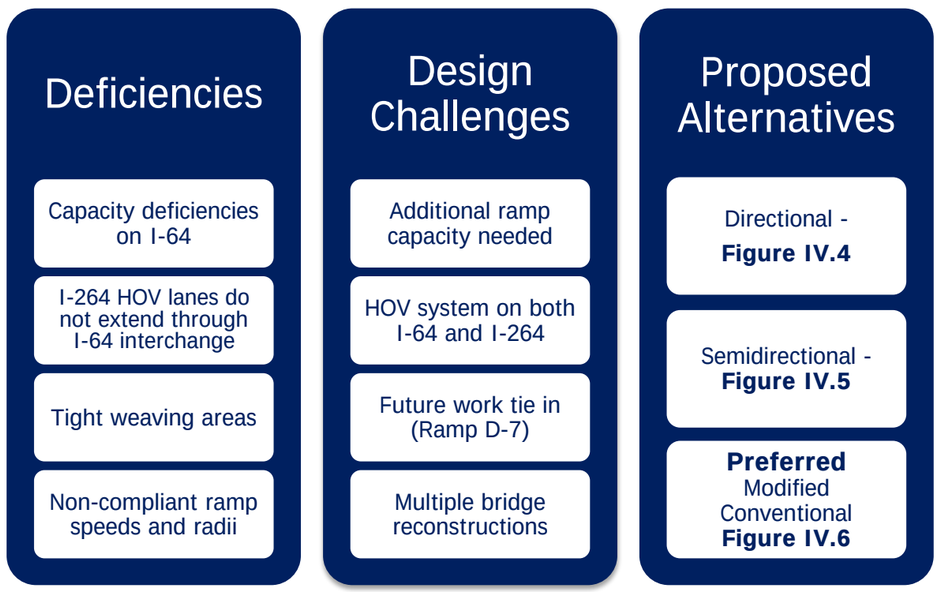
IV. I-64/I-264 Interchange



IV.1 Existing Conditions

This section describes the existing operational conditions at the I-64/I-264 interchange. These conditions are described through the discussion of the roadway geometry, volumes, capacity analysis, and crash history.

IV.1.1 Geometry, Speeds, Lanes, Traffic Control

Figure IV.1 displays a summary of the existing roadway geometry at the interchange of I-64 and I-264. I-64/I-264 interchange is configured in a typical cloverleaf geometry with additional directional ramps and the I-264 CD system running through the interchange. The CD system connects I-64 with the Newtown Road interchange to the east and to the Military Highway interchange to the west.

Concurrent flow HOV lanes along the mainline freeway lanes of I-264 to the east and west of the I-64 interchange are terminated at the approach to I-64. HOV restrictions are terminated because off-ramps without HOV restrictions are provided in both directions of travel. Motorists in single-occupancy vehicles could not legally access these off ramps if the HOV restrictions were not removed on the respective ramp approaches.

Numerous geometric deficiencies exist at the I-64 interchange, and some of the notable deficiencies include:

- Lane balance is non-compliant throughout interchange on EB I-264
- Ramp speeds are non-compliant at 4 locations
- Ramp gores are non-compliant at 4 locations
- Acceleration lane length is non-compliant at 2 locations
- Deceleration lane length is non-compliant at 2 locations
- Ramp radii are non-compliant for posted speeds at 2 locations

Additional details on the existing conditions geometry at the I-64 interchange can be found in the Technical Appendix.

IV.1.2 Volumes & Operations

Figure IV.2: Existing Volumes displays the existing volumes for the I-64/I-264 interchange for the year 2014. Traffic counts were conducted during early December 2014, with counts conducted on Tuesdays, Wednesdays and/or Thursdays. The peak hour counts document the typical commuter pattern on I-264, with heavier volumes in the westbound direction during the AM peak period and in the eastbound direction during the PM peak period. I-64 displayed typical commuter patterns with heavier volumes westbound in the AM peak period and eastbound during the PM peak period. The I-64 reversible HOV system is open in the westbound direction in the AM peak period and it is open in the eastbound direction in the PM peak period.

I-264 Corridor Evaluation Study

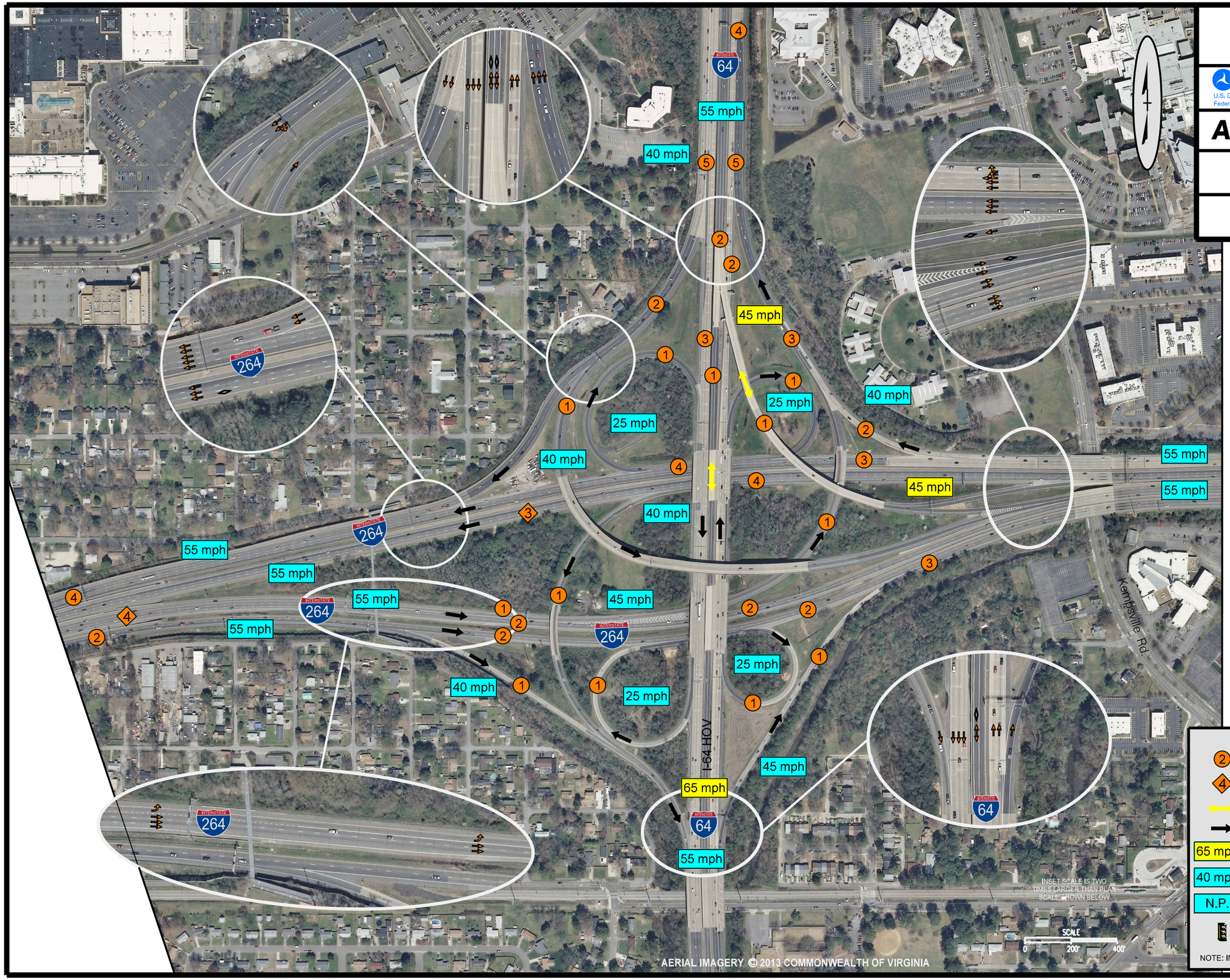
U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2014 Existing Geometry
I-264 & I-64 Interchange

Figure IV.1	July 2016



LEGEND

- NUMBER OF LANES
- NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph — HOV SYSTEM POSTED SPEED
- 40 mph — POSTED SPEED
- N.P. — NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2014 Peak Hour Volumes
I-264 & I-64 Interchange

Figure IV.2	July 2016

Table 4.1 displays a summary of the HCS capacity analysis of the 2014 existing conditions at the interchange of I-64 and I-264. Several of the movements at this interchange are currently operating with LOS F conditions in at least one peak hour. The westbound I-264 mainline freeway segment is operating with LOS F conditions in the AM peak hour. The weave on the eastbound I-264 CD lanes between westbound I-64 to southbound Newtown Road operates with LOS F conditions in both peak hours. Inadequate service levels are also found on the merge segment of eastbound and westbound I-264 with I-64 eastbound; both peak hours exhibit LOS E conditions. The diverge movement from the westbound I-264 mainline lanes to I-64 eastbound operates with LOS F conditions in the AM peak hour.

