Attachment 3

I-95/VA Route 606 Interchange Bridge Replacement

Interchange Modification Report

Route 606 Widening Project

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
LOCATION AND DESIGN

Interchange Modification Report for

Route 606 Bridge Replacement over I-95 with Route 606 Improvements
UPC No.'s: 100829 and 105463
August 2017

Jeremy J Beck
2017.08.02 16:07:56 -04'00'

Dewberry
Fairfax, Virginia
Transportation Engineer

Responsible for Pages
1 to 32
and 75

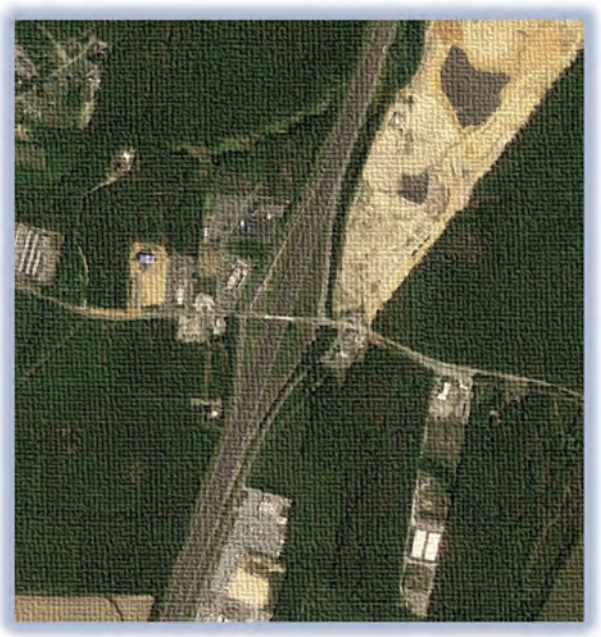
Gerard Mrykalo
2017.08.02 16:16:52 -04'00'

Dewberry
Fairfax, Virginia
Transportation Engineer

Responsible for Pages
33 to 74

Route 606 Bridge Replacement over I-95 with Route 606 Improvements

INTERCHANGE MODIFICATION REPORT



AUGUST 2017

SUBMITTED TO:

The U.S. Department of Transportation

Federal Highway Administration

SUBMITTED BY:

The Virginia Department of Transportation

PREPARED BY:

Dewberry Consultants LLC

IN ASSOCIATION WITH:

Shirley Contracting Company, LLC

1 EXECUTIVE SUMMARY

The Interstate 95 (I-95)/Mudd Tavern Road (Route 606) interchange is located in Spotsylvania County, Virginia, approximately 12 miles south of Fredericksburg. The interchange provides direct access to the community of Thornburg as well as several local businesses and recent and future development.

The Virginia Department of Transportation (VDOT) proposes improvements to the interchange to include replacement of the existing bridge carrying Route 606 over I-95, reconstructing Route 606 at the interchange, adjusting interchange ramp connections to Route 606, and relocating a portion of Mallard Road. The project accommodates pedestrian and bicycle traffic, is identified in VDOT's 2017 Six-Year Improvement Program (SYIP) (UPC 100829 and UPC 105463), and is consistent with the Fredericksburg Area Metropolitan Planning Organization's (FAMPO) 2040 Long Range Transportation Plan.

The purpose of the improvement is primarily to replace the existing bridge carrying Route 606 over I-95, which is structurally deficient and functionally obsolete. However, the improvements also increase capacity and reduce crash potential, particularly at the ramp terminal intersections, to address current and projected levels of demand at the interchange.

Multiple design alternatives were screened and a Preferred Build Alternative was identified by VDOT. The Preferred Build Alternative was then refined based on public input, resulting in the Final Build Alternative. This process is documented in the I-95/Route 606 Interchange Improvements Build Alternative Analysis Report (Report), provided as Appendix A with this IMR. The Report summarized the evaluation of the proposed interchange improvements under existing, Future No-Build and Future Build Conditions with respect to traffic operation and safety.

Subsequent to the establishment of the Final Build Alternative, VDOT issued a Request for Proposal (RFP) for the design and construction of the interchange improvement as a design-build project. During procurement, an alternative interchange concept was formulated, preliminarily reviewed by VDOT and included as part of the selected Design-Builders proposal.

The alternative interchange concept eliminates the roundabout as well as relocated Mallard Road and replaces them with an offset diamond configuration on the east side of I-95. The alternative concept also improves a portion of existing Mallard Road, re-configures the entrance to the Dominion Raceway Development, provides enhanced traffic operations, reduces overall impacts, and remains within the initial project limits while continuing to satisfy the purpose and need of the original interchange improvement. This alternative interchange concept, known as the Modified Final Build Alternative, is the subject of this Interchange Modification Report (IMR).

Under No-Build Conditions, operational analyses demonstrated that all intersections within the study area are expected to operate at LOS F with low travel speeds and high level of delay along Route 606 as well as I-95. Under Build Conditions associated with the Final Build Alternative, analyses demonstrated that intersections associated with the ramps and Route 606 east of the interchange are expected to operate at LOS C or better and that freeway segments in the study area are expected to operate at free-flow speeds with minimal congestion.

The Modified Final Build Alternative is expected to operate in some cases equal to the Final Build Alternative, while in many cases better than the Final Build Alternative. Generally, the two alternatives have equal operations along I-95, with the Modified Final Build Alternative having better operations along the conventional roadways and intersections. I-95 freeway segments in the study area operate at free-flow speed with minimal congestion for both alternatives. These results validate that both the Final Build Alternative and the Modified Final Build Alternative have better LOS throughout the study area when compared to the No-Build Conditions. For the intersections, all Modified Final Build Alternative intersections for both periods (AM and PM peaks) operate at LOS A or LOS B, while for the Final Build Alternative, three intersections operate at LOS C in the AM Peak and one intersection operates at LOS C in the PM peak. Breaking this down to the next level of detail, the Modified Final Build Alternative has no approaches (such as EB, WB, NB, SB) or movements (such as SB lefts, SB thru's, SB rights) operating at an LOS D or worse for either peak period. With the Final Build Alternative, four movements operate at LOS D in the AM Peak and five movements operate at LOS D in the PM peak.

This IMR builds upon work previously completed by VDOT and documents the requirements of the Federal Highway Administration (FHWA) and VDOT for modifying an existing interchange on the interstate system, Furthermore, this IMR provides clear justification regarding the need for the revised access to the interstate system.

1.1 FHWA Policy Requirements

This IMR addresses each of the eight FHWA interstate access policy requirements for the proposed project as described in the following narrative.

1.1.1 Policy Requirement 1: Need for Access Point Revision

The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands:

Travel patterns indicate pronounced directional peaks oriented to the north of the subject interchange during weekday morning periods and from the north of the subject interchange during weekday evening peak hour periods. This pattern of commuter activity, which centers in Fredericksburg, Northern Virginia and Washington DC, is well established and is expected to persist over time. Further, land use projections indicate that the subject interchange will need to continue to support access to increasing commercial development located along Route 606, US Route 1, and other roadways in the vicinity of the interchange. The combined effect of travel patterns, regional growth, and local development results in severe traffic congestion under projected 2018 and 2038 No-Build Conditions.

Accordingly, the existing interchange configuration, including the associated local roadway network, cannot be reasonably improved to address the need for capacity and safety improvements. The adjacent interchanges north and south of the subject interchange are located approximately eight miles away. It is not realistic to expect that motorists having destinations along Route 606 or originating near the subject interchange will use adjacent interchanges. Therefore, the reconstruction of the subject interchange, including the re-alignment and widening of Route 606 and the improvement of Mallard Road, is needed to satisfactorily accommodate the design-year traffic demands.

1.1.2 Policy Requirement 2: Reasonable Alternatives

The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate without the proposed change(s) in access:

Several alternatives, including Transportation System Management (TSM) Strategies, were considered during the development process associated with the Final Build Alternative which can be found within the I-95/Route 606 Interchange Improvements Build Alternatives Report included as Appendix A with this IMR. It was determined that TSM Strategies alone will not meet the needs of the subject interchange. Therefore, the reconstruction of the subject interchange, including the re-alignment and widening of Route 606 and the improvement of Mallard Road, is needed to satisfactorily accommodate the design-year traffic demands.

1.1.3 Policy Requirement 3: Operational and Collision Analysis

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, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, 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, shall 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. Requests for a proposed change in access must 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 streets. Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative:

The operational and safety analysis study area for this IMR incorporates the necessary roadway network which includes the I-95 mainline from one half mile north to one half mile south of the Route 606 overpass, all ramps serving the subject interchange, Route 606 from and including the US Route 1 intersection to one half mile east of the Thornburg Shell Station, and a portion of Mallard Road within the interchange area. The adjacent interchanges along I-95 are located well beyond the operational area of influence of the study interchange, and were therefore not included in the study area.

Traffic analysis indicates that the Final Build Alternative improves traffic operations within the study area when compared to the No-Build Alternative in the Opening Year. However, the Final Build Alternative alone is not sufficient to address future traffic demand within the study area through the 2038 Design Year. Specifically, the existing two-lane section of Route 606 west of the interchange is expected to cause congestion along Route 606 as well as within the interchange area. VDOT is currently evaluating improvements to Route 606 between US Route 1 and the southbound I-95 ramp terminals to address this identified issue. The Final Build Alternative is, however expected to reduce delay as well as queuing and improve overall operations in all analysis years.

Information presented in this IMR demonstrates that the Final Build Alternative reduces the potential for vehicle crashes within the study area. Specifically, the ramp and intersection improvements, and the conversion of permitted signal phases to protected phases reduces the potential for crashes on the freeway segments, ramps, arterials, and intersections within the study area.

The Final Build Alternative and the Modified Final Build Alternative incorporate substantial geometric improvements including widening the bridge over I-95, incorporating exclusive left-turn bays, reducing access point density, increasing the capacity of Route 606 as well as enhancing driver navigation and reducing delay. The Modified Final Build Alternative also eliminates a full intersection along Route 606 (the I-95 northbound ramp intersections) by replacing the heavy eastbound double left turn movement associated with the Final Build Alternative with a free flow right turn movement to access I-95 northbound, reducing the potential for crashes. Exclusive turn lanes at the ramp terminal intersections are also expected to significantly reduce the crash potential along Route 606. In summary, the Modified Final Build Alternative is also expected to significantly reduce the crash potential in the corridor.

