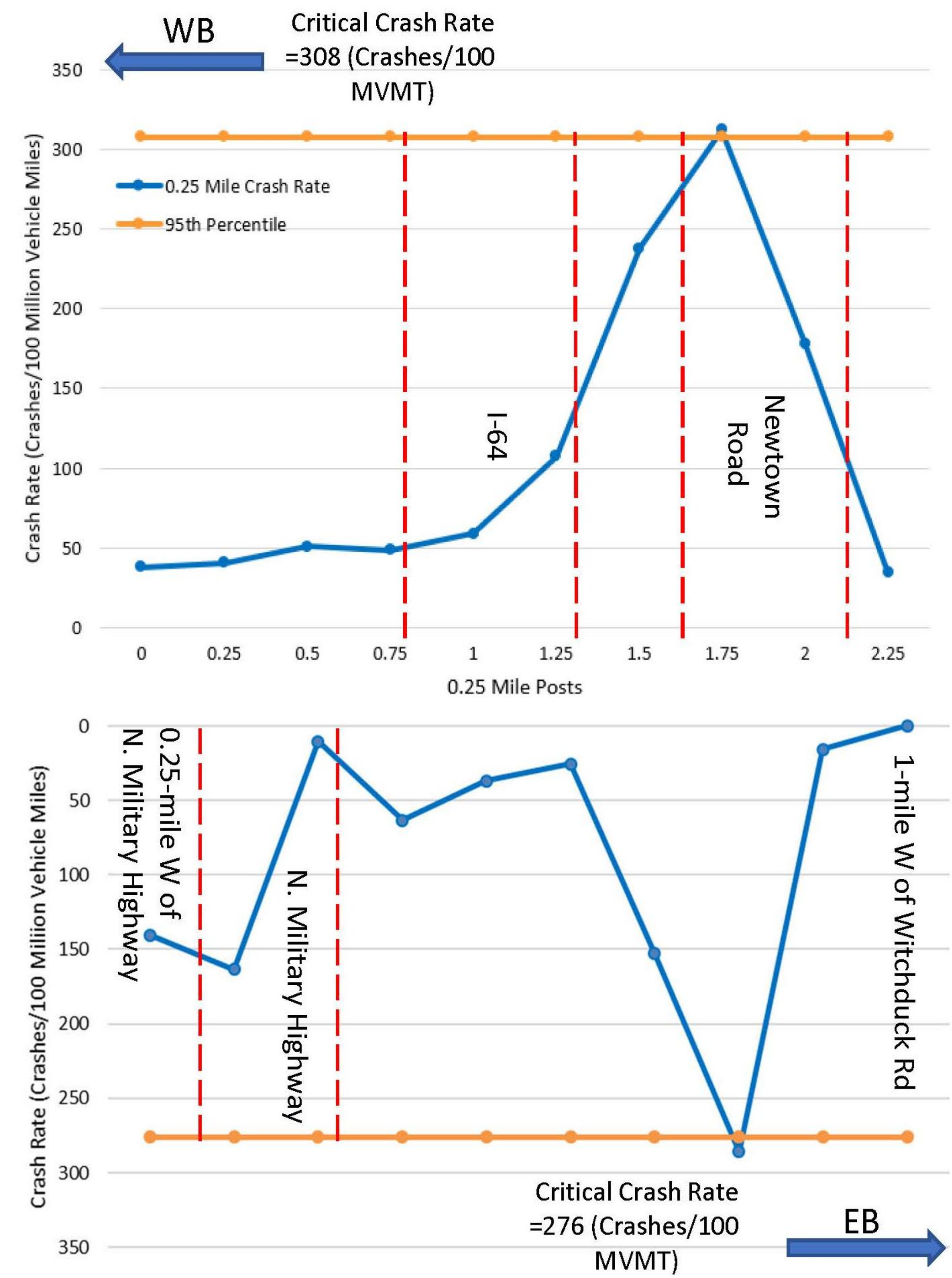


Figure 3-37: Crash Rate Analysis for I-264 C/D Roadways per 1/4 Mile



The crash data used for this study identify several locations along I-264 within the limits of the I-64/I-264 Phase I and Phase II construction projects that have experienced high crash rates and/or concentrated crash clusters from 2015 to 2017. The ongoing construction projects are anticipated to reduce crash potential in future years at the following locations:

- Eastbound I-264 C/D road at Newtown Road (crash hotspot)
- Eastbound I-264 at the Witchduck Road interchange

Tables 3-24 through 3-27 summarize crash experience on I-264 by lighting conditions, weather conditions, road surface conditions, and truck involvement for the 2015-2017 period. The crash data for the I-264 corridor is generally representative of statewide crash data with respect to environmental factors. Heavy trucks are involved in crashes at a comparable rate as evidenced statewide.

Table 3.24: Crash Data for I-264 by Light Conditions

Location		Dawn	Daylight	Dusk	Dark, Lighted	Dark, Not Lighted	Unknown	Total
I-264 EB Mainline	Study area limit to Military Hwy.	0	36	1	13	0	0	50
	Military Hwy. to I-64	0	15	0	8	0	0	23
	I-64 to Newtown Rd.	1	64	3	14	4	0	86
	Newtown Rd. to Witchduck Rd.	3	152	8	41	7	0	211
	Witchduck Rd. to study area limit	0	33	1	13	0	0	47
	Subtotal	4	300	13	89	11	0	417
EB C/D Roadway		0	64	3	26	3	0	96
I-264 WB Mainline	Study area limit to Witchduck Rd.	2	34	0	24	0	0	60
	Witchduck Rd. to Newtown Rd.	6	59	2	43	14	0	124
	Newtown Rd. to I-64	5	79	4	21	2	0	111
	I-64 to Military Hwy.	1	6	1	2	0	1	11
	Military Hwy. to study area limit	2	6	0	3	0	0	11
	Subtotal	16	184	7	93	16	1	693
WB C/D Roadway		14	98	8	44	5	0	14
Total		**34**	**646**	**31**	**252**	**35**	**1**	**999**
Percent in Corridor		3.4%	64.7%	3.1%	25.2%	3.5%	0.1%	100.0%
Statewide trend		2.8%	66.6%	2.0%	12.7%	15.8%	0.1%	100.0%

Like I-64, the majority length of I-264 within the study area is lighted. Therefore, the crash occurrence rate in "dark, not lighted" conditions is lower than the statewide trend, which reflects a larger percentage of interstate mileage that is not lighted. The inverse is true for the crash occurrence under "dark, lighted" conditions. Other corridor trends are similar to statewide trends, as related to lighting conditions.

Table 3.25: Crash Data for I-264 by Weather Conditions

Location		Clear	Fog	Mist	Rain	Snow	Sleet / Hail	Other	Total
I-264 EB Mainline	Study area limit to Military Hwy.	38	0	2	9	1	0	0	50
	Military Hwy. to I-64	20	0	0	3	0	0	0	23
	I-64 to Newtown Rd.	76	0	2	7	1	0	0	86
	Newtown Rd. to Witchduck Rd.	177	0	2	30	2	0	0	211
	Witchduck Rd. to study area limit	31	0	1	15	0	0	0	47
	Subtotal	342	0	7	64	4	0	0	417
EB C/D Roadway		74	0	4	17	1	0	0	96
I-264 WB Mainline	Study area limit to Witchduck Rd.	45	0	1	13	1	0	0	60
	Witchduck Rd. to Newtown Rd.	97	0	1	22	4	0	0	124
	Newtown Rd. to I-64	95	0	1	14	1	0	0	111
	I-64 to Military Hwy.	8	0	0	2	1	0	0	11
	Military Hwy. to study area limit	9	0	0	2	0	0	0	11
	Subtotal	254	0	3	53	7	0	0	317
WB C/D Roadway		142	0	2	21	4	0	0	169
Total		**812**	**0**	**16**	**155**	**16**	**0**	**0**	**999**
Percent in Corridor		81.3%	0.0%	1.6%	15.5%	1.6%	0.0%	0.0%	100.0%
Statewide trend		77.0%	0.4%	1.4%	16.1%	3.9%	1.1%	0.1%	100.0%

Crash data for the I-264 corridor is similar to statewide trends across all weather conditions. Data show variances between corridor and statewide trends of approximately 1% to 3% by weather condition category.

The same is generally true for crash data associated with road surface conditions. The occurrence rate for crashes in snow and ice are lower in the I-264 corridor than for interstates across Virginia. This trend is attributable to the moderate climate of the Hampton Roads area, which experiences inclement winter weather less frequently than other areas of the state.

Table 3.26: Crash Data for I-264 by Road Surface Conditions

Location		Dry	Slush	Wet	Snow	Ice	Water	Other	Total
I-264 EB Mainline	Study area limit to Military Hwy.	37	0	12	1	0	0	0	50
	Military Hwy. to I-64	20	0	3	0	0	0	0	23
	I-64 to Newtown Rd.	75	0	10	0	1	0	0	86
	Newtown Rd. to Witchduck Rd.	174	1	33	1	1	0	1	211
	Witchduck Rd. to study area limit	31	0	16	0	0	0	0	47
	Subtotal	337	1	74	2	2	0	1	417
EB C/D Roadway		68	0	26	1	0	1	0	96
I-264 WB Mainline	Study area limit to Witchduck Rd.	45	0	14	0	1	0	0	60
	Witchduck Rd. to Newtown Rd.	97	1	23	3	0	0	0	124
	Newtown Rd. to I-64	91	0	18	1	0	1	0	111
	I-64 to Military Hwy.	7	0	3	0	0	0	1	11
	Military Hwy. to study area limit	8	0	2	0	0	0	1	11
	Subtotal	248	1	60	4	1	1	2	60
WB C/D Roadway		136	0	29	3	1	0	0	169
Total		**789**	**2**	**189**	**10**	**4**	**2**	**3**	**999**
Percent in Corridor		79.0%	0.2%	18.9%	1.0%	0.4%	0.2%	0.3%	100.0%
Statewide trend		75.2%	0.0%	19.1%	3.0%	2.2%	0.2%	0.3%	100.0%

Table 3.27: Truck Involvement in Crashes on I-264

Location		Truck(s) Involved	Truck(s) Not Involved	Total
I-264 EB Mainline	Study area limit to Military Hwy.	0	50	50
	Military Hwy. to I-64	1	22	23
	I-64 to Newtown Rd.	4	82	86
	Newtown Rd. to Witchduck Rd.	8	203	211
	Witchduck Rd. to study area limit	0	47	47
	Subtotal	13	404	417
EB C/D Roadway		3	93	96
I-264 WB Mainline	Study area limit to Witchduck Rd.	1	59	60
	Witchduck Rd. to Newtown Rd.	0	124	124
	Newtown Rd. to I-64	3	108	111
	I-64 to Military Hwy.	0	11	11
	Military Hwy. to study area limit	0	11	11
	Subtotal	4	313	317
WB C/D Roadway		4	165	169
Total		**24**	**975**	**999**
Percent in Corridor		2.4%	97.6%	100.0%
Statewide trend		2.1%	97.9%	100.0%

Based on the data presented in Table 3.27, the percentage of crashes involving trucks in the I-264 corridor is consistent with the percentage evidenced across Virginia.

3.10 Crash Analysis - Interchanges

This section presents the findings of the crash analysis at interchanges within the study area. To evaluate crash patterns that differ from those associated with the mainline travelways as a whole, data referenced in this section include crashes occurring on mainline interstate segments through interchanges and along interchange ramps. Crashes occurring on mainline travelways, as represented in this data set, are a subset of all mainline crashes addressed in the previous section of this report.

For the purposes of these analyses, ramp terminal intersections (e.g. Northampton Boulevard at westbound I-64 exit ramp) are not included as part of the interchange and are addressed in Section 3.11 entitled "Crash Analysis - Intersections".

I-64/I-264 Interchange - There were a total of 383 crashes within this interchange during the three-year study period. This interchange is closely spaced with the I-264/Newtown Road interchange to the east and the I-264/Military Highway interchange to the west. Rear-end collisions were the most prevalent type (65.8%), followed by fixed-object off-road crashes (17.0%), sideswipe same-direction crashes (9.9%), and angle collisions (6.8%). These four crash types accounted for 99.5% of crashes reported at this interchange.

I-264/Military Highway Interchange - There were a total of 200 crashes reported within this interchange during the three-year study period. Consistent with other facilities within the study area, the four most frequent crash types accounted for 92.0% of all crashes. However, fixed-object off-road crashes accounted for nearly a third (32.5%) of all crashes. Of the 31 crashes occurring on ramps, 12 occurred on the eastbound I-264 exit ramp to northbound Military Highway, and all of them were categorized as fixed-object off-road collisions. This ramp operates with an advisory speed limit of 20 mph. It is possible that this particular cluster of crashes can be attributed to vehicles exceeding the advisory speed limit for the tight radius loop ramp. Five of the eight crashes on the westbound I-264 exit ramp to northbound Military Highway also involved fixed-object off-road collisions. That ramp also operates with a 20 mph advisory speed limit.

<u>I-264/Newtown Road Interchange</u> - A total of 415 crashes were reported at the I-264/Newtown Road interchange during the three-year study period. Rear-end, angle, and fixed object off-road crashes accounted for 91.8% of all crashes. There was one fatal crash reported on November 28, 2016, which occurred on the westbound I-264 exit ramp to northbound Newtown Road. This was a fixed-object off-road crash where the vehicle collided with a tree. A review of existing conditions identified a tree marked with a painted white cross, located left of the ramp travelway on the outside of a horizontal curve. The crash occurred when it was dark with dry surface conditions.

<u>I-264/Witchduck Road Interchange</u> - Crashes were not analyzed for the south half of the I-264/Witchduck Road interchange because the current I-64/I-264 Phase II improvement project is reconstructing the eastbound ramps. The north half of this interchange was evaluated because the westbound ramps are not being improved as part of any planned or programmed project.

A total of 107 crashes were reported on westbound I-264 at the Witchduck Road interchange during the three-year study period. The most prevalent crash type was rear-end collision (68%), followed by angle collisions (12%), and fixed-object off-road crashes (9%). Rear-end and angle crashes are typical at an interchange where vehicles experience prolonged periods of stop-and-go flow conditions, often due to heavy volumes, lane changes, and merge/diverge maneuvers at ramps. Of the ten fixed-object off-road crashes, 60% occurred when it was dark and 40% occurred during periods with wet surface conditions.

<u>I-64/Northampton Boulevard Interchange</u> - A total of 185 crashes occurred at this interchange during the three-year study period. Rear-end, fixed-object, sideswipe, and angle crashes account for 96.2% of all crashes within the interchange area. Of the 18 crashes that occurred on ramps, eight occurred on the eastbound I-64 exit ramp to Northampton Boulevard. Of these, four were rear-end collisions and four were fixed-object off-road crashes. The fixed-object off-road crashes may be due to vehicles exceeding the 30 mph advisory speed limit on this loop ramp.

<u>I-64/Indian River Road Interchange</u> - A total of 205 crashes occurred at this interchange during the three-year study period. Four crash types (rear-end, fixed-object, sideswipe, and angle) accounted for 92.7% of all reported crashes. Of the 32 crashes occurring on ramps, 14 crashes (44%) occurred on the westbound I-64 exit ramp to eastbound Indian River Road. Of these 14 crashes, nine were fixed-object off-road collisions. The advisory speed limit for this ramp is posted at 30 mph at the mainline diverge, and subsequently reduces to 25 mph in advance of an S-curve approaching Indian River Road. The prevalence of fixed-object off-road crashes on this ramp may be attributed to vehicles exceeding the posted advisory speed limit.

3.11 Crash Analysis - Intersections

Crash experience was analyzed at the following signalized intersections:

- Military Highway
  - Corporate Boulevard
  - Hoggard Road
  - Poplar Hall Drive
- Newtown Road
  - Kempsville Road / Princess Anne Road
  - Center Drive
  - Stoney Point S / WB I-264 exit ramp (ramp termini)
  - Ethan Allen Lane / Cleveland Street
- Northampton Boulevard
  - USAA Drive / Kempsville Road
  - EB I-64 entrance ramp (entrance ramp) / IKEA Way
  - WB I-64 exit ramp (ramp termini)
  - Wesleyan Drive / Premium Outlets Boulevard
- Indian River Road
  - Reon Drive
  - Regent University Drive / Founders Inn
  - Centerville Turnpike / Parkland Lane

For the purposes of this study, crashes occurring within 150 ft of an intersection were considered to occur at that intersection. This study assumes that intersections being improved by current construction projects were evaluated and designed to reduce crash potential. Accordingly, the following locations are excluded from the analyses undertaken for this study:

- The eastbound I-264 ramp terminal intersections at Newtown Road and Witchduck Road have been excluded from the analysis because these intersections are being reconstructed as part of the I-64/I-264 Phase I and II projects.
- Witchduck Road north of I-264 is under construction as part of the Witchduck Road Phase 2 Improvements, and will improve the intersections at Southern Boulevard and Cleveland Street.
- The eastbound I-64 exit ramp to Northampton Boulevard was recently reconfigured from a loop ramp to a signalized T-intersection, which now permits left turns from the ramp. Crash data for this improved condition are not yet available.

There were a total of 453 crashes at all study intersections, 60% involving property damage only and 40% involving injuries, resulting in injuries to 281 persons. One fatality was reported at the Newtown Road/Stoney Point South intersection. The angle collision involved a northbound left-turning motorist who was intoxicated. The crash occurred after dark and with dry surface conditions.

Table 3.28 presents a summary of crash types during the three-year study period. The most prevalent crash types at intersections were rear-end collisions (56%), angle collisions (23%), and sideswipe same-direction crashes (11%). Rear-end collisions are common at signalized intersections when drivers following too closely fail to stop or slow down for vehicles ahead. Of the 104 angle crashes, 61% occurred when motorists turned left or disregarded the traffic signal, and 39% occurred due to improper lane changes.

The three intersections along Indian River Road within the study area experience a relatively high number of crashes, with rear-end collisions accounting for 69% of the total. The intersections are located within one half mile of the I-64 interchange. The rear-end crashes may be attributed to the speed differential between through vehicles on Indian River Road and vehicles entering/exiting I-64 that can cause "stop and go" conditions and sudden lane changes.

The Northampton Boulevard/Wesleyan Drive intersection experienced the highest number of crashes among all intersections within the study area over the three-year period studied. Of the 77 crashes reported at this location, 49 (64%) involved rear-end collisions. The intersection is located within 0.3 miles of the I-64/Northampton Boulevard interchange and operates with heavy demand on all four approaches. The high percentage of rear-end collisions at this intersection is consistent with heavy congestion and multiple lane changes in advance of lane drops at ramp terminals. Twelve sideswipe collisions were reported at this intersection, possibly due to the offset intersection geometry that requires through traffic crossing Northampton Boulevard to follow a reverse-curve travel path.

Table 3.28: Crash Types at Intersections, 2015-2017

Intersection	Intersection Summary by Crash Type										
	Rear-End	Angle	Sideswipe, Same Direction	Sideswipe, Opposite Direction	Fixed Object in Road	Fixed Object Off-Road	Non-Collision	Pedestrian	Head-on	Other	Total
Indian River Road at Reon Drive	31	5	4	1	1	1	1	0	1	0	45
Indian River Road at Regent University Drive	41	8	5	0	0	5	1	0	0	0	60
Indian River Road at Centerville Turnpike / Parkland Lane	44	5	8	0	1	1	1	1	0	2	63
Newtown Road at Kempsville Road / Princess Anne Road	7	5	2	0	0	2	0	1	0	0	17
Newtown Road at Center Drive	8	5	0	0	0	0	0	0	0	0	13
Newtown Road at Stoney Point S/WB I-264 exit ramp	16	10	2	0	0	0	0	0	0	0	28
Newtown Road at Ethan Allen Lane / Cleveland Street	7	10	0	0	0	3	0	0	1	0	21
South Military Hwy. at Corporate Boulevard	10	1	3	0	0	0	0	0	0	1	15
North Military Highway at Hoggard Road	9	9	8	0	0	1	0	0	1	0	28
North Military Highway at Poplar Hall Drive	7	23	5	0	1	2	0	1	1	2	42
Northampton Boulevard at Kempsville Road / USAA Drive	20	8	0	0	0	2	1	0	0	2	33
Northampton Boulevard at WB I-64 exit ramp	3	6	0	1	0	1	0	0	1	0	12
Northampton Boulevard at Wesleyan Drive/Premium Outlets Boulevard	49	9	12	1	1	2	0	0	0	3	77
Total	**252**	**104**	**49**	**3**	**4**	**20**	**4**	**3**	**5**	**10**	**454**

3.12 Safety Analysis Summary - Existing Conditions

The following summary points identify safety issues under existing conditions and support the purpose and need for the project:

- The total number of crashes on I-64 within the study area increased by approximately 90 crashes per year during the three-year period studied, representing an increase of 42% from 2015 to 2017. The number of crashes on I-264 within the study area has increased 12% over the same time period.
- Annual crash rates on both I-64 and I-264 exceed the districtwide and statewide rates for the respective years, and have increased each of the years studied. The rates at which the crash rates have increased outpaces the trends observed from districtwide or statewide data.
- Injury crash rates on both I-64 and I-264 are higher than the districtwide and statewide rates. Injury crash rates by facility and by direction have generally increased from 2015 to 2017.
- The majority of crashes experienced on I-64 and I-264 within the study area are of types associated with heavy congestion, variable operating speeds, and high-density weave conditions. These crash types can typically be addressed by constructing physical improvements that increase capacity, reduce congestion, reduce speed differentials, and enhance driver expectancy.
- Nearly 45% of the 1,570 reported crashes along both directions of I-64 within the study area occurred on eastbound I-64 between the Northampton Boulevard interchange and the I-64/I-264 interchange.
- Crash data and statistically-established crash "hotspots" correlate to areas observed in the field as experiencing congestion, variable operating speeds, and high densities. Hotspots are located as follows:
  - Westbound I-64 approaching the I-264 interchange (being improved as part of the I-64/I-264 Phase I project)
  - Westbound I-264 C/D roadway between Newtown Road and the I-64 interchange
  - Westbound I-264 mainline at Newtown Road
  - Eastbound I-264 beyond the mainline-C/D roadway diverge, west of the Military Highway interchange

- Although not ranked as hotspots, the following locations also exhibit high crash rates that correlate to observed and modeled operational problems:
  - Westbound I-64 through the Indian River Road interchange
  - Westbound I-64 at the merge of the entrance ramp from eastbound and westbound I-264
  - Westbound I-64 at the merge of the entrance ramp from Northampton Boulevard (data reflect conditions prior to recent improvements at this location)
  - Eastbound I-64 approaching the Indian River Road interchange
  - Eastbound I-64 from the Northampton Boulevard interchange to the I-264 interchange
  - Westbound I-264 at the Witchduck Road interchange
  - Eastbound I-264 at the mainline-C/D roadway diverge, west of the Military Highway interchange
  - Eastbound I-264 C/D road between entrance and exit loop ramps at the Military Highway interchange
  - Eastbound I-264 mainline from I-64 to Newtown Road
  - Eastbound I-264 at the Witchduck Road interchange (being improved as part of the I-64/I-264 Phase II project)
  - Eastbound I-264 C/D road at the Newtown Road interchange (being improved as part of the I-64/I-264 Phase I and Phase II projects)

Additional findings include the following:

- Crash experience on I-64 and I-264 is generally consistent with statewide experience with respect to environmental factors such as lighting conditions, weather, and road surface conditions. Where differences were noted, they are attributable to differences between the physical setting of the study area and conditions across Virginia. Examples include crash experience in "dark, not lighted" conditions, and crash experience under snowy and icy road surface conditions.
- The fatality crash rates for I-64 and I-264 are highly variable because of the low number of fatalities experienced in any given year. As such, direct comparisons with districtwide or statewide data over a period of three years are difficult.

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CHAPTER 4: ALTERNATIVES CONSIDERED

This chapter provides an overview of the no-build and build alternatives developed and considered in this study. Study activities included development and evaluation of improvement alternatives for each of the six interchanges within the study area, and considered improvements between interchanges as needed to meet operational objectives. This chapter also addresses Transportation System Management strategies considered to augment build alternatives.

Evaluations were performed within the framework of the three-tiered evaluation process that is fully described in Section 2.1. The tiered study approach used progressively more detailed analyses to narrow the range of possible design solutions down to a single recommended alternative. The tiered screening process eliminated alternatives at each tier that failed to satisfy project objectives, and advanced for further study those alternatives that met project objectives.

Screening activities and results reflect analyses undertaken at interim stages of the study. Conclusions and decisions regarding alternatives are presented in this report as they were analyzed and understood at the time of the screening activities. Throughout the course of the study, alternatives and analyses were refined to arrive at recommended improvements.

4.1 No-Build Alternative

The No-Build Alternative represents projected future 2044 conditions if no improvements were advanced as part of this project, and provides a baseline condition against which build alternatives were measured for effectiveness. The No-Build Alternative retains the existing configuration of roadways within the study limits, but reflects completion of the following projects included in the HRTPO LRTP:

- I-64/I-264 Ramp Improvements (UPC 57048) - Phase I of the I-64/I-264 interchange improvements involves construction of new ramps from westbound I-64 to eastbound I-264, and improvements to Newtown Road. The project is under construction and is scheduled for completion in October 2019.
- I-264 / Witchduck Road Interchange and Ramp Extension (C-D Road) (UPC 17630) - Phase II of the I-64/I-264 interchange improvements extends the eastbound I-264 C/D roadway from Newtown Road through the Witchduck Road interchange, and includes improvements along Witchduck Road, Greenwich Road, and Cleveland Street. The project is under construction and is scheduled for completion in September 2021.
- Witchduck Road Phase II Improvements (City of Virginia Beach CIP No. 2-025) - This project widens Witchduck Road between I-264 and Virginia Beach Boulevard. The project is currently under construction and has a projected completion date in 2019.
- I-64 Express Lanes Segment 2 (UPC 112923) - The project will convert the existing HOV lanes on I-64 to dynamically priced high-occupancy toll lanes between I-264 and the I-464 interchange. This segment of the Express Lanes network is in design now, and construction is scheduled for completion in 2021. A companion portion of the Segment 2 Express Lanes will be constructed with the I-64 Southside Widening and High Rise Bridge Phase I project (UPC 106692), from the I-64/I-264/I-664 interchange at Bowers Hill to the I-464 interchange. The High Rise Bridge Phase I project is scheduled for completion in July 2021. The High Rise Bridge Phase II project, which will further widen High Rise Bridge and I-64 towards Bowers Hill is scheduled for completion in 2037.
- Widening of I-64 / Hampton Roads Bridge-Tunnel Expansion - The project will widen I-64 and construct a third tunnel to provide additional capacity between Settlers Landing Road in Hampton and I-564 in Norfolk. Completion of the project is scheduled for 2024. The project will remove an existing bottleneck on I-64 upstream of the I-64/I-264 interchange, with the anticipated effect of increasing traffic volumes within the study area.

4.2 Tier 1 Alternatives and Screening

As noted in Section 2.1 of this report, Tier 1 screening involved developing improvement concepts to address known and observed capacity constraints, operational problems, and safety issues within the study area.

With the exception of the I-64/Indian River Road interchange, all of the interchanges in the study area were the focus of recent previous studies completed by VDOT. For the locations previously studied, the recommended improvements identified in the prior studies were carried forward for consideration as part of the Tier 1 screening and were evaluated against other improvement concepts developed for this study. For all interchanges within the study area, additional improvement concepts were developed through consultation with VDOT staff and Study Team members including representatives of the City of Norfolk, the City of Virginia Beach, and FHWA.

Evaluation criteria included the following:

- Right-of-way impacts - measured the number and type of parcels impacted;
- Traffic operations - focused on analysis of link capacities, intersection capacity, and merge, weave, and diverge operations using HCS and Synchro software; and ability to eliminate specific weave movements;
- Pedestrian/Bicycle accommodations - ability to provide desired sidewalk connections; and number of pedestrian crossings of uncontrolled free-flow ramp terminals;
- Compliance with adopted plans - consistency with recommended improvements identified by prior studies, or compatibility with land use plans adopted by local agencies; and
- Potential environmental impacts - degree to which environmental impacts would be potentially impacted; based on a review of preliminary resource inventory information prepared by VDOT.

The Study Team convened on October 11, 2018 to discuss and evaluate Tier 1 alternatives. The following information in this section describes the alternatives considered as part of Tier 1 screening activities, and the evaluation of alternatives at each interchange. The following information is presented for each alternative:

- Figures illustrating each alternative considered. For all figures, red lines represent roadway segments, yellow lines represent bridges, and the circled numbers indicate the lane count under build conditions. Exhibits identify which alternatives were carried forward into Tier 2 screening.
- Accompanying each set of figures is an evaluation matrix prepared to document the advantages and disadvantages of each alternative by location. Color coding in the matrices represents favorable (green), moderate (yellow), or unfavorable (red) attributes. Information contained in the matrices (Tables 4.1 through 4.6) supports the Study Team's decisions regarding improvement alternatives selected for Tier 2 evaluation and screening.

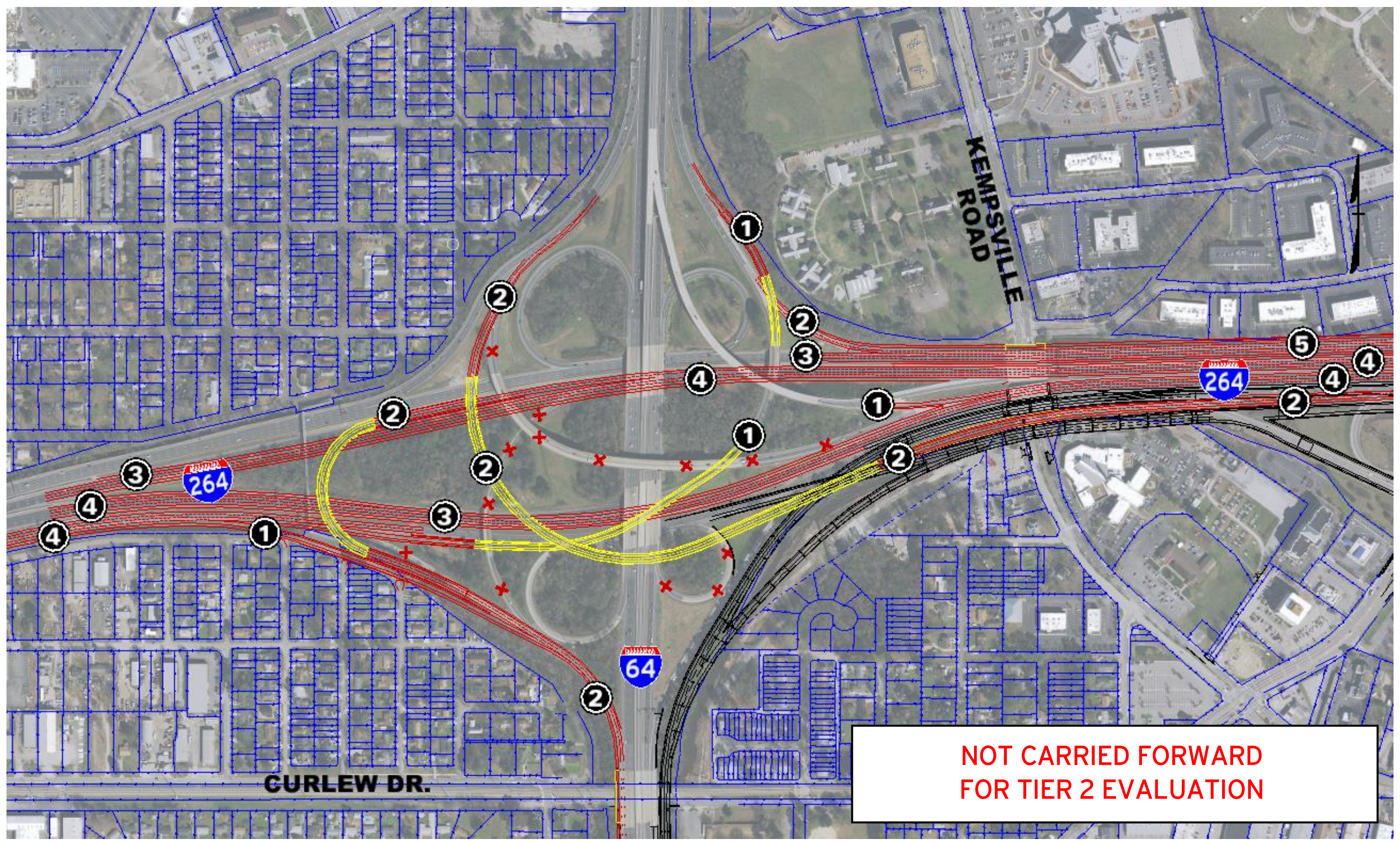
Alternatives carried forward into Tier 2 evaluation were considered by the Study Team to be worthy of refinement and further study. The no-build alternative was carried forward for each interchange.

In general, alternatives that were determined to be less effective at addressing traffic congestion or safety issues were eliminated from further consideration. Alternatives determined to have fatal flaws with respect to interchange geometry or directional connectivity were also eliminated from further consideration. Alternatives determined to have substantially greater right-of-way impacts than others with little or no operational benefits were eliminated. Potential environmental impacts were considered, but were generally not primary factors in screening Tier 1 alternatives because geometric improvements were developed only to an initial concept level at this stage of the study.

I-64/I-264 Interchange

Alternative 1 (Figure 4-1) - This alternative was identified as a recommended improvement in the 2016 I-264 Corridor Study. The westbound I-264 exit ramp to eastbound I-64 is configured as a righthand exit with a tight-radius elevated ramp. This exit ramp operates from the westbound through facility, not the C/D roadway. Closely spaced loop ramps along the westbound I-264 C/D roadway remain in place, whereas the loop ramp in the southeast quadrant of the interchange is removed. New semi-directional ramps are provided for the eastbound I-264 to westbound I-64 movement and the eastbound I-64 to eastbound I-264 movement.

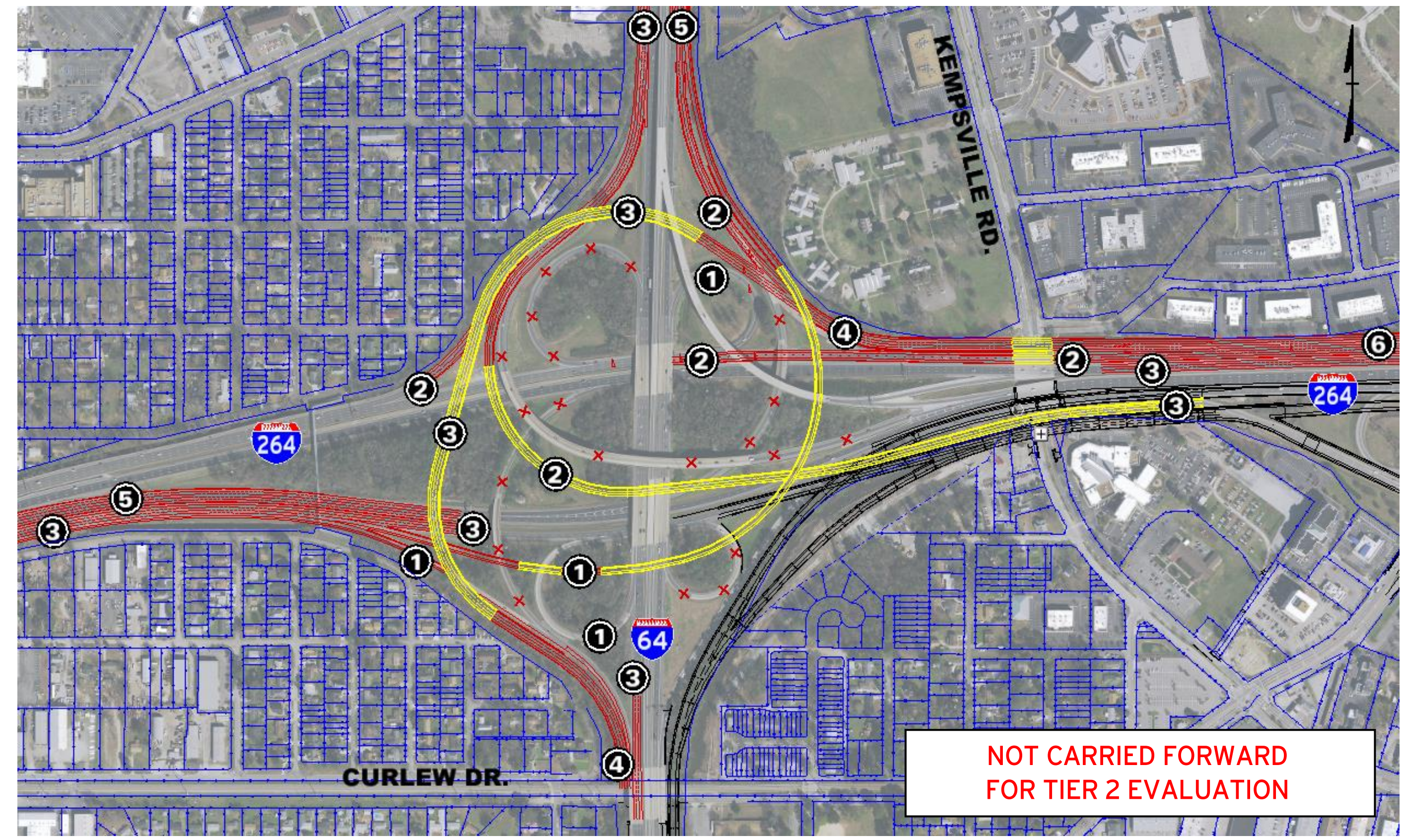
Figure 4-1: Tier 1 I-64/I-264 Interchange Alternative 1



Alternative 1 was not carried forward for several reasons. Analyses indicated that the weave area along the westbound I-264 C/D roadway between Newtown Road and I-64 would operate with heavy congestion and low speeds. To accommodate vertical clearance requirements, the ramp from eastbound I-264 to westbound I-64 would require use of steep profile grades that exceed allowable values set forth by AASHTO guidance. In addition, the ramp from westbound I-264 to eastbound I-64 would require use of a reduced design speed and steep departure grades from westbound I-264, both of which would not satisfy AASHTO design guidelines.

Alternative 2 (Figure 4-2) - An outer ramp network is created along westbound I-264. The northwest loop ramp and the left exit from the westbound I-264 through facility are replaced with a three-lane semi-directional ramp to eastbound I-64. To minimize right-of-way impacts, a portion of this ramp is situated on a viaduct structure over the outer connection ramp from eastbound I-64 to westbound I-264. The southeast loop ramp and the left exit from the eastbound I-264 C/D roadway are replaced with a semi-directional ramp from the eastbound I-264 C/D roadway to westbound I-64.

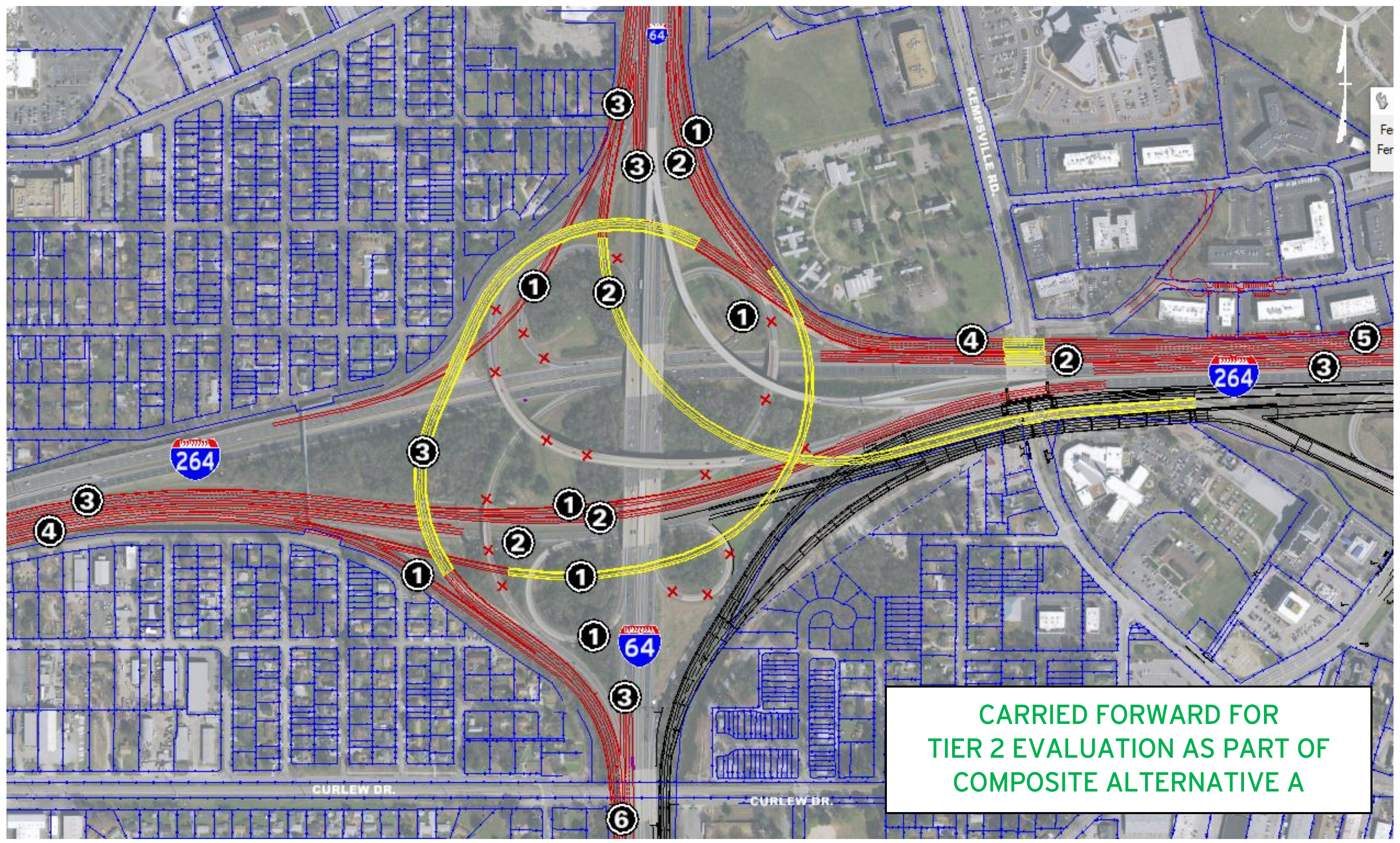
Figure 4-2: Tier 1 I-64/I-264 Interchange Alternative 2



Tier 1 analyses indicates that Alternative 2 would not provide sufficient weave capacity on the westbound I-264 C/D roadway between Newtown Road and I-64. Alternative 2 fails to correct substandard sight distance to the ramp diverge from eastbound I-64 to eastbound and westbound I-264. For these reasons, Alternative 2 was not carried forward for further evaluation.

Alternative 3 (Figure 4-3) - This provides the same functional layout as Alternative 2, but provides different geometry along eastbound I-64 at the ramp exits to eastbound and westbound I-264. Alternative 3 eliminates the viaduct structure associated with Alternative 2 at this location, and replaces it with ramp overpass geometry that involves simple spans carrying the westbound I-264 ramp to eastbound I-64 over the outer connection ramp from eastbound I-64 to westbound I-264.

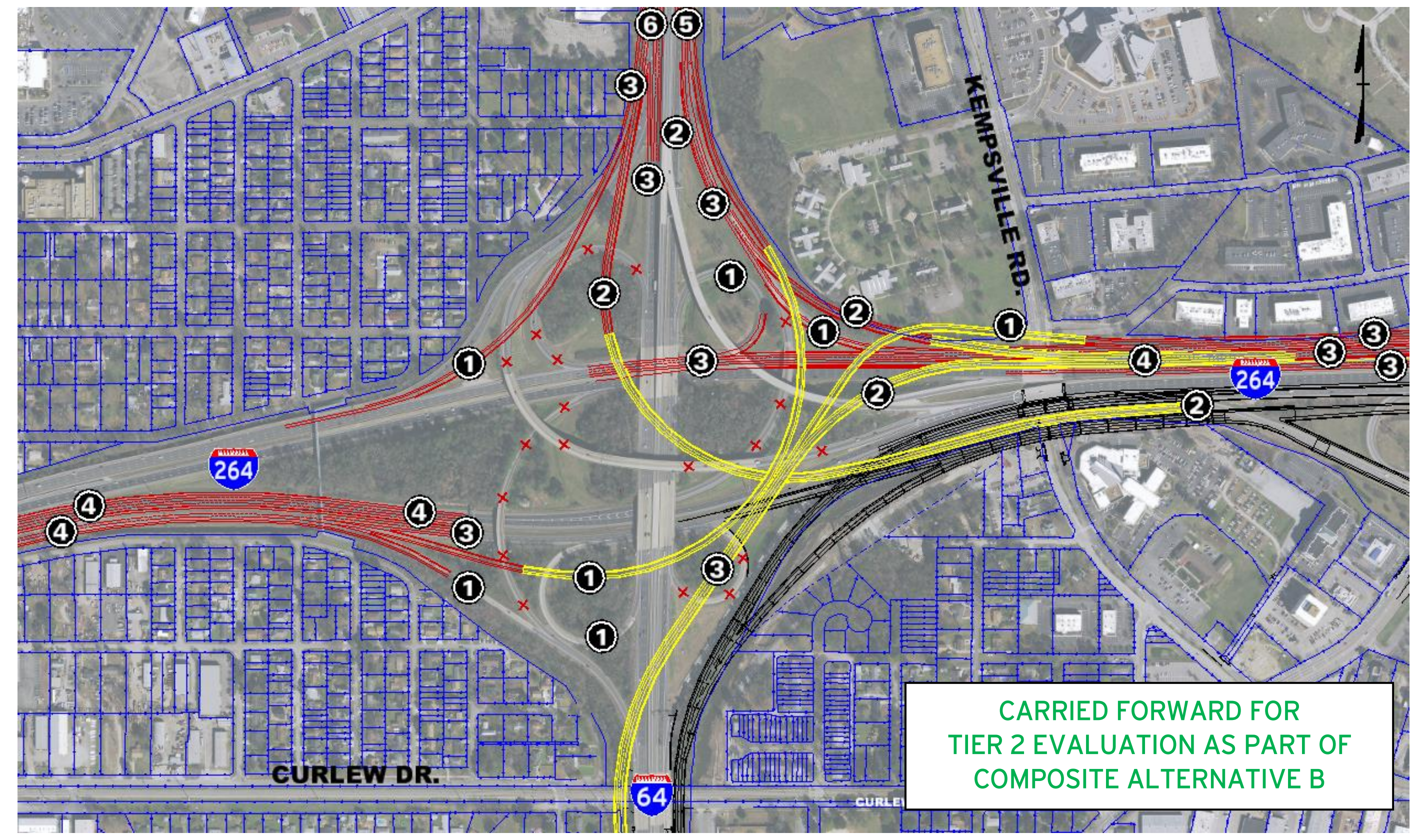
Figure 4-3: Tier 1 I-64/I-264 Interchange Alternative 3



Alternative 3 avoids the use of a fracture-critical viaduct structure in the northwest quadrant of the interchange (as featured in Alternative 2). Left exits and merge weave areas along eastbound and westbound I-264 are eliminated, and operational analyses produced favorable results regarding remaining weave, diverge, and merge areas. Accordingly, Alternative 3 was carried forward for refinement and further evaluation.

Alternative 4 (Figure 4-4) - A braided ramp configuration is provided along the westbound I-264 C/D roadway for direct connections from both roadways to eastbound and westbound I-64. Portions of the C/D roadway are situated on a structure atop the westbound mainline roadway. The ramp carrying westbound I-264 traffic to eastbound I-64 is elevated and traverses the southeast quadrant of the interchange. As in Alternatives 2 and 3, the left exits from the I-264 through roadways and two of the loop ramps along the C/D roadways are replaced with elevated semi-directional ramps.

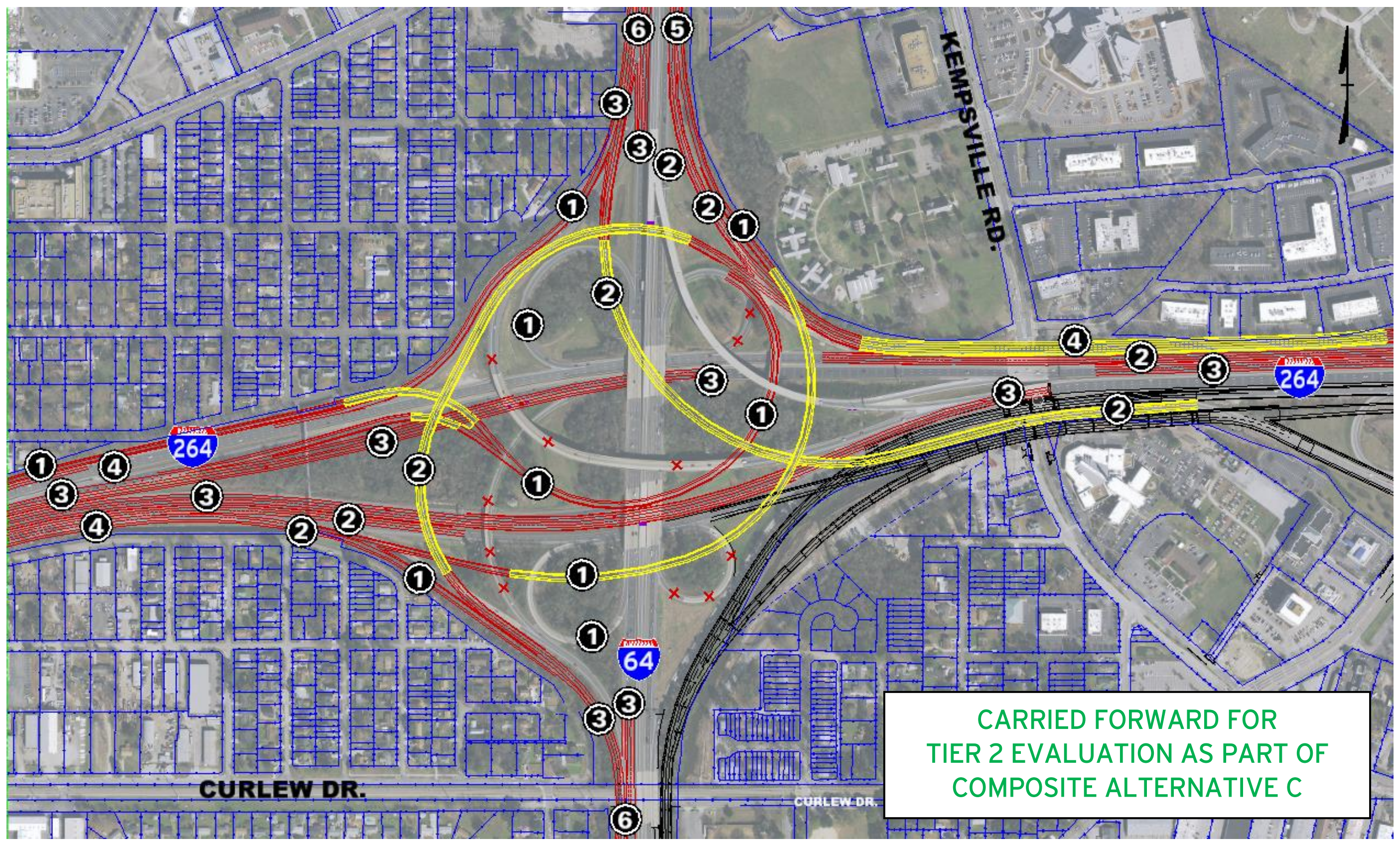
Figure 4-4: Tier 1 I-64/I-264 Interchange Alternative 4



Alternative 4 was carried forward due to its ability to provide full connectivity between both the westbound I-264 mainline and C/D roadways and I-64; elimination of left exit ramps from I-264 and merge-weave areas at closely spaced loop ramps; and favorable results from Tier 1 traffic operations analyses.

Alternative 5 (Figure 4-5) - An outer ramp to westbound and eastbound I-64 is provided along westbound I-264. To minimize right-of-way impacts, the westbound I-264 ramps to I-64 are situated parallel to and elevated above the C/D roadway. The southeast loop ramp and the left exit from the eastbound I-264 C/D roadway are replaced with a semi-directional ramp from the eastbound C/D roadway to westbound I-64. The northeast loop ramp is converted to a semi-directional ramp providing access to the westbound I-264 through lanes and a direct connection to Military Highway. This ramp configuration repurposes the pavement of the existing left exit ramp departing eastbound I-264, and establishes flow in the opposite direction from existing conditions. The left exit from the westbound I-264 through facility is replaced with a two-lane semi-directional ramp. The northwest loop ramp remains in service and provides redundant access from westbound I-264 to eastbound I-64.

Figure 4-5: Tier 1 I-64/I-264 Interchange Alternative 5



Alternative 5 was carried forward for refinement and further evaluation in Tier 2 screening. Operational analyses indicated favorable results with respect to weave, merge, and diverge conditions, which are different along westbound I-264 than other concepts under consideration. Like other concepts advanced, Alternative 3 eliminates left exits and merge-weave areas at closely spaced loop ramps.

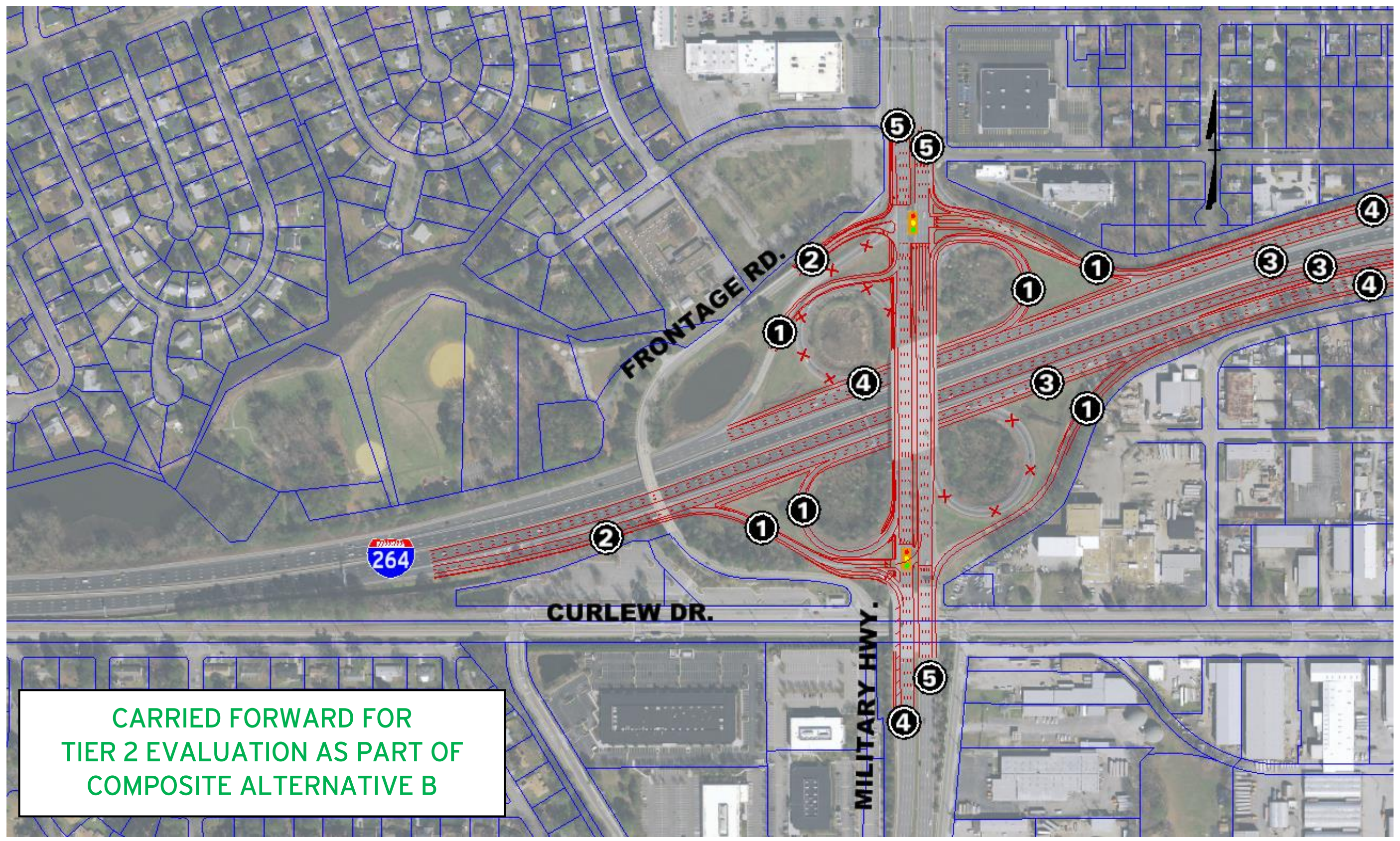
Table 4.1: Tier 1 Evaluation Matrix, I-64/I-264 Interchange

	I-64 / I-264 INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3	BUILD ALTERNATIVE 4	BUILD ALTERNATIVE 5
EVALUATION CRITERIA	Existing conditions; no improvements.	From I-264 Corridor Study; "Modified Conventional" semi-directional layout ❶	Semi-directional; eliminate left exits; eliminate NW and SE loops ❷	Semi-directional with improved EB I-64 exit; eliminate left exits; eliminate NW & SE loops ❸	Semi-directional with improved EB I-64 exit and more direct WB-WB connection; eliminate left exits; eliminate NW & SE loops ❹	Semi-directional with improved EB I-64 exit; eliminate left exits; eliminate SE loop; retain NW loop; repurpose NE loop ❺
Right-of-Way Impacts	No action - no right-of-way impacts.	Impacts to 6 residential parcels; truncation of Hargrove Street; cul-de-sac of Hicks Ave. and Glenrock Rd.	Impacts possible to Barry Robinson Center; four commercial parcels along Center Drive.	Impacts possible to two residential parcels (Glen Rocks); Barry Robinson Center; four commercial parcels along Center Drive.	Impacts possible to two residential parcels (Glen Rocks); Barry Robinson Center; four commercial parcels along Center Drive.	Impacts possible to two residential parcels (Glen Rocks); Barry Robinson Center; four commercial parcels along Center Drive.
Traffic Operations	Weaves at LOS F; operation of left exits. EB-to-EB ramp over capacity; WB-to-EB loop ramp over capacity.	Oversaturated diverge and weave areas, EB and WB I-264. No improvements to EB I-64 exit geometry at I-264.	Oversaturated weave conditions for WB I-264 west of Newtown. No improvements to EB I-64 exit geometry at I-264.	Eliminates weaves along I-264 at loop ramps, left exits, and primary weaves on WB I-264 C/D west of Newtown. Requires minimum length lane drops on EB I-64.	Eliminates weaves along I-264 at loop ramps, left exits, primary weaves along WB I-264 C/D; requires short lane drops along EB I-64.	Eliminates weaves along I-264 at loop ramps, left exits, and primary weaves on WB I-264 C/D west of Newtown. Requires minimum length lane drops on EB I-64.
Pedestrian/Bicycle Accommodations	Provides bike/ped overpass for N-S connectivity across interchange.	Replacement bike/ped overpass structure provided.	Replacement bike/ped overpass structure not shown but could be provided.	Replacement bike/ped overpass structure not shown but could be provided.	Replacement bike/ped overpass structure not shown but could be provided.	Replacement bike/ped overpass structure not shown but could be provided.
Compliance with Adopted Plans	Interchange improvements are programmed in the CLRP.	Identified as the 'preferred alternative' in the I-264 Corridor Study.	Satisfies CLRP; differs from I-264 Corridor Study recommendations.	Satisfies CLRP; differs from I-264 Corridor Study recommendations.	Satisfies CLRP; differs from I-264 Corridor Study recommendations.	Satisfies CLRP; differs from I-264 Corridor Study recommendations.
Potential Environmental Impacts	No action - no impacts.	Sensitive neighborhoods (2 parcels); Forested wetlands (0.25 ac); Salt marsh wetlands (0.25 ac); Stream (1,400 ft);	Sensitive properties (0.25 ac) and neighborhoods (1 parcel); Forested wetlands (0.25 ac); Salt marsh wetlands (0.75 ac); Stream (1,400 ft); Potentially contaminated site	Sensitive properties (0.25 ac) and neighborhoods (1 parcel); Forested wetlands (0.25 ac); Salt marsh wetlands (0.50 ac); Stream (1,400 ft); Potentially contaminated site	Sensitive properties (1.0 ac) and neighborhoods (1 parcel); Forested wetlands (0.5 ac); Salt marsh wetlands (1.0 ac); Stream (1,400 ft); Potentially contaminated site	Sensitive properties (0.25 ac) and neighborhoods (1 parcel); Forested wetlands (0.25 ac); Salt marsh wetlands (0.5 ac); Stream (1,400 ft); Potentially contaminated site
		❶ Requires ramp profile grades steeper than those allowable by AASHTO or VDOT criteria. Not recommended based on geometry.	❷ Paired with Alternative 1 or Alternative 2 at the Newtown Road interchange.	❸ Paired with Alternative 1 or Alternative 2 at the Newtown Road interchange.	❹ Paired with Alternative 3 or Alternative 4 at the Newtown Road interchange.	❺ Paired with Alternative 3 or Alternative 4 at the Newtown Road interchange.
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD	NOT CARRIED FORWARD	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION
Basis for Rejection:	--	Poor weave operations on EB and WB I-264; poor ramp geometry	Poor weave operations, WB I-264 to I-64; no improvement to EB I-64 exit to I-264	--	--	--

I-264/Military Highway Interchange

Alternative 1 (Figure 4-6) - This alternative was identified as a recommended improvement in the 2016 I-264 Corridor Study. The existing full clover interchange is converted to a partial clover by removing the westbound-to-southbound and eastbound-to-northbound loop ramps; and converting the remaining free-flow ramp terminals along Military Highway to signalized intersections with select free-flow movements. Existing bridges carrying Military Highway and the Frontage Road remain in place. The geometry along eastbound I-264 at the C/D diverge is improved to provide one additional lane entering the C/D roadway. Included in the layout along the west side of Military Highway is new sidewalk that crosses two free-flow ramps and one signalized intersection.

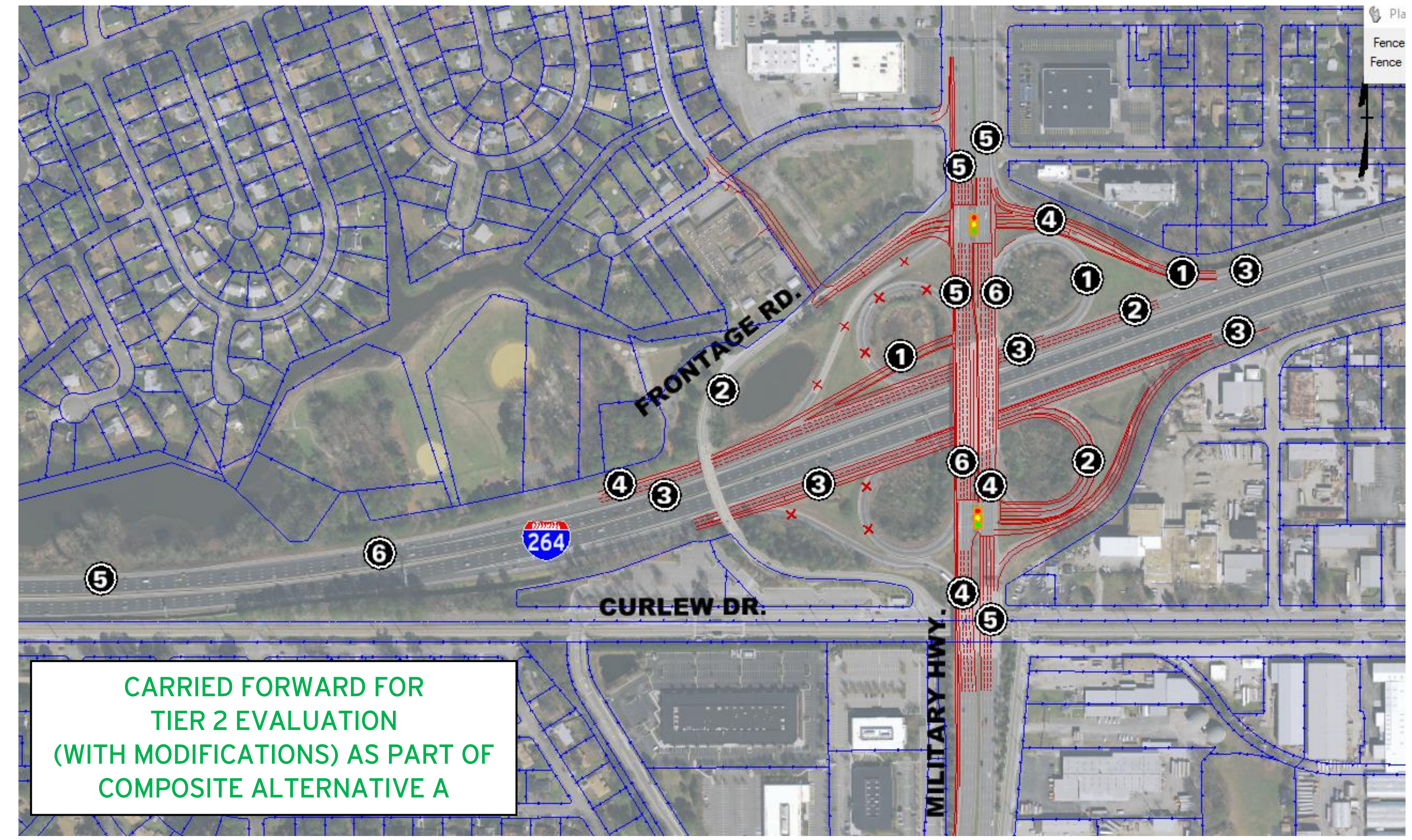
Figure 4-6: Tier 1 I-264/Military Highway Interchange Alternative 1



Alternative 1 was carried forward into Tier 2 evaluation based on its ability to eliminate merge-weave areas along the I-264 C/D roadways, and acceptable traffic operations at signalized ramp terminal intersections.

Alternative 2 (Figure 4-7) - The existing full clover interchange is converted to a partial clover layout by eliminating the westbound-to-southbound and the southbound-to-eastbound loop ramps. The remaining ramp terminals along Military Highway are converted to signalized intersections, with select free-flow movements. The directional entrance ramp to westbound I-264 is relocated to separate the ramp terminal along Military Highway from the signalized intersection at the Frontage Road and the westbound I-264 exit ramp terminal. The layout includes new sidewalk along the west side of Military Highway that crosses one free-flow ramp and one signalized intersection. The existing bridge carrying Military Highway over I-264 remains in place.

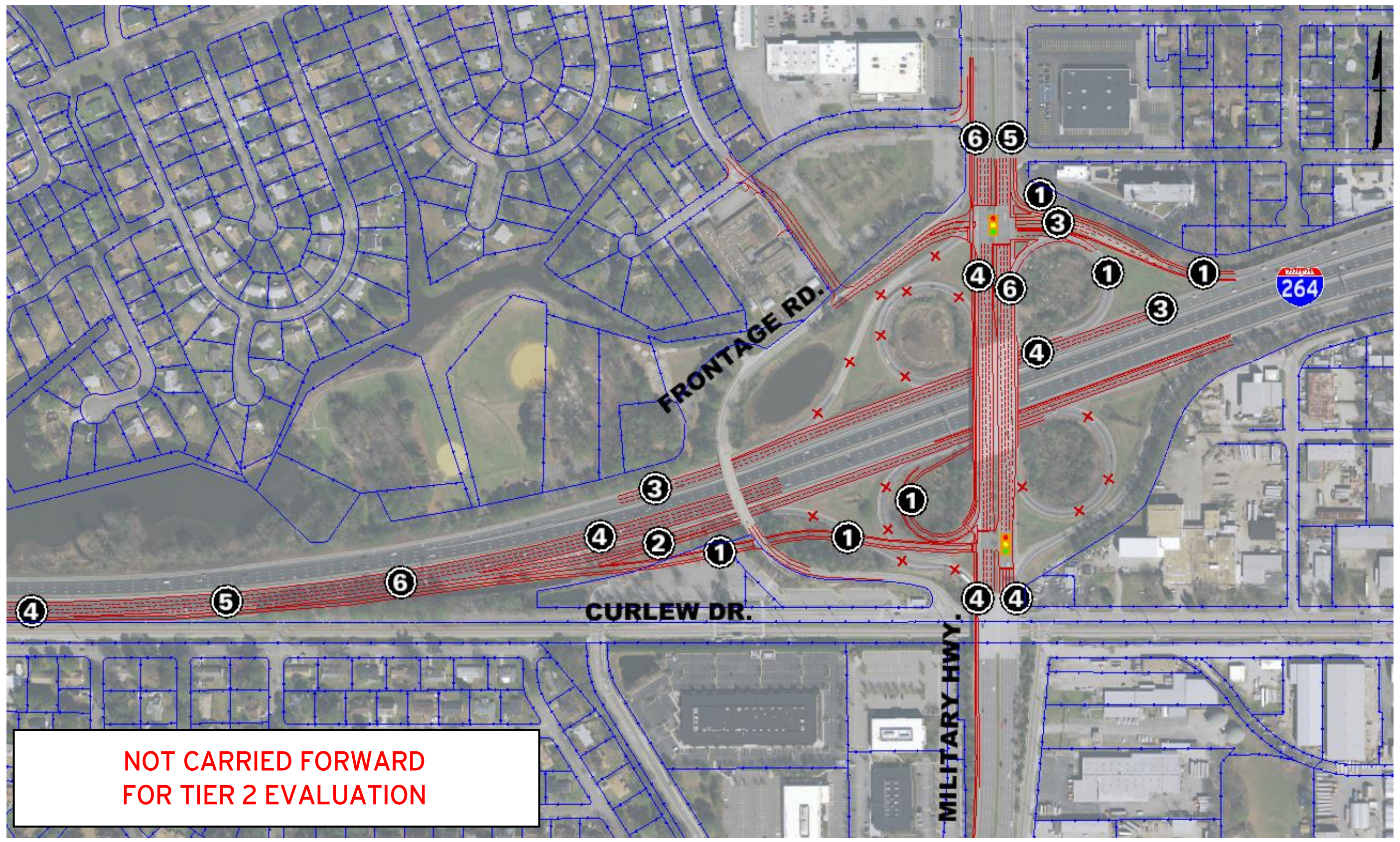
Figure 4-7: Tier 1 I-264/Military Highway Interchange Alternative 2



Alternative 2 corrects the deceleration length for the eastbound exit ramp to eastbound and westbound Military Highway, and eliminates merge-weave areas along the I-264 C/D roadways. Traffic operations at the signalized ramp terminal intersections were determined to be acceptable with refinements. Accordingly, Alternative 2 was carried forward for further evaluation in Tier 2 screening.

Alternative 3 (Figure 4-8) - This alternative was submitted to the Study Team for consideration by the City of Norfolk. It converts the existing interchange to a partial clover layout by eliminating the eastbound-to-northbound and westbound-to-southbound loop ramps; and signalizing the remaining ramp terminal movements along Military Highway. This concept is unique among those considered in that it constructs a new exit ramp from eastbound I-264 to provide direct vehicle access to the Frontage Road and Military Highway. The existing bridges over I-264 remain in place. A new sidewalk is provided along the west side of Military Highway, crossing one free-flow ramp and two signalized intersections.