The weave on westbound I-264 CD lanes, between Newtown Road and I-64, routinely exhibits congested conditions in both peak hours; however the HCS analysis does not display poor service levels. The HCS analysis does not capture the congestion for two reasons: 1) the lane drop on westbound I-64 in close proximity to the weave causes drivers to avoid the outermost lane; and, 2) the downstream off-ramp to eastbound I-64 causes drivers to maneuver to the right-center lane which is heavily used by weaving traffic.

Table 4.2 (shown on the next page) displays a summary of the CORSIM capacity analysis of the existing conditions at the interchange of I-64 and I-264. CORSIM results were similar to the HCS analysis and in some cases slightly better. Generally there are numerous LOS C and LOS D conditions found throughout the interchange. The CORSIM analysis includes additional analysis of a few movements that were not analyzed in the HCS 2010 analysis because the geometric configuration was not compatible with analysis methodology (i.e. add lanes and drop lanes). LOS D and E conditions were present in the AM and PM peak hours, respectively, at the merge of the eastbound and westbound I-264 ramp to eastbound I-64. The westbound mainline between I-64 and Newtown Road operates with LOS E conditions in the AM peak hour and the diverge from I-264 westbound mainline to I-64 eastbound operates with LOS F in the AM peak hour.

The weave on westbound I-264 CD road is known to be congested in both peak hours; however the CORSIM analysis does not display poor service levels. The CORSIM analysis does not capture the congestion because the configuration of the CORSIM network prevents motorists from knowing well in advance that there is a lane drop on I-64 westbound in close proximity to the weave. Normally CORSIM drivers can see lane drops downstream if there is a continuous freeway network to the lane drop; however, in this network there is a series of short ramp and freeway segments between the weave section and the lane drop on I-64, preventing the driver from recognizing the lane drop. Thus traffic is spread fairly evenly in CORSIM through the weave section, but this does not occur under actual conditions in the field.

Table 4.1
Summary of 2014 Existing Conditions HCS Capacity Analysis
I-264 & I-64 Interchange

Movement (Type)	AM Peak Hour		PM Peak Hour	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
EB I-264 ML between Military Hwy and I-64 (Freeway)	16.4	B	25.4	C
EB I-264 ML to WB I-64 (Diverge)	16.1	B	30.1	D
EB I-264 CD to EB I-64 (Diverge)	23.0	C	26.1	C
EB/WB I-64 & EB I-264 CD (Weave)	17.8	B	18.1	B
WB I-64 to EB I-264 CD & EB I-264 CD to SB Newtown Rd (Weave)	**V/C = 1.086**	**F**	**V/C = 1.006**	**F**
EB I-264 ML between I-64 and Newtown Rd (Freeway)	18.6	C	33.3	D
WB I-264 ML between I-64 and Newtown Rd (Freeway)	**80.2**	**F**	19.2	C
WB I-264 ML to WB I-64 HOV (Diverge)	**50.5**	**F*** **	-	-
WB I-264 ML to EB I-64 (Diverge)	**41.4**	**F*** **	21.2	C
SB Newtown Rd to WB I-264 CD & WB I-264 CD to WB I-64 (Weave)	23.8	B	25.6	C
EB/WB I-64 & WB I-264 CD (Weave)	17.1	B	20.1	B
EB I-64 to WB I-264 CD & WB I-264 CD to NB Military Hwy (Weave)	18.2	B	12.7	B
WB I-264 ML between Military Hwy and I-64 (Freeway)	26.8	D	12.5	B
EB I-64 North of I-264 (Freeway)	27.5	D	26.1	D
WB I-264 CD/EB I-264 CD & EB I-64 (Weave)	21.0	C	26.9	C
WB I-264 ML & EB I-264 CD to EB I-64 (Merge)	**40.4**	**E**	**38.1**	**E**
EB I-64 South of I-264 (Freeway)	35.0	D	**35.5**	**E**
WB I-64 South of I-264 (Freeway)	23.0	C	20.2	C
EB I-264 CD/WB I-264 CD & WB I-64 (Weave)	26.1	C	26.0	C
WB I-64 North of I-264 (Freeway)	26.8	D	30.2	D

*** VR > Max**
**** VFO + VR12 > Max**
***** VFI + V12 > Max**

Table 4.2
Summary of 2014 Existing Conditions CORSIM Capacity Analysis
I-264 & I-64 Interchange

Movement (Type)	AM Peak Hour		PM Peak Hour	
	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS
EB I-264 ML between Military Hwy and I-64 (Freeway)	11.7	B	20.3	C
EB I-264 ML to WB I-64 (Diverge)	14.5	B	26.0	C
EB I-264 CD to EB I-64 (Diverge)	17.4	B	19.5	B
EB/WB I-64 & EB I-264 CD (Weave)	16.5	B	15.0	B
WB I-64 to EB I-264 CD & EB I-264 CD to SB Newtown Rd (Weave)	25.0	C	21.2	B
EB I-264 ML between I-64 and Newtown Rd (Freeway)	17.6	B	27.2	D
WB I-264 ML between I-64 and Newtown Rd (Freeway)	**40.3**	**E**	16.9	B
WB I-264 ML to WB I-64 HOV (Diverge)	**51.1**	**F**	-	-
WB I-264 ML to EB I-64 (Diverge)	**53.2**	**F**	15.4	B
SB Newtown Rd to WB I-264 CD & WB I-264 CD to WB I-64 (Weave)	20.8	B	23.1	B
EB/WB I-64 & WB I-264 CD (Weave)	13.2	B	15.1	B
EB I-64 to WB I-264 CD (Merge)	12.2	B	8.8	A
WB I-264 ML between Military Hwy and I-64 (Freeway)	17.5	B	10.2	A
EB I-64 North of I-264 (Freeway)	25.4	C	23.4	C
WB I-264 CD/EB I-264 CD & EB I-64 (Weave)	16.3	B	20.3	C
WB I-264 ML & EB I-264 CD to EB I-64 (Merge)	31.7	D	**40.6**	**E**
EB I-64 South of I-264 (Freeway)	22.2	C	33.2	D
WB I-64 South of I-264 (Freeway)	25.4	C	19.5	C
WB I-64 to I-64 WB HOV (Diverge)	24.5	C	-	-
WB I-64 to I-264 EB (Diverge)	31.6	D	28.3	D
EB I-264 CD/WB I-264 CD & WB I-64 (Weave)	21.2	C	20.3	C
EB I-264 ML & WB I-264 CD to WB I-64 (Merge)	26.3	C	28.6	D
WB I-64 North of I-264 (Freeway)	25.3	C	28.2	D

Factors Affecting Capacity Analysis Results

When reviewing the results exhibited in **Tables 4.1 and 4.2**, several limitations of capacity analysis need to be considered, and key limitations in this analysis include the following:

1. Geometric Limits: *Highway Capacity Manual* procedures for freeway and interchange movements are static, location-specific calculations that do not consider the relationship upstream or downstream constraints may have on traffic flow. Congestion located upstream of the ramp diverge point being analyzed may meter heavy traffic flow through the analysis point resulting in a lower vehicle density than expected based on field observations.
2. Model Boundary Limits: As with geometric limits, the limits of the CORSIM model boundary do not consider external traffic flow conditions. For this analysis, the key area where the model boundary affects results is on the eastbound I-64 approach to the off-ramp to eastbound and westbound I-264. Focusing on PM peak period conditions, traffic flow entering this ramp area is heavily influenced by congestion associated movements at the adjacent upstream Northampton Boulevard interchange. This congestion is located outside of the CORSIM model limits, and here also, upstream congestion meters traffic volume flow through the analysis area resulting in lower vehicle densities.
3. Lane Utilization: Lane utilization refers to the distribution of vehicle over two or more lanes. Generally for a given volume, the more even the distribution the better the service level. Where volumes are not evenly distributed, averaging volumes over a number of lanes will generate analysis results that are likely to be better than observed in the field. This is reflected in the results **Table 4.2** *(See: SB Newtown Rd to WB I-264 CD & WB I-264 CD to WB I-64 (Weave))* for the westbound I-264 CD weave section between the on-ramp from southbound Newtown Road and the off-ramp to westbound I-64. Field observation confirms that, in the AM peak period, most motorists use the inside lane, resulting in queues extending on westbound I-264 CD back through the Newtown Road interchange area. However, the analysis results, which are based on an even distribution of vehicles over the two lanes, show a density of 20.8 pc/mi/ln, indicating that no congestion should be expected.

In summary, the results shown in Tables 4.1 and 4.2 should be viewed considering limitations associated with the analysis methodologies.

The interchange of I-64 with I-264 presents a complex set of roadway geometries, and the use of standardized analytical tools to evaluate their operational performance does not accurately reflect all deficient conditions. Based on field observations, the operation of the interchange for several key movements is worse than indicated by the analysis results.

Based on field observations, the operation of the interchange for several key movements is worse than indicated by the analysis results.

IV.1.3 Crashes

Figure IV.3 displays the 4-year crash history at I-64 for the period 2009-2012. **Figure IV.3** illustrates a large number of crashes throughout the interchange; crashes are particularly dense on the east side of the interchange towards the Newtown Road interchange. The heavy crash pattern on the east side of the interchange matches up with heavy congestion in the area. Heavy crash patterns are very noticeable on the westbound CD road on the east side of the interchange. The proximity of the Newtown Road interchange plays a role in the crash patterns and congestion – much of the traffic changes lanes between I-64 and Newtown Road.

Table 4.3 summarizes the crash history at the I-64 interchange by direction and type of freeway facility (CD or mainline) for the period 2009-2012. A total of 315 crashes occurred in the vicinity of the I-64 interchange over the period 2009-2012. A majority of the crashes, 144, were rear end crashes. The second most frequent type of crash was Fixed Object Off-Road crashes with a total of 101. The two most frequent types of crashes at this interchange made up 78% of the total crashes. There were 93 injury crashes and 1 fatal crash.

Figure IV.3 and **Table 4.3** both demonstrate typical crash patterns caused by congested conditions. Furthermore, substandard roadway geometrics combined with tight interchange spacing (Newtown Road and Military Highway interchanges) are also significant contributing causes to the crash history experienced at this interchange.

Table 4.3
Summary of Crash History at I-64 & I-264 Interchange
2009-2012

Location	Type of Crash						Severity		
	Rear End	Angle	Sideswipe - Same Dir.	Fixed Object Off Road	Misc.	**Total**	Property Damage Only	Injury	Fatal
EB CD	19	1	3	8	0	**31**	18	13	0
WB CD	24	2	6	8	1	**41**	31	10	0
EB ML	11	6	3	13	2	**35**	23	12	0
WB ML	42	9	9	16	7	**83**	54	28	1
EB Ramp	13	1	1	25	4	**44**	33	11	0
EB/WB Ramp	13	0	1	7	1	**22**	15	7	0
WB Ramp	16	3	3	20	2	**44**	35	9	0
HOV Ramp	6	2	1	4	2	**15**	12	3	0
Total	**144**	**24**	**27**	**101**	**1**	**315**	**221**	**93**	**1**

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

Crash Type Map (2009-2012)
I-264 & I-64 Interchange

Figure IV.3	July 2016

N

Military Circle Mall
Poplar Hall Dr
Aldridge St
Yoder Ave
Kempsville Cir
I-64
Benton St
Lucas Ave
Glenrock Rd
Hicks Ave
Finney St
Brockwell Ave
Frizzell Ave
Honaker Ave
Bartee St
Wellman St
Chambers St
I-264
Center Dr
Hargrove St
Blackstone St
Adderley St
Rolleston Ave
Curlew Dr
Ronald Rd
Foresttown Dr
Bristol Ave
Amarillo Ave
Abilene Ave
Houston Ave

LEGEND

CRASH TYPE

- Rear End
- Angle
- Head On
- Sideswipe - Same Direction
- Sideswipe - Opposite Direction
- Fixed Object in Road
- Train
- Non-Collision
- Fixed Object - Off Road
- Bicyclist
- Motorcyclist
- Backed Into
- Other

Feet
0 200 400

IV.2 Forecasted Conditions

The analysis of forecasted conditions includes the development and evaluation of future volumes and operations for the year 2040. No Build Alternative and three improvement alternatives are described, followed by an explanation of the basis for the selection of the preferred alternative. Cost and impacts for the preferred alternative are listed at the end of this section as well.

IV.2.1 Forecasted Volumes & Operations

Table 4.4 displays the forecasted year 2040 peak hour volumes for the No Build Alternative (regular font) and Build Alternatives (**bold font**) at the I-64 interchange. Existing volumes are also listed (*in italics*) in order to provide for comparison. Significant growth (> 20%) is observed on I-64 south of I-264, particularly in the Build Alternatives. Moderate growth (~10-20%) can be found on I-64 north of I-264 and on I-264 east of I-64. Virtually no growth occurs on I-264 west of I-64. Each of the Build Alternatives uses different locations for the ramp connections; this causes significant shifts in volume between the CD Road and the mainline lanes, which has an influence on volumes at the Military Highway interchange and the Newtown Road interchange.

The roadway geometry for the No Build Alternative includes funded improvements for the widening of Ramp D-7 from westbound I-64 WB to eastbound I-264. This improvement provides a two-lane off-ramp with connections to both the eastbound I-264 mainline lanes and the CD lanes. These improvements extend to the Witchduck Road interchange. No other improvements are currently fully funded in the *Six-Year Improvement Program*.