A signage and pavement marking plan for the Modified Final Build Alternative is included with this IMR as Figure 6-2.

1.1.4 Policy Requirement 4: 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 for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards:

Similar to the Final Build Alternative, the Modified Final Build Alternative retains the current full directional access between I-95 and Route 606, connecting interchange movements with the local roadway network. However, there are distinct differences between the Final Build Alternative and the Modified Build Alternative as described below.

The Final Build Alternative retains the existing diamond configuration of the interchange, but signalizes both I-95 ramp terminal intersections at Route 606. A wider bridge replaces the existing overpass of I-95 and accommodates a four-lane, urban divided roadway (Route 606) with left turn lanes for eastbound and westbound Route 606 onto northbound and southbound I-95. The Final Build Alternative also extends the four-lane, urban divided Route 606 section east of I-95 to form a roundabout with relocated Mallard Road near the eastern terminus, providing a right in right out intersection at the current connection of Mallard Road with Route 606 and a partial egress, directional median with Dominion Raceway Avenue. Motorists seeking to enter the Dominion Raceway Development from I-95 or from Route 606 west of the I-95

interchange conduct a U-turn movement through the roundabout. Vehicles seeking existing Mallard Road from Route 606 east of the I-95 interchange utilize relocated Mallard Road.

The Modified Final Build Alternative adjusts the Final Build Alternative by placing the northbound I-95 ramps within the southeast quadrant of the interchange. The northbound ramps connect with Mallard Road (improved to a divided roadway north of the ramp terminals) at a signalized intersection. The northbound I-95 off-ramp continues to utilize the existing deceleration lane and diverge gore, but is diverted to connect with improved Mallard Road. The northbound I-95 on-ramp, after leaving the Mallard Road intersection, turns north and runs beneath the Route 606 overpass adjacent to northbound I-95 and connects with the existing northbound ramp prior to its connection with northbound I-95. Both southbound I-95 ramps continue to be configured as traditional tight diamond ramps with signalized control.

The Modified Final Build Alternative provides a four-lane, urban divided Route 606 section east of I-95 up to the intersection with Mallard Road and Dominion Raceway Avenue, which are aligned, forming a four-way signalized intersection with Route 606. East of this intersection Route 606 transitions to a two-lane divided roadway and eventually into a two-lane undivided roadway, connecting with existing Route 606. The roundabout associated with the Final Build Alterative as well as relocated Mallard Road are eliminated, reducing the overall impacts of the interchange improvements.

An Access Management Waiver (AM-W), provided as Appendix B with this IMR, is required for the Modified Final Build Alternative. Specifically, the AM-W is needed for the spacing between the I-95 northbound ramp terminal/Mallard Road signalized intersection and the Route 606/Mallard Road/Dominion Raceway Avenue signalized intersection as well as the spacing between the I-95 northbound ramp terminal and the Thornburg Shell Station entrances adjacent to Mallard Road. All other design elements associated with the Modified Final Build Alternative meet or exceed standards.

1.1.5 Policy Requirement 5: Land Use and Transportation Plans

The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the Congestion Management Process within transportation management areas, as appropriate, and as specified in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93:

The Modified Final Build Alternative is consistent with Spotsylvania County's Comprehensive Plan (approved by the Board of Supervisors on November 14, 2013) which was updated on June 14, 2016 to show planned improvements on Route 606. The interchange improvement is identified in the Fredericksburg Area Metropolitan Planning Organization's (FAMPO) Constrained Long Range Plan (CLRP) 2013 and is consistent with the 2040 Long Range Transportation Plan. Funding for the project was identified in VDOT's 2014 SYIP (UPC 100829 and UPC 105463) and remains funded in VDOT's 2017 SYIP.

1.1.6 Policy Requirement 6: Future Interchanges

In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan:

FAMPO's CLRP reflects a comprehensive summary of transportation needs throughout the region, including improvements at the study interchange. There are no other planned interchanges within the study area.

1.1.7 Policy Requirement 7: Coordination

When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvement. The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point:

The Modified Final Build Alternative is not associated with any specific private development or change in land use. Rather, it is VDOT's cost-effective and minimally impactful response to the cumulative effect of local and regional growth and increasing congestion.

The traffic volume forecast is based on the latest version of the FAMPO travel demand model. The inputs and outputs of the travel demand model are endorsed by VDOT and reflect the demand associated with all programmed land use within the coverage area. Additionally, new trips anticipated to be generated by several development projects located adjacent to the interchange are incorporated into the forecast.

1.1.8 Policy Requirement 8: Environmental Processes

The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of the environmental processing:

Multiple design alternatives were screened and a Preferred Build Alternative was identified by VDOT. The Preferred Build Alternative was then refined based on public input, resulting in the Final Build Alternative. The environmental work for the Final Build Alternative was conducted under two separate VDOT UPC's (105463 and 100829) and a Categorical Exclusion (for UPC 105463) and a Programmatic Categorical Exclusion (for UPC 100829) were approved by FHWA. Both are provided as Appendix C with this IMR.

Subsequent to the establishment of the Final Build Alternative, VDOT issued a Request for Proposal for the design and construction of the interchange improvements as a design-build project. During procurement, an alternative interchange concept (the Modified Final Build Alternative) was formulated, preliminarily reviewed by VDOT, and included as part of the selected Design-Builders proposal. The Modified Final Build Alternative improves upon the Final Build Alternative by reducing project impacts while improving traffic operations and lowering the overall cost of the improvements. Environmental commitments associated with the Categorical Exclusion and the Programmatic Categorical Exclusion are included as part of the Modified Final Build Alternative and the Environmental Re-Evaluation is provided as Appendix D with this IMR.

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2 PROJECT BACKGROUND

Interstate 95 serves both interstate travel as well as regional commuter traffic oriented to the Washington DC, Fredericksburg, and Richmond metropolitan areas. The subject interchange is one of two access points to I-95 in Spotsylvania County. Adjacent interchanges along I-95 are located approximately 8 miles away at Jefferson Davis Highway (Route 1) to the north and approximately 8 miles away at Ladysmith Road (Route 639) to the south.

The proposed project replaces the bridge carrying Route 606 over I-95, increases capacity of Route 606 to accommodate forecast land development and traffic demand, and enhances safety within the interchange. Proposed improvements to the interchange include replacement of the existing bridge carrying Route 606 over I-95, reconstructing Route 606 at the interchange, adjusting interchange ramp connections to Route 606, and reconfiguring a portion of Mallard Road. The project includes accommodations for pedestrian and bicycle traffic and is coordinated with VDOT's on-going improvement plan for Route 606.

Spotsylvania County's Comprehensive Plan (approved by the Board of Supervisors on November 14, 2013) was updated on June 14, 2016 to show the proposed improvements on Route 606. The improvement is identified in the Fredericksburg Area Metropolitan Planning Organization's (FAMPO) Constrained Long Range Plan (CLRP) 2013 and is consistent with the 2040 Long Range Transportation Plan as well. Funding for the project was identified in VDOT's 2014 SYIP (UPC 100829 and UPC 105463) and remains funded in VDOT's 2017 SYIP. The UPC 100829 (Replacement of the Route 606 Bridge over I-95) portion of the project has state and federal funding. The UPC 105463 (roadway improvements to Route 606) portion of the project has local and revenue sharing funds in addition to state and federal funding.

2.1 PURPOSE

The purpose of the proposed interchange improvement is to replace the existing bridge carrying Route 606 over I-95, increase capacity to address current and projected traffic volumes, and enhance safety. Analyses performed as part of this IMR support the following needs:

- The existing bridge carrying Route 606 over I-95 is structurally deficient and functionally obsolete. Replacement of the existing bridge is warranted;
- Under existing 2015, 2018 No-Build and 2038 No-Build Conditions, multiple individual movements at the ramp terminal intersections along Route 606 are projected to operate at LOS F and queue lengths are expected to exceed available storage;
- Recently constructed land development projects generate several hundred vehicle trips during the weekday peak hour periods and several thousand trips per day. This development, along with the interchange improvements themselves, will drive secondary development of currently vacant land within or near the study area;
- Under Existing Conditions, Route 606 provides no accommodations for pedestrian or bicycle traffic although such accommodations are identified in the Spotsylvania County Trailways Master Plan;
- Under Existing Conditions, intersection sight lines along Route 606 emanating from the I-95 exit ramp terminals do not satisfy current AASHTO standards.

This IMR presents the analysis of the Final Build Alternative (previously completed by VDOT) as well as the Modified Final Build Alternative and compares them to the No-Build Alternative. This document justifies the proposed improvements through analysis of Existing Conditions, Future No-Build Conditions and Future Build Conditions. Refinement of the Final Build Alternative was based on public input, construction cost, crash reduction potential, traffic operations, impacts to right-of-way, and environmental resources and utilities. The Modified Final Build Alternative improved upon the Final Build Alternative by reducing project impacts while improving traffic operations and lowering the overall cost of the improvements.