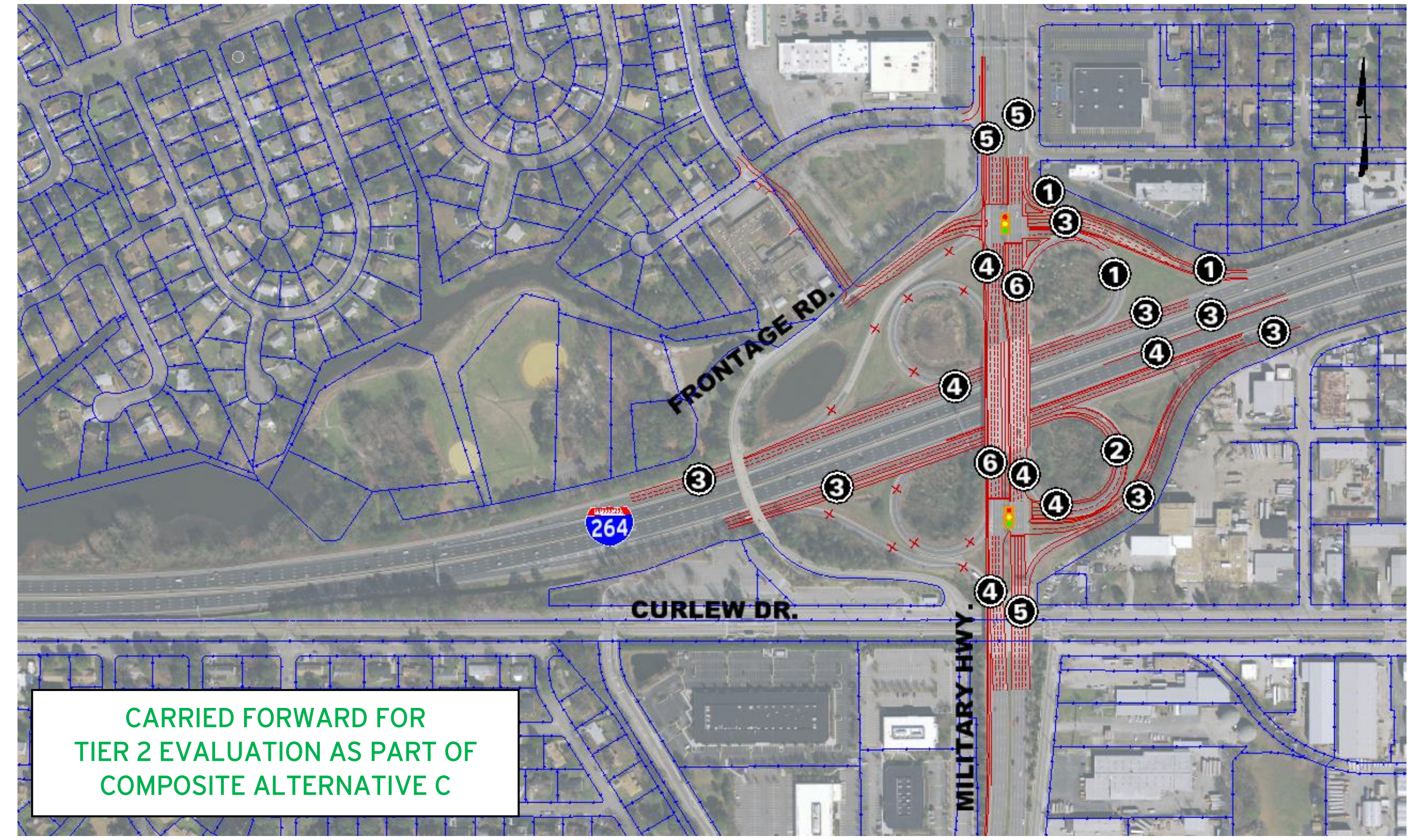
Figure 4-8: Tier 1 I-264/Military Highway Interchange Alternative 3



Alternative 3 would introduce an intermediate intersection along the alignment of the exit ramp from the eastbound I-264 C/D roadway. This ramp-intersection arrangement is unconventional, and increases the potential for wrong-way entry onto I-264. In addition, the relocated exit ramp from the eastbound I-264 C/D roadway would impact parking spaces at the Tide LRT station. For these reasons, Alternative 3 was not carried forward into Tier 2 analysis.

Alternative 4 (Figure 4-9) - The existing full clover interchange is converted to a partial clover layout by eliminating all ramps in the west half of the interchange and improving existing ramps on the east side of the interchange. Ramp terminal intersections along Military Highway are signalized, and existing bridges remain in place. A new sidewalk is provided along the west side of Military Highway, crossing one signalized intersection.

Figure 4-9: Tier 1 I-264/Military Highway Interchange Alternative 4



Alternative 4 concentrates all entrance movements to westbound I-264 into a single ramp terminal intersection along Military which was found to provide acceptable operations. This arrangement eliminates consecutive entrance ramps onto the westbound I-264 C/D roadway. It is also the only concept studied that eliminates pedestrian crossings of free-flow ramp terminals along Military Highway in favor of crossings at signalized intersections. Based on these findings, Alternative 2 of was carried forward for Tier 2 analysis.

Table 4.2: Tier 1 Evaluation Matrix, I-264/Military Highway Interchange

	I-264 / MILITARY HIGHWAY INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3	BUILD ALTERNATIVE 4	
EVALUATION CRITERIA	Existing conditions; no improvements	From I-264 Corridor Study; Partial clover, retains loop ramps in NE and SW quadrants	Partial clover, retains loop ramps in NE and SE quadrants with directional ramp to WB I-264	Partial clover, retains loop ramps in NE and SW quadrants with directional ramp from EB I-264 *	Partial clover, retains loop ramps in NE and SE quadrants	
Right-of-Way Impacts	No action - no right-of-way impacts.	None apparent.	None apparent.	Impacts to Military Highway Tide station, with loss of parking; mitigation required.	None apparent.	
Traffic Operations	Deficient ramp acceleration and deceleration lengths. LOS F for weaves on C/Ds; LOS E for merges onto C/Ds.	EB exit ramp deceleration and WB directional entrance ramp acceleration remain deficient. Intersection LOS D or better.	Adequate deceleration length for EB exit ramp; Acceleration length for WB directional ramp deficient. LOS D/E and C/C for north and south intersections.	Adequate acceleration length for both entrance ramps. Queues beyond gore with one-lane EB exit ramp. LOS D/E and C/C at north and south intersections.	Provides required acceleration and deceleration lengths for ramps to/from west. Intersection LOS D or better.	
Pedestrian/Bicycle Accommodations	No sidewalk provided along Military Highway within project limits.	New sidewalk not detailed, but assumed along west side of Military Highway; peds cross one free-flow ramps.	New sidewalk along west side of Military Highway; peds cross one free-flow ramp.	New sidewalk along west side of Military Highway; peds cross one free-flow ramps.	New sidewalk along west side of Military Highway; peds use only signal-controlled crossings.	
Compliance with Adopted Plans	Improvements identified in CLRP.	Consistent with I-264 Corridor Study.	Inconsistent with I-264 Corridor Study, but provides better geometry for exit movement along EB I-264.	Inconsistent with I-264 Corridor Study, but provides enhanced access to Tide station from areas west.	Inconsistent with I-264 Corridor Study but provides better geometry for EB exit and WB entrance movement along I-264.	
Potential Environmental Impacts	No action - no impacts.	Impacts to tidal channel/BMPs.	None apparent.	None apparent.	None apparent.	

* Layout requires ramp geometry that is contrary to AASHTO and VDOT guidance. Not recommended based on geometry.

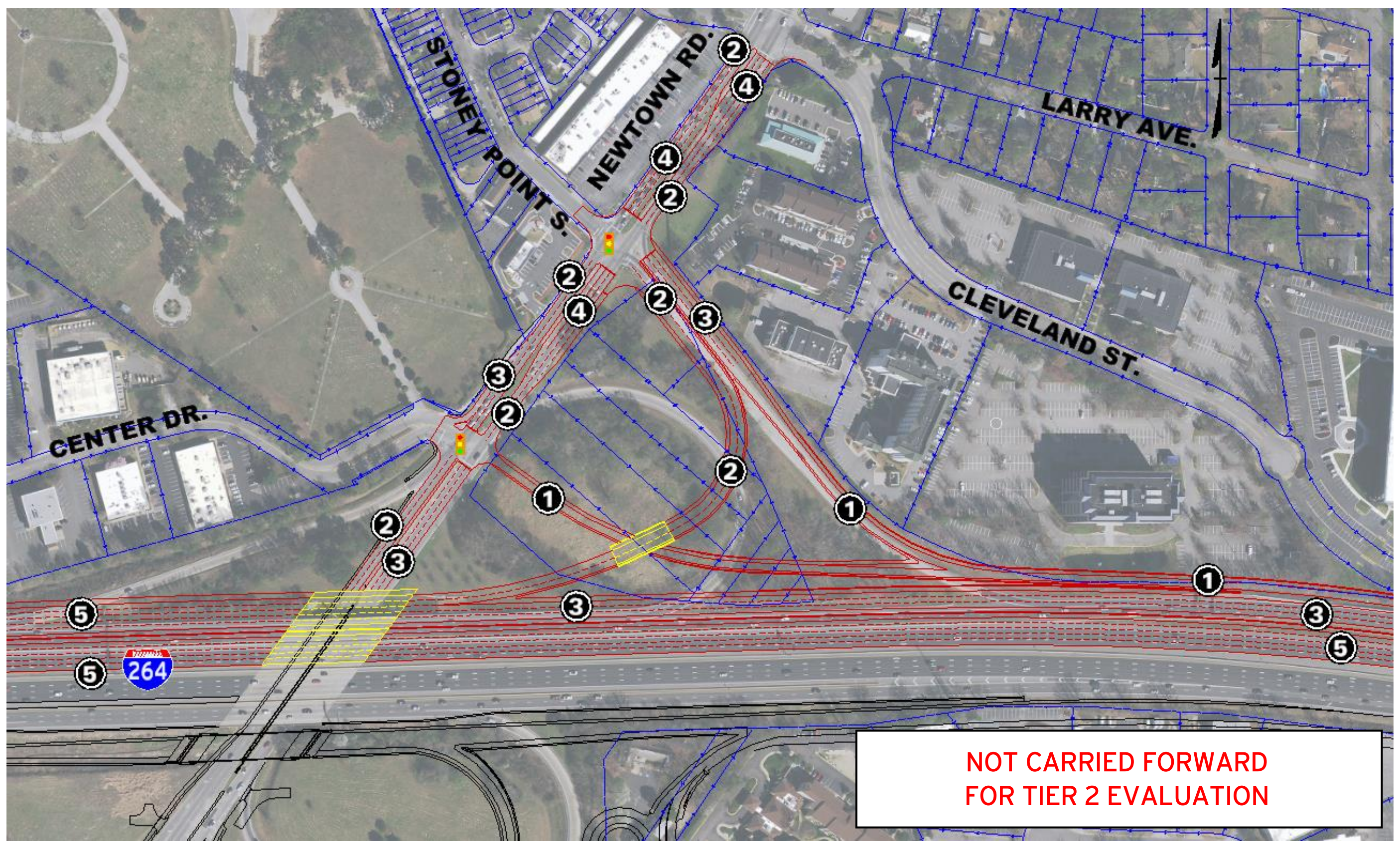
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION (with modifications)	NOT CARRIED FORWARD	CARRIED FORWARD FOR TIER 2 EVALUATION
Basis for Rejection:	--	--	--	Unconventional ramp geometry; impacts to the Tide LRT station	--

I-264/Newtown Road Interchange

Improvement concepts at this interchange focus on the entrance and exit ramps serving westbound I-264. Improvements to the eastbound I-264 ramps are under construction now (UPC 57048 and UPC 17630) and are shown as black lines in the following four figures.

Alternative 1 (Figure 4-10) - This alternative was identified as a recommended improvement in the 2016 I-264 Corridor Study. The layout provides a split exit ramp from westbound I-264 to two signalized intersections along Newtown Road. Access to westbound I-264 is provided by a single ramp from Newtown Road opposite Stoney Point South. Due to the configuration of the westbound I-264 C/D roadway, this alternative can be paired only with Alternatives 2 or 3 at the I-64/I-264 interchange.

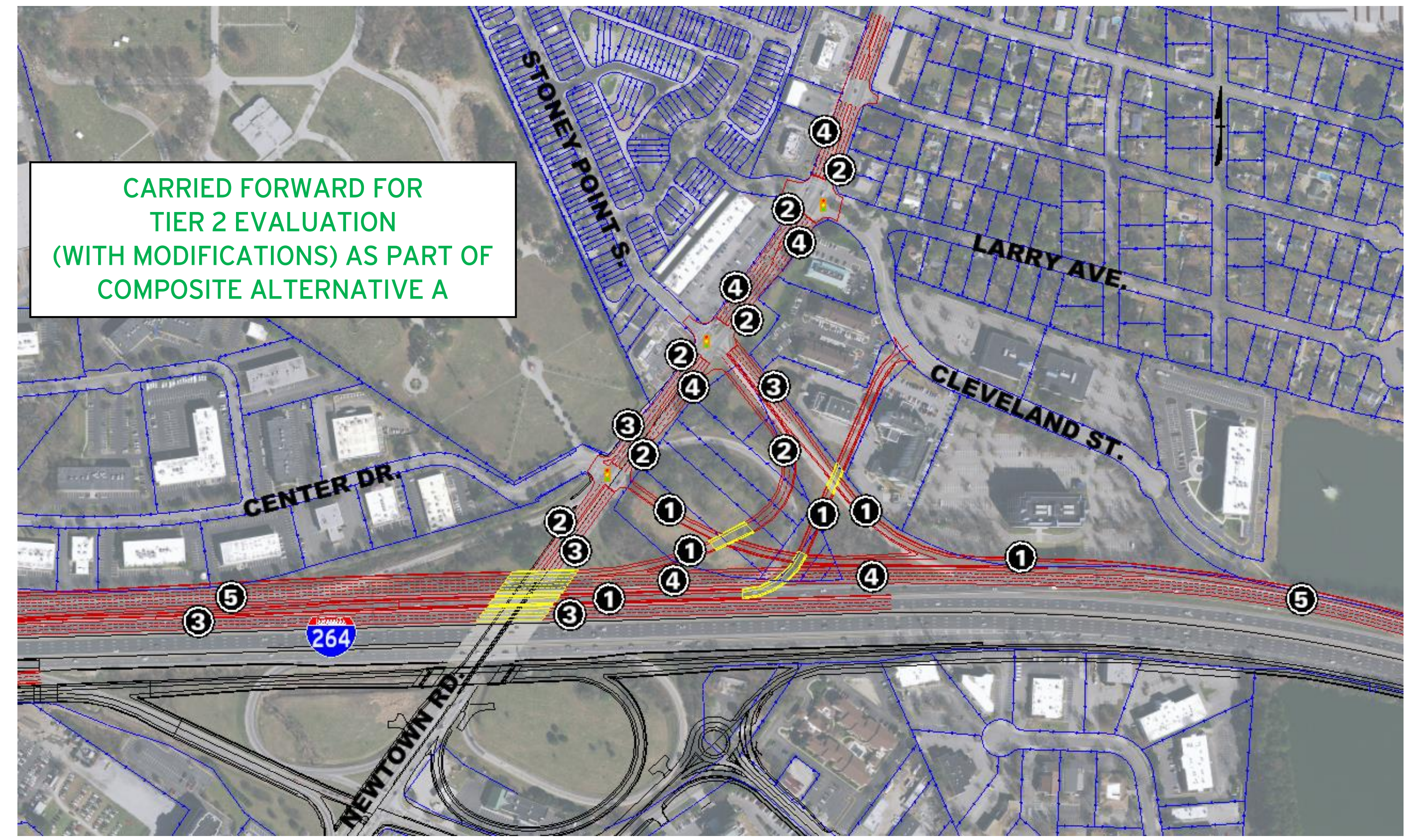
Figure 4-10: Tier 1 I-264/Newtown Road Interchange Alternative 1



Under Alternative 1, all traffic from Newtown Road enters the westbound I-264 C/D roadway, resulting in heavy downstream weaving movements in advance of the I-264/I-264 interchange. The limited distance between the two interchanges results in poor weave performance. For this reason, Alternative 1 was not carried forward for Tier 2 evaluation.

Alternative 2 (Figure 4-11) - A split exit ramp is provided from westbound I-264. Two entrance ramps are provided to westbound I-264, one from Newtown Road at the Stoney Point South intersection, and the second from Cleveland Street. Dual entrance ramps from Newtown Road provide direct access to the westbound I-264 C/D roadway and the westbound I-264 mainline. This concept requires full acquisition of an office building along Cleveland Street, and relocation of all tenants. Like Alternative 1, this alternative can be paired only with Alternatives 2 or 3 at the I-64/I-264 interchange.

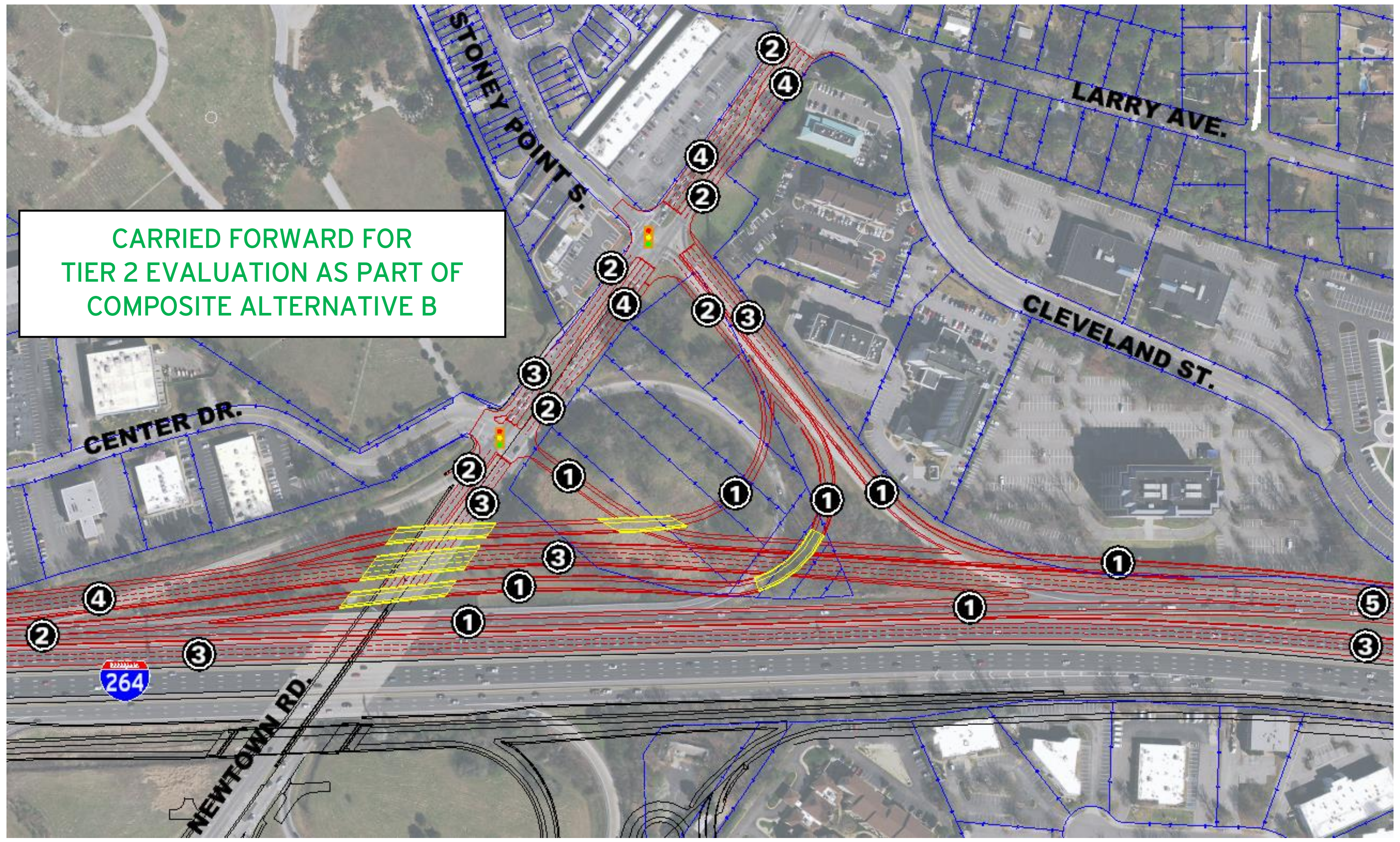
Figure 4-11: Tier 1 I-264/Newtown Road Interchange Alternative 2



Alternative 2 provides a split entrance ramp arrangement from Newtown Road to westbound I-264 mainline and C/D roadway. Analyses indicate that this dual ramp arrangement provides acceptable downstream merge/weave operations between Newtown Road and the I-64/I-264 interchange, as well as along Newtown Road at signalized intersections. This alternative was selected for Tier 2 analysis, but with refinements to address concerns cited by the City of Virginia Beach regarding right-of-way and community impacts.

Alternative 3 (Figure 4-12) - This concept provides split entrance ramps to westbound I-264 oriented to the C/D roadway and the ramps to I-64. Alternative 3 includes development of a westbound I-264 outer C/D roadway situated north of the existing westbound I-264 (inner) C/D roadway. Due to the required configuration of the receiving roadways, this concept can only be paired with Alternatives 4 and 5 at the I-64/I-264 interchange. A split exit ramp from westbound I-264 is provided, as with the other alternatives at this interchange. All directional movements are retained at the signalized Newtown Road/Stoney Point South/ramp terminal intersection.

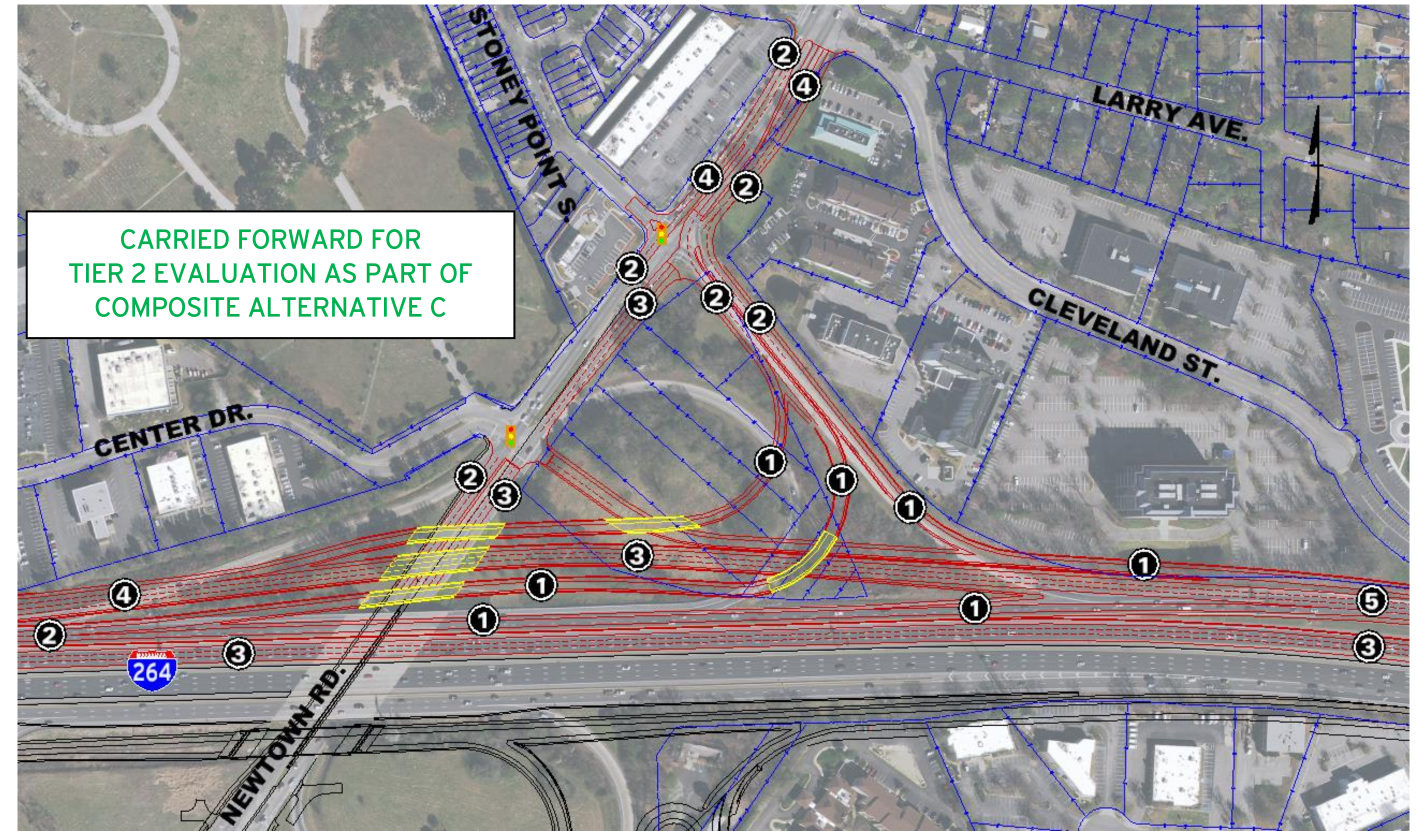
Figure 4-12: Tier 1 I-264/Newtown Road Interchange Alternative 3



The additional of an outer C/D roadway along westbound I-264 resulted in favorable merge-weave operations approaching the I-64/I-264 interchange. Intersection operations were acceptable under most conditions studied, but were overall favorable enough to warrant refinement and further revaluation. For these reasons, Alternative 3 was carried forward for refinement and further evaluation under Tier 2.

Alternative 4 (Figure 4-13) - The concept provides the same split exit ramp from WB I-264 as is provided with the other alternatives. Split entrance ramps to the westbound I-264 C/D roadway and ramps to I-64 are provided. A continuous 'green-T' intersection is provided at the Stoney Point South intersection, with northbound left turns from Newtown Road redirected to the intersection at Cleveland Street/Ethan Allen Lane. Access to/from Stoney Point South is modified to right in/right out movements at Newtown Road. Like Alternative 3, this alternative can be paired only with Alternatives 4 or 5 at the I-64/I-264 interchange.

Figure 4-13: Tier 1 I-264/Newtown Road Interchange Alternative 4



Alternative 4 was carried forward to evaluate the alternative intersection configurations along Newtown Road. Initial analyses indicated favorable intersection operations, with freeway merge-weave operations identical to those of Alternative 3.

Table 4.3: Tier 1 Evaluation Matrix, I-264/Newtown Road Interchange

	I-264 / NEWTOWN ROAD INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3	BUILD ALTERNATIVE 4	
EVALUATION CRITERIA	Existing conditions; no improvements	From I-264 Corridor Study; split exit ramp from WB I-264 and double entrance ramp to WB I-264 *	Split exit ramp from WB I-264; Split entrance from Newtown Road and Cleveland Street *	Split exit ramp from WB I-264; braided entrance ramps to WB I-264 **	Split exit ramp from WB I-264; continuous green-T ramp terminal; braided entrance ramps to WB I-264 **	
Right-of-Way Impacts	No action - no right-of-way impacts.	Impacts to commercial properties along Newtown Road.	Impacts to commercial properties along Newtown Road; acquisition of office condo and relocate tenants.	Impacts to commercial properties along Newtown Road.	Impacts to commercial properties along Newtown Road.	
Traffic Operations	Ramps, WB C/D, and mainline I-264 over capacity; merges and weaves at LOS F.	LOS B/C for south exit ramp intersection; LOS E/E for north ramp intersection (LOS F/F for SB left turn movement). Acceptable merge operations.	LOS B/C for south exit ramp intersection; LOS D/E for north ramp intersection; LOS B/D at Cleveland. Acceptable merge operations.	LOS B/C for south exit ramp intersection; LOS E/E for north ramp intersection (LOS F/F for SB left turn movement). Acceptable merge operations.	LOS B/C for south exit ramp intersection; LOS D/E for north ramp intersection. LOS C/D for Ethan Allen intersection. Acceptable merge operations.	
Pedestrian/Bicycle Accommodations	Discontinuous sidewalk network with project limits.	Provides all sidewalk connections and ped crossings.	Provides all sidewalk connections and ped crossings.	Provides all sidewalk connections and ped crossings.	Provides all sidewalk connections and ped crossings.	
Compliance with Adopted Plans	Compatible with Newtown SGA Plan (plan does not reflect any improvements north of I-264).	Improvements beyond those shown in Newtown SGA Plan.	Modified traffic routing via Cleveland Street.	Improvements beyond those shown in Newtown SGA Plan.	Modified neighborhood and commercial access at northern edge of SGA Plan area.	
Potential Environmental Impacts	No action - no impacts.	Impacts to potential contamination site.	Impacts to potential contamination site.	Impacts to potential contamination site.	Impacts to potential contamination site.	

* Paired with Alternative 2 or Alternative 3 at the I-64/I-264 interchange.

** Paired with Alternative 4 or Alternative 5 at the I-64/I-264 interchange.

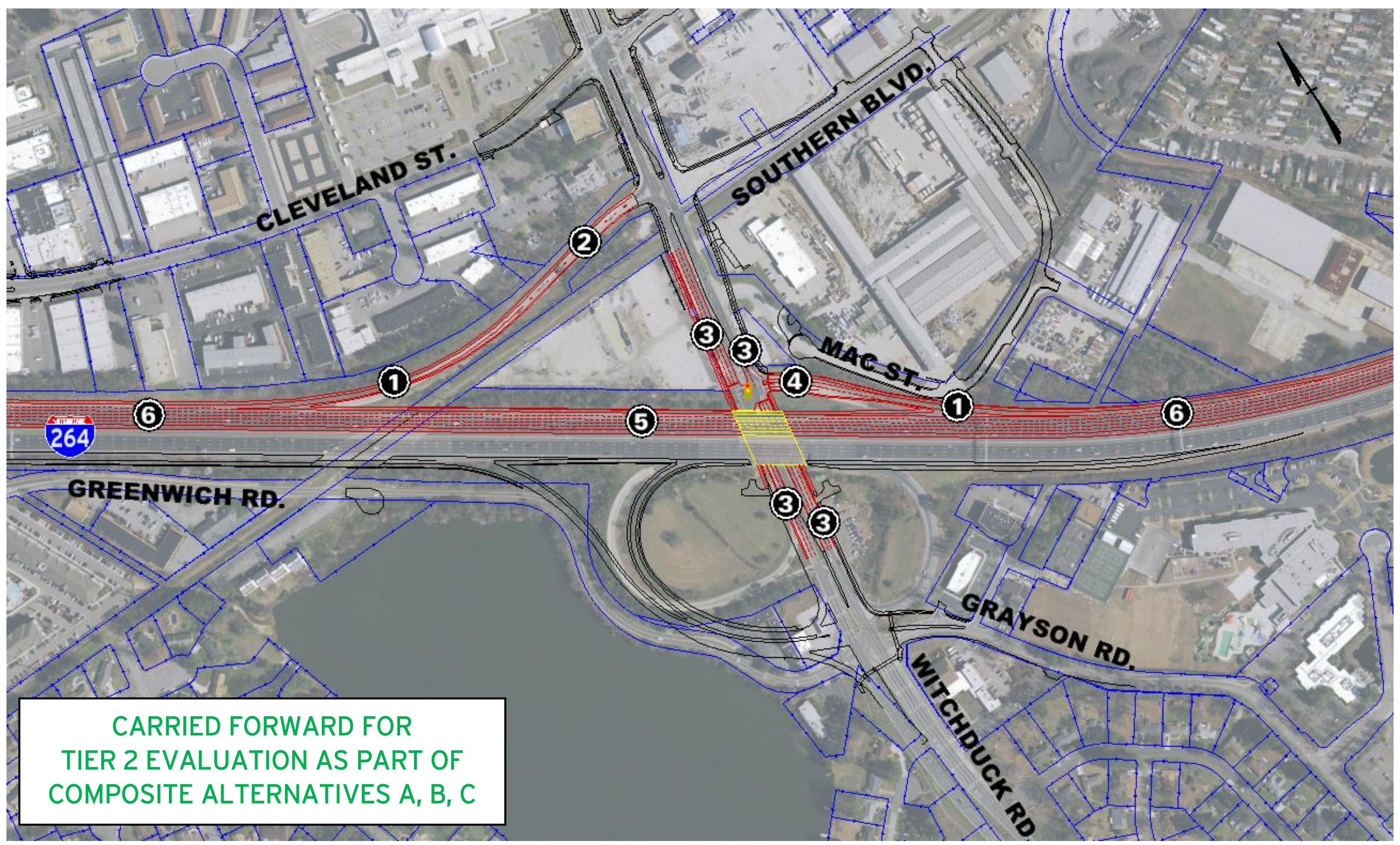
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD	CARRIED FORWARD FOR TIER 2 EVALUATION (with modifications)	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION
Basis for Rejection:	--	Poor weave operations on WB I-264 approaching I-64	--	--	--

I-264/Witchduck Road Interchange

Improvement concepts at this interchange focus on the entrance and exit ramps serving westbound I-264. Improvements to the eastbound I-264 ramps at Witchduck Road are currently under construction (UPC 17630). North of I-264, the Witchduck Road Phase II improvement project is also currently under construction. Improvements associated with those two projects are shown in black in the following two figures.

Alternative 1 (Figure 4-14) - This alternative was identified as a recommended improvement in the 2016 I-264 Corridor Study, and reflects widening of eastbound I-264 and reconfiguration of the south half of the interchange that is currently under construction. Improvements to eastbound I-264 include mainline widening to provide six through travel lanes, and reconstruction of entrance and exit ramps to accommodate mainline widening. The existing bridge carrying eastbound and westbound I-264 over Witchduck Road is replaced. The existing bridge carrying I-264 over a former rail corridor is widened.

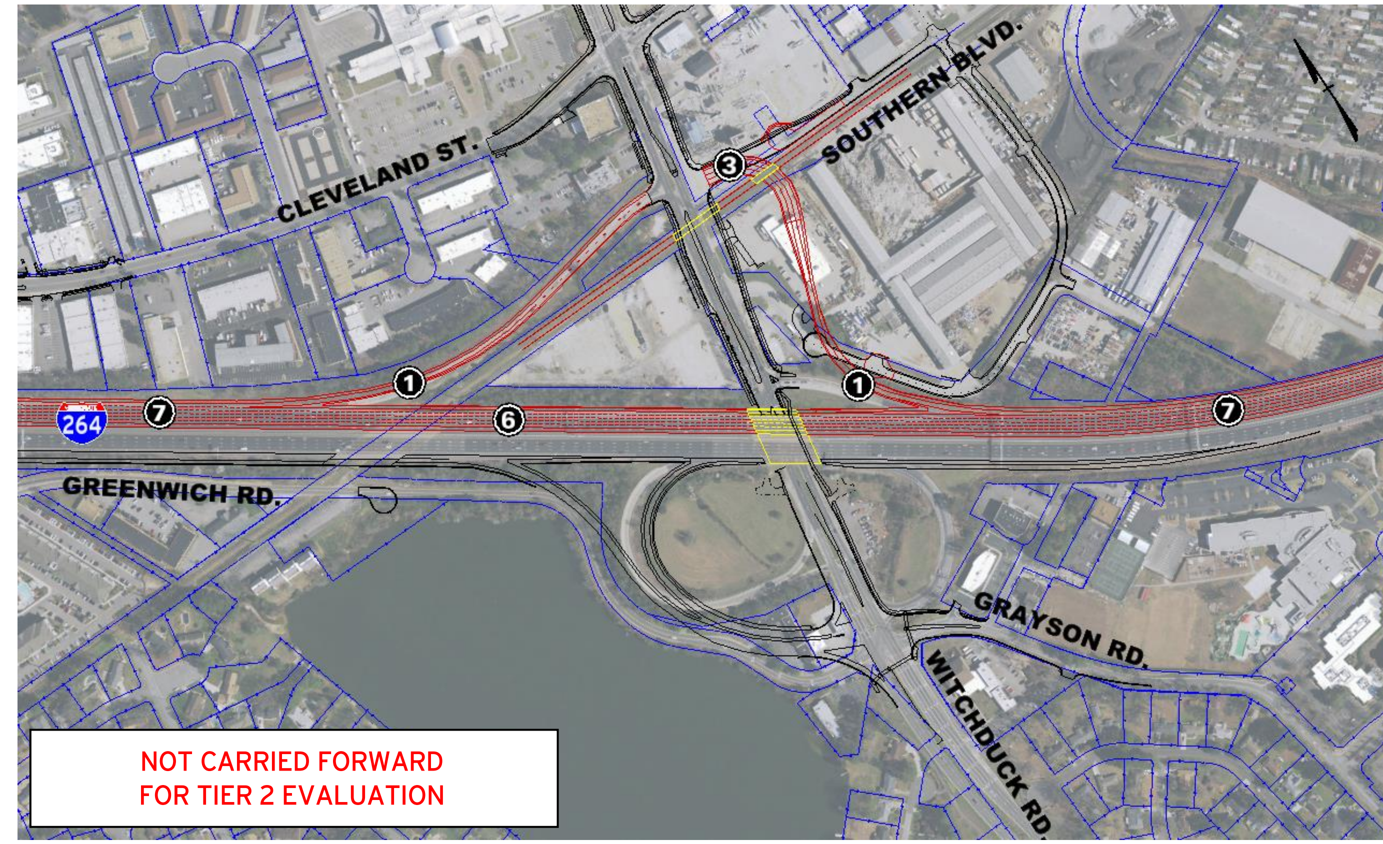
Figure 4-14: Tier 1 I-264/Witchduck Road Interchange Alternative 1



Tier 1 analyses indicate acceptable traffic operations along westbound I-264 and in the Witchduck Road corridor. The concept is consistent with recommendations from prior planning studies undertaken by VDOT and the City of Virginia Beach. Alternative 1 was therefore carried forward into Tier 2 screening.

Alternative 2 (Figure 4-15) - This layout extends and relocates the westbound exit ramp to a new signalized intersection along Witchduck Road opposite the existing entrance ramp; truncates Mac Street; and truncates Southern Boulevard east of Witchduck Road. The revised ramp alignment requires the full acquisition and relocation of a business. The layout eliminates one signalized intersection along Witchduck Road north of I-264.

Figure 4-15: Tier 1 I-264/Witchduck Road Interchange Alternative 2



Alternative 2 involved significant changes to the local street network contained in the Pembroke Strategic Growth Area Plan prepared by the City of Virginia Beach. These changes were considered to be fatal flaws with this concept, and it was therefore not advanced into Tier 2 evaluation.

Table 4.4: Tier 1 Evaluation Matrix, I-264/Witchduck Road Interchange

	I-264 / WITCHDUCK ROAD INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2			
EVALUATION CRITERIA	Existing conditions; no improvements	From I-264 Corridor Study; realign WB ramps improve ramp terminal intersections	Realign exit ramp from WB I-264 to align with entrance ramp terminal			
Right-of-Way Impacts	No action - no right-of-way impacts.	Anticipated to fit within existing right-of-way.	Full acquisition of commercial parcel and relocate business; Reconfigure right-of-way for Mac Street and Southern Blvd.			
Traffic Operations	Ramps, WB C/D, and mainline I-264 over capacity; merges and weaves at LOS F.	Merge onto mainline I-264 LOS D or better. LOS D/E at exit ramp intersection; LOS B/D at Southern Blvd. intersection.	Merge onto mainline I-264 LOS D or better. LOS D/E at exit ramp intersection. Closure of Southern Blvd. forces LOS F operations at Cleveland.			
Pedestrian/Bicycle Accommodations	Discontinuous sidewalk network with project limits.	Provides full sidewalk network within limits of project.	Provides full sidewalk network within limits of project.			
Compliance with Adopted Plans	Not compatible with programmed improvements to I-264.	Compatible with I-264 Corridor Plan and Pembroke SGA Plan.	Not compatible with Pembroke SGA Plan.			
Potential Environmental Impacts	No action - no impacts.	Impacts to jurisdictional drainage ditch.	Impacts to jurisdictional drainage ditch; impacts to potential contamination site.			

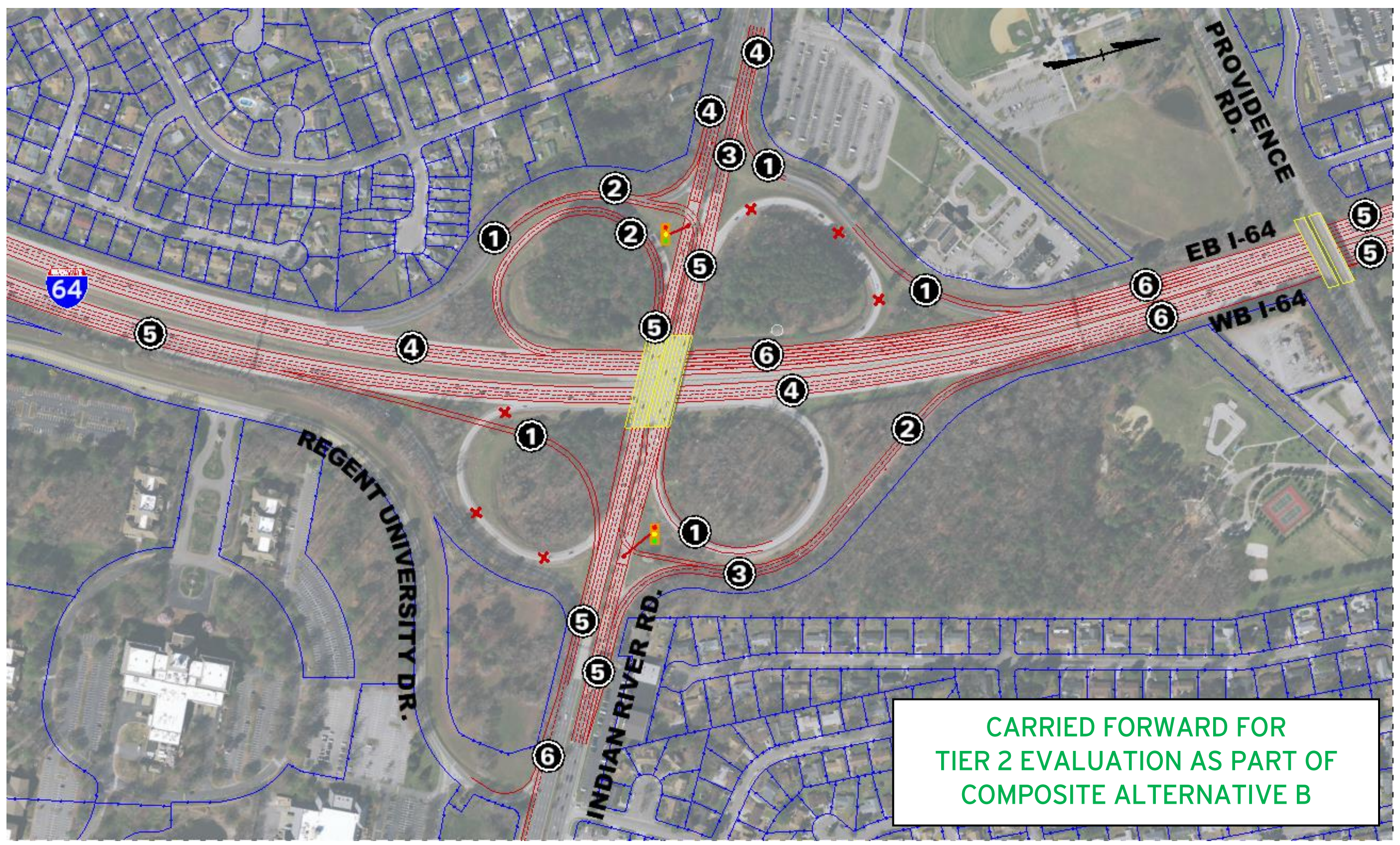
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD
Basis for Rejection:	--	--	Right-of-way impacts; incompatible with City SGA Plan

I-64/Indian River Road Interchange

Alternative 1 (Figure 4-16) - This alternative converts the existing full clover layout to a partial clover configuration by eliminating the westbound Indian River-to-eastbound I-64 and eastbound Indian River-to-westbound I-64 loop ramps in favor of signalized left turn movements along Indian River Road. This eliminates the merge-weave areas on eastbound and westbound I-64, between closely spaced loop ramps, as well as both directions along Indian River Road in the core of the interchange. Merge-weave areas remain in each direction along Indian River Road between the interchange and downstream signalized intersections at Reon Drive and at Regent University Drive.

The concept also includes relocation of the westbound I-64 exit ramp to eastbound Indian River Road to provide greater separation between the ramp terminal and the downstream intersection along Indian River Road at Regent University Drive. The existing bridge carrying Indian River Road over I-64 is widened to receive a dual lane exit ramp from eastbound I-64, widened from the existing single lane. The entrance ramp to westbound I-64 is widened to two lanes, which requires the replacement of the two parallel bridges carrying Providence Road over I-64.

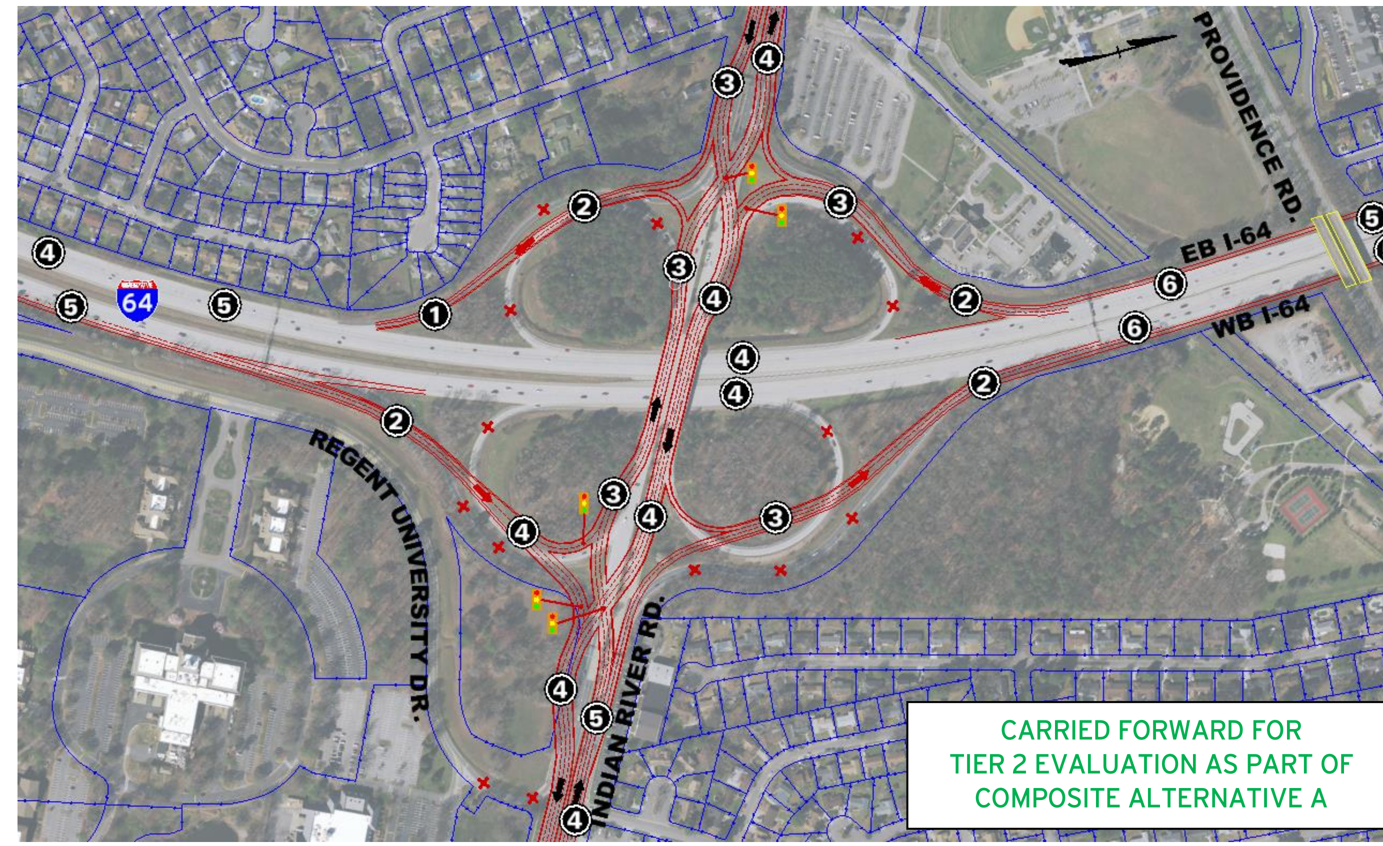
Figure 4-16: Tier 1 I-64/Indian River Road Interchange Alternative 1



Alternative 1 would provide acceptable traffic operations at signalized ramp terminal intersections, and would eliminate weaving areas on eastbound and westbound I-64. The layout would fit within existing right-of-way. For these reasons, Alternative 1 was carried forward for refinement and further analysis in Tier 2 screening.

Alternative 2 (Figure 4-17) - This alternative converts the existing full clover interchange into a diverging diamond interchange. The eastbound and westbound Indian River Road travelways are realigned to create two signalized crossover intersections, and ramp terminals along Indian River Road are reconfigured to tie into the realigned directional travelways. All loop ramps are removed, leaving only the directional ramps in service. Auxiliary lanes are provided along I-64 to accommodate widening of the eastbound and westbound I-64 exit ramps, as well as the westbound I-64 entrance ramp. The existing bridge carrying Indian River Road over I-64 remains in place. The two parallel bridges carrying Providence Road over I-64 are replaced.

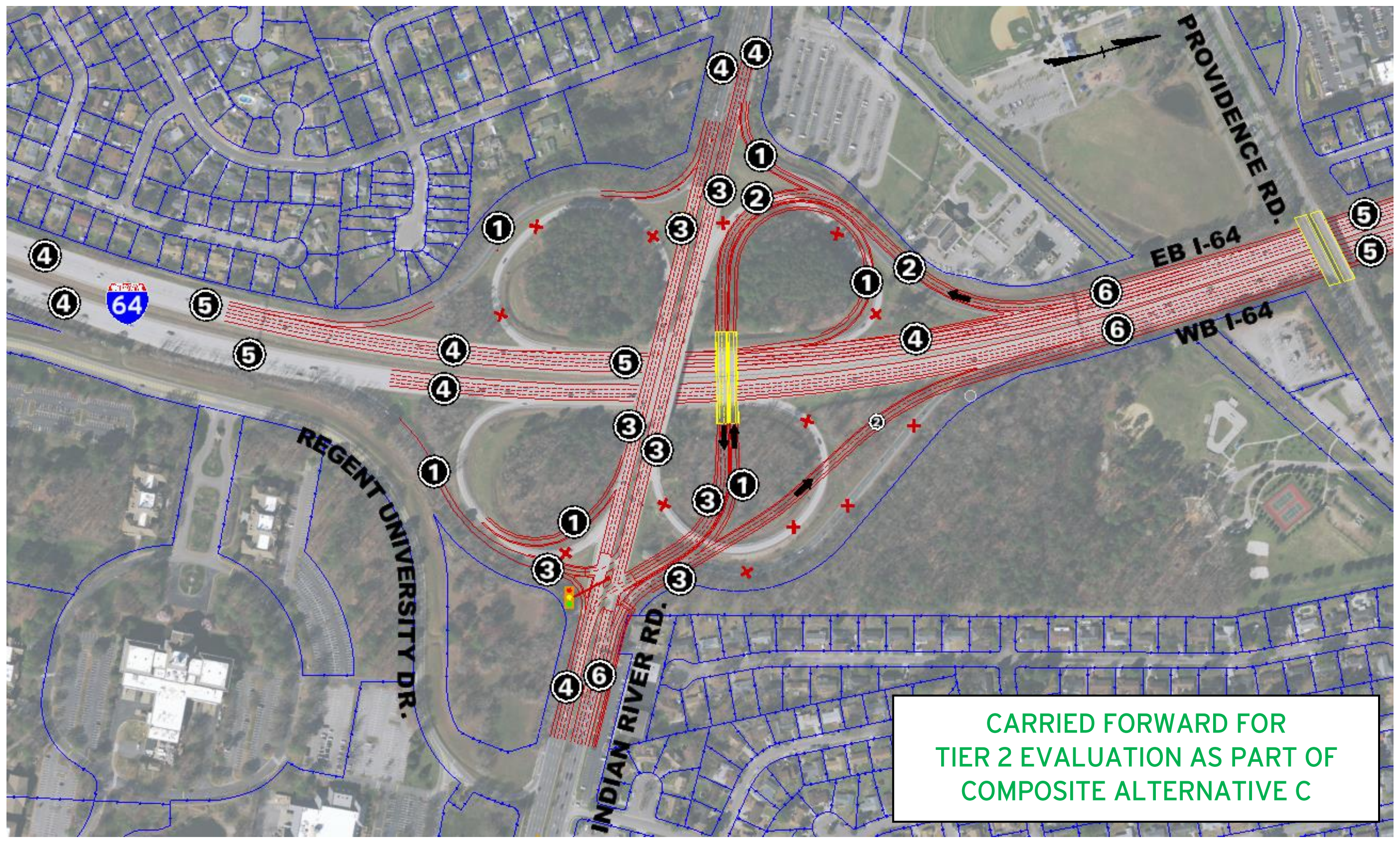
Figure 4-17: Tier 1 I-64/Indian River Road Interchange Alternative 2



Tier 1 traffic analyses resulted in acceptable levels of service at the crossover intersections along Indian River Road, and eliminates all pedestrian and bicyclist crossings of free-flow ramp terminals. Minor right-of-way impacts were identified. On the basis of these findings, Alternative 2 was carried forward for Tier 2 evaluation.

Alternative 3 (Figure 4-18) - Under this concept, a new bridge is constructed to carry a pair of semi-directional ramps over I-64 accommodating movements from westbound Indian River Road to eastbound I-64, and from eastbound I-64 to eastbound Indian River Road. The existing loop ramps in the northeast and southwest quadrants of the interchange are removed, and the outer connection ramps remain in place. The exit ramp from eastbound I-64 and the entrance ramp to westbound I-64 are widened from one to two lanes. The existing bridge carrying Indian River Road over I-64 remains in place. The two parallel bridges carrying Providence Road over I-64 are replaced.

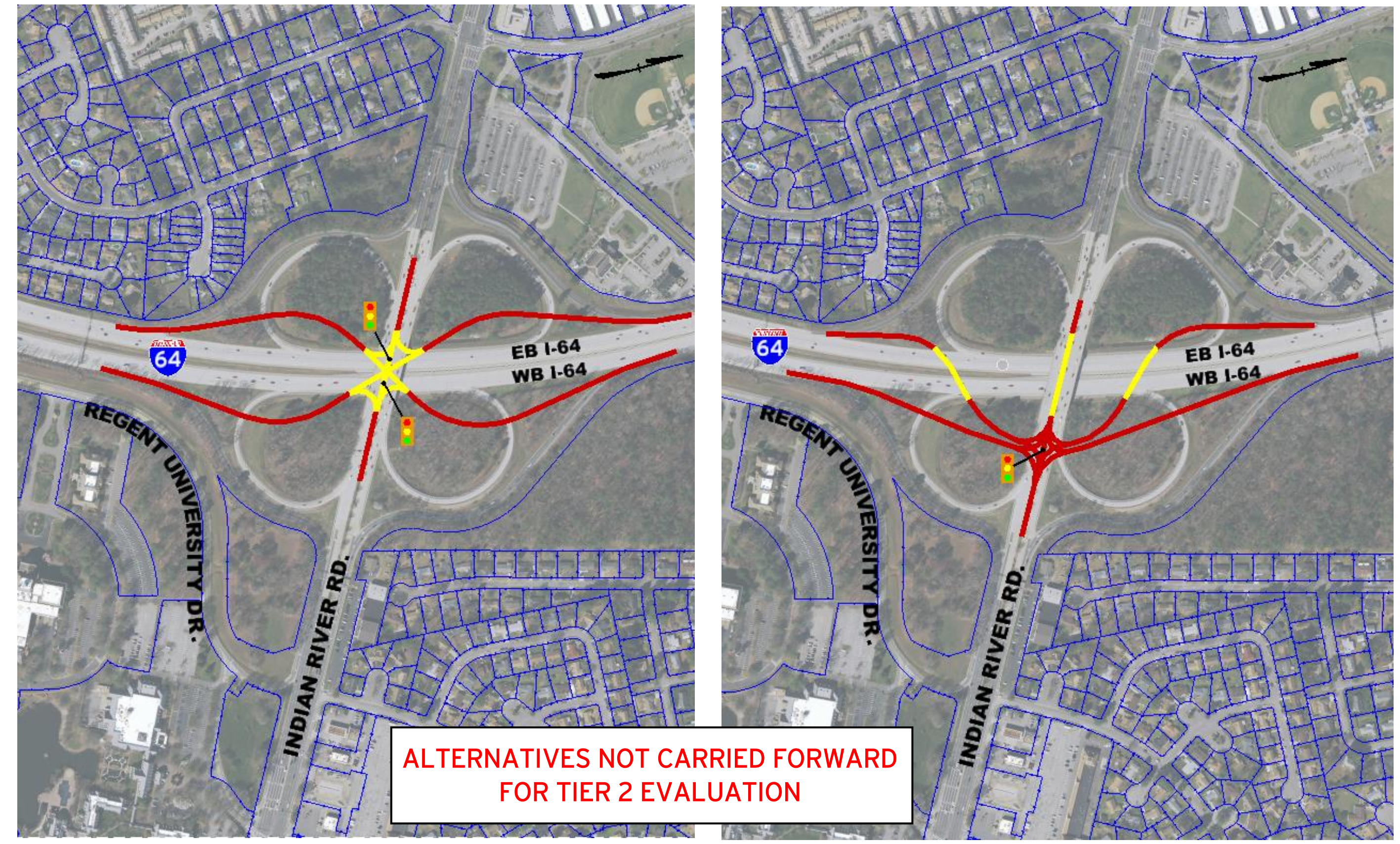
Figure 4-18: Tier 1 I-64/Indian River Road Interchange Alternative 3



Alternative 3 was advanced for its ability to eliminate weaving areas along eastbound and westbound I-64, and to provide acceptable traffic operations at the new signalized ramp terminal intersection. In addition, the layout requires no additional right-of-way, and reduces the number of free-flow ramp terminals that pedestrians and bicyclists would need to cross. Alternative 3 was advanced into Tier 2 screening.

Alternative 4 (Figure 4-19) - This concept replaces the existing interchange with a single-point urban interchange (SPUI), either centered over I-64 or offset east of I-64 along Indian River Road. All existing ramps would be replaced with new ramps on new alignments. The existing bridge carrying Indian River Road over I-64 would be replaced or undergo significant widening. The two parallel bridges carrying Providence Road over I-64 are replaced.

Figure 4-19: Tier 1 I-64/Indian River Road Interchange Alternative 4



Analyses performed for Alternative 4 determined that a single-point intersection along Indian River Road would operate with heavy delay and a failing overall level of service. The concept is also inconsistent with the Centerville Strategic Growth Area Plan prepared by the City of Virginia Beach. For these reasons, Alternative 4 was not carried forward into Tier 2 screening.

Table 4.5: Tier 1 Evaluation Matrix, I-64/Indian River Road Interchange

	I-64 / INDIAN RIVER ROAD INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3	BUILD ALTERNATIVE 4	
EVALUATION CRITERIA	Existing conditions; no improvements	Partial clover, retains loop ramps in NE ad SW quadrants	Diverging diamond	Partial offset single-point urban interchange (SPUI)	Single-point urban interchange (SPUI)	
Right-of-Way Impacts	No action - no right-of-way impacts.	Anticipated to fit within existing right-of-way.	Impacts to undeveloped parcel in SE quadrant of interchange.	Anticipated to fit within existing right-of-way.	Anticipated to fit within existing right-of-way.	
Traffic Operations	LOS F for weaves EB and WB I-64; LOS F for weaves on Indian River WB (am) and EB (PM).	Eliminates weaves on I-64 and Indian River; addresses ramp capacity constraints. LOS C or better at signalized intersections.	Eliminates weaves on I-64 and Indian River; addresses ramp capacity constraints. LOS D or better at signalized intersections.	Eliminates weaves on I-64 and Indian River; addresses ramp capacity constraints. LOS C or better at signalized intersections.	LOS F at single-point intersection during weekday pm peak hour.	
Pedestrian/Bicycle Accommodations	Peds/bikes cross 8 free-flow ramps.	Peds/bikes cross six free-flow ramps, some of which could be signalized.	All ped/bike crossings signalized; peds/bikes use median between crossovers.	Peds/bike cross two free-flow ramp terminals.	SPUIs typically present challenges for bicyclists and pedestrians.	
Compliance with Adopted Plans	Consistent with Centerville SGA Plan (which does not identify improvements to the existing I-64/Indian River Road interchange).	Inconsistent with Centerville SGA Plan, but supportive of SGA Plan objectives.	Inconsistent with Centerville SGA Plan, but supportive of SGA Plan objectives.	Inconsistent with Centerville SGA Plan, but supportive of SGA Plan objectives.	Inconsistent with Centerville SGA Plan.	
Potential Environmental Impacts	No action - no impacts.	None apparent.	Impacts to forested wetlands (NE loop).	Impacts to forested wetlands (NE loop).	Impacts to forested wetlands (NE and SE loops).	

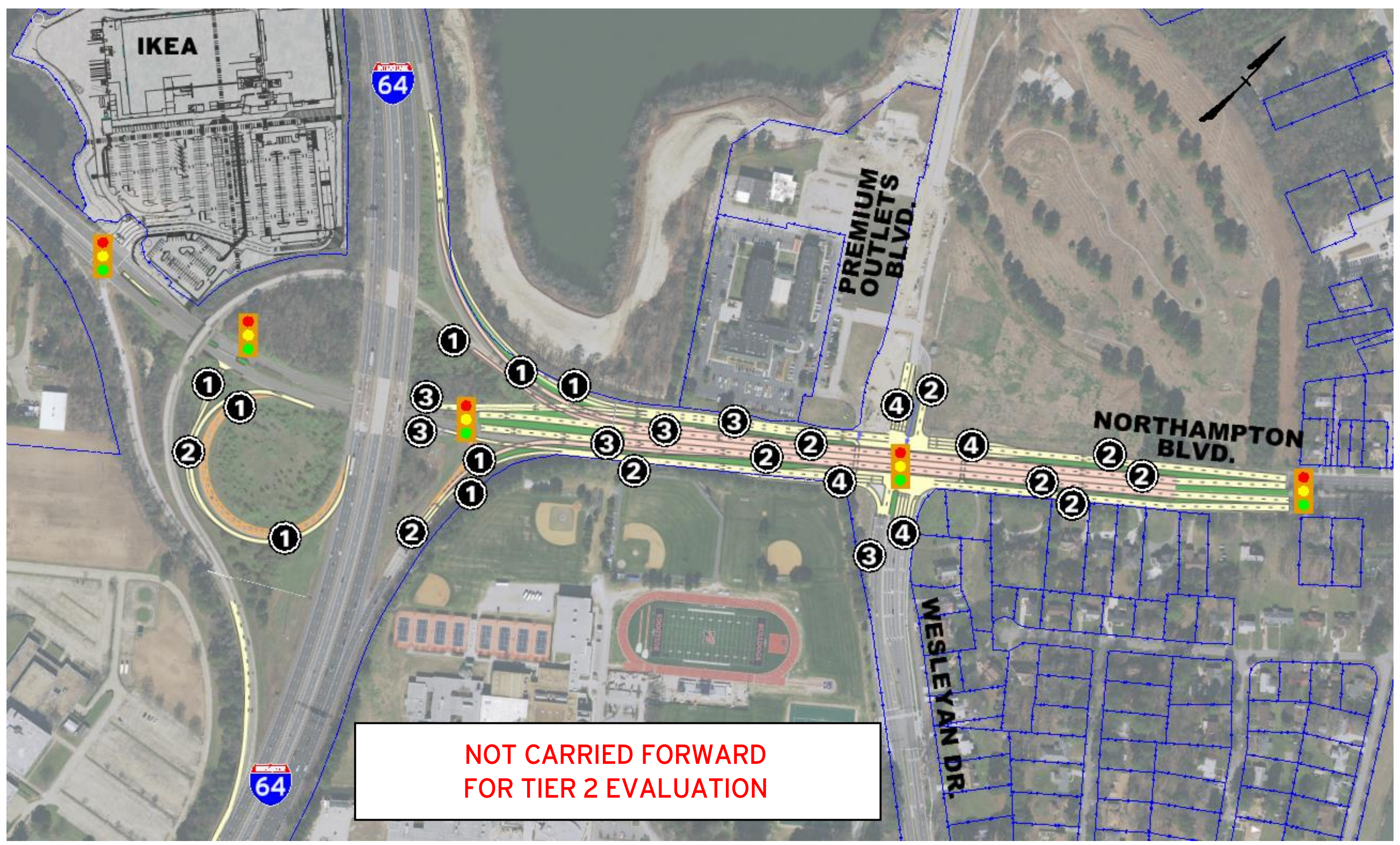
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD
Basis for Rejection:	--	--	--	--	Poor LOS at single-point ramp terminal intersection; inconsistent with City SGA Plan

I-64/Northampton Boulevard Interchange

Improvement alternatives at this interchange provide all directional movements that are provided under existing conditions. Refer to Section 5.3 for information regarding the missing eastbound Northampton Boulevard to westbound I-64 movement at this interchange.

Alternative 1 (Figure 4-20) - This alternative was identified as a recommended improvement in a 2016 STARS study conducted for this interchange. Improvements include an elevated segment of Northampton Boulevard east of I-64, an overpass of the Northampton Boulevard/Wesleyan Drive intersection, and directional frontage roads providing local access and serving eastbound and westbound movement along Northampton Boulevard. Braided ramps provide connections between the at-grade segment of Northampton Boulevard and the elevated roadway, to the entrance ramps to eastbound and westbound I-64, as well as to and from the exit ramp from westbound I-64. To accommodate trips from Wesleyan Drive and Premium Outlets Boulevard to eastbound I-64, the concept provides a left turn lane from westbound Northampton Boulevard to the I-64 entrance ramp opposite IKEA Way.

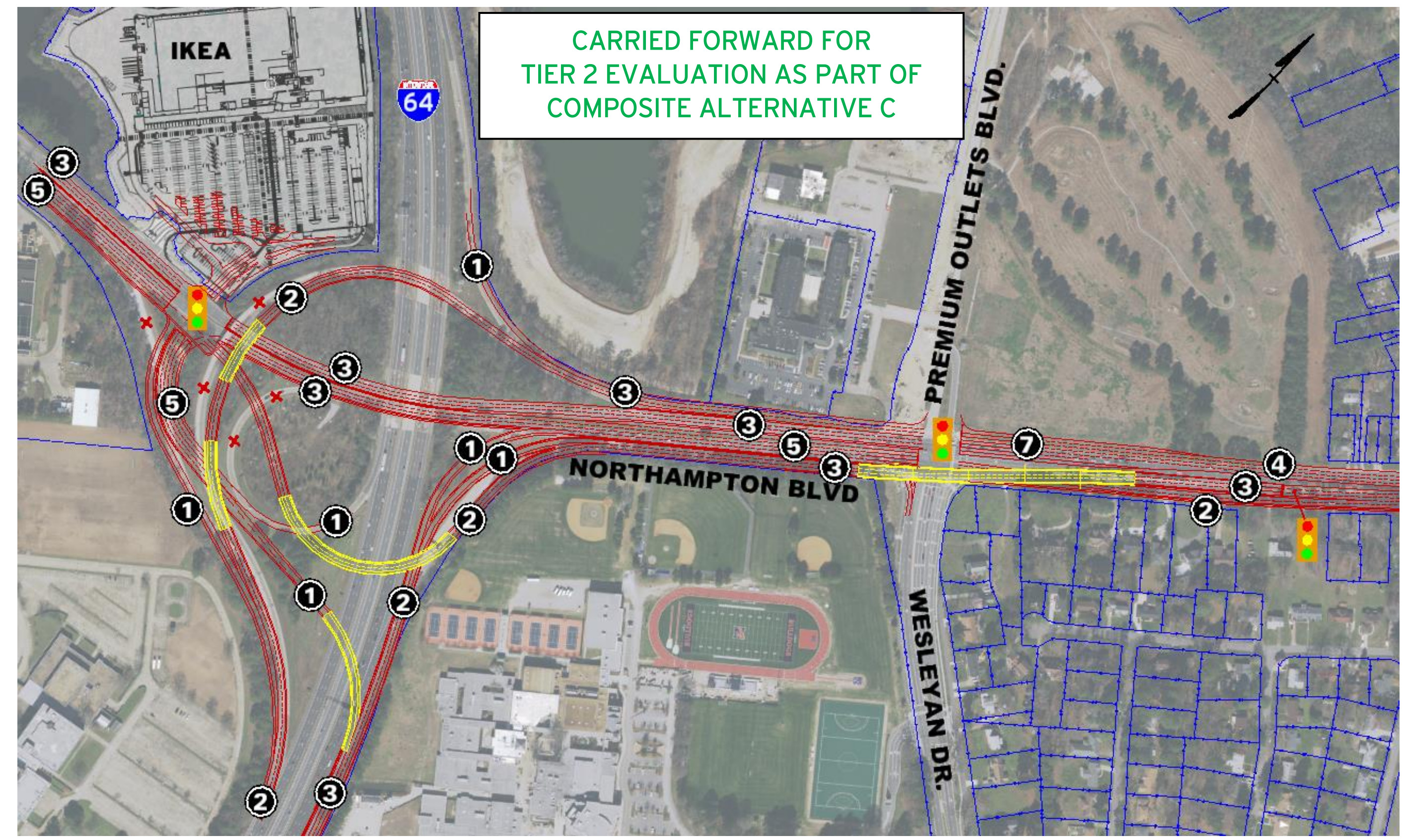
Figure 4-20: Tier 1 I-64/Northampton Boulevard Interchange Alternative 1



Analyses indicated heavily congested weaving operations on the eastbound Northampton Boulevard frontage road between the westbound I-64 exit ramp and Wesleyan Drive. In addition, the complex braided ramps along Northampton Boulevard east of I-64 would require profile grades that exceed the allowable values set forth by AASHTO guidelines. For these reasons, Alternative 1 was not carried forward for further evaluation under Tier 2 analysis. Elements of the Alternative 1 layout were incorporated into other alternatives at this interchange, as described in the following subsections.

Alternative 2 (Figure 4-21) - Under this improvement concept, a new elevated roadway is constructed to allow eastbound through traffic on Northampton Boulevard to bypass merge-weave areas and the signalized intersection at Wesleyan Drive. Westbound Northampton Boulevard is widened to provide additional capacity onto the ramp accessing eastbound I-64 and the ramp accessing westbound I-64. The bridge carrying westbound Northampton Boulevard to eastbound I-64 is replaced to provide additional capacity and restore required vertical clearance. The exit ramp from westbound I-64 is elevated along the I-64 mainline, and splits to provide access to eastbound Northampton Boulevard and westbound Northampton Boulevard at a signalized intersection at a relocated IKEA Way. Relocated improvements include reconfiguration of the IKEA site circulation road and parking areas, with no loss in parking capacity.

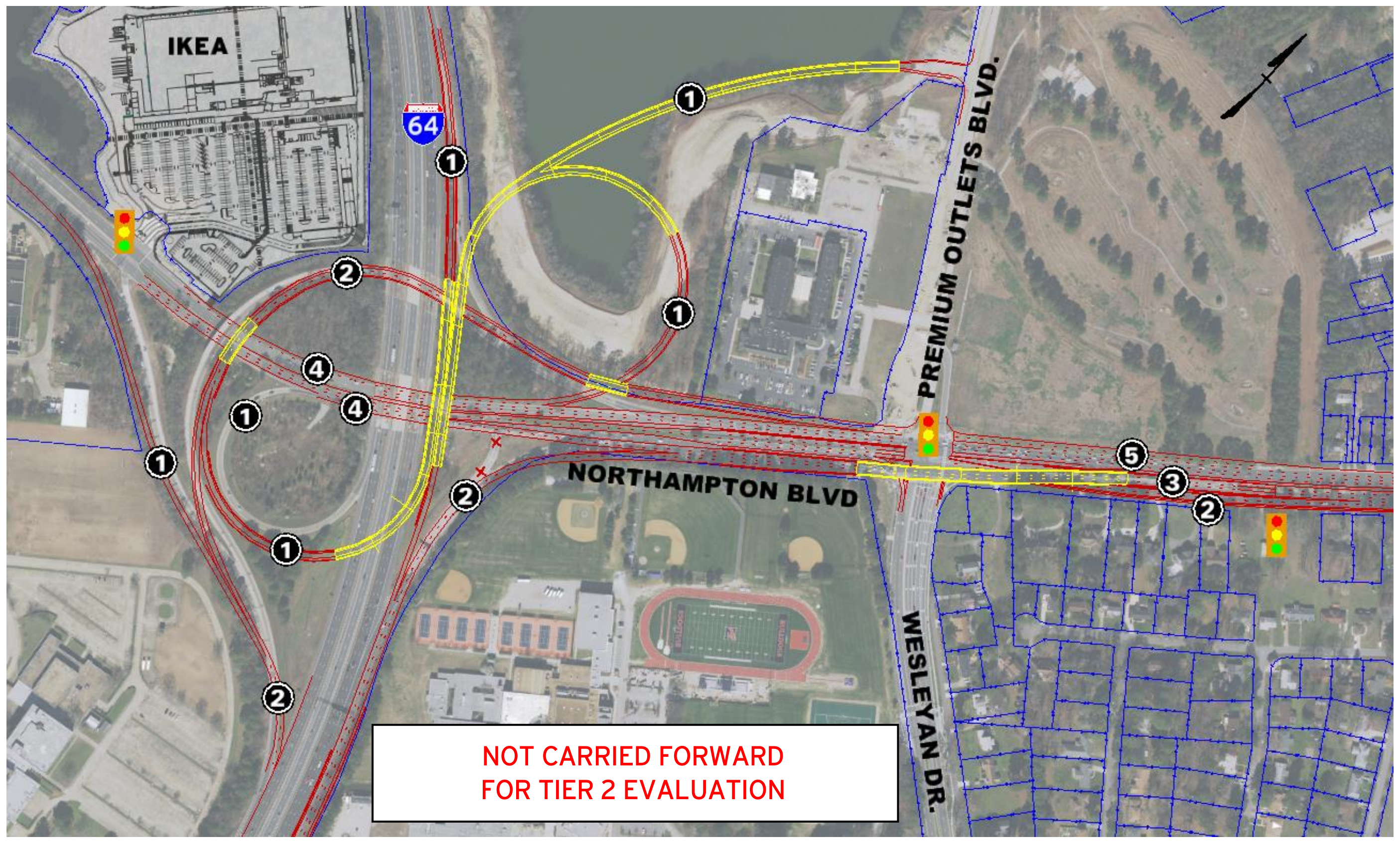
Figure 4-21: Tier 1 I-64/Northampton Boulevard Interchange Alternative 2



Alternative 2 reduces the number of signalized intersections in the Northampton Boulevard corridor, which would benefit traffic operations. All required traffic movements are accommodated. While it requires a portion of the parking lot serving the IKEA site to be reconfigured, right-of-way impacts are similar to other alternatives considered. Alternative 2 was carried forward into Tier 2 analysis.