Table 4.4
Forecasted 2040 Volumes
I-64 & I-264 Interchange

Interstate & Direction	Movement From	Movement To	2014 Existing Conditions AM Peak Hour	2014 Existing Conditions PM Peak Hour	2040 No Build Conditions AM Peak Hour	2040 No Build Conditions PM Peak Hour	2040 Build Conditions AM Peak Hour	2040 Build Conditions PM Peak Hour
I-264 EB	CD Road after Military Hwy		*2,224*	*2,558*	2,224	2,602	**2,418**	**2,806**
	Mainline after Military Hwy		*2,833*	*4,860*	2,868	4,955	**2,833**	**4,860**
	EB I-264 CD	EB I-64	*450*	*683*	496	740	**536**	**952**
	EB I-264 Mainline	WB I-64	*720*	*1,206*	720	1,206	**720**	**1,206**
	EB I-264 CD	WB I-64	*264*	*333*	285	333	**266**	**355**
	CD Road after I-64		*4,146*	*3,641*	2,862	2,646	**3,168**	**2,735**
	Mainline after I-64		*4,128*	*6,213*	4,658	1,999	**2,303**	**6,213**
I-264 WB	CD Road before I-64		*4,592*	*5,218*	5,280	6,105	**5,186**	**5,908**
	WB I-264 CD	WB I-64	*2,300*	*2,604*	2,619	2,829	**2,426**	**2,645**
	WB I-264 CD	EB I-64	*612*	*1,218*	957	1,850	**972**	**1,977**
	Mainline before I-64		*5,683*	*3,146*	6,505	3,662	**6,804**	**3,839**
	WB I-264 Mainline	WB I-64 HOV	*468*	*0*	479	0	**483**	**0**
	WB I-264 Mainline	EB I-64	*1,993*	*1,161*	2,804	1,677	**3,099**	**1,854**
	CD Road before Military Hwy		*3,246*	*2,468*	3,302	2,497	**3,483**	**2,684**
	Mainline before Military Hwy		*3,222*	*1,985*	3,222	1,985	**3,222**	**1,985**
I-64 EB	EB I-64 north of interchange		*6,011*	*5,560*	6,935	6,402	**6,683**	**6,142**
	EB I-64	WB I-264 CD	*921*	*464*	921	464	**921**	**464**
	EB I-64	EB I-264 Mainline	*2,014*	*1,935*	2,510	2,172	**2,131**	**1,935**
	EB I-64	EB I-264 CD	*667*	*553*	672	617	**700**	**553**
	EB I-64 HOV	EB I-264 Mainline	*0*	*624*	0	688	**0**	**624**
	EB I-64 south of interchange		*5,465*	*5,669*	7,089	7,416	**7,538**	**7,973**
I-64 WB	WB I-64 north of interchange		*5,857*	*6,606*	6,888	7,420	**6,564**	**7,742**
	I-64 HOV north of interchange		*1,258*	*1,047*	1,417	1,201	**1,496**	**1,198**
	WB I-64	WB I-264 CD	*644*	*607*	677	607	**774**	**934**
	WB I-64	EB I-264 CD	*1,969*	*1,546*	747	500	**852**	**683**
	WB I-64	EB I-264 Mainline	*0*	*0*	2,018	1,999	**2,303**	**2,734**
	I-64 HOV south of interchange		*790*	*424*	938	513	**1,013**	**574**
	WB I-64 south of interchange		*5,187*	*4,616*	6,705	6,157	**7,081**	**7,787**

Shown later in this section, **Table 4.5** displays a summary of the HCS capacity analysis of the No Build Alternative and three Build alternatives at the interchange of I-64 and I-264.

Generally No Build Alternative movements deteriorated one letter grade from those analyzed under existing conditions. Again, several of the movements at this interchange are currently operating with LOS F conditions in at least one peak hour.

The improvements associated with the widening improvements to Ramp D-7 (from WB I-64 to EB I-264) results in a substantial improvement to the weave between the Ramp D-7 junction with the eastbound I-264 CD and southbound Newtown Road off-ramp, improving service levels from LOS F to LOS B.

In the other direction, the weave on the westbound I-264 CD between the I-64 loop ramps fell from LOS B to LOS F in the PM peak hour as volumes exceeded capacity (more specifically, the HCS capacity check for the ramp exceeded capacity). Similarly, the weave on eastbound I-64 between the I-264 loop ramps fell from LOS C to LOS F in the PM peak hour, as conditions became overcapacity (here also, the ramp HCS capacity check exceeded capacity).

Mainline lanes on eastbound I-264 are forecast to operate with LOS E conditions to the west of the I-64 interchange in the PM peak hour. In the opposite direction, westbound I-264 mainline lanes between I-64 and Newtown Road are forecast to operate at LOS F in the AM peak hour.

The off-ramp diverge movement from the westbound I-264 mainline lanes to eastbound I-64 is forecasted to fail in both peak hours; the merge of this ramp into eastbound I-64 is also forecast to fail in both peak hours. Forecasted volumes for this ramp have increased to well beyond the capacity of a single lane ramp.

Eastbound I-64 south of I-264 is forecast to fail in both peak hours. Forecasted volumes on this segment are well beyond the capacity of the current and planned freeway section of three lanes with a concurrent flow HOV lane.

Also shown later in this section, **Table 4.6** displays a summary of the CORSIM capacity analysis of the No Build Alternative and the three Build alternatives at the interchange of I-64 and I-264.

Consistent with the HCS analysis results, the No Build Alternative CORSIM results were generally one letter grade worse than the results from existing conditions analysis. Several of the movements fell to LOS E and F conditions.

Again, the Ramp D-7 improvement modifications address deficiencies in the weave section on the eastbound I-264 CD between Ramp D-7 merge and the southbound Newtown Road off-ramp diverge to LOS B conditions in both peak hours.

The westbound I-264 mainline ramp to eastbound I-64 ramp is severely overcapacity under No Build Alternative conditions, which causes traffic to back up through the mainline back towards the mainline/CD road split. Both directions of I-64 south of I-264 operate with inadequate service levels (LOS E conditions).

The merge of the I-264 ramps to eastbound I-64 operates with LOS F conditions in the PM peak hour. The I-64 eastbound diverge movement to I-264 eastbound/westbound operates with LOS F conditions in both peak hours. These deficiencies are caused by forecasted traffic volumes exceeding the capacity of the ramp from eastbound I-64 to the eastbound I-264 mainline lanes.

No Build Alternative analysis indicates that by 2040 various movements at the I-64/I-264 interchange will deteriorate to operate over capacity.

IV.2.2 Improvement Alternatives

I-64/I-264 interchange has numerous geometric deficiencies as well as many forecasted operational deficiencies. Current improvements associated with Ramp D-7 (WB I-64 to EB I-264) only mitigate deficiencies associated with movements oriented to or from eastbound I-264.

To address the remaining forecasted deficiencies three improvement alternatives have been developed and analyzed. These are shown in **Figures IV.4, IV.5 and IV.6.** Geometric compliance has been intentionally provided with all proposed improvements. All three Build alternatives include one additional lane on I-64 in both directions of travel on both sides of I-264 – to the Northampton Boulevard interchange and to the Indian River Road interchange. As found using the microsimulation modeling, these improvements will be necessary to handle forecasted future volume and prevent bottleneck conditions.

The first improvement alternative (**Figure IV.4 – Directional)** consists of 4 new directional ramps. This improvement alternative removes all weave movements within the I-64/I-264 interchange and requires a modest increase in right of way.

The second improvement alternative (**Figure IV.5 – Semidirectional)** consists of several directional ramps that spiral in a counterclockwise direction. All weave movements are eliminated within the I-64/I-264 interchange and only a very small amount of right of way may be required.

The third improvement alternative (**Figure IV.6 – Modified Conventional**) provides 3 new directional ramps while maintaining 3 of the existing loop ramps. By eliminating one loop ramp, two weave segments are eliminated while 2 weave segments would remain within the I-64/I-264 interchange. This alternative may require a very small amount of right of way.

Improvements to the transition on eastbound I-64 toward the Twin Bridges – included in all three Build Alternatives – are shown in **Figure IV.7.**

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2040 Build Alternative
I-264 & I-64 Interchange
Directional

Figure IV.4	July 2016

D1 D2 D3 D4 D5 D6 D7 D8 D9 D11 D12 D13

55 mph 40 mph 45 mph 50 mph

I-264 I-64

Curlew Dr
Tide LRT
Future Work In Place
Newtown LRT Station
Kempsville Rd.
Norfolk - Virginia Beach

LEGEND

- NUMBER OF LANES
- NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

SCALE
0 200 400

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2040 Build Alternative
I-264 & I-64 Interchange
Semidirectional

Figure IV.5	July 2016

D12 D13 D3 D5 D10 D11 D4 D2 D9 D8 D6 D7

45 mph 40 mph 55 mph 45 mph 40 mph 45 mph 55 mph 55 mph 45 mph 45 mph

Underpass

I-264 I-64

Kempsville Rd.