2.2 Related Highway/Land Development Projects

This IMR reflects consideration of the following highway improvement and land development projects:

- A multiuse motorsport raceway project (Dominion Raceway Development) was approved by Spotsylvania County and VDOT. The raceway is situated in the northeast quadrant of the interchange and opened in the spring of 2016. The site's raceway and commercial elements generate approximately 1,050 vehicle trips (to/from) on the highest weekday peak hour (Weekday AM);
- Secondary land development activity on currently vacant parcels located in the southeast quadrant of the interchange is anticipated, however, these properties have no approved development site plans. Based on experience elsewhere in Virginia, VDOT considers development of these properties likely following completion of interchange improvements. Land in the southeast quadrant of the interchange is designated for "C3 Highway District" commercial development pursuant to County zoning ordinances, which allows for a broad range of service-oriented businesses (retail, restaurant, hotel, auto service, banks, etc.) as well as offices and warehouses. For the purposes of this study, VDOT estimates that by 2038, parcels located along Mallard Road and Route 606 east of the interchange will be 90 and 50 percent developed, respectively. The current 2010 travel demand model developed and administered by the FAMPO and the Spotsylvania County subarea model do not reflect the approved Dominion Raceway Development, secondary land development, or the additional traffic generated by either. As such, this traffic was layered onto the volumes developed from the FAMPO model outputs; see Section 7 of this IMR for the volume development;
- FAMPO's 2040 Long Range Transportation Plan (LRTP) published in 2013 includes a project to relocate Route 606 and the interchange with I-95 north of its current location. However, VDOT has verified that these plans are being updated to reflect potential improvements to Route 606 within the existing Route 606 corridor. FAMPO plans to remove the Route 606 relocation project from their LRTP to be consistent with the action of the County removing it from their comprehensive plan. FAMPO's LRTP is currently being updated;
- The 2013 Spotsylvania County Comprehensive Plan, approved November 2013 (updated June 2016), includes the Route 606 over I-95 bridge replacement project, as well as the widening of Route 606 from US 1 to the east side of the I-95 interchange with a four-lane divided typical section;
- FAMPO's LRTP identifies widening I-95 from 6 to 8 lanes throughout Spotsylvania County. The project is currently unfunded and therefore is a component of the Highway Needs Plan, not the Financially Constrained Plan (CLRP). Based on direction provided by VDOT, improvements to the subject interchange are being advanced such that future widening of I-95 will provide one additional travel lane in each direction. Due to the limited width of the existing I-95 median near the interchange, future widening will be accomplished to the outside of I-95;

- VDOT and Spotsylvania County are committed to widen Route 606 west of the interchange by the Design Year (2038). Therefore, this IMR assumes that Route 606 west of the interchange will remain a two-lane undivided roadway in the opening year (2018) and that Route 606 will be widened to a four-lane roadway by the 2038 Design Year. Per VDOT, Route 606 re-construction west or I-95 is fully funded and is estimated to be advertised to bidders for construction in December of 2019;
- Re-construction of the Route 1/Route 606 intersection safety enhancements was completed in the summer of 2016;

2.3 Support and Commitment from Stakeholders

As a result of VDOT's coordination with local stakeholders, Spotsylvania County supports the interchange improvement project. The County recently updated its Comprehensive Plan to eliminate the earlier-identified project to relocate the subject interchange north of its current location, include the bridge replacement and interchange improvement project (the subject of this IMR), and include the project to widen Route 606 to four lanes between US Route 1 and the subject interchange.

3 Study Area

The existing traffic flow through the subject interchange suggests a commuting pattern where the majority of traffic from Route 606 enters the I-95 mainline to travel northbound towards Washington, DC and Fredericksburg during the AM peak period and in the reverse direction during the PM peak period. Another pattern observed in this area is higher through traffic volumes in both directions on I-95 during Friday evenings than during other weekday PM peak periods. Increased interstate travel along the east coast of the United States corresponding to weekend travel most likely accounts for elevated Friday traffic volumes on I-95. Directional commuter travel patterns were observed on Route 606 and are expected to increase in the future due to recent and future development.

FHWA and VDOT guidelines for developing Interchange Modification Reports typically involve analysis of traffic operations at the study interchange as well as at adjacent interchanges. Because the adjacent interchanges along I-95 to the north and the south are located approximately 8 miles away and because analysis of merge/diverge conditions at the Route 606 ramp terminals with I-95 point toward comparable levels of service under 2038 No-Build and 2038 Build Conditions, FHWA and VDOT previously determined that the adjacent interchanges along I-95 are beyond the operational area of influence of the study interchange and are therefore not included as part of this IMR. The Framework Document prepared for the initial IMR was approved by FHWA and VDOT with the stipulation that the IMR demonstrate comparable merge/weave operations under No-Build and Build Conditions.

The IMR study area shown in Figure 3-1 below was previously determined and includes the following roadways and intersections:

- Route 606 from and including the US Route 1 intersection to a point one half mile east of the I-95 northbound ramp terminal intersection including the Mallard Road/Dominion Raceway Avenue intersection as well as the Thornburg Shell Station intersection;
- All ramps serving the existing subject interchange;
- I-95 mainline, from one half mile north to one half mile south of the Route 606 interchange;
- The intersection of Route 606 and Dan Bell Lane.

Figure 3-1: IMR Study Area

4 EXISTING CONDITIONS

4.1 DEMOGRAPHICS

Based on Spotsylvania County's Comprehensive Plan, the County population has increased from 90,395 in 2000 to 122,397 in 2010. The FAMPO LRTP population projections suggest that the County's population in 2040 will reach nearly 240,600, an increase of approximately 118,200 residents, or an average annual increase of just over 3 percent per year.

4.2 LAND USE

The subject interchange is located within a Primary Development Boundary and is surrounded by commercial land use consistent with the County's C-3 Highway District Zoning. West of the interchange, there are existing large tracts of undeveloped land north and south of Route 606 which are also zoned for commercial uses. Dan Bell Lane intersects Route 606 and provides access to hotels, gas stations and fast food restaurants. Approaching US Route 1, developed properties support small-scale commercial businesses such as mini-warehouse storage, a post office and a strip retail center, contributing to an urban-like environment.

East of the interchange, Mallard Road provides access to a recreational vehicle dealership, a truck repair facility and several undeveloped parcels. Mallard Road also provides access to a multi-business gas station which relies on the current ingress/egress locations for proper site circulation. The entrance to the Dominion Raceway Development is located just to the east of Mallard Road's existing intersection with Route 606, which provides the sole access to the multiuse land development project. A VDOT facility containing a District Learning Center, a Maintenance Training Academy and the District Smart Traffic Center is located further to the east along Route 606. Other properties east of the interchange within the study limits are currently undeveloped, contributing to an overall rural environment.

4.3 ROADWAY GEOMETRY

Nationally, I-95 runs 1,907 miles from Miami, Florida to the Canadian border at Houlton, Maine. Within Virginia, I-95 covers a total distance of 179 miles between North Carolina and the District of Columbia. Interstate 95 currently provides three travel lanes in each direction and has a posted speed limit of 70 mph within the study area. Travel lanes measure 12 feet wide while left and right shoulders for the northbound and southbound lanes measure approximately 10 feet wide. The median separating the northbound and southbound travel lanes measures 40 feet (edge of travel lane to edge of travel lane) within the study area.

Based on archival information available from online sources, construction on I-95 in Virginia started in 1958. Interstate 95 through Spotsylvania County, including the Route 606 interchange, was opened to traffic in 1964. The interchange has a traditional diamond configuration, with diagonal ramps serving both northbound and southbound directions. Ramp grades are within the 2-4 percent range. Ramp terminal intersections along Route 606 are stopped controlled and separated by a distance of approximately 600 feet. Route 606 overpasses I-95 with a minimum vertical clearance of nearly 16 feet, nine inches over the southbound lanes and 16 feet, 12 inches over the northbound lanes.

Existing Route 606 is a two-lane undivided roadway providing direct access to the community of Thornburg. It provides east-west travel through Spotsylvania County, and extends into neighboring Caroline and Orange Counties. Within the study area, Route 606 operates with a posted speed limit of 35 mph. Pavement width varies considerably within the study area limits, measuring 40 feet wide where paved shoulders are provided, or 24 feet where unpaved shoulders are present.

Several existing intersections are present along Route 606 within the study area. These intersections include Dan Bell Lane (stop-control on the minor approach), the I-95 southbound ramp terminals (stop-control on the minor approach), the I-95 northbound ramps (stop-control on the minor approach), Mallard Road (stop-control on minor approach) and Dominion Raceway Avenue (stop-control on the minor approach).

Dan Bell Lane is a two-lane undivided private roadway that provides access to commercial properties situated north of Route 606 and west of I-95. Dan Bell Lane provides a pavement width of approximately 28 feet and does not provide a posted speed limit.

Existing Mallard Road is a two-lane undivided roadway that functions as a frontage road along the east side of I-95 between Route 606 and the south branch of the Mattaponi River. Mallard Road provides direct access to a recreational vehicle dealership, a truck repair facility and several undeveloped parcels. As a result, truck traffic on Mallard Road, as a component of overall traffic volumes, is high. Mallard Road provides a pavement width of approximately 22 feet and operates with a posted speed limit of 40 mph.

The intersection of Route 606 and the driveway serving the Thornburg Shell Station is located approximately 150 feet east of Mallard Road. The access for the Dominion Raceway Development is located opposite the Thornburg Shell Station driveway on Route 606 and is approximately 350 feet east of the existing I-95 northbound ramp terminal.

US Route 1 is a four-lane undivided roadway that is generally parallel to I-95 between Washington DC and Richmond. Pavement width measures approximately 50 feet, with wider pavement provided at locations with turn lanes or pavement tapers. US Route 1 accommodates local and regional north-south travel and provides direct access to a broad range of commercial, residential, and other land uses. The intersection of US Route 1 and Route 606 operates under traffic signal control. Near this intersection, US Route 1 operates with a posted speed limit of 45 mph.

Table 4-1 summarizes the existing roadway information within the study area to include functional classifications, VDOT geometric standards and posted speed limits.

Table 4-1: Existing Roadway Information

Roadway	**Functional Classification (VDOT Geometric Standard**	**Posted Speed Limit (mph)**	**Notes**
I-95	Rural Principle Arterial – Freeway (GS-1)	70	
Mudd Tavern Road (Route 606)	Rural Minor Arterial System (GS-2)	35	West of the I-95 Northbound Ramp Terminal Intersection
Mudd Tavern Road (Route 606)	Rural Collector Road System (GS-3)	35	East of the I-95 Northbound Ramp Terminal Intersection
Dan Bell Lane	N/A	N/A	Private Roadway
I-95 Southbound Ramps	Interchange Ramp (GS-R)	35	Posted Advisory Speed
I-95 Northbound Ramps	Interchange Ramp (GS-R)	35	Posted Advisory Speed
Mallard Road (F163)	Urban Local Street System (GS-8)	40	
Dominion Raceway Avenue	Urban Local Street System (GS-8)	25	South of first entrance on Dominion Raceway Avenue

Current and anticipated land development activity will have an urbanizing effect on the project setting. Considering these changes in land use and character of the area, VDOT has elected to apply urban design standards to the design of Route 606. The use of urban standards allows for more positive access control with the use of curb and gutter and raised medians, facilitates a smaller footprint of disturbance, and results in fewer right-of-way impacts.

4.4 Multimodal Accommodations

The study area is not currently served by any form of mass transit and park-and-ride facilities are not present. None of the existing roadways within the study area provide any dedicated pedestrian or bicycle facilities.