Alternative 3 (Figure 4-22) - This concept constructs new semi-directional ramps from westbound Northampton Boulevard to westbound I-64, and from westbound I-64 to westbound Northampton Boulevard. To eliminate a merge-weave area on eastbound Northampton Boulevard for traffic exiting westbound I-64 destined for Premium Outlets Boulevard, the concept includes a new ramp over Lake Wright to provide a direct connection to Premium Outlets Boulevard. The concept includes an elevated roadway for through traffic on eastbound Northampton Boulevard, and an overpass of the signalized intersection at Wesleyan Drive. The bridge carrying the semi-directional entrance ramp to eastbound I-64 over Northampton Boulevard is replaced to provide additional capacity and restore required vertical clearance.

Figure 4-22: Tier 1 I-64/Northampton Boulevard Interchange Alternative 3



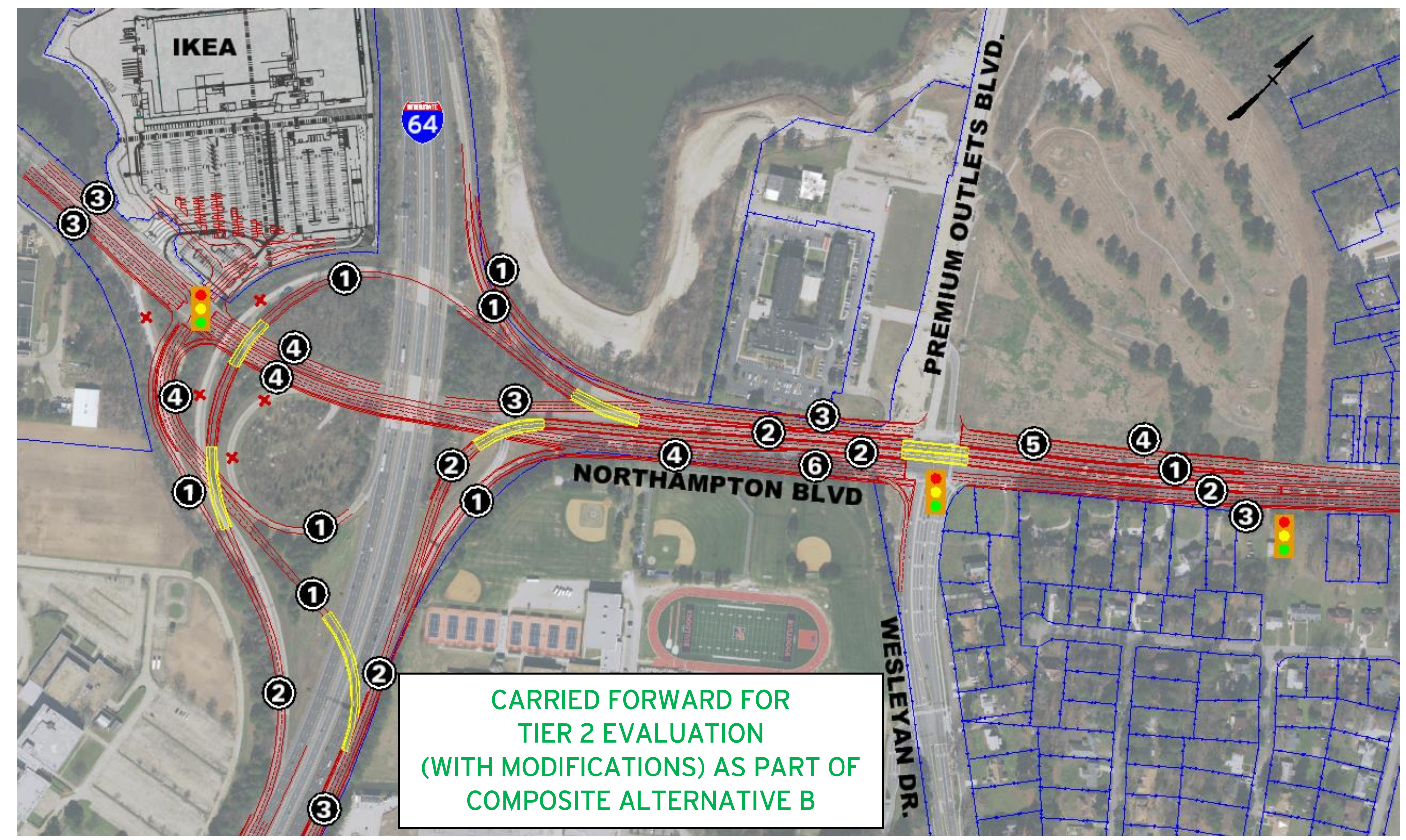
This alternative would have direct impacts to Lake Wright, which is a source of drinking water for the City of Norfolk. This was determined to be a fatal flaw of Alternative 3, and it was therefore not carried forward for further evaluation.

Alternative 4 (Figure 4-23) - This alternative is a modification of Alternative 1 that retains the concept of an elevated through travelway and one-way local frontage roads along Northampton Boulevard east of I-64. This alternative involves simplified braided connections in the Northampton Boulevard corridor east of I-64. The layout provides connections between interchange ramps, an elevated road serving eastbound and westbound through traffic, and directional frontage roads. Unlike Alternative 1, this alternative does not provide directional connections between Northampton Boulevard and the west end of the elevated road. Trips with origins or destinations in the Northampton Boulevard corridor west of I-64 do not have access to the elevated roadway, and must use the "local" roadways between I-64 and Wesleyan Drive.

To retain access from Wesleyan Drive and Premium Outlets Boulevard to eastbound I-64, the layout includes dual left turn lanes along westbound Northampton Boulevard at the signalized intersection at IKEA Way and the eastbound I-64 entrance ramp terminal.

This concept incorporates the same configuration for the exit ramp from westbound I-64 as is included in Alternative 2, described above. The bridge carrying the semi-directional entrance ramp to eastbound I-64 over Northampton Boulevard is replaced to provide required vertical clearance.

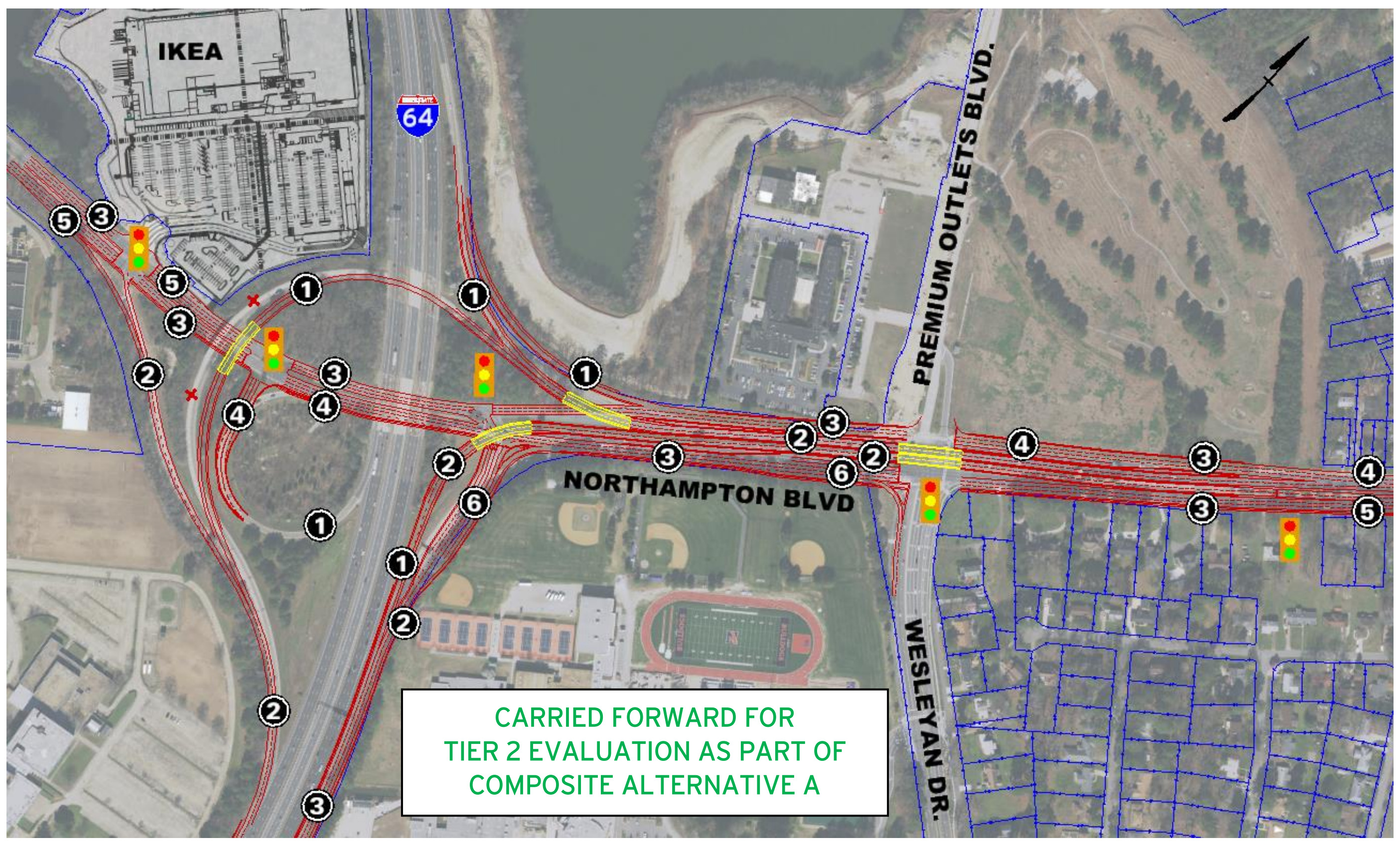
Figure 4-23: Tier 1 I-64/Northampton Boulevard Interchange Alternative 4



Analyses indicated that Alternative 4 could provide acceptable traffic operations, and accommodate required traffic movements. Like Alternative 2, the number of signalized intersections along Northampton Boulevard is reduced, which would reduce travel delay in the corridor. Alternative 4 was therefore selected for refinement and further evaluation under Tier 2 analysis, Alternative 5 (Figure 4-24) - This alternative is also modification of Alternative 1. The layout retains the configuration and location of signalized intersections along Northampton Boulevard used in Alternative 1. Those improvements are paired with the simplified braided ramp system, elevated travelway, and local frontage roads along Northampton Boulevard east of I-64 as featured in Alternative 4. As with Alternative 4, the bridge carrying the semi-directional entrance ramp to eastbound I-64 over Northampton Boulevard is replaced. The signalized intersection along Northampton Boulevard at the eastbound I-64 entrance ramp terminal and IKEA Way remains in place. Like Alternative 4, this alternative does not provide directional connections between Northampton Boulevard and the west end of the elevated road, requiring trips with origins or destinations in the Northampton Boulevard corridor west of I-64 to use the "local" roadways between I-64 and Wesleyan Drive.

To retain access from Wesleyan Drive and Premium Outlets Boulevard to eastbound I-64, the layout includes dual left turn lanes along westbound Northampton Boulevard at the signalized intersection at IKEA Way and the eastbound I-64 entrance ramp terminal.

Figure 4-24: Tier 1 I-64/Northampton Boulevard Interchange Alternative 5



Alternative 5 was carried forward into Tier 2 analysis based on its ability to provide acceptable traffic operations and accommodate required traffic movements without fatal flaws relative to other criteria considered.

Table 4.6: Tier 1 Evaluation Matrix, I-64/Northampton Boulevard Interchange

	I-64 / NORTHAMPTON BOULEVARD INTERCHANGE					
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3	BUILD ALTERNATIVE 4	BUILD ALTERNATIVE 5
EVALUATION CRITERIA	Existing conditions; no improvements (includes recent improvements at ramp terminal intersections)	From STARS study; braided ramps between I-64 and Northampton Boulevard east	Hybrid semi-directional/partial SPUI; elevated bypass for EB through traffic	Semi-directional with displaced access to Wesleyan Drive; ramps over Lake Wright	Hybrid semi-directional/partial SPUI; elevated facility for EB and WB through traffic	Modified existing conditions; retains signal at EB and WB I-64 exit ramp terminals
Right-of-Way Impacts	No action - no right-of-way impacts.	Impacts to Norfolk Academy, residential parcels.	Impacts to Norfolk Academy, hotel, residential parcels.	Direct impacts to City park and commercial properties.	Impacts to Norfolk Academy, hotel, residential parcels.	Impacts to Norfolk Academy, hotel, residential parcels.
Traffic Operations	LOS F at Wesleyan/PO intersection; LOS F at I-64 WB exit ramp intersection; other locations LOS C or better. WB-to-EB ramp over capacity.	Steep grades at braid; LOS C/C at Wesleyan/PO; other locations LOS C or better. Heavy weaves along EB frontage road, and approaching Burton Station Dr.	LOS C or better at signal approaching Burton Station Dr.; LOS E/E at Wesleyan/PO intersection; other locations LOS D or better.	Not analyzed due to fatal flaw environmental impact (see below).	LOS C or better at signal approaching Burton Station Dr.; LOS D/D at Wesleyan/PO intersection; other locations LOS D or better.	LOS C or better at signal approaching Burton Station Dr.; LOS B/E at Wesleyan/PO intersection; other locations LOS D or better.
Pedestrian/Bicycle Accommodations	No continuous sidewalk within project limits; peds/bikes cross one free-flow ramp.	New sidewalk not shown, but could be provided; requires ped/bike crossings of four free-flow movements.	New sidewalk not shown, but could be provided; requires ped/bike crossings of two free-flow movements.	New sidewalk not shown, but could be provided; requires ped/bike crossings of three free-flow movements.	New sidewalk not shown, but could be provided; requires ped/bike crossings of three free-flow movements.	New sidewalk not shown, but could be provided; requires ped/bike crossings of three free-flow movements.
Compliance with Adopted Plans	Recent short-term improvements reflected in Burton Station SGA Plan.	Accommodates future retail access point as RI/RO at Northampton; otherwise consistent with Plan.	Accommodates future retail access point as RI/RO at Northampton; otherwise consistent with Plan.	Inconsistent with Burton Station SGA Plan.	Accommodates future retail access point as RI/RO at Northampton; otherwise consistent with Plan.	Accommodates future retail access point as RI/RO at Northampton; otherwise consistent with Plan.
Potential Environmental Impacts	No action - no impacts.	4(f) impacts, Norfolk Academy; forested wetlands along EB and WB I-64.	4(f) impacts, Norfolk Academy; forested wetlands along EB and WB I-64.	Impacts to City park; crossing Lake Wright (fatal flaw); forested wetlands along EB and WB I-64.	4(f) impacts, Norfolk Academy; forested wetlands along EB and WB I-64.	4(f) impacts, Norfolk Academy; forested wetlands along EB and WB I-64.
Evaluation Results:	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD	CARRIED FORWARD FOR TIER 2 EVALUATION	NOT CARRIED FORWARD	CARRIED FORWARD FOR TIER 2 EVALUATION (with modifications)	CARRIED FORWARD FOR TIER 2 EVALUATION
Basis for Rejection:	--	Steep profile grades required at complex braided ramps; heavy weaves approaching Wesleyan Dr.	--	Impacts to Lake Wright (drinking water source); inconsistent with City SGA Plan	--	--

I-64 Widening

Based on a review of initial traffic volume projections, it was noted that projected volumes will exceed existing capacity along I-64 within the study area. Accordingly, all improvement concepts include widening I-64 to provide one additional through lane in the eastbound and westbound directions between Indian River Road and I-264, and from I-264 to Northampton Boulevard. The additional through lanes are not carried through the I-64/I-264 interchange because through volumes do not warrant additional capacity. The additional through lanes originate or terminate at the I-64/I-264 interchange as lane additions or lane reductions associated with ramps.

Tier 1 Screening Summary

Using the evaluations, the Study Team selected interchange alternatives to advance into Tier 2 screening for further refinement and evaluation. Table 4.7 summarizes the Tier 1 alternatives selected for further consideration, and their arrangement into composite Alternatives A, B, and C. Alternative A includes the individual interchange concepts most favored by the Study Team, followed by Alternatives B and C, in descending order of preference.

Table 4.7: Tier 1 Alternatives Selected for Advancement to Tier 2

Interchange	Tier 1 Alternative Selected		
I-64 / I-264	Alt. 3	Alt. 4	Alt. 5
I-264 / Military Highway	Alt. 2 (modified)	Alt. 1	Alt. 4
I-264 / Newtown Road	Alt. 2 (modified)	Alt. 3	Alt. 4
I-264 / Witchduck Road	Alt. 1	Alt. 1	Alt. 1
I-64 / Indian River Road	Alt. 2	Alt. 1	Alt. 3
I-64 / Northampton Boulevard	Alt. 5	Alt. 4 (modified)	Alt. 2
	Tier 2 Alternative A	Tier 2 Alternative B	Tier 2 Alternative C

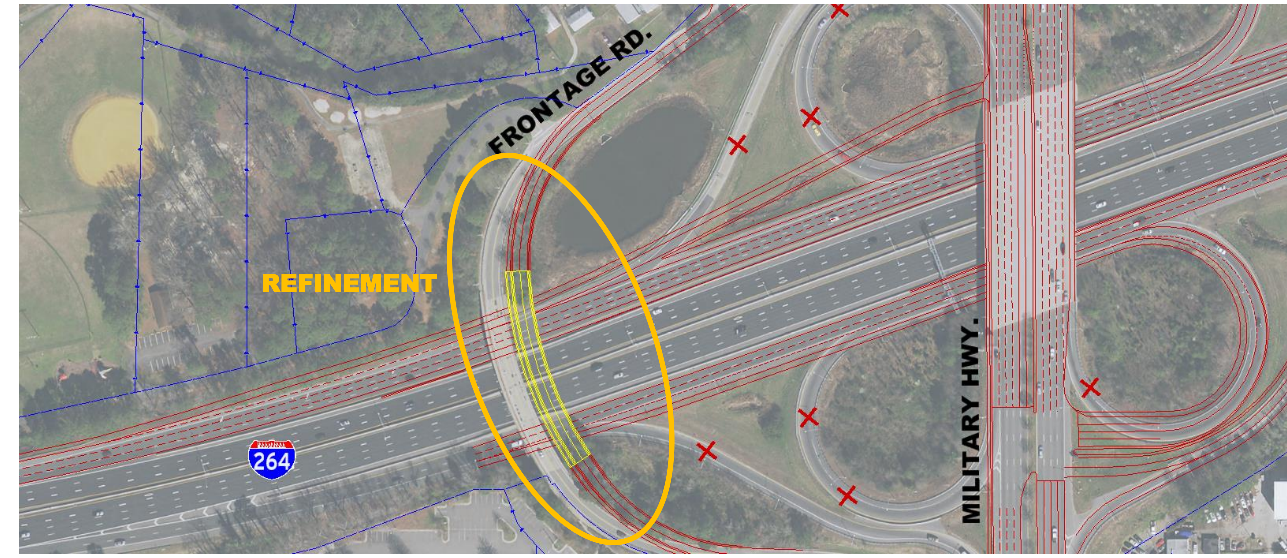
To address projected traffic demand, widening I-64 within the study area was carried forward into Tier 2 as part of all three composite alternatives. This approach allowed for an analysis of each improvement alternative without metering of traffic flow on freeway segments upstream of the I-64/I-264 interchange.

Refinement of Selected Tier 1 Alternatives

Based on input from Study Team members, the following alternatives were refined as they were advanced into Tier 2 screening:

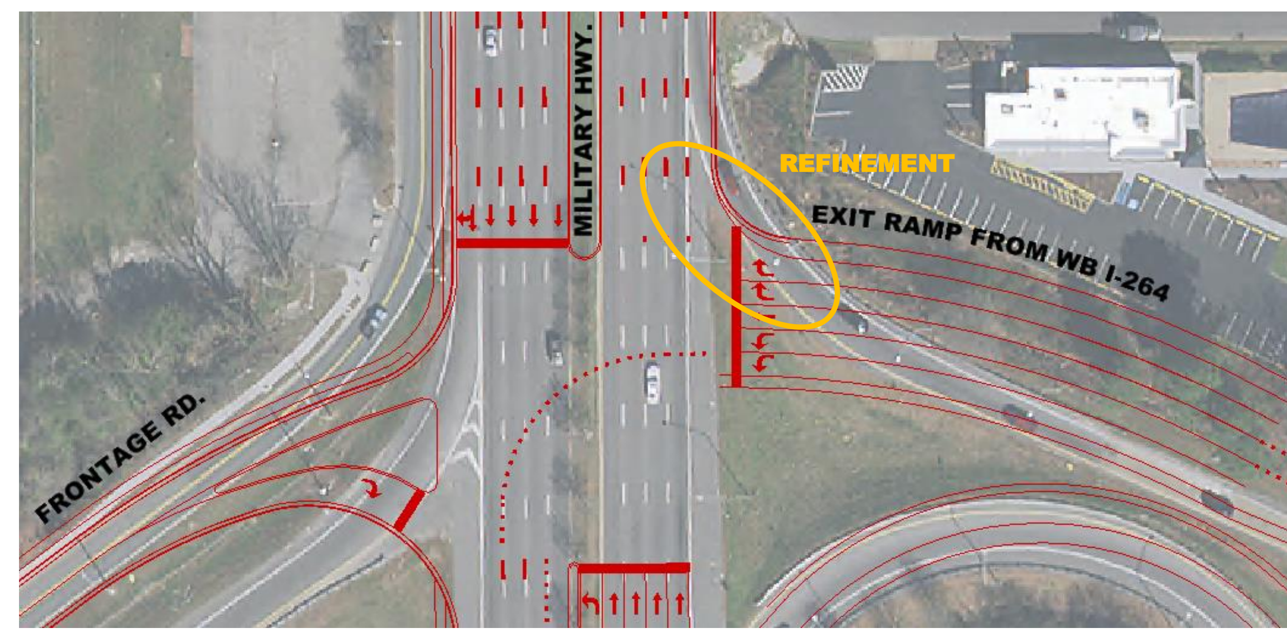
- I-264/Military Highway Interchange Alternative 2 (Figures 4-25 and 4-26, correlating to Figure 4-7) - The existing bridge carrying Frontage Road over I-264 constrains the ability to provide adequate ramp geometry. This alternative was revised to include replacement of the bridge carrying Frontage Road over I-264, and to provide adequate acceleration length for the entrance ramps from Military Highway to westbound I-264.

Figure 4-25: Modifications to Tier 1 I-264/Military Highway Interchange Alternative 2 (Bridge)



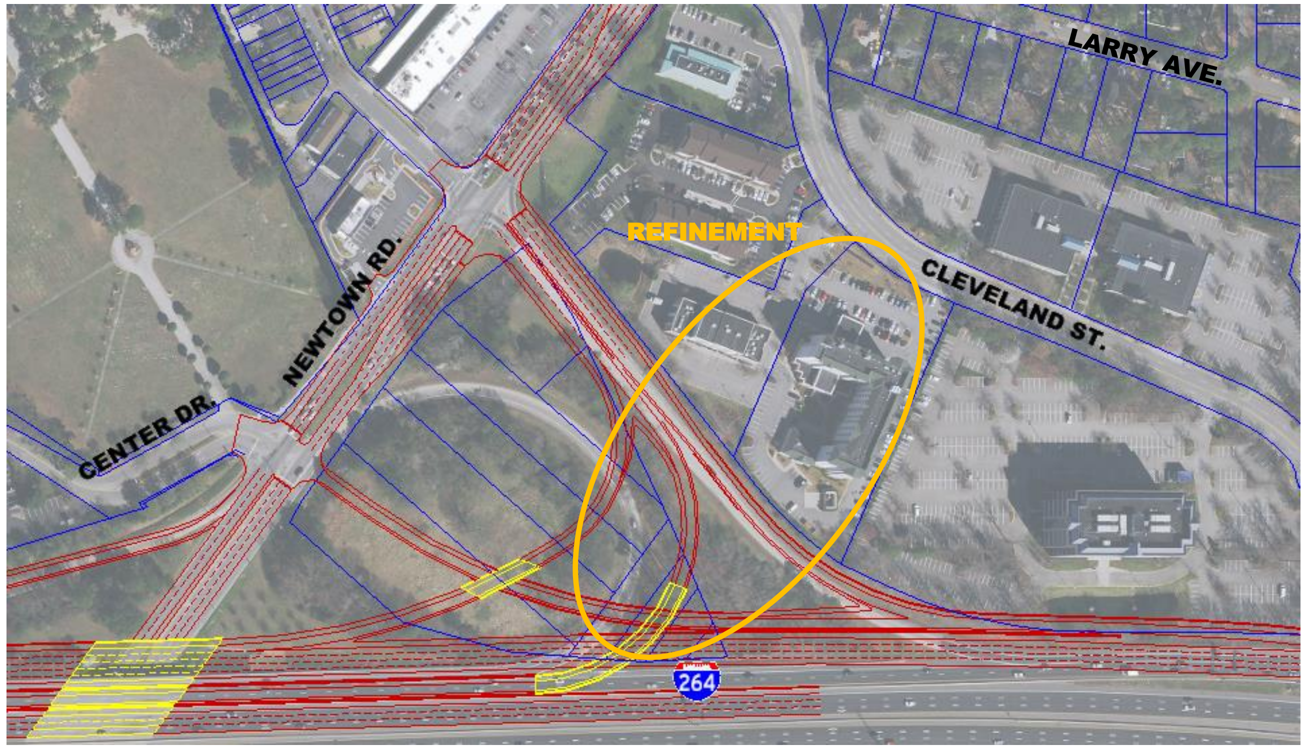
The City of Norfolk requested that the study include evaluation of a signalized right turn movement from the westbound I-264 exit ramp to northbound Military Highway. Accordingly, Alternative 2 at this interchange was also modified to reflect a signal-controlled dual right turn movement at this location, while other alternatives retained a free-flow right turn movement. The signal-controlled movement is shown in Figure 4-26.

Figure 4-26: Modifications to Tier 1 I-264/Military Highway Interchange Alternative 2 (WB Right Turn)



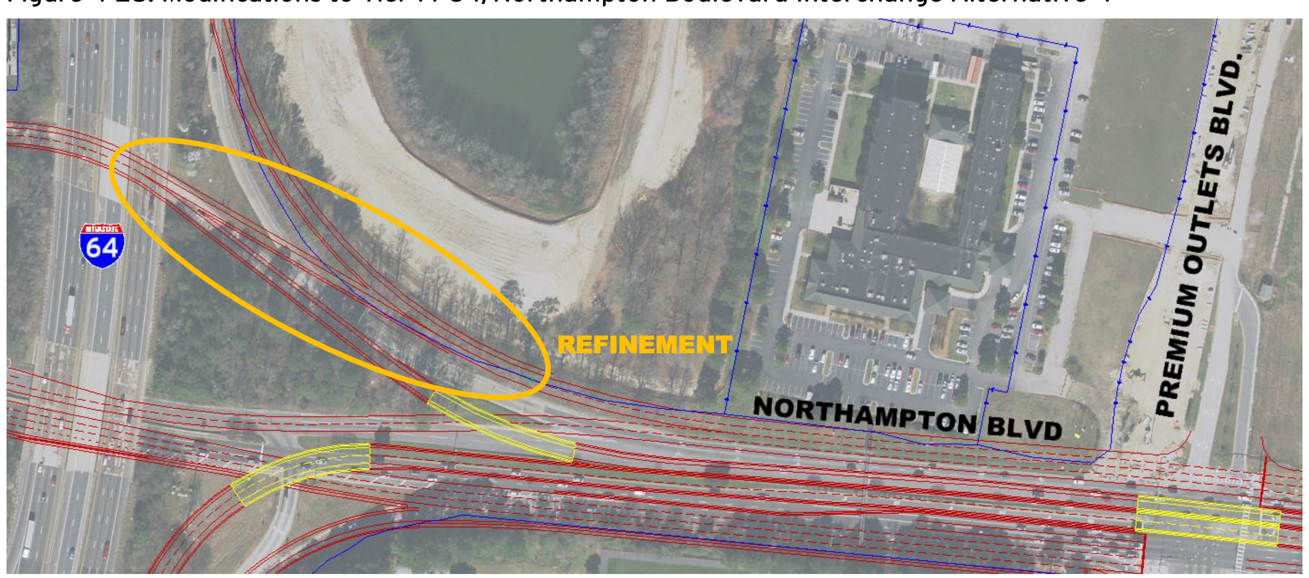
- I-264/Newtown Road Interchange Alternative 2 (Figure 4-27, correlates to Figure 4-11) - City of Virginia Beach staff noted that this layout places significant ramp volume onto Cleveland Street, and routes those trips past Larry Avenue, which is a residential street. The alternative also requires acquisition and relocation of an office building. Based on this input, this alterative was revised to add a directional entrance ramp from southbound Newtown Road, remove the entrance ramp from Cleveland Street, and avoid impacts to the office building.

Figure 4-27: Modifications to Tier 1 I-264/Newtown Road Interchange Alternative 2



- I-64/Northampton Boulevard Interchange Alternative 4 (Figure 4-28, correlates to Figure 4-23) - The Study Team desired to test an alternative ramp configuration at this interchange. Therefore, this alternative was modified to allow access to the existing semi-directional ramp oriented to eastbound I-64 from both the elevated and local facilities along westbound Northampton Boulevard. This change eliminates the need for motorists from Wesleyan Drive or Premium Outlets Boulevard to enter eastbound I-64 through the signalized Northampton Boulevard/IKEA Way intersection.

Figure 4-28: Modifications to Tier 1 I-64/Northampton Boulevard Interchange Alternative 4



4.3 Concepts Considered but not Advanced

The following design concepts were considered during development of Tier 1 layouts but were not fully developed as alternatives for further consideration.

Roundabouts (multiple locations)

Consistent with VDOT policy, roundabouts were considered when formulating potential improvement concepts at existing and new intersections within the study area.

Several conditions precluded roundabouts from further consideration. Among these were high total approach volumes, in many cases approaching or exceeding 6,000 vph; high volume of left-turning traffic; and location in corridors having traffic signals at adjacent locations. In addition, most of the intersections have developed properties located in all four quadrants, making conversion to a roundabout costly with respect to right-of-way impacts. These factors are all identified as disadvantages or limitations of roundabouts in NCHRP Report 672, which VDOT references in its Road Design Manual.

Diverging Diamond Interchange (Newtown Road)

A diverging diamond interchange (DDI) at the I-264/Newtown Road interchange would require the placement of a crossover intersection along Newtown Road on either side of I-264. The south crossover intersection would need to be located at the Newtown Road/I-264 eastbound exit ramp/Greenwich Road intersection, and would limit access to Greenwich Road to right-in/right-out movements. This access limitation would effectively negate enhancements to local travel patterns associated with the Cleveland Street overpass and connection to Greenwich Road, which are being constructed now as part of the I-64/I-264 Phase II improvements.

The westbound I-264 ramp terminals are separated by a distance of approximately 550 ft and are located at signalized intersections with Center Drive and Stoney Point South. This substantially complicates placement of a north crossover intersection along Newtown Road because neither of the local street intersections can be eliminated, and it would be impractical to convert either Center Drive or Stoney Point South to one-way operation as needed for a crossover intersection. Based on these considerations, a DDI at this location was not considered a viable alternative for Tier 1 analysis.

Diverging Diamond Interchange (Witchduck Road)

Like the Newtown Road corridor, the configuration and access requirements for crossover intersections along Witchduck Road eliminate the DDI as a viable concept. The south crossover intersection would need to be located at the Witchduck Road/I-264 eastbound exit ramp/Grayson Road intersection. This would require Grayson Road to be converted to one-way operation departing Witchduck Road, which is not practical considering the mixed commercial and residential land uses it serves. As such, a DDI at this location was not considered viable.

Offset Single-Point Urban Interchange (Indian River Road)

An offset single-point urban interchange (SPUI) places the single-point intersection at a preferred location along the arterial to achieve optimal distance to adjacent signalized intersections. The single-point intersection serves identical traffic volumes of a traditional SPUI, but at a different location along the arterial. In this case, a traditional SPUI at the I-64/Indian River Road interchange was determined to operate at a failing level of service. Therefore, an offset SPUI was eliminated from consideration.

4.4 Tier 2 Screening

As noted in Section 4.2, improvement alternatives selected for further study were advanced into Tier 2 analysis and screening. Initial capacity analyses under Tier 2 screening were performed for intersections using Synchro software to develop optimized phasing and timing for signalized intersections. Once developed, the optimized signal operations information was coded into VISSIM models for Alternatives A, B, and C. Tier 2 analyses focused on weekday PM peak period operations.

Developing and refining each alternative was undertaken as an iterative process. Following building and initial running of each VISSIM model, operational metrics were reviewed, and geometric changes were identified. Examples of such changes included additional lanes, moving or reconfiguring ramp terminals, minor roadway alignment shifts, turn prohibitions, and signalization. Geometry was then developed and coded into a revised model, followed by a second model run. This process was continued until model results were optimized for the highway layout associated with each alternative. When geometric changes were deemed to warrant reevaluation of signal operations, Synchro analyses were updated, and revised signal timing and phasing data was coded into revised VISSIM models.

Major design refinements were determined to be necessary for the Witchduck Road interchange. Analyses performed for the Witchduck Road corridor revealed that improvements currently being made as part of the Witchduck Road Phase II project (City of Virginia Beach CIP No. 2.025) will be unable to accommodate future traffic volumes projected for 2044. Under projected conditions with programmed improvements in place, operations on Witchduck Road would deteriorate to near total gridlock, with queuing extending back onto eastbound and westbound I-264 along the exit ramps to Witchduck Road. Operational problems were attributable to high volume conflicting movements at the Witchduck Road/Cleveland Street intersection, and short spacings between adjacent signalized intersections along Witchduck Road that limit queue capacity and inhibit weaving movements. To address these conditions, the following three arterial improvement concepts were prepared and incorporated into Alternatives A, B, and C for evaluation:

- Jug handle concept (Witchduck Alternative A) - This concept eliminates the direct westbound left turn movement from Cleveland Street onto southbound Witchduck Road, and reroutes that movement north along Jersey Avenue, west along Admiral Wright Road, and then south onto Witchduck Road. This concept reduces conflicting turning movements at the Witchduck Road/Cleveland Street intersection, and provides the rerouted movement with an increased distance along southbound Witchduck Road in which to change lanes and ultimately reach the entrance ramp to westbound I-264.
- "Barbell" U-turns along Cleveland Street (Witchduck Alternative B) - Under this concept, direct left turn movements between Witchduck Road and Cleveland Street are prohibited. Those movements are rerouted to either of two U-turn pockets along Cleveland Street, located east and west of Witchduck Road.
- "Barbell" U-turns along Witchduck Road (Witchduck Alternative C) - This concept effectively creates a 'superstreet' layout for Witchduck Road which prohibits all direct left turn movements to or from Witchduck Road and eliminates all direct through movements across Witchduck Road. All left turn and crossing movements would occur at either of two U-turn pockets along Witchduck Road, one located south of Southern Boulevard and the second located north of Cleveland Street.

Evaluation Criteria

Each alternative was evaluated by individual interchange with respect to the following criteria:

Traffic operations - An overall rating for each interchange was developed to reflect several quantitative metrics regarding traffic operations. For freeway segments and ramps, these included travel speeds, flow densities, travel times, and vehicle throughput. For arterials, these include delay and the degree to which arterial operations negatively affect interstate mainline or ramp operations. Alternatives were rated as having an aggregate low, moderate, or high degree of congestion.

Compliance with design standards - Each alternative was evaluated to identify the associated number of design exceptions, design waivers, and access management waivers pursuant to current guidelines set forth by AASHTO and VDOT. Alternatives were rated as having a relatively low, moderate, or high degree of deviation from design standards.

Right-of-way impacts - For each alternative, conceptual right-of-way impacts were identified to address spatial requirements of the geometric layout, construction-phase access requirements, and post-construction maintenance needs. Impacts were quantified as the number of impacted properties; the number and area of partial-take and full-take acquisitions; the number and type of relocations; and the number and area of permanent and temporary easements. Alternatives were rated as having a low, moderate, or high degree of right-of-way impacts.

Potential environmental impacts - Impacts associated with each alternative layout were estimated using resource locations and extents identified by VDOT in a May 2018 Preliminary Environmental Review. Information regarding tidal channels was supplemented with mapping obtained through the City of Norfolk website. Impacts were quantified as length of streams, length of tidal channels, number and area of environmentally sensitive parcel(s), and values for other types of potential impacts. Alternatives were rated as having an aggregate low, moderate, or high level of potential impact to known environmental resources.

Constructability - Constructability was evaluated qualitatively with respect to sequencing of work, maintenance of traffic, and erection of structures. Conceptual layouts for each alternative were reviewed to determine the feasibility of sequencing roadway construction while maintaining at least the existing number of lanes by movement. A separate review was conducted to evaluate the constructability of bridges and retaining walls in each alternative, with respect to erection sequencing and operations. Reviews resulted in subjective overall ratings for each alternative as having a low, moderate, or high level of complexity with respect to constructability.

Construction cost and total project cost - Conceptual improvements associated with each alternative were quantified using select pay items, unit prices, and cost factors for construction activities. Construction costs were totaled and factored to include inflation to 2030, which is the projected midpoint year of construction for the entire improvement program. Total project costs were calculated to include right-of-way and utility relocation costs; project development activities such as preliminary engineering and construction engineering and inspection services; and a 35% contingency, commensurate with the conceptual level of design information developed through the course of this IMR study. Alternatives were rated as having low, moderate, or high costs, which are relative among the alternatives evaluated.

Appendix D contains the refined layouts for Alternatives A, B, and C, along with summaries of right-of-way impacts, environmental impacts, constructability considerations, and construction cost estimates generated to support evaluation of the alternatives by interchange location. Traffic analysis results are included in Appendix G.

Evaluation of Tier 2 Alternatives and Selection of Tier 3 Improvements

The Study Team convened on April 9, 2019 to discuss and evaluate the three composite design alternatives. Table 4.8 summarizes the decisions of the Study Team relative to the selection of improvements by interchange, and development of a composite Alternative D comprised of the preferred improvements at each interchange extracted from the previously developed Alternatives A, B, and C.

Table 4.8: Selection of the Recommended Alternative

Interchange	Tier 2 Alternatives				Recommended Improvement by Interchange (Composite Alternative D)
I-64 / I-264	Alt. A	Alt. B	Alt. C	⇨	Alt. C
I-264 / Military Highway				⇨	Alt. A
I-264 / Newtown Road				⇨	Alt. C
I-264 / Witchduck Road				⇨	Alt. A (with refinements)
I-64 / Indian River Road				⇨	Alt. B
I-64 / Northampton Boulevard				⇨	Alt. A

Following selection of alternatives to be advanced from Tier 2 evaluations, design refinements were determined to be needed to address the following:

- Input by stakeholder agencies during the Tier 2 evaluation process; and,
- Capacity and operational issues identified based on the results of Tier 3 microsimulation analysis of 2044 AM peak hour conditions.

The refined composite recommended improvements are designated Alternative E.

In some areas, recommended improvements are identified within the limits of current construction projects. This is attributable to the current construction projects being planned several years ago, with design years before 2044. Anticipated growth in traffic demand beyond the design year of current construction projects and projected for 2044 creates the need for a higher level of improvement beyond what is currently being constructed.

The following subsections present information specific to improvements at each interchange:

- A narrative description of the basis for selecting the recommended alternative at each interchange;
- A narrative description of design refinements incorporated into composite Alternative D toward development of composite Alternative E;
- The evaluation matrix used to support evaluation of Tier 2 improvement alternatives by the Study Team. The recommended improvements by interchange are shaded green in each matrix, and are identified as "RECOMMENDED". Red text identifies attributes of each alternative that were considered unfavorable to selection, and which helped inform selection of recommended improvements.
- Layout exhibits for recommended improvements included in composite Alternative E which underwent Tier 3 analysis for projected 2044 AM peak period conditions, as well as projected 2024 AM and PM peak period conditions.

I-64/I-264 Interchange

<u>Basis for Selection for Alternative C</u> - (See Table 4.9) Alternative A was determined to have lower mainline through speeds than Alternative C, and greater tidal channel impacts than either Alternatives B or C. In addition, Alternative A served the lowest percentage of entering traffic among all alternatives, and would not enable traffic entering from Newtown Road to merge across the C/D roadway lanes to access the downstream I-264/Military Highway interchange. For these reasons, Alternative A was not recommended despite having the lowest construction cost of the three alternatives considered.

While Alternative B served all directional access needs better than Alternative A, it was not selected as the recommended improvement. Alternative B featured several bridges that would be complex to construct and maintain, and incorporated a total of 21 fracture-critical elements (non-redundant straddle piers). VDOT's preference is to avoid such structures where possible. Alternative B was determined to have relatively low mainline travel speeds, had the highest construction cost of all alternatives, and would likely impact a City of Norfolk sewage pump station located on the west side of Kempsville Road near Center Drive.

Alternative C was selected as the recommended alternative at this interchange. It serves the greatest percentage of entering traffic, has the highest mainline travel speeds, and serves all directional access needs. Alternative C is estimated to have the least impact to tidal channels, avoids impacts to the City sewage pump station, and has fewer fracture-critical structures than Alternative B. Alternative C is otherwise comparable to the other alternatives relative to most other criteria.

Due to the proximity of the I-64/I-264 interchange and the I-264/Newtown Interchange, Alternatives A, B, and C at these two interchanges were developed and evaluated as paired improvements. Refer to the Section 4.5 subsection on the I-264/Newtown Road interchange for additional justification for selection of Alternative C at both of these interchanges.

<u>Design Refinements</u> - Analysis of AM peak period volumes revealed the need for an additional (third) travel lane serving the westbound I-264 to westbound I-64 movement. Downstream volumes along westbound I-64 also warrant an additional lane, resulting in a proposed six-lane section north of this interchange. This additional westbound lane was determined to have a negative impact on the ability of traffic entering westbound I-64 from westbound I-264 and destined for the slip ramp to the I-64 Express Lanes to weave across the westbound I-64 through lanes. To address the need for additional weave length, the slip ramp between the westbound I-64 general-purpose lanes and the Express Lanes will be relocated approximately 2,200 ft north of its present location.

Several additional changes were made to the layout of improvements at the I-64/I-264 interchange to simplify construction, reduce the potential for motorist confusion, and reduce project costs. Through detailed microsimulation analyses, the changes were determined to provide favorable traffic operations. The changes are described as follows:

- Remove the existing loop ramp serving the movement from the westbound I-264 C/D roadway to eastbound I-64. Alternatives developed earlier in the study maintained this ramp in service to provide reserve capacity to the new semi-directional ramp serving the same directional movement. A review of refined traffic volume projections indicates that the proposed semi-directional ramp will have sufficient reserve capacity as planned.
- Removing the loop ramp identified in the preceding bullet item allows the upstream loop ramp along the westbound C/D roadway to remain in place. Accordingly, the loop ramp serving the movement from westbound I-64 to westbound I-264 is now retained, and the bifurcated ramp network providing access to westbound I-264 and Military Highway included in the Tier 2 Alternative C is removed from the project. This change removes two complex bridges and multiple retaining walls from the project, and simplifies directional signage associated with affected traffic movements.
- Tier 2 Alternative C situated the outer ramp network to westbound and eastbound I-64 (between Newtown Road and I-64) on a viaduct structure, minimizing impacts to developed commercial properties located between westbound I-264 and Center Drive. This layout was refined to place the outer ramp network at grade, parallel to and north of the existing westbound C/D roadway. While this change does increase the direct impacts to the commercial properties, the change reduces construction cost, reduces long-term maintenance needs, reduces the potential for roadway icing during winter weather, and reduces the visual impacts of the improvements.

Recommended improvements in the vicinity of the I-64/I-264 interchange are shown in Figures 4-29 through 4-32 starting on page 4-26.

Table 4.9: Tier 2 Evaluation of Alternatives, I-64/I-264 Interchange

RECOMMENDED
CARRIED FORWARD TO TIER 3

EVALUATION CRITERIA	I-64 / I-264 INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
	Existing conditions; no improvements	Semi-directional layout with improved EB I-64 exit; eliminate left exits from I-264; retain NE and SW loop ramps; eliminate NW & SE loop ramps; construct WB I-264 outer ramp network to I-64	Semi-directional with improved EB I-64 exit and more direct WB-WB connection; eliminate left exits; eliminate NW & SE loops; construct WB I-264 ramps to I-64 on structure over C/D roadway	Semi-directional with improved EB I-64 exit; eliminate left exits; eliminate SE loop; retain NW loop; repurpose NE loop; construct elevated ramps to I-64 along WB I-264
Traffic Operations	Throughput (served/demand): 56.1% No. of ramps with spillback to mainline: 3 No. of links with density at LOS E: 0 No. of links with density at LOS F: 30 Avg. mainline thru travel speed (mph): 24.2 Mainline thru speed range (mph): <10.0 - 59.3 Left exit ramps: 2 No. of weaves: 8 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 97.6% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 ★ No. of links with density at LOS F: 0 ★ Avg. mainline thru travel speed (mph): 53.4 Mainline thru speed range (mph): 32.6 - 58.5 Left exit ramps: 0 No. of weaves: 5 Full access to/from adjacent interchanges? No ★ Upstream metering along WB I-64 reduced service volumes and prevents high densities from developing.	Throughput (served/demand): 98.2% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 3 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 53.5 Mainline thru speed range (mph): 33.5 - 59.0 Left exit ramps: 0 No. of weaves: 4 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 99.1% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 3 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 56.1 Mainline thru speed range (mph): 49.5 - 58.8 Left exit ramps: 0 No. of weaves: 4 Full access to/from adjacent interchanges? Yes
Compliance with Design Standards	No action; no compliance measures required. 2 fracture-critical bridges (straddle bents)	1 Design Exception 7 Design Waivers 4 fracture-critical bridges (straddle bents)	1 Design Exceptions 6 Design Waivers 21 fracture-critical bridges (straddle bents)	1 Design Exceptions 6 Design Waivers 4 fracture-critical bridges (straddle bents)
Right-of-Way Impacts	No construction; no impacts.	16 impacted parcels 15 partial takes (3.5 ac) 1 full take (0.2 ac) and 1 res. relocation 1 permanent easement (0.3 ac) 6 temporary easements (0.5 ac)	17 impacted parcels 17 partial takes (3.1 ac) 0 full takes (0 ac) and 0 relocations 1 permanent easement (0.2 ac) 6 temporary easements (1.9 ac) Impacts to City of Norfolk sewage pump station	17 impacted parcels 17 partial takes (2.8 ac) 0 full takes (0 ac) and 0 relocations 4 permanent easements (0.3 ac) 3 temporary easements (1.6 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	5.6 ac of lakes and wetlands 2,170 LF channelized streams & ditches 3,190 LF tidal channels 2 listed/pot. NRHP eligible properties (1.0 ac) 1 property with potential hazardous materials 1 potential 4(f) property / (0.8 ac)	5.5 ac of lakes and wetlands 2,400 LF channelized streams & ditches 2,380 LF tidal channels 3 listed/pot. NRHP eligible properties (1.1 ac) 2 properties with potential hazardous materials 0 potential 4(f) properties (0 ac)	5.5 ac of lakes and wetlands 2,790 LF channelized streams & ditches 2,260 LF tidal channels 2 listed/pot. NRHP eligible properties (0.7 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: Moderate / High Bridges: Moderate / High (507,000 sf)	Roadway/Civil: High Bridges: High (624,000 sf)	Roadway/Civil: High Bridges: Moderate / High (644,000 sf)
Constr. / Total Cost	$0 / $0	$401.3M / $654.6M	$483.1M / $781.3M	$475.1M / $768.8M
Basis for Selection	--	--	--	Travel speeds, directional access, number of straddle bents, impacts to utilities and tidal channels

Figure 4-29 - Tier 3 Recommended Improvements, I-64/I-264 Interchange, Alt. E

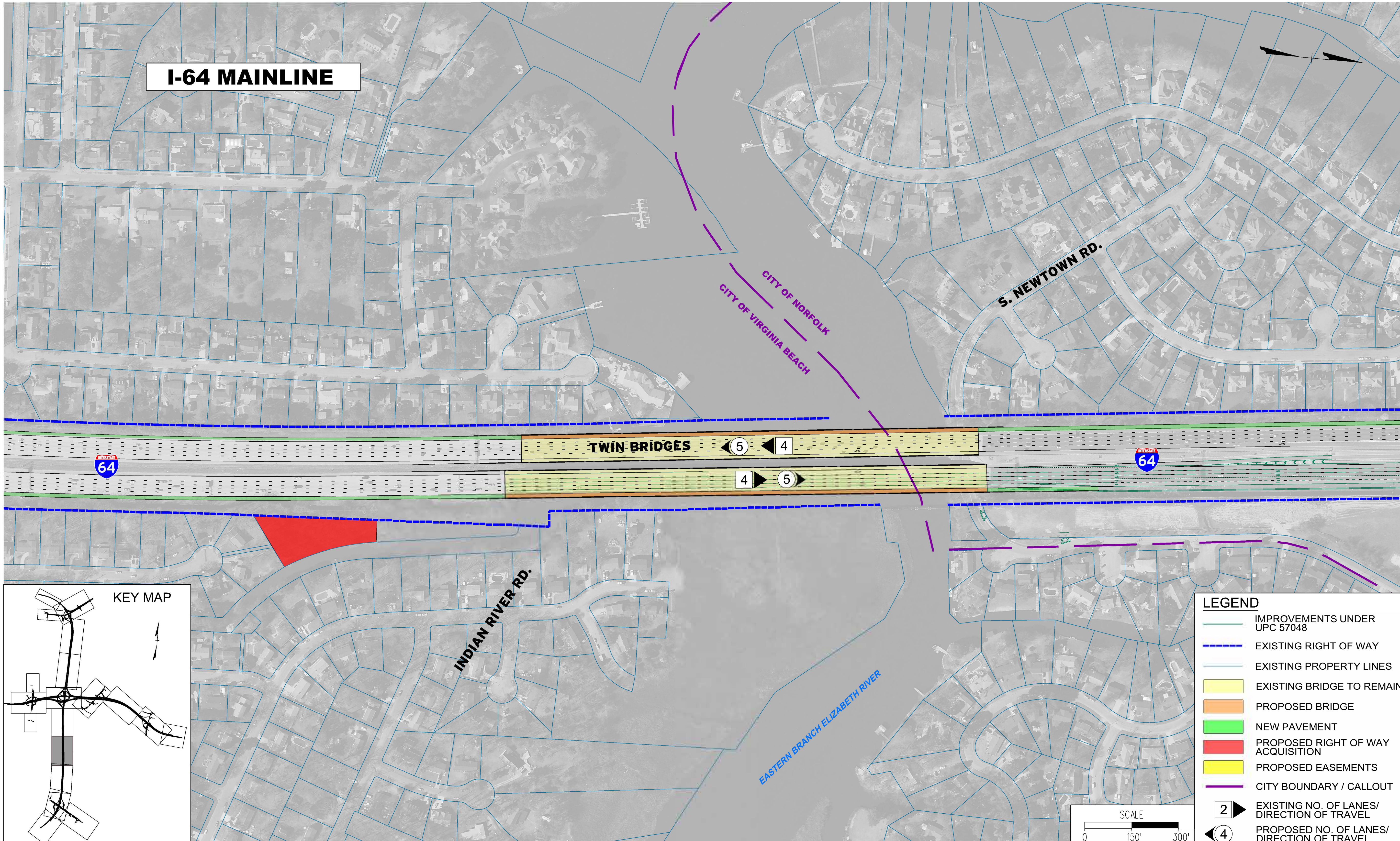


Figure 4-30 - Tier 3 Recommended Improvements, I-64/I-264 Interchange, Alt. E

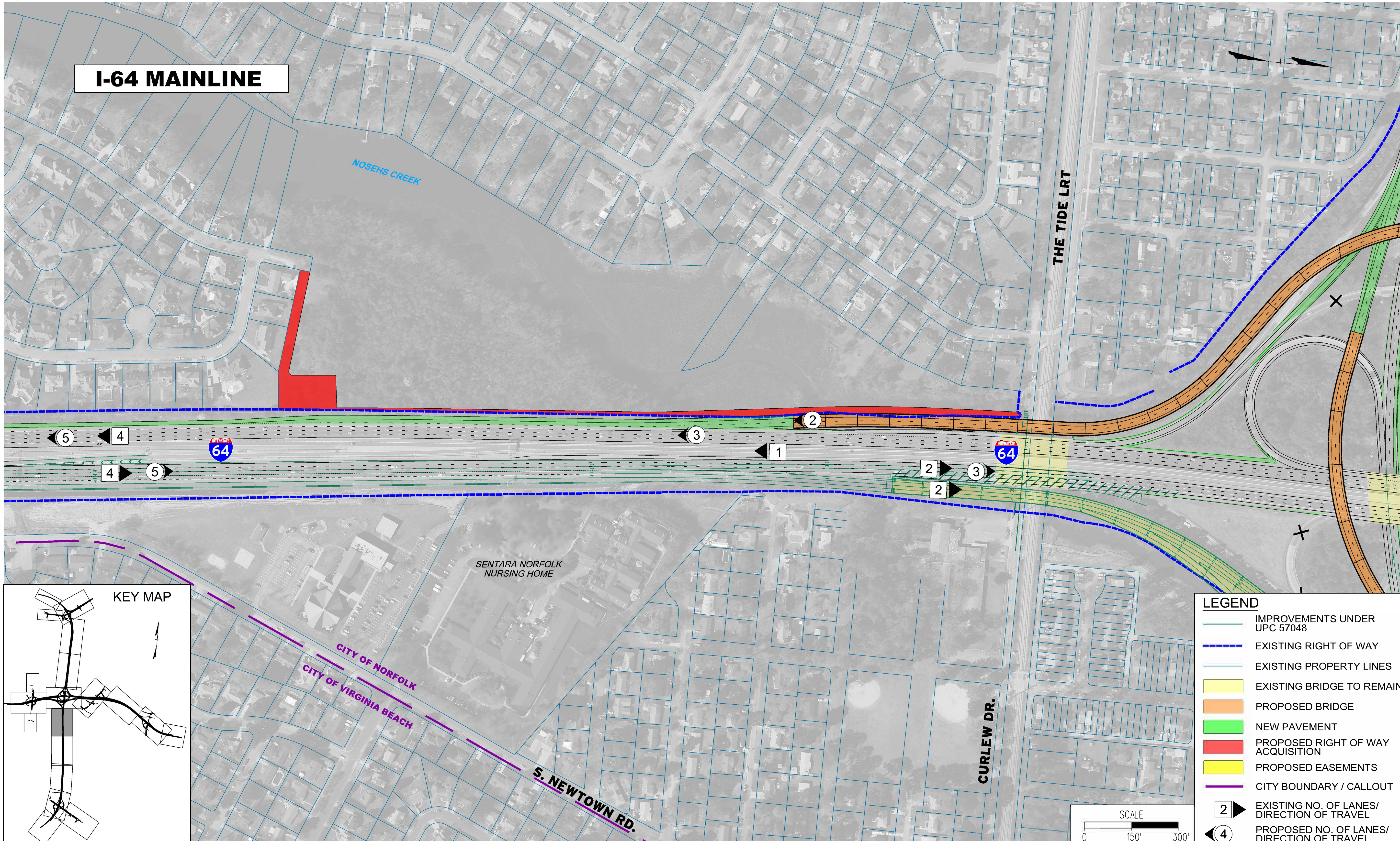


Figure 4-31 - Tier 3 Recommended Improvements, I-64/I-264 Interchange, Alt. E

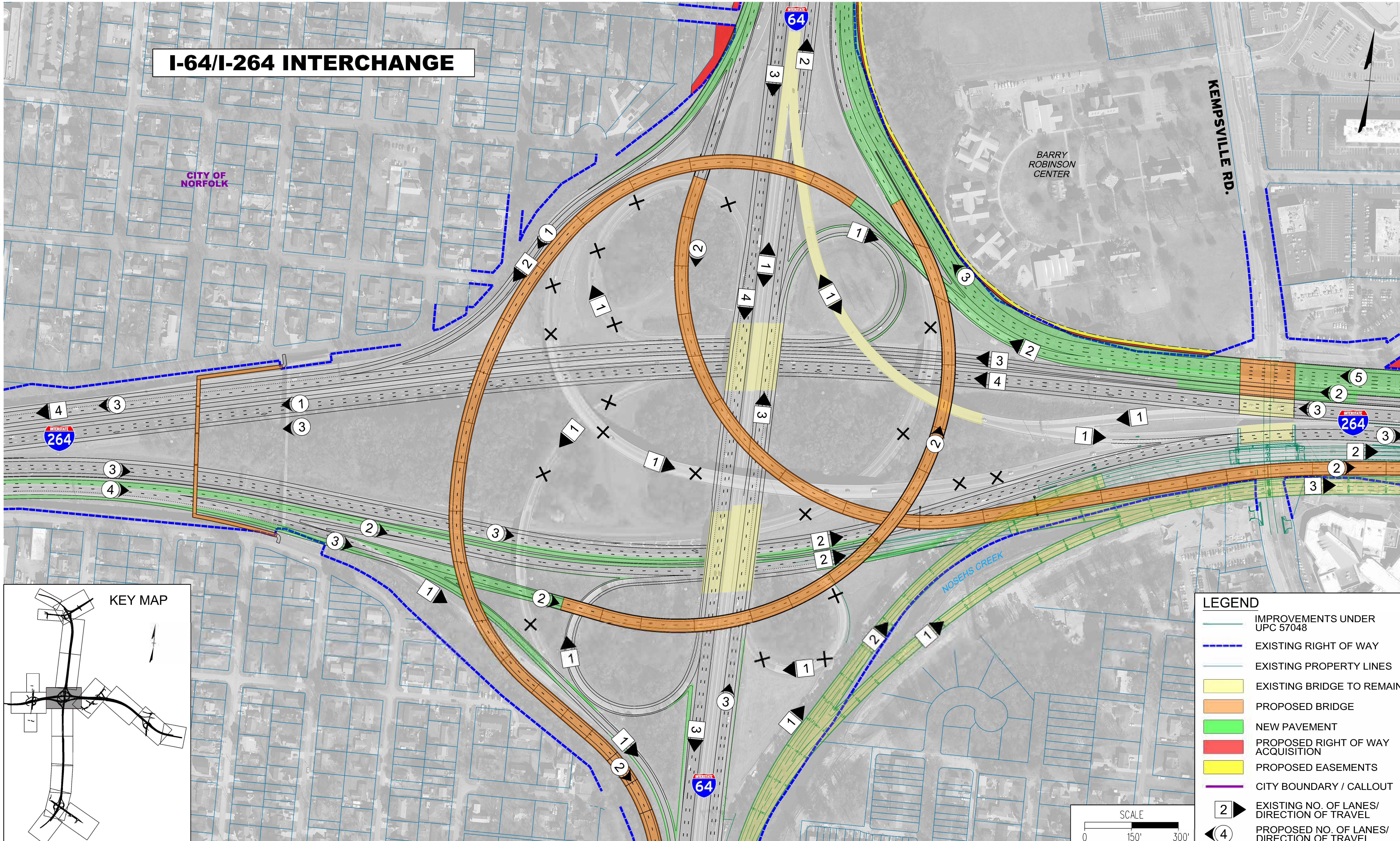
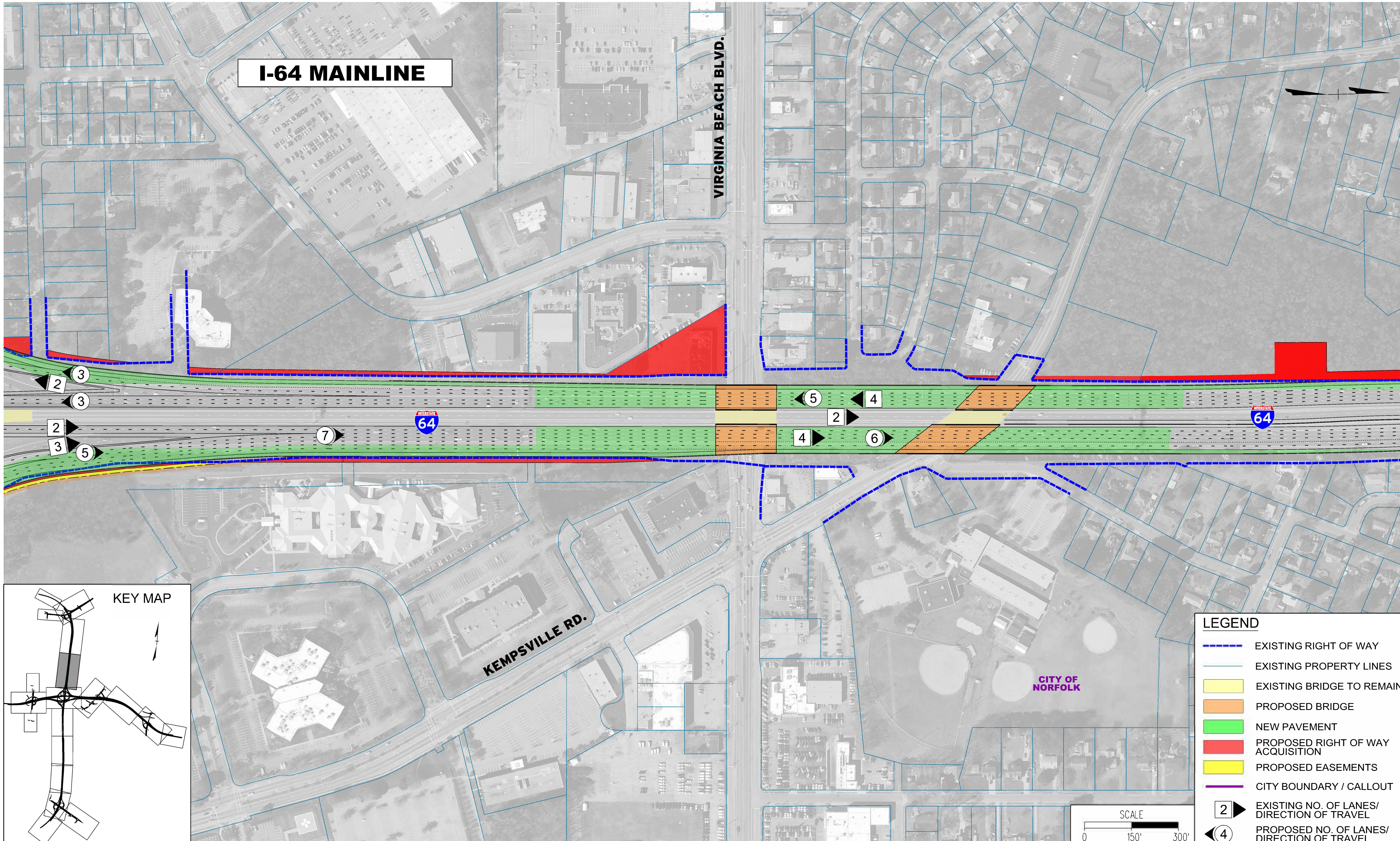


Figure 4-32 - Tier 3 Recommended Improvements, I-64/I-264 Interchange, Alt. E



I-264/Military Highway Interchange

Basis for Selection for Alternative A - (see Table 4.10) Alternative B was determined to operate with one ramp experiencing queue spill back onto I-264, and lower throughput along southbound Military Highway than the other two alternatives considered. Despite being the alternative with the lowest construction cost, the traffic operations were not favorable enough to select Alternative B.

Alternatives A and C offer comparable traffic operations, relative to throughput, mainline through speeds, and percentage of demand served. Alternative C would require one less design exception, impacts to two fewer parcels, fewer impacts to tidal channels, and would cost approximately $7.4M (20%) less to construct than Alternative A. However, the City of Norfolk stated a preference for Alternative A based on the following assertions:

- Alternative A involves fewer vehicle conflict points at ramp terminal intersections along Military Highway, resulting in increased flexibility to accommodate future growth and more reserve capacity;
- Alternative A requires less weaving on upstream segments of Military Highway, resulting in better lane utilization on Military Highway; and,
- Alternative A would perform better in the event that motorists detour off of I-64 during a traffic incident that affects through volume capacity on the interstate.

Based on the acceptable traffic operations projected for Alternative A and the stated preference by the City of Norfolk, Alternative A was selected as the recommended improvement at this interchange.

Design Refinements - The right turn movement from northbound Military Highway to the eastbound entrance ramp to I-264 was modified from a free-flow movement to a signal-controlled dual right movement to eliminate the merge conflict point on the entrance ramp. Dual right turn storage lanes are included to accommodate queuing of the signal-controlled right turn movement, requiring widening of the bridge carrying Military Highway over Curlew Drive and the Tide LRT.

Recommended improvements are shown in Figures 4-33 and 4-34 on pages 4-32 and 4-33, respectively.