Norfolk Virginia Beach

Newtown LRT Station

Future Work In Place

Curlew Dr Tide LRT Curlew Dr Tide LRT

SCALE 0 200' 400'

AERIAL IMAGERY © 2013 COMMONWEALTH OF VIRGINIA

LEGEND

- NUMBER OF LANES
- NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2040 Build Preferred Alternative
I-264 & I-64 Interchange
Modified Conventional

Figure IV.6	July 2016

D10
D12
D13
D3
D5
D11
D2
D9
D8
D6
D7
D4

55 mph
45 mph
30 mph
60 mph
N.P.

Removal of Military NB directional on-ramp to I-264 EB CD Required

Curlew Dr
Tide LRT
Future Work In Place
Newtown LRT Station
Kempsville Rd.
Norfolk
Virginia Beach

LEGEND

- NUMBER OF LANES
- NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph HOV SYSTEM POSTED SPEED
- 40 mph POSTED SPEED
- N.P. NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

SCALE
0 200 400

I-264 Corridor Evaluation Study

U.S. Department of Transportation
Federal Highway Administration

VDOT
Virginia Department of Transportation

AECOM

2040 Build Alternative
I-264 & I-64 Interchange
I-64EB Acceleration Lane

Figure IV.7	July 2016

Eastern Branch
Elizabeth River

Mill Creek

55 mph

55 mph

Future Work In Place

64

64

SCALE
0 200' 400'

LEGEND

- 2 — NUMBER OF LANES
- 4 — NUMBER OF LANES INCLUDING HOV
- HOV SYSTEM
- DIRECTION OF TRAVEL
- 65 mph — HOV SYSTEM POSTED SPEED
- 40 mph — POSTED SPEED
- N.P. — NOT POSTED SPEED
- PROPOSED / EXISTING SIGNAL

NOTE: INSET SCALE = 2x PLAN SCALE

The improvement alternatives have been analyzed using the same procedures – HCS and CORSIM - used in the analysis of existing conditions and No Build Alternative. The results of the capacity analysis for all the forecasted year 2040 alternatives (including the No Build Alternative) are shown in **Table 4.5** and **Table 4.6.** In **Table 4.5**, a density listed with a ($^{+}$) was analyzed as a freeway segment due to HCS limitations for considering add lanes (where an on-ramp creates a continuous additional lane to the freeway) and drop lanes (where a continuous freeway lane drops to an off-ramp). The I-64/I-264 interchange Build Alternative improvements have several locations where the geometry is atypical and is not capable of being appropriately analyzed using HCS 2010 procedures.

Directional

The first Build Alternative improvement, Directional, removes all weave movements, but it will add substantial traffic volumes to the westbound I-264 CD system since it would provide the only connection to eastbound I-64; the existing westbound I-264 mainline ramp to I-64 is eliminated.

The results in **Table 4.5** and **Table 4.6** show that almost all of the movements associated with the interchange ramps exhibit adequate service levels of D or better. Most of the movements are forecast to operate with LOS B and C. In **Table 4.5**, HCS results exhibit LOS E on the verge of LOS D for mainline eastbound I-64 south of the I-264 interchange in the PM peak hour.

CORSIM analysis forecasts all movements to operate with LOS D or better conditions in both peak hours.

Semidirectional

The second Build Alternative improvement provides for a directional ramp configuration with a series of spiraling directional ramps. Three of the four existing loop ramps are removed, eliminating two weave areas within the interchange.

The results in **Table 4.5** and **Table 4.6** show that most of the movements associated with the interchange ramps exhibit adequate service levels of D or better. Again, most of the movements in this alternative operate with LOS B or C conditions. In **Table 4.5**, HCS results exhibit LOS E on the verge of LOS D for mainline eastbound I-64 south of the I-264 interchange in the PM peak hour. The HCS results also exhibit LOS E for mainline westbound I-264 west of the interchange in the AM peak hour. Two additional movements that displayed LOS E in the AM peak hour from the I-264 westbound mainline are the diverge movement to westbound I-64 HOV and the diverge movement to eastbound I-64 (analyzed as a freeway segment).

CORSIM analysis forecasts all movements to operate with LOS D or better in both peak hours.

Modified Conventional

The third Build Alternative improvement maintains three of the four existing loop ramps while providing for 3 new directional ramps. This configuration eliminates two of the four existing weave segments, leaving two weave segments remaining within the I-64/I-264 interchange.

The results in **Table 4.5** and **Table 4.6** show that most of the movements at the interchange are forecast to operate with LOS D or better conditions. In **Table 4.5**, HCS results exhibit LOS E on the verge of LOS D for mainline eastbound I-64 south of the I-264 interchange in the PM peak hour, just as in the previously discussed alternative improvements. The HCS results also exhibit LOS E for mainline westbound I-264 west of the interchange in the AM peak hour. Two additional movements exhibiting LOS E in the AM peak hour on mainline westbound I-264 are the diverge movement to westbound I-64 HOV and the diverge movement to eastbound I-64 (analyzed as a freeway segment).

The merge from the westbound I-264 mainline lanes and eastbound I-264 CD to eastbound I-64 (analyzed as a freeway segment) exhibits LOS D in both peak hours. The difference with this movement in relation with the other two alternative improvements is that the directions from eastbound and westbound I-264 merge together before merging with eastbound I-64 instead of providing two separate ramps merging with I-64. The weave movements involving eastbound and westbound I-64 with westbound I-264 CD and eastbound and westbound I-264 with eastbound I-64 exhibit LOS F in the PM peak hour. This is due to the high ramp volume in the PM peak hour from westbound I-264 CD to eastbound I-64 (HCS capacity checks for the ramp cause the movement to fail). The additional capacity added on the mainline westbound I-264 ramp to eastbound I-64 should help to alleviate the conditions on the CD ramp in this alternative improvement by attracting volume from the duplicative CD loop ramp.

CORSIM analysis forecasts all movements to operate with LOS D or better conditions in both peak hours.

For all three Build Alternatives, the CORSIM results indicate better operational performance than indicated by the HCS results.

Table 4.5
Summary of HCS Capacity Analysis Results
Year 2040 Alternatives: I-64 & I-264 Interchange