4.5 Access Management

Along both the east and west sides of I-95, the existing Limited Access (L/A) ends where interstate right-of-way meets Route 606 right-of-way just outside the I-95 ramp terminals. The existing L/A does not extend along the Route 606 right-of-way and therefore does not prevent access to Dan Bell Lane, Mallard Road, Dominion Raceway Avenue or the Thornburg Shell Station outside of the interchange ramps.

Since 1964 (when the I-95/Route 606 interchange was opened to traffic), adjacent land development created several roadway and entrance connections in close proximity to the L/A as presented in Table 4-2.

Table 4-2: Existing Access Locations

Access Type	**Properties Served**	**Distance to Existing Ramp Terminal (ft.)/Side**
Route 606, West of I-95 Southbound Ramp Terminal Intersection		
Commercial Entrance	Valero Gas Station	180/South
Private Roadway (Dan Bell Lane)	Commercial Businesses	220/North
Commercial Entrance	Valero Gas Station	260/South
Commercial Entrance	Exxon Gas Station	280/North
Entrance	Water Tower/Citgo Gas Station	310/South
Commercial Entrance	Exxon Gas Station	370/North
Commercial Entrance	Citgo Gas Station	380/South
Commercial Entrance	McDonald's	460/North
Commercial Entrance	Citgo Gas Station	505/South
Commercial Entrance	McDonald's	605/North
Commercial Entrance	Taco Bell/Hotel	850/North
Entrance	Treatment Facility	1300/North
Route 606, East of I-95 Northbound Ramp Terminal		
Public Roadway (Mallard Road)	Commercial Businesses and Vacant Land	190/South
Commercial Entrance	Thornburg Shell Gas Station	360/South
Private Roadway (Dominion Raceway Avenue)	Dominion Raceway Development	410/North
Entrance	VDOT Facility	1080/South
Entrance	VDOT Facility	1300/South
Mallard Road, South of Route 606		
Commercial Entrance	Thornburg Shell Gas Station	140/East
Commercial Entrance	Thornburg Shell Gas Station	310/East
Commercial Entrance	Recreational Vehicle Dealership	1550/East

4.6 Environmental Conditions and Constraints

According to the Environmental Re-Evaluation as well as the Categorical Exclusion and Programmatic Categorical Exclusion, provide as Appendices C and D with this IMR, there are no known sensitive environmental resources within the study area. A Virginia Outdoors Foundation (VOF) Permanent Conservation Easement has been recorded on the property owned by Gerald and Juanita Sklar, located north of Route 606 and east of Dominion Raceway Avenue, however the proposed project will avoid impacts to this easement.

4.7 Existing Operations Conditions and Crash History

Development of existing traffic volumes, operational analyses and crash analysis are addressed in Sections 7, 8, and 9 of this IMR.

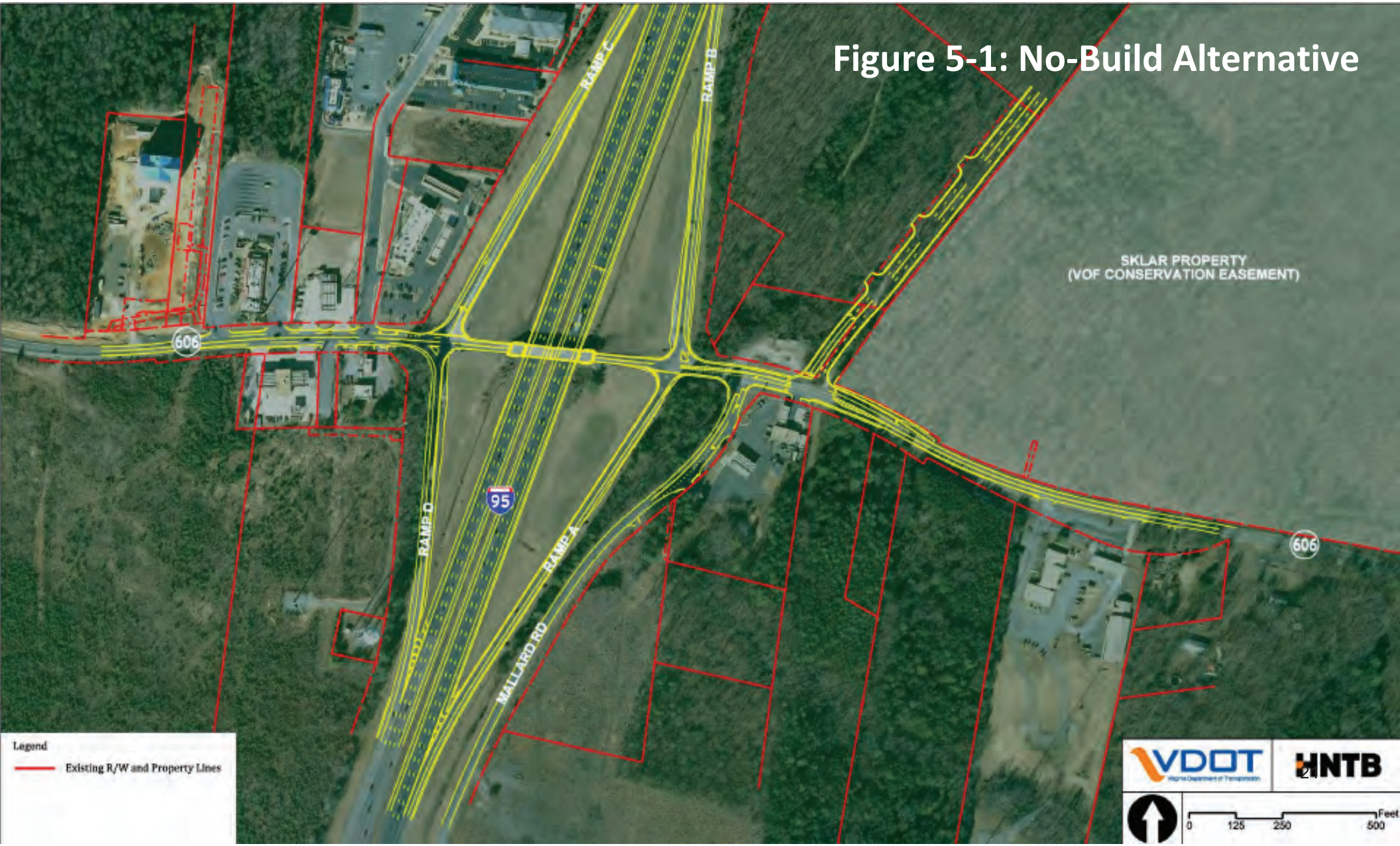
5 ALTERNATIVES CONSIDERED

5.1 NO-BUILD ALTERNATIVE

The No-Build Alternative provides no improvements to the study area roadways other than those projects that are already underway, approved or programmed to be completed by the opening year for this project (2018). The No-Build Alternative is shown in Figure 5-1 and reflects completion of the following projects:

- Improvements to the US Route 1/Route 606 intersection;
- The Dominion Raceway Development located in the northeast quadrant of the interchange (Dominion Raceway Avenue);
- VDOT and Spotsylvania County are committed to widening Route 606 west of the interchange by the Design Year (2038). Therefore, this IMR assumes that Route 606 west of the interchange will remain a two-lane undivided roadway in the opening year (2018) but that Route 606 will be widened to a four-lane roadway by the Design Year.

Figure 5-1: No-Build Alternative



5.2 Final Build Alternative

The Final Build Alternative retains the existing diamond configuration of the interchange, but signalizes both I-95 ramp terminal intersections at Route 606. A wider bridge replaces the existing overpass of I-95 and accommodates a four-lane, urban divided roadway (Route 606) with left turn lanes for eastbound and westbound Route 606 onto northbound and southbound I-95. The reconstructed bridge is compatible with programmed improvements to Route 606 west of the interchange, which will extend the four-lane, urban divided roadway section in the future.

The Final Build Alternative also extends the four-lane, urban divided Route 606 section east of I-95 to form a roundabout with relocated Mallard Road near the eastern terminus, providing a right in right out intersection at the current connection of Mallard Road with Route 606 and a partial egress, directional median with Dominion Raceway Avenue. Motorists seeking to enter the Dominion Raceway Development from I-95 or from Route 606 west of the I-95 interchange conduct a U-turn movement through the roundabout. Vehicles seeking existing Mallard Road from Route 606 east of the I-95 interchange utilize relocated Mallard Road. Traffic access to the Thornburg Shell Station is effectively reduced to those vehicles traveling east on Route 606. The Final Build Alternative is shown in Figure 5-2.

Figure 5-2: Final Build Alternative

5.3 MODIFIED FINAL BUILD ALTERNATIVE

The Modified Final Build Alternative (devised during the RFP associated with the design and construction of the subject interchange improvement) significantly changes the Final Build Alternative by placing the northbound I-95 ramps within the southeast quadrant of the interchange. The northbound ramps connect with Mallard Road (improved to a divided roadway north of the ramp terminals) at a signalized intersection. The northbound I-95 off-ramp continues to utilize the existing deceleration lane and diverge gore, but is diverted to connect with improved Mallard Road.

After leaving the Mallard Road intersection, the northbound I-95 on-ramp turns north and runs beneath the Route 606 overpass adjacent to northbound I-95 (accounting for the ultimate I-95 eight-lane section) and connects with the existing northbound ramp prior to its connection with northbound I-95. The southbound I-95 ramps continue to be configured as traditional tight diamond ramps with signalized control.

Route 606 shifts to the north (completely off of the existing I-95 overpass) and provides a four-lane, urban divided roadway with left turn lanes for westbound Route 606 onto southbound I-95 and eastbound Route 606 onto Dominion Raceway Avenue. Route 606, including the reconstructed bridge, is compatible with future planned improvements to Route 606 west of the interchange, which will eventually extend the four-lane, urban divided roadway section.

The Modified Final Build Alternative provides a four-lane, urban divided Route 606 section east of I-95 up to the intersection with Mallard Road and Dominion Raceway Avenue, which are aligned, forming a four-way signalized intersection with Route 606. East of this intersection Route 606 transitions to a two-lane divided roadway and eventually into a two-lane undivided roadway, connecting with existing Route 606. The roundabout associated with the Final Build Alterative as well as relocated Mallard Road are eliminated, reducing the overall impacts of the interchange improvements. The Modified Final Build Alternative is shown in Figure 5-3.