Table 4.10: Tier 2 Evaluation of Alternatives, I-264/Military Highway Interchange

RECOMMENDED
CARRIED FORWARD TO TIER 3

	I-264 / MILITARY HIGHWAY INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
EVALUATION CRITERIA	Existing conditions; no improvements	Partial clover, retains loop ramps in NE and SE quadrants with directional ramp to WB I-264; replace Frontage Road bridge over I-264 and improve EB I-264 C/D diverge geometry.	Partial clover, retains loop ramps in NE and SW quadrants with directional ramps to WB and EB I-264.	Partial clover, retains loop and directional ramps in NE and SE quadrants.
Traffic Operations	Throughput (served/demand): 57.8% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 0 No. of links with density at LOS F: 10 Avg. mainline thru travel speed (mph): 38.8 Mainline thru speed range (mph): <10.0 - 57.0 Left exit ramps: 0 No. of weaves: 6 No. of ramp terminal intersections operating at overall LOS E or F: N/A No. of movements at ramp terminal intersections operating at LOS E or F: N/A SB throughput at WB I-264 ramps (vph): 1,000 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 98.3% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 56.0 Mainline thru speed range (mph): 47.9 - 58.6 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 5 SB throughput at WB I-264 ramps (vph): 4,550 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 96.6% No. of ramps with spillback to mainline: 1 No. of links with density at LOS E: 1 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 55.9 Mainline thru speed range (mph): 46.1 - 58.5 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 6 SB throughput at WB I-264 ramps (vph): 3,800 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 97.8% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 2 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 55.2 Mainline thru speed range (mph): 46.9 - 58.5 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 5 SB throughput at WB I-264 ramps (vph): 4,250 Full access to/from adjacent interchanges? Yes
Compliance with Design Standards	No action; no compliance measures required. 0 fracture-critical bridges	1 Design Exception (relocated bridge pier) 4 Design Waivers 0 fracture-critical bridges	0 Design Exceptions 5 Design Waivers 0 fracture-critical bridges	0 Design Exceptions 4 Design Waivers 0 fracture-critical bridges
Right-of-Way Impacts	No construction; no impacts.	6 impacted parcels 6 partial takes (0.8 ac) 0 full takes (0 ac) and 0 relocations 0 permanent easements (0 ac) 2 temporary easements (0.2 ac)	4 impacted parcels 4 partial takes (0.7 ac) 0 full takes (0 ac) and 0 relocations 0 permanent easements (0 ac) 1 temporary easements (0.1 ac)	4 impacted parcels 4 partial takes (0.7 ac) 0 full takes (0 ac) and 0 relocations 0 permanent easements (0 ac) 2 temporary easements (0.1 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	0 ac of lakes and wetlands 1,860 LF channelized streams & ditches 530 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 0 potential 4(f) properties / 0 ac	0 ac of lakes and wetlands 1,130 LF channelized streams & ditches 330 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 0 potential 4(f) properties (0 ac)	0 ac of lakes and wetlands 1,810 LF channelized streams & ditches 310 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 0 potential 4(f) properties (0 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: Moderate / High Bridges: Moderate / High (11,000 sf)	Roadway/Civil: Low / Moderate Bridges: N/A (no bridge improvements)	Roadway/Civil: Moderate Bridges: N/A (no bridge improvements)
Constr. / Total Cost	$0 / $0	$37.1M / $81.9M	$23.7M / $60.9M	$29.7M / $70.3M
Basis for Selection	--	Queue spillback, throughput	--	--

Figure 4-33 - Tier 3 Recommended Improvements, I-264/Military Highway Interchange, Alt. E

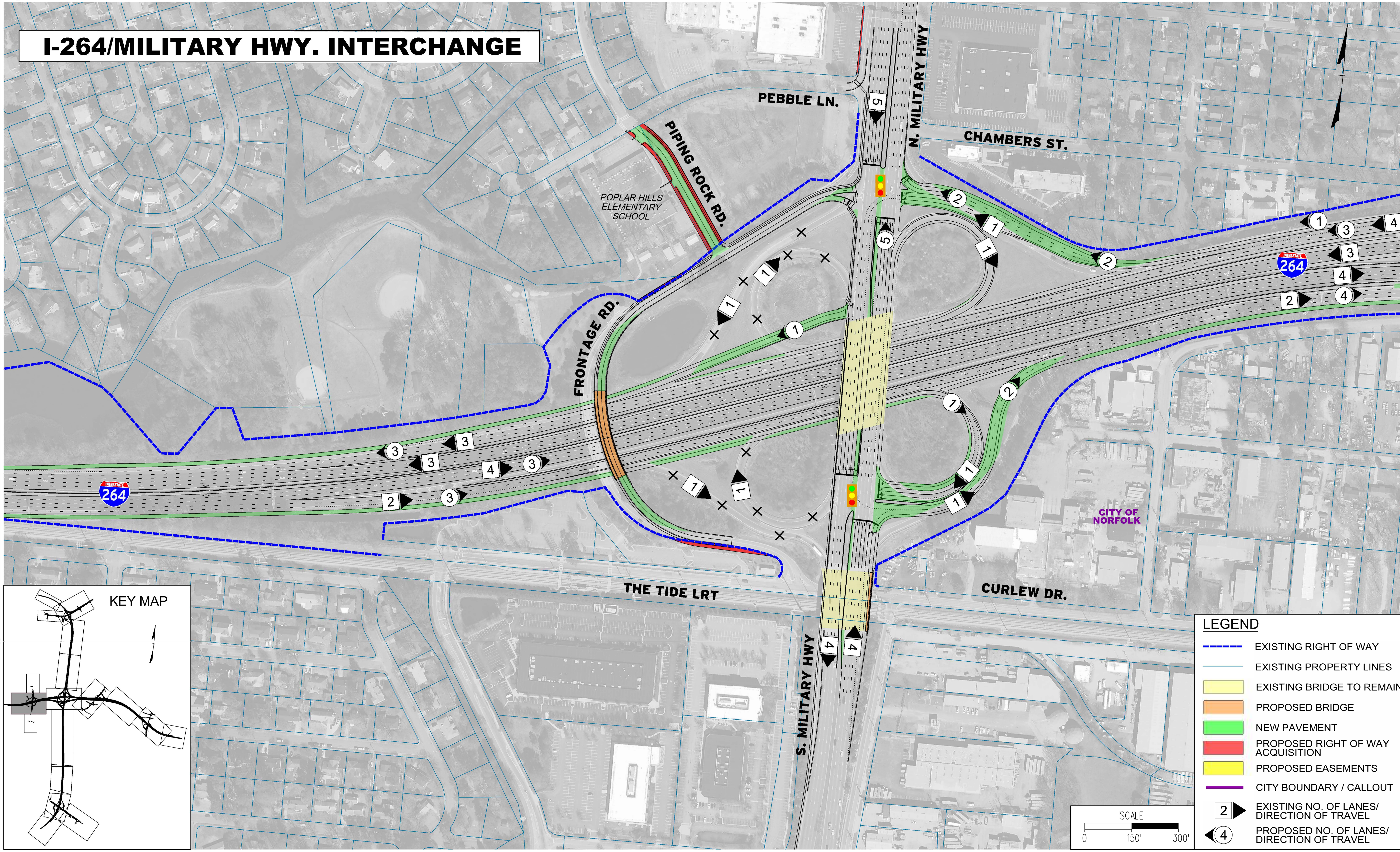
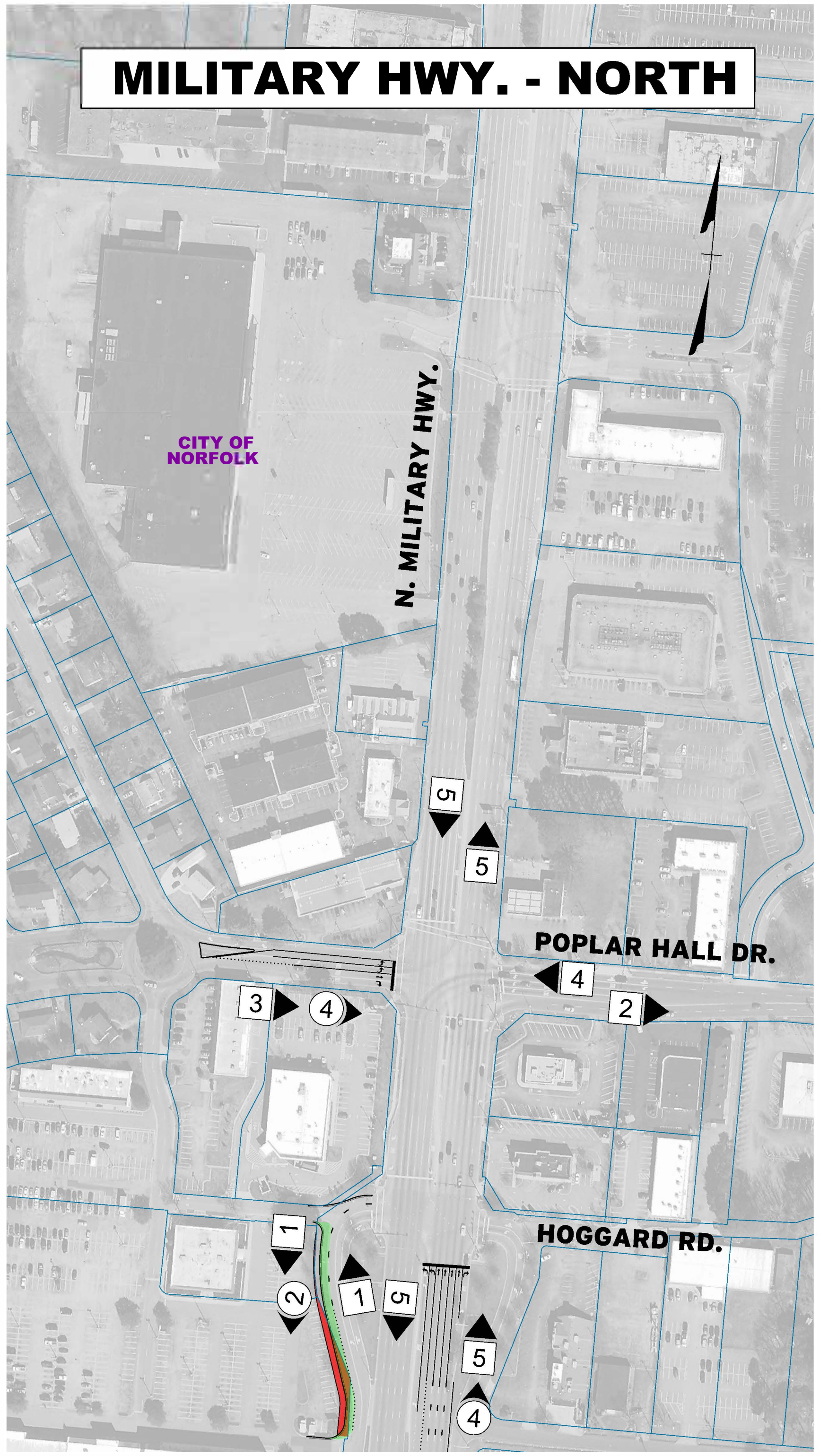
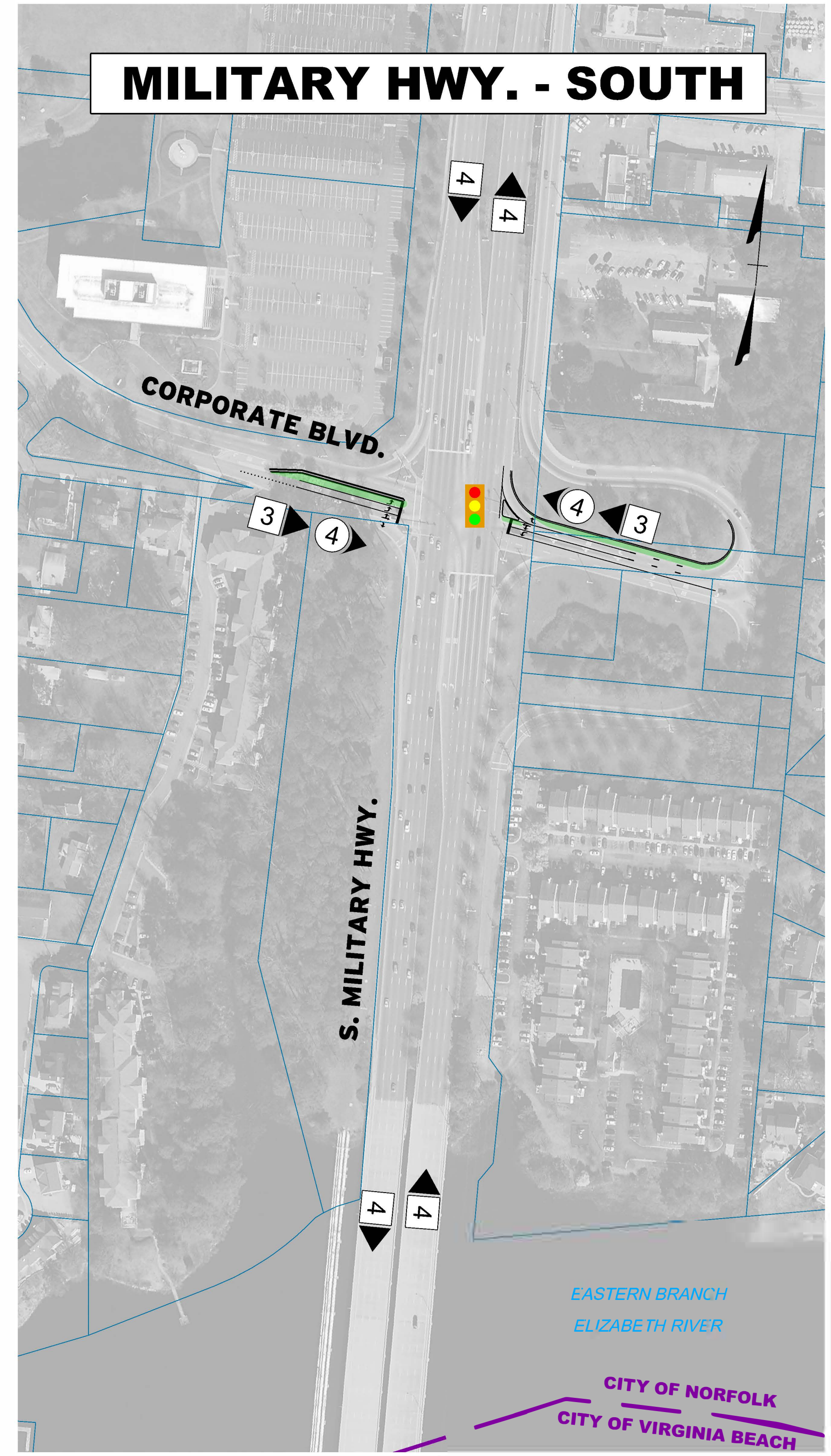
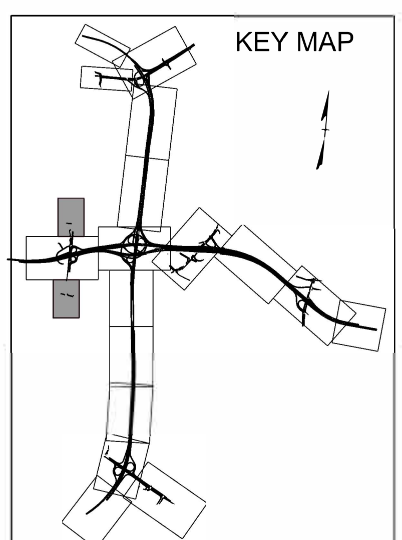


Figure 4-34 - Tier 3 Recommended Improvements, I-264/Military Highway Interchange, Alt. E







SCALE
0 150' 300'

LEGEND

- EXISTING RIGHT OF WAY
- EXISTING PROPERTY LINES
- EXISTING BRIDGE TO REMAIN
- PROPOSED BRIDGE
- NEW PAVEMENT
- PROPOSED RIGHT OF WAY ACQUISITION
- PROPOSED EASEMENTS
- CITY BOUNDARY / CALLOUT
- 2 EXISTING NO. OF LANES/ DIRECTION OF TRAVEL
- 4 PROPOSED NO. OF LANES/ DIRECTION OF TRAVEL

I-264/Newtown Road Interchange

Basis for Selection of Alternative C - (See Table 4.11) As noted previously in this section, improvements at the I-64/I-264 interchange and the I-264/Newtown Road interchange were developed and evaluated as paired improvements as part of Alternatives A, B, and C. With respect to operations at the I-264/Newtown Road interchange, analyses indicated that Alternative A did not allow traffic entering westbound I-264 from Newtown Road to weave across the lanes on the C/D roadway to ultimately access the I-264/Military Highway interchange. Study Team members considered it critical that the selected interchange layout accommodate this movement to avoid having trips divert to Virginia Beach Boulevard, Kempsville Road, and/or other east-west arterials. In addition, Alternative A was estimated to have the lowest mainline travel speeds, the greatest impacts to streams, impacted the most parcels, and had the highest cost. Therefore, Alternative A was not recommended for further study.

Alternative B also failed to perform as well as Alternative C with respect to mainline travel speeds and traffic operations at the ramp terminal intersections. In addition, Alternative B was estimated to impact several more parcels and a greater net length of streams than Alternative C. For these reasons, as well as the selection of Alternative C at the I-64/I-264 interchange, Alternative C is recommended at the I-264/Newtown Road interchange.

Design Refinements - Analysis of weekday AM peak conditions revealed the need for further improvements to the Kempsville Road/Princess Anne Road/Newtown Road intersection. This study recommends dynamic lane use on the westbound Princess Anne Road approach to this intersection to avoid the need for further right-of-way impacts and possible full acquisition and relocation of a gas station on an adjacent parcel. In addition, the City of Norfolk requested that improvements along southbound Newtown Road approaching Cleveland Street be extended further north to enhance lane balance between through lanes and turn lanes. Accordingly, roadway widening along southbound Newtown Road was extended approximately 300 ft north of Cleveland Street.

Left and right turn storage lanes on eastbound Kempsville Road at Newtown Road were extended to accommodate projected queue lengths. In addition, the left turn lane on southbound Newtown Road at Greenwich Road was extended to enhance lane continuity in the Newtown Road corridor, and accommodate projected queuing.

Recommended improvements are shown in Figures 4-35 and 4-36 on pages 4-36 and 4-37, respectively.

Table 4.11: Tier 2 Evaluation of Alternatives, I-264/Newtown Road Interchange

RECOMMENDED
CARRIED FORWARD TO TIER 3

	I-264 / NEWTOWN ROAD INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
EVALUATION CRITERIA	Existing conditions; no improvements	Split exit ramp and spilt entrance ramp to/from WB I-264.; directional entrance ramp to WB I-264 from SB Newtown Rd.; widen intersections at Center Dr., Greenwich Rd., Kempsville Rd./Princess Anne Rd.	Split exit ramp from WB I-264; braided entrance ramps to WB I-264; widen intersections at Center Dr., Greenwich Rd., and Kempsville Rd./Princess Anne Rd.	Split exit ramp from WB I-264; continuous green-T ramp terminal; braided entrance ramps to WB I-264; widen intersections at Center Dr., Greenwich Rd., and Kempsville Rd./Princess Anne Rd.
Traffic Operations	Throughput (served/demand): 59.0% No. of ramps with spillback to mainline: 2 No. of links with density at LOS E: 0 No. of links with density at LOS F: 19 Avg. mainline thru travel speed (mph): 30.0 Mainline thru speed range (mph): ‹10.0 - 58.5 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 3 No. of movements at ramp terminal intersections operating at LOS E or F: 21 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 98.0% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 No. of links with density at LOS F: 3 Avg. mainline thru travel speed (mph): 51.8 Mainline thru speed range (mph): 22.6 - 59.0 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 12 Full access to/from adjacent interchanges? No	Throughput (served/demand): 98.1% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 0 No. of links with density at LOS F: 1 Avg. mainline thru travel speed (mph): 52.3 Mainline thru speed range (mph): 28.1 - 59.1 Left exit ramps: 0 No. of weaves: 1 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 10 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 99.3% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 2 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 53.7 Mainline thru speed range (mph): 42.3 - 58.9 Left exit ramps: 0 No. of weaves: 0 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 8 Full access to/from adjacent interchanges? Yes
Compliance with Design Standards	No action; no compliance measures required. 0 fracture-critical bridges	0 Design Exceptions 1 Design Waiver 1 fracture-critical bridge (straddle bent)	0 Design Exceptions 1 Design Waiver 0 fracture-critical bridges	0 Design Exceptions 1 Design Waiver 0 fracture-critical bridges
Right-of-Way Impacts	No construction; no impacts.	31 impacted parcels 30 partial takes (3.5 ac) 1 full take (0.6 ac) and 1 comm. relocation 3 permanent easements (1.5 ac) 14 temporary easements (1.7 ac)	23 impacted parcels 23 partial takes (2.5 ac) 0 full takes (0 ac) and 0 relocations 2 permanent easements (0.2 ac) 14 temporary easements (2.7 ac)	20 impacted parcels 20 partial takes (2.3 ac) 0 full takes (0 ac) and 0 relocations 5 permanent easements (0.7 ac) 12 temporary easements (1.0 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	1.1 ac of lakes and wetlands 3,490 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)	0.9 ac of lakes and wetlands 2,110 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)	0.5 ac of lakes and wetlands 1,680 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: High Bridges: Moderate (119,000 sf)	Roadway/Civil: High Bridges: Moderate (113,000 sf)	Roadway/Civil: High Bridges: Moderate / High (123,000 sf)
Constr. / Total Cost	$0 / $0	$133.8M / $242.4M	$120.5M / $220.5M	$121.8M / $222.5M
Basis for Selection	--	--	--	Travel speeds, link densities, full access, intersection operations, stream impacts, right-of-way impacts

Figure 4-35 - Tier 3 Recommended Improvements, I-264/Newtown Road Interchange, Alt. E

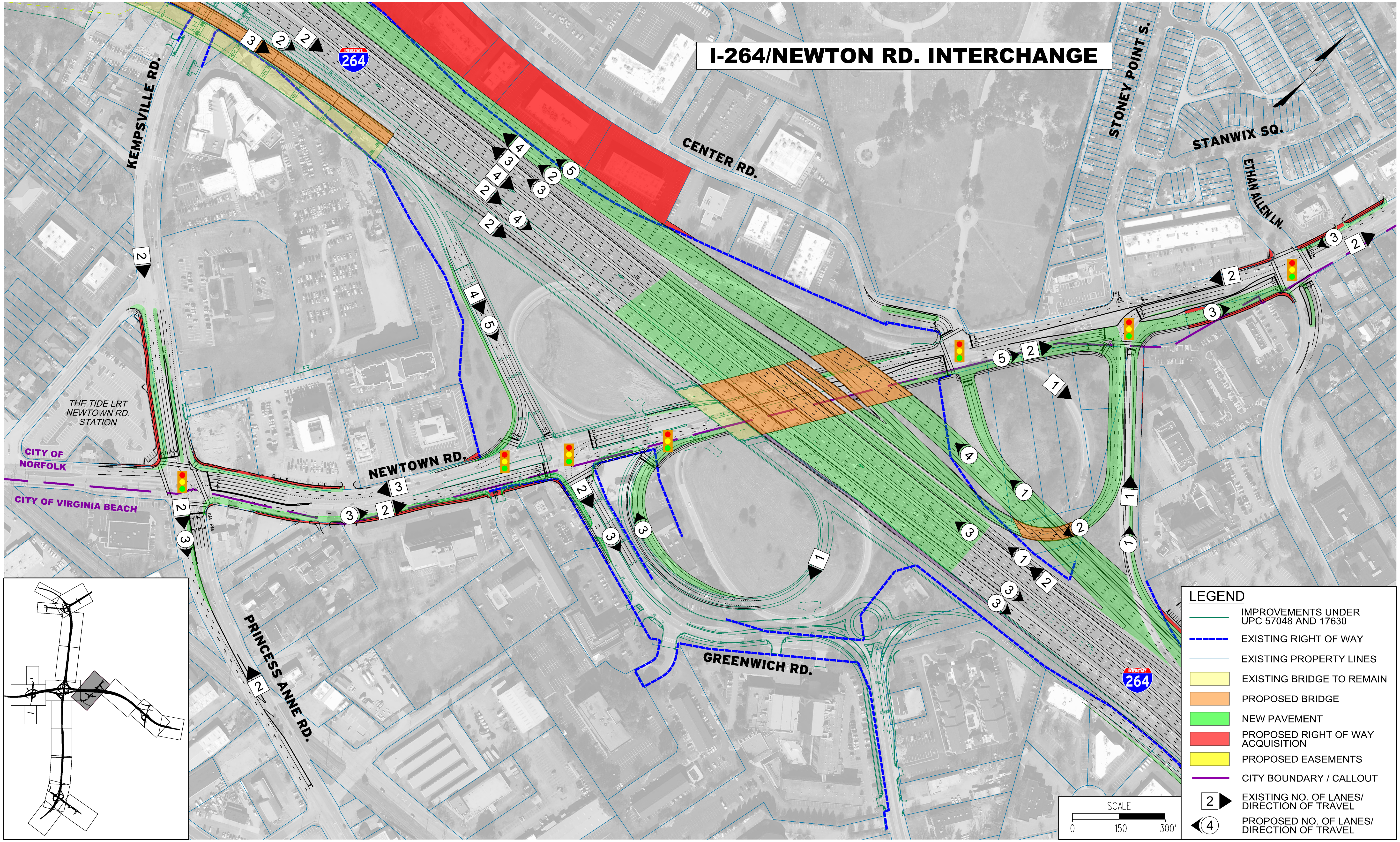
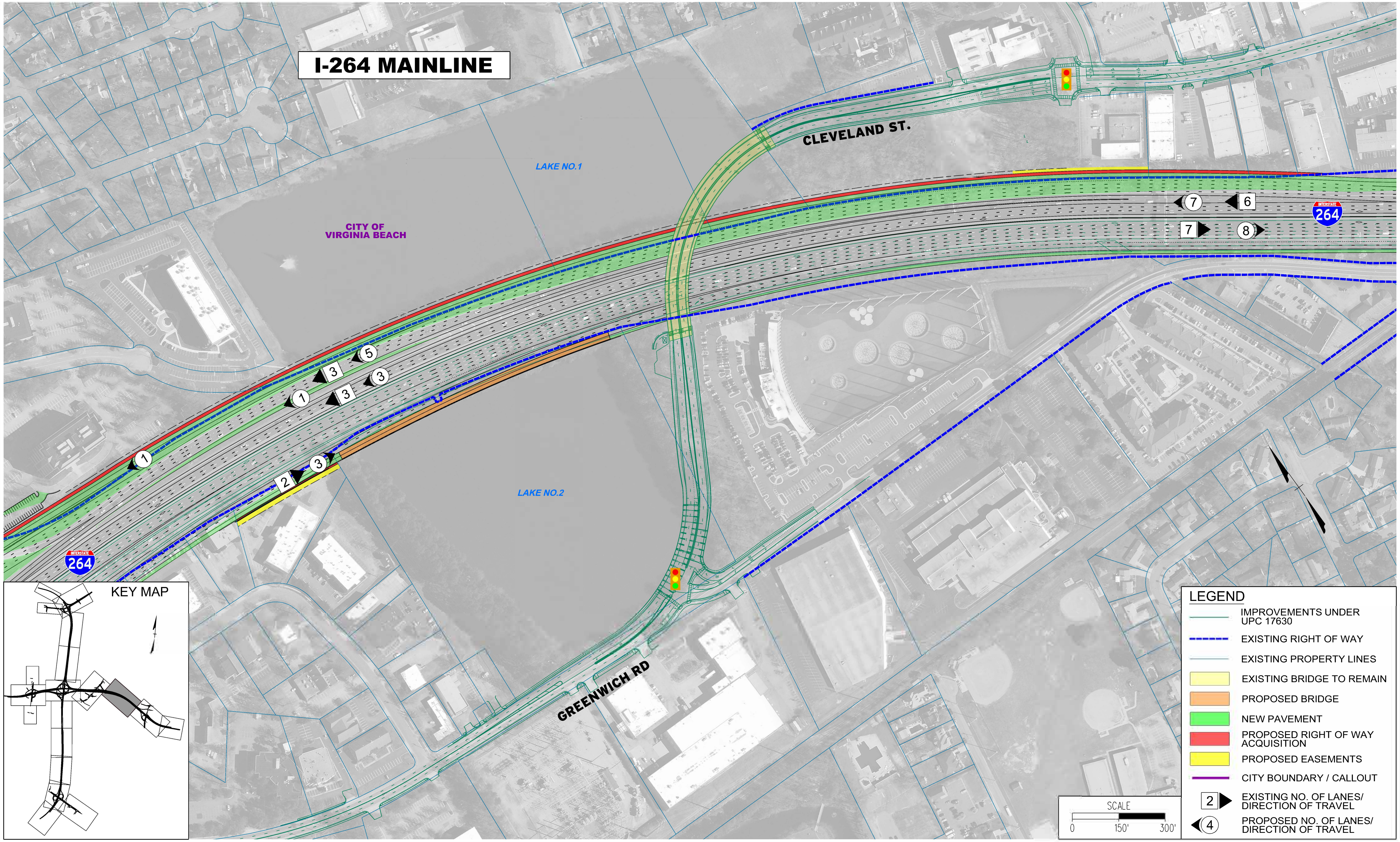


Figure 4-36 - Tier 3 Recommended Improvements, I-264/Newtown Road Interchange, Alt. E



I-264/Witchduck Road Interchange

Basis for Selection of Alternative A (with refinements) - (See Table 4.12) Alternatives B and C were determined to be ineffective at serving projected 2044 PM peak period traffic demand. Queuing was found to be extensive enough that it would spill back onto I-264 and inhibit traffic flow in both directions. Accordingly, Alternatives B and C were not recommended for advancement into Tier 3 analysis.

Alternative A was determined to be effective at serving projected demand, and arterial operations were favorable with respect to delay and queuing. However, the jug handle concept was rejected by the City of Virginia Beach for several reasons:

- The concept would require Jersey Avenue to serve high traffic volumes, which is incompatible with current and projected land uses;
- The concept would require a median opening along Witchduck Road to be reestablished, following a recent decision by the city to close a median opening at the same location; and,
- The concept was inconsistent with planned improvements to the Cleveland Street corridor to support an urban renewal initiative.

Elements of Alternative A were accepted by the City of Virginia Beach, including minor widening of Witchduck Road south of Cleveland Street, and widening and turn restrictions at the Witchduck Road/Grayson Road intersection. Therefore, Alternative A was selected to move forward into Tier 3 analysis, but with modifications to be formulated through further analysis focusing on achieving acceptable operations in the Witchduck Road corridor without a jug handle.

Design Refinements - Recent improvements in the Witchduck Road corridor include the relocation of Southern Boulevard to align with the entrance ramp to westbound I-264. This particular improvement was made to accommodate more direct access to the ramp from areas within the Pembroke Strategic Growth Area (SGA) Plan located east of Witchduck Road and south of Virginia Beach Boulevard. Because the regional travel demand model uses a large traffic assignment zone to cover much of the Pembroke SGA, there is flexibility in the routing for traffic projected to exit the area.

Accordingly, traffic volumes destined for westbound I-264 and previously assigned to westbound Cleveland Street were reassigned to westbound Southern Boulevard. Supplemental microsimulation analyses were then performed to assess operations and identify an alternative layout for improvements that address projected demand.

Design refinements to Alternative A include the following:

- Widening of the westbound Southern Boulevard approach to Witchduck Road to provide an additional left turn lane;
- Revised lane use for the six lanes on northbound Witchduck Road approaching Cleveland Street to provide three dedicated left turn lanes, two through lanes, and a shared through/right turn lane;
- Widening of westbound Cleveland Street to provide three travel lanes from Witchduck Road to Cleveland Place; and
- Dynamic lane use on the westbound Cleveland Street approach to Witchduck Road to vary the lane use during weekday AM and PM peak periods.

The exit ramp from westbound I-264 to Witchduck Road was widened to provide five lanes approaching the ramp terminal intersection, consisting of two left turn lanes, a shared left-right turn lane, and two right turn lanes. This change reduces overall queue lengths on the exit ramp.

To accommodate projected demand, the recommended roadway section for westbound I-264 was modified to provide an additional through lane for a total of six lanes.

Recommended improvements are shown in Figures 4-37 and 4-38 on pages 4-40 and 4-41, respectively.

The gore separating the westbound I-264 mainline from the westbound I-264 CD Road was evaluated during the study and was shifted approximately 2,500 ft east to prevent the vehicles entering from the Witchduck Road ramp and crossing five lanes to enter the mainline I-264. To fully close the gap between the two gores and eliminate any possibility for this maneuver, the median barrier will be extended further east approximately 1,000 ft to the western limits of the existing bridge over the former railroad tracks during the preliminary design phase.

Table 4.12: Tier 2 Evaluation of Alternatives, I-264/Witchduck Road Interchange

RECOMMENDED (WITH REFINEMENTS) CARRIED FORWARD TO TIER 3

	I-264 / WITCHDUCK ROAD INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
EVALUATION CRITERIA	Completion of existing I-64/I-264 Phase I and II projects; completion of Witchduck Road Phase II project, north of I-264.	Modify the Witchduck/Grayson intersection; modify loop entrance ramp from Witchduck to EB I-264; construct jug handle for WB Cleveland St. via Jersey Ave. and Admiral Wright Rd.	Modify the Witchduck/Grayson intersection; modify loop entrance ramp from Witchduck to EB I-264; construct U-turn bulbs on Cleveland St. and Greenwich Rd. for displaced lefts at Witchduck.	Modify the Witchduck/Grayson intersection and loop entrance ramp from Witchduck to EB I-264; construct U-turn bulbs on Witchduck; eliminate direct left and through movements from all minor streets.
Traffic Operations	Throughput (served/demand): 61.2% No. of ramps with spillback to mainline: 2 No. of links with density at LOS E: 0 No. of links with density at LOS F: 6 Avg. mainline thru travel speed (mph): 30.0 Mainline thru speed range (mph): <10.0 - 58.5 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 3 No. of movements at ramp terminal intersections operating at LOS E or F: 17 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 98.6% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 0 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 53.2 Mainline thru speed range (mph): 42.6 - 58.4 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 5 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 98.9% * No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 0 No. of links with density at LOS F: 1 Avg. mainline thru travel speed (mph): 56.2 Mainline thru speed range (mph): 54.7 - 58.2 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 10 Full access to/from adjacent interchanges? Yes	* Improvements along Witchduck Road north of I-264 tested for Alternatives B and C resulted in major congestion that affected traffic operations at other interchanges. Data reported for Alternatives B and C are the same, and reflect removal of capacity constraints along Witchduck Road north of I-264 to allow analysis of other interchanges.
Compliance with Design Standards	No action; no compliance measures required. 0 fracture-critical bridges	0 Design Exceptions 1 Design Waiver 0 fracture-critical bridges	0 Design Exceptions 1 Design Waiver 0 fracture-critical bridges	0 Design Exceptions 1 Design Waiver 0 fracture-critical bridges
Right-of-Way Impacts	No construction; no impacts.	25 impacted parcels 21 partial takes (2.1 ac) 3 full takes (0.2 ac) and 5 res. relocations 0 permanent easements (0 ac) 15 temporary easements (1.2 ac)	28 impacted parcels 16 partial takes (2.1 ac) 10 full takes (3.4 ac), 6 comm. & 4 res. relocations 0 permanent easements (0 ac) 14 temporary easements (1.2 ac)	26 impacted parcels 22 partial takes (3.8 ac) 3 full takes (0.2 ac) and 0 relocations 0 permanent easements (0 ac) 17 temporary easements (1.0 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	2.7 ac of lakes and wetlands 1,780 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)	2.7 ac of lakes and wetlands 1,780 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 0 potential 4(f) properties (0 ac)	2.7 ac of lakes and wetlands 1,780 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 2 properties with potential hazardous materials 0 potential 4(f) properties (0 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: Moderate Bridges: Moderate (51,000 sf)	Roadway/Civil: Moderate / High Bridges: Moderate (51,000 sf)	Roadway/Civil: Moderate / High Bridges: Moderate (51,000 sf)
Constr. / Total Cost	$0 / $0	$96.4M / $180.6M	$105.9M / $200.3M	$103.5M / $195.1M
Basis of Selection	--	Traffic operations / queuing, right-of-way impacts, construction cost	--	--

Figure 4-37 - Tier 3 Recommended Improvements, I-264/Witchduck Road Interchange, Alt. E

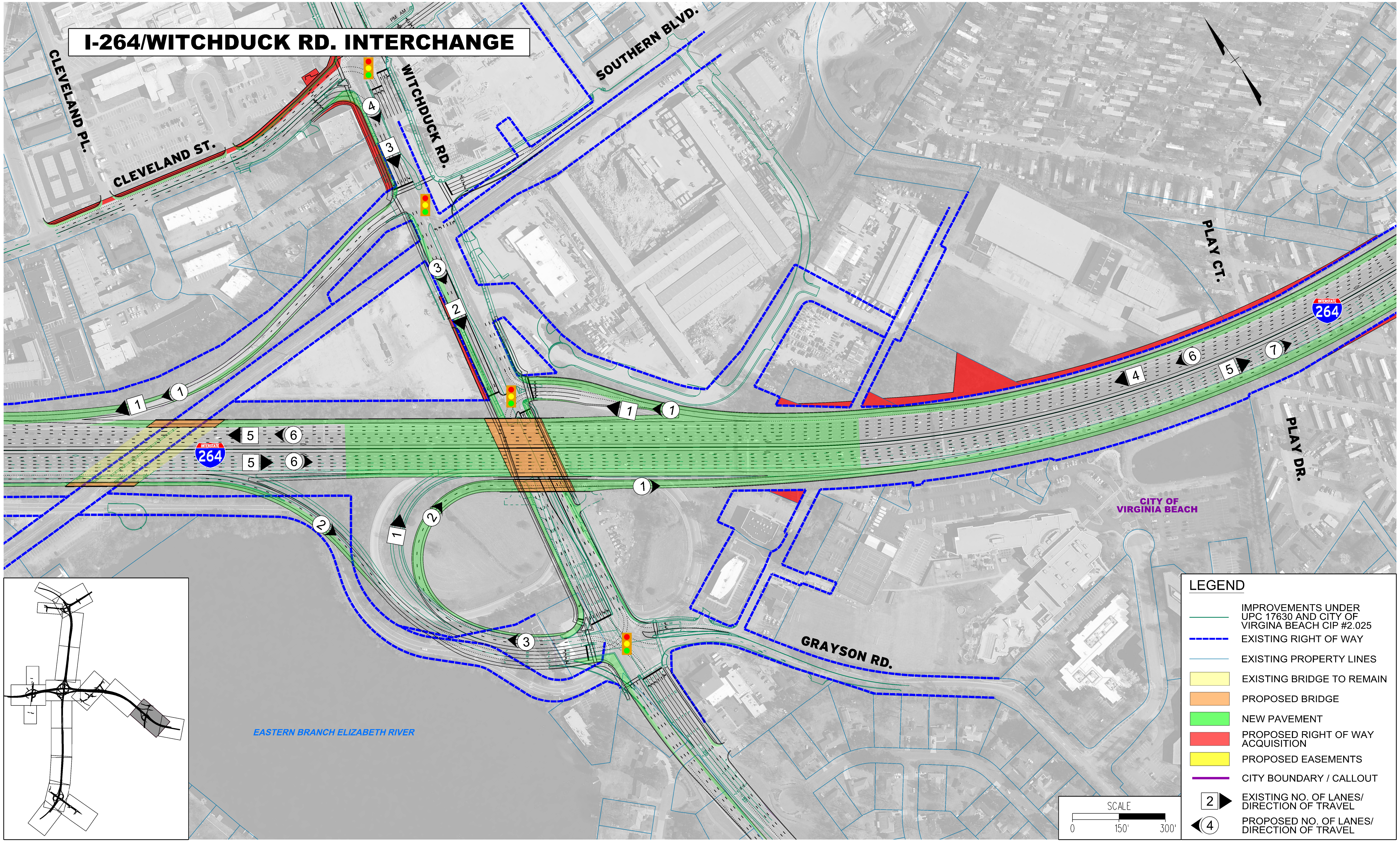
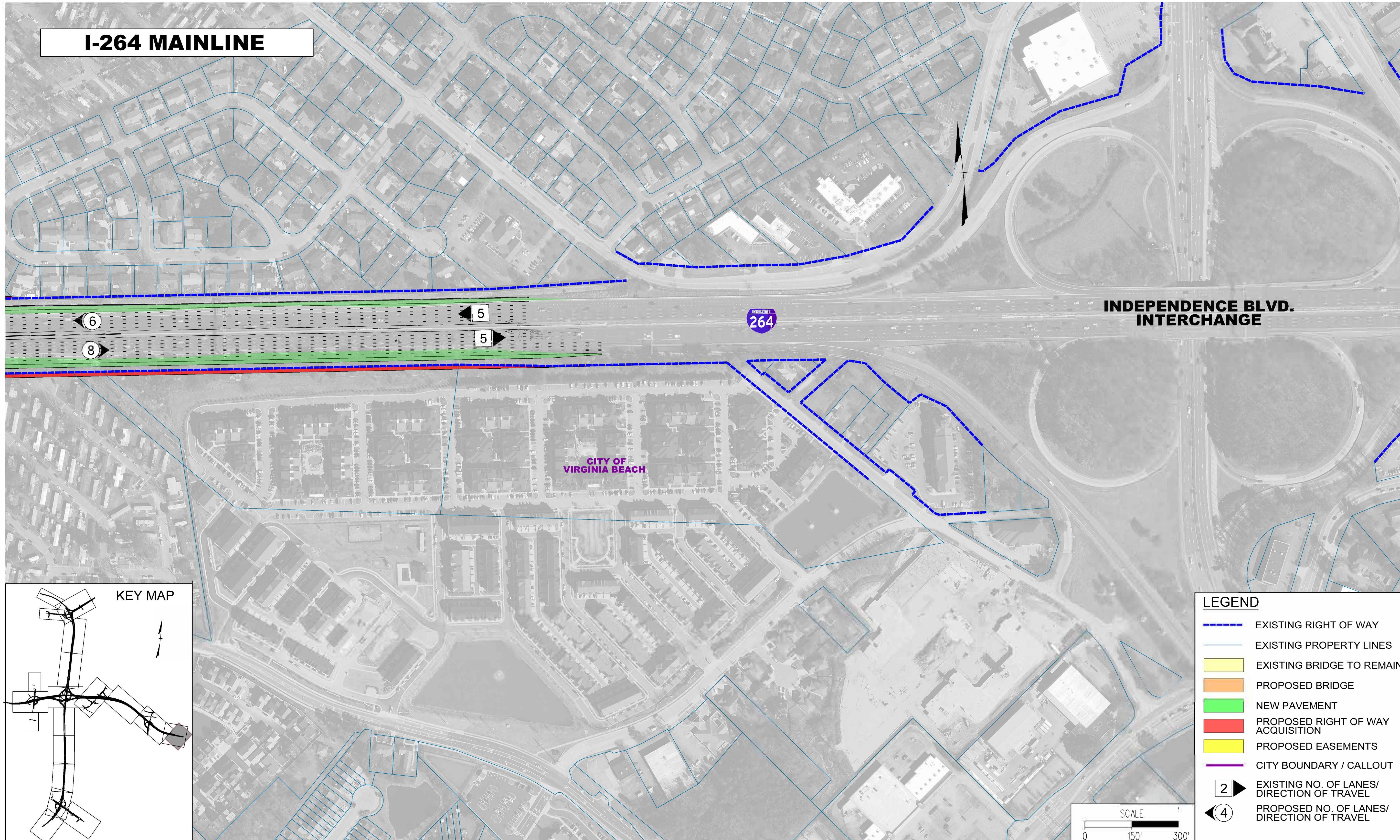


Figure 4-38 - Tier 3 Recommended Improvements, I-264/Witchduck Road Interchange, Alt. E



I-64/Indian River Road Interchange

Basis for Selection for Alternative B - (See Table 4.13) Operations for Alternative A were determined to be constrained by the short distance between the west crossover intersection and the Reon Drive intersection, which also limited queuing capacity in both eastbound and westbound directions on Indian River Road. Three ramp terminal intersections operated at LOS E or F, and one ramp experienced queue spill back onto the I-64 mainline. For these reasons, Alternative A was not selected for advancement to Tier 3 analysis.

Alternatives B and C offered comparable traffic operations, right-of-way impacts, and level of compliance with design standards. However, Alternative C resulted in greater wetland impacts than Alternative B and had a construction cost $7.5M (12%) higher than Alternative B. As a result, Alterative B was selected as the recommended improvement at this interchange.

Design Refinements - The exit ramp from eastbound I-64 to westbound Indian River Road was realigned to maximize downstream weaving distance and queuing at the Reon Drive intersection. Analysis of projected 2044 AM peak period conditions revealed the need to widen the entrance ramp to eastbound I-64 to two lanes and provide an additional downstream auxiliary lane along eastbound I-64. The auxiliary lane along eastbound Indian River Road approaching this ramp was extended back to Reon Drive.

The left turn storage lane along westbound Indian River Road at Reon Drive was extended to accommodate projected queue lengths.

The right turn movement from eastbound Indian River Road to the eastbound entrance ramp to I-64 was modified from a free-flow movement to a signal-controlled dual right movement to eliminate the merge conflict point on the entrance ramp. A second right turn storage lane on Indian River Road was added to accommodate queuing of the signal-controlled right turn movement.

Recommended improvements are shown in Figures 4-39 through 4-42, starting on page 4-44.

Table 4.13: Tier 2 Evaluation of Alternatives, I-64/Indian River Road Interchange

RECOMMENDED
CARRIED FORWARD TO TIER 3

	I-64 / INDIAN RIVER ROAD INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
EVALUATION CRITERIA	Existing conditions; no improvements	Convert interchange to diverging diamond layout; widen Indian River and improve intersections from I-64 to Centerville Tpke.; replace Providence Road bridges over I-64.	Partial clover, retains loop ramps in NE and SW quadrants; widen Indian River and improve intersections from I-64 to Centerville Tpke.; replace Providence Road bridges over I-64.	Partial offset single-point urban interchange (SPUI); widen Indian River and improve intersections from I-64 to Centerville Tpke.; replace Providence Road bridges over I-64.
Traffic Operations	Throughput (served/demand): 71.9% No. of ramps with spillback to mainline: 1 No. of links with density at LOS E: 0 No. of links with density at LOS F: 8 Avg. mainline thru travel speed (mph): 32.5 Mainline thru speed range (mph): <10.0 - 59.0 Left exit ramps: 0 No. of weaves: 6 No. of ramp terminal intersections operating at overall LOS E or F: N/A No. of movements at ramp terminal intersections operating at LOS E or F: N/A Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 95.9% No. of ramps with spillback to mainline: 1 No. of links with density at LOS E: 1 No. of links with density at LOS F: 2 Avg. mainline thru travel speed (mph): 47.8 Mainline thru speed range (mph): 27.9 - 58.4 Left exit ramps: 0 No. of weaves: 0 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 3 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 98.7% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 No. of links with density at LOS F: 1 Avg. mainline thru travel speed (mph): 54.9 Mainline thru speed range (mph): 42.8 - 58.5 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 0 Full access to/from adjacent interchanges? Yes	Throughput (served/demand): 99.3% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 No. of links with density at LOS F: 1 Avg. mainline thru travel speed (mph): 52.4 Mainline thru speed range (mph): 32.4 - 58.3 Left exit ramps: 0 No. of weaves: 1 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 0 Full access to/from adjacent interchanges? Yes
Compliance with Design Standards	No action; no compliance measures required. 0 fracture-critical bridges	0 Design Exceptions 4 Design Waivers 0 fracture-critical bridges	0 Design Exceptions 3 Design Waivers 0 fracture-critical bridges	0 Design Exceptions 3 Design Waivers 0 fracture-critical bridges
Right-of-Way Impacts	No construction; no impacts.	8 impacted parcels 6 partial takes (1.7 ac) 1 full take (2.4 ac) and 0 relocations 0 permanent easements (0 ac) 6 temporary easements (1.0 ac)	13 impacted parcels 9 partial takes (1.1 ac) 1 full take (2.4 ac) and 0 relocations 0 permanent easements (0 ac) 11 temporary easements (0.7 ac)	13 impacted parcels 11 partial takes (1.3 ac) 1 full take (2.4 ac) and 0 relocations 0 permanent easements (0 ac) 12 temporary easements (0.8 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	0 ac of lakes and wetlands 0 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 1 potential 4(f) property (0.7 ac)	0 ac of lakes and wetlands 0 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 1 potential 4(f) property (0.3 ac)	0.8 ac of lakes and wetlands 0 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 1 property with potential hazardous materials 1 potential 4(f) property (0.5 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: Moderate / High Bridges: Moderate (23,000 sf)	Roadway/Civil: Low / Moderate Bridges: Moderate (33,000 sf)	Roadway/Civil: Moderate / High Bridges: Low / Moderate (42,000 sf)
Constr. / Total Cost	$0 / $0	$67.6M / $141.2M	$61.5M / $131.5M	$69.0M / $143.1M
Basis of Selection	--	--	Travel speeds, queuing, intersection operations, wetland impacts, construction cost	--

Figure 4-39 - Tier 3 Recommended Improvements, I-64/Indian River Road Interchange, Alt. E

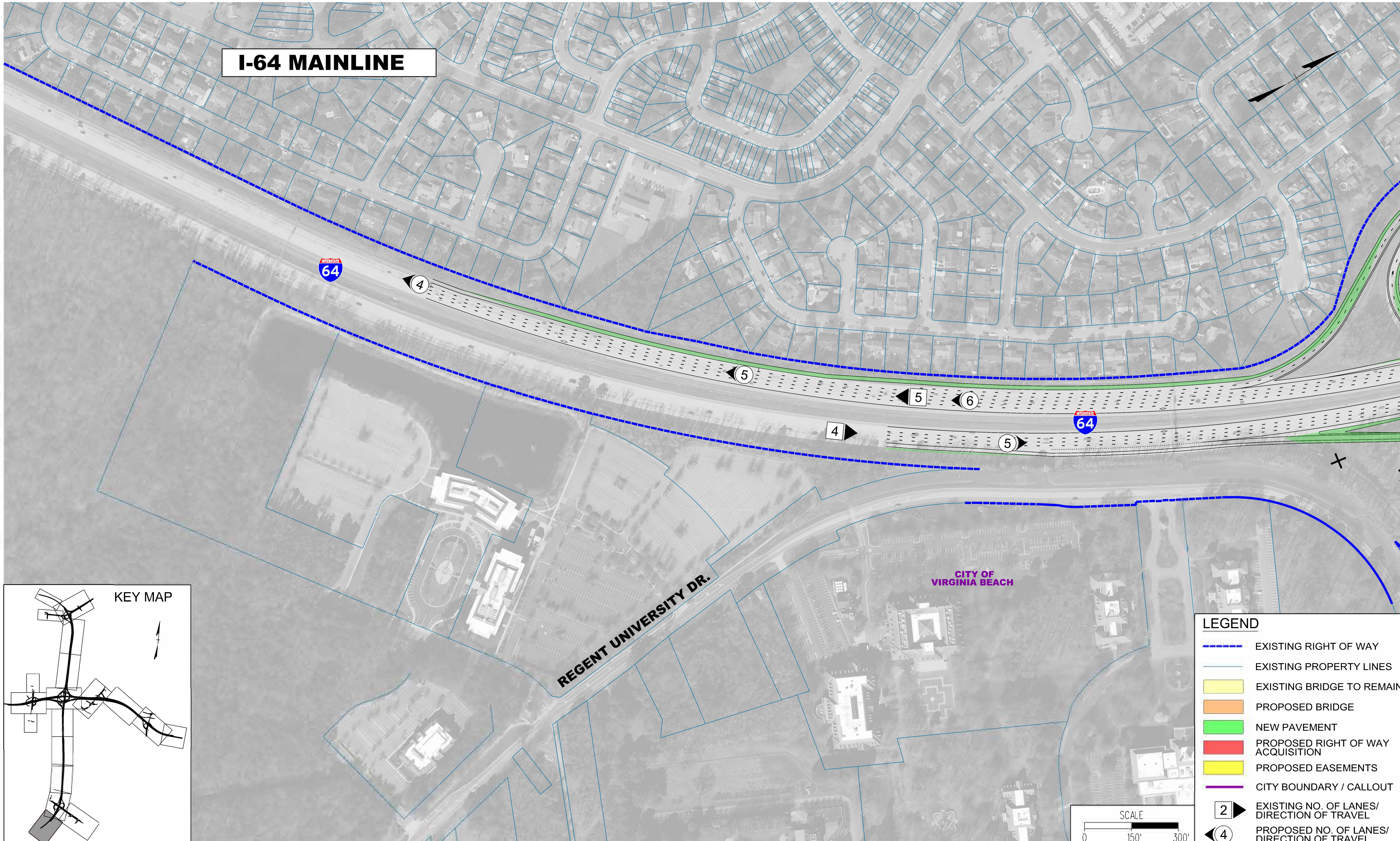


Figure 4-40 - Tier 3 Recommended Improvements, I-64/Indian River Road Interchange, Alt. E

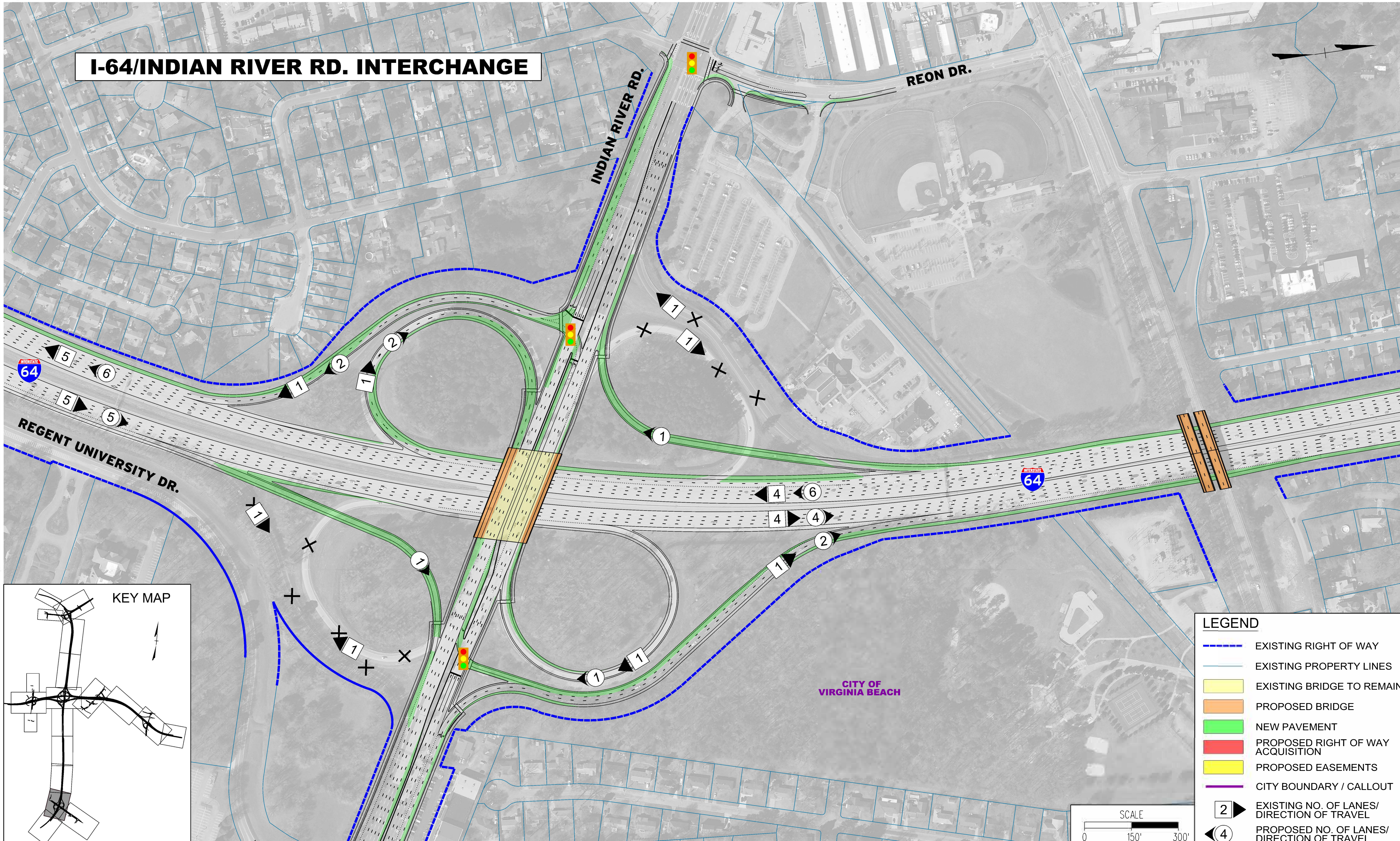


Figure 4-41 - Tier 3 Recommended Improvements, I-64/Indian River Road Interchange, Alt. E

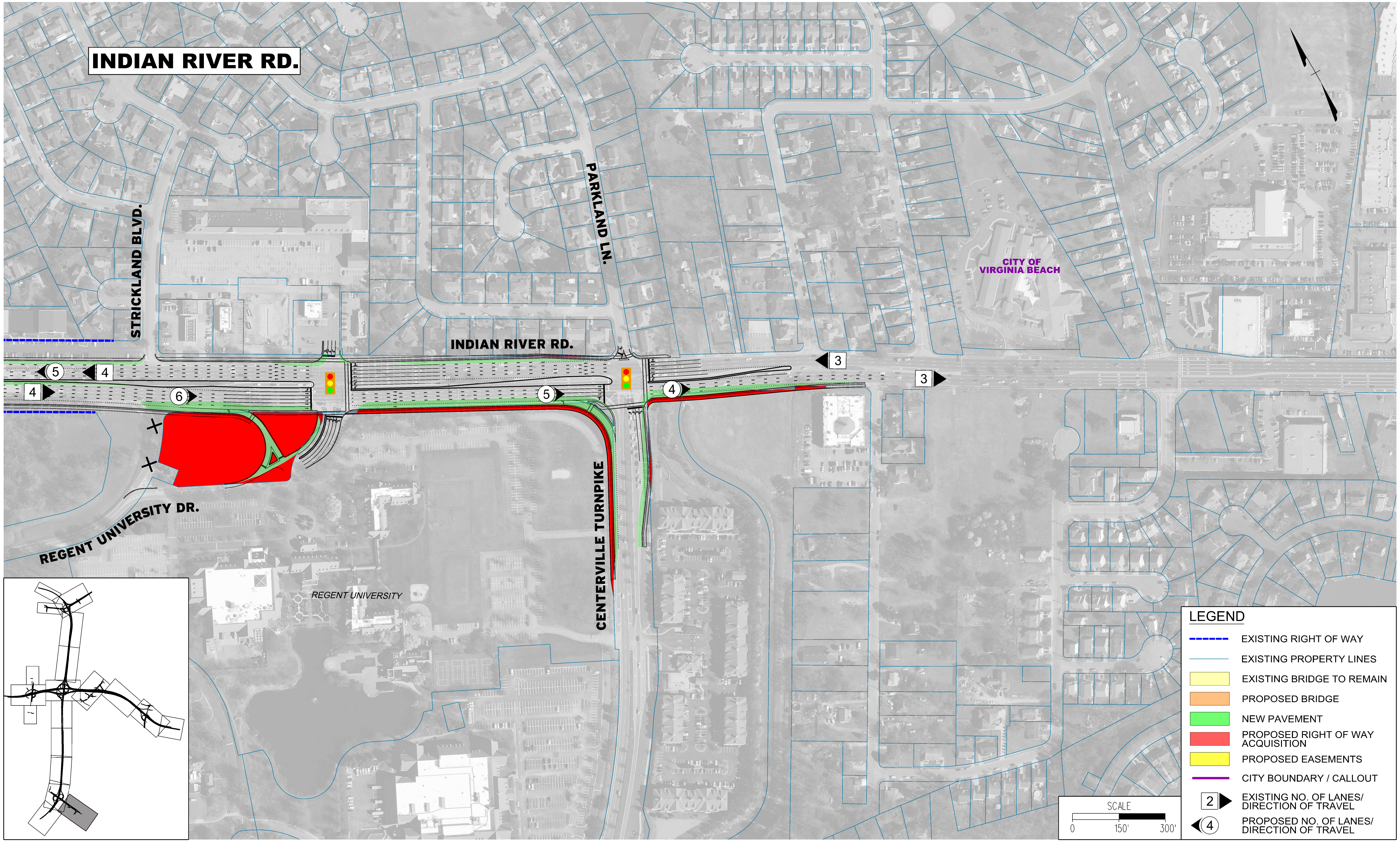
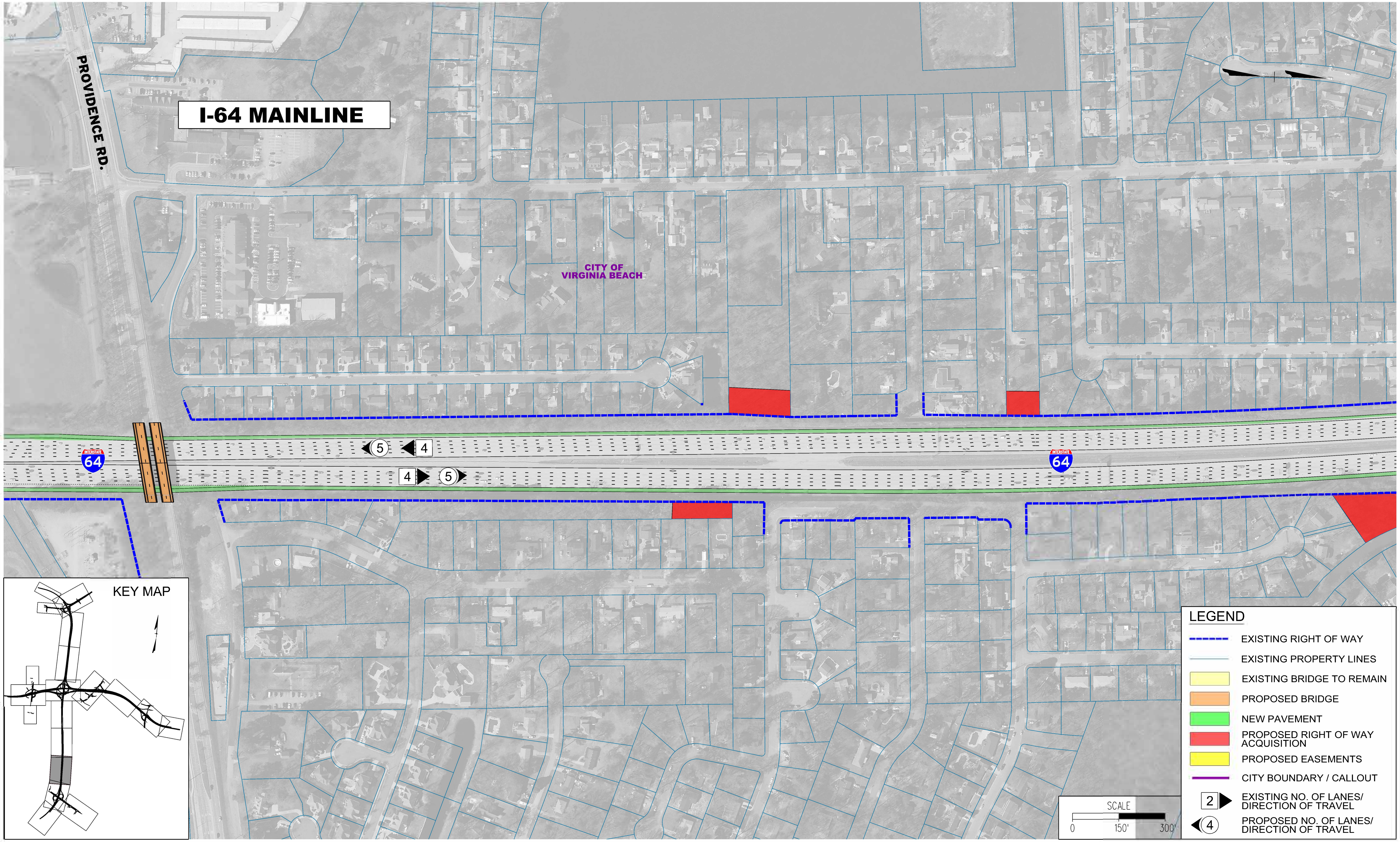


Figure 4-42 - Tier 3 Recommended Improvements, I-64/Indian River Road Interchange, Alt. E



I-64/Northampton Boulevard Interchange

Basis for Selection of Alternative A - (See Table 4.14) Alternatives B and C provided comparable mainline travel speeds to those forecasted for Alternative A, but operated with more weaving areas and a higher number of ramp terminal intersection movements operating at LOS E or F. While right-of-way impacts were comparable across all three alternatives considered, Alternative A was evaluated as more favorable than Alternatives B or C for having no fracture-critical bridges, fewer wetland impacts, less complex construction, and the lowest construction cost. Therefore, Alternative A was identified as the recommended improvement at this interchange.

Design Refinements - To better accommodate bicyclists and pedestrians in the Northampton Boulevard corridor, the continuous flow right turn from eastbound Northampton Boulevard to the entrance ramp to eastbound I-64 was modified to signalized dual right turn lanes, with downstream widening of the entrance ramp to receive two lanes. To take further advantage of the two receiving lanes on the ramp, westbound Northampton Boulevard was widened to provide one additional left turn lane into this same ramp. This measure will reduce overall delay and queuing at this intersection, and provide additional reserve capacity for future demand.

Recent improvements were made to the exit ramp from westbound I-64 to Northampton Boulevard, resulting in three right turn lanes oriented to eastbound Northampton Boulevard. Under existing conditions, two of the turn lanes are signal controlled and the third allows free-flow movement. Recommended improvements were refined to include realignment of the exit ramp, and signal control of all three right turn lanes. The elevated ramp over the Wesleyan Drive intersection will serve some of the demand otherwise accommodated with the triple right movement. The full signal control for all of the right turn lanes will provide enhanced protection for pedestrians and bicyclists in the Northampton Boulevard corridor.

Microsimulation analysis of projected 2044 AM conditions reveals the need for a fourth lane on westbound I-64 beyond the exit ramp to Northampton Boulevard. As further described in Section 5.3, the recommended improvements at this interchange include a shoulder running lane on westbound I-64 north of this exit ramp, which would operate during the weekday AM peak period only. At a minimum, the shoulder running lane should extend to the next interchange along I-64 to the north (Military Highway/Robin Hood Road). Subsequent study will be needed to determine if the shoulder lane should extend further along westbound I-64.

Recommended improvements are shown in Figures 4-43 through 4-45, starting on page 4-50.

Table 4.14: Tier 2 Evaluation of Alternatives, I-64/Northampton Boulevard Interchange

RECOMMENDED
CARRIED FORWARD TO TIER 3

	I-64 / NORTHAMPTON BOULEVARD INTERCHANGE			
	NO-BUILD ALTERNATIVE	BUILD ALTERNATIVE A	BUILD ALTERNATIVE B	BUILD ALTERNATIVE C
EVALUATION CRITERIA	Existing conditions; no improvements (includes recent improvements at ramp terminal intersections)	Modified existing conditions; retains signal at EB and WB I-64 exit ramp terminals; elevated facility over Wesleyan Drive intersection for EB and WB through traffic.	Hybrid semi-directional/partial SPUI; elevated facility for EB and WB through traffic	Hybrid semi-directional/partial SPUI; elevated bypass for EB through traffic
Traffic Operations	Throughput (served/demand): 54.2% No. of ramps with spillback to mainline: 1 No. of links with density at LOS E: 0 No. of links with density at LOS F: 8 Avg. mainline thru travel speed (mph): 34.5 Mainline thru speed range (mph): <10.0 - 59.0 Left exit ramps: 0 No. of weaves: 0 No. of ramp terminal intersections operating at overall LOS E or F: 2 No. of movements at ramp terminal intersections operating at LOS E or F: 5 Full access to/from adjacent interchanges? No	Throughput (served/demand): 97.6% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 2 No. of links with density at LOS F: 2 Avg. mainline thru travel speed (mph): 50.4 Mainline thru speed range (mph): 40.4 - 57.9 Left exit ramps: 0 No. of weaves: 0 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 2 Full access to/from adjacent interchanges? No	Throughput (served/demand): 98.3% No. of ramps with spillback to mainline: 1 No. of links with density at LOS E: 4 No. of links with density at LOS F: 0 Avg. mainline thru travel speed (mph): 48.6 Mainline thru speed range (mph): 44.5 - 57.2 Left exit ramps: 0 No. of weaves: 1 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 5 Full access to/from adjacent interchanges? No	Throughput (served/demand): 98.7% No. of ramps with spillback to mainline: 0 No. of links with density at LOS E: 1 No. of links with density at LOS F: 1 Avg. mainline thru travel speed (mph): 54.4 Mainline thru speed range (mph): 42.2 - 56.9 Left exit ramps: 0 No. of weaves: 2 No. of ramp terminal intersections operating at overall LOS E or F: 0 No. of movements at ramp terminal intersections operating at LOS E or F: 4 Full access to/from adjacent interchanges? No
Compliance with Design Standards	No action; no compliance measures required. 0 fracture-critical bridges	0 Design Exceptions 4 Design Waivers 0 fracture-critical bridges	2 Design Exceptions 3 Design Waivers 2 fracture-critical bridges (straddle bents)	2 Design Exceptions 2 Design Waivers 5 fracture-critical bridges (straddle bents)
Right-of-Way Impacts	No construction; no impacts.	21 impacted parcels 15 partial takes (3.1 ac) 1 full take (0.3 ac) and 0 relocations 0 permanent easements (0 ac) 15 temporary easements (2.1 ac)	21 impacted parcels 17 partial takes (3.9 ac) 1 full take (0.3 ac) and 0 relocations 5 permanent easements (0.8 ac) 11 temporary easements (0.9 ac)	23 impacted parcels 16 partial takes (4.1 ac) 1 full take (0.3 ac) and 0 relocations 1 permanent easements (0.2 ac) 18 temporary easements (5.1 ac)
Potential Environmental Impacts	No construction; degraded air quality; no attenuation features for noise impacts beyond existing walls; elevated crash rates anticipated to persist.	0.1 ac of lakes and wetlands 3,690 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 1 potential 4(f) property (1.0 ac)	1.8 ac of lakes and wetlands 3,210 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 1 potential 4(f) property (0.6 ac)	1.9 ac of lakes and wetlands 4,600 LF channelized streams & ditches 0 LF tidal channels 0 listed/pot. NRHP eligible properties (0 ac) 0 properties with potential hazardous materials 1 potential 4(f) property (0.7 ac)
Constructability (level of complexity)	N/A - no construction.	Roadway/Civil: Moderate Bridges: Moderate (45,000 sf)	Roadway/Civil: Moderate / High Bridges: High (66,000 sf)	Roadway/Civil: High Bridges: Moderate / High (105,000 sf)
Constr. / Total Cost	$0 / $0	$88.9M / $176.1M	$126.4M / $234.8M	$144.4M / $262.8
Basis of Selection	--	Queuing, intersection operations, no. of straddle bents, wetland impacts, construction cost	--	--

Figure 4-43 - Tier 3 Recommended Improvements, I-64/Northampton Boulevard Interchange, Alt. E

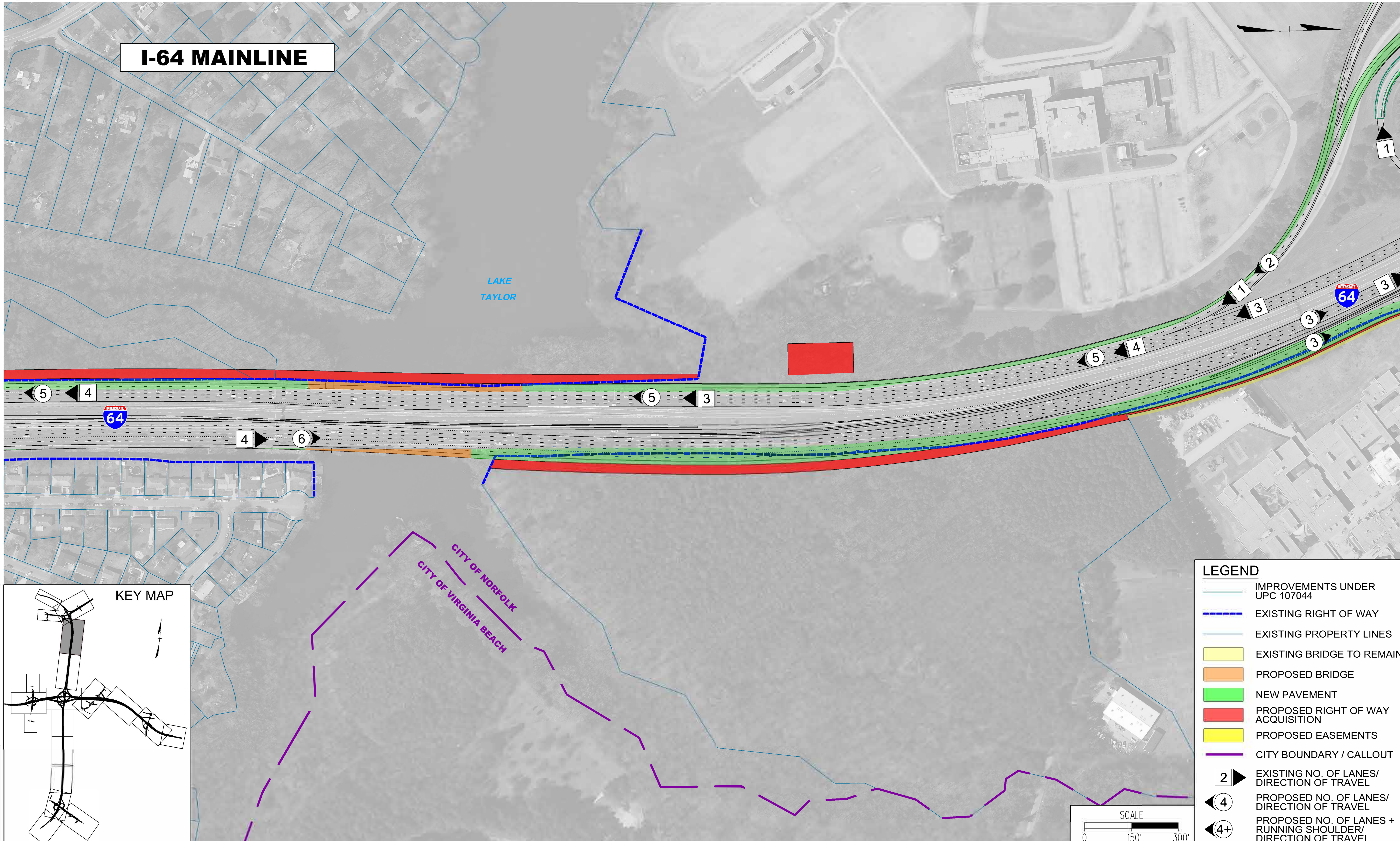


Figure 4-44 - Tier 3 Recommended Improvements, I-64/Northampton Boulevard Interchange, Alt. E

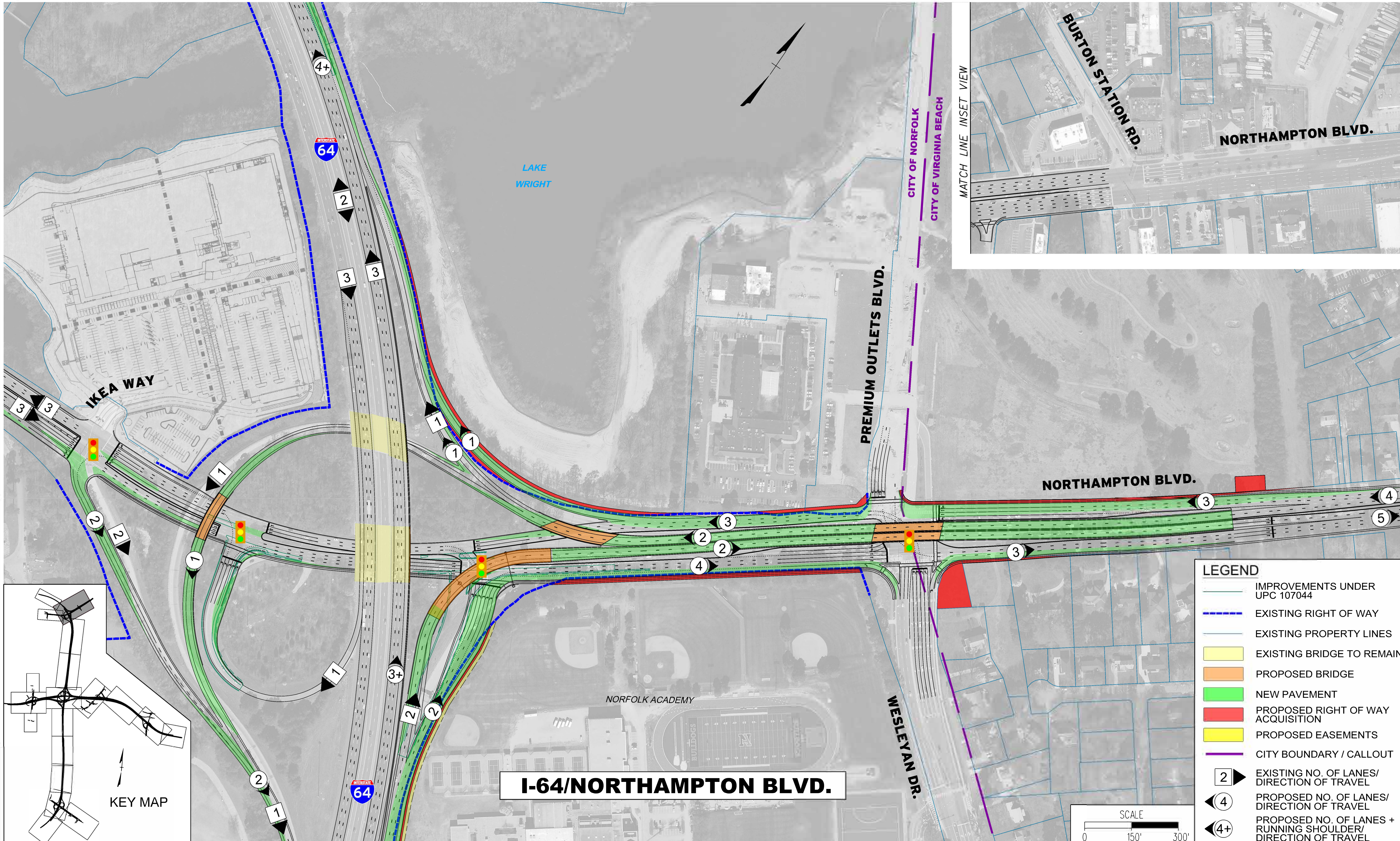
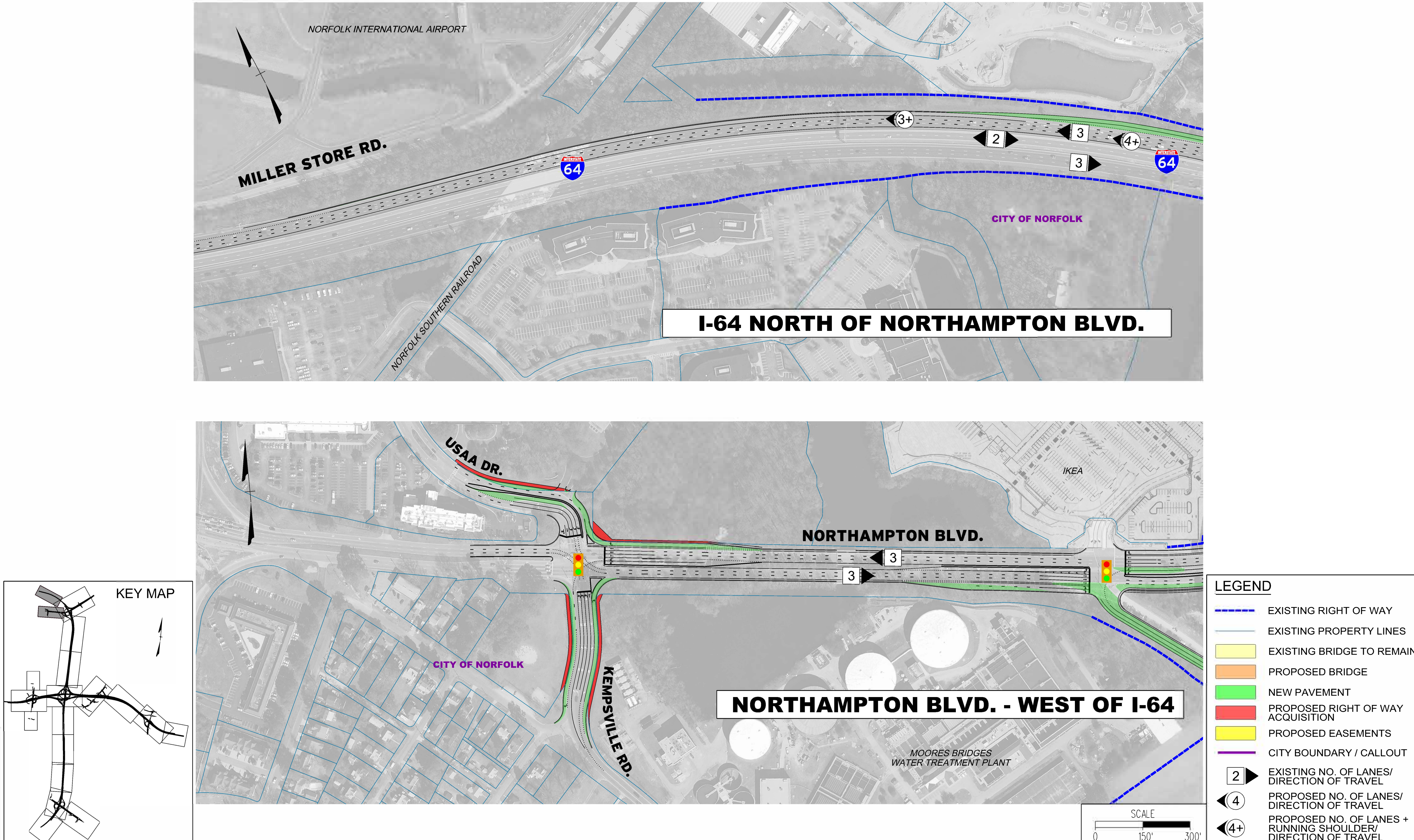


Figure 4-45 - Tier 3 Recommended Improvements, I-64/Northampton Boulevard Interchange, Alt. E



Widening of I-64

Widening I-64 north and south of I-264 is a required improvement that was carried forward into Tier 3 analysis. Widening of eastbound I-64 to provide one additional through lane ends at the Indian River Road interchange.