Year 2040 Alternative		No Build Alternative				Directional				Semidirectional				Modified Conventional			
Time of Day		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
Dir.	Movement (Type)	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS
East-bound I-264	EB I-264 ML between Military Hwy and I-64 (Freeway)	16.6	B	**36.5**	**E**	12.3	B	25.4	C	9.2	A	19.1	C	9.2	A	19.1	C
	EB I-264 ML to WB I-64 (Diverge)	16.4	B	**30.9**	**F****	13.4+	B	27.5+	D	-	-	-	-	-	-	-	-
	EB I-264 CD to EB I-64 (Diverge)	23.0	C	26.5	C	13.0+	B	14.8+	B	14.2+	B	18.1+	C	14.2+	B	18.1+	C
	EB/WB I-64 & EB I-264 CD (Weave)	17.4	B	18.4	B	-	-	-	-	-	-	-	-	-	-	-	-
	EB I-64 to I-264 EB CD (Merge)	-	-	-	-	22.3	C	20.0	C	22.3	C	20.0	C	22.3	C	20.0	C
	WB I-64 to EB I-264 CD & EB I-264 CD to SB Newtown Rd (Weave)	19.0	B	17.2	B	23.9	B	19.2	B	23.9	B	19.2	B	23.9	B	19.2	B
	EB/WB I-64 to I-264 EB ML (Merge)	-	-	-	-	16.8+	B	23.2+	C	16.8+	B	23.2+	C	16.8+	B	23.2+	C
	EB I-264 ML between I-64 and Newtown Rd (Freeway)	21.0	C	25.9	C	-	-	-	-	-	-	-	-	-	-	-	-
West-bound I-264	WB I-264 ML between I-64 and Newtown Rd (Freeway)	**220.6**	**F**	22.3	C	20.1	C	8.5	A	**41.9**	**E**	16.5	B	**41.9**	**E**	16.5	B
	WB I-264 ML to WB I-64 HOV (Diverge)	**57.4**	**F*****	-	-	18.8	B	-	-	**37.2**	**E**	-	-	**37.2**	**E**	-	-
	WB I-264 ML to EB I-64 (Diverge)	**48.2**	**F*****	25.5	C	-	-	-	-	**36.5+**	**E**	16.5+	B	**36.5+**	**E**	16.5+	B
	SB Newtown Rd to WB I-264 CD & WB I-264 CD to WB I-64 (Weave)	27.3	C	31.1	C	29.8+	D	26.4+	D	18.5+	C	20.1+	C	18.5+	C	20.1+	C
	EB/WB I-64 & WB I-264 CD (Weave)	20.1	B	**V/C=1.102**	**F**	-	-	-	-	-	-	-	-	29.0	C	**V/C = 1.302**	**F**
	WB I-264 CD to I-64 EB (Diverge)	-	-	-	-	26.1+	D	21.8+	C	-	-	-	-	-	-	-	-
	WB I-64 to WB I-264 CD (Weave)	-	-	-	-	23.1	B	18.0	B	15.4+	B	14.0+	B	-	-	-	-
	EB I-64 to I-264 WB CD (Weave)	18.5	B	12.7	B	9.6+	A	6.0+	A	23.7	B	14.6	B	23.7	B	14.6	B
	WB I-264 ML between Military Hwy and I-64 (Freeway)	26.8	D	12.1	B	26.8	D	12.1	B	26.8	D	12.1	B	26.8	D	12.1	B
East-bound I-64	EB I-64 to EB/WB I-264 (Diverge)	25.4+	C	23.5+	C	24.4+	C	22.6+	C	24.4+	C	22.6+	C	24.4+	C	22.6+	C
	EB I-64 North of I-264 (Freeway)	32.6	D	29.7	D	24.4	C	22.6	C	24.4	C	22.6	C	24.4	C	22.6	C
	WB I-264 CD/EB I-264 CD & EB I-64 (Weave)	29.8	D	**V/C=1.091**	**F**	-	-	-	-	-	-	-	-	34.9	D	**V/C = 1.119**	**F**
	EB I-64 to EB I-264 CD (Diverge)	-	-	-	-	17.3	B	17.7	B	17.3	B	17.7	B	-	-	-	-
	WB I-264 ML & EB I-264 CD to EB I-64 (Merge)	**51.3**	**F****	**48.6**	**F****	-	-	-	-	23.0+	C	23.7+	C	27.6+	D	28.5+	D
	WB I-264 CD to EB I-64 (Merge)	-	-	-	-	25.6+	C	25.0+	C	-	-	-	-	-	-	-	-
	EB I-264 CD to EB I-64 (Merge)	-	-	-	-	17.6	B	20.7	C	-	-	-	-	-	-	-	-
	EB I-64 South of I-264 (Freeway)	33.6	D	**57.9**	**F**	27.6	D	**36.5**	**E**	27.6	D	**36.5**	**E**	27.6	D	**36.5**	**E**
West-bound I-64	WB I-64 South of I-264 (Freeway)	**58.1**	**F**	27.0	D	**35.6**	**E**	27.7	D	**35.6**	**E**	27.7	D	**35.6**	**E**	27.7	D
	WB I-64 to I-64 WB HOV (Diverge)	**37.8**	**E**	-	-	33.1	D	-	-	33.1	D	-	-	33.1	D	-	-
	WB I-64 to I-264 EB (Diverge)	30.0+	D	27.1+	D	25.1+	C	27.7+	D	25.1+	C	27.7+	D	25.1+	C	27.7+	D
	EB I-264 CD/WB I-264 CD & WB I-64 (Weave)	31.9	D	29.6	D	-	-	-	-	-	-	-	-	-	-	-	-
	WB I-64 to WB I-264 CD (Diverge)	-	-	-	-	25.2	C	27.9	C	25.0+	C	28.3+	D	21.6	C	24.3	C
	EB I-264 CD to WB I-64 (Merge)	-	-	-	-	-	-	-	-	24.9+	C	29.7+	D	-	-	-	-
	EB I-264 CD or ML & WB I-264 CD to WB I-64 (Merge)	20.6+	C	23.7+	C	21.0+	C	24.7+	C	24.0+	C	28.1+	D	20.3+	C	24.5+	C
	WB I-64 North of I-264 (Freeway)	32.3	D	**35.4**	**E**	24.0	C	28.1	D	24.0	C	28.1	D	24.0	C	28.1	D

Table 4.6
Summary of CORSIM Capacity Analysis Results
Year 2040 Alternatives: I-64 & I-264 Interchange

Year 2040 Alternative		No Build Alternative				Directional				Semidirectional				Modified Conventional			
Time of Day		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
Dir.	Movement (Type)	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS
East-bound I-264	EB I-264 ML between Military Hwy and I-64 (Freeway)	11.9	B	20.7	C	11.7	B	20.4	C	8.6	A	15.2	B	8.7	A	15.1	B
	EB I-264 ML to WB I-64 (Diverge)	14.8	B	26.4	C	12.3	B	22.5	C	-	-	-	-	-	-	-	-
	EB I-264 CD to EB I-64 (Diverge)	18.1	B	20.6	C	12.6	B	14.2	B	14.0	B	18.6	B	13.4	B	17.2	B
	EB/WB I-64 & EB I-264 CD (Weave)	15.8	B	15.8	B	-	-	-	-	-	-	-	-	-	-	-	-
	EB I-64 to I-264 EB CD (Merge)	-	-	-	-	15.9	B	12.5	B	14.7	B	12.3	B	15.0	B	12.2	B
	WB I-64 to EB I-264 CD & EB I-264 CD to SB Newtown Rd (Weave)	18.7	B	18.3	B	19.8	B	16.0	B	19.2	B	16.4	B	19.6	B	15.7	B
	EB/WB I-64 to I-264 EB ML (Merge)	-	-	-	-	17.6	B	23.2	C	17.1	B	23.3	C	17.5	B	23.6	C
	EB I-264 ML between I-64 and Newtown Rd (Freeway)	19.5	C	28.3	D	-	-	-	-	-	-	-	-	-	-	-	-
West-bound I-264	WB I-264 ML between I-64 and Newtown Rd (Freeway)	**118.8**	**F**	**80.6**	**F**	21.8	C	10.9	A	29.2	D	15.3	B	28.8	D	15.5	B
	WB I-264 ML to WB I-64 HOV (Diverge)	**110.7**	**F**	-	-	20.8	C	-	-	30.3	D	-	-	29.4	D	-	-
	WB I-264 ML to EB I-64 (Diverge)	**73.8**	**F**	**65.6**	**F**	-	-	-	-	29.9	D	15.8	B	29.3	D	16.1	B
	SB Newtown Rd to WB I-264 CD & WB I-264 CD to WB I-64 (Weave)	19.9	B	25.1	C	20.0	B	18.5	B	18.0	B	20.4	B	18.1	B	20.3	B
	EB/WB I-64 & WB I-264 CD (Weave)	13.5	B	19.4	B	-	-	-	-	-	-	-	-	16.8	B	22.7	B
	WB I-264 CD to I-64 EB (Diverge)	-	-	-	-	22.8	C	18.5	B	-	-	-	-	-	-	-	-
	WB I-64 to WB I-264 CD (Weave)	-	-	-	-	11.9	A	10.0	A	15.1	B	13.2	B	-	-	-	-
	EB I-64 to I-264 WB CD (Weave)	10.3	A	8.0	A	9.1	A	6.5	A	13.1	B	10.0	A	13.4	B	10.3	A
	WB I-264 ML between Military Hwy and I-64 (Freeway)	10.5	A	6.0	A	19.1	C	10.8	A	17.4	B	9.8	A	17.2	B	10.6	A
East-bound I-64	EB I-64 to EB/WB I-264 (Diverge)	**65.5**	**F**	**74.3**	**F**	26.1	C	23.3	C	26.3	C	23.3	C	26.0	C	23.4	C
	EB I-64 North of I-264 (Freeway)	29.7	D	**47.0**	**F**	22.4	C	20.5	C	22.4	C	20.5	C	22.4	C	20.5	C
	WB I-264 CD/EB I-264 CD & EB I-64 (Weave)	20.0	C	34.0	D	-	-	-	-	-	-	-	-	20.7	C	26.2	C
	EB I-64 to EB I-264 CD (Diverge)	**-**	**-**	**-**	**-**	15.9	B	16.1	B	15.9	B	16.2	B	-	-	-	-
	WB I-264 ML & EB I-264 CD to EB I-64 (Merge)	**38.1**	**E**	**57.0**	**F**	-	-	-	-	28.9	D	26.9	C	26.4	C	26.8	C
	WB I-264 CD to EB I-64 (Merge)	-	-	-	-	27.8	C	25.1	C	-	-	-	-	-	-	-	-
	EB I-264 CD to EB I-64 (Merge)	-	-	-	-	27.7	C	29.4	D	27.7	C	30.4	D	-	-	-	-
	EB I-64 South of I-264 (Freeway)	**35.2**	**E**	**38.8**	**E**	32.5	D	33.3	D	32.9	D	34.4	D	32.7	D	33.9	D
West-bound I-64	WB I-64 South of I-264 (Freeway)	30.4	D	26.6	D	25.5	C	26.7	D	25.5	C	26.7	D	25.5	C	28.2	D
	WB I-64 to I-64 WB HOV (Diverge)	28.6	D	-	-	24.8	C	-	-	24.8	C	-	-	24.8	C	-	-
	WB I-64 to I-264 EB (Diverge)	30.0	D	27.4	C	25.8	C	28.8	D	25.2	C	29.8	D	25.5	C	28.2	D
	EB I-264 CD/WB I-264 CD & WB I-64 (Weave)	24.8	C	23.9	C	-	-	-	-	-	-	-	-	-	-	-	-
	WB I-64 WB to I-264 CD (Diverge)	-	-	-	-	17.4	B	19.7	B	23.0	C	26.5	C	17.0	B	20.9	C
	EB I-264 CD to WB I-64 (Merge)	-	-	-	-	-	-	-	-	24.8	C	30.9	D	-	-	-	-
	EB I-264 ML & WB I-264 CD to WB I-64 (Merge)	27.3	C	30.8	D	20.6	C	26.3	C	23.0	C	26.7	C	20.7	C	25.3	C
	WB I-64 North of I-264 (Freeway)	27.7	D	30.7	D	22.3	C	26.7	D	22.9	C	26.6	D	22.3	C	26.2	D