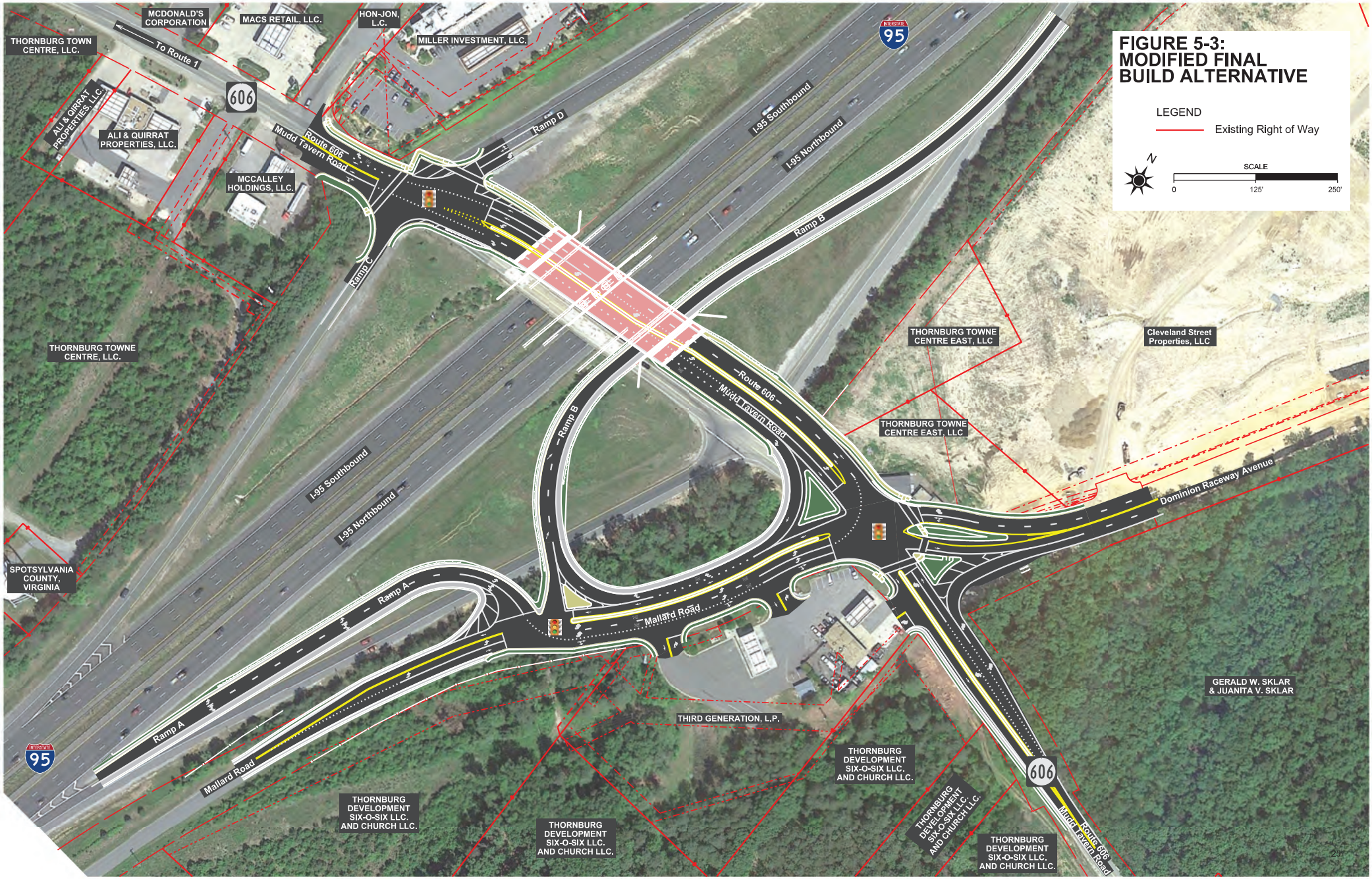


FIGURE 5-3:
MODIFIED FINAL
BUILD ALTERNATIVE
LEGEND
Existing Right of Way
SCALE
0
125'
250'
MCDONALD'S CORPORATION
MACS RETAIL, LLC.
HON-JON, L.C.
MILLER INVESTMENT, LLC.
THORNBURG TOWN CENTRE, LLC.
To Route 1
606
ALI & QIRRAT PROPERTIES, LLC.
ALI & QIRRAT PROPERTIES, LLC.
MCCALLEY HOLDINGS, LLC.
Mudd Tavern Road
Route 606
Ramp D
Ramp C
Ramp B
I-95 Southbound
I-95 Northbound
95
THORNBURG TOWNE CENTRE, LLC.
THORNBURG TOWNE CENTRE EAST, LLC
Cleveland Street Properties, LLC
THORNBURG TOWNE CENTRE EAST, LLC
Dominion Raceway Avenue
SPOTSYLVANIA COUNTY, VIRGINIA
Ramp A
Mallard Road
THIRD GENERATION, L.P.
GERALD W. SKLAR & JUANITA V. SKLAR
THORNBURG DEVELOPMENT SIX-O-SIX LLC. AND CHURCH LLC.

6 ROADWAY GEOMETRY

Information on existing interchange geometry was previously obtained from the original 1956 record design drawings provided by VDOT and topographic survey information collected by VDOT for the interchange improvement project. Design guidelines set forth in A Policy on Geometric Design of Highways and Streets, AASHTO 2011 (Green Book), VDOT's 2016 Road and Bridge Standards and VDOT's Road Design Manual (RDM), Revised January 2017 were used in the evaluation of existing interchange geometry.

The Modified Final Build Alternative provides additional through lanes and turn lanes where needed to facilitate acceptable Level-of-Service based on detailed operational analyses presented later in this IMR. However, no physical improvements to I-95 or to any of the entrance/exit acceleration/deceleration and/or ramp gore areas are proposed, nor are they warranted. As such, the following geometric analysis is limited to interchange areas affected by the proposed improvements associated with the Modified Final Build Alternative.

6.1 GEOMETRIC ANALYSIS

Table 6-1 summarizes the existing horizontal curve data for each of the four ramps associated with the subject interchange.

Table 6-1: Existing Interchange Horizontal Curve Data

Ramp	Controlling Curve Radius (ft.)	Controlling Superelevation (ft./ft.)	Controlling Curve Design Speed (mph)	Ramp Posted Advisory Speed (mph)
Northbound I-95 Off-Ramp (Ramp A)	1847	0.032	35	35
Northbound I-95 On-Ramp (Ramp B)	2150	0.028	35	Not Posted
Southbound I-95 Off-Ramp (Ramp C)	2189	0.028	35	35
Southbound I-95 On-Ramp (Ramp D)	1896	0.040	40	Not Posted

DESIGN SPEED BASED ON VDOT STANDARD TC-5.11, E = 8% MAXIMUM

Table 6-2 summarizes AAHSTO guidance related to design speeds for each of the four ramps associated with the subject interchange. Per the Green Book, ramp design speeds should approximate the low-volume running speed on the intersecting highways. For diagonal ramps of a diamond interchange, a value in the middle range is usually attainable. However, this design speed is not always practical, and lower design speeds may be selected, but should not be less than the lower range of ramp design speeds provided in Table 10-1 of the Green Book.

Where a ramp joins a crossroad or street, forming an at-grade intersection, Table 10-1 of the Green Book is not applicable to that portion of the ramp near the intersection because a stop sign or signal control is normally employed. This terminal design should be predicated on near-minimum turning conditions.

Table 6-2: AASHTO Guidance for Ramp Design Speed

Ramp	I-95 Design Speed (mph)	Ramp Design Speed (mph)			Design Speed Guidance (mph)	Controlling Curve Speed (mph)
		Lower (50%)	Middle (70%)	Upper (85%)		
Northbound I-95 Off-Ramp (Ramp A)	75	40	55	65	40	35
Northbound I-95 On-Ramp (Ramp B)	75	40	55	65	40	35
Southbound I-95 Off-Ramp (Ramp C)	75	40	55	65	40	35
Southbound I-95 On-Ramp (Ramp D)	75	40	55	65	40	40

The horizontal curve on the southbound I-95 on-ramp satisfies the recommended lower range value of 40 mph while the horizontal curves on the remaining ramps fall just below the recommended lower range value of 40 mph. The northbound and southbound I-95 off-ramps do, however, provide a posted advisory speed limit of 35 mph and acceleration and deceleration lengths adjacent to I-95 for all ramps exceed the minimum lengths prescribed in Table 10-3 and 10-5 of the Green Book.

As provided within the Section 9 of this IMR, no crashes have been recorded on the northbound off-ramp, the northbound on-ramp or the southbound off-ramp during the 2011-2013 period. The absence of crashes on these ramps suggests that the curve geometry does not have a material effect on operational safety and has not/does not increase crash potential at these locations.

6.2 Controlling Horizontal Alignment, Curvature, and Superelevation

Table 6-3 summarizes the proposed controlling horizontal alignment, curvature and superelevation data for each of the four ramps associated with the subject interchange (Modified Final Build Alternative) as well as for Mallard Road north of the northbound I-95 ramp terminal.

Table 6-3: Proposed Controlling Horizontal Alignment, Curvature, and Superelevation Data

Roadway	Location	Curve Radius (ft.)	Curve Superelevation (ft./ft.)	Curve Design Speed (mph)	Ramp Posted Advisory Speed
Northbound I-95 Off-Ramp (Ramp A)	I-95 Gore	1847	0.032	35	35
Northbound I-95 On-Ramp (Ramp A)	Mallard Road Terminal	130	0.072	20	N/A
Northbound I-95 On-Ramp (Ramp B)	Mallard Road Terminal	255	0.069	25	N/A
Northbound I-95 On-Ramp (Ramp B)	I-95 Gore	2150	0.028	35	N/A
Southbound I-95 Off-Ramp (Ramp D)	I-95 Gore	2189	0.028	35	35
Southbound I-95 On-Ramp (Ramp C)	I-95 Gore	1896	0.040	40	N/A
Mallard Road	North of Ramp A/B Terminal	359	Normal (ULS)	30	N/A

RAMP C AND RAMP D NOMENCLATURE CHANGED WITH MODIFIED FINAL BUILD ALTERNATIVE

6.3 GEOMETRIC CONFIGURATION

6.3.1 Ramp Geometry

Similar to the Final Build Alternative, the Modified Final Build Alternative will not adjust the existing ramp tapers nor the ramp acceleration/deceleration lengths adjacent to I-95 (including the gore areas). However, the Modified Final Build Alternative places the northbound I-95 ramps within the southeast quadrant of the interchange ("Offset Diamond") and connects them to an improved Mallard Road at a signalized intersection.