Design Refinements - Weekday AM peak volumes under projected 2044 build conditions will require a six-lane roadway section along westbound I-64 between I-264 and the I-64/Northampton Boulevard interchange. In addition, recommended improvements include a shoulder running lane along westbound I-64 during the AM peak period only from the exit ramp to Northampton Boulevard to the I-64/Military Highway interchange. The need for widening along westbound I-64 west of the Military Highway interchange should be the focus of a subsequent study.

4.5 Transportation System Management (TSM) Strategies

TSM strategies focus on improving the operational efficiency of transportation systems without major system improvements such as adding lanes or new ramps. TSM strategies can include signing and pavement striping improvements, traffic surveillance and control equipment, incident management programs, HOV facilities, and travel demand management measures. Corridor- and system-wide TSM strategies may incorporate improvements to mass transit service, pedestrian/bicycle facilities, and intelligent transportation systems (ITS).

The Hampton Roads area already has many of these strategies in place or in operation. The following TSM strategies were considered to augment the recommended build alternative.

Pedestrian and Bicyclist Facilities

All alternatives developed in this study include improvements to enhance mobility for pedestrians and cyclists. These are described in detail in Section 5.7, and generally consist of sidewalk segments to close gaps in the existing sidewalk network, shared use paths, and facilities to enhance pedestrian safety for crossing roadways.

HOV and HOT Lanes

High-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes provide operational benefits to motorists who rideshare, increasing the capacity of a highway corridor to move people.

HOV lanes are currently in operation in the I-264 corridor, but are discontinuous through the I-64/I-264 interchange. All design alternatives considered in this study provide continuous HOV lanes on I-264 within the study limits, including new HOV lanes through the I-64/I-264 interchange.

HOV and HOT lanes are currently in operation in the I-64 corridor - HOV lanes south of the Eastern Branch of the Elizabeth River and Express Lanes (HOT lanes) north of the river. A VDOT design project (UPC 112923 - I-64 Express Lanes Segment 2) is underway to convert the I-64 HOV lanes to HOT lanes between Battlefield Boulevard and the south terminus of the Segment 1 HOV lanes near I-264. All design alternatives considered in this study retain the existing Express Lanes north of the Eastern Branch Elizabeth River, and are compatible with the HOV-HOT conversion project south of the river.

Transit Service

Existing transit service within the study area is summarized in Section 3.4 of this document. The following addresses plans to expand transit service within the study area.

The Hampton Roads Regional Transit Vision Plan was prepared by Hampton Roads Transit, Williamsburg Area Transit Authority, and the Virginia Department of Rail and Public Transportation, and was finalized in February 2011. The plan identifies several short-term (by 2025), long-term (by 2035), and extended-term (beyond 2035) initiatives to provide expanded commuter rail, light rail, bus rapid transit, streetcar, and high-speed ferry service in the Hampton Roads region. The following projects identified in the Transit Vision Plan are located within the study area, and are therefore considered to have the potential to reduce vehicle traffic within the study area:

- Corridor L (short-term) - This is the Tide LRT line that is currently in service in the Curlew Drive corridor. This facility was under construction at the time the Transit Vision Plan was completed. Influences of this LRT line on traffic volumes are realized in the traffic count program conducted for this IMR study.
- Corridor M (short-term) - This initiative is an eastward extension of the Tide LRT from its east terminus at Newtown Road to Virginia Beach. On November 8, 2016, this improvement was defeated by public referendum. There are no current plans to extend the LRT as documented in the Transit Vision Plan.
- Corridors J and N (extended-term) - These are extensions of the Tide LRT from the existing Military Highway station to the Norfolk Naval Station and the Greenbrier area. While these system extensions have the potential to reduce traffic on Military Highway and I-64, the timing of the improvements is uncertain relative to the 2044 design year used for this IMR study. As a result, projected traffic volumes have not been reduced to reflect any benefits that may be derived by these LRT system expansion initiatives.

In 2018, HRTPO developed a proposal for focused investment in a "public transit backbone" in order to improve the local public transit system. The objectives in doing so are to provide more frequent service, service hours consistent across city limits, and shelters at warranted stops. The initiative focuses on a limited number of primary routes running where public transit is most needed. On October 26, 2018, HRTPO staff presented its "public transit backbone" plan to agency stakeholders. Within the IMR study area, the plan identifies the Military Highway and Newtown Road corridors for focused investment. While the specific improvements envisioned as part of the plan are not yet identified, the roadway corridors identified currently support bus transit operations and are envisioned to continue to do so. Roadway and interchange improvements identified in this IMR document as part of the recommended alternative will provide increased vehicle capacity for the Military Highway and Newtown Road corridors and are therefore consistent with and supportive of HRTPO's "public transit backbone" initiative.

Hampton Roads Transit is currently planning the next generation of regional bus transit service through their Transit Transformation Project. The study involves a comprehensive review of transit service and facilities and will plan future improvements based on stakeholder input. The study is scheduled for completion by the end of 2019.

Park and Ride Facilities

The VDOT website identifies three existing park and ride lots located within the study area, all of which provide transit service, shelters, lighting, and bike racks:

- Military Highway LRT Station, Lot #414 - provides 226 spaces, located in the City of Norfolk
- Newtown Road LRT Station, Lot #415 - provides 266 spaces, located in the City of Norfolk
- Indian River Road, Lot #189 - provides 267 spaces, located in the City of Virginia Beach

Three other park and ride lots are located near the study area and likely reduce travel demand within the study area:

- Ballentine/Broad Creek LRT Station, Lot #413 - provides 99 spaces, located in the City of Norfolk in the I-264 corridor
- Greenbriar Mall, Lot #261 - provides 50 spaces, located in the City of Chesapeake in the I-64 corridor
- Silverleaf Station, Lot #72 - provides 279 spaces, located in the City of Virginia Beach in the I-264 corridor

In 2013 VDOT completed a statewide Park and Ride Lot Inventory and Usage Study, which included an audit of all of Virginia's park and ride lots; developed a new set of web pages to help users find park and ride lots; and compiled a list of recommendations for new, expanded, or enhanced park and ride lots. Figure 4-46 identifies areas identified by VDOT for prioritized investment in park and ride facilities near the IMR study area.

Figure 4-46: Park and Ride Priority Investment Areas (PIAs)

Source: HRTPO, www.hrtpo.org/uploads/docs/P14-Statewide_Park_and_Ride_Strategy_Priority_List.pdf; Excerpt from presentation entitled "Park and Ride Lot Investment Strategies" by VDOT Hampton Roads District to the Hampton Roads Transportation Technical Advisory Committee, May 7, 2014.

The study also identifies the following recommended projects in the study area to enhance park and ride capacity and reduce travel demand:

- Expand the Indian River park and ride lot to provide 50-100 additional spaces. This improvement is the No. 1 ranked park and ride priority in VDOT Hampton Roads District.
- Expand the Silverleaf Station park and ride lot to provide 50 additional spaces. This improvement is the No. 2 ranked park and ride priority in the District.

These improvements are important in advancing the park and ride operations across the region and will extend ridesharing opportunities to a greater number of motorists. Each improvement can be expected to yield an incremental benefit to interstate operations by potentially reducing the number of vehicles through a nominal increase in average vehicle occupancy. Park and ride operations are one component of an overall TSM strategy being deployed by VDOT for the Hampton Roads region.

ITS Facilities

Proposed improvements will include ITS trunk infrastructure along I-64 and I-264 that are components of VDOT's ITS network serving the Hampton Roads region. System components will be replaced if they are impacted by improvements associated with the recommended alternative. Deployment will continue to support congestion mitigation and incident management functions through control and monitoring of dynamic message signs, cameras, traffic signals, and traffic count stations.

TRAFFIX

Funded through the HRTPO and staffed through HRT, TRAFFIX is a cooperative interagency entity that promotes and implements TDM strategies in the Hampton Roads region. According to the HRTPO website, TRAFFIX initiatives include "a wide variety of programs and incentives, including carpooling and commuter matching, guaranteed ride programs, NuRide rewards, park and ride, park and sail, vanpooling and van leasing, and teleworking."

The TRAFFIX Oversight Committee includes a VDOT representative, along with representatives from HRT and government jurisdictions within the HRTPO planning area. VDOT's presence on this committee ensures that TDM strategies administered through TRAFFIX and highway improvement projects are and will remain mutually supportive toward reducing travel demand and congestion across the region.

Summary of TSM Strategies

On an individual and collective basis, these TSM strategies will benefit overall traffic operations in the study area. Many of these strategies have been in operation for many years and have helped to reduce traffic demand to levels observed in the field today. However, TSM alone will not address the capacity constraints and safety issues associated with existing and projected future conditions. Therefore, TSM strategies alone will not satisfy the purpose and need for this project.

CHAPTER 5: ROADWAY GEOMETRY

5.1 Design Criteria

Highway & Bridge Geometry

The design layouts were developed using criteria and guidance set forth in the following documents:

- A Policy on Geometric Design of Highways and Streets, AASHTO, 2011
- A Policy on Design Standards – Interstate System, AASHTO, 2016
- Highway Safety Manual, AASHTO, 2010
- Road Design Manual, Volume 1, VDOT, 2005
- Structure and Bridge Manual, Volume V, Parts 2 and 3, VDOT, 2011
- Road and Bridge Standards, VDOT, 2016
- Applicable Instructional and Informational Memoranda, VDOT, Location & Design Division
- A Policy on Design Standards - Interstate System, AASHTO, 2016
- Guardrail Installation Training Manual, VDOT, August 2017

Design guidance and standards in these documents were applied to roadways within the project limits based on the functional classification and design speed of each roadway. Table 5.1 summarizes select design criteria for roadways within the project limits.

Design Vehicle

Roadway improvements accommodate a WB-67 truck/semitrailer as the design vehicle. While this design vehicle reflects current guidance by VDOT for the design of interchanges and reflects a design requirement set forth by AASHTO for interstates, it is a conservative choice. Based on the publication No. DMV109 entitled "*Virginia's Size, Weight and Equipment Requirements for Trucks, Trailers and Towed Vehicles*" (Virginia DMV, July 1, 2016), the dimensions of the AASHTO standard WB-62 design vehicle represent the longest truck/semitrailer vehicle permitted on Virginia interstates and other designated highways without an oversize permit. (The DMV requires that vehicles having overall dimensions of the WB-67 be operated with the trailer axles moved forward to achieve the wheelbase of the WB-62 design vehicle. This requirement for a kingpin-to-axle distance of no more than 41 ft is set forth in Virginia Code §46.2-1112.)

Table 5.1: Roadway Design Criteria

Design Criteria	I-64	I-264	Interstate C/D Roadways	Interchange Ramps (Semi-/Directional)	Interchange Ramps (Loop)	Military Highway	Newtown Road	Witchduck Road	Northampton Boulevard	Indian River Road (west of EB I-64 ramps)	Indian River Road (east of EB I-64 ramps)
Functional classification	Urban Principal Arterial - Interstate	Urban Principal Arterial - Interstate	Urban Principal Arterial - Interstate	Interchange Ramp	Interchange Ramp	Urban Principal Arterial	Urban Minor Arterial	Urban Minor Arterial	Urban Principal Arterial	Urban Minor Arterial	Urban Principal Arterial
VDOT Standard	GS-5	GS-5	GS-5	GS-R	GS-R	GS-5	GS-6	GS-6	GS-5	GS-6	GS-5
Terrain	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level	Level
Design speed	70 mph	70 mph	60 mph	40 / 45 / 50 mph	25 / 30 / 35 mph	45 mph	35 mph	35 mph	45 mph	45 mph [1]	45 mph [1]
Stopping sight distance	730 ft	730 ft	570 ft	305 / 360 / 425 ft	155 / 200 / 250 ft	360 ft	250 ft	250 ft	360 ft	360 ft	360 ft
Minimum length, vertical curve	210 ft	210 ft	180 ft	120 / 135 / 150 ft	75 / 90 / 105 ft	135 ft	105 ft	105 ft	135 ft	135 ft	135 ft
Superelevation	8% max. TC-5.11R	8% max. TC-5.11R	8% max. TC-5.11R	8% max. TC-5.11R	8% max. TC-5.11R	4% max. TC-5.11U	4% max. TC-5.11U	4% max. TC-5.11U	4% max. TC-5.11U	4% max. TC-5.11U [1]	4% max. TC-5.11U [1]
Maximum ratio [2], compound curve radii	1.5:1	1.5:1	1.5:1	2:1	2:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Vertical clearance [3]	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft	16.5 ft
Minimum width, travel lane	12 ft	12 ft	12 ft	16 ft [4]	16 ft [4]	12 ft [5]	12 ft [5]	12 ft [5]	12 ft [5]	12 ft [5]	12 ft [5]
Minimum width, paved left shoulder	12 ft [6][7]	12 ft [6][7]	12 ft [6][7]	6 ft [7][8]	6 ft [7][8]	1 ft [9]	1 ft [9]	1 ft [9]	1 ft [9]	1 ft [9]	1 ft [9]
Minimum width, paved right shoulder	12 ft [7]	12 ft [7]	12 ft [7]	10 ft [7][8]	10 ft [7][8]	2 ft [9]	2 ft [9]	2 ft [9]	2 ft [9]	2 ft [9]	2 ft [9]
Minimum profile grade	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Maximum profile grade	5.0%	5.0%	5.0%	[10]	[10]	6.0%	7.0%	7.0%	6.0%	6.0%	6.0%

[1] A DDI layout (if selected for this location) would use a design speed of 35 mph and Urban Low Speed criteria for superelevation.
[2] Ratio applies only for consecutive horizontal curves having descending radii.
[3] Values provided for new bridges; clearance to a fracture-critical member is 17.5 ft. Vertical clearance of existing bridges to remain will be retained without improvement. If an existing bridge has substandard vertical clearance and requires widening or other significant work, the vertical clearance will be corrected to the value identified in the table.
[4] Design value shown is for a single-lane ramp with a design speed greater than 25 mph. 12 ft lanes used on multilane ramps. 18 ft lanes used on loop ramps with a design speed of 25 mph or less.
[5] Guidelines allow for the use of 11 ft travel lanes away from interchanges.
[6] Design value shown applies to directional roadway sections of three or more travel lanes.
[7] Design value shown reflects location of a shoulder adjacent to guardrail or concrete barrier, which is the predominant condition within the project limits. If no such barrier is present, the required paved width is 2 ft less than the value shown.
[8] Paved shoulder widths along ramps are subject to widening to achieve required stopping sight distance.
[9] Value represents offset to vertical curbing left, or width of gutter pan right.
[10] For design speeds 25-30 mph, use maximum grade of 5-7%; for design speeds of 35-40 mph, use maximum grade of 4-6%; for design speeds of 45-50 mph, use maximum grade of 3-5%.

5.2 Geometric Configuration for Recommended Alternative

The following summarizes the geometric improvements and anticipated right-of-way impacts at each interchange within the study area. Recommended improvements are illustrated in Chapter 4, Figures 4-29 through 4-45. Figure references are provided at the beginning of each subsection below. Large-format exhibits of the recommended improvements are also included in Appendix E.

Acquisition of new right-of-way along I-264 and I-64 will require alteration to the existing limited access lines for each corridor. AASHTO guidance recommends that a break in the access control line along crossroads or frontage roads that intersect interstates should be no closer to the ramp terminal than 100 ft in urban conditions. For the purposes of interpreting this guidance for this study, the study area is considered to be in an urban setting. Recommended improvements to interchanges within the study area will require that L/A lines be adjusted to comply with AASHTO guidance. These adjustments will be coordinated with detailed design during subsequent stages of project development.

I-64/I-264 Interchange

(Figures 4-31, 4-32, 4-41, 4-42) The recommended design of this interchange accommodates projected volumes and addresses the operational and safety problems evident under existing conditions. Full directional access between I-64 and I-264 will be provided. Route continuity through the interchange will be maintained by retaining existing through facilities, and will be enhanced by removing left exit ramps that diverge from the through lanes.

The eastbound I-64 ramp diverge geometry to I-264 will be reconfigured to provide motorists with direct line of sight to the exit ramp decision points. All exit ramps from I-264 will diverge from C/D roadways, rather than from a combination of both mainline and C/D facilities as under existing conditions. All left exit ramps will be eliminated, and all of the four merge-weave areas between closely spaced loop ramps will be eliminated. Existing loop ramps from westbound I-64 to the westbound I-264 C/D roadway, and from eastbound I-64 to the eastbound I-264 C/D roadway will remain in service. Both of these loop ramps satisfy a minimum design speed of 25 mph and provide profile grades ranging from 0.5% to 4.0%

The interchange will be served from the east with a new ramp network to eastbound and westbound I-64 that is constructed parallel and adjacent to the existing westbound I-264 C/D roadway. The outer ramp network will be designed to 60 mph, and will terminate with a directional ramp to westbound I-64 and a semi-directional ramp to eastbound I-64. The existing westbound C/D roadway will remain in service.

The alignments of I-64 and I-264 approaching and departing the interchange will remain unchanged. Profile grades for interstate segments approaching and departing the interchange will remain unchanged, except where necessary to correct deficiencies in vertical clearance over local roadways. This will occur along eastbound and westbound I-64 over Kempsville Road and over Virginia Beach Boulevard.

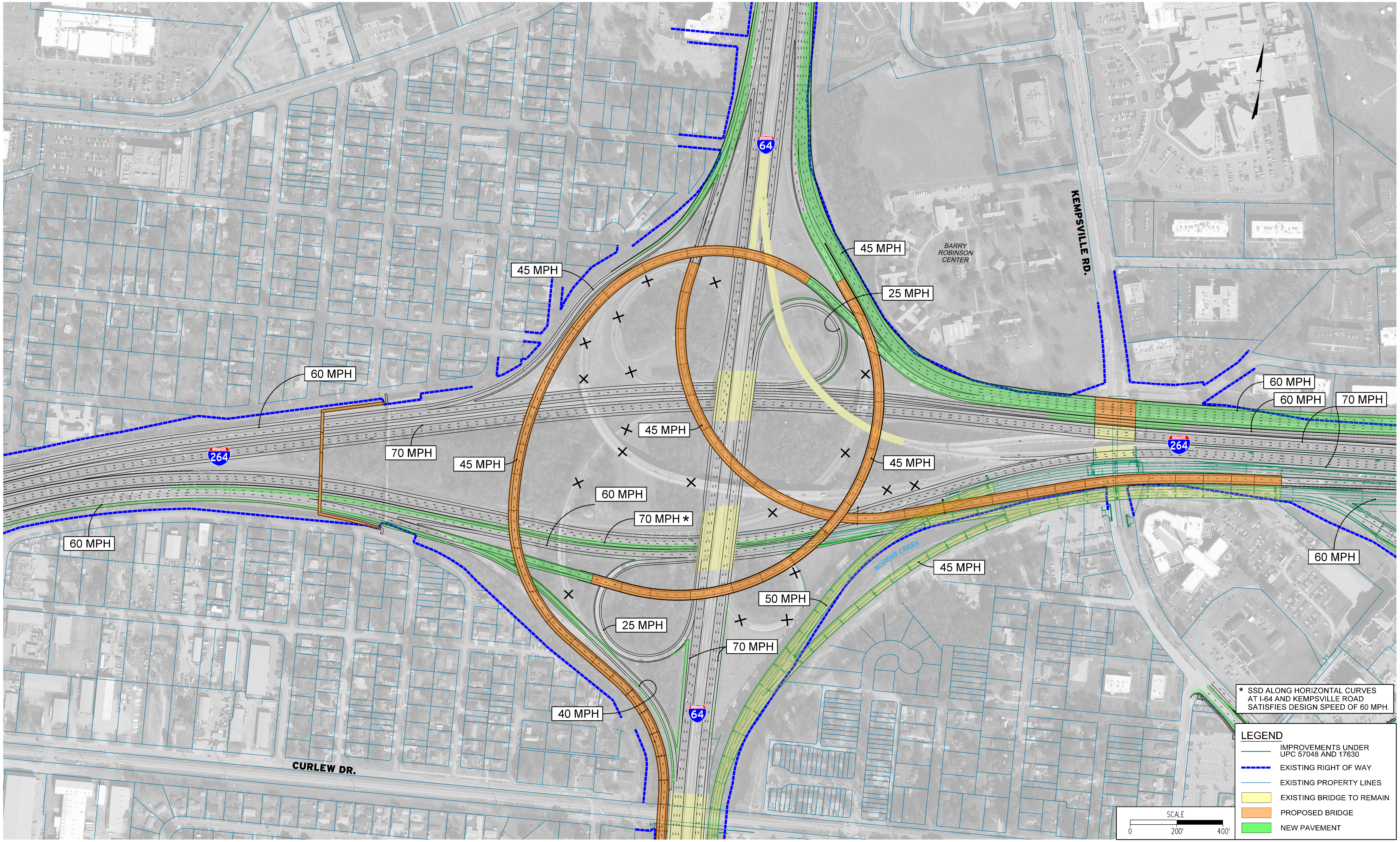
Semi-directional ramps will be provided to accommodate major movements at this interchange:

- Eastbound I-64 to eastbound I-264 - This ramp will provide two-lanes, doubling the capacity of the existing single-lane semi-directional ramp it will replace. The geometry satisfies a minimum design speed of 45 mph. Profile grades are in the range of 0.3% to 4.9%.
- Westbound I-264 to eastbound I-64 - This two-lane ramp replaces the existing single-lane left-exit ramp from the westbound I-264 mainline, as well as the existing loop ramp from the westbound I-264 C/D roadway. The ramp design speed is 45 mph, based on controlling horizontal curvature. Profile grades range from 0.5% to 5.0%.
- Eastbound I-264 to westbound I-64 - This two-lane ramp replaces the existing single-lane loop ramp from the eastbound I-264 C/D roadway as well as the left-exit directional ramp from the eastbound I-264 mainline. The new ramp accommodates a minimum design speed of 45 mph. Profile grades for this ramp range from 0.3% to 5.0%.

Right-of-way impacts are anticipated at the following locations:

- Northeast quadrant - A strip of property to be acquired along the majority of the south and west property lines of the Barry Robinson Center property. There are not anticipated to be any direct impacts to developed features of the site. Improvements will impact four developed commercial properties located between westbound I-264 and Center Drive. While this study anticipates that these impacts will require full acquisition of the commercial properties and relocation of tenants, impacts may be reduced through final design activities to the extent that relocations may not be necessary.
- Northwest quadrant - A strip of property to be acquired along the eastern property lines for four commercial parcels. One residential parcel will be acquired in full, with relocation.
- Southwest quadrant - A strip of property along the eastern property line of one undeveloped parcel through which Nosehs Creek runs.
- Southeast quadrant - Partial acquisition from the Coastal Virginia Church property for expansion of an existing VDOT stormwater management facility.

Figure 5-1 - I-64/I-264 Interchange Design Speeds



I-264/Military Highway Interchange

(Figure 4-29) The existing full cloverleaf configuration will be modified to a partial cloverleaf to eliminate the short weaving areas along the eastbound and westbound I-264 C/D roadways. Relocated ramp terminals will form two new signalized intersections along Military Highway. To eliminate left turns at the north signalized ramp terminal intersection along Military Highway, the southbound Military Highway to westbound I-264 movement will use a new directional ramp. Ramp terminals along I-264 are located along the eastbound and westbound C/D roadways. Ramp geometry is described as follows:

- Westbound I-264 to northbound and southbound Military Highway - This ramp will consist of two lanes, one for traffic from the westbound I-264 C/D road and one for traffic from the extended ramp serving the westbound I-64 to westbound I-264 movement at the I-64/I-264 interchange. The existing one-lane ramp widens to provide five lanes at the ramp terminal intersection along Military Highway - two left turn lanes, one shared left-through lane, and two right turn lanes. The profile grades for this ramp range from 1.5% to 3.0%. The ramp design speed is 35 mph.
- Northbound Military Highway to westbound I-264 C/D - This existing one-lane loop ramp will remain in service and will generally follow the alignment of the existing ramp. The horizontal geometry of the loop ramp satisfies a design speed of 25 mph. Profile grades for this ramp range from approximately 0.3% to 3.8%. The ramp lane will enter the westbound C/D roadway as an added lane, resulting in acceleration distance that exceeds the AASHTO-required value of 1,020 ft.
- Southbound Military Highway to westbound I-264 C/D - This ramp will be relocated tight to the mainline, maximizing separation between its ramp terminal and the new upstream signalized intersection along Military Highway. The current taper style entrance will be replaced with a parallel entrance. Profile grades for this ramp range from 0.5% to 4.3%. The ramp design speed is 45 mph, although the controlling curvature at the ramp gore satisfies a design speed of 60 mph. The length of the ramp will enable acceleration to 60 mph, allowing use of the minimum gap acceptance length of 300 ft for the auxiliary lane.
- Eastbound I-264 C/D exit ramp to northbound and southbound Military Highway - Operational analyses indicated that drivers decelerating for the existing exit ramp to southbound Military Highway create congestion on the eastbound C/D roadway, affecting traffic operations at the diverge from the eastbound I-264 mainline. In addition, the existing loop entrance ramp from southbound Military Highway to the eastbound I-264 C/D roadway operates with deficient acceleration distance, and induces slow-speed merge-weave operations along the eastbound C/D roadway. To address these conditions, these two ramps are eliminated and all movements from the eastbound I-264 C/D roadway to northbound and southbound Military Highway are rerouted onto the existing loop exit ramp from eastbound I-264 which will remain in service. The layout provides an extended deceleration lane that exceeds the required 460 ft. The single lane exit ramp will widen to provide four lanes approaching the signalized ramp terminal intersection at Military Highway - two left turn lanes and two right turn lanes. The widened ramp will follow the profile of the existing ramp, which has grades in the range of 0.5% to approximately 6.5%. The ramp design speed is 25 mph.
- Northbound and southbound Military Highway to eastbound I-264 C/D - The existing one-lane ramp is widened to two lanes to accommodate dual turn lanes from southbound Military Highway and dual signalized right turn lanes from northbound Military Highway. Profile grades for this ramp range from 0.5% to 4.0%. The ramp design speed is 25 mph, based on controlling horizontal curvature. The last horizontal curve along the ramp alignment satisfies a design speed of 40 mph, and is long enough to permit acceleration to 35 mph before the parallel auxiliary lane along the eastbound I-264 C/D roadway. The downstream half of the entrance ramp is realigned off the existing ramp to achieve the required separation distance to the downstream ramp along the eastbound I-264 C/D roadway.

The north end of Frontage Road is realigned to intersect Military Highway opposite the westbound I-264 exit ramp terminal. The left turn movement from Frontage Road onto northbound Military Highway will be prohibited to maximize capacity for other movements at this intersection that carry higher volumes. To accommodate the prohibited movement, the interchange layout includes an extension of existing Piping Rock Road to connect Frontage Road with Pebble Lane. The bridge carrying Frontage Road over I-264 will be replaced on a new alignment to allow the existing bridge to remain in service during construction.

Right-of-way impacts are anticipated, and are primarily associated with the improvements to Frontage Road and the extension of Piping Rock Road. Properties impacted include the following:

- Parcel occupied by Poplar Halls Elementary School, with no impacts to developed features of the site;
- An undeveloped parcel east of the school property;
- Strip acquisition from a commercial property to accommodate widening of the frontage road intersecting Military Highway opposite Hoggard Road; and
- Strip acquisition from the parcel occupied by the Tide LRT station along Curlew Drive, with no impacts to developed features of the station site.

I-264/Newtown Road Interchange

(Figures 4-32, 4-33) To address merge-weave operations along the existing westbound I-264 C/D roadway between the Newtown Road interchange and the I-64/I-264 interchange, the recommended interchange layout includes development of an outer roadway along westbound I-264. The outer ramp network will separate traffic oriented to I-64 from other traffic on the existing C/D roadway oriented to westbound I-264, Military Highway, and points west. This will effectively improve traffic operations by eliminating certain weaving movements, reducing merge-weave volumes, and reducing the number of lane changes required for the majority of weaving traffic.

Access to northbound and southbound Newtown Road from westbound I-264 will be provided from the existing C/D roadway which will be widened to provide two additional lanes. A one-lane exit ramp from the westbound I-264 C/D roadway splits to form two ramps that intersect Newtown Road at existing signalized intersections at Center Drive and at Stoney Point South. The ramp design speed is 35 mph, and profile grades range from 0.5% to 1.0%. The layout provides approximately 1,800 ft of deceleration distance, which exceeds the required length of 405 ft.

The "wishbone" configuration of the westbound I-264 exit ramp divides ramp traffic flow entering Newtown Road, and provides more efficient signal operations at each intersection by limiting the turn movements exiting each ramp. Both ramp terminal intersections will undergo widening to provide additional through and turn lanes on all approaches. To provide required capacity for major intersection movements, the north ramp terminal intersection will prohibit the through movement across Newtown Road from the ramp onto Stoney Point South. This is a low-volume movement that will be rerouted via northbound Newtown Road to westbound Ethan Allen Lane, to Stanwix Square and onto Stoney Point South. Traffic currently turning left from Stoney Point South onto northbound Newtown Road will be routed in the reverse direction via Stanwix Square and Ethan Allen Lane.

Access from northbound and southbound Newtown Road to westbound I-264 will be provided through a single entrance ramp intersecting Newtown Road opposite Stoney Point South. Dual and triple turn lanes will feed traffic onto the ramp from northbound and southbound Newtown Road, respectively. The entrance ramp rises to overpass the outer ramp to eastbound and westbound I-64. It provides 985 ft of weaving distance before it splits into two single-lane ramps that access the westbound I-264 C/D roadway and the outer ramp to I-64. The weaving distance has been maximized to allow motorists to position themselves in the correct lane for their intended destination. Profile grades for this pair of ramps range from 0.5% to 6.6%. Traffic entering the outer ramp network will have access to eastbound or westbound I-64. Traffic entering the C/D roadway will have access to eastbound I-64, Military Highway, and points west along I-264. Both ramps enter their respective roadways as lane additions with no downstream merge point.

The connection from the westbound C/D roadway to the outer ramp network is configured as a left entrance ramp. AASHTO guidance includes cautions regarding the use of left entrance ramps related to driver expectancy and speed differential at the downstream merge point. However, several factors indicate that the recommended left entrance ramp will operate well:

- As previously noted, the subject ramp is configured as a lane addition, with no downstream merge point;

- The ramp design will allow an operating speed of 45 mph at the ramp gore, reducing the speed differential versus adjacent through travel lanes to approximately 10 mph;
- Microsimulation analyses demonstrate favorable traffic operations with the left entrance configuration, and operations that are superior to those tested with a right entrance configuration. These results evidence the operational benefits of placing vehicles destined for eastbound I-64 on the left side of the outer roadway, eliminating the need for them to weave across multiple lanes; and,
- Left entrance ramps are in operation elsewhere in the I-264 corridor (at the Waterside Drive interchange) and elsewhere in the Hampton Roads region (I-64/Tidewater Drive interchange, and others).

Ramps to and from eastbound I-264 that are currently under construction will remain in service, but will require modifications to address projected demand:

- Eastbound I-264 outer C/D to southbound Newtown Road and Greenwich Road - The terminal of the four-lane ramp will be widened to provide triple right turn lanes onto southbound Newtown Road. The two through lanes to Greenwich Road will remain unchanged. The ramp design speed is 40 mph. Profile grades for this ramp range from 0.5% to 3.0% and will remain unchanged.
- Eastbound I-264 outer C/D to northbound Newtown Road - The single lane free-flow ramp will remain in service, but will be signalized and widened to provide two additional lanes at the downstream terminal to increase capacity. The ramp design speed is 25 mph. Profile grades for this ramp range from 0.5% to 3.4% and will remain unchanged.
- Northbound and southbound Newtown Road to eastbound I-264 outer C/D - This single lane ramp, which originates from the Greenwich Road roundabout, will remain in service. The existing ramp ties to the eastbound outer C/D facility, and the auxiliary lane drops. Recommended improvements widen eastbound I-264 and extend the auxiliary lane to the Witchduck Interchange. The ramp design speed is 35 mph. Profile grades for this ramp range from 0.5% to 3.0% and will remain unchanged.

Right-of-way impacts are anticipated at the following locations:

- Along westbound I-264, strip acquisitions from two commercial properties, and three parcels owned by the City of Virginia Beach (at Lake #1, located north of I-264 and west of the Cleveland Street overpass);
- Along I-264 eastbound outer C/D road, strip acquisition from one commercial property;
- Widening of Newtown Road, strip acquisition from 16 commercial parcels; and
- For widening of the Newtown Road/Kempsville Road/Princess Anne Road intersection, strip acquisition from one commercial parcel, and one parcel occupied by the Tide LRT Newtown Road station with the loss of 26 parking spaces (leaving a total of 240 spaces).

I-264/Witchduck Road Interchange

(Figures 4-34, 4-35) The existing half partial clover/half-diamond interchange configuration will be maintained, with additional lanes provided on Witchduck Road and ramps to accommodate projected demand. Improvements include replacement of the existing bridge carrying I-264 over Witchduck Road. Ramps are described as follows:

- Westbound I-264 to northbound and southbound Witchduck Road - The existing one lane exit ramp will be realigned and reprofiled to accommodate the widened I-264 mainline section. Dual left and dual right turn lanes will be provided at the ramp terminal intersection at Witchduck Road. The ramp design speed is 35 mph, which is limited by a crest vertical curve. Profile grades for this ramp range from 1.5% to 5.2%. The ramp layout provides required deceleration distance from 60 mph to the beginning of the controlling vertical curve.
- Northbound and southbound Witchduck Road to westbound I-264 - The existing single-lane entrance ramp will remain in service. The throat of the ramp will be reconfigured to receive two lanes from westbound Southern Boulevard and a dual left turn movement from northbound Witchduck Road. The downstream end of the ramp will be realigned to accommodate the widened I-264 mainline roadway section, and will be configured as a lane addition to the I-264 mainline. The ramp design speed is 50 mph. Profile grades for this ramp range from 0.3% to 3.5%.
- Eastbound I-264 to northbound and southbound Witchduck Road - The exit ramp is currently being reconstructed to provide two lanes on a new alignment. It will remain in service, but upstream portions of it will be realigned to accommodate the widened I-264 roadway section. The free right-turn movement onto southbound Witchduck Road will be converted into a signalized right/thru lane to improve pedestrian safety and allow creation of a triple left turn movement onto northbound Witchduck Road without pavement widening. The ramp design speed is 45 mph. Profile grades for the new ramp range from 0.4% to 4.0%, and will remain unchanged.
- Northbound and southbound Witchduck Road to eastbound I-264 - This loop entrance ramp is currently being reconstructed on a new alignment in the southwest quadrant of the interchange. Recommended improvements include realignment and widening to two lanes through the loop, reducing to a single lane prior to merging with I-264. The design will accommodate the widened I-264 roadway section. The realigned ramp will be situated on a new two-lane bridge overpassing Witchduck Road, allowing the outer auxiliary lane on eastbound I-264 to be converted to an additional through lane, and to facilitate construction staging. The ramp design speed is 25 mph. Profile grades for this ramp range from 0.5% to 3.5%.

Left turns and through movements from Grayson Road onto southbound Witchduck Road will be prohibited to reduce signal phases and achieve acceptable signal operations. This traffic movement will be rerouted to the south along Grayson Road and will enter Witchduck Road through the Witchduck Road/Bonney Road intersection.

Right-of-way impacts are anticipated at the following locations:

- Along eastbound I-264, strip acquisition from the County View (south) residential mobile home park, requiring relocation of an estimated two residential trailers. Strip acquisition of undeveloped frontage from two multi-unit residential developments. Full acquisition of one triangular parcel with no relocations.
- Along westbound I-264, strip acquisition from the County View (north) residential mobile home park, requiring relocation of an estimated three residential trailers. Strip acquisition from three commercial properties with no relocations. Acquisition of one residential property with relocation. Full acquisition of two triangular parcels with no relocations.
- Along Witchduck Road, strip acquisition from two commercial parcels on the west side of Witchduck Road, south of Cleveland Street.

I-64/Indian River Road Interchange

(Figures 4-37, 4-38) The existing full cloverleaf configuration will be modified to a partial cloverleaf, eliminating the short weave areas between loop ramp terminals along eastbound and westbound I-64 and along eastbound and westbound Indian River Road. Two new signalized ramp terminal intersections will be located on Indian River Road, each of which will control through movements on Indian River Road that oppose turning movements oriented to interstate entrance ramps. Loop ramps with free-flow terminals along Indian River Road will remain in the northeast and southwest quadrants of the interchange:

- Eastbound I-64 to eastbound Indian River Road - This ramp will be widened from one to two lanes along its existing alignment and profile. The geometry satisfies a minimum design speed of 25 mph, with the final horizontal curve approaching Indian River Road designed for 30 mph. Profile grades are in the range of 0.3% to 2.7%. The two ramp lanes will join eastbound Indian River Road, followed by a lane drop. Acceleration distance of 315 ft is provided, exceeding the 280 ft required for acceleration from 30 mph to 45 mph.
- Westbound I-64 to westbound Indian River Road - The existing one-lane loop ramp will remain in service and will undergo minor realignment approaching the ramp terminal at westbound Indian River Road to accommodate the arterial road section. The geometry satisfies a minimum design speed of 25 mph, with the final horizontal curve approaching Indian River Road designed for 30 mph. The ramp will join westbound Indian River Road as an auxiliary lane, followed by a lane drop. Acceleration distance of 409 ft is provided,

exceeding the 280 ft required for acceleration from 30 mph to 45 mph. Profile grades are in the range of 0.3% to 2.6%.

The existing outer connection ramps in the northeast and southwest quadrants of the interchange will also remain, with the following modifications:

- Eastbound and westbound Indian River Road to eastbound I-64 - This ramp will receive traffic from signal-controlled dual left turn lanes from westbound Indian River Road and dual signalized right turn lanes from eastbound Indian River Road. The upstream end of the existing ramp will be widened to accommodate three lanes. The remaining length of the ramp will be widened to provide two lanes that will enter eastbound I-64 as auxiliary lanes. Profile grades are in the range of 0.3% to 1.0%. The alignment of the ramp will generally follow that of the existing ramp, with minor realignment to maximize distance between successive horizontal curves. Developed residential properties adjacent to the ramp constrain the ramp alignment and require use of a shortened superelevation transition. The geometry satisfies a minimum design speed of 35 mph, and the horizontal curve at the eastbound I-64 gore satisfies a 40 mph design speed. The dual auxiliary lanes provide a gap acceptance length of 1,000 ft, which is within the recommended range of 900 ft to 2,000 ft recommended by AASHTO.
- Eastbound and westbound Indian River Road to westbound I-64 - This ramp will receive traffic from a signal-controlled left turn lane from eastbound Indian River Road and dual free-flow right turn lanes from westbound Indian River Road. The ramp alignment will generally follow the existing ramp, with minor realignment at the ramp terminal along westbound I-64. Ramp geometry satisfies a minimum design speed of 35 mph at the diverge from westbound Indian River Road, and 40 mph approaching the downstream ramp terminal. The dual auxiliary lanes provide a gap acceptance length of 1,000 ft, which satisfies AASHTO guidance. The ramp profile will remain unchanged, with grades in the range of 0.3% to 1.0%.

Outer connection ramps in the northwest and southeast quadrant of the interchange will be realigned to maximize downstream weave distance to downstream signalized intersections along Indian River Road:

- Eastbound I-64 to westbound Indian River Road - The ramp will be realigned to provide an additional 350 ft for merge-weave operations in advance of the signalized intersection of Indian River Road and Reon Drive. At this intersection, the ramp lane entering westbound Indian River Road terminates as a dedicated right turn lane onto Reon Drive. The geometry satisfies a minimum design speed of 30 mph, with the terminal geometry at the departure from eastbound I-64 designed for 60 mph. Profile grades are in the range of 0.3% to 2.0%.
- Westbound I-64 to eastbound Indian River Road - The ramp will be reconstructed on a new alignment to provide an additional 325 ft for merge-weave operations between the ramp terminal along eastbound Indian River Road and the downstream signalized intersection at Regent University Drive. At this intersection, the ramp lane added to eastbound Indian River Road terminates as a dedicated right turn lane. The free right turn movement entering Regent University is relocated approximately 325 ft east of its present location to increase merge-weave distance along eastbound Indian River Road. The ramp geometry satisfies a minimum design speed of 30 mph, with geometry at the departure from westbound I-64 satisfying a design speed of 60 mph. Profile grades are in the range of 0.3% to 2.0%.

Improvements along Indian River Road include widening to provide one additional through lane in each direction between the I-64 interchange and Centerville Turnpike; additional turn lanes at intersections, and new signal equipment.

Right-of-way impacts are anticipated at the following locations:

- East of the interchange, strip acquisition from six residential parcels are anticipated to be required to accommodate widening of westbound Indian River Road.
- East of the interchange, acquisition of parcels to accommodate the widening of eastbound Indian River Road, including one undeveloped property and one developed property owned by Regent University; an undeveloped portion of a property occupied by an apartment complex; and one property owned by a church. The church-owned parcel contains two burial sites that may be impacted by recommended improvements.

I-64/Northampton Boulevard Interchange

(Figures 4-45, 4-46) The recommended improvements retain the basic hybrid semi-directional layout of the existing interchange, but provides major capacity improvements for targeted movements, and resolves merge-weave conditions on Northampton Boulevard. The major improvement involves a new grade-separated ramp structure carrying traffic between I-64 and points east of the study area along Northampton Boulevard. The elevated ramp structure carries two lanes in each direction, and touches down along Northampton Boulevard east of Wesleyan Drive. Eastbound lanes are signal-controlled at the merge with eastbound Northampton Boulevard to address weaving between the end of the ramp and the downstream signalized intersection at Burton Station Drive.

In the westbound direction, the elevated ramp provides express travel between Northampton Boulevard and eastbound and westbound I-64, allowing traffic to bypass the signalized intersection at Wesleyan Drive and Premium Outlets Boulevard. In the eastbound direction, it provides traffic exiting westbound I-64 with a bypass of "local" traffic on eastbound Northampton Boulevard and the signalized intersection at Wesleyan Drive and Premium Outlets Boulevard. Access between Northampton Boulevard and the Wesleyan Drive/Premium Outlets Boulevard corridor is provided with directional frontage roads, which will also carry through trips on Northampton Boulevard oriented to or from points west of the interchange.

The following addresses the design of the five ramps at this interchange:

- Westbound I-64 to eastbound and westbound Northampton Boulevard - The ramp departs westbound I-64 with two lanes, and splits to provide two lanes onto the eastbound "express" ramp to eastbound Northampton Boulevard and two lanes to the signalized ramp terminal intersection at Northampton Boulevard. The ramp widens to provide six lanes approaching the signal, consisting of a triple left turn movement and a triple right turn movement. The free-flow right movement is eliminated in favor of signal control. The ramp geometry satisfies a minimum design speed of 30 mph, with the diverge from westbound I-64 satisfying a design speed of 60 mph. Profile grades are in the range of 0.3% to 5.8%.
- Eastbound I-64 to eastbound and westbound Northampton Boulevard - The existing loop ramp and signalized ramp terminal intersection along Northampton Boulevard will remain in service, as recently constructed. The ramp approach to the intersection will be widened by one lane to provide dual left turn lanes and triple right turn lanes onto Northampton Boulevard. The geometry satisfies a minimum design speed of 30 mph. Profile grades are in the range of 0.5% to 4.0%.
- Eastbound and westbound Northampton Boulevard to eastbound I-64 - This ramp will remain in service and will be widened by one lane to receive a dual left turn movement from westbound Northampton Boulevard, which will serve traffic originating from Wesleyan Drive and Premium Outlets Boulevard. The existing free-flow right turn movement from eastbound Northampton Boulevard onto the ramp will be reconfigured as a signalized dual right turn movement to enhance safety and operations for bicyclists and pedestrians. The two lanes will merge to a single lane prior to joining with the single-lane ramp from the westbound Northampton Boulevard elevated "express" ramp. The resulting two-lane ramp will join eastbound I-64 as dual auxiliary lanes that extend to the I-64/I-264 interchange. The ramp geometry satisfies a minimum design speed of 50 mph. The ramp alignment will generally follow that of the existing ramp, and profile grades are in the range of 0.5% to 2.0%.
- Westbound Northampton Boulevard "express" to eastbound and westbound I-64 - This movement services traffic on westbound Northampton Boulevard originating from points east of Wesleyan Drive. A two-lane ramp will diverge from westbound Northampton Boulevard east of the Wesleyan Drive intersection, then elevate on structure in the median to bypass the Wesleyan Drive/Premium Outlets Boulevard intersection. It will overpass westbound Northampton Boulevard, then split to provide one-lane ramp connections to westbound I-64 and eastbound I-64. The connection to eastbound I-64 will use the existing underpass of the I-64 mainline, and further west, will be located on a new alignment to replace the existing bridge carrying the ramp over Northampton Boulevard. The connection to westbound I-64 will generally follow the alignment of the existing ramp. The geometry for these ramps satisfy a minimum design speed of 35 mph. Profile grades are in the range of 0.5% to 7.0%.

- Westbound Northampton Boulevard "local" to westbound I-64 - This at-grade one-lane ramp will merge with the existing entrance ramp to westbound I-64 to serve traffic originating from Wesleyan Drive and Premium Outlets Boulevard. This will form a two-lane ramp which will taper to one lane prior to merging with westbound I-64. The geometry satisfies a minimum design speed of 45 mph. Profile grades are in the range of 0.5% to 1.5%.

Right-of-way impacts are anticipated at the following locations:

- Along the westbound I-64 exit ramp and along the south side of Northampton Boulevard, strip acquisitions from the parcel occupied by Norfolk Academy, with no direct impacts anticipated to the school's facilities.
- Along the entrance ramp to westbound I-64, a narrow strip acquisition from property owned by the City of Norfolk occupied by a linear park at Lake Wright.
- Along the south side of Northampton Boulevard east of Wesleyan Drive, strip acquisitions from seven residential parcels for roadway widening, and full acquisition of an undeveloped parcel for storm water management use.
- Along the north side of Northampton Boulevard east of Wesleyan Drive, strip acquisition from three commercial properties.
- Along westbound Northampton Boulevard west of the interchange, strip acquisition from two commercial parcels adjacent to the Northampton Boulevard/USAA Drive intersection.
- Along Kempsville Road approaching Northampton Boulevard, strip acquisition from two parcels owned by the City of Norfolk.

Under existing conditions, the I-64/Northampton Boulevard interchange provides full directional access with the exception of the movement from eastbound Northampton Boulevard to westbound I-64. This directional movement is provided at the adjacent I-64/Military Highway interchange located to the northwest. Conversely, the I-64/Military Highway interchange does not provide an entrance ramp to eastbound I-64, which is a movement provided at the Northampton Boulevard interchange. As such, these two interchanges operate in concert with each other to provide full directional movement between I-64 and the arterial roadway network.

The recommended improvements at the I-64/Northampton Boulevard interchange do not provide the missing eastbound Northampton-to-westbound I-64 movement. This is justified by the following:

- The geographic location of the two interchanges and the alignment of roadways between the two interchanges lend themselves to maintaining the current access arrangement. Table 5.2 presents estimated travel times from various origins to a common point on westbound I-64. The travel time estimates indicate shorter travel times to westbound I-64 from most motorist origins. Only traffic originating from the IKEA store would derive a travel time benefit by using the Northampton Boulevard interchange for destinations along westbound I-64, but only by a nominal margin.
- Opportunities to accommodate the missing movement at the Northampton Boulevard interchange with a new ramp are limited, based on land use and right-of-way constraints. Lake Wright (a drinking water source), the City of Norfolk Moore's Bridges Water Treatment Facility, Lake Taylor High School, and Norfolk Academy are all located adjacent to the interchange. A semi-directional ramp would have direct impacts to one or more of these. A loop ramp would have direct impacts to multiple ball fields and possibly buildings on the Norfolk Academy campus.
- The cost of new infrastructure required to accommodate the missing movement at the Northampton Boulevard interchange could increase the construction cost of recommended improvements at this interchange by an estimated $40M or more.

Based on these factors, the recommended improvements at this interchange do not include a ramp to accommodate the movement from eastbound Northampton Boulevard to westbound I-64.

I-64 Widening

Recommended improvements include widening of eastbound and westbound I-64 within the study area to accommodate projected traffic demand. Widening of eastbound and westbound I-64 will require replacement of the two parallel bridges carrying Providence Road over I-64. Improvements will also require widening of the Twin Bridges carrying I-64 over the Eastern Branch of the Elizabeth River.

Eastbound I-64 Widening - In the eastbound direction, a two-lane entrance ramp from Northampton Boulevard will merge with the three existing through lanes for a total of five continuous lanes to the I-64/I-264 interchange. Near the I-64 overpass of Virginia Beach Boulevard, eastbound I-64 will widen to provide a choice diverge lane, resulting in three lanes oriented to the ramps to I-264 and three through lanes. South of I-264, eastbound I-64 will be widened to provide one additional through lane to the Indian River Road interchange. Widening of eastbound I-64 to provide additional through travel lanes beyond the Indian River Road interchange is not necessary to accommodate projected 2044 traffic volumes.

Westbound I-64 Widening - In the westbound direction, a two-lane entrance ramp from Indian River Road will merge with four through lanes. One auxiliary ramp lane will drop near the Providence Road overpass, and the fifth lane will be carried to the I-64/I-264 interchange. Two exit ramp lanes diverge from the westbound I-64 mainline to eastbound I-264, and the additional westbound lane is carried into the I-64/I-264 interchange where it will terminate as an auxiliary lane for the existing loop ramp to westbound I-264. North of the I-64/I-264 interchange, westbound I-64 will be widened from the existing four-lane section to provide a total of six travel lanes - two lanes from the core of the I-64/I-264 interchange, two lanes from eastbound I-264, and three lanes (reduced to two) from westbound I-264. Two lanes will diverge as exit ramp lanes to Northampton Boulevard. The westbound slip ramp to the median reversible Express Lanes will be relocated approximately 2,200 ft north of its current location to enhance weave operations for motorists entering I-64 from I-264.

North of the exit ramp to Northampton Boulevard, westbound I-64 is recommended to operate with the three existing travel lanes and a shoulder running lane during the AM peak period. Minor widening of the westbound shoulder, the bridge carrying westbound I-64 over Northampton Boulevard, and the bridge carrying westbound I-64 over the eastbound I-64 entrance ramp is recommended to provide a full 12 ft wide shoulder and 2 ft offset to guardrail and bridge parapet. The westbound shoulder running lane is recommended to extend at least to the I-64/Military Highway interchange. Widening westbound I-64 beyond the I-64/Military Highway interchange should be examined in a subsequent study.

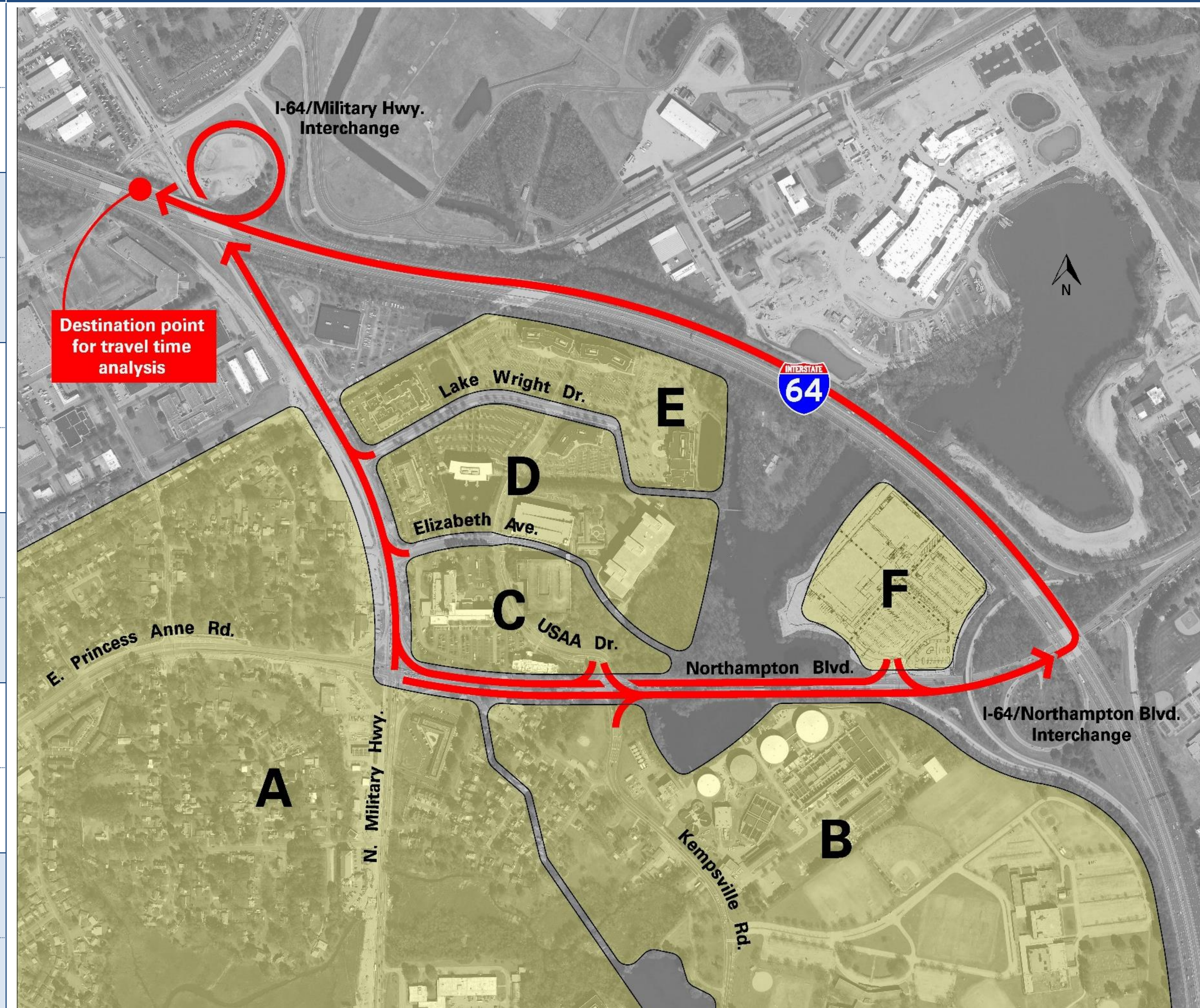
5.3 Decision Sight Distance

AASHTO guidance identifies decision sight distance as an important design element for interstate highways, especially in advance of exit ramps where decisions by drivers are required in areas containing multiple directional and regulatory signage. Decision sight distances are longer than stopping sight distances across the range of design speeds used because the additional length offers drivers additional margin for error and affords them sufficient time and distance to maneuver their vehicles rather than to stop.

AASHTO guidance provides two tiers of recommended decision sight distance - recommended and minimum. "Desired recommended" lengths are derived based on the time required for motorists actions prior to arrival at a decision point such as a physical ramp gore. "Desired minimum" values are calculated as 125% of the stopping sight distance. AASHTO guidance also states: "If it is not practical to provide decision sight distance because of horizontal or vertical curvature or if relocation of decision points is not practical, special attention should be given to the use of suitable traffic control devices for providing advance warning of the conditions that are likely to be encountered."

Table 5.3 on page 5-10 summarizes decision sight distance values in advance of exit ramp decision points within the study area under existing and recommended build conditions. Values are based on a review of record drawings, base mapping, online imagery, and conceptual design activities completed to date for the recommended improvements. Under existing conditions, four locations fail to provide minimum decision sight distance:

Table 5.2: Travel Time Justification for Partial Interchange at Northampton Boulevard

Area	Origin	Travel Route to Destination Point along WB I-64 [1]	Estimated Travel Time (min:sec) [2]	Shorter Travel Time	Area Map
A	Princess Anne Rd., west of Military Hwy. or Military Hwy., south of Northampton Blvd.	via I-64 / Northampton Blvd. interchange	02:54		
		via I-64 / Military Hwy. interchange	01:29	✓	
B	Kempsville Rd., south of Northampton Blvd.	via I-64 / Northampton Blvd. interchange	02:32		
		via I-64 / Military Hwy. interchange	01:50	✓	
C	Commercial developments along USAA Dr. (south)	via I-64 / Northampton Blvd. interchange	03:05		
		via I-64 / Military Hwy. interchange	01:34	✓	
D	Commercial developments along USAA Dr. (north)	via I-64 / Northampton Blvd. interchange	03:17		
		via I-64 / Military Hwy. interchange	01:51	✓	
E	Commercial developments north of Lake Wright Dr.	via I-64 / Northampton Blvd. interchange	03:18		
		via I-64 / Military Hwy. interchange	01:29	✓	
F	IKEA	via I-64 / Northampton Blvd. interchange	02:04	✓	
		via I-64 / Military Hwy. interchange	02:17		

[1] A loop ramp is the assumed ramp configuration for the missing movement from eastbound Northampton Boulevard to westbound I-64, although a loop ramp may not be preferred or viable at this location. Travel route shown is conceptual.

[2] Travel times are not modeled, but are computed based only on posted speed limits and roadway segment lengths. No time is estimated for intersection delay.

Table 5.3: Evaluation of Decision Sight Distance

Location	Design Speed (mph)	Diverge Decision Point	Approximate DSD Existing Conditions (ft)	Preferred DSD [1] (ft)	Minimum DSD [2] (ft)	Approximate DSD Provided [3] (ft)	Meets Guidance?
EB I-64 mainline	70	Exit ramp to Northampton Boulevard	630	1,445	913	(existing)	no
	70	Diverge, ramps to EB & WB I-264	>1,500	1,445	913	>1,500	Preferred
	70	Exit ramp to EB I-264 outer C/D	1,250	1,445	913	(existing)	Minimum
	70	Exit ramp to WB Indian River Road	1,450	1,445	913	1,450	Preferred
	70	Exit ramp to EB Indian River Road	977	1,445	913	1,100	Minimum
WB I-64 mainline	70	Exit ramp to EB Indian River Road	>1,500	1,445	913	>1,500	Preferred
	70	Exit ramp to WB Indian River Road	>1,500	1,445	913	(existing)	Preferred
	70	Exit ramp to EB I-264	>1,500	1,445	913	(existing)	Preferred
	70	Exit ramp to WB I-264	>1,500	1,445	913	(existing)	Preferred
	70	Slip ramp to median Express Lanes	>1,500	1,445	913	>1,500	Preferred
	70	Exit ramp to Northampton Boulevard	>1,500	1,445	913	>1,500	Preferred
EB I-264 mainline	70	Exit to EB C/D roadway	>1,500	1,445	913	(existing)	Preferred
	70	Exit ramp to Witchduck Road	570 [5]	1,445	913	(existing)	no
EB I-264 C/D roadway	60	Exit ramp to NB Military Highway	>1,500	1,280	713	(existing)	Preferred
	60	Exit ramp to I-64 EB/WB ramp	--	1,280	713	1040	Minimum
WB I-264 mainline	70	Exit ramp to Witchduck Road	700	1,445	913	920	Minimum
	70	Exit to WB outer C/D roadway	>1,500	1,445	913	1,450	Preferred
WB I-264 outer ramp network	60	Exit ramp to Newtown Road	--	1,280	713	>1,500	Preferred
	45	Diverge, ramps to EB & WB I-64	--	930	450	900	Minimum
WB I-264 C/D roadway	60	Exit ramp to outer ramp network	--	1,280	713	1,160	Minimum
	60	Exit ramp to Military Highway	1,020	1,280	713	(existing)	Minimum
Ramp, EB I-64 to EB & WB I-264	40	Ramps to EB I-264 and WB I-264	330	825	382	700	Minimum
Ramp, EB I-264 to EB & WB I-64	50	Ramps to EB I-64 and WB I-64	--	1,030	532	900	Minimum
Entrance ramp from Newtown Road to WB I-264 C/D roadway	30	Ramps to WB I-264 C/D roadway and outer ramp network	--	620	250	480	Minimum
Exit ramp to Newtown Road	30	North and south ramps to Newtown Road	--	620	250	425	Minimum
Ramp, WB I-64 to EB I-264	45 [5]	Ramps to EB I-264 inner and outer C/D roadways	545 [5]	930	450	(existing)	Minimum
EB I-264 outer C/D roadway	45 [5]	Exit ramp to SB Newtown Road	800 [5]	930	450	(existing)	Preferred
EB I-264 outer C/D roadway	45 [5]	Loop exit ramp to NB Newtown Road	742 [5]	930	450	(existing)	Minimum
Ramp, WB I-64 to Northampton Boulevard	50	Diverge, ramps to WB and EB Northampton Boulevard	--	1,030	532	1,050	Preferred

[1] Decision sight distance per AASHTO guidance per Green Book, Table 3-3, Avoidance Maneuver E.

[2] Stopping sight distance x 1.25, rounded up to the nearest foot. AASHTO guidance per Green Book, p. 10-92; "The sight distance on a freeway preceding the approach nose of an exit ramp should exceed the minimum stopping sight distance for the through traffic design speed, desirably by 25 percent or more."

[3] All decision sight distances provided for the recommended alternative are subject to refinement during future design stages of project development.

[4] Decision sight distance will be constrained by the profile of I-264 at the overpasses of the railroad and Witchduck Road. As such, the decision sight distance will be at least equal to the stopping sight distance for a design speed of 70 mph.

[5] Value is based on evaluation of design plans prepared for improvements that are currently under construction.

- Eastbound I-64, approach to loop exit ramp to eastbound and westbound Northampton Boulevard - Decision sight distance at this location is limited by horizontal and vertical curvature of the eastbound I-64 mainline roadway. Correction of this condition would require full reconstruction of the eastbound portion of the interstate, and is beyond the scope of recommended improvements.
- Eastbound I-264 approach to the exit ramp to northbound and southbound Witchduck Road - The profile of eastbound I-264 limits the decision sight distance to the apparent stopping sight distance for the existing vertical curve over the railroad situated east of Witchduck Road. Recommended improvements do not include reconstruction of the bridge carrying I-264 over the railroad, and therefore will not correct the deficient decision sight distance at this location. This condition will be mitigated with the use of overhead signage in advance of the exit ramp.
- Westbound I-264, approach to exit ramp to Witchduck Road - Decision sight distance is limited by horizontal curvature of the I-264 mainline roadway. This condition will be corrected with shoulder widening as part of the recommended improvements.
- Exit ramp from eastbound I-64, approach to diverge to eastbound and westbound I-264 - Under existing conditions the decision sight distance in advance of this ramp diverge is limited by vertical curvature. This condition will be corrected with the recommended improvements.

5.4 Multiple Turn Lanes at Intersections

Dual Turn Lanes at Intersections

The recommended improvements will result in dual-lane turning movements at the following locations:

- Westbound I-264 C/D exit ramp to Military Highway, dual right onto Military Highway
- Southbound Military Highway, dual left onto entrance ramp to eastbound I-264 C/D roadway
- Northbound Military Highway, dual right onto entrance ramp to eastbound I-264
- Northbound Military Highway, dual left onto Hoggard Road
- Westbound Corporate Boulevard, dual left onto Military Highway
- Eastbound Poplar Hall Drive, dual left onto Military Highway
- Westbound Princess Anne Road, dual right onto Newtown Road (under PM peak hour conditions only; this will convert to a single right during the AM peak hour using dynamic lane use control)
- Eastbound Kempsville Road, dual left onto Newtown Road
- Westbound Greenwich Road, dual right onto Newtown Road
- Eastbound I-264 loop exit ramp to Newtown Road, dual right onto Newtown Road
- Eastbound Center Drive, dual right onto Newtown Road
- Westbound I-264 south exit ramp to Newtown Road, dual left onto Newtown Road
- Westbound I-264 north exit ramp to Newtown Road, dual right onto Newtown Road
- Northbound Newtown Road, dual right onto the entrance ramp to westbound I-264
- Westbound Cleveland Street, dual left onto Newtown Road
- Westbound Grayson Road, dual right onto Witchduck Road
- Southbound Witchduck Road, dual left onto Grayson Road
- Westbound I-264 exit ramp to Witchduck Road, dual left onto Witchduck Road
- Northbound Witchduck Road, dual left onto westbound I-264 entrance ramp
- Westbound Southern Boulevard, dual left onto Witchduck Road
- Westbound Cleveland Street, dual left onto Witchduck Road (under PM peak hour conditions only; this will convert to a single left during the AM peak hour using dynamic lane use control)
- Eastbound Cleveland Street, dual right onto Witchduck Road (geometry modified from existing)
- Southbound Reon Drive, dual left onto Indian River Road
- Westbound Indian River Road, dual left onto the entrance ramp to eastbound I-64
- Westbound Indian River Road, dual left onto Regent University Drive
- Southbound Founders Inn Drive (opposite Regent University Drive), dual left onto Indian River Road
- Westbound Indian River Road, dual left onto Centerville Turnpike
- Eastbound Northampton Boulevard, dual right onto entrance ramp to eastbound I-64
- Westbound Northampton Boulevard, dual left onto entrance ramp to eastbound I-64
- Westbound Northampton Boulevard, dual left onto Kempsville Road
- Eastbound Northampton Boulevard, dual left onto Premium Outlets Boulevard
- Southbound Premium Outlets Boulevard, dual left onto Northampton Boulevard
- Southbound Premium Outlets Boulevard, dual right onto Northampton Boulevard

In general, dual turn lanes are used where capacity analyses conducted for projected 2044 peak hour periods demonstrate a need for more than one turn lane. Dual turn lanes are provided to allow for the signal green time to be reallocated to other movements that experience heavy demand. This design approach minimizes queue lengths and overall delay, and better accommodates pedestrian walk phases. The design of intersection features where dual left turn lanes are proposed will follow VDOT guidance provided in the VDOT Roadway Design Manual (Appendix F, Section 3). Proposed intersection geometry for all dual lane turning movements will be verified during subsequent stages of design using AutoTurn® software, v10.0 or later.

Triple Turn Lanes at Intersections

Triple-lane turning movements are proposed at the following locations:

- Eastbound I-264 C/D exit ramp to Military Highway, triple left onto Military Highway
- Westbound I-264 C/D exit ramp to Military Highway, triple left onto Military Highway
- Eastbound Corporate Boulevard, triple left onto Military Highway
- Eastbound I-264 exit ramp to Newtown Road, triple right onto Newtown Road
- Southbound Newtown Road, triple left onto Princess Anne Road
- Southbound Newtown Road triple left onto Greenwich Road
- Southbound Newtown Road, triple left onto the entrance ramp to westbound I-264
- Northbound Witchduck Road, triple left onto the entrance ramp to eastbound I-264
- Westbound I-264 exit ramp to Witchduck Road, triple right onto Witchduck Road
- Westbound I-264 exit ramp to Witchduck Road, triple left onto Witchduck Road
- Eastbound I-264 exit ramp to Witchduck Road, triple left onto Witchduck Road
- Northbound Witchduck Road, triple left onto Cleveland Street
- Eastbound Cleveland Street, triple right onto Witchduck Road
- Northbound Regent University Drive, triple left onto Indian River Road
- Northbound Centerville Turnpike, triple left onto Indian River Road
- Southbound USAA Drive, triple left onto Northampton Boulevard
- Northbound Kempsville Road, triple left onto Northampton Boulevard
- Exit ramp from eastbound I-64 to Northampton Boulevard, triple right onto Northampton Boulevard
- Exit ramp from westbound I-64 to Northampton Boulevard, triple left onto Northampton Boulevard
- Northbound Wesleyan Drive, triple left onto Northampton Boulevard

VDOT does not provide specific guidance on the design of intersection geometry for triple left-turn movements. Accordingly, VDOT guidance for each lane of a dual left-turn movements will be applied to each lane of the triple left turn movement. As with the dual left-turn movements, proposed geometry for triple left-turn movements will be verified using AutoTurn® software and reviewed with VDOT staff for approval during subsequent stages of design.

The design approach for triple left-turn movements will be to accommodate the turning paths for concurrent turns by a WB-67 design vehicle in each of the outer two turn lanes. An SU-40 design vehicle will be accommodated in the innermost turn lane. Proposed signage and pavement markings are addressed in Section 5.9.

Research conducted by the University of Florida Transportation Research Center ("*Triple Left-Turn Lanes at Signalized Intersections*"; Courage, Stephens, Gan, & Willis, 2002) evaluated operational and safety performance of triple left-turn movements at several sites in Florida. In general, the triple left-turn movements studied did not demonstrate an appreciable increase in crash frequency over dual left-turn movements in similar settings. Further, the study concluded that the percentages of crashes at study locations involving the triple left-turn movements were not over-represented for various crash types, especially considering the high volumes each movement serves.

The research contains recommendations to FDOT for study and design of triple left-turn lanes. These are generally the same as those proposed by other research focusing on this topic, *Criteria for the Geometric Design of Triple Left-Turn Lanes* Ackeret, 1994, as well as online guidance provided by FHWA (www.fhwa.dot.gov/publications/-research/safety/04091/12.cfm#c1212). Composite recommendations for the design of triple left-turn lanes are summarized in Table 5.4, along with the corresponding design approach.

Table 5.4: Research Recommendations for Triple Left Movements vs. Design Approach

Technical Recommendation	Design Approach
Conduct operational analysis using appropriate design software.	Triple left-turn movements were analyzed using Synchro software, and modeled using VISSIM software.
Analyze turning paths for appropriate design vehicle with min 2 ft lateral separation. [1]	Turn paths will provide 2 ft min. separation for one SU-40 in the inner lane and two concurrent WB-67s in outer lanes.
Provide three downstream receiving lanes for 300 ft, and at least two lanes beyond that.	Three downstream receiving lanes provided for 300 ft minimum, with two lanes provided beyond.
Provide clear pavement markings.	Pavement markings will comply with current VDOT design guidance.
Resolve conflicts with pedestrians and bicyclists.	Triple left-turn movements will be phased separately from pedestrian movements.
Provide exclusive left-turn lanes (preferred).	Exclusive left-turn lanes will be provided.
Provide adequate signage (advance overhead lane use signage preferred).	Advance overhead lane use signage will be provided, consistent with VDOT/MUTCD guidance.
Provide raised median with a width of at least 2 ft (4 ft preferred) next to receiving lanes.	Raised median adjacent to receiving lanes will be provided.
Provide storage bay of adequate length.	Storage lengths will be maximized, and limited where necessary by adjacent intersections or other constraints.

[1] Courage, Stephens, Gan, and Willis recommend a 4 ft separation; Ackeret recommends a 2 ft separation.

5.5 Acceleration and Deceleration Distances

The recommended improvements include new entrance and exit ramps to I-64 and I-264 at each of the interchanges studied. Required acceleration and deceleration lengths for ramps are set forth in the AASHTO Green Book. Tables 5.5 and 5.6 summarize the acceleration and deceleration lengths for ramps included in the conceptual layout of recommended alternatives. Where entrance ramps are situated upstream of exit ramps, the layout provides sufficient acceleration and deceleration distances without overlap.

Recent research documented in the 2012 NCHRP Report 730 ("*Design Guidance for Freeway Mainline Ramp Terminals*") has considered whether ramps serving high truck volumes should be designed with longer acceleration and deceleration distances. Key findings and recommendations of the research are excerpted as follows:

- "A value of 1,000 ramp trucks/day appears to be a good threshold for defining when the truck volume is significant, but this value should not be considered an absolute."
- ". . . freeway mainline ramp terminals should be designed based upon free-merge/diverge conditions (i.e., free-flow conditions) . . . [which provide] sufficient length . . . to accommodate merging/diverging behaviors during more congested operating conditions. This is consistent with current AASHTO policy."
- "It is most appropriate to design freeway mainline ramp terminals based upon average operating speeds of vehicles, rather than design speeds . . . [which is] consistent with current AASHTO policy. Designs based upon design speeds would provide terminals that are over-designed."

Accordingly, required distances cited in Tables 5.5 and 5.6 use AASHTO prescribed values, without adjustments.