IV. 2.3 Alternative Cost

Planning level cost estimates were developed for the three improvement alternatives for the I-64 and I-264 Interchange. Detailed calculations have been included in the Technical Appendix. It should be noted that the estimates do not include costs associated with complete removal of existing I-264 through lanes and inflation/escalation. A 4" overlay was assumed over portions of I-264 that are not being completely removed.

It should be noted that each Build Alternative includes a transition on eastbound I-64 extending to the Twin Bridges over the eastern branch of the Elizabeth River (shown previously in **Figure IV.7)**. The additional cost captures the transition of the merge lanes from I-264 onto I-64 eastbound south of I-264, and these improvements extend beyond the limits of the graphics (**Figures IV.3 – IV.5**). This additional cost includes widening the eastbound I-64 bridge over the eastern branch of the Elizabeth River (known as the "Twin Bridges"). The cost estimates in year 2015 dollars are:

Alternative	Cost (in $million)
Directional	**$536.0**
Semidirectional	**$473.2**
Modified Conventional	**$466.9**

IV.2.4 Stakeholder Coordination

Coordination meetings were held with staff from the City of Norfolk and the City of Virginia Beach. In general, representatives from both cities were supportive of the evaluation process and the selection of the Modified Conventional as the preferred alternative.

IV.2.5 Impacts

Identification of potential impacts on key resources from construction of the three improvement alternatives was evaluated using desktop GIS mapping analysis. Detailed exhibits are in the Technical Appendix. Summarized in **Table 4.7**, the results show that all three alternatives would impact water resources (wetlands, for example); however there does not appear to be any potential impacts to Section 4(f) properties (public parks, for example). The Directional alternative will cause slightly more impacts to buildings and residences than the other two alternatives.

IV.3 Recommendation

Each of the alternatives is able to provide for adequate traffic operations for most movements at the interchange in both peak hours.

The **Directional** alternative is significantly more expensive - approximately $70 million more than the two other alternatives. It also has at least one major operational drawback - it only provides a connection from westbound I-264 to eastbound I-64 via the CD system, resulting in a substantial increase in traffic volumes on the CD.

Table 4.7
I-64 & I-264 Interchange Improvement Alternative Impacts

Improvement Alternative	WATER	BUILDINGS	RESIDENTIAL	POTENTIAL SECTION 4F
Directional	Y	2	10	N
Semidirectional	Y	0	4	N
Modified Conventional	Y	0	4	N

The **Semidirectional** provides adequate traffic service (based on CORSIM analysis) but includes the highest investment of the three alternatives in structures. This would result in higher maintenance costs over the service life of the improvements.

The **Modified Conventional** alternative maintains two of the existing weave movements at the interchange; however these weave segments are forecast to operate with no lower than LOS C conditions (CORSIM analysis). By retaining 3 of the 4 loop ramps, the interchange configuration of this alternative would provide for flexibility in:

1. Developing maintenance of traffic plans with the sequence of construction during construction, and
2. Providing additional options for re-routing traffic in response to incidents after completion of construction.

Based on the added flexibility and lower future maintenance costs provided by the **Modified Conventional Alternative**, it is recommended as the Preferred Alternative.

Based on the added flexibility and lower future maintenance costs provided by the Modified Conventional Interchange Alternative, it is recommended as the Preferred Alternative.

IV.4 I-64 Widening Improvement

As previously state in Section IV.2.4, all three Build alternatives include one additional lane on I-64 in both directions of travel on both sides of the I-264 interchange – to the Northampton Boulevard interchange and to the Indian River Road interchange. These lanes will be needed for the roadway to provide adequate service to forecasted peak hour traffic volumes. Without the added capacity on I-64, the recommended improvements to the I-64/I-264 interchange associated with merging with or diverging from I-64 will not provide adequate service, and the benefits to motorists from the investment in the interchange improvements will be diminished.

The results of the analysis of forecasted conditions on mainline I-64 freeway segments, summarized in **Table 4.8,** show that for the No Build Alternative both the HCS and CORSIM analysis results exhibit deficient conditions. In contrast, with the Build Alternative's addition of one lane in each direction, deficiencies are reduced in the HCS analysis results and eliminated in the CORSIM analysis results.

Table 4.8
Summary of HCS Analysis and CORSIM Analysis
I-64 Freeway Segment: North and South of I-264 Interchange
Year 2040 No Build and Build Alternatives

I-64 Freeway Segment	Direction	AM Peak Hour		PM Peak Hour	
		No Build	Build	No Build	Build
HCS Analysis					
I-64 (I-264 – Northampton Blvd)	EB	D	C	D	C
	WB	D	C	**E**	D
I-64 (I-264 – Indian River Road)	EB	D	D	**F**	**E**
	WB	**F**	**E**	D	D
CORSIM Analysis					
I-64 (I-264 – Northampton Blvd)	EB	D	C	**F**	C
	WB	D	C	D	D
I-64 (I-264 – Indian River Road)	EB	**E**	D	**E**	D
	WB	D	C	D	D

While this study has not developed detailed alternative improvement concepts for widening I-64, the most likely general improvement concept was developed and planning level cost estimates were developed for informational purposes. Furthermore, the analysis did not include movements associated with the I-64 interchanges at either Northampton Boulevard or Indian River Road.