The northbound I-95 off-ramp continues to utilize the existing deceleration lane and diverge gore, but is diverted to connect with improved Mallard Road. The northbound I-95 on-ramp departs the Mallard Road intersection, turns north, and is placed beneath the Route 606 overpass adjacent to northbound I-95 (accounting for the ultimate I-95 eight-lane section) connecting with the existing northbound ramp prior to northbound I-95. Both northbound I-95 ramps provide two-lanes where needed to accommodate operations at the Mallard Road signal.

The southbound I-95 ramps continue to be configured as traditional tight diamond ramps with signalized control. The terminal areas of the southbound ramps are adjusted to accommodate the Route 606 improvements.

6.3.2 Mallard Road

The Modified Build Alternative eliminates the relocation of Mallard Road as well as the roundabout at the intersection of Route 606 and relocated Mallard Road proposed as part of the Final Build Alternative. Instead, Mallard Road is improved (in-place) to an urban divided roadway between its intersection with the northbound I-95 ramps and Route 606. One lane in each direction along Mallard Road is provided and an auxiliary lane adjacent to southbound Mallard Road facilitates a free-flow movement from eastbound Route 606 to northbound I-95 which eliminates a relatively high left turning volume on Route 606. In addition, dual left turn lanes are provided for the movement between northbound Mallard Road and westbound Route 606.

Dominion Raceway Avenue is aligned with improved Mallard Road forming a four-approach, traffic signal controlled intersection with Route 606 providing fully directional ingress/egress to the Dominion Raceway Development. Traffic access to the Thornburg Shell Station is provided to vehicles traveling east on Route 606 as well as vehicles traveling north on Mallard Road.

6.3.3 Intersection Sight Lines

Under Existing Conditions, intersection sight lines extending from the I-95 exit ramp terminals at Route 606 are constrained by bridge parapets and the vertical curvature of Route 606 over I-95. The design of the Modified Final Build Alternative provides sight lines that comply with current AASHTO design guidelines.

6.4 Multimodal Accommodations

VDOT anticipates that the full build-out of the Dominion Raceway Development and other future land development activity local to the interchange will generate pedestrian activity. Accordingly, the Modified Final Build Alternative includes sidewalk adjacent to westbound Route 606 within the limits of the improvement. Pedestrian crossings of Route 606 are provided at signalized intersections and refuge islands are provided at the Route 606/Mallard Road/Dominion Raceway Avenue intersection.

Route 606 is identified in the Spotsylvania County Trailways Master Plan (adopted February 22, 2011) as a part of the County's planned bike mobility network. The Bike/Pedestrian Roadway Improvement Plan component of the overall Master Plan calls for "shoulder improvements" along Route 606. Accordingly, the design of the Modified Final Build Alternative includes widened outside curb lanes to accommodate shared use by motorists and bicyclists. The proposed improvements include 14-foot wide outer travel lanes, based on the following considerations:

- Average operating speeds on Route 606 within the limits of the proposed improvements are expected to be 30 mph or less based on the presence of two traffic signals and general urbanized setting;
- Per the AASHTO Guide for the Development of Bicycle Lanes, travel lanes measuring 14 feet wide or greater allow motorists to pass bicyclists without encroaching into the adjacent lane;
- Per the VDOT Road Design Manual, the use of a wide outside lane (14 feet) is acceptable in an urban setting with an ADT over 10,000 vpd, adequate sight distance, and travel speeds that are 30 mph or less.

Based on the current land use zoning and the absence of residential land uses in the immediate vicinity of the interchange, it is anticipated that pedestrian activity will be greater than bicycle activity. The proposed accommodations for bicyclists reflect VDOT's position that for the anticipated modal activity along Route 606 near the interchange, it is preferable to provide on-roadway bicycle accommodations rather than mix pedestrian and bicycle traffic on a shared facility.

6.5 Design Exceptions

There are no anticipated Design Exceptions associated with the Modified Final Build Alternative.

6.6 Design Waivers

There are no anticipated Design Waivers associated with the Modified Final Build Alternative.

6.7 Access Management Criteria and Waivers

As provided within Table 4-2 of this IMR, east of the interchange, five access points exist along Route 606 within 1,320 feet of the I-95 northbound ramp terminal intersection while 12 access points exist along Route 606, west of the interchange, within 1,320 feet of the I-95 southbound ramp terminal. Along Mallard Road, south of Route 606, three access points exist within 1,550 feet. Thus, Route 606 just east of the interchange has an existing Access Point Density (access point per mile) of 20.3 ap/mi, while Route 606 just west of the interchange has an existing Access Point Density of 48.7 ap/mi. Mallard Road has an existing Access Point Density of 10.2 ap/mi.

The Modified Final Build Alternative eliminates the I-95 northbound ramp terminal intersection with Route 606, moving it to Mallard Road south of Route 606, while improving Mallard Road north of the ramp terminal and aligning Dominion Raceway Avenue. This produces four access points along Mallard Road within 1,550 feet south of Route 606, or a proposed Access Point Density of 13.6 ap/mi. However, a raised median is provided along Mallard Road restricting two of the access points (Thornburg Shell Gas Station) to right-in-right-out only (each considered to be one-half of a full access point). This effectively reduces the proposed Access Point Density along Mallard Road to 10.2 ap/mi (no change from Existing Condition).

The Modified Final Build Alternative eliminates the I-95 northbound ramp intersection with Route 606 as well as the roundabout near the eastern terminus with relocated Mallard Road, replacing it with a four-approach intersection along Route 606 (Mallard Road and realigned Dominion Raceway Avenue). This eliminates two intersections along Route 606 east of I-95 (when compared to the Final Build Alternative) providing an Access Point Density of 12.2 ap/mi and reduces the overall footprint of the project. The Modified Final Build Alternative does not affect the existing access points west of the interchange.

Similar to the Final Build Alternative, the Modified Final Build Alternative intentionally focuses on improvements along Route 606 at and between the interchange ramp terminal intersections. As a result, proposed improvements along Route 606 west of the interchange will be addressed in detail as part of a separate project that has been programmed by VDOT to study and consider widening Route 606 from the I-95 interchange to US Route 1.

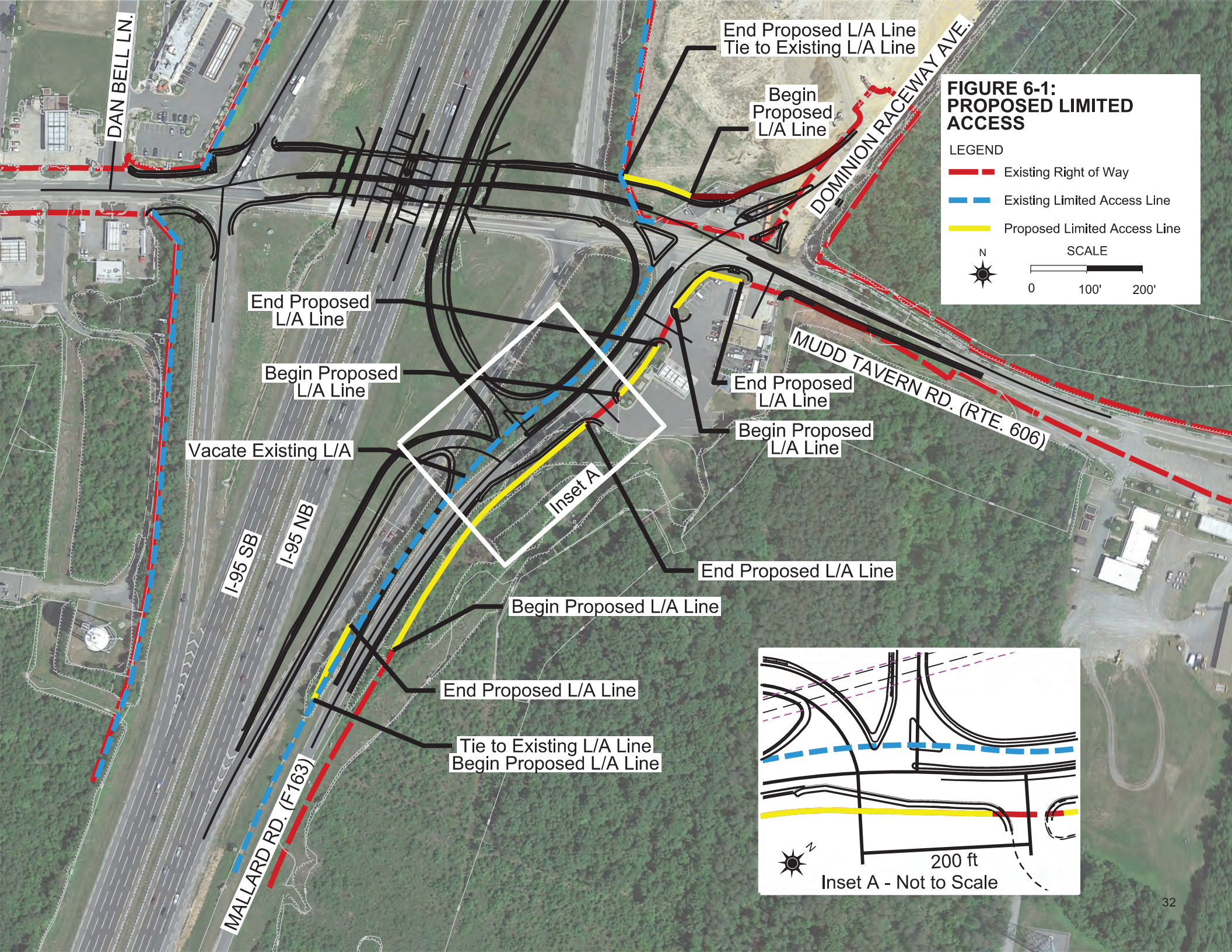
VDOT's Road Design Manual provides a systematic approach to balancing the access and mobility needs of roadways and establishes criteria for the minimum spacing of intersection and entrances near interchange areas. Access Management Waivers, provided as Appendix B with this IMR, are being pursued for locations where the Modified Final Build Alternative does not meet VDOT criteria for minimum access point spacing which include:

- The spacing between the proposed signalized terminal of the I-95 northbound interchange ramp and signalized intersection of Route 606 (first adjacent signalized intersection);
- The spacing between the proposed signalized terminal of the I-95 northbound interchange ramp and the Thornburg Shell Gas Station entrances along Mallard Road.