Table 5.5: Acceleration Lengths for Entrance Ramps

Ramp	Truck volume >1,000 vph?	Speed Change	Distance Required (ft)	Distance Provided (ft)
EB & WB I-264 to WB I-64	yes	40 - 70 mph	1,000	1,685
EB I-64 to EB I-264 inner C/D	yes	50 - 70 mph	580	1,230
EB I-64 to WB I-264 C/D	no	45 - 70 mph	820	>1,000 [1]
EB I-264 C/D to EB I-64	no	30 - 70 mph (existing)	1,350	480
WB I-264 outer ramp to EB I-64	no	40 - 70 mph	1,000	2,380
EB I-64 to EB I-264 outer C/D	no	25 - 60 mph (existing)	1,020	1,020
WB I-64 to WB I-264 C/D	no	25 - 60 mph (existing)	1,020	>1,020 [2]
SB Military Highway to WB I-264 C/D	no	15 - 60 mph	570	1,230
NB Military Highway to WB I-264 C/D	no	25 - 60 mph	1,020	>1,200 [2]
Military Highway to EB I-264 C/D	no	25 - 60 mph	1,020	>1,200 [2]
Newtown Road to WB I-264 outer ramp to I-64	no	50 - 60 mph	180	>180 [1][2]
Newtown Road to WB I-264 C/D	no	30 - 60 mph	910	1,350
Witchduck Road to WB I-264 C/D	no	50 - 60 mph	180	>180 [2]
Witchduck Road to EB I-264	no	30 - 70 mph	1,350	1,425 [2]
WB Northampton to WB I-64	no	40 - 70 mph (existing)	1,000	1,260
EB & WB Northampton Boulevard to EB I-64	yes	50 - 70 mph	580	>1,000 [2]

[1] Reported distance is exclusive of deceleration distance to downstream exit ramp.

[2] Ramp lane enters through travelway as an additional through lane.

Table 5.6: Deceleration Lengths for Exit Ramps

Ramp	Truck volume >1,000 vph?	Speed Change	Distance Required (ft)	Distance Provided (ft)
EB I-64 to WB I-264	no	70 - 45 mph	390	580
EB I-64 to EB I-264	yes	70 - 40 mph	440	1,500
EB I-64 to EB I-264 C/D	no	70 - 25 mph (existing)	550	980
WB I-64 to WB I-264 C/D	no	70 - 30 mph (existing)	520	830
EB I-264 C/D to EB I-64	no	60 - 45 mph	300	370
EB I-264 C/D to WB I-64	yes	60 - 40 mph	350	1,070
WB I-264 outer ramp to WB I-64	yes	60 - 40 mph	350	>700 [3]
WB I-264 outer ramp to EB I-64	no	60 - 40 mph	350	>700 [3]
EB I-264 C/D to Military Highway	no	60 - 20 mph	480	1,200
WB I-264 C/D to Military Highway	no	60 - 30 mph	430	>430 [3]
WB I-264 C/D to Newtown Road	no	60 - 40 mph	350	>1,200
Exit ramp to NB Newtown Road	no	40 - 25 mph	200 [4]	>1,200
EB I-264 to Witchduck Road	no	70 - 30 mph	520	>520 [3]
WB I-264 to Witchduck Road	no	70 - 50 mph	340	340
EB I-64 to WB Indian River Road	no	70 - 30 mph	520	1,020
EB I-64 to EB Indian River Road	no	70 - 30 mph	520	>1,200
WB I-64 to WB Indian River Road	no	70 - 30 mph	520	860
WB I-64 to EB Indian River Road	no	70 - 30 mph	520	520
EB I-64 to Northampton Boulevard	no	70 - 35 mph (existing)	490	850
WB I-64 to Northampton Boulevard	yes	70 - 30 mph	570	1,265

[1] Reported distance is exclusive of deceleration distance to downstream exit ramp.

[2] Ramp lane enters through travelway as an additional through lane.

[3] Reported distance is exclusive of acceleration distance for preceding entrance ramp.

[4] Distance not provided in AASHTO Green Book Table 10-5. Required distance is estimated.

The proposed layout retains several existing ramps without geometric improvements. One entrance ramp (from the eastbound I-264 C/D road to eastbound I-64) does not provide required acceleration distance under existing conditions. Improvement to extend the acceleration lane at this location are not proposed in order to minimize impacts to tidal wetlands and the floodplain associated with Nosehs Creek, which is a tributary to the Eastern Branch Elizabeth River. However, with the recommended improvements, traffic demand on this ramp will be reduced from 2,770 vph to 623 vph during the AM peak period, and from 2,875 vph to 1,286 vph during the 2044 PM peak period. With these volume reductions, microsimulation analyses indicate favorable operations without extending the acceleration lane.

5.6 Proposed Limited Access (L/A) Lines

AASHTO guidance recommends that a break in the access control line along crossroads or frontage roads that intersect interstates should be no closer to the ramp terminal than 100 ft in urban conditions. For the purposes of interpreting this guidance for this study, the study area is considered to be in an urban setting. Recommended improvements to interchanges within the study area will require that L/A lines be adjusted to comply with AASHTO guidance. These adjustments will be coordinated with detailed design during subsequent stages of project development.

5.7 Design Exceptions (DEs)

VDOT policy set forth in I&IM-LD-227.11 requires documentation and approval of Design Exceptions (DEs) when deviations from AASHTO design criteria occur on VDOT-owned and VDOT-maintained roadways relative to 10 controlling design elements. Table 5.7 summarizes design exceptions associated with the geometric layout of the recommended improvements, based on the conceptual design prepared to support this study. The need for Design Exceptions will continue to be evaluated through the preliminary design phase of project development.

DE1 - WB I-64 Shoulder Width at I-64/I-264 Interchange

Under existing conditions, the left lane on westbound I-64 drops at a point approximately 1,900 ft north of the crossing of the Eastern Branch Elizabeth River. The recommended improvements include widening westbound I-64 to continue the left (third) lane beyond this lane drop. Lateral clearance is limited at this location by the median HOV facility on the left and the gore of the exit ramp to eastbound I-264 on the right. To fit the third lane through this area, the left shoulder must be reduced. To avoid this Design Exception, the new ramp currently being constructed to eastbound I-264 would need to be moved east, or the median HOV facility and eastbound I-64 mainline would need to be shifted west. Both facilities are situated on structures (bridge and walled section, respectively) at this location.

DE2 - EB & WB I-264 Shoulder Width at I-264/Military Highway Interchange

DE2 is associated with reconstruction of the bridge carrying Frontage Road over I-264, and the placement of a bridge pier in line with the median barrier separating eastbound and westbound I-264 mainline roadways. The existing bridge is supported by a pier located in the same median barrier. The new pier will have the same approximate dimensions and will be located approximately 40 ft east of the existing pier, allowing the existing bridge to remain in service during construction of the new bridge. To avoid this Design Exception, the alignments of the eastbound and westbound I-264 mainline roadways would each need to be shifted outward by approximately 9 ft to create wider shoulders. In addition, the eastbound and westbound I-264 C/D roadways would each need to be realigned and shifted outward approximately 20 ft. The extent of remedial improvements needed to avoid this Design Exception are impractical, and would likely equal or exceed the cost of the new bridge.

DE3 - WB I-64 Shoulder Width at I-64/Northampton Boulevard Interchange

DE3 will be required to operate a shoulder running lane along the outside of the westbound I-64 general-purpose travel lanes north of the exit to Northampton Boulevard. During the AM peak period, the existing 12 ft right shoulder will be operated as a travel lane. This Design Exception will address the proposed 2 ft lateral offset from the edge of the shoulder lane to the guardrail and bridge parapets, which will require minor roadway and bridge widening. The lateral offset will be the effective shoulder width during periods of shoulder operation.

DE4 - Vertical Clearance, Bridges over Northampton Boulevard and Ramp

Similar to DE3, DE4 will also be required to operate a shoulder running lane along westbound I-64 in the vicinity of the I-64/Northampton Boulevard interchange. Bridge No. 2830 carries westbound I-64 over Northampton Boulevard, and Bridge No. 2827 carries westbound I-64 over the ramp from westbound Northampton Boulevard to eastbound I-64. Under existing conditions, the vertical clearance beneath each of these bridges is less than the minimum required value of 16'-6". For each bridge, the deck will undergo minor widening on the high side of superelevation to provide a 2 ft lateral offset from the edge of the shoulder running lane to the bridge parapet. This widening will not reduce the available vertical clearance for either bridge, nor will the widening correct the deficiency at either location.

Table 5.7: Design Exceptions and Design Waivers Required for the Recommended Alternative

		Interchange	Roadway	Location	Value Required	Value Provided [1]	Comments
Design Exceptions							
DE1	Shoulder width	I-64/I-264	WB I-64	left shoulder, thru lanes at ramp to EB I-264	12 ft	12 - 7.7 ft	Avoids reconstruction of median HOV facility, EB I-64 mainline, ramp to EB I-264
DE2	Shoulder width	I-264/Military Highway	WB I-264 mainline	left shoulder, at pier for Frontage Road bridge	12 ft	12 - 3 ft	Replicates narrow shoulder at location of existing bridge to be replaced.
DE3	Shoulder width	I-64/Northampton Blvd,	WB I-64 mainline	north of exit ramp to Northampton Boulevard	12 ft	2 ft	Shoulder running lane is recommended to serve AM peak period demand only.
DE4	Vertical clearance	I-64/Northampton Blvd.	WB I-64 mainline	Bridge 2830 (I-64 WBL over Northampton Boulevard) & Bridge 2827 (64 WBL over ramp from Northampton Blvd. to EB I-64)	16-6"	14'-6" / 15'-3"	Bridges to be widened with no further reduction in vertical clearance at either location.
Design Waivers							
DW1	Ramp separation	I-64/I-264	EB I-264 C/D	between exit ramp from EB C/D and diverge to EB & WB I-64	800 ft	702 ft	Location of Military Highway and I-64 interchanges fixed; preceding ramp separation distance is met.
DW2	Ramp separation	I-64/I-264	WB I-64	between EB & WB I-264 ramps and merge to WB mainline I-64	800 ft	590 ft	Reduced ramp separation distance increases weave distance for motorists oriented to Express Lanes.
DW3	SE transition length	I-64/I-264	WB I-64	ramp from EB I-264 (45 mph)	385 ft	310 ft	Reduced tangent length used to avoid/minimize right-of-way impacts.
DW4	SE transition length	I-64/I-264	EB I-64	ramp to WB I-264 (40 mph)	241 ft	201 ft	Ramp geometry similar to existing, and reuses existing pavement to avoid right-of-way impacts.
DW5	SE transition length	I-64/I-264	EB I-64	ramp to WB I-264 (40 mph)	241 ft	144 ft	Ramp geometry similar to existing, and reuses existing pavement to avoid right-of-way impacts.
DW6	SE transition length	I-64/I-264	WB I-264 C/D	ramp to EB I-64 (45 mph)	407 ft	263 ft	Geometry allows new ramp to be constructed while existing ramp remains in service.
DW7	Ramp design speed	I-264/Military Highway	EB I-264 entrance ramp	controlling horizontal curve	30 mph	25 mph	Curvature reduced to provide required ramp separation distance along EB I-264 C/D roadway.
DW8	SE transition length	I-264/Military Highway	EB I-264 entrance ramp	tangent (25 mph)	200 ft	128 ft	Positions controlling curve to maximize downstream ramp separation along EB I-264 C/D roadway.
DW9	Sidewalk buffer width	I-264/Newtown Road	Newtown Road	east side, north of Princess Anne Road	4.0 ft	0 - 2.5 ft	Minimizes right-of-way impacts and avoid full take and relocation of commercial properties.
DW10	Ramp design speed	I-264/Witchduck Road	WB I-264 exit ramp	crest vertical curvature	40 mph	35 mph	Ramp length limited to avoid impacts to Mac Street and full take and relocation of commercial property.
DW11	SE transition length	I-64/Northampton Blvd.	WB I-64 exit ramp	exit ramp to Northampton (35 mph)	167 ft	111 ft	Minimizes right-of-way impacts to Norfolk Academy.
DW12	SE transition length	I-64/Northampton Blvd.	EB I-64 entrance ramp	entrance ramp from Northampton (40 mph)	268 ft	247 ft	Allows construction of new bridge over Northampton Blvd. with existing bridge in service.

[1] Values are subject to change as a result of design refinement during subsequent stages of project development.

5.8 Design Waivers (DWs)

Pursuant to VDOT I&IM 227.11, VDOT policy requires Design Waivers (DWs) be approved when deviations from VDOT's design criteria occur on VDOT-owned and VDOT-maintained roadways. Table 5.8 summarizes Design Waivers by interchange location associated with the geometric layout of the recommended alternative, based on the conceptual design prepared to date. The need for Design Waivers will continue to be evaluated through the preliminary design phase of project development.

The Design Waivers are associated with several design requirements set forth by AASHTO and VDOT, including the following:

- Ramp separation - AASHTO design guidance recommends separation of successive ramps to allow for adequate weaving distance and signage placement. For DW1, the distance between the ramps is constrained by the distance between the I-264/Military Highway interchange and the I-64/I-264 interchange, which is fixed and cannot reasonably be increased. For waiver DW2, the distance between the affected ramps is reduced to increase the downstream distance along westbound I-64 to the slip ramp entering the Express Lanes.
- Superelevation transition length - AASHTO and VDOT design guidance recommends the length of superelevation transitions that are empirically derived, and achieve rates of pavement surface rotation that are comfortable and visually appealing to motorists. Within the study area, developed and environmentally sensitive properties adjacent to the interstate right-of-way pose design constraints. As a result, it is preferable in some cases to design successive horizontal curves such that minimum transition lengths are not provided. This is the justification for DW3, DW4, and DW5 at the I-64/I-264 interchange; and waiver DW11 at the I-64/Northampton Boulevard interchange.

  DW6 (I-64/I-264 interchange) and DW12 (I-64/Northampton Boulevard interchange) are needed to allow new ramps to be constructed while leaving existing ramps in service. DW8 (I-264/Military Highway interchange) allows the eastbound entrance ramp to be positioned such that the resulting spacing to the downstream ramp satisfies AASHTO guidance.
- Ramp design speed - AASHTO design guidance recommends a range of ramp design speeds that correlate to the mainline design speed and the ramp configuration. Where the design speed cannot be met, a waiver is needed to address the pairing of ramp design speed with mainline design speed, even though design elements of the ramp itself satisfy the reduced design speed.

  For DW7 (I-264/Military Highway interchange), the design speed of the controlling horizontal curve on the eastbound entrance ramp is reduced to 25 mph. This results in the gore shifting to the west, and the downstream ramp separation distance satisfying design guidance. For DW10 (I-264/Witchduck Road interchange), the westbound I-264 exit ramp design speed is reduced to 35 mph to allow use of a shortened crest vertical curve on the ramp. Use of a longer crest vertical curve to satisfy the recommended design speed of 40 mph would require a longer ramp along an alignment that impacts Mac Street. This would, in turn, affect primary access to a commercial property and likely result in that property's full acquisition and business relocation.
- Sidewalk buffer width - VDOT design guidance requires a lateral setback from the back of curbing or curb and gutter to the near edge of sidewalk. The setback, or buffer strip, allows for placement of signage and enhances pedestrian comfort. DW9 (I-264/Newtown Road interchange) is needed to minimize right-of-way impacts to developed commercial properties along the east side of Newtown Road north of Princess Anne Road. The affected properties include a gas station with pumps and a canopy in proximity to the property frontage, and three commercial office buildings with constrained site layouts and/or parking in proximity to the property frontage.

5.9 Pedestrian and Bicycle Accommodations

The recommended build alternative includes improvements to enhance mobility for pedestrians and bicyclists. Where no sidewalks are provided under existing or projected no-build conditions, they are provided as part of the recommended improvements. Where recommended improvements will impact existing sidewalk, replacement facilities will be provided.

Pedestrian/bicycle facilities are included in the recommended improvements at the following locations, with the reason for the new facilities identified in parentheses:

- Replacement of the bridge carrying a shared use path across I-264, approximately 1,500 ft west of I-64 (highway widening)
- Sidewalk, west side of Military Highway, from 900 ft south of Curlew Drive to Pebble Lane (gap in existing sidewalk network).
- Sidewalk, west side of Frontage Road, from Curlew Drive to Military Highway (replacement due to roadway realignment).
- Sidewalk, both sides of extended Piping Rock Road, from Pebble Lane to Frontage Road (new roadway).
- Sidewalk along portions of Kempsville Road, Princess Anne Road, and Newtown Road south of Greenwich Road (roadway widening).
- Sidewalk, both sides of Newtown Road between Greenwich Road and Center Drive (gaps in existing sidewalk network).
- Sidewalk, east side of Newtown Road between Center Drive and Cleveland Street (gap in existing sidewalk network and roadway widening).
- Sidewalk, west side of Newtown Road between Cleveland Street and Coliss Avenue (roadway widening).
- Sidewalk, west side of Witchduck Road between Grayson Road and Cleveland Street (roadway widening).
- Shared use path, both sides of Indian River Road from of Reon Drive to Centerville Turnpike (roadway widening).
- Shared use path, south side of Indian River Road from Centerville Turnpike to 600 ft east of Centerville Turnpike (roadway widening).
- Sidewalk, north side of new north bridge and south side of new south bridge carrying Providence Road over I-64 (bridge replacement).
- Sidewalk, south side of Northampton Boulevard between IKEA Way and Norwich Avenue (roadway widening).
- Bike lanes, both sides of Northampton Boulevard between USAA Drive and IKEA Way (system continuity between improvements at adjacent intersections).

Improvements comply with the City of Norfolk Bicycle and Pedestrian Strategic Plan (2014). Improvements comply with the 2011 City of Virginia Beach Bikeways and Trails Plan, with the exception of facilities along Indian River Road. The city's plan includes on-street bike lanes in both directions along Indian River Road. The recommended improvements reflect the use of shared use paths rather than on-street bike lanes based on the following considerations:

- The VDOT Road Design Manual recommends use of shared use paths or a separated bike lane for prevailing conditions on Indian River Road: ADT over 10,000 vpd, no on-street parking, design speed of 45 mph, and posted speed limit of 45 mph.
- Improvements along Indian River Road include long right turn lanes and auxiliary lanes, some of which measure 1,100 ft long. An on-street bike lane would therefore need to operate between high speed travel lanes for extended distances.
- The right-of-way along Indian River Road is adjacent to residential properties and parking lots for developed commercial parcels. A typical section featuring shared use paths requires less width than a typical section incorporating separated on-street bike lanes and sidewalks, and would therefore result in fewer impacts to

adjacent properties.

Final decisions regarding the nature and extent of bicycle and pedestrian facilities along Indian River Road will be made during preliminary design. Likewise, where transit bus stops are located within the project limits, they will be accommodated during the preliminary design phase.

5.10 Signage and Pavement Markings

A conceptual signage plan was prepared for the recommended build alternative and is provided in Appendix E. The layout was developed to comply with current requirements set forth by the Manual on Uniform Traffic Control Devices (MUTCD)(2009 Edition) and VDOT MUTCD Supplement (2011 Edition).

The layout focuses on large-scale guide signs needed for motorist orientation and directional aid, but does not identify regulatory and warning signs that will be needed. Signage layout is coordinated with existing signage to remain, and proposed pavement markings. The signing plan is subject to refinement and further detailing during subsequent stages of project development and detailed design activities.

Pavement markings are illustrated at a conceptual level in Figures 5-2 through 5-14 on the following pages, and in a large-format exhibit in Appendix E. Markings are provided for travel lanes, shoulders, lane additions, lane reductions, HOV lanes, stop bars, and crosswalks. Detailed markings such as gore striping are not illustrated and will be prepared during final design.

Figure 5-2 - Conceptual Signing Plan, I-64 South of Indian River Road

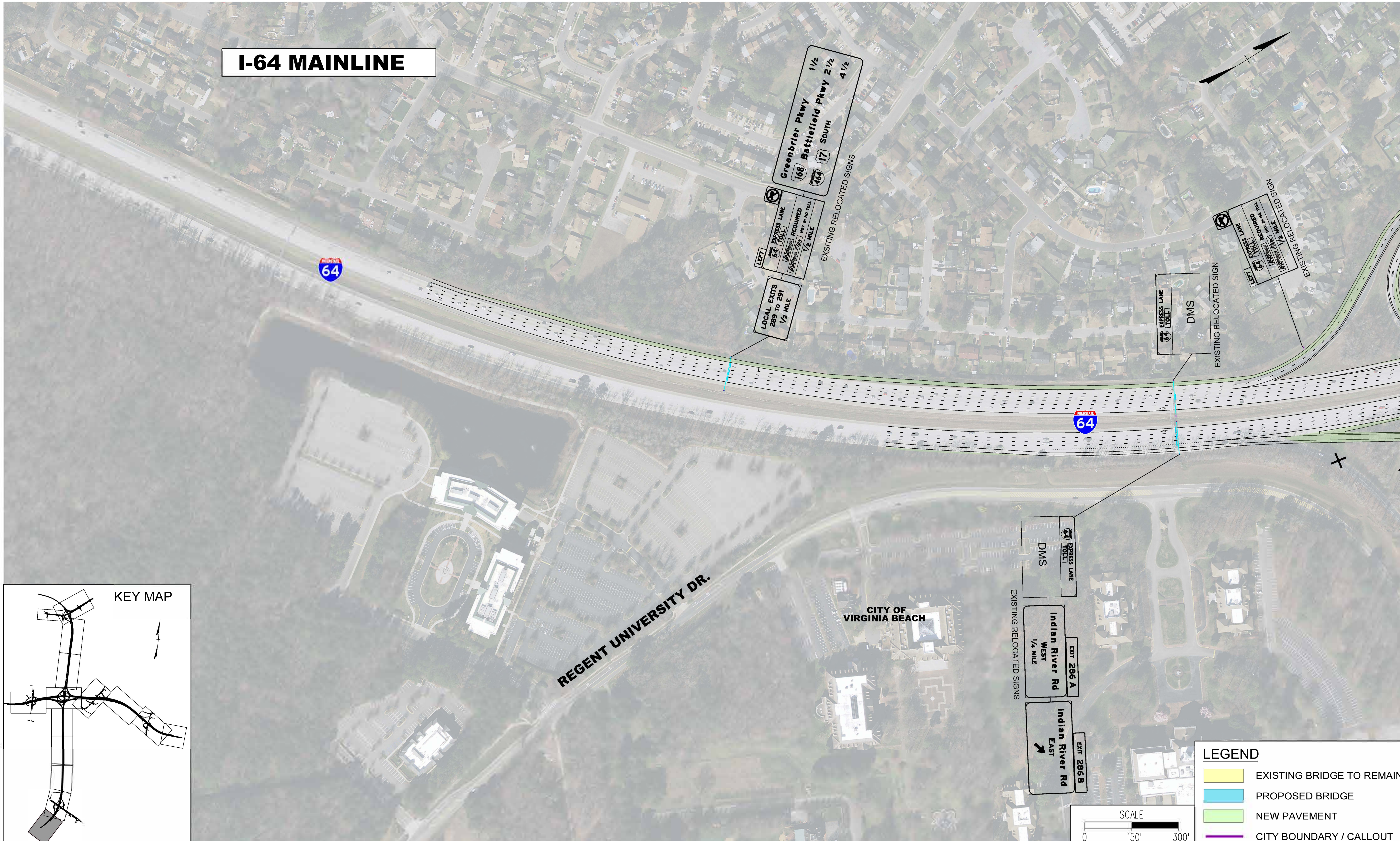


Figure 5-3 - Conceptual Signing Plan, I-64/Indian River Road Interchange

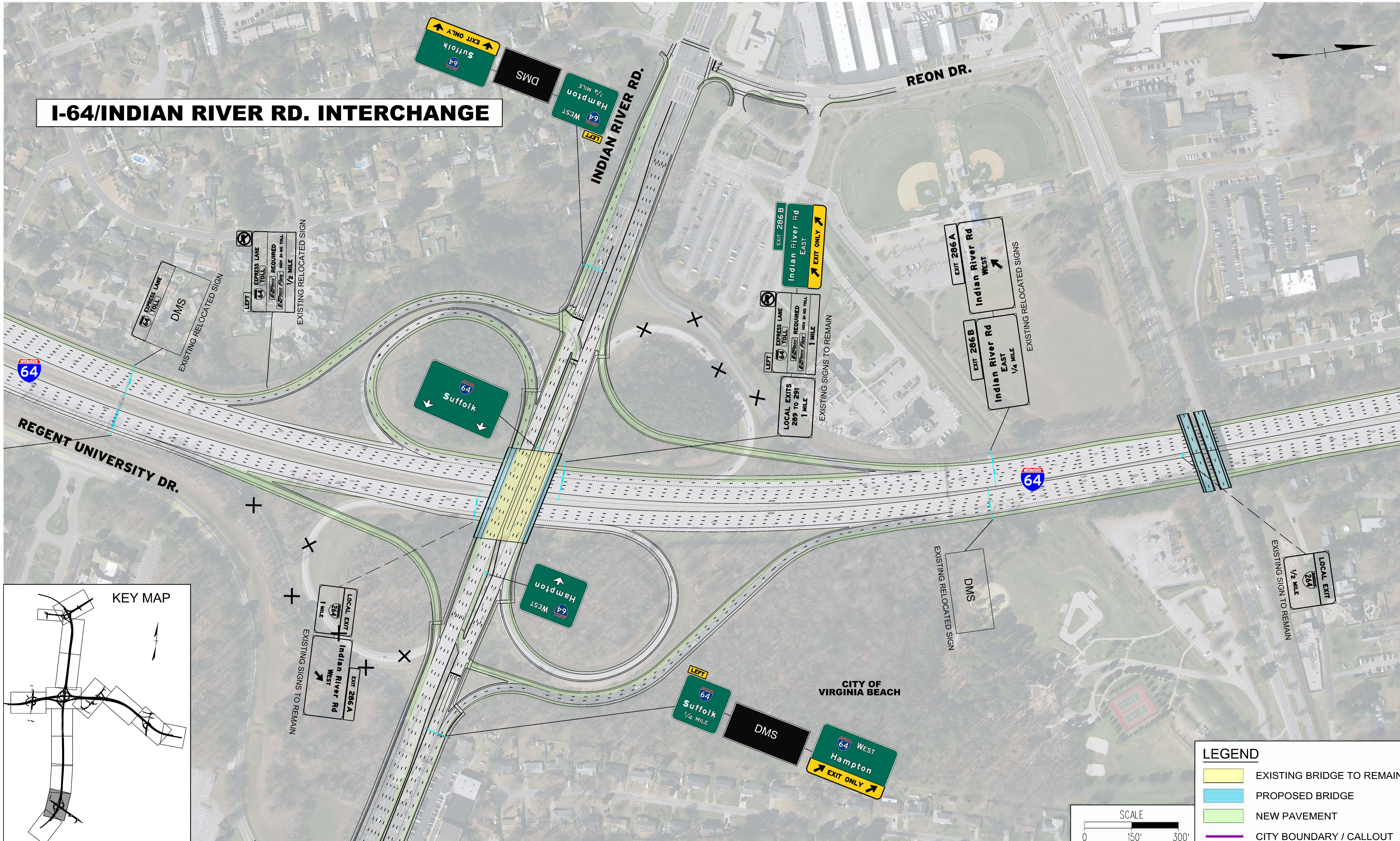


Figure 5-4 - Conceptual Signing Plan, I-64 North of Indian River Road

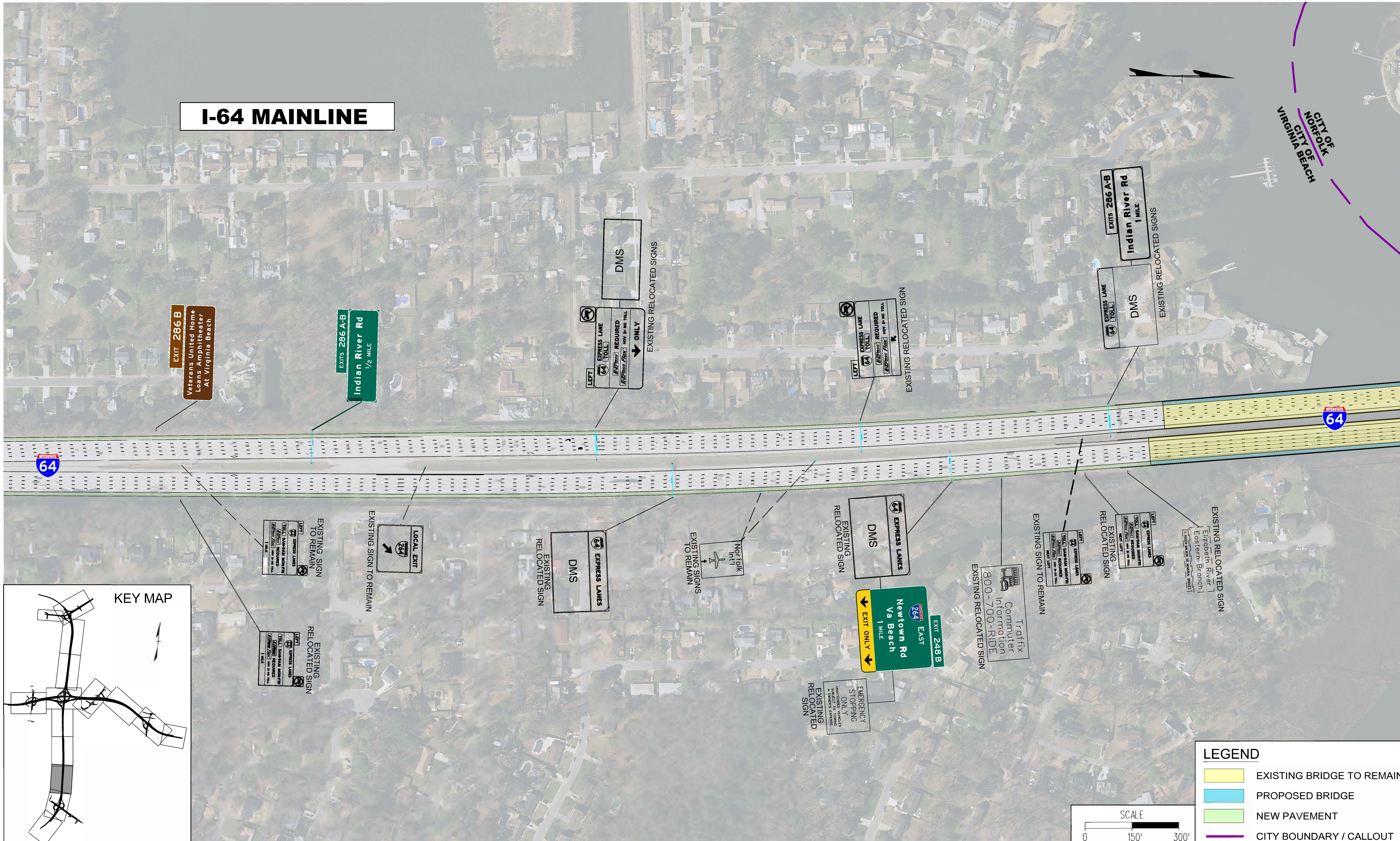


Figure 5-5 - Conceptual Signing Plan, I-64 South of I-264

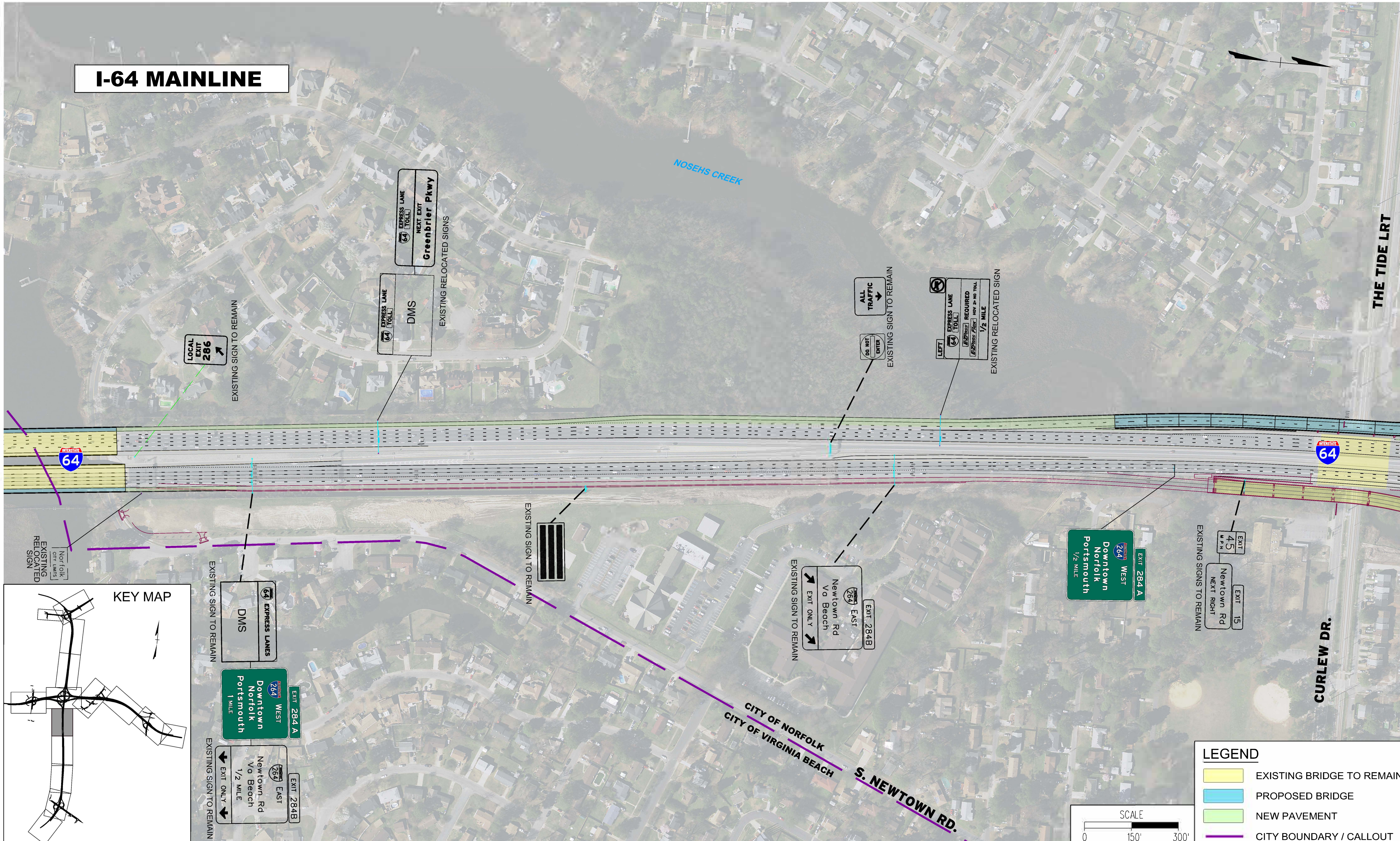


Figure 5-6 - Conceptual Signing Plan, I-64/I-264 Interchange

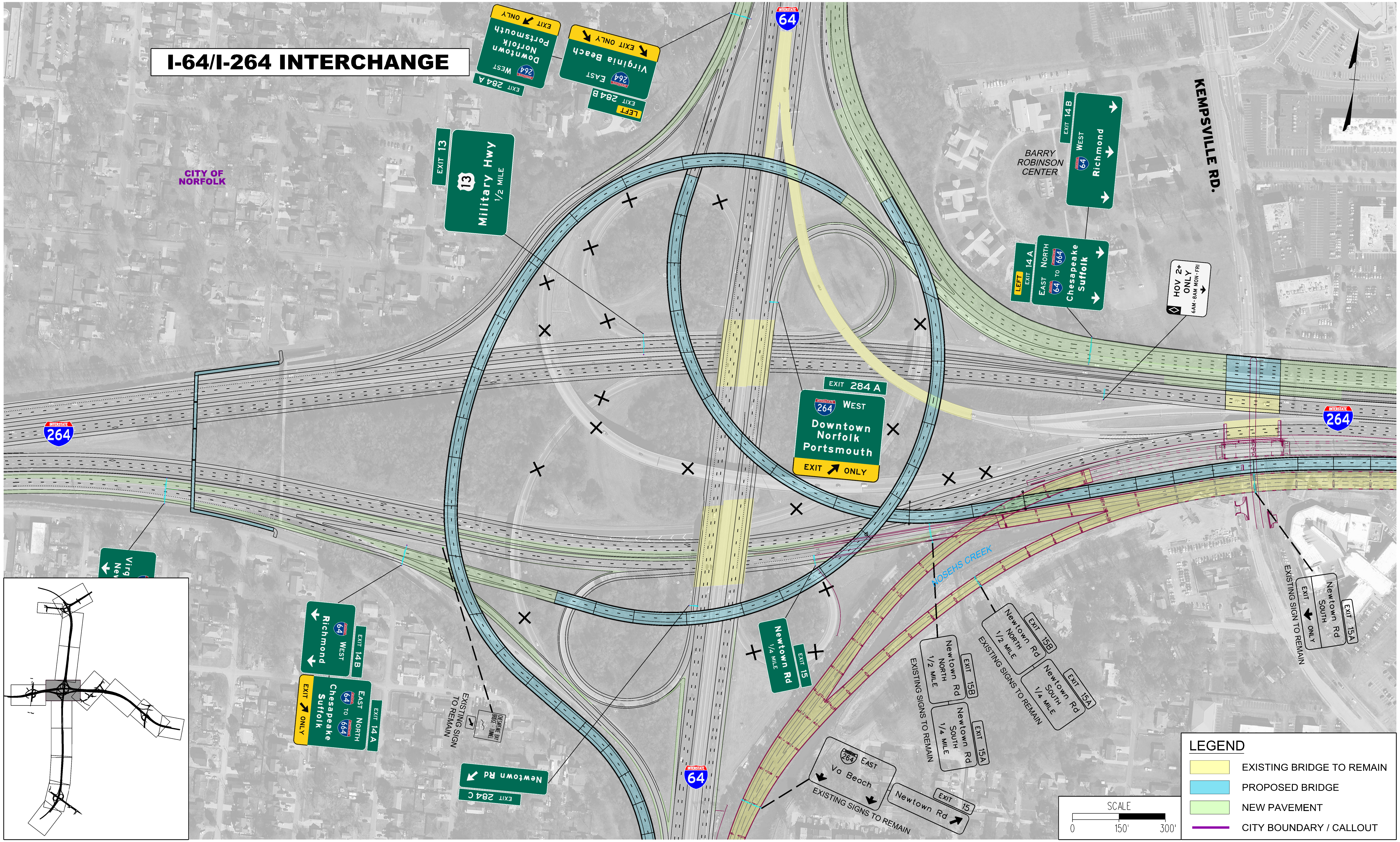


Figure 5-7 - Conceptual Signing Plan, I-64 North of I-264

Figure 5-8 - Conceptual Signing Plan, I-64 South of Northampton Boulevard

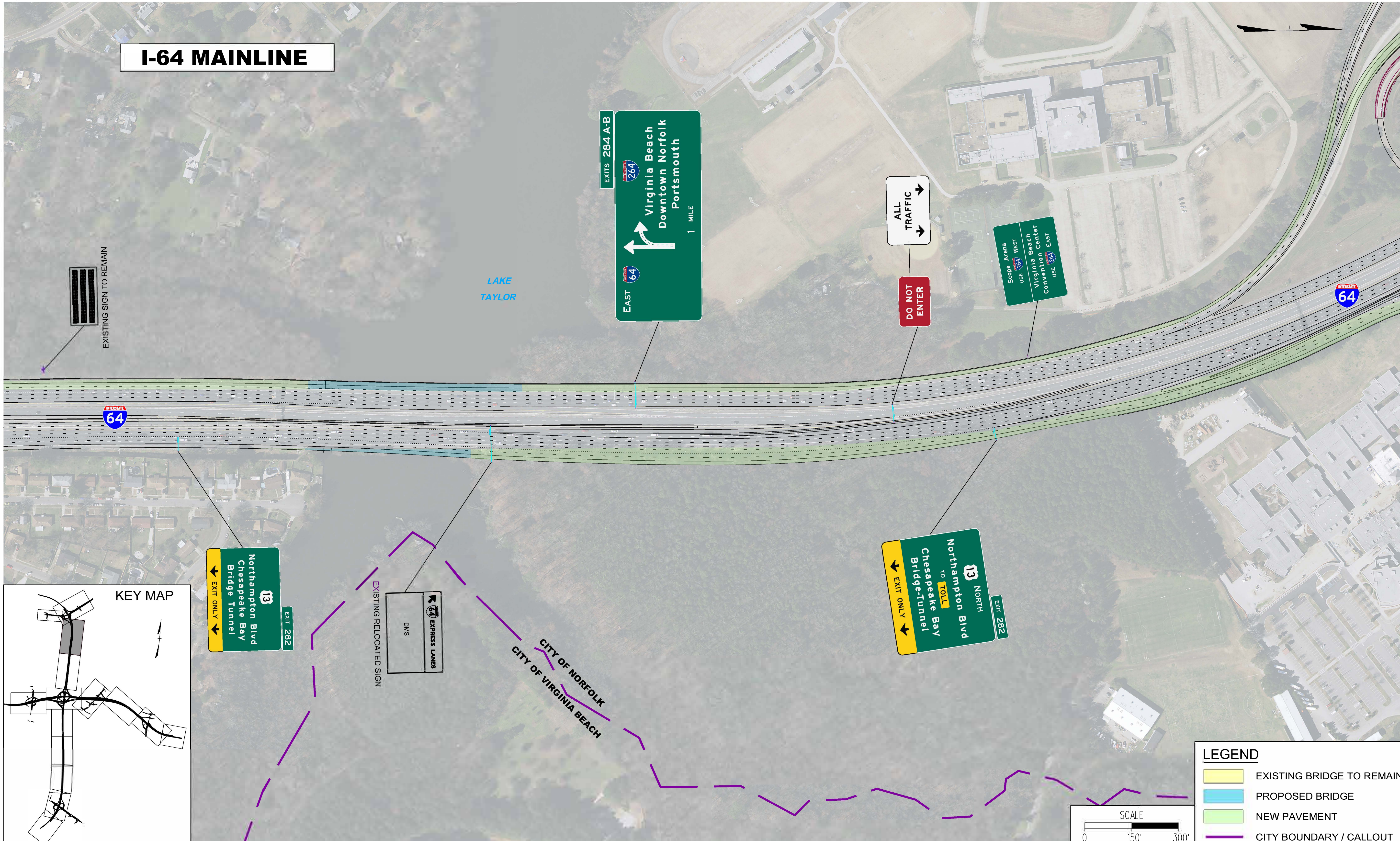


Figure 5-9 - Conceptual Signing Plan, I-64/Northampton Boulevard Interchange

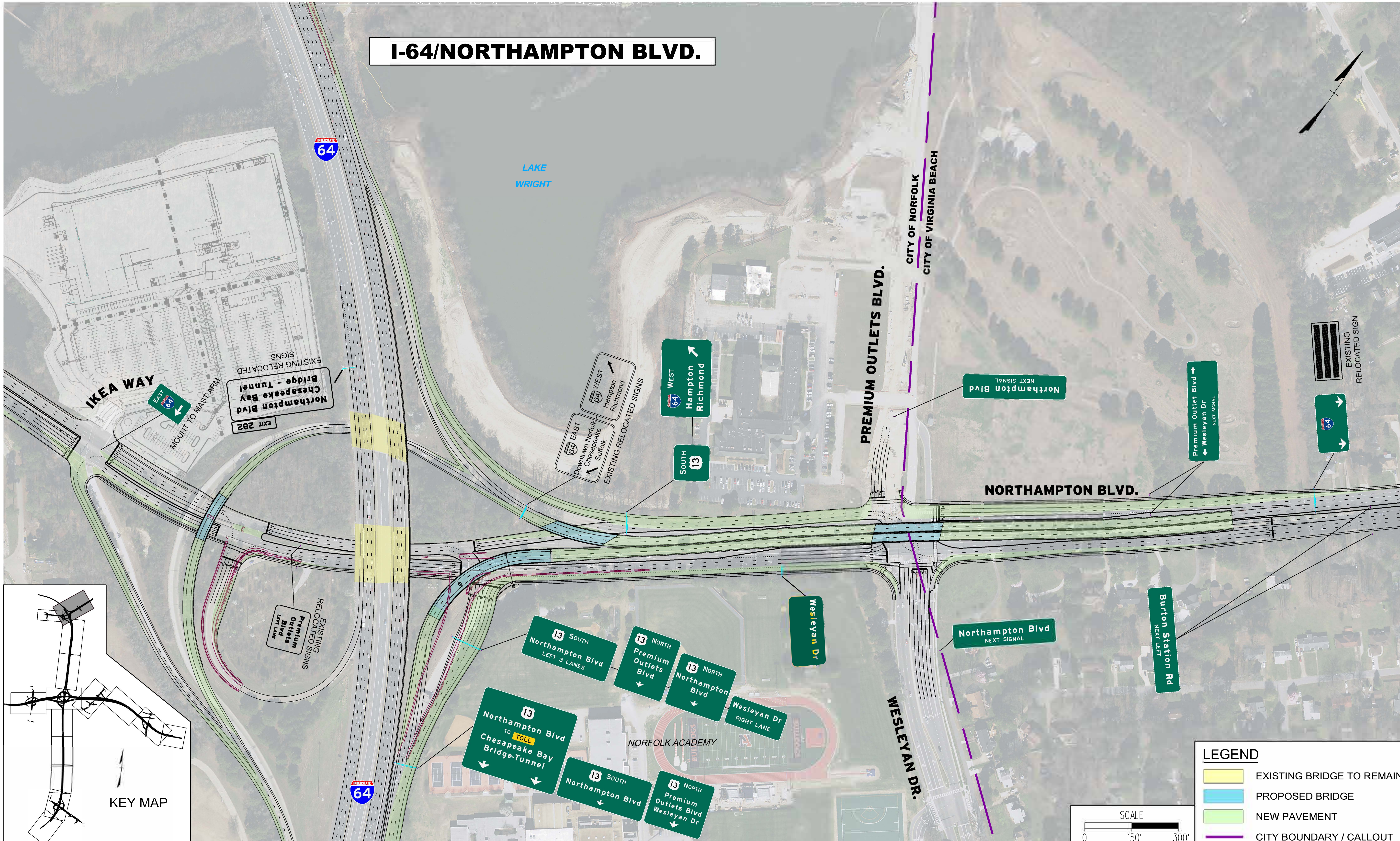


Figure 5-10 - Conceptual Signing Plan, Northampton Boulevard West of I-64

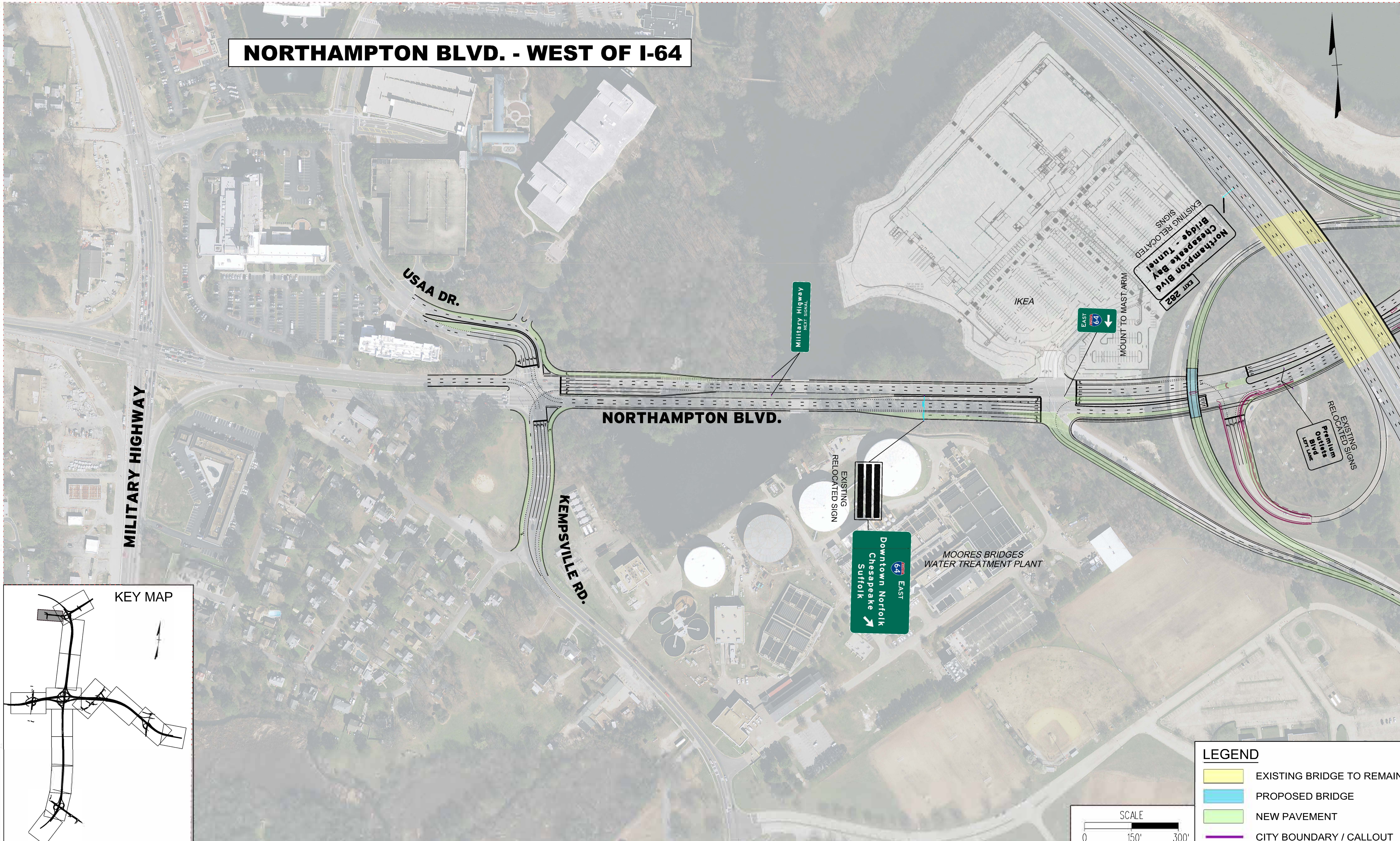


Figure 5-11 - Conceptual Signing Plan, I-264/Military Highway Interchange

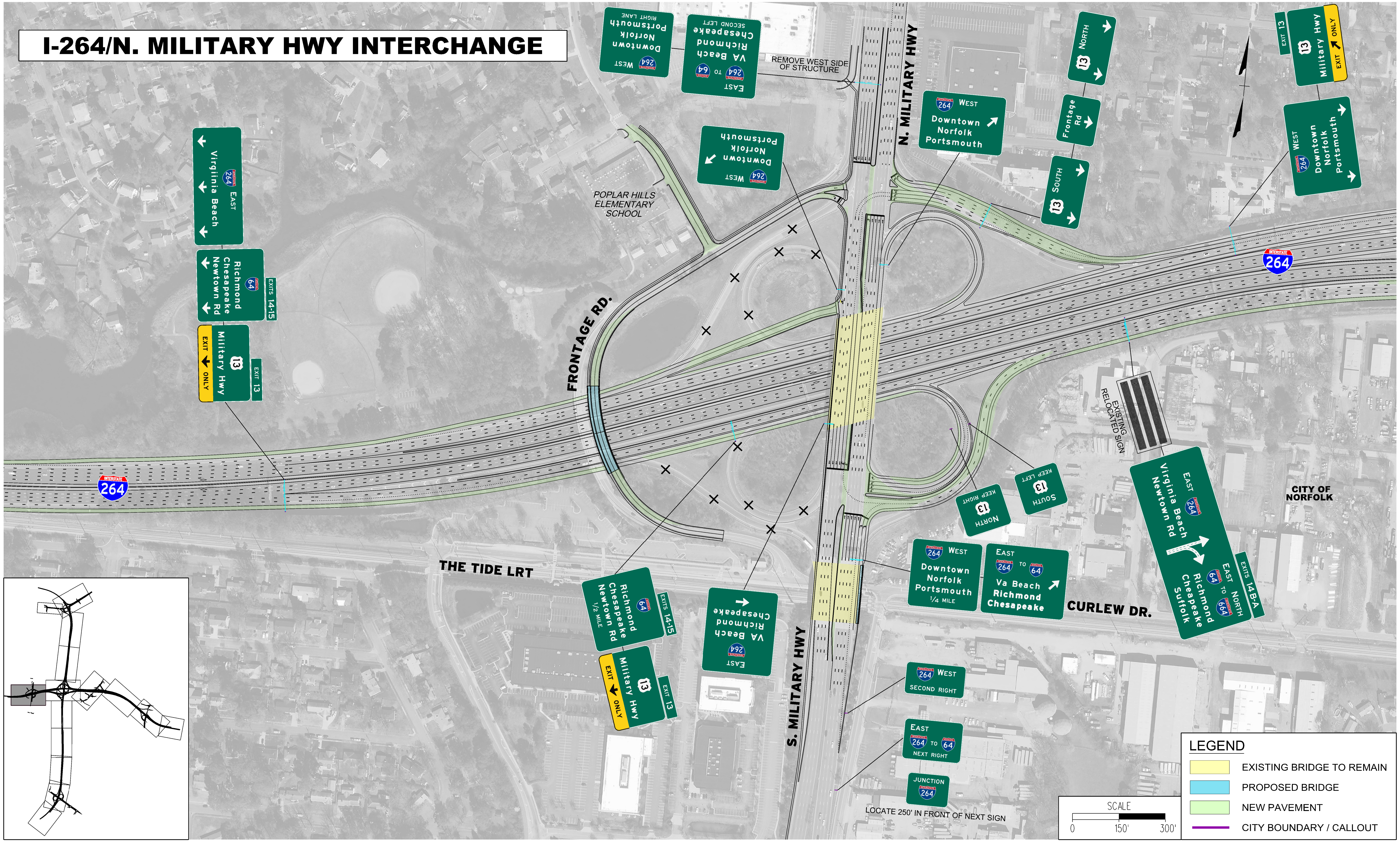


Figure 5-12 - Conceptual Signing Plan, I-264/Newtown Road Interchange

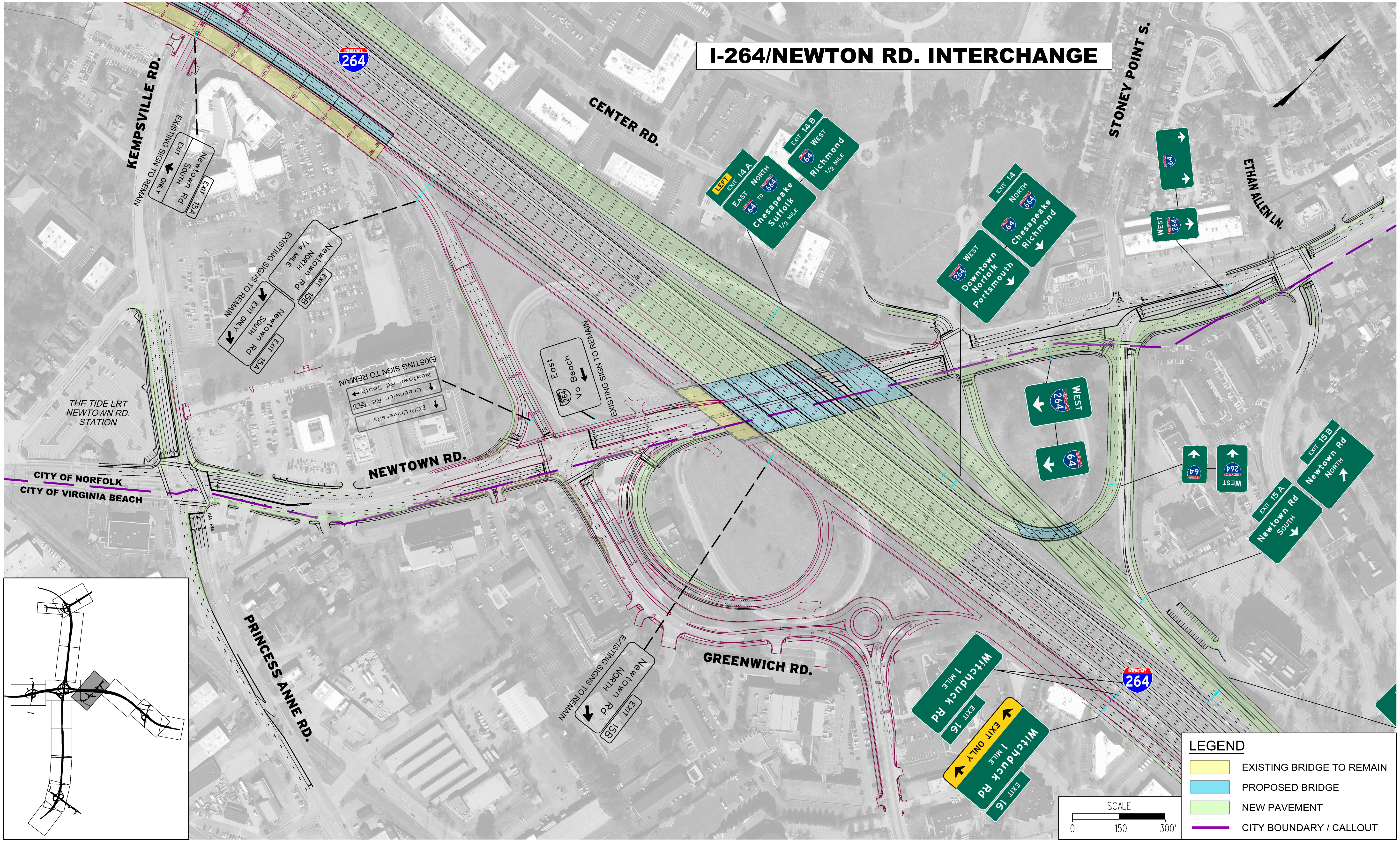


Figure 5-13 - Conceptual Signing Plan, I-264 at Greenwich Road Overpass

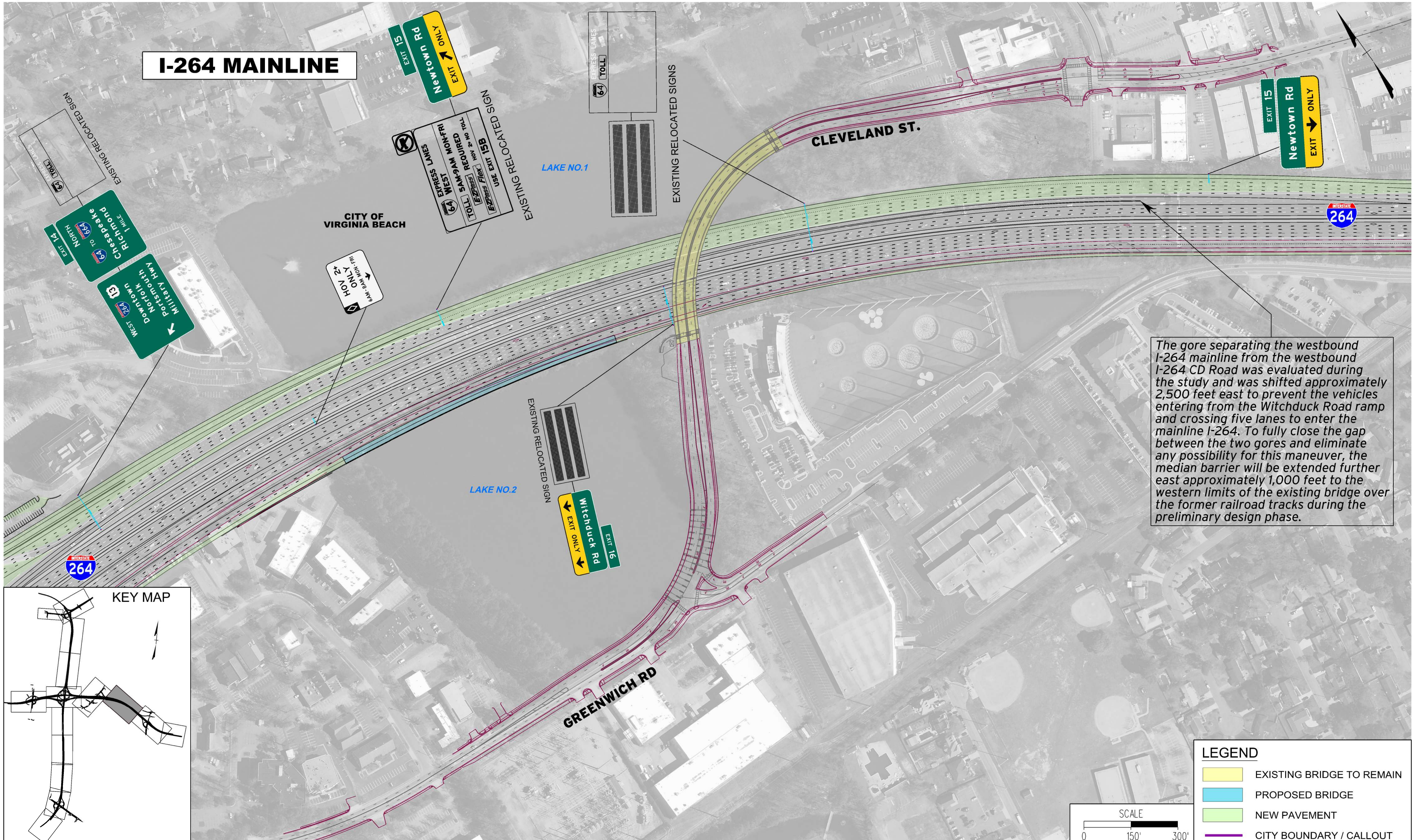


Figure 5-14 - Conceptual Signing Plan, I-264/Witchduck Road Interchange

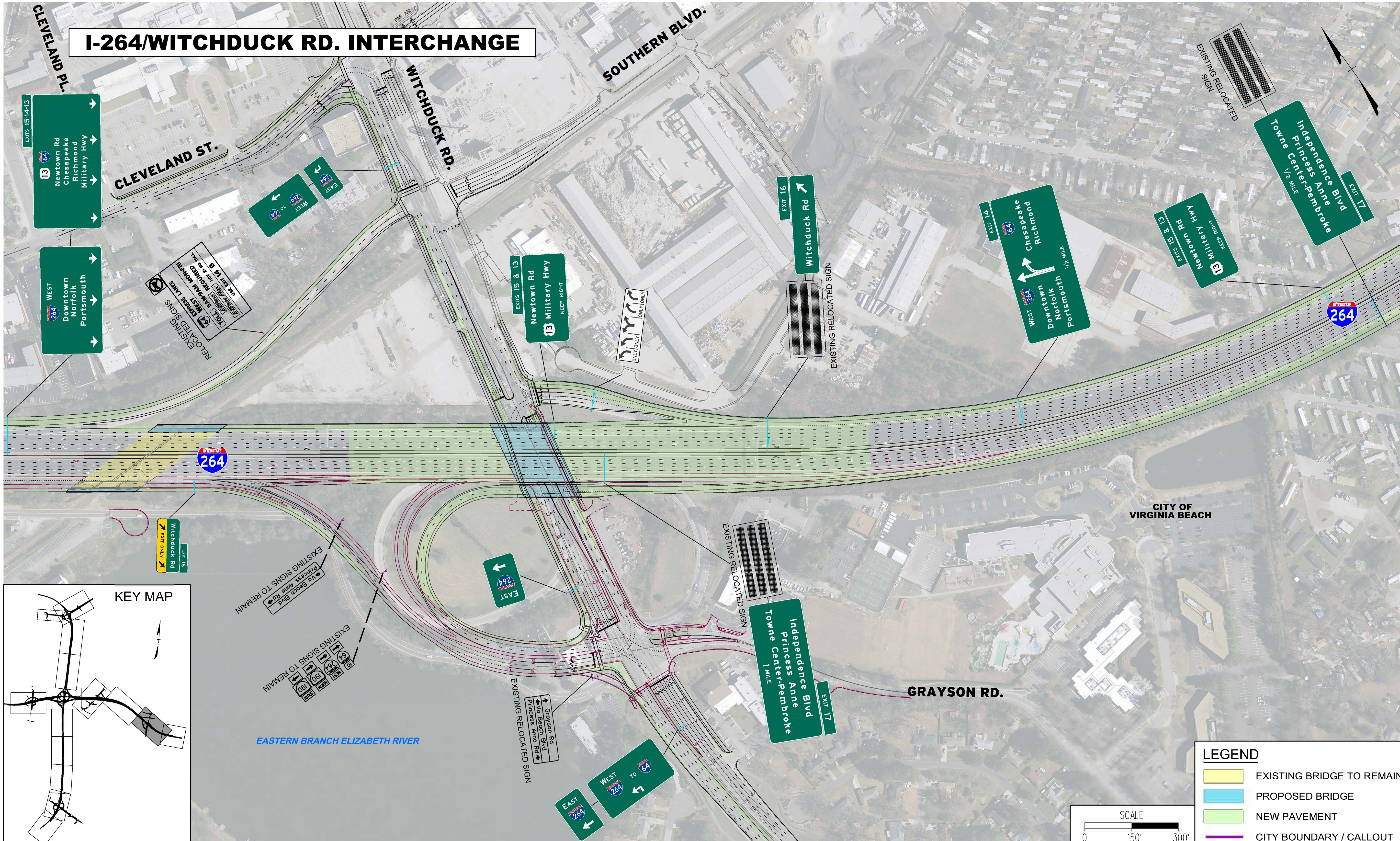
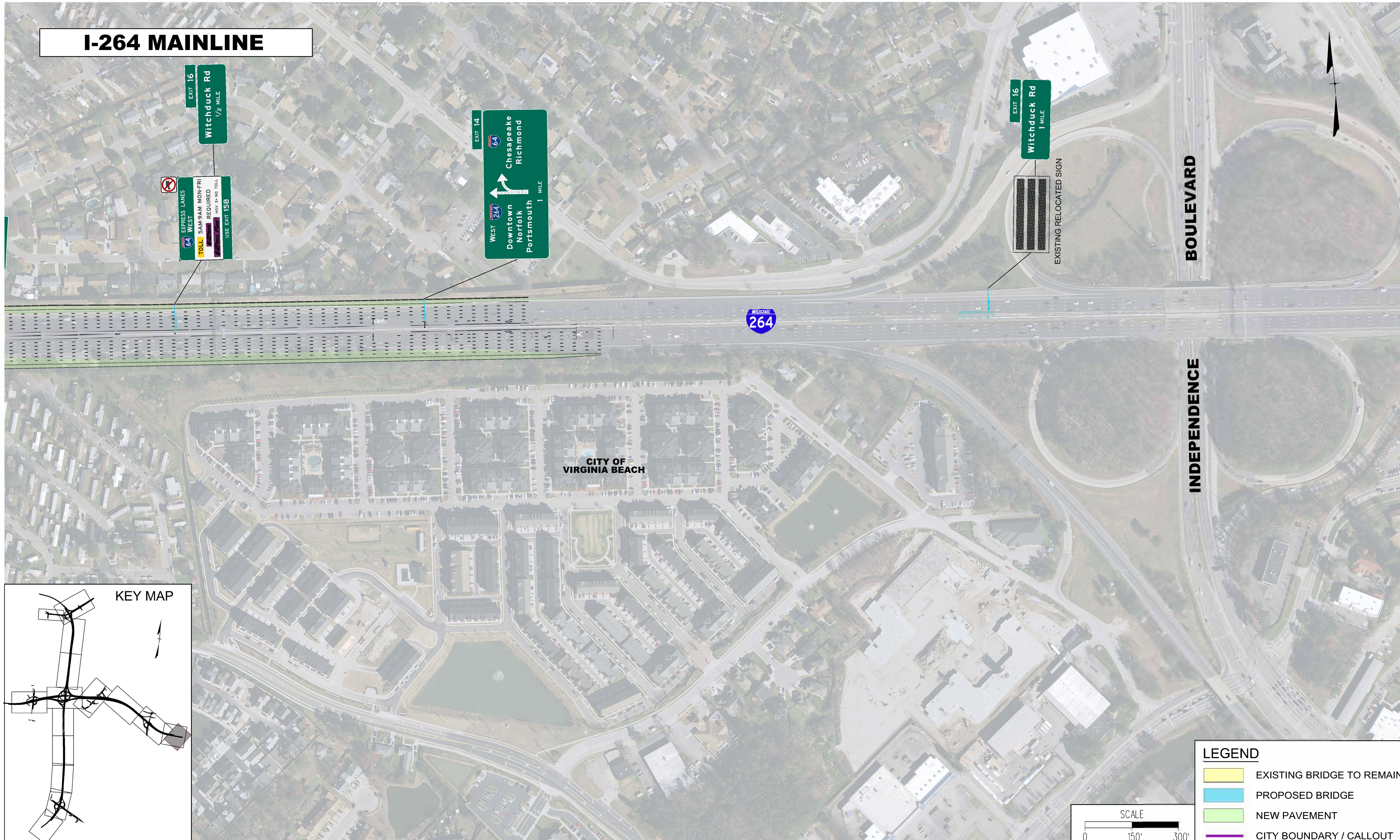


Figure 5-15 - Conceptual Signing Plan, I-264 East of Witchduck Road



CHAPTER 6: TRAFFIC VOLUMES AND OPERATIONS - 2024 & 2044

6.1 Projected 2024 and 2044 Traffic Volumes

The traffic volume projection horizons established for this study are an opening year of 2024 and a design year of 2044. The travel demand model administered by the HRTPO uses a horizon year of 2040. This required that projected traffic volumes generated by the HRTPO model be extrapolated from 2040 to 2044 for use in this study. Appendix B contains a summary of the procedures used to develop projected 2044 traffic volumes.

Using procedures set forth in VDOT guidance documents and NCHRP Report 765, traffic volumes were developed for the following conditions:

2024 No-Build Conditions - This condition reflects completion of programmed improvements within the study area through 2024, and no improvements associated with recommendations resulting from this study. Volume diagrams for 2024 no-build conditions are included in Appendix F.

2024 Build Conditions - This condition reflects completion of the recommended alternative identified in this study, and completion of all other improvements within the study area that are programmed for completion by 2024. Where necessary, vehicle trips are rerouted to reflect the relocation and directional orientation of interstate ramps, as well as intersection improvements that affect local access. Volume diagrams for 2024 build conditions are included in Appendix F.

2044 No-Build Conditions - This condition reflects completion of programmed improvements within the study area through 2044, and no improvements associated with recommendations resulting from this study. Volume diagrams for 2044 no-build conditions are included in Appendix F.

2044 Unconstrained Conditions - A separate run of the HRTPO travel demand model was run with additional capacity along I-64 and I-264 and select ramps that are overcapacity under existing or projected conditions. This approach removed capacity constraints within the study area and enabled the model to develop future demand volumes for 2040, which were then grown to represent demand in the 2044 design year. Traffic volumes were assigned to the roadway network associated with each of the three design alternatives developed under Tier 2 screening.

2044 Build Conditions - This condition reflects completion of the recommended alternative identified in this study, and completion of all other programmed improvements within the study area through 2044. Figures 6-1 through 6-12 on the following pages present projected volumes for the recommended build alternative for the 2044 AM and PM peak periods. As with the 2024 build condition, traffic volumes for the improved network reflect reassignment of trips to address modified ramp and intersection geometry and access conditions. The volumes represent forecasted traffic demand, and reflect capacity improvements outside of the study area that would allow full demand to enter the study area.

Average Weekday Daily Traffic Volumes

Table 6.1 summarizes projected 2024 and 2044 AWDT volumes for select roadway segments within the study limits. The 2044 data reflect the recommended build condition.