IV.4.1 I-64: West to Northampton Boulevard

Beginning with the westbound I-64 movement between I-264 and Northampton Boulevard, a single lane needs to be added from the gore area of the I-264 on-ramp merge with the westbound I-64 mainline lanes to the diverge area of the off-ramp to Northampton Boulevard – a distance of approximately 7,100 feet.

For the reverse eastbound I-64 improvement, a single lane needs to be added from the merge of the on-ramp from Northampton Boulevard - where the mainline freeway transitions to three (3) lanes – to the diverge area where the off-ramp to I-264 transitions to two (2) lanes - a distance of approximately 5,800 feet.

It should be noted that the added lanes on I-64 are not extended through the Northampton Boulevard interchange area, but instead are either dropped (westbound) or added (eastbound) at ramp diverge or merge areas. Future improvements to the configuration of the I-64/Northampton Boulevard interchange will require more detailed analysis, including an Interchange Modification Report (IMR), to determine the most appropriate improvement strategy.

Cost

The cost estimate should be considered preliminary, and the following should be considered:

- A geotechnical review of the future pavement design has not been conducted.
- The cost estimate has assumed overlay of existing pavement, widening and new lanes. The cost estimate does not include complete mainline pavement reconstruction.

Although the addition of one lane in each direction constitutes a relatively minor change in the overall pavement section, the age of the facility (it was constructed in the mid-1960's), the number of large bridges and the extent of improvement required to meet current design standards results in a substantial estimate of improvement cost. To provide adequate clearance for traffic, four I-64 bridges will need to be replaced: two over Kempsville Road and two over Virginia Beach Boulevard. Finally, meeting current design standards will require a more extensive shoulder section than currently provided, increasing right of way impacts and costs.

After considering these factors, a planning level cost estimate of $343.2 million has been developed.

IV.4.2 I-64: East to Indian River Road

Beginning with the westbound I-64 movement between Indian River Road and I-264, a single lane needs to be added from the merge of the on-ramp from westbound Indian River Road (just east of the Providence Road bridge over I-64) to the off-ramp to eastbound I-264 – a distance of approximately 6,800 feet. It should be noted that the off-ramp to eastbound I-264 (Ramp D-7) is funded to be improved by 2020.

For the reverse eastbound I-64 improvement, a single lane needs to be added from the merge of the on-ramp from I-264 - where the mainline freeway transitions to three (3) lanes just east of Curlew Drive – to the diverge area for the off-ramp to westbound Indian River Road (just east of Providence Road) - a distance of approximately 10,000 feet.

Here also, the added lanes on I-64 are not extended through the Indian River Road interchange area, and future improvements to the configuration of the interchange will require more detailed analysis, including an IMR, to determine the most appropriate improvement strategy.

Cost

As with improvements between I-264 and Northampton Boulevard, the age, number of large bridges and the extent of improvement required to meet current design standards for the segment to Indian River Road also results in a substantial estimate of improvement cost.

Four bridges will need to be replaced: the twin I-64 bridges over the eastern branch of the Elizabeth River and the two bridges on Providence Road over I-64. Meeting current design standards will require a more extensive shoulder section than currently provided, increasing right of way impacts and costs.

After considering these factors, a planning level cost estimate of $649.6 million has been developed.

IV.4.3 Part-Time Shoulder Use on I-64

Recognizing that the cost of widening I-64 in either direction from I-264 presents a substantial financial challenge, the evaluation of the use of existing shoulders under a part-time basis may present an opportunity to improve the I-64/I-264 interchange and provide motorists with the benefits of the added roadway capacity.

Part-Time Shoulder Use is a transportation system management and operation (TSM&O) strategy that allows use of shoulders as travel lanes during some, but not all, hours of the day. It is one possible strategy for addressing congestion and reliability issues within the transportation system, and can be particularly cost-effective where alternatives to add lanes are infeasible, undesirable, or cost prohibitive. Part-time shoulder use is most cost-effective in constrained right-of-way conditions; however, there are certain minimum geometric clearances, visibility, and pavement requirements that must be considered before part-time shoulder use can be implemented.[1]

The decision to pursue the option of part-time shoulder use should be made as part of a comprehensive Performance-Based Practical Design (PBPD) assessment of design and TSM&O options for achieving the agency's performance objectives for the facility design and operations.

Figure IV-8: Part-time Shoulder Use Traffic Control on Westbound I-264, Virginia Beach (Google Earth image)

First the physical feasibility of part-time shoulder use should be evaluated to determine if it is a feasible option, and a region should decide if part-time shoulder use is consistent with its long term transportation goals and objectives. Then, a preliminary assessment should be made to identify one or more design and operations concepts for evaluation. This assessment, conducted under the overall umbrella of a PBPD process, should assess the operational and safety effects of part-time shoulder use to ensure it is indeed a cost-effective means for achieving the agency's performance objectives for the facility. Throughout this evaluation, key planning and environmental, maintenance, operations, design, and emergency responder stakeholders should be involved to ensure a successful outcome.[2] As stated in the report:

Part-time shoulder use may be an effective TSM&O strategy for operations and reliability of a facility in particular situations. In this context, part-time shoulder use is defined as follows:

- *The shoulder is used for travel only during those times of day when the adjoining lanes are likely to be heavily congested (e.g., during peak hours, when congestion is detected, or when general purpose lanes are closed for construction or incidents).*
- *When not needed as an additional travel lane, the shoulder will be restored to its original purpose as a "shoulder," and the basic physical characteristics of the shoulder are retained and recognizable.*

[1] U.S. Department of Transportation, Federal Highway Administration. *Use of Freeway Shoulders for Travel – Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy*. January 2016. p.1

[2] *Use of Freeway Shoulders for Travel.* p.3

The term "part-time" does not require that the use of shoulders as a TSM&O strategy is "short-term" and will be discontinued by some fixed date. Although part-time shoulder use may be used as an interim treatment while a conventional project (e.g., construction of additional lanes) awaits funding or completion, it may also be used indefinitely.[3]

FHWA recommends the consideration of Part-time shoulder use only within an overall TSM&O strategy for relieving congestion and improving peak period operation of a corridor. It should be considered if consistent with a region's long-range plan and congestion management process (CMP). The National Environmental Policy Act (NEPA) process is used to determine if part-time shoulder use is the preferred solution for a corridor, and preliminary engineering activities determine specific operating characteristics. Throughout these processes, a number of questions should be addressed, such as the following:

- Is part-time shoulder use consistent with the goals and priorities identified in the Regional Plan and Congestion Management Process?
- What is the transportation need in the corridor?
- Should part-time shoulder use be considered as a reasonable alternative to meet a transportation need or as a component of an alternative?
- Does the region have experience with transportation system management and operation (TSM&O) implementation?
- Is part-time shoulder use feasible from a constructability standpoint?
- Is real-time monitoring and incident response in place?
- What are the impacts?
- Does part-time shoulder use reduce cost compared to traditional projects?
- How can lanes designated for part-time shoulder use be designed and operated to optimize benefits and mitigate any adverse impacts?[4]

The option to use shoulders on a part-time basis must be considered within a comprehensive planning and operations analysis process, and it has been found to be a feasible option on I-264 in Virginia Beach. When the concurrent flow HOV lanes were installed on I-264, the use of the shoulder during periods when the HOV restrictions were in force were permitted. Since 1992, the shoulder on I-264 has been used on those mainline freeway segments where HOV restrictions are in force.

The part-time use of shoulders on I-64 is an option that may be appropriate to accommodate phasing of improvements to the I-64 corridor, including improvements to the I-64/I-264 interchange. A final determination will require extensive planning and operations study. Given the potential for part-time shoulder use to expand the number of options available for implementing improvements to the I-64/I-264 interchange, this study recommends inclusion of an evaluation of part-time shoulder use in the development of strategies for implementing phased improvements.

[3] *Use of Freeway Shoulders for Travel.* p.5
[4] *Use of Freeway Shoulders for Travel.* p.27.