Refer to Section 6.8 of this document for additional discussion on the proposed extents of Limited Access along Route 606, and the anticipated benefits derived from the proposed improvements. Please also refer to Section 9 for a detailed discussion regarding safety of the Modified Final Build Alternative.

6.8 Proposed Limited Access Line

The project expands Limited Access (L/A) throughout the interchange area as coordinated with VDOT and is shown in Figure 6-1.The L/A west of I-95 remains in its existing condition but will most likely be revised by VDOT as part of a separate Route 606 improvement project. The L/A east of I-95 is adjusted to account for the improvement of Mallard Road, including the connection of the I-95 northbound ramps and the reconfiguration of the Route 606/Mallard Road/Dominion Raceway Avenue intersection. The locations of the L/A lines terminate more than the AASHTO prescribed minimum of 100 feet beyond the ramp terminals.


DAN BELL LN.
End Proposed L/A Line
Tie to Existing L/A Line
Begin
Proposed
L/A Line
DOMINION RACEWAY AVE.
FIGURE 6-1:
PROPOSED LIMITED
ACCESS
LEGEND
Existing Right of Way
Existing Limited Access Line
Proposed Limited Access Line
N
SCALE
0
100'
200'
End Proposed
L/A Line
Begin Proposed
L/A Line
MUDD TAVERN RD. (RTE. 606)
End Proposed
L/A Line
Begin Proposed
L/A Line
Vacate Existing L/A
Inset A
I-95 SB
I-95 NB
End Proposed L/A Line
Begin Proposed L/A Line
End Proposed L/A Line
Tie to Existing L/A Line
Begin Proposed L/A Line
MALLARD RD. (F163)
N
200 ft
Inset A - Not to Scale

6.9 MULTILANE TURN MOVEMENTS

The Modified Final Build Alternative incorporates multilane turning movements at the following locations:

- The I-95 northbound off-ramp terminal with Mallard - Road utilizes a left, shared left/right configuration for traffic exiting I-95 northbound onto Mallard Road;
- The Mallard Road left turn movement onto Route 606 westbound - utilizes a dual left turn configuration for traffic seeking westbound Route 606 from Mallard Road.

Proposed intersection geometry for vehicle turn movements has been verified and provides appropriate lateral offsets and separations.

6.10 INTERCHANGE SIGNAGE AND PAVEMENT MARKINGS

Figure 6-2 illustrates the proposed interchange signing and pavement markings for the Modified Final Build Alternative which complies with current MUTCD and VDOT standards for interstates and other state highways. The layout highlights major guide signs needed for motorist orientation and directional aid, but does not identify regulatory, warning, or minor guide signs that will be needed (these will be included in final design). The signing and pavement marking layout reflects the following considerations:

- Proposed signing has been designed for Route 606 to provide directional guidance and lane use orientation to vehicles. Specifically, proposed signing provides route number, destination, and cardinal direction information in advance of decision points;
- Proposed pavement markings are coordinated with the layout and messages on the proposed signing. Together the proposed signing and pavement markings are designed to enhance opportunities for vehicles to orient themselves to the correct lane in advance of decision points, and minimize the potential for downstream weaving and last-minute lane changes;
- The ramp diverge and converge configurations along I-95 remain unchanged, therefore, existing signing on I-95 is proposed to remain in place;
- Additional lane use arrows are also proposed for the I-95 northbound ramp movements and for Mallard Road to enhance driver comprehension of lane assignments.

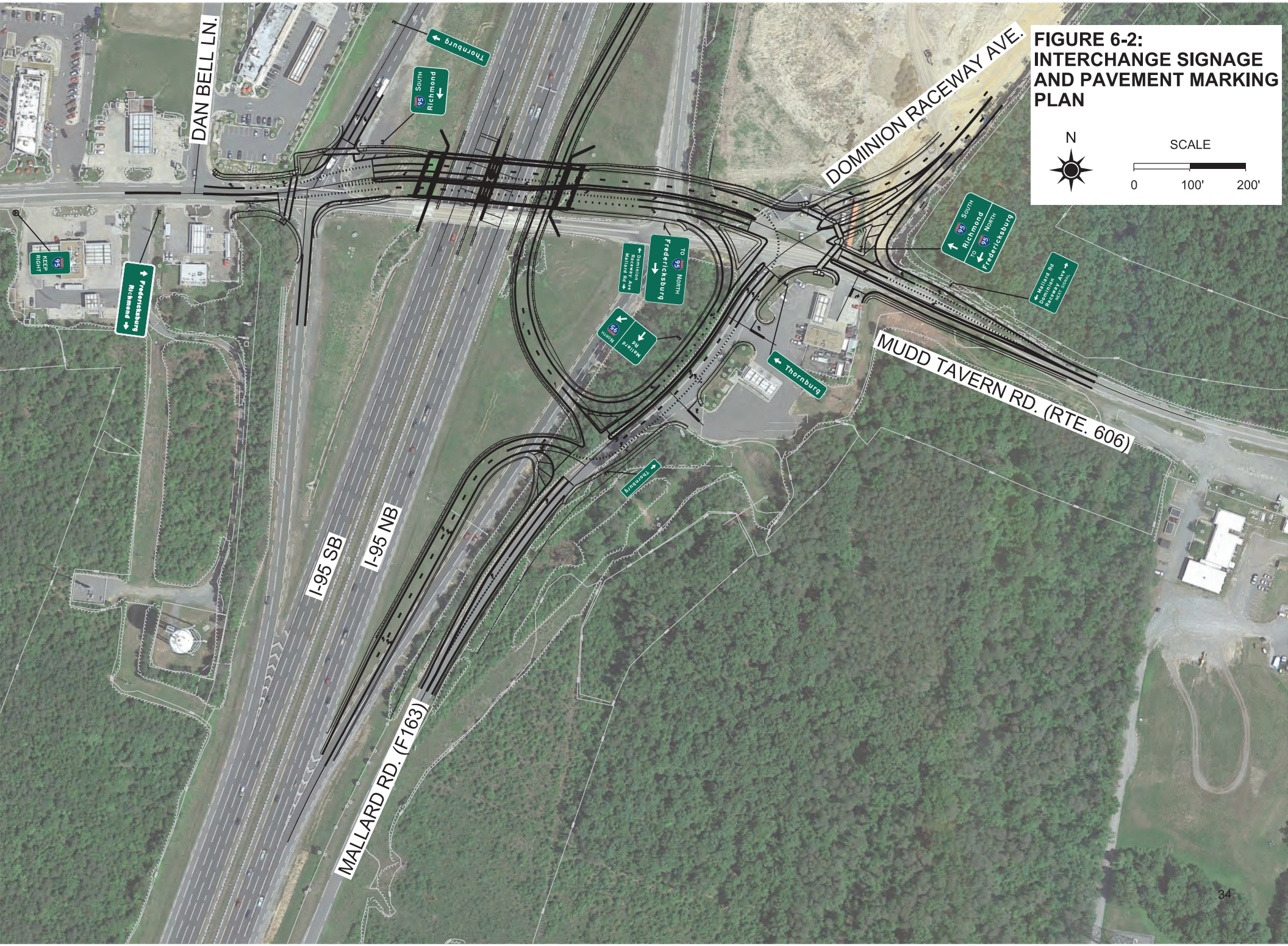


FIGURE 6-2: INTERCHANGE SIGNAGE AND PAVEMENT MARKING PLAN

N

SCALE

0 100' 200'

7 TRAFFIC VOLUME DEVELOPMENT

This Section provides an overview of the methodology used for forecasting traffic volumes from the existing volumes and the assumptions used in the process. For purposes of this IMR, AADT's reflect the Hybrid Methodology presented in Appendix F of this IMR. Content and methodologies consistent with the previously prepared I-95/Route 606 Interchange Improvements Build Alternative Analysis Report presented in Appendix A of this IMR are utilized in this Chapter where applicable.

7.1 TRAFFIC ANALYSIS YEARS

Traffic operational analyses were performed for the Existing Conditions 2015 and the Design Year (2038) assuming a twenty-year design life for the project. Traffic volumes were developed for the No-Build and Build scenarios for 2038. No-Build Conditions include the planned and programmed improvements in the region as included in FAMPO's CLRP and land use development changes estimated by FAMPO and VDOT. Per VDOT's input, FAMPO is currently updating the CLRP to include Route 606 widening west of the interchange. Build conditions are comprised of the two alternatives as described in Section 5 of this IMR.

In this study area, the peak hours identified on the freeway and arterial network were typical weekday (Tuesday-Thursday) AM and Friday PM. Existing traffic counts on the freeway and intersection turning movement counts show higher volumes on Friday evening when compared to a typical weekday PM peak hour at most of the locations. The future volume projections are even higher on a Friday evening due to the anticipated schedule of race events to be held at the Dominion Raceway Development. As a result, operational analyses were performed for weekday AM and Friday PM peak hour conditions.

7.2 2015 TRAFFIC VOLUMES

Traffic counts (from 2012) shown in the Dominion Raceway Traffic Impact Analysis (TIA) [1]were used as the base volumes for the arterial network at and east of the interchange including the ramps to and from I-95. For the Route 606/Dan Bell Lane intersection, traffic volume data collected by VDOT in February 2012 [2] was used because the Dominion Raceway TIA did not include analysis of any locations along Route 606 west of the southbound ramp terminal intersection. For the Route 606/ US Route 1 intersection, analyses used VDOT record data from March 2011. I-95 mainline data was generated from the 24-hr volume and vehicle classification data (dated October 2012) obtained from VDOT's permanent count stations located near the subject interchange[3]. These data represent the most recent data available.

[1] Figure 9 (based on data from Bridge Structure Replacement Scoping Document Route 606 over Interstate 95 by VDOT), Dominion Raceway TIA, dated January 2013.
[2] Attachment A1, Bridge Structure Replacement Scoping Document Route 606 over Interstate 95 by VDOT, dated July 2012.
[3] I-95 northbound – 1.1 miles north of the ramp from Route 606, I-95 southbound – 1.1 miles north of the ramp to Route 606.

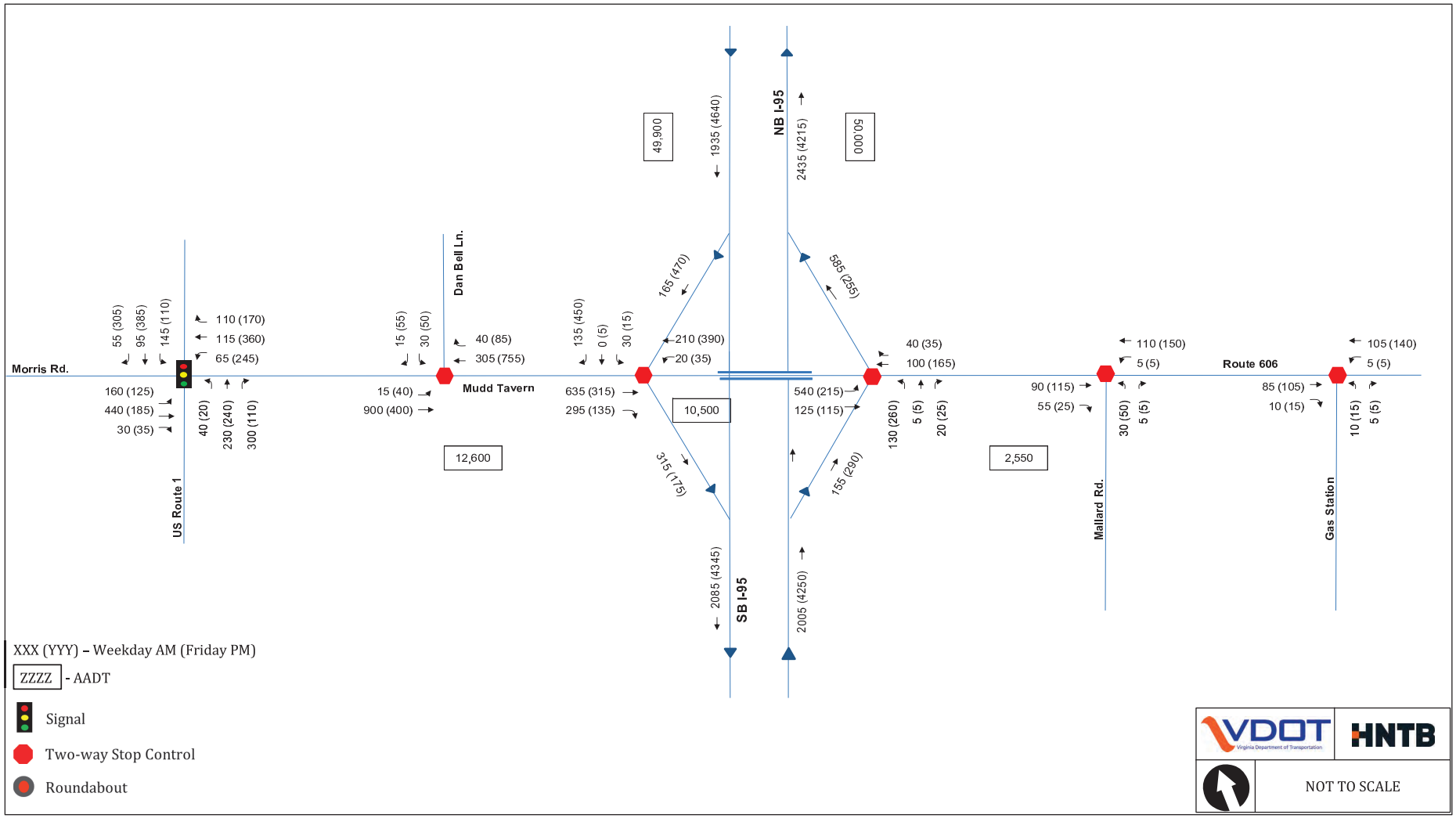
VDOT elected to grow 2012 volumes to 2015 conditions instead of performing new traffic counts as there were no land development or highway improvement projects near the study area between 2012 and 2015 that resulted in different volume trends and/or growths. To develop 2015 volumes, 2012 volumes were grown at an annual rate shown in Table 7-1. These peak hour volumes were then post-processed and balanced using the NCHRP 255 process throughout the study area. Figure 7-1 shows the peak hour traffic volumes and AADTs within the study area under existing 2015 conditions.

Table 7-1: Annual Growth Rate by Facility

Facility	**Dominion Raceway TIA**	**Bridge Scoping**	**IMR**
I-95	1.5%	1.75%	1.75%
US Route 1	3.0%	N/A	3.0%
Route 606	2.0%	3.0% west of I-95 1.25% east of I-95	3.0% west of I-95 2.0% east of I-95
Other Roadways	2.0%	0.5%	2.0%

Figure 7-1: Existing (2015) Volumes for Weekday AM and Friday PM Peak Hours

Figure 7-1: Existing (2015) Volumes for Weekday AM and Friday PM peak hours



Peak Hour Factors (PHFs) recorded in the field in 2012 were used for Existing Conditions. In the study area, PHF's ranged between 0.25 and 0.94 during the peak hours for the study area intersections. I-95 mainline PHF ranges between 0.93 and 0.99, depending on time period and direction. A PHF of 0.92 is used, consistent with VDOT guidance, at locations where data is not available. Table 7-2 shows the heavy vehicle percentages developed from the 2012 count data that were used in the operational analyses.

Table 7-2: Average Heavy Vehicle Percentages

Roadway	**Weekday AM**	**Friday PM**
I-95	16%	17%
US Route 1	16%	15%
Route 606	6%	6%
Other Roadways	8%	5%

To calibrate the microsimulation models, field observations were performed in September 2013 during the peak hours to record queues, traffic patterns, driver behavior, travel speeds and travel times in the study area. During these field visits, it was also noted that the peak traffic demand occurs during a small portion of the peak hour for a number of the movements, validating the calculated PHF from the data collection efforts of previous studies. These data needs are consistent with the calibration methodology outlined by FHWA [4]. When the Existing Conditions year shifted from 2013 to 2015, calibrated 2013 models were updated with newer volumes (from 2015).

7.3 Forecasting Methodology and Assumptions

7.3.1 Opening Year (2018) Traffic Volumes

Based on documented VDOT guidance[5], the higher of 0.92 or the PHF in the Existing Conditions is used in all future scenarios. The heavy vehicle percentage is kept similar to Existing Conditions. The methodology used to develop traffic volumes for the year 2018 is discussed below.

Step 1: For the arterial network, the 2017 background traffic from the TIA [6]was used as the basis for traffic volumes. Annual growth rates shown above in Table 7-1 were applied to each roadway to develop Opening Year volumes.

Step 2: For I-95, data from VDOT's permanent counts station was used. Similar to the arterial network, annual growth rates were applied to 2013 volumes to generate 2018 volumes.

Step 3: In addition to the growth in the background traffic, traffic impact studies and land-use information for parcels within the study area were reviewed, consistent with VDOT guidance. As the FAMPO model does not include the Dominion Raceway Development within its land-use assumptions, and shows little growth in the southeast quadrant of the interchange, such trips were layered on as described in the next two steps.

[4] Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software.
[5] Traffic Operations and Safety Analysis Manual (TOSAM) – Version 1.0, VDOT.
[6] Figure 11, Dominion Raceway Traffic Impact Analysis, dated January 2013.

Step 4: The total trips [7]generated by the recently approved Dominion Raceway Development were added to the volume developed in the Step 2. Because the raceway property is assumed to be fully developed by 2017, additional growth is not applied to obtain 2018 raceway trips.

Step 5: FAMPO model shows limited growth occurring in the southeast quadrant of the subject interchange by 2018. However, upon VDOT's review of historical data interchanges along I-95 north of the study interchange, higher growth is anticipated than is indicated in the FAMPO model. The following steps were used by VDOT to develop estimates of site-generated trips for land uses in these areas:

- Reviewed the Spotsylvania Comprehensive Land-Use Plan to identify future land uses, which consist of Business Park and Office Park land uses and fast-food establishments. Drive-through operations were assumed to be part of the fast food restaurant operations;
- Computed the developable land acreage of the undeveloped parcels along Mallard Road and along Route 606 east of the VDOT facility;
- Used a floor-area-ratio (FAR) of 0.25 to estimate potential building size;
- Used building sizes and ITE land use codes 770, 750 and 934 to estimated daily and peak hour site trips;
- By 2018, parcels along Mallard Road and Route 606 east of the Thornburg Shell Station were assumed to be 50 percent and 20 percent build-out respectively;
- Trip distribution was obtained from the TIA [8] with minor adjustments. Commercial/service land uses: 45% north, 5% east, 35% south, 15% west, with a 60/40 directional split; Office/employment center land uses: 50% north, 5% east, 30% south, 15% west, with a 70/30 directional split.

The trips generated by these developments were added to the traffic volume developed in Step 4, above.

Step 6: The total traffic volumes were balanced to include all component volumes described above. Traffic volumes were balanced adjusting the volumes on arterial network with volumes on I-95 held constant. Volumes along Route 606 between US Route 1 and Dan Bell Lane were not balanced to account for several driveways with direct access to Route 606.

Step 7: To account for the geometric reconfiguration of the study area intersections in the Final Build Alternative, the balanced 2018 No-Build traffic volumes developed in Step 6 were slightly reassigned. Volume diagrams for 2018 No-Build, and Final Build Alternative are presented in Figures 7-2 and 7-3.

[7] Figure 23.C, Dominion Raceway Supplemental Traffic Impact Analysis, dated April 2013.
[8] Figure 14, Dominion Raceway Traffic Impact Analysis, dated January 2013.

Figure 7-2: 2018 No-Build Volumes for Weekday AM and Friday PM peak hours