Table 6.1: AWDT Volumes for Select Roadway Links, Future 2024 and 2044 Build Conditions

Roadway	Segment Location	Facility	AWDT Volume (vpd)	
			2024	2044
I-64	Between Indian River Rd. and I-264	EB GP	85,300	126,600
		Express Lanes	12,200	12,900
		WB GP	100,800	129,100
	Between I-264 and Northampton Blvd.	EB GP	93,700	133,600
		Express Lanes	21,400	22,600
		WB GP	107,300	144,500
I-264	Between Military Hwy. and I-64	EB C/D	53,700	60,300
		EB thru	36,200	42,700
		WB thru	34,500	37,000
		WB C/D	47,500	57,300
	Between I-64 and Newtown Rd.	EB outer C/D	57,500	68,300
		EB inner C/D	48,000	55,200
		EB thru	39,600	46,200
		WB thru	35,700	38,300
		WB C/D	21,300	25,700
		WB ramp to I-64	77,800	105,400
	Between Newtown Rd. and Witchduck Rd.	EB C/D	32,600	33,000
		EB thru	97,100	114,500
		WB thru	35,700	38,300
		WB C/D	85,700	116,000
	East of Witchduck Rd.	EB	127,100	143,900
		WB	114,200	145,700
Indian River Road	West of I-64	EB & WB	36,300	48,000
	East of I-64	EB & WB	83,100	94,400
Military Highway	South of I-264	EB & WB	56,000	61,000
	North of I-264	EB & WB	66,300	82,100
Newtown Road	South of I-264	EB & WB	14,900	19,500
	North of I-264	EB & WB	40,100	50,500
Witchduck Road	South of I-264	EB & WB	25,400	33,900
	North of I-264	EB & WB	38,000	49,500
Northampton Boulevard	West of I-64	EB & WB	38,000	47,500
	East of I-64	EB & WB	87,300	99,500

Figure 6-1: Traffic Volumes, 2044 AM Recommended Build Conditions, I-64/I-264 Interchange

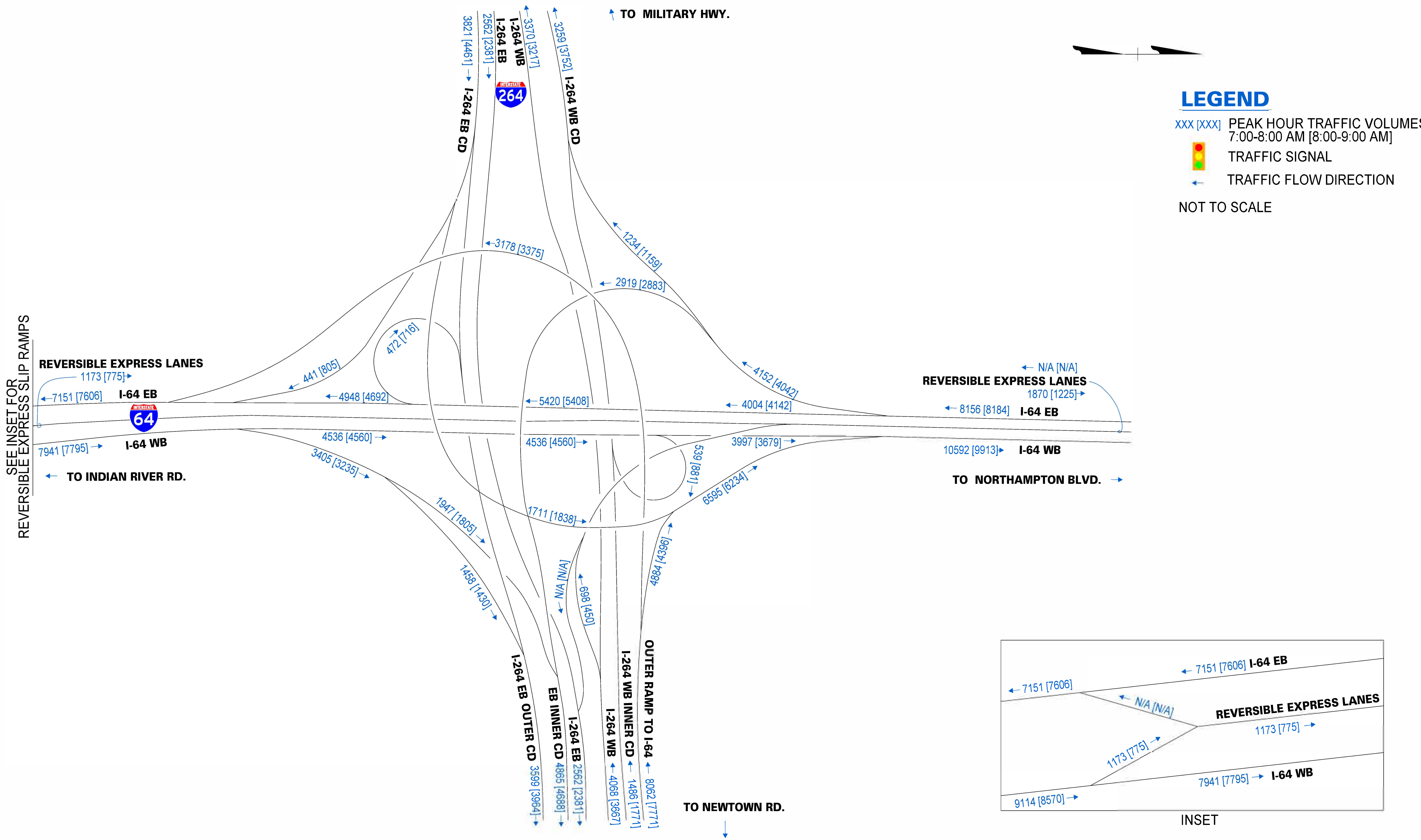


Figure 6-2: Traffic Volumes, 2044 AM Recommended Build Conditions, I-264/Military Highway Interchange

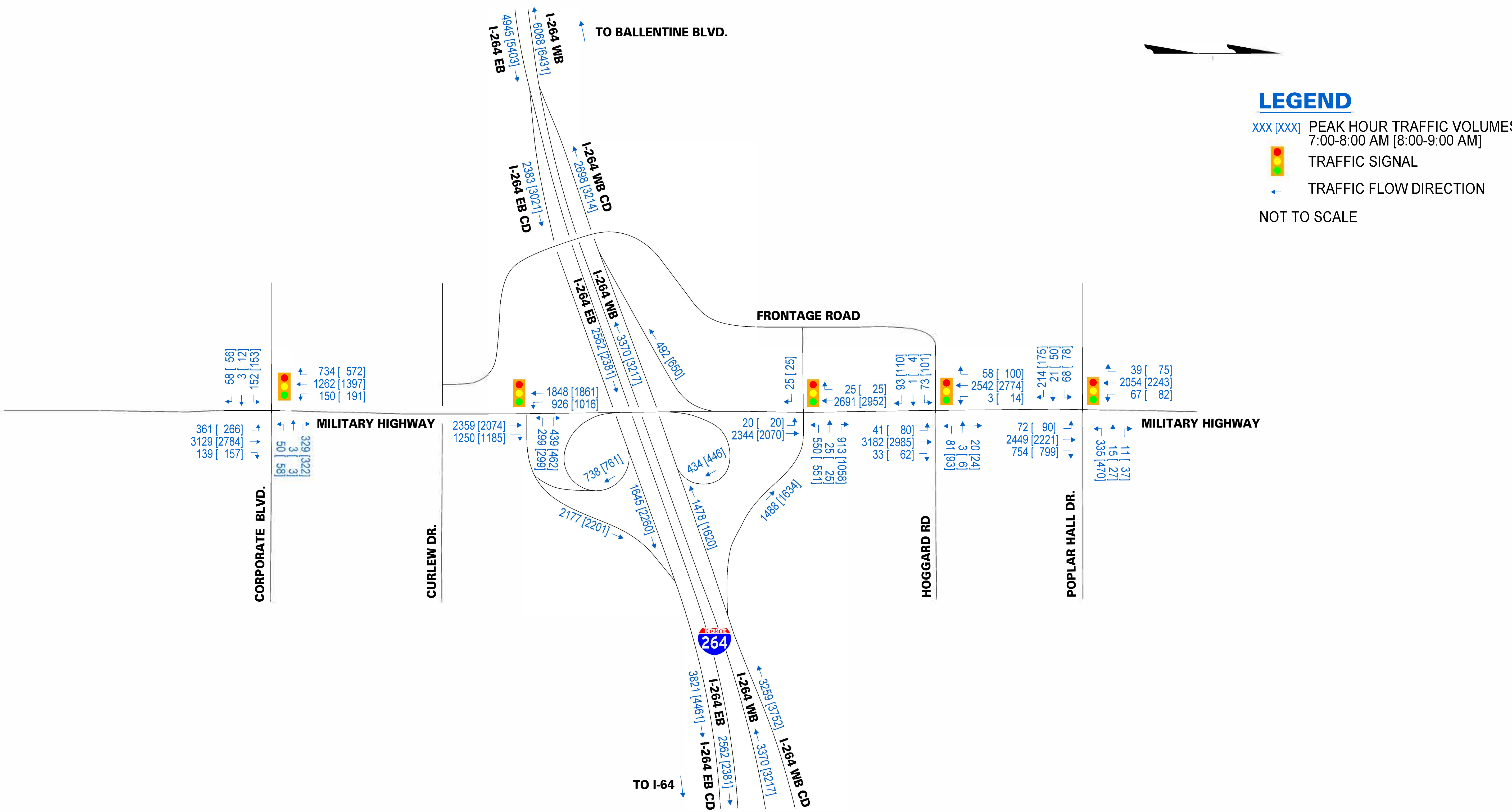


Figure 6-3: Traffic Volumes, 2044 AM Recommended Build Conditions, I-264/Newtown Road Interchange

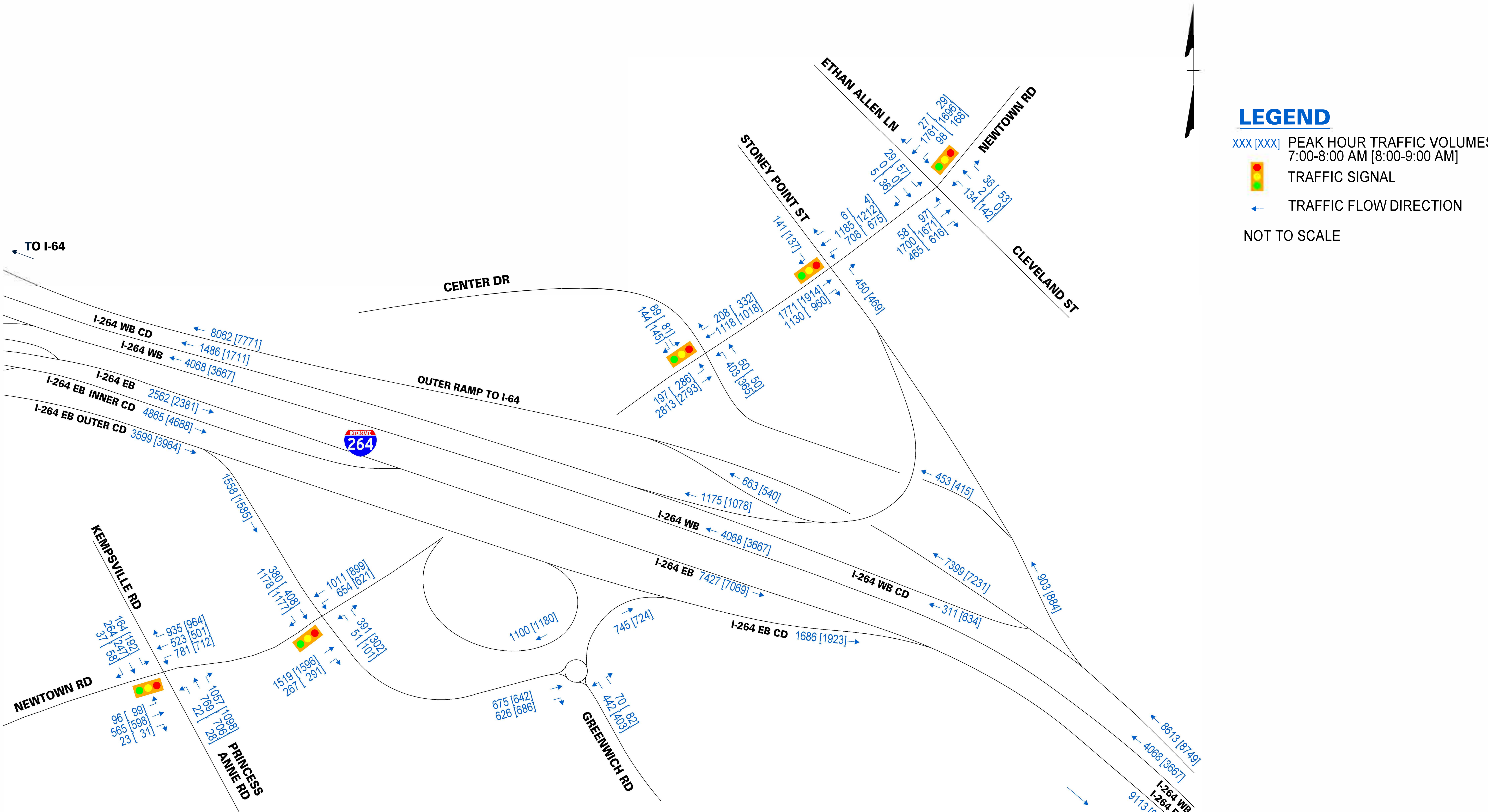


Figure 6-4: Traffic Volumes, 2044 AM Recommended Build Conditions, I-264/Witchduck Road Interchange

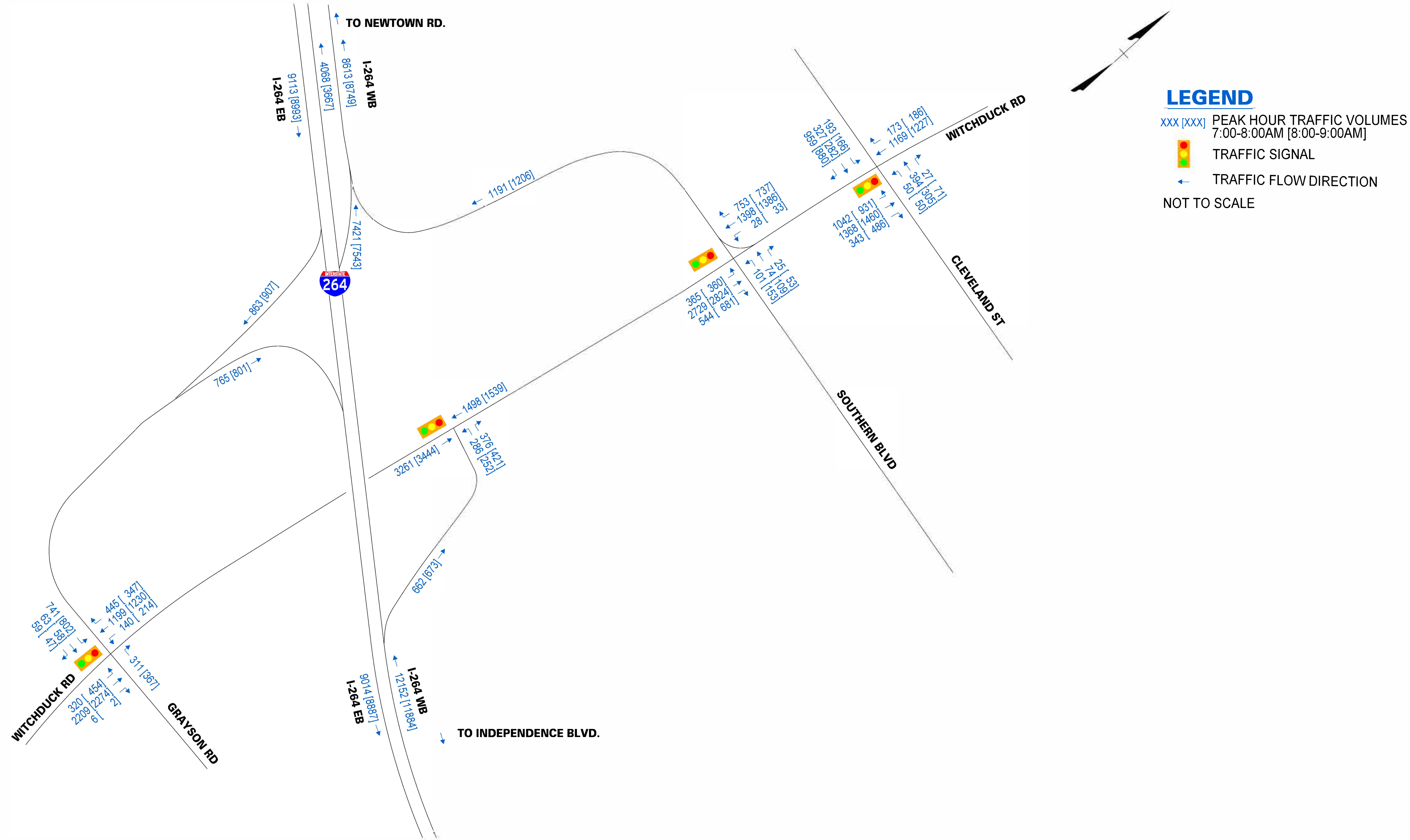


Figure 6-5: Traffic Volumes, 2044 AM Recommended Build Conditions, I-64/Indian River Road Interchange

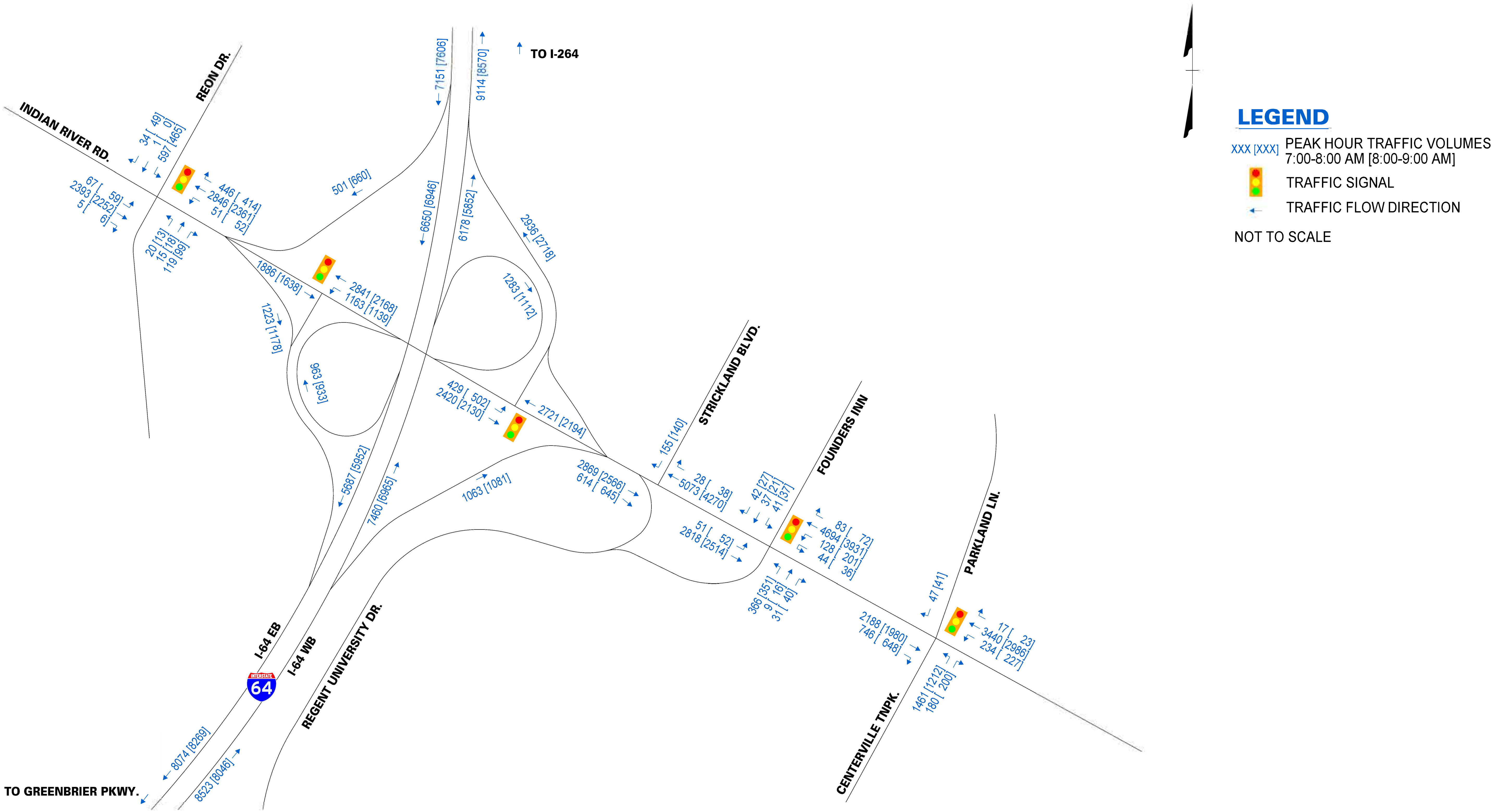


Figure 6-6: Traffic Volumes, 2044 AM Recommended Build Conditions, I-64/Northampton Blvd. Interchange

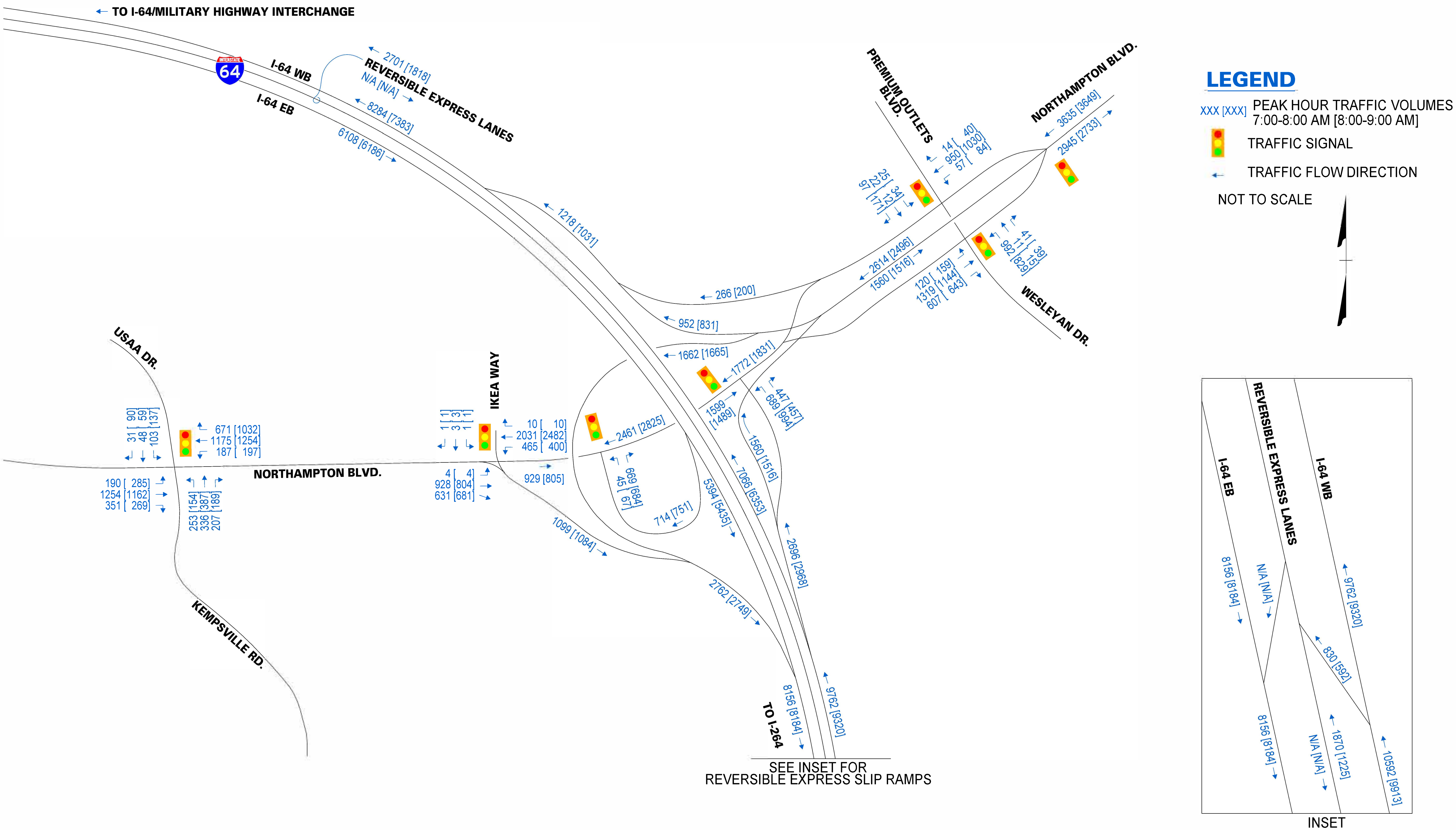


Figure 6-7: Traffic Volumes, 2044 PM Recommended Build Conditions, I-64/I-264 Interchange

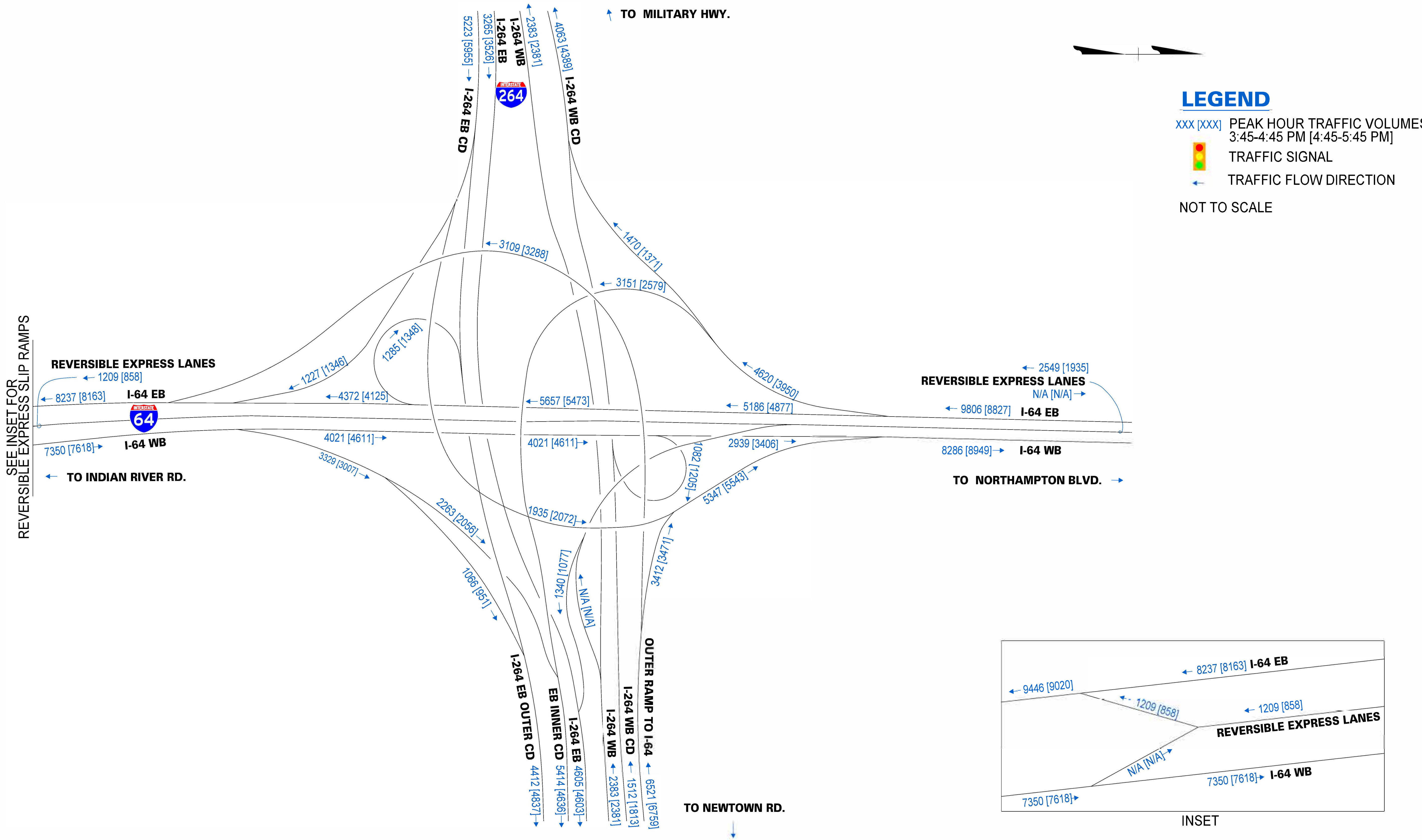


Figure 6-8: Traffic Volumes, 2044 PM Recommended Build Conditions, I-264/Military Highway Interchange

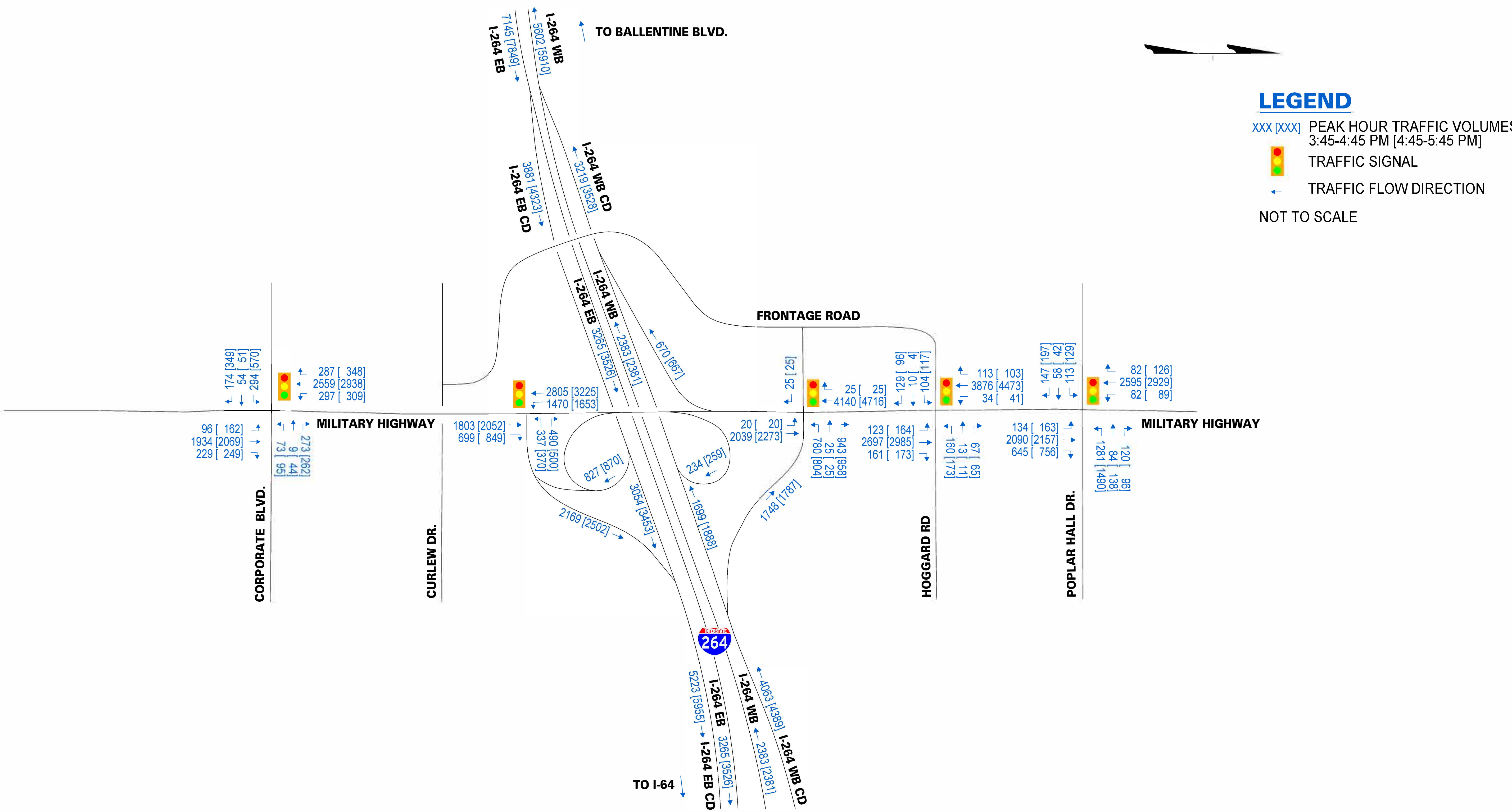


Figure 6-9: Traffic Volumes, 2044 PM Recommended Build Conditions, I-264/Newtown Road Interchange

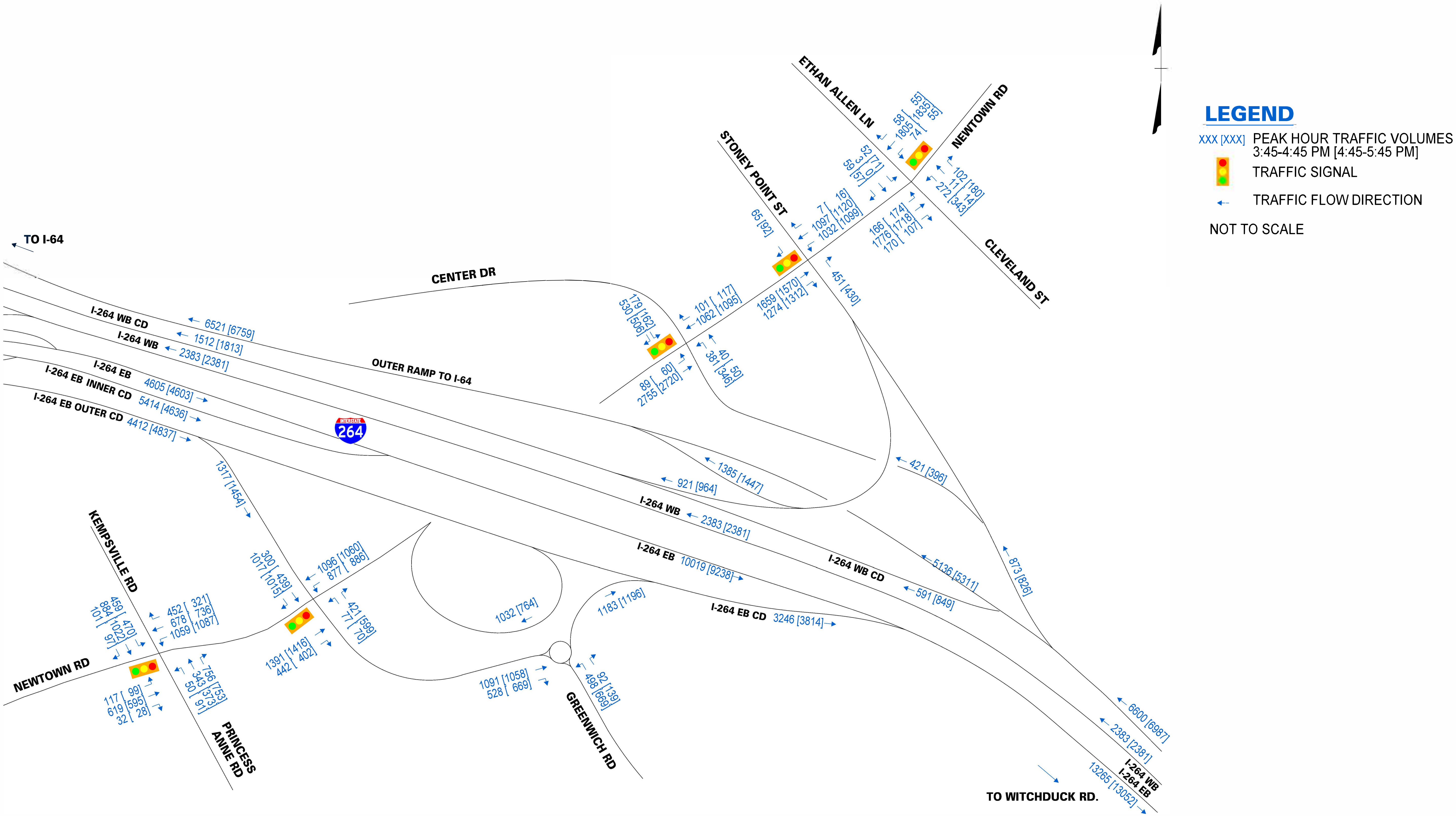


Figure 6-10: Traffic Volumes, 2044 PM Recommended Build Conditions, I-264/Witchduck Road Interchange

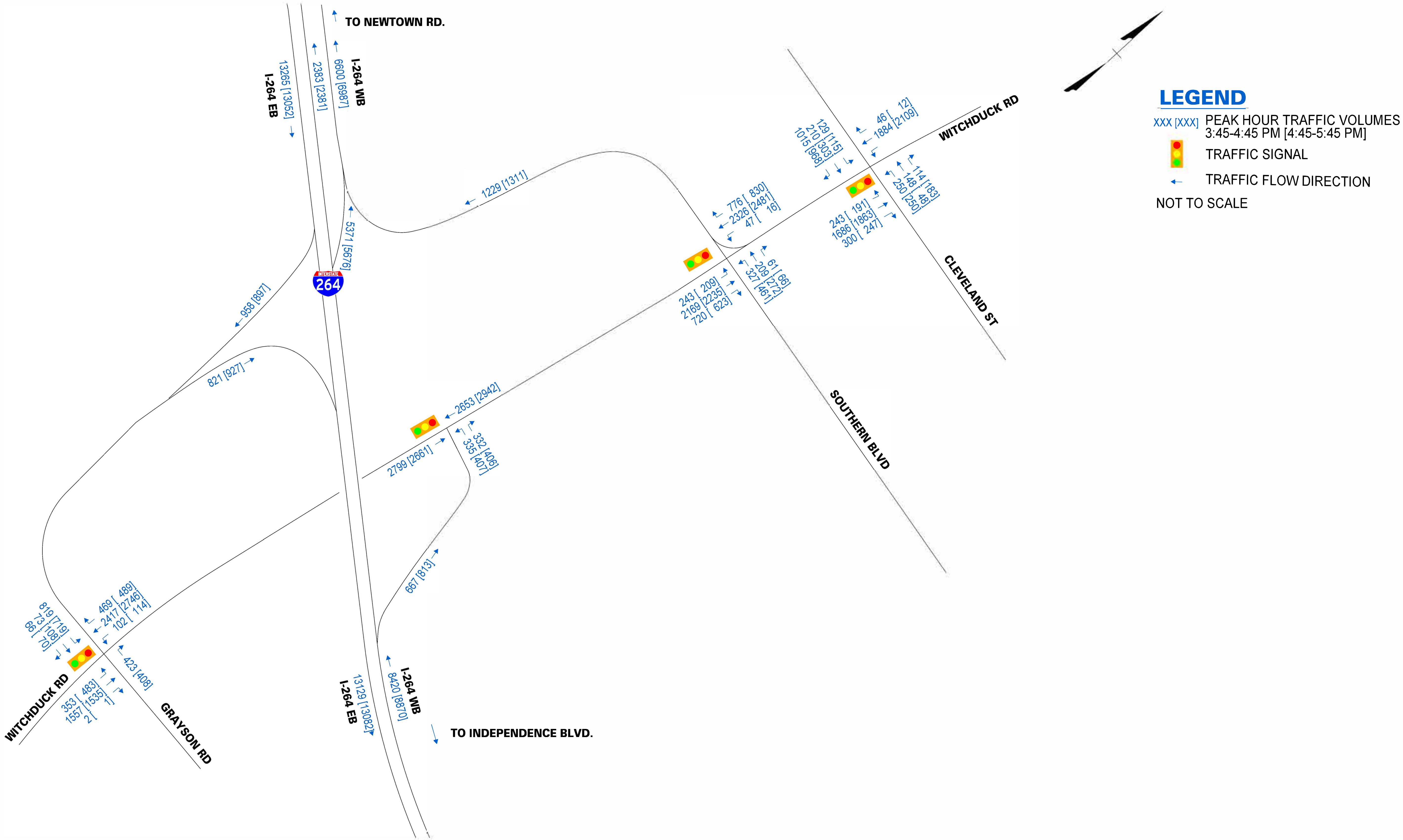


Figure 6-11: Traffic Volumes, 2044 PM Recommended Build Conditions, I-64/Indian River Road Interchange

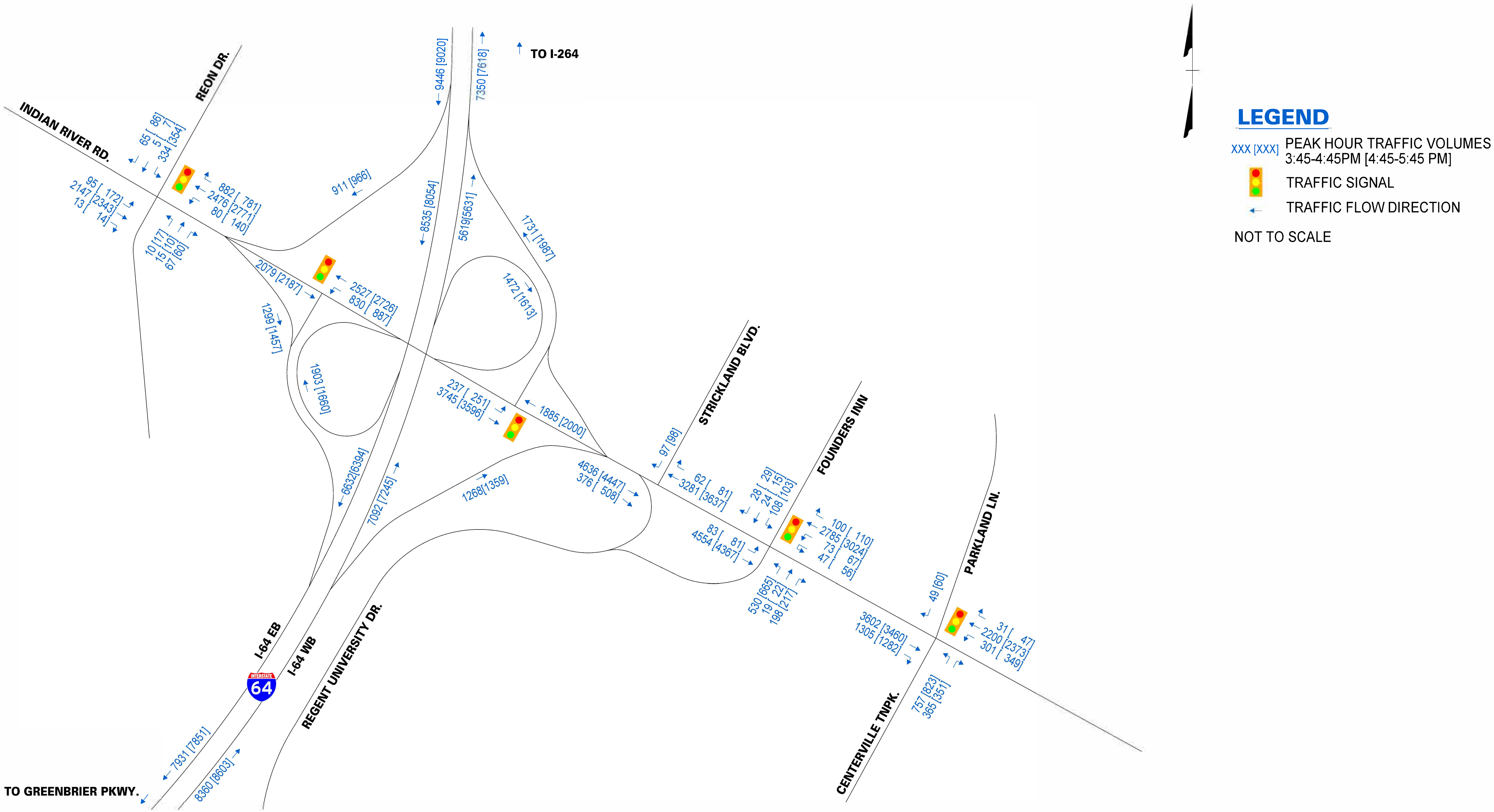
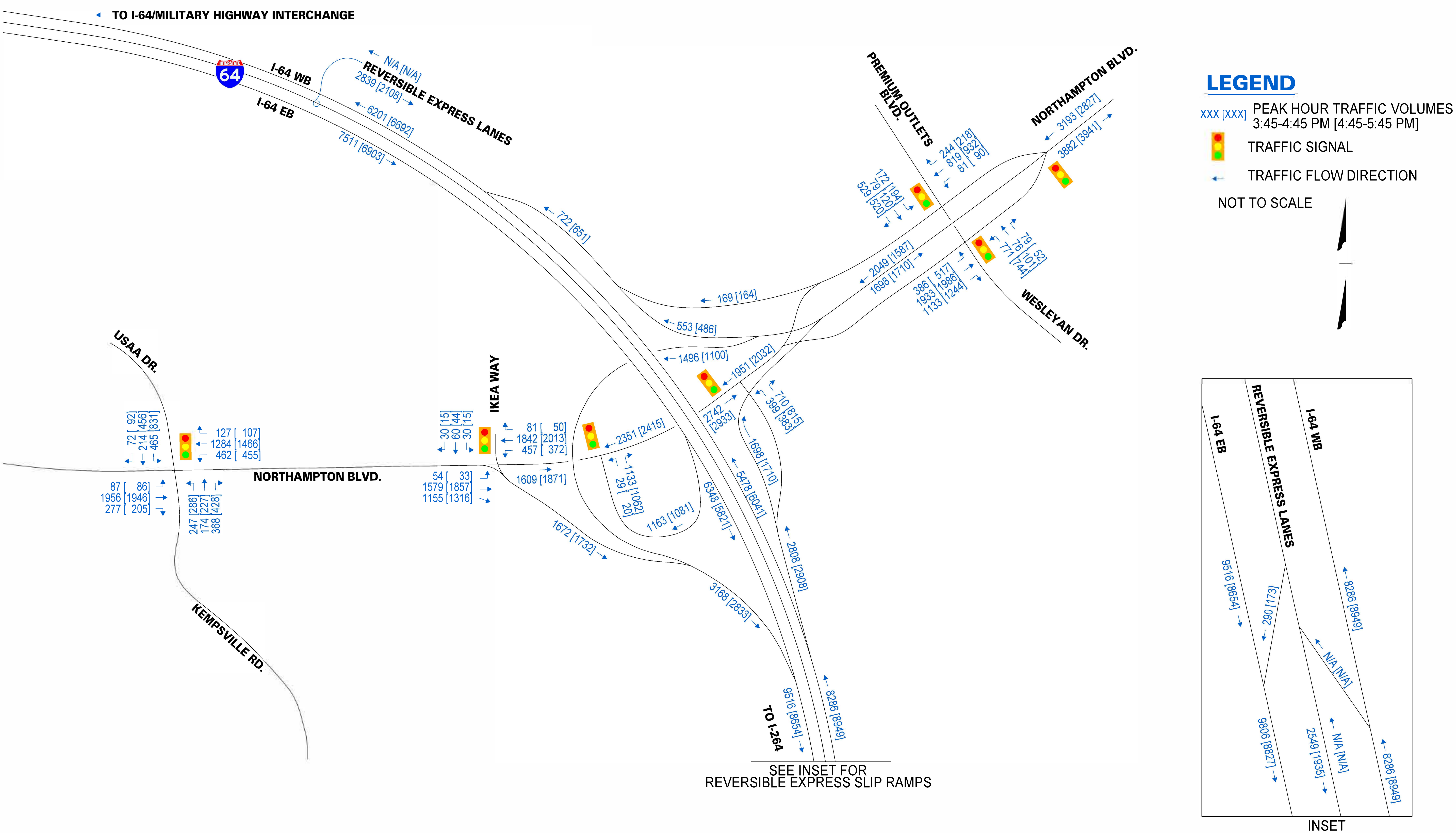


Figure 6-12: Traffic Volumes, 2044 PM Recommended Build Conditions, I-64/Northampton Blvd. Interchange



6.2 Projected 2044 Traffic Operations

Signal Timing for Future Year Analyses

The existing signal timings for the study area intersections were obtained from the cities of Norfolk and Virginia Beach. For all analyses, Synchro software was used to develop initial optimized signal timing and phasing for each signalized intersection under 2024 and 2044 build and no-build conditions. Timing and phasing was then imported into VISSIM. Following a review of the VISSIM simulation, splits and offsets were in some cases adjusted in VISSIM before initiating and completing the multiple model runs required. The adjustments account for VISSIM's enhanced ability to model travel patterns between intersections. In some cases, the clearance intervals were also updated in VISSIM to reflect changes in intersection crossing distances attributable to current or pending construction projects.

Analysis Results - 2044 No-Build Conditions

The year 2044 represents the design year for the proposed improvements. The no-build conditions represent the baseline conditions against which proposed improvements are evaluated. The no-build condition represents a no-change condition for the interchange but does reflect completion of other improvements within the study area, consistent with the region's constrained long-range transportation plan as noted in Section 4.1.

Freeway Link Densities – Tables 6.2 and 6.3 on the following two pages present the 2044 no-build conditions freeway link densities for I-64 and I-264, respectively. Density information for 2044 no-build conditions is presented in graphical format in Appendix G. Both I-64 and I-264 are expected to operate under severely congested conditions in the 2044 no-build conditions during the AM and PM peak periods. Operational deficiencies at intersections along Newtown Road and Witchduck Road (described further in the subsection entitled "Intersections" on page 7-9) result in queue spillback onto I-264. These queues then extend back onto I-64, effectively gridlocking the interstate network. For I-64 through traffic, the I-64/I-264 interchange then becomes the metering point in either direction. The westbound I-264 mainline is affected by the operational constraints of the left exit ramp to eastbound I-64, which will continue to operate over capacity.

During AM peak hour 1, before operations along I-264 affect I-64 traffic, westbound I-64 from I-264 to beyond Northampton Boulevard are expected to operate under heavily to severely congested conditions, including the merge and diverge points at the Northampton Boulevard interchange. This is due to the volume exceeding the capacity of the three-lane mainline roadway through the interchange. Also during AM peak hour 1, heavy weaving and merging conditions at the Indian River Road interchange impede mainline flow.

In AM peak hour 2, the I-64/I-264 interchange becomes a metering point for westbound I-64 traffic, resulting in lower throughput toward the Northampton Boulevard Interchange. Because of this metering, westbound I-64 entering traffic from Northampton Boulevard is not impeded during AM peak hour 2. Congestion from the I-64/I-264 interchange spills back to Indian River Road during AM peak hour 2.

During both the AM and PM peak periods, the single-lane ramp from eastbound I-64 to eastbound I-264 constrains flow on eastbound I-64. Queuing from this constraint point spills back to the I-64/Northampton Boulevard interchange during both peak periods.

The reversible I-64 Express Lanes are expected to continue to operate under light traffic conditions. In some cases, flow densities under 2044 no-build conditions are lower than existing 2018 conditions due to upstream congestion metering traffic flow.

Queuing Beyond Ramp Storage Capacity - Under 2044 no-build conditions, congestion along Newtown and Witchduck Roads spills back onto I-264 during both AM and PM peak periods. Queuing at other locations also impacts freeway operations:

- The westbound and eastbound I-264 exit ramps at Witchduck Road queue back onto I-264.
- The westbound and eastbound exit ramps to Newtown Road queue back onto the I-264 and I-64 mainline.
- The demand on westbound I-264 left exit ramp is expected to exceed the capacity of a single-lane ramp during both AM and PM peak periods.

Travel Times and Travel Speeds - Table 6.4 on page 6-17 summarizes travel times and average speeds for selected routes under 2044 no-build conditions during the peak periods studied. Average travel speeds lower than 40 mph are highlighted.

As traffic congestion builds on the interstates due to operational deficiencies within the study area, travel speeds decline throughout the network. The analyses indicated that the majority of travel routes evaluated will operate with average speeds lower than 40 mph during each of the peak hour periods studied. During the PM peak hour 2, all of the travel routes except Route No. 3 will operate with an average travel speed below 20 mph. These results represent degraded traffic operations as compared to existing 2018 conditions. Low travel speeds within each travel route correspond with locations that operate under heavily to severely congested conditions, as described above in the subsection entitled "Freeway Link Densities".

Severely congested conditions on both I-64 and I-264 result in increases of travel time over existing conditions for all travel route segments. The eastbound I-264 mainline and C/D road are impacted the most due to operational deficiencies at signalized intersections along Newtown Road and Witchduck Road. Those roadways are effectively gridlocked due to queuing on the exit ramps extending back onto the interstates.

Table 6.2: Traffic Analysis Results for I-64, Flow Density, 2044 No-Build Conditions

Roadway	Segment	Density (veh/ln/mi) AM1	AM2	PM1	PM2
WB I-64	Freeway entry to study area and diverge at Indian River Road	46.6	80.8	39.5	117.6
WB I-64	Exit ramp to EB Indian River Road	28.3	23.8	77.5	36.4
WB I-64	Freeway between Indian River Road ramps	60.5	108.5	27.9	117.7
WB I-64	Entrance ramp from EB Indian River Road	11.4	21.3	7.4	34.6
WB I-64	Weave at Indian River Road	70.6	118.6	26.2	127.2
WB I-64	Exit ramp to WB Indian River Road	40.5	31.3	51.9	35.1
WB I-64	Freeway between Indian River Road ramps	94.2	130.9	23.3	144.2
WB I-64	Entrance ramp from WB Indian River Road	112.9	147.1	40.5	168.4
WB I-64	Merge at WB Indian River Road	91.5	121.6	26.2	147.7
WB I-64	Freeway, entrance from Indian River Road to Express Lanes slip	72.4	105.5	43.0	140.0
WB I-64	Express Lanes slip ramp (south of I-264)	22.4	13.3	N/A	N/A
WB I-64	Diverge at EB I-264	28.7	78.6	35.2	99.1
WB I-64	Exit ramp to EB I-264	66.0	138.9	64.0	104.1
WB I-64	Freeway, EB I-264 exit ramp to EB I-264 entrance loop ramp	39.0	27.3	27.8	89.6
WB I-64	Entrance ramp from EB I-264 C/D	35.6	21.0	15.4	86.3
WB I-64	Weave between I-264 entrance and exit loop ramps	41.2	25.5	24.3	84.5
WB I-64	Exit ramp to WB I-264	17.2	18.5	34.3	196.3
WB I-64	Freeway between weave and I-264 major merge	43.4	26.3	24.5	10.4
WB I-64	Entrance ramp from EB I-264	18.8	19.6	29.1	11.4
WB I-64	Entrance ramp from WB I-264	34.0	29.0	24.1	3.8
WB I-64	Major merge at I-264	41.6	28.1	26.9	8.5
WB I-64	Freeway, I-264 to Express Lanes slip ramp	45.5	29.2	28.1	9.0
WB I-64	Express Lanes slip ramp (north of I-264)	16.0	10.5	N/A	N/A
WB I-64	Freeway, Express Lanes slip to exit ramp to Northampton Blvd.	52.1	27.9	28.6	9.2
WB I-64	Diverge at Northampton Boulevard	54.5	23.1	23.6	7.6
WB I-64	Exit ramp to Northampton Boulevard	23.5	23.0	33.4	6.6
WB I-64	Freeway between Northampton Boulevard ramps	84.7	28.4	26.5	8.6
WB I-64	Entrance ramp from Northampton Boulevard	46.4	27.2	12.9	6.1
WB I-64	Merge at Northampton Boulevard	52.4	33.2	28.7	9.6
WB I-64	Freeway mainline exit from study area	38.6	30.2	28.9	9.9
EB I-64	Freeway entry to study area	41.8	95.1	91.5	173.3
EB I-64	Diverge at Northampton Boulevard	53.6	92.5	87.4	155.8
EB I-64	Exit ramp to Northampton Boulevard	15.7	15.7	22.7	7.2
EB I-64	Freeway between Northampton Boulevard ramps	79.2	115.7	112.3	189.5
EB I-64	Entrance ramp from Northampton Boulevard WB	103.9	127.3	160.7	210.9
EB I-64	Entrance ramp from Northampton Boulevard EB	10.8	14.8	147.7	215.0
EB I-64	Merge at Northampton Boulevard	71.1	82.9	85.8	173.8
EB I-64	Freeway, Northampton Blvd. on-ramp to Express Lanes slip	70.3	80.0	75.1	180.4
EB I-64	Express Lanes slip ramp (north of I-264)	N/A	N/A	7.5	49.0
EB I-64	Freeway, Express Lanes slip to dedicated lanes to I-264	64.9	92.3	95.4	188.1
EB I-64	Major diverge at I-264	81.7	111.1	83.0	168.9
EB I-64	Exit ramp to WB I-264	8.0	7.4	6.2	2.0
EB I-64	Exit ramp to EB I-264	51.3	49.0	52.5	13.4
EB I-64	Freeway segment in vicinity of double white lines	31.3	36.7	38.2	112.1
EB I-64	Freeway before weave at I-264	17.6	27.0	33.6	91.0

Table 6.2 (continued): Traffic Analysis Results for I-64, Flow Density, 2044 No-Build Conditions

Roadway	Segment	Density (veh/ln/mi) AM1	AM2	PM1	PM2
EB I-64	Entrance ramp from WB I-264 C/D road	25.2	55.4	64.5	217.4
EB I-64	Weave between I-264 entrance and exit loop ramps	17.6	35.1	34.9	94.4
EB I-64	Exit ramp to EB I-264 C/D road	14.0	99.5	87.5	211.8
EB I-64	Freeway after weave at I-264 loop ramps	19.4	19.6	20.7	5.4
EB I-64	EB entrance ramp from WB I-264	69.8	84.4	114.5	41.4
EB I-64	EB entrance ramp from EB I-264	10.7	8.8	21.4	7.9
EB I-64	Merge at I-264	30.1	30.8	31.5	12.4
EB I-64	Freeway, I-264 merge to Express Lanes slip	32.6	33.2	33.9	13.8
EB I-64	Express Lanes slip ramp (south of I-264)	N/A	N/A	27.4	19.9
EB I-64	Freeway, Express Lanes slip to exit ramp to Indian River Road	24.3	24.8	31.2	14.4
EB I-64	Diverge at WB Indian River Road	22.1	22.6	28.8	13.4
EB I-64	Exit ramp to WB Indian River Road	9.9	13.0	19.4	9.5
EB I-64	Freeway after diverge at WB Indian River Road ramp	22.6	22.6	28.6	13.2
EB I-64	Entrance ramp from WB Indian River Road	28.7	23.1	31.8	14.9
EB I-64	Weave at Indian River Road	21.9	21.5	28.7	12.6
EB I-64	Exit ramp to EB Indian River Road	22.7	23.9	68.2	28.5
EB I-64	Freeway after weave	22.3	21.6	24.8	12.2
EB I-64	Entrance ramp from EB Indian River Road	30.1	30.8	11.3	13.6
EB I-64	Merge at Indian River Road	24.9	24.3	24.2	13.1
EB I-64	Freeway exit from study area	27.7	27.0	27.0	14.6
I-64 Reversible Express Lanes	WB freeway after diverge from general-purpose lanes	17.6	10.5	N/A	N/A
I-64 Reversible Express Lanes	WB I-264 flyover entrance ramp to WB Express Lanes	16.1	11.6	N/A	N/A
I-64 Reversible Express Lanes	WB freeway after merge at I-264 ramp	12.2	7.9	N/A	N/A
I-64 Reversible Express Lanes	First slip ramp to WB Express Lanes (north of I-264)	16.0	10.5	N/A	N/A
I-64 Reversible Express Lanes	WB merge at Express Lanes slip ramp (north of I-264)	18.7	12.0	N/A	N/A
I-64 Reversible Express Lanes	WB freeway exit from study area	18.1	12.0	N/A	N/A
I-64 Reversible Express Lanes	EB freeway entry to study area	N/A	N/A	22.4	17.6
I-64 Reversible Express Lanes	EB diverge at Express Lanes slip north of I-264	N/A	N/A	20.8	22.8
I-64 Reversible Express Lanes	Express Lanes slip ramp to EB I-64 (north of I-264)	N/A	N/A	7.5	49.0
I-64 Reversible Express Lanes	EB freeway, from Express Lanes slip to I-264	N/A	N/A	20.1	15.2
I-64 Reversible Express Lanes	EB diverge at I-264 flyover	N/A	N/A	21.4	15.6
I-64 Reversible Express Lanes	EB I-64 flyover to EB I-264	N/A	N/A	38.6	30.5
I-64 Reversible Express Lanes	EB freeway, from I-264 to Express Lanes slip	N/A	N/A	21.0	15.1

Table 6.3: Traffic Analysis Results for I-264, Flow Density, 2044 No-Build Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
EB I-264 Mainline	Freeway entry to study area and Diverge at C/D road	19.6	35.6	34.3	139.7
	Ramp to C/D road	11.1	61.2	41.5	183.5
	Freeway segment with HOV lane	14.6	14.1	19.7	8.4
	Freeway segment between end of HOV lane and exit for WB I-64	14.5	14.1	19.5	8.2
	Diverge to WB I-64	14.6	14.2	19.7	8.2
	Exit ramp to WB I-64	18.8	19.6	29.1	11.4
	Freeway between exit for WB I-64 and merge from EB I-64	21.1	21.1	27.3	11.8
	Entrance ramp from EB I-64 Express Lanes flyover	N/A	N/A	38.6	30.5
	Entrance ramp from EB I-64 general-purpose lanes flyover	51.3	49.0	52.5	13.4
	Merge from EB I-64	19.8	26.5	27.8	13.2
	Freeway between flyover merges and merge from inner C/D road	19.8	26.5	27.8	13.2
	Entrance ramp from inner C/D road	12.5	38.4	25.1	8.7
	Freeway at merge from inner C/D road	17.3	67.2	35.7	16.5
	Entrance ramp from outer C/D road	16.7	183.8	118.8	158.9
	Weave between merge from outer C/D road and Witchduck Road	59.9	129.9	88.9	96.1
	Exit ramp to Witchduck Road	7.8	10.0	20.4	18.1
	Freeway between Witchduck ramps	22.6	16.8	31.3	17.0
	Entrance ramp from Witchduck Road	195.6	202.2	214.0	216.3
	Freeway at merge with Witchduck Road ramp	19.2	14.8	27.7	15.8
	Freeway exit from study area	23.0	17.7	33.3	18.9
EB I-264 Outer C/D Road	Freeway start of EB C/D road and diverge to Military Highway	11.1	71.4	42.0	183.0
	Exit ramp to SB Military Highway	8.4	7.2	8.3	4.9
	Freeway between Military Highway ramps	12.4	84.3	64.5	169.7
	Entrance ramp from SB Military Highway	34.4	108.2	95.9	206.7
	Weave at Military Highway	12.4	84.3	64.5	169.7
	Exit ramp to NB Military Highway	12.6	10.5	15.3	6.8
	Freeway between Military Highway ramps	12.4	84.3	64.5	169.7
	Entrance ramp from Military Highway	75.6	183.9	65.0	217.7
	Weave between Military Highway entrance and EB I-64 exit ramps	28.2	116.8	70.7	184.4
	Exit ramp to EB I-64	10.7	8.8	21.4	7.9
	Freeway between I-64 ramps	24.4	137.2	81.2	175.4
	Entrance ramp from EB I-64	14.0	99.5	87.5	211.8
	Weave at I-64 entrance and exit loop ramps	24.4	137.2	81.2	175.4
	Exit ramp to WB I-64	35.6	21.0	15.4	86.3
	Freeway between I-64 ramps	26.8	146.9	86.4	163.4
	Entrance ramp from WB I-64	47.0	154.1	69.2	134.5
	Weave between WB I-64 and Newtown Road	47.3	157.3	85.3	154.6
	Exit ramp to SB Newtown Road	45.3	65.7	7.6	8.1
	Freeway between Newtown ramps	13.9	90.3	88.3	153.3
	Exit ramp to NB Newtown Road	28.8	16.9	17.1	52.7
	Freeway between Newtown ramps	5.8	136.3	112.5	184.8
	Entrance ramp from Greenwich Road	19.9	153.8	115.8	181.3
	Freeway, from Greenwich Rd. entrance ramp to EB I-264 mainline	7.8	168.6	115.0	166.3

Table 6.3 (continued): Traffic Analysis Results for I-264, Flow Density, 2044 No-Build Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
[1]	Ramp from WB I-64	16.9	10.9	19.8	11.4
	Inner C/D road to EB I-264 mainline	12.6	19.8	18.6	8.8
WB I-264 Mainline	Freeway entry to study area and diverge at Witchduck Road	87.3	88.6	27.5	156.8
	Exit ramp to Witchduck Road	10.8	12.7	24.1	9.9
	Freeway between Witchduck ramps	68.3	69.8	36.9	157.6
	Entrance ramp from SB Witchduck Road	35.1	35.4	29.9	167.6
	Weave between Witchduck entrance ramp and diverge at C/D road	49.5	58.6	46.1	138.1
	Ramp to C/D road	56.7	57.3	28.2	150.7
	Freeway between C/D road and Express Lanes flyover	32.1	68.8	90.3	49.4
	Diverge at exit ramp to Express Lanes flyover	36.9	64.0	107.4	45.3
	Exit ramp to flyover to EB I-64 Express Lanes	16.1	11.6	N/A	N/A
	Freeway diverge at left exit to EB I-64	30.5	54.0	104.9	29.1
	Left exit ramp to EB I-64	69.8	84.4	114.5	41.4
	Freeway between left exit ramp to EB I-64 and merge at C/D road	13.5	15.2	9.2	6.8
	Ramp from C/D road	23.1	19.2	18.4	4.5
	WB I-264 at merge at C/D road	19.1	18.6	14.7	6.7
	Freeway exit from study area	20.9	20.4	16.0	7.4
WB I-264 C/D Road	Start of C/D road	56.8	57.4	28.2	150.4
	Diverge at Newtown Road	57.9	61.5	29.7	160.4
	Exit ramp to Newtown Road	14.4	66.6	37.3	116.4
	Freeway between Newtown ramps	74.6	64.6	32.0	171.8
	Entrance ramp from NB Newtown Road	26.3	13.7	23.9	155.4
	Freeway between Newtown entrance ramps	37.0	31.2	26.7	175.3
	Entrance ramp from SB Newtown Road	19.8	11.7	19.3	125.5
	Weave between Newtown Road and I-64	26.1	24.3	25.3	144.3
	Exit ramp to WB I-64	34.0	29.0	24.1	3.8
	Freeway between I-64 ramps	12.1	16.5	19.8	77.2
	Entrance ramp to WB I-264	17.2	18.5	34.3	196.3
	Weave at I-64 entrance and exit loop ramps	11.9	16.0	19.9	67.9
	Exit ramp to EB I-64	25.2	55.4	64.5	217.4
	Freeway between I-64 ramps	10.8	9.1	11.5	2.4
	Entrance ramp from EB I-64	8.0	7.4	6.2	2.0
	Weave between I-64 and Military Highway	11.1	10.0	10.9	4.2
	Exit ramp to NB Military Highway	23.2	24.0	23.1	5.3
	Freeway between Military Highway ramps	12.2	12.1	11.9	21.4
	Entrance ramp from NB Military Highway	14.6	10.5	6.0	5.5
	Weave at Military Highway ramps	12.1	15.1	12.6	26.5
	Exit ramp to SB Military Highway	14.7	74.0	61.6	166.5
	Freeway between Military Highway ramps	12.1	9.4	9.6	2.4
	Entrance ramp from SB Military Highway	14.3	16.0	16.0	4.3
	Merge at SB Military Highway	15.8	13.3	13.2	3.2
	C/D road ramp to WB I-264	23.1	19.2	18.4	4.5

[1] EB I-264 Inner C/D Road

Table 6.4: Travel Time and Speed Data for Projected 2044 No-Build Conditions

Travel Time Route No.	1	2	3	4	5	6	7	8	9
Route Start Point	WB I-64, south of Indian River Road	EB I-64, north of Northampton Blvd.	EB I-264 mainline at diverge to C/D	WB I-264 mainline, east of Witchduck Rd.	EB I-264 C/D, at diverge with mainline	WB I-264 C/D, at diverge with mainline	EB I-64, on ramp from Northampton Blvd.	WB I-264, on ramp from Witchduck Rd.	WB I-264, on ramp from Witchduck Rd.
Route End Point	WB I-64, north of Northampton Blvd.	EB I-64, south of Indian River Road	EB I-264 mainline east of Witchduck Rd.	WB I-264 mainline, at merge with C/D	EB I-264 C/D, at merge with mainline	WB I-264 C/D, at merge with mainline	EB I-264, exit ramp to Witchduck Rd.	EB I-64, exit ramp to Indian River Rd.	WB I-64, exit ramp to Northampton Blvd.
Route Length (mi)	5.91	6.01	4.34	4.33	2.40	2.36	4.02	4.28	3.72
AM Peak Hr. 1 Travel time (min)	10.7	8.8	4.7	7.3	2.6	3.4	8.1	5.8	6.4
AM Peak Hr. 1 Avg. speed (mph)	33.0	41.0	55.2	35.4	54.6	41.9	29.7	44.0	35.1
AM Peak Hr. 2 Travel time (min)	12.0	12.2	6.2	9.1	9.8	3.2	12.9	7.7	5.0
AM Peak Hr. 2 Avg. speed (mph)	29.5	29.4	42.3	28.6	14.7	44.2	18.7	33.2	44.3
PM Peak Hr. 1 Travel time (min)	6.5	11.2	5.8	11.8	8.6	3.2	9.7	11.4	3.9
PM Peak Hr. 1 Avg. speed (mph)	54.2	32.2	44.5	22.1	16.7	44.8	24.9	22.5	56.9
PM Peak Hr. 2 Travel time (min)	26.3	53.5	9.0	20.1	89.8	64.0	34.3	16.4	25.2
PM Peak Hr. 2 Avg. speed (mph)	13.5	6.7	29.1	12.9	1.6	2.2	7.0	15.6	8.9

Orientation of Numbered Travel Time Routes

Intersections - Table 6.5 summarizes the results of traffic analyses conducted for projected 2044 no-build conditions. Traffic operations are anticipated to degrade at almost all of the study area's 21 intersections. During AM peak hour 2, 13 of the 21 study area intersections are expected to operate at heavily to severely congested conditions. During PM peak hour 2, 19 intersections are expected to operate under the same conditions. Some intersections begin to fail (heavily to severely congested) during the first hour in either peak period. As congestion builds at those intersections, the queues spill back to the adjacent intersections, affecting those intersections as well.

Table 6.5: Traffic Analysis Results for Intersections, 2044 No-Build Conditions

Roadway	Intersection at	Control	Average Delay (seconds per vehicle)			
			AM1	AM2	PM1	PM2
S. Military Highway	Corporate Blvd.	S	35.3	66.1	35.5	399.2
	Hoggard Rd.	S	13.5	18.1	25.4	195.4
	Poplar Hall Dr.	S	17.8	32.7	125.5	576.6
Newtown Road	Kempsville Rd. / Princess Anne Rd.	S	122.5	180.6	251.3	796.8
	Greenwich Rd. / I-264 EB ramp	S	99.1	250.1	96.9	564.4
	Center Dr.	S	13.0	29.2	53.8	234.1
	Stoney Point S. / I-264 WB exit ramp	S	34.8	66.9	41.1	488.1
	Cleveland St. / Ethan Allen Ln.	S	23.9	58.9	54.3	427.2
Witchduck Road [1]	Grayson Rd. / I-264 EB ramps	S	365.8	481.9	327.3	625.1
	I-264 WB exit ramp	S	49.7	47.2	46.6	60.0
	I-264 WB on-ramp / Southern Blvd.	S	31.9	31.8	65.7	87.9
	Cleveland St.	S	90.0	120.3	216.5	257.3
Indian River Road	Reon Dr.	S	43.6	43.2	30.1	35.4
	Strickland Blvd.	U	55.0	105.1	5.4	148.3
	Regent University Drive	S	62.2	92.2	64.9	146.5
	Centerville Turnpike	S	203.5	287.4	63.4	205.3
Northampton Boulevard	USAA Dr. / Kempsville Rd.	S	40.1	73.2	108.8	466.6
	I-64 EB on-ramp / IKEA Way	S	1.9	2.3	37.6	244.6
	I-64 EB exit ramp	S	16.1	61.9	66.0	243.1
	I-64 WB exit ramp	S	35.3	20.9	22.7	17.9
	Wesleyan Dr./Premium Outlets Dr.	S	99.2	303.2	316.6	549.0

Control: S – Signalized, U – Unsignalized
[1] Reflects reconfiguration of Witchduck Road as part of the I-64/I-264 Phase II project and the Witchduck Road Phase 2 project.

Analysis Results - 2044 Build Conditions, Recommended Alternative

The Study Team developed improvements that would accommodate the projected demand for 2044 build conditions for the freeway links (basic segments, weave, merge and diverge areas), ramps, ramp termini, and arterials within the interchange influence areas. The recommended improvements are shown in Figures 4-29 through 4-45 and described in detail in Section 5.3.

Constrained Model - The process of screening and refining alternatives identified improvements at the first intersection beyond ramp terminal intersections to minimize the potential for queuing at those intersections to spill back and affect operations on interchange ramps. Improvements at intersections were formulated to reflect any of the following conditions:

- The number of through and turn lanes needed to address projected demand; or,
- The number of through and turn lanes that were considered practical maximums. For the purposes of this study, triple turn lanes and five through lanes were considered the practical maximum improvements; or,
- Intersection widening to the extent that adjacent developed properties would be impacted but remain functional, without the need for full acquisition and relocation or without significant impacts to site operations for parking, access, and on-site circulation.

Accordingly, the following intersections will meter traffic flow to the interstate network during the AM peak period even if improved as shown in the recommended build conditions:

- Newtown Road at Kempsville Road and Princess Anne Road
- Witchduck Road at Cleveland Street
- Indian River Road at Reon Drive
- Indian River Road at Regent University Drive
- Indian River Road at Centerville Turnpike
- Northampton Boulevard at Kempsville Road and USAA Drive

Signal timings were developed at ramp termini and intersections adjacent to the interchange that favor traffic moving away from each interchange. This approach ensures that any queuing that develops at study area intersections will be contained within the available storage and will not extend back onto the interstates. However, this then creates a condition during the AM peak period in which some intersections meter traffic into the study area, even with improvements. For example, the AM peak period signal timing developed at the intersection of Witchduck Road and Cleveland Street favors the northbound approach to prevent queuing back onto I-264. This reduces green time for the remaining approaches, which results in metering traffic toward I-264. Under these conditions, full demand is not realized on the interstate network, representing the constrained build condition. Analysis results for the constrained build condition are included in Appendix G.

Unconstrained Model - Conditions which meter traffic onto the interstates do not allow for operational evaluation of the proposed interstate improvements as a means to accommodate full projected traffic demand. To counter this metering effect, signal controls at the above-referenced intersections which meter traffic into the study area were turned off for the AM peak hour VISSIM microsimulation. (Analysis of the PM peak hour period did not require use of this technique because proposed intersection improvements at all locations are sufficient to address projected PM peak demand.) This means that the intersections operate in free-flow conditions and vehicles advance through the intersections unimpeded during the microsimulation model. This allows the full traffic demand from the arterials to reach the interstates, and allows the proposed interstate improvements to be evaluated, which is of primary interest in this study. These are referred to as the unconstrained build conditions.

The AM peak hour results presented in Tables 6.6 and 6.7 are for the unconstrained build conditions, for which full detailed results are presented in Appendix G. Performance results during the AM peak hour are not reported for those intersections identified above because operational constraints were removed at those locations.

Freeway link densities - Tables 6.6 and 6.7 present the 2044 build conditions freeway link densities for I-64 and I-264 respectively. Density information for 2044 build conditions is presented in graphical format in Appendix G. The VISSIM models indicated that operational conditions along both I-64 and I-264 would be greatly improved over the 2044 no-build conditions. Some metering into the study area is expected to occur at the limits of the study area. This is due to the upstream capacity of the freeway network. Within the study area, several locations along the interstates are expected to have brief periods that momentarily experience heavily congested conditions during the first hour of each peak period. These locations briefly operate with slower speeds, but do not initiate congestion and all traffic demand is served. These slowdowns dissipate during the second hour of each peak period.

The reversible I-64 Express Lanes are expected to continue to operate under light traffic conditions.

Table 6.6: Traffic Analysis Results for I-64, Flow Density, 2044 Build Conditions

Roadway and Segment		Density (veh/ln/mi) AM1	AM2	PM1	PM2
WB I-64	Freeway entry to study area	39.4	36.4	44.0	64.8
WB I-64	Diverge at Indian River Road	29.4	27.8	29.2	29.1
WB I-64	Exit ramp to EB Indian River Road	26.6	27.9	32.9	33.6
WB I-64	Freeway between Indian River Road exit ramps	29.2	27.4	27.7	27.3
WB I-64	Exit ramp to WB Indian River Road	40.4	36.2	47.8	51.6
WB I-64	Freeway between Indian River Road exit and entrance ramps	26.6	25.2	24.2	23.3
WB I-64	Entrance ramp from WB Indian River Road	36.9	33.4	22.6	26.4
WB I-64	Merge from WB Indian River Road	29.9	27.7	23.4	23.7
WB I-64	Freeway, from Indian River Rd. entrance ramp to Express Lanes slip	32.2	30.0	25.5	25.6
WB I-64	Express Lanes slip ramp (south of I-264)	26.0	17.5	N/A	N/A
WB I-64	Diverge at EB I-264	28.7	27.4	27.0	26.0
WB I-64	Exit ramp to EB I-264	37.8	34.4	34.4	26.4
WB I-64	Freeway between exit ramps for EB and WB I-264	31.4	26.3	23.0	25.8
WB I-64	Freeway at diverge to WB I-264	36.2	28.2	23.8	28.0
WB I-64	Exit ramp to WB I-264	20.7	30.9	40.7	45.3
WB I-64	Freeway between diverge to WB-I-264 ramp and I-264 major merge	37.2	32.6	25.2	28.8
WB I-64	Entrance ramp from EB I-264	19.9	21.0	22.7	23.1
WB I-64	Entrance ramp from WB I-264	33.0	29.9	22.1	22.2
WB I-64	Major merge from I-264	29.4	26.7	21.7	22.8
WB I-64	Freeway, I-264 to Express Lanes slip	31.4	29.0	23.1	24.4
WB I-64	Express Lanes slip ramp (north of I-264)	18.5	13.7	N/A	N/A
WB I-64	Freeway, Express Lanes slip to exit ramp to Northampton Blvd.	31.5	29.0	24.2	25.6
WB I-64	Diverge to Northampton Boulevard	29.2	27.3	23.7	25.1
WB I-64	Exit ramp to Northampton Boulevard	27.5	30.2	28.3	29.0
WB I-64	Freeway between Northampton Boulevard ramps	30.7	27.4	29.9	32.3
WB I-64	Entrance ramp from Northampton Boulevard	29.1	25.1	17.0	15.2
WB I-64	Merge from Northampton Boulevard and exit from study area	30.6	26.1	26.5	28.1
EB I-64	Freeway entry to study area	26.3	26.7	32.9	30.1
EB I-64	Diverge to Northampton Boulevard	26.8	27.4	36.8	31.8
EB I-64	Exit ramp to Northampton Boulevard	15.7	16.7	36.0	29.5
EB I-64	Freeway between Northampton Boulevard ramps	31.1	31.6	40.5	34.5
EB I-64	Entrance ramp from WB Northampton Boulevard	62.3	62.0	55.7	39.7
EB I-64	Entrance ramp from EB Northampton Boulevard	38.3	37.5	62.8	63.5
EB I-64	Merge from Northampton Boulevard	28.4	28.7	46.3	30.8
EB I-64	Freeway, from Northampton Blvd. on-ramp to Express Lanes slip	29.8	30.5	53.4	33.6
EB I-64	Express Lanes slip ramp (north of I-264)	N/A	N/A	4.5	2.8
EB I-64	Freeway, from Express Lanes to major diverge to I-264 (EB and WB)	28.0	28.3	34.4	30.9
EB I-64	Exit ramp to WB I-264	29.4	27.1	37.0	32.9
EB I-64	Exit ramp to EB I-264	33.2	33.4	36.2	30.0
EB I-64	Freeway at diverge to EB I-264 C/D road	18.1	18.8	24.5	22.9
EB I-64	Exit ramp to EB I-264 C/D road	15.9	24.9	47.5	52.8
EB I-64	Freeway, from exit ramp to EB 264 to entrance ramp from EB 264	20.0	19.5	23.0	20.5
EB I-64	Entrance ramp from EB I-264	9.9	18.2	29.1	30.5
EB I-64	Merge from EB I-264	20.1	21.7	27.2	25.2

Table 6.6 (continued): Traffic Analysis Results for I-64, Flow Density, 2044 Build Conditions

Roadway and Segment		Density (veh/ln/mi) AM1	AM2	PM1	PM2
EB I-64	Entrance ramp from WB I-264	33.7	38.1	33.8	35.8
EB I-64	Merge at I-264 WB ramp, prior to Express Lanes slip ramp	32.1	40.3	32.3	31.5
EB I-64	Express Lanes slip ramp (south of I-264)	N/A	N/A	27.4	20.3
EB I-64	Freeway, Express Lanes slip to exit ramp to Indian River Road	24.0	26.0	33.6	31.7
EB I-64	Diverge to WB Indian River Road	22.5	24.4	31.5	29.8
EB I-64	Exit ramp to WB Indian River Road	12.3	17.2	25.7	26.6
EB I-64	Diverge to EB Indian River Road ramp	18.3	19.5	24.5	23.0
EB I-64	Exit ramp to EB Indian River Road	14.0	14.5	28.8	25.1
EB I-64	Freeway after diverge to EB Indian River Road ramp	23.2	24.8	28.5	27.4
EB I-64	Entrance ramp from Indian River Road	30.9	30.2	16.8	18.7
EB I-64	Merge at Indian River Road	28.4	29.5	28.3	27.8
EB I-64	Freeway exit from study area	30.3	31.4	29.3	29.0
WB I-64 Exp. Lanes	Freeway after diverge from general-purpose lanes	18.8	13.1	N/A	N/A
WB I-64 Exp. Lanes	WB I-264 flyover entrance ramp to WB Express Lanes	14.2	9.9	N/A	N/A
WB I-64 Exp. Lanes	Express Lanes after merge at I-264 ramp	18.5	13.7	N/A	N/A
WB I-64 Exp. Lanes	First slip ramp to WB Express Lanes (north of I-264)	14.3	10.0	N/A	N/A
WB I-64 Exp. Lanes	Merge at Express Lanes slip ramp (north of I-264)	20.3	14.4	N/A	N/A
WB I-64 Exp. Lanes	Express Lanes exit from study area	22.0	25.4	N/A	N/A
EB I-64 Exp. Lanes	EB freeway entry to study area	N/A	N/A	22.4	16.7
EB I-64 Exp. Lanes	Diverge at Express Lanes slip north of I-264	N/A	N/A	20.3	15.3
EB I-64 Exp. Lanes	Express Lanes slip ramp to EB I-64 (north of I-264)	N/A	N/A	4.5	2.8
EB I-64 Exp. Lanes	EB freeway between Express Lanes slip and I-264	N/A	N/A	20.1	15.5
EB I-64 Exp. Lanes	Diverge at I-264 flyover	N/A	N/A	21.2	16.0
EB I-64 Exp. Lanes	EB I-64 flyover to EB I-264	N/A	N/A	22.0	17.6
EB I-64 Exp. Lanes	EB freeway from I-264 to Express Lanes slip	N/A	N/A	20.9	15.4

Table 6.7: Traffic Analysis Results for I-264, Flow Density, 2044 Build Conditions

Roadway and Segment		Density (veh/ln/mi) AM1	AM2	PM1	PM2
EB I-264 Mainline	Freeway entry to study area and diverge at C/D road	22.0	25.4	31.2	34.4
EB I-264 Mainline	Freeway mainline	14.4	13.6	18.7	19.9
EB I-264 Mainline	Freeway lane add at EB I-64 Express Lanes flyover merge	10.7	10.2	38.6	31.2
EB I-264 Mainline	Merge from EB I-64 Express Lanes flyover	N/A	N/A	19.9	19.7
EB I-264 Mainline	Freeway between flyover merge and merge from inner C/D road	12.7	12.1	24.4	25.2
EB I-264 Mainline	Entrance ramp from inner C/D road	27.6	27.2	37.0	27.5
EB I-264 Mainline	Freeway at merge from inner C/D road	24.1	23.2	39.5	30.2
EB I-264 Mainline	Weave between merge from outer C/D road and Witchduck Road	19.1	19.3	30.2	31.1
EB I-264 Mainline	Exit ramp to Witchduck Road	10.2	12.9	11.6	11.0
EB I-264 Mainline	Freeway between Witchduck ramps	23.1	23.2	36.2	35.7
EB I-264 Mainline	Entrance ramp from Witchduck Road	12.9	13.6	13.9	15.9
EB I-264 Mainline	Freeway at merge with Witchduck Road ramp	20.6	20.8	31.3	31.1
EB I-264 Mainline	Freeway exit from study area	21.5	21.7	32.6	32.3

Table 6.7 (continued): Traffic Analysis Results for I-264, Flow Density, 2044 Build Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
EB I-264 Outer C/D Road	Freeway start of EB C/D road and diverge to Military Highway	16.2	20.6	26.8	30.1
	Exit ramp to NB/SB Military Highway	13.1	13.6	14.5	15.2
	Freeway between Military Highway ramps	14.0	19.0	26.0	29.5
	Entrance ramp from NB/SB Military Highway	32.8	33.4	34.7	37.0
	Weave between Military Highway entrance and EB I-64 exit ramps	17.9	20.7	25.1	30.2
	Exit ramp to EB I-64	9.9	18.2	29.1	30.5
	Exit ramp to WB I-64 flyover	19.9	21.0	22.7	23.1
	Freeway before merge from EB I-64 entrance ramp	14.3	15.8	18.1	22.4
	Entrance ramp from EB I-64	15.9	24.9	47.5	52.8
	Freeway between merge from EB I-64 and WB I-64 entrance ramps	16.4	20.1	26.9	33.5
	Entrance ramp from WB I-64	33.1	33.1	24.6	20.9
	Weave between WB I-64 and Newtown Road	20.8	23.3	26.8	29.5
	Exit ramp to SB Newtown Road	14.6	15.2	12.5	13.7
	Freeway between Newtown ramps	14.7	17.4	23.0	25.2
	Exit ramp to NB Newtown Road	31.5	35.3	30.2	21.6
	Freeway, from NB Newtown exit ramp to Greenwich entrance ramp	7.8	10.0	17.4	22.4
	Entrance ramp from Greenwich Road	28.4	27.2	46.0	45.2
	Freeway, from Greenwich Rd. entrance ramp to EB I-264 mainline	9.5	10.7	18.4	21.6
EB I-264 Inner C/D	Ramp from WB I-64	21.6	20.2	25.9	22.4
	Freeway prior to merge from EB I-64 flyover	19.0	18.1	24.1	21.3
	Entrance ramp from EB I-64 lanes flyover	33.2	33.4	36.2	30.0
	Merge at EB I-64 flyover	22.8	22.5	27.1	22.2
	Freeway, from EB I-64 ramp to EB I-264 mainline merge	27.6	27.2	34.9	27.2
WB I-264 Mainline	Freeway entry to study area	47.6	75.8	24.0	25.4
	Diverge at Witchduck Road	52.3	64.5	23.3	24.7
	Exit ramp to Witchduck Road	12.5	13.1	12.9	17.2
	Freeway, between Witchduck exit ramp and diverge to WB C/D road	33.1	32.8	22.4	23.2
	Ramp to WB I-264 C/D Rd.	31.2	32.3	23.5	24.9
	Freeway between C/D road and Express Lanes flyover	22.4	20.8	13.5	13.5
	Exit ramp to flyover to EB I-64 Express Lanes	18.8	13.1	13.5	13.5
	Freeway after exit ramp to Express Lanes	18.4	18.2	13.6	13.6
	Freeway prior to merge from WB I-264 C/D road	18.3	18.2	13.6	13.6
	Ramp from C/D Road	12.9	15.3	15.4	16.6
	Freeway at merge from WB I-264 C/D road	18.9	21.2	19.2	20.3
	Exit from study area	24.3	26.8	23.8	24.9
WB I-264 C/D Road	Start of C/D road	31.2	32.3	23.5	24.9
	Entrance ramp from Witchduck Road	42.3	42.3	43.8	46.9
	Weave between Witchduck Road and Newtown Road	29.3	30.1	22.9	24.2
	Exit ramp to Newtown Road	20.1	19.4	20.0	18.9
	Freeway C/D road at diverge for outer ramp	29.2	30.2	22.0	23.6
	To outer ramp	31.5	31.2	21.9	22.6
	Freeway prior to slip ramp from Newtown Road	5.0	10.5	10.1	14.3
	Entrance slip ramp from Newtown Road to C/D Road	38.4	35.6	29.5	30.2
	Merge from Newtown Road slip ramp	22.4	28.4	23.7	30.2
	Freeway between Newtown Road merge and I-64 ramp	25.1	29.8	26.2	31.3

Table 6.7 (continued): Traffic Analysis Results for I-264, Flow Density, 2044 Build Conditions

Roadway and Segment		Density (veh/ln/mi)			
		AM1	AM2	PM1	PM2
WB I-264 C/D Road	Entrance ramp from WB I-64	20.7	30.9	40.7	45.3
	Merge at WB I-64 entrance ramp	17.9	23.1	23.6	27.1
	Entrance ramp from EB I-64	29.4	27.1	37.0	32.9
	Weave between I-64 and Military Highway	18.9	21.6	28.6	32.4
	Exit ramp to Military Highway	28.8	32.0	40.2	45.0
	Freeway between Military Highway ramps	15.1	17.8	20.7	23.0
	Entrance ramp from Military Highway NB	16.2	17.0	8.8	10.0
	Merge at NB Military Highway entrance ramp	12.9	14.8	14.7	16.2
	Entrance ramp from SB Military Highway	13.4	18.1	17.8	17.7
	Merge to WB freeway	12.9	15.3	15.4	16.6
WB I-264 Outer Ramp to I-64	Outer ramp prior to slip ramp from Newtown Road	31.7	31.4	22.2	22.9
	Entrance ramp from Newtown Road prior to slip ramp split	33.4	30.2	47.0	46.9
	Entrance slip ramp from Newtown Road to outer ramp	23.0	19.2	50.2	51.0
	Outer ramp prior to split between EB/WB I-64	27.0	26.5	22.3	23.0
	Exit ramp from outer ramp to WB I-64	33.0	29.9	22.1	22.2
	Exit ramp from outer ramp to EB I-64	33.7	38.1	33.8	35.8

Queuing beyond ramp storage capacity - Under 2044 Build Conditions, the study area ramp termini are not expected to experience queuing that extends beyond the ramp storage capacity. As discussed within the "Intersections" subsection below, signal timings were developed at ramp termini and intersections adjacent to the interchange to favor traffic moving away from the interchange. Queuing will occur on the ramps and arterials, but queues are predicted to be contained within available storage areas, as summarized in Table 6.8.

Table 6.8: Queuing at Signalized Ramp Termini for I-64 and I-264, 2044 Build Conditions

Exit Ramp Terminal Location	Distance, Stop Bar to Exit Ramp Gore (ft)	AM Peak Maximum Queue (ft)	PM Peak Maximum Queue (ft)
EB I-264 C/D road exit loop ramp to Military Hwy.	595	268	223
WB I-264 C/D road exit ramp to Military Hwy.	730	560	570
EB I-264 Outer C/D road exit ramp to SB Newtown Rd. & Greenwich Rd.	765	513	507
EB I-264 Outer C/D road exit loop ramp to NB Newtown Rd.	1,150	459	762
WB I-264 C/D road exit ramp to Newtown Rd. at Center Dr.	840	297	576
WB I-264 C/D road exit ramp to Newtown Rd. at Stoney Point S.	720	271	340
EB I-264 exit ramp to Witchduck Road	1,280	553	451
WB I-264 C/D road exit ramp to Witchduck Road	450	268	299
WB I-64 exit ramp to Northampton Boulevard	480	343	239
EB I-64 exit ramp to Northampton Boulevard	865	341	815

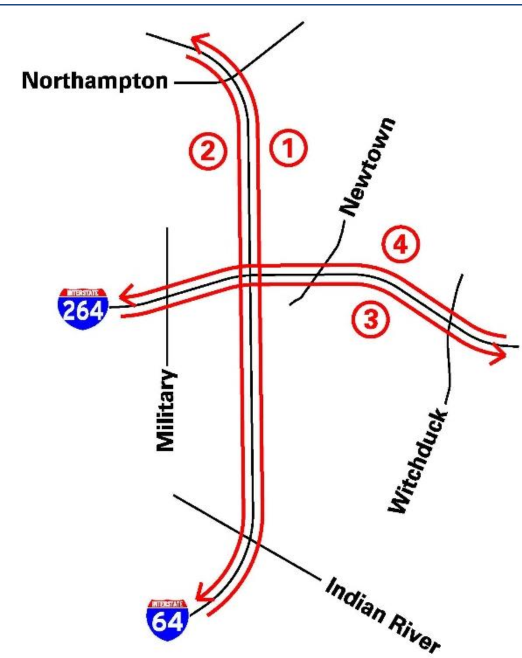
Travel times and travel speeds - Tables 6.9 and 6.10 on the following pages summarize travel times and average speeds for selected routes under 2044 build conditions during the AM and PM peak periods, respectively.

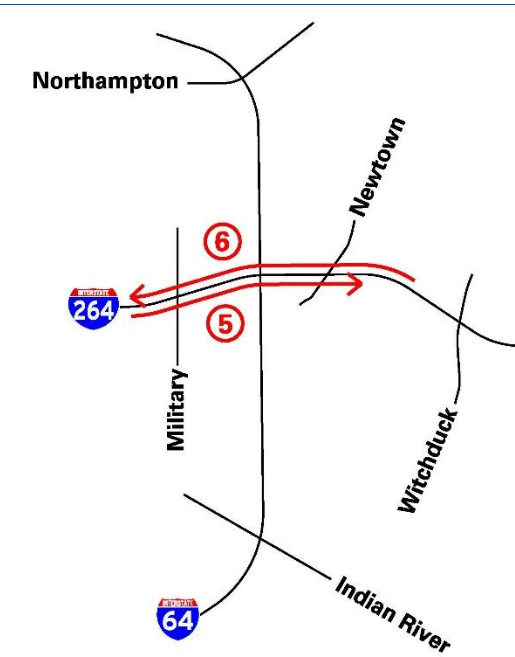
Travel speeds for nearly all travel routes improve in the 2044 build conditions when compared with the 2044 no-build condition, and most travel speeds improve compared to the 2018 existing conditions.

Table 6.9: Travel Time Data for Projected 2044 AM Build Conditions

	Travel Time Route No.	1	2	3	4	5	6	7	8	9
	Route Start Point	WB I-64, south of Indian River Road	EB I-64, north of Northampton Blvd.	EB I-264 mainline at diverge to C/D	WB I-264 mainline, east of Witchduck Rd.	EB I-264 C/D, at diverge with mainline	WB I-264 C/D, at diverge with mainline	EB I-64, on ramp from Northampton Blvd.	WB I-264, on ramp from Witchduck Rd.	WB I-264, on ramp from Witchduck Rd.
	Route End Point	WB I-64, north of Northampton Blvd.	EB I-64, south of Indian River Road	EB I-264 mainline east of Witchduck Rd.	WB I-264 mainline, at merge with C/D	EB I-264 C/D, at merge with mainline	WB I-264 C/D, at merge with mainline	EB I-264, exit ramp to Witchduck Rd.	EB I-64, exit ramp to Indian River Rd.	WB I-64, exit ramp to Northampton Blvd.
	Route Length (mi)	5.91	6.01	4.34	4.33	2.40	2.86	4.02	4.28	3.72
AM Peak Hr. 1	Travel time (min)	6.3	6.2	4.5	4.9	2.8	2.8	4.7	5.2	3.9
AM Peak Hr. 1	Time savings (min)	4.4	2.5	0.2	2.5	-0.2	0.5	3.5	0.6	2.5
AM Peak Hr. 1	% Time reduction	41%	29%	5%	34%	-7%	16%	43%	11%	39%
AM Peak Hr. 1	Avg. speed (mph)	56.0	57.8	58.1	53.5	51.3	60.2	51.8	49.4	57.7
AM Peak Hr. 2	Travel time (min)	6.1	6.3	4.5	5.5	2.8	2.8	4.7	5.4	3.8
AM Peak Hr. 2	Time savings (min)	5.9	6.0	1.7	3.6	6.9	0.4	8.2	2.3	1.2
AM Peak Hr. 2	% Time reduction	55%	68%	36%	49%	263%	11%	101%	40%	19%
AM Peak Hr. 2	Avg. speed (mph)	58.0	57.6	58.1	47.3	50.9	60.6	51.8	47.5	58.7

Orientation of Numbered Travel Time Routes





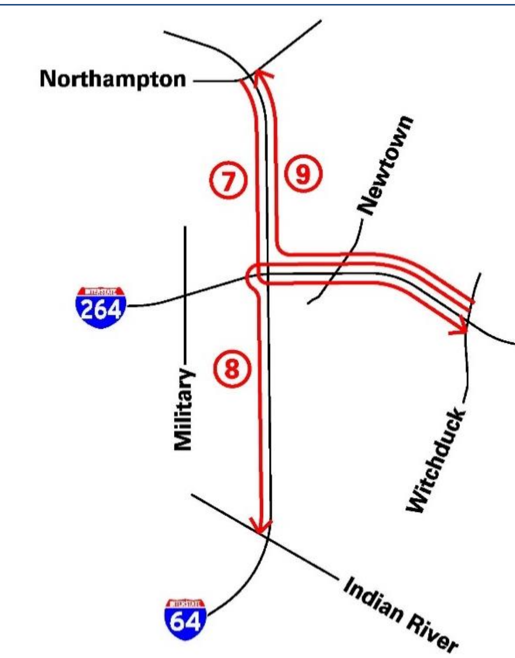
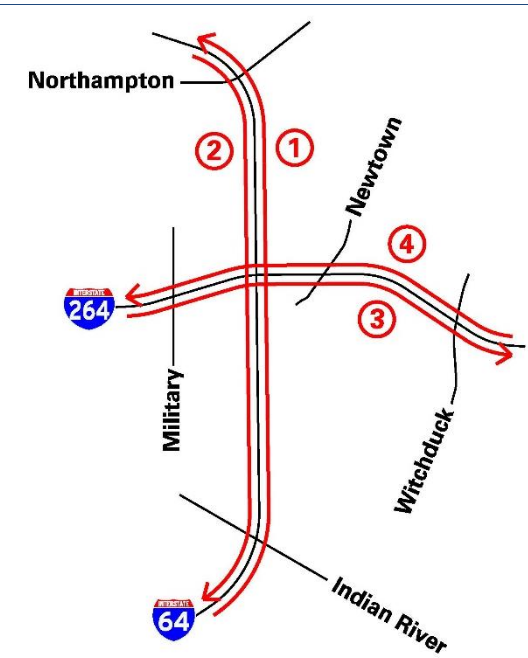
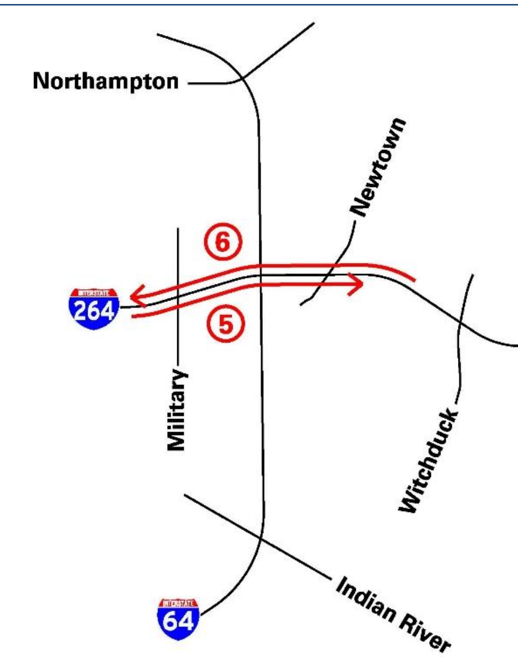


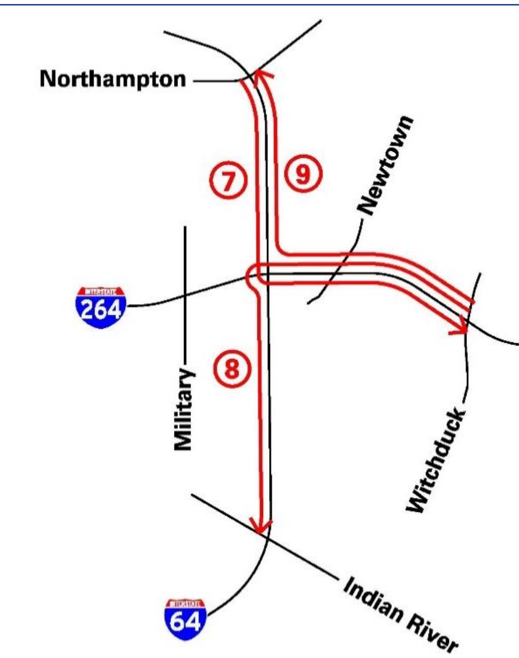
Table 6.10: Travel Time Data for Projected 2044 PM Build Conditions

	Travel Time Route No.	1	2	3	4	5	6	7	8	9
	Route Start Point	WB I-64, south of Indian River Road	EB I-64, north of Northampton Blvd.	EB I-264 mainline at diverge to C/D	WB I-264 mainline, east of Witchduck Rd.	EB I-264 C/D, at diverge with mainline	WB I-264 C/D, at diverge with mainline	EB I-64, on ramp from Northampton Blvd.	WB I-264, on ramp from Witchduck Rd.	WB I-264, on ramp from Witchduck Rd.
	Route End Point	WB I-64, north of Northampton Blvd.	EB I-64, south of Indian River Road	EB I-264 mainline east of Witchduck Rd.	WB I-264 mainline, at merge with C/D	EB I-264 C/D, at merge with mainline	WB I-264 C/D, at merge with mainline	EB I-264, exit ramp to Witchduck Rd.	EB I-64, exit ramp to Indian River Rd.	WB I-64, exit ramp to Northampton Blvd.
	Route Length (mi)	5.91	6.01	4.34	4.33	2.40	2.86	4.02	4.28	3.72
PM Peak Hr. 1	Travel time (min)	6.2	6.6	4.6	4.4	2.9	2.9	4.9	5.0	3.7
	Time savings (min)	0.3	4.6	1.2	7.4	5.8	0.2	4.8	6.4	0.2
	% Time reduction	5%	41%	21%	63%	67%	7%	50%	56%	5%
	Avg. speed (mph)	56.8	54.5	56.2	59.2	50.4	58.3	49.5	51.0	60.1
PM Peak Hr. 2	Travel time (min)	6.3	6.3	4.6	4.4	2.9	2.9	4.7	5.0	3.7
	Time savings (min)	20.1	47.1	4.3	15.7	86.9	61.1	29.6	11.4	21.4
	% Time reduction	76%	88%	48%	78%	97%	96%	86%	69%	85%
	Avg. speed (mph)	56.6	56.9	56.4	59.2	49.0	59.7	51.7	50.9	59.9

Orientation of Numbered Travel Time Routes







Intersections - Table 6.11 summarizes traffic analysis results for 2044 build conditions at intersections within the study area. As described earlier in this section, the AM peak period VISSIM model was run to reflect both constrained and unconstrained operations. The results presented below for the AM peak hours represent the unconstrained model. Therefore, intersection performance results are not presented at locations where capacity constraints were removed.

Table 6.11: Traffic Analysis Results for Intersections, 2044 Build Conditions

Roadway	Intersection at	Control	Average Delay (seconds per vehicle)			
			AM1	AM2	PM1	PM2
S. Military Highway	Corporate Blvd.	S	21.1	20.3	25.5	34.8
	I-264 EB ramps	S	30.8	31.5	20.0	19.2
	I-264 WB ramps	S	28.7	29.8	24.0	22.8
	Hoggard Rd.	S	11.9	14.0	19.3	22.4
	Poplar Hall Dr.	S	18.1	21.3	72.5	75.0
Newtown Road	Kempsville Rd. / Princess Anne Rd.	S	*	*	60.0	81.5
	Greenwich Rd. / I-264 EB exit ramp	S	36.9	37.1	40.6	46.1
	EB I-264 exit ramp (to NB Newtown Rd.)	S	20.4	20.5	24.3	23.2
	Center Dr.	S	22.2	21.3	38.1	40.4
	Stoney Point S. / I-264 WB exit ramp	S	16.1	15.4	26.1	33.4
	Cleveland St. / Ethan Allen Ln	S	12.5	18.4	36.2	46.4
	Greenwich Rd. roundabout	S	17.3	15.4	36.7	45.5
Witchduck Road	Grayson Rd. / I-264 EB ramps	S	41.6	56.0	38.4	39.3
	I-264 WB exit ramp	S	6.9	5.5	2.5	3.5
	I-264 WB entrance ramp / Southern Blvd.	S	16.8	18.1	18.8	21.7
	Cleveland St.	S	*	*	43.7	47.6
Indian River Road	Reon Dr.	S	*	*	24.4	30.6
	I-64 EB ramps	S	14.4	14.3	11.2	11.4
	I-64 WB ramps	S	9.9	10.5	6.1	6.8
	Strickland Blvd.	U	6.9	5.5	2.5	3.5
	Regent University Dr.	S	*	*	34.2	38.1
	Regent University Dr. (right turn merge)	U	*	*	8.0	8.4
	Centerville Turnpike	S	*	*	20.1	21.1
Northampton Boulevard	USAA Dr. / Kempsville Rd.	S	*	*	42.3	62.1
	I-64 EB entrance ramp / IKEA Way	S	8.3	6.8	16.0	15.4
	I-64 EB exit ramp	S	9.1	8.2	12.1	10.1
	I-64 WB exit ramp	S	17.0	18.8	11.6	11.0
	Wesleyan Dr./Premium Outlets Blvd.	S	31.7	31.4	36.4	37.4
	Northampton EB Bypass merge	S	31.2	28.4	30.6	35.3

* Results are not shown for intersections where signal constraints were removed.

VISSIM reports queue lengths from the stop bar to the last queued vehicle destined for a particular movement. For turning movements, this may or may not be the length of queued vehicles within a turn lane. Where analysis results presented in Appendix G identify that queuing will exceed available storage, VISSIM analysis indicates that vehicles destined to turn left or right will be queued in a through lane upstream of the turn bay. In these cases, the actual queue length for turning vehicles may obstruct the through lane, or the turn lane may contain the actual queue length but may not be accessible to vehicles trapped in the queue for the adjacent through movement. For these conditions, turn lanes having an operational effect on interchanges were generally lengthened to the extent practical with respect to proximity to adjacent intersections and other site constraints.

6.3 Summary of Projected Traffic Operations

2044 No-Build Conditions

The traffic analysis for 2044 no-build conditions incorporated other projects that are projected to be completed pursuant to the region's constrained long-range transportation plan for 2040. Even with those improvements in place, traffic conditions are expected to deteriorate along I-64 and I-264 within the study area:

- Operational deficiencies at intersections along Newtown and Witchduck Roads are expected to result in queue spill back onto I-264. Queuing is expected to extend back into the I-64/I-264 interchange, which would become a metering point for I-64 traffic. This condition is projected to occur during both the AM and PM peak periods.
- The single-lane left exit from westbound I-264 to eastbound I-64 will continue to operate over capacity, resulting in queuing that impacts westbound I-264 through traffic.
- Most travel routes are expected to experience travel speeds less than 40 mph. The eastbound I-64 route through the study area will operate with an average speed below 20 mph during PM peak hour 2.
- Traffic operations are anticipated to degrade at almost all intersections studied:
  - During AM peak hour 2, 13 of the 21 study area intersections are expected to operate at heavily congested or severely congested conditions.
  - During PM peak hour 2, 18 of the 21 study area intersections are expected to operate at heavily congested or severely congested conditions.
  - Typically, where one intersection fails, it results in queuing that extends upstream and affects adjacent intersections.

Operational analyses of 2044 no-build conditions indicate that without improvements, traffic operations will continue to deteriorate when compared with 2018 existing conditions. Improvements are therefore necessary to preserve safe and efficient operations at the I-64/I-264 interchange, as demonstrated through the analyses for 2044 build conditions.

2044 Build Conditions

The Study Team developed improvements that would accommodate the projected demand for 2044 build conditions for the freeway links (basic segments, weave, merge and diverge areas), ramps, ramp termini and the crossing arterials within the interchange influence areas, except as noted below. The improvements ensure that traffic would be accommodated on the interstates and the signal timing plans favored traffic moving away from the interstates. This ensured that queues were accommodated within available storage so to prevent queue spillback onto the interstates. Even if improved to the extent identified in this study the following intersections will meter traffic approaching the interstates:

- Newtown Road at Kempsville Road and Princess Anne Road
- Witchduck Road at Cleveland Street
- Indian River Road at Reon Drive
- Indian River Road at Regent University Drive
- Indian River Road at Centerville Turnpike
- Northampton Boulevard at Kempsville Road and USAA Drive

Additional improvements to accommodate all traffic at the peripheral intersections were not practical as the intersections were already at their limits for number of lanes or would result in full acquisition. The signal controls for the above intersections were turned off in the AM peak hour VISSIM model to evaluate full demand entering the network and reaching the interstates. The following are key observations from the analysis of the 2044 build conditions:

- Proposed improvements will restore acceptable traffic operations to interstates and ramps within the project limits.
- Some locations within the study area may experience momentary heavily congested conditions during the first hour of either peak period, but higher densities will dissipate in the second hour.
- Queues are expected to be contained within available storage at intersections, and are not expected to extend back onto the interstates.
- Travel speeds on most interstate segments are expected to improve compared to the 2018 existing conditions or 2044 no-build conditions. Increases in travel speeds are notable in that the improvements will also serve higher throughput than is possible under 2018 existing and 2044 no-build conditions.

CHAPTER 7: SAFETY ANALYSIS

7.1 Safety Considerations under No-Build Conditions

Historic crash data for the I-64 and I-264 corridors within the study area were analyzed for the years from 2015 through 2017, and are summarized earlier in this chapter in Sections 7.3 and 7.4. Consistent with guidance provided in VDOT's TOSAM document, a quantitative evaluation of safety conditions within the study area for 2044 no-build conditions was performed using procedures for predictive methods outlined in AASHTO's Highway Safety Manual (HSM).

For this IMR, the Enhanced Interchange Safety Analysis Tool (ISATe) was used to evaluate freeway segments, C/D roadway segments, ramps, and ramp terminal intersections. ISATe is a spreadsheet-based tool that uses a series of algorithms to apply crash modification factors and safety performance factors documented in AASHTO's HSM to predict the future crash potential associated with a roadway network.

Procedures for using ISATe typically involve two steps. First, the predicted number of crashes is generated based on Safety Performance Functions (SPFs) and Crash Modification Factors (CMFs). Inputs for this step include both geometric features of the roadways such as shoulder widths and alignment curvature; and operational characteristics of the roadways such as forecasted daily traffic volumes. The second step generates expected crashes through the Empirical Bayes (EB) Method using historic crash data. However, based on guidance provided in ISATe User Manual (TTI, May 2013), the EB Method was determined to not apply to conditions associated with this study for the following reasons:

- Interchange ramps are proposed to be removed, relocated, and/or combined with other ramps.
- Segments of I-64 and I-264 will undergo widening that will change the basic number of through lanes

As a result, the EB Method was not used to compare expected crash data with results from the predictive model, and the evaluation of safety conditions in this study is limited to the predicted average crash frequency using step one procedures described above. For these same reasons, ISATe was not used to evaluate existing conditions, consistent with technical guidance provided in the ISATe user manual.

Annual Average Daily Traffic (AADT) is an input parameter to the analysis. Conversion factors were applied to Annual Average Weekday Daily Traffic (AAWDT) data collected in 2018 to arrive at AADT values. The factors used were calculated using AADT and AAWDT values published by VDOT for the interstate segments in the study area.

The use of ISATe is limited by several additional factors and conditions for which the model cannot account in predicting crash frequency. The following limitations apply to analysis of 2044 no-build and/or 2044 build conditions:

- Presence of continuous access HOV lanes. HOV lanes are in operation along I-264 under existing 2018 conditions, and will remain in operation under 2044 build conditions.
- ISATe worksheets limit the number of through lanes on a freeway segment to 10. Freeway segments having more than 10 through lanes were evaluated as 10-lane sections, using AADT values that were proportionally reduced to account for the reduced lane count used in the analysis.
- Presence of limited-access managed lanes. Managed lanes are present on I-64.
- Use of shoulder as a travel lane. Recommended improvements include a part-time shoulder use lane on westbound I-64, north of the exit ramp to Northampton Boulevard.
- Presence of reversible lanes. The managed lanes on I-64 are reversible.
- Ramps and C/D roadways with 3 or more lanes. Proposed improvements include a five-lane outer ramp from the westbound I-264 C/D road to eastbound and westbound I-64. In addition, ramps at the Military Highway, Newtown Road, Witchduck Road, Indian River Road, and Northampton Boulevard interchanges include ramps with three lanes. AADT volumes were proportionally reduced to account for the reduced number of lanes used in the analysis.
- Crossing roadways at ramp terminal intersections are limited to six lanes on the crossroad, requiring the use of proportionally reduced AADT volumes where total lane count exceeds six on the arterials.
- Signalized ramp terminal intersections with AADTs that exceed the maximum prescribed values for arterials. Conditions at all of the arterials intersecting interchange ramps in the study area exceed the maximum volume thresholds.
- Presence of frontage roads. Recommended improvements along Northampton Boulevard include creation of directional frontage roads that will intersect the terminal intersection for the westbound I-64 exit ramp.
- Presence of triple left turn movements on an arterial at a ramp terminal intersection. Build conditions reflect operation of triple left turn movements from southbound Newtown Road to westbound I-264, and from northbound Witchduck Road to eastbound I-264.
- One-way operation on a crossing arterial at a ramp terminal intersection. Proposed improvements include a signalized terminal intersection along the northbound Newtown Road travelway at the exit ramp from the eastbound I-264 C/D road.
- Presence of a roundabout at a ramp terminal. The entrance ramp to eastbound I-264 from Greenwich Road operates with a roundabout at its terminal.

Based on the nature and extent of these limitations, the use of ISATe for 2044 build conditions on this project may or may not produce results that are meaningful toward direct comparisons with results for 2044 no-build conditions.

ISATe methodology predicts crash severity for each crash type as follows:

- K crashes – crashes involving fatalities;
- A, B, C – injury crashes involving injury(ies) of decreasing severity;
- PDO - crashes involving property damage only.

These results of the ISATe analysis for 2044 no-build conditions are summarized in Table 7.1.

Table 7.1: Predicted Crash Frequency, 2044 No-Build Conditions

Location	Predicted Crash Frequency (number of crashes, 2044) [1] Fatal	Injury	Property Damage Only	Total	Crash Rate [2]
Freeway Segments					
I-64 Mainline	2	138	351	491	117.2
I-264 Mainline	1	56	142	199	96.6
I-264 C/D	1	89	61	151	216.0
Freeway Ramps					
I-64/I-264 interchange	0	20	29	49	165.8
I-264/Military Hwy. interchange	0	7	13	20	74.7
I-264/Newtown Rd. interchange	0	4	7	11	22.8
I-264/Witchduck Rd. interchange	0	3	5	8	21.7
I-64/Indian River Rd. interchange	0	9	13	22	233.6
I-64/Northampton Blvd. interchange	0	5	7	12	128.4
Ramp Terminal Intersections					
EB I-264 C/D exit ramp to Military Hwy.	[3]				
WB I-264 C/D exit ramp to Military Hwy.	[3]				
EB I-264 C/D exit ramp to Newtown Rd.	0	4	3	7	65.3
WB I-264 C/D exit ramp to Newtown Rd. at Stoney Point S.	0	3	5	8	41.7
WB I-264 exit ramp to Newtown Rd. at Center Dr.	[4]				
EB I-264 C/D entrance/exit ramps to/from Witchduck Rd.	0	3	4	7	39.7
WB I-264 exit ramp to Witchduck Rd.	0	3	4	7	38.3
WB I-264 entrance ramp from Witchduck Rd.	0	2	4	6	27.6
WB I-64 entrance ramp from Indian River Rd.	[3]				
EB I-64 entrance ramp from Indian River Rd.	[3]				
EB I-64 entrance ramp from Northampton Blvd.	0	2	3	5	31.3
EB I-64 exit ramp to Northampton Blvd.	0	4	3	7	50.9
WB I-64 exit ramp to Northampton Blvd.	0	9	11	20	68.2
Total Crashes throughout Study Area	**4**	**361**	**665**	**1,030**	

[1] Number of crashes rounded to the nearest integer value.
[2] Crash rates for freeway segments and ramps are expressed in units of crashes per 100 million vehicle-miles traveled. Crash rates for ramp terminal intersections are expressed in units of crashes per 100 million vehicles entering.
[3] Ramp terminals are unsignalized under existing and 2044 no-build conditions.
[4] No ramp terminal intersection at this location under existing or 2044 no-build conditions.

Analysis output is considered to underreport the number of crashes because AADT data was reduced to account for the maximum lane count allowed in the ISATe tool. Computed crash rates reflect the proportional reduction in AADTs. The computed crash rates for 2044 no-build conditions shown in Table 7.1 may not be directly comparable to the crash rates computed for existing conditions (from 2015 to 2017) in the previous subsection because the two sets of rates were computed using different analytical methods.

7.2 Effects of the Recommended Alternative on Safety

To assess the effectiveness of the recommended improvements on reducing crash potential within the study area, ISATe analysis was performed for 2044 build conditions. Analyses were prepared using the same assumptions and adjustments identified above for the 2044 no-build analyses, and the same analysis limitations apply as noted for the 2044 no-build analyses. Analysis results for 2044 build conditions are summarized in Table 7.2.

Table 7.2: Predicted Crash Frequency, 2044 Build Conditions

Location	Predicted Crash Frequency (number of crashes, 2044) [1] Fatal	Injury	Property Damage Only	Total	Crash Rate [2]
Freeway Segments					
I-64 Mainline	1	124	314	439	101.5
I-264 Mainline	1	44	109	154	85.6
I-264 C/D	1	44	49	94	133.4
Freeway Ramps					
I-64/I-264 interchange	1	34	41	76	138.8
I-264/Military Hwy. interchange	0	3	8	11	38.0
I-264/Newtown Rd. interchange	0	6	10	16	16.7
I-264/Witchduck Rd. interchange	0	3	5	8	20.7
I-64/Indian River Rd. interchange	0	8	13	21	222.9
I-64/Northampton Blvd. interchange	0	14	18	32	167.1
Ramp Terminal Intersections					
EB I-264 C/D exit ramp to Military Hwy.	0	3	6	9	36.4
WB I-264 C/D exit ramp to Military Hwy.	0	7	10	17	68.8
EB I-264 C/D exit ramp to Newtown Rd.	0	3	3	6	49.0
WB I-264 C/D exit ramp to Newtown Rd. at Stoney Point S.	0	5	9	14	36.5
WB I-264 Exit ramp to Newtown Rd. at Center Dr.	0	2	3	5	13.5
EB I-264 C/D entrance/exit ramps to/from Witchduck Rd.	0	3	4	7	33.9
WB I-264 exit ramp to Witchduck Rd.	0	3	3	6	30.8
WB I-264 entrance ramp from Witchduck Rd.	0	1	3	4	14.5
WB I-64 entrance ramp from Indian River Rd.	0	6	11	17	60.8
EB I-64 entrance ramp from Indian River Rd.	0	11	12	23	139.6
EB I-64 entrance ramp from Northampton Blvd.	0	1	3	4	24.1
EB I-64 exit ramp to Northampton Blvd.	0	4	4	8	44.3
WB I-64 exit ramp to Northampton Blvd.	0	6	9	15	41.2
Total Crashes throughout Study Area	**4**	**335**	**647**	**986**	

[1] Number of crashes rounded to the nearest integer value.
[2] Crash rates for freeway segments and ramps are expressed in units of crashes per 100 million vehicle-miles traveled. Crash rates for ramp terminal intersections are expressed in units of crashes per 100 million vehicles entering.

Given the limitations of the analysis methodology, predictive data for 2044 no-build and 2044 build conditions may or may not be directly comparable. As with the no-build analysis, output data for 2044 build conditions is considered to underreport the number of crashes because AADT data was reduced to account for the maximum lane count allowed in the ISATe tool. Computed crash numbers and rates reflect the reduced AADTs.

Analyses indicate that recommended improvements are predicted to reduce crash experience and crash rates along all freeway segments and at all ramp terminal intersections studied. Improvements are predicted to reduce crash experience and rates for all interchange ramp groups except for the following:

- Ramps at the I-64/I-264 interchange
- Ramps at the I-264/Newtown Road interchange
- Ramps at the I-64/Northampton Boulevard interchange

These results are explained by the algorithm used in the predictive crash model that is the basis for ISATe procedures. The calculations reflect an exponential relationship between crash frequency and AADT, based on the following equation:

$$N = L \times e^{f(AADT)} \times C$$

where:

N = predicted average crash frequency (total number of crashes per year);
L = length of the segment (miles);
$e^{f(AADT)}$ = exponential function of AADT; and,
C = calibration factor.

As AADT increases, there is an exponential increase in the number of predicted crashes. This increase is compounded where roadway segments increase in length. Where total ramp lengths increase, so do the number of predicted crashes, even if AADTs were to remain constant.

The following addresses recommended build conditions for the ramp groups at the three interchanges identified above, and identifies safety benefits of the recommended improvements, many of which are not reflected in ISATe analysis results.

I-64/I-264 interchange - Under build conditions, the dual westbound I-264 movements to eastbound I-64 are consolidated from two ramps onto a single ramp. The new ramp for this movement serves higher total volumes, and has a length of 2.35 miles, which is five times longer than the 0.47 mile total length of the two ramps it replaces. The same consolidation condition applies to the eastbound I-264 movement to westbound I-64. The higher volumes and longer ramp lengths yield a higher value for total crash frequency, and crash frequency by crash severity for this interchange. The increase in traffic volumes served under build conditions overcomes the predicted increase in crash frequency and the crash rate decreases.

Recommended improvements at the I-64/I-264 interchange will address existing and projected operational and geometric deficiencies with the effect of reducing crash potential at this interchange:

- Ramp and C/D roadway capacities will be increased to accommodate projected volumes, reducing recurrent congestion.
- Decision sight distance approaching the ramp from eastbound I-64 to eastbound and westbound I-264 will be increased to satisfy current design guidelines.
- The left exit from eastbound I-264 will be removed, eliminating vehicle speed differentials for exiting and through traffic.
- The left exit from westbound I-264 will be removed. This will eliminate vehicle speed differentials for exiting and through traffic, and will eliminate queue spillback into the westbound I-264 through lanes during both AM and PM peak hour periods.
- Elimination of the left exits from eastbound and westbound I-264 and creation of continuous HOV lanes through the interchange will eliminate the need for HOV through traffic to change lanes into the general-purpose lanes.
- Traffic movements exiting I-264 in both directions will be moved from the through facilities to the C/D roadways, allowing for simplified signage and reducing the potential for motorist confusion.
- Weaving operations along the westbound I-264 C/D roadway between the Newtown Road interchange and I-64 will be improved by reducing critical weaving volumes and increasing weave distances.
- Merge-weave operations on the I-264 C/D roadways at the closely-spaced loop ramps will be eliminated by removing one loop ramp in each direction.
- Acceleration and deceleration lengths for remaining loop ramps will be improved to satisfy current design guidelines.
- Westbound I-64 will be widened to provide an additional travel lane between the exit ramp to eastbound I-264 and the loop exit ramp to the westbound I-264 C/D road. This additional capacity will reduce recurrent congestion on this roadway segment that would be realized under projected 2044 no-build conditions.

I-264/Newtown Road interchange - Under no-build conditions, the total ramp length at this interchange measures 1.17 miles. Recommended improvements increase this value to 1.62 miles, which is attributed to the proposed split ramp configuration for the exit movement from westbound I-264 to Newtown Road. The design will accommodate higher service volumes, which coupled with the increase in total ramp length yields a higher calculated number of crashes at this interchange. Higher service volumes offset this effect, resulting in an overall reduced crash rate.

The recommended improvements will achieve the following benefits relative to safety:

- Increased capacity at ramp terminal intersections will eliminate queue spill back onto I-264 and I-64 from the eastbound and westbound I-264 exit ramps to Newtown Road. This will reduce crash potential associated with recurrent congestion, vehicle deceleration in through lanes, and vehicle speed differentials on I-264 and I-64.
- Weave operations on the westbound I-264 C/D road system will be improved by reducing critical weaving volumes and increasing weave distances.

I-64/Northampton Boulevard interchange - The recommended improvements at this interchange include a new elevated ramp system along Northampton Boulevard and an extended exit ramp from westbound I-64 mainline. These improvements increase the total ramp length from 1.49 miles to 2.92 miles. This increase in total ramp length overcomes the calculated effect of splitting AADT between existing Northampton Boulevard and the new ramps, yielding an increase in crash frequency and crash rate. At this interchange, the increase in total service volume is not enough to overcome the calculated effect of increased ramp length, and the predicted crash rate increases.

Under build conditions, recommended improvements will address existing and projected deficiencies and result in the following safety benefits:

- The entrance ramp to eastbound I-64 from eastbound and westbound Northampton Boulevard will be widened to two lanes, and the downstream segment of eastbound I-64 will be widened to receive the additional lane. These measures will reduce recurrent severe congestion on the entrance ramp and the downstream segment of eastbound I-64.
- The exit ramp from westbound I-64 to Northampton Boulevard will be widened and lengthened to provide additional capacity at the ramp terminal intersection and additional queuing capacity on the ramp to prevent queue spill back onto westbound I-64.
- The elevated ramp system along Northampton Boulevard will reduce queuing on the westbound I-64 exit ramp.
- The outer shoulder along westbound I-64 will be widened through the Northampton Boulevard interchange to accommodate use of the shoulder as an active travel lane during the weekday AM peak period. This will provide additional capacity to reduce recurrent congestion on westbound I-64.

7.3 Safety Analysis Summary - Projected Conditions

2044 No-Build Conditions

The ISATe tool was used to develop a predicted number of crashes under 2044 no-build conditions. For conditions associated with this study, analytical methods do not allow a direct comparison of historical crash frequency from 2015 to 2017 with predicted crash frequency prepared using the ISATe tool. Similarly, computed crash rates for 2044 no-build conditions cannot be directly compared with historical rates either. However, a generalized comparison indicates that the predicted number of crashes under 2044 no-build conditions is higher than has been experienced on an average annual basis from 2015 to 2017 across the study area.

Currently, there are three active construction projects in the study area - the I-64/I-264 Phase I improvements, I-64/I-264 Phase II improvements, and the Witchduck Road Phase 2 improvements. These projects were developed and designed to address previously identified capacity and safety issues. The projected future no-build conditions defined for this study reflect completion of these current construction projects. The identified projects are the only programmed improvements that would reduce crash potential within the study area. Once these projects are completed, crash frequency and crash rates in areas associated with current improvements are expected to initially drop, then gradually rise over time as congestion returns over time.

The region is expected to continue to grow in population, and is expected to support higher levels of employment, and visitation due to recreation. Roadways not currently being improved under active construction projects are expected to experience growing congestion. Crash potential will continue to increase as the roadway network will serve higher traffic volumes without physical improvements.

2044 Build Conditions

Quantitative analysis indicates a reduction in the number of crashes predicted during the 2044 design year when compared with 2044 no-build conditions. Recommended improvements are predicted to results in approximately 21 fewer fatal and injury crashes, and 14 fewer property-damage-only crashes under 2044 build conditions.

Limitations of the ISATe crash prediction tool do not permit direct comparisons with crash trends experienced during the 2015-2017 period. However, generalized comparisons indicate that predicted crash rates on I-64 and I-264 under 2044 build conditions are lower than those evidenced in the study area from 2015 to 2017.

Recommended improvements were developed to address geometric and operational issues identified under existing 2018 and/or projected 2044 no-build conditions that correlate to recorded or predicted crash experience within the study area. Improvements that are shown in this study to reduce recurrent congestion, improve operations at ramp terminal operations, eliminate left exits, eliminate queue spill back onto interstate mainline through lanes, increase decision sight distance, and alleviate or eliminate merge-weave conditions will reduce crash potential under projected build conditions.

CHAPTER 8: PROGRAMMING PLAN

This chapter of the report summarizes the approach used to identify the limits of improvements necessary for the I-64/I-264 interchange, and establish a program of improvements that can be implemented over time.

8.1 Program Limits

As described in previous sections of this report, study activities have identified a set of recommended improvements to all interchanges within the study area. This overall set of improvements represents the nature and extent of improvements necessary to accommodate projected traffic volumes throughout the study area through the 2044 planning horizon. However, the primary focus of this IMR is the I-64/I-264 interchange, and not all improvements identified in the study are necessary to achieve safe and efficient traffic operations at the I-64/I-264 interchange.

Given the extent of the improvements necessary to improve operations and reduce crash potential at the I-64/I-264 interchange, it is not reasonable or feasible to advance all improvements at once. Improvements are anticipated to be constructed through a series of smaller projects ("subprojects") undertaken over several years. Figures 8-1 and 8-2 on the following pages illustrate the Program limits and identify subprojects in the I-264 corridor and the I-64 corridor, respectively. Appendix H contains large-scale exhibits illustrating subproject limits.

All subprojects are configured to have logical termini and independent utility relative to NEPA requirements. FHWA defines "logical termini" as (1) rational end points for a transportation improvement, and (2) rational end points for a review of the environmental impacts. FHWA considers a project to have "independent utility" if it is usable and is a reasonable expenditure even if no other improvements are made in the area. The subprojects within the Program limits satisfy these elements, and are generally described as follows (with no significance to the lettering or order):

- Subproject A - Improves the movement from eastbound I-64 to eastbound I-264. Improvements begin at the I-64/Northampton Boulevard interchange, and end at the mainline-C/D merge along eastbound I-264 east of the Newtown Road interchange.
- Subproject B - Widens eastbound I-264 from the mainline-C/D merge point east of the Newtown Road interchange to east of Witchduck Road. This subproject includes replacement of the bridge carrying I-264 over Witchduck Road, and improvements to eastbound ramps between I-264 and Newtown Road. This subproject is an eastward continuation of Subproject A.
- Subproject C - Widens westbound I-64 from north of the Kempsville Road overpass to the exit ramp to Northampton Boulevard. This subproject also includes minor widening of westbound I-64 to operate a part-time shoulder lane during the weekday AM peak period between the exit ramp to Northampton Boulevard and the entrance ramp from Northampton Boulevard. This subproject is a northward continuation of Subprojects D and E.
- Subproject D - Improves the movement from eastbound I-264 to westbound I-64. Improvements begin at the eastbound I-264 mainline-C/D roadway diverge point located west of the Military Highway interchange, and end along westbound I-64 north of the Kempsville Road overpass.
- Subproject E - Improves the movement from the westbound I-264 C/D roadway to westbound I-64. Improvements include widening westbound I-264 west of Witchduck Road, constructing a new westbound I-264 outer C/D roadway, reconfiguring the north half of the I-264/Newtown Road interchange, and widening westbound I-64 to provide a part-time shoulder lane north of Northampton Boulevard.
- Subproject F - Improves the movement from the westbound I-264 C/D roadway to eastbound I-64. Improvements begin along a new westbound I-264 C/D roadway constructed with Subproject E, and end along eastbound I-64 at the Indian River Road interchange.

Improvements along adjacent segments of interstates upstream or downstream of the I-64/I-264 interchange are projected to be necessary to alleviate future congestion due to increasing demand over time, and will maintain free-flow operations at the I-64/I-264 interchange.

Analyses performed as part of this study demonstrate that the improvements represented by the subprojects will achieve the following objectives:

- They will provide acceptable traffic operations at the I-64/I-264 interchange through the 2044 planning horizon year, whether the other improvements at adjacent interchanges are completed or not.
- They will address the operational effects of improvements at the I-64/I-264 interchange on other interchanges within the study area.

Improvements identified in this study but not included in the subprojects are not required to achieve acceptable operations at the I-64/I-264 interchange.

8.2 Subproject Evaluation

Subprojects were evaluated relative to timing, congestion, and safety using criteria summarized in Table 8.1.

Table 8.1: Evaluation Criteria for Subprojects

		Rating
Timing of Need	How soon the subproject is projected to be needed (the first year a volume/capacity ratio exceeds 1.0)	
	Immediate (improvement is needed between 2019 and 2024)	10
	Mid-term (improvement is needed between 2025 and 2029)	5
	Long-term (improvement is needed beyond 2030)	1
Congestion	The highest volume/capacity ratio for a component highway link under existing 2018 conditions	
	> 1.1	10
	1.0 - 1.1	6
	0.9 - 1.0	3
	< 0.9	1
Safety	2015-2017 peak crash rate within the subproject relative to the Districtwide crash rate for interstates	
	> 495 crashes/100MVMT [1] (5.5x Districtwide crash rate)	10
	450 - 495 crashes/100MVMT (5x - 5.5x Districtwide crash rate)	9
	405 - 450 crashes/100MVMT (4.5x - 5x Districtwide crash rate)	8
	360 - 405 crashes/100MVMT (4x - 4.5x Districtwide crash rate)	7
	315 - 360 crashes/100MVMT (3.5x - 4x Districtwide crash rate)	6
	270 - 315 crashes/100MVMT (3x - 3.5x Districtwide crash rate)	5
	225 - 270 crashes/100MVMT (2.5x - 3x Districtwide crash rate)	4
	180 - 225 crashes/100MVMT (2x - 2.5x Districtwide crash rate)	3
	135 - 180 crashes/100MVMT (1.5x - 2x Districtwide crash rate)	2
	90 - 135 crashes/100MVMT (1x - 1.5x Districtwide crash rate)	1
	< 90 crashes/100MVMT (Districtwide crash rate)	0

[1] Crash rates are expressed in units of crashes per 100 million vehicle-miles traveled.

Subprojects were rated to identify areas that would benefit most from proposed improvements. Table 8.2 on page 8-4 summarizes the preliminary evaluation results for subprojects included in the Program limits. Prerequisites, if any, are identified for each subproject, and are based on geometric and operational considerations associated with

Figure 8-1 - Recommended Improvement Program Limits along I-264

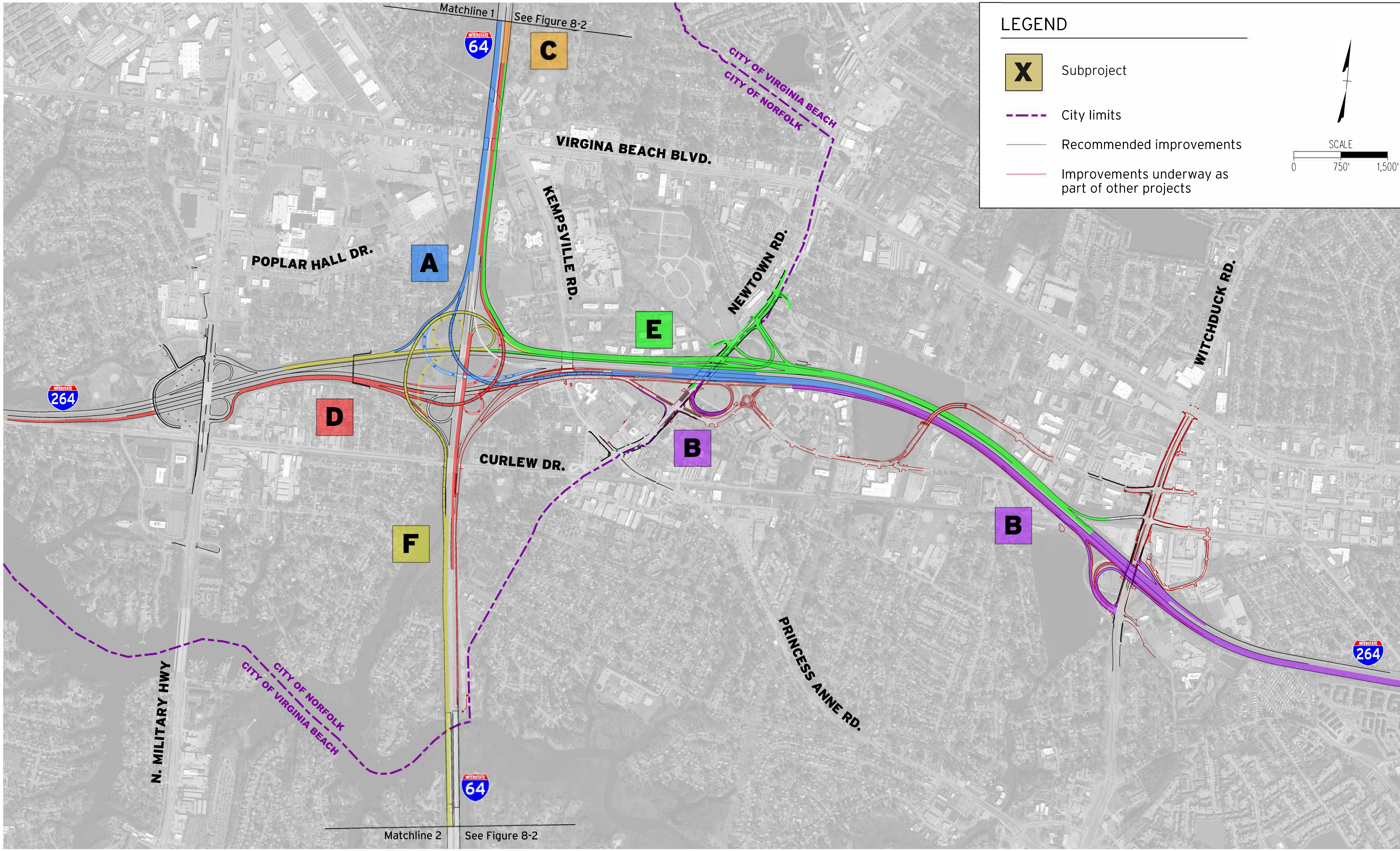


Figure 8-2 - Recommended Improvement Program Limits along I-64

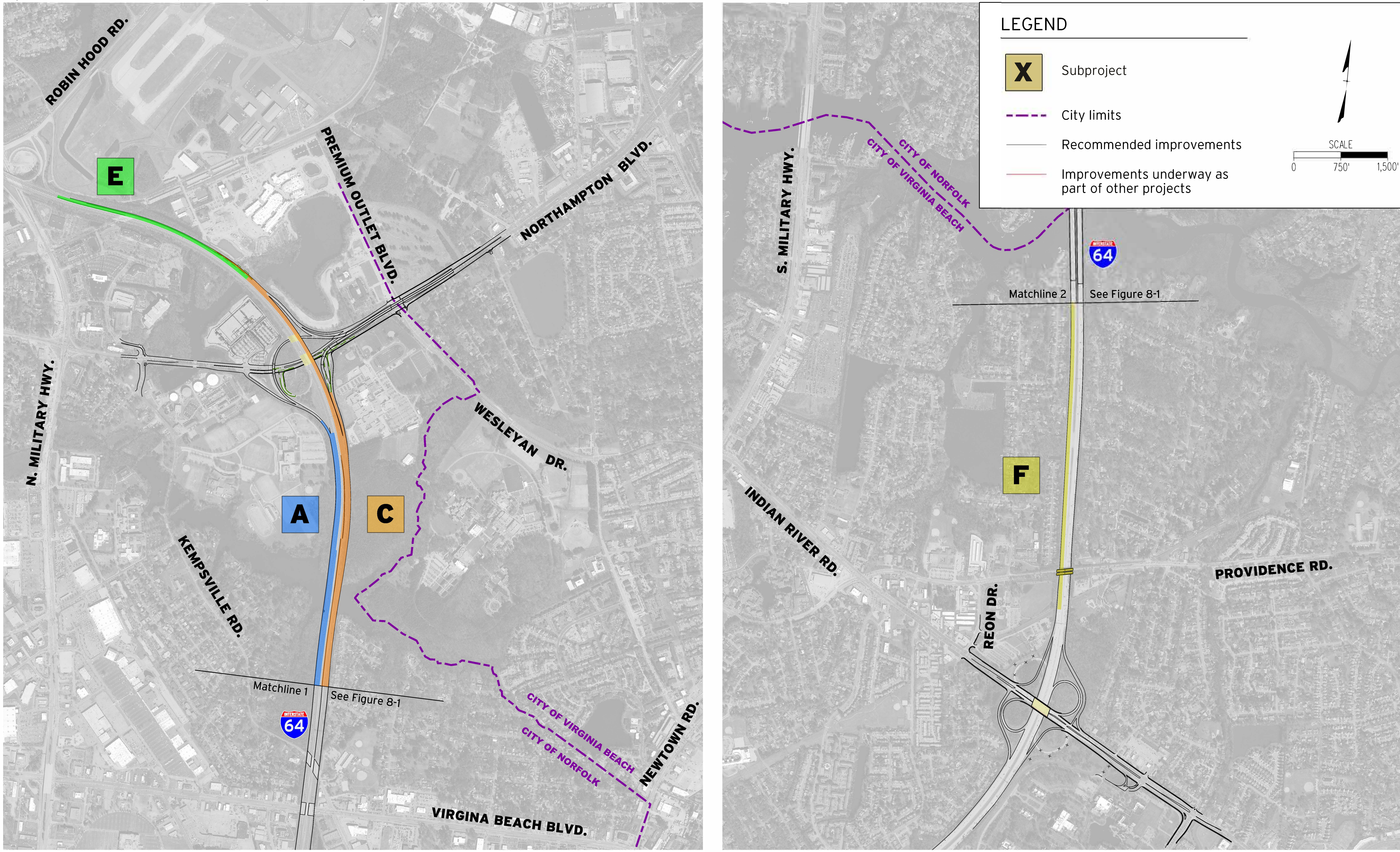


Table 8.2: Phasing of the I-64/I-264 Interchange Improvements

	Subproject	Description	Purpose	Prerequisite	Timing of Need	Congestion	Safety	Total Score	Estimated Total Cost
A	EB I-64 to EB I-264 semi-directional ramp, Northampton Blvd. to east of Newtown Rd.	Construct structures through interchange, bridges carrying EB I-64 over Kempsville Rd. and Virginia Beach Blvd., and bridge carrying EB I-264 over Newtown Rd.; widen EB I-64 by 1-2 lanes from Northampton Blvd. entrance ramp; widen EB I-264 one lane to C/D merge with mainline.	Provides additional capacity; reduces crash potential on EB I-64; improves weave condition on EB I-64 upstream of I-64/I-264 interchange; raises three structures to achieve required vertical clearance.	--	10	6	10	26	$415M
B	EB I-264 widening, Newtown Road to east of the Witchduck Road interchange	Widen EB I-264 outer C/D from Newtown Rd. interchange to mainline merge point; widen EB I-264 to east of Witchduck Rd.; reconfigure EB I-264 entrance ramp from Witchduck Rd. Widen EB I-264 exit ramps to provide additional lanes; modify signals at ramp terminal intersections along Newtown Rd. Replace bridge carrying I-264 over Witchduck Rd.	Required when WB I-64 to EB I-264 volume exceeds capacity of Phase I and Phase II improvements. Will eliminate queue spillback into the I-64/I-264 interchange.	A	5	1	3	9	$185M
C	WB I-64 widening, I-264 through the Northampton Boulevard interchange	Widen WB I-64 from north of Virginia Beach Blvd. to Northampton Blvd. interchange; construct minor widening of bridges carrying WB I-64 over Northampton Blvd.; north of exit ramp to Northampton Blvd., operate shoulder use lane along WB I-64 during AM peak only.	Required when additional capacity is needed along WB I-64; will eliminate queue spillback into the I-64/I-264 interchange.	D / E [1]	1	6	2	9	$80M
D	EB I-264 to WB I-64 semi-directional ramp, from Military Highway interchange to north of Kempsville Road	Construct ramp through interchange and merge lanes onto WB I-64; realign entrance ramp from Military Highway, widen EB I-264 C/D, and widen WB I-64 to three lanes approaching overpass of EB I-264. Remove loop exit ramp from EB I-264 C/D to WB I-64, and remove left exit from EB I-264 mainline.	Eliminates left exit from EB I-264 mainline; eliminates EB I-264 to WB I-64 loop ramp and associated merge-weave areas; provides additional ramp capacity; enables continuous EB HOV lane through I-64/I-264 interchange, and improves capacity of WB I-64 beyond the exit ramp to EB I-264.	--	5	6	5	16	$180M
E	WB I-264 Newtown Road Interchange to WB I-64	Construct WB I-264/Newtown interchange improvements; widen Newtown Rd. from Greenwich Rd. to north of Cleveland Street; construct WB I-264 C/D roadway and outer ramp to EB/WB I-64; widen WB I-64 to receive new ramp lanes. Widen WB I-64 shoulder north of entrance ramp from Northampton Blvd., operate shoulder use lane along WB I-64 during AM peak only.	Alleviates congestion and merge-weave conditions on WB I-264; provides additional ramp, mainline, and arterial capacity.	--	10	6	6	22	$280M
F	WB I-264 to EB I-64 semi-directional ramp and EB I-64 widening to the Indian River Road interchange	Construct ramp through interchange, over Nosehs Creek and Curlew Dr. Widen EB I-64 to provide one additional lane to Indian River Rd. exit ramp; replace bridges carrying Providence Rd. over I-64. Remove loop exit ramp from WB I-264 C/D roadway and left exit ramp from WB I-264 mainline.	Eliminates left exit from WB I-264 mainline facility; provides additional capacity on ramp and WB I-64 mainline; enables continuous WB HOV lane through the I-64/I-264 interchange.	E	10	10	4	24	$295M
								Total	$1.435B

[1] Subproject will need to be constructed with either Subproject D or E, whichever is constructed last.

constructing a given subproject separately from others. The subprojects were submitted to HRTPO for official scoring and prioritization toward inclusion in the 2045 Long Range Transportation Plan.

Table 8.3 identifies recommended improvements outside of the Program limits that do not improve operations or reduce crash potential at the I-64/I-264 interchange. These projects improve upstream access to I-64 or I-264 upstream of the I-64/I-264 interchange and are warranted prior to 2044 to achieve acceptable traffic operations at these locations.

Table 8.3: Other Improvements Not Required for Operations and Safety at the I-64/I-264 Interchange

Subproject	Description
Newtown Road corridor improvements	Widening, intersection, and signal improvements along Newtown Road, Greenwich Road to Kempsville Road; widen EB Greenwich Road from Newtown Road to Ballard Court. Widen Princess Anne Road from Newtown Road to Freight Lane.
I-264/Witchduck Road Interchange and Witchduck Road corridor improvements	Widen WB I-264 from emergency pull-off area to C/D diverge; replace bridge carrying I-264 over Witchduck Road. Widen SB Witchduck Road, with improvements at the Cleveland Street and Southern Boulevard intersections.
I-264/Military Highway Interchange and Military Highway corridor improvements	Construct directional entrance ramp, SB Military Highway to WB I-264; replace Frontage Road bridge over I-264; remove ramps in SW and NW quadrants of interchange; construct improvements along Military Highway at Corporate Boulevard and Poplar Hall Drive. Construct Piping Rock Road from Pebble Lane to Frontage Road.
I-64/Indian River Road Interchange, Indian River Road corridor improvements, WB I-64 widening	Reconfigure interchange to partial clover layout; widening WB I-64 from the Indian River Road to I-264; widening, intersection, and signal improvements along Indian River Road from Reon Drive to Centerville Road.
I-64/Northampton Boulevard Interchange and Northampton Boulevard corridor improvements	Reconstruct bridge carrying entrance ramp to EB I-64 over Northampton Boulevard. Widen Northampton Boulevard from IKEA Way to east of Wesleyan Drive; construct elevated through travelway from I-64 to east of Wesleyan Drive. Widen WB I-64 exit ramp to Northampton Boulevard. Signal improvements along Northampton Boulevard at ramp terminal intersections and at Wesleyan Drive.

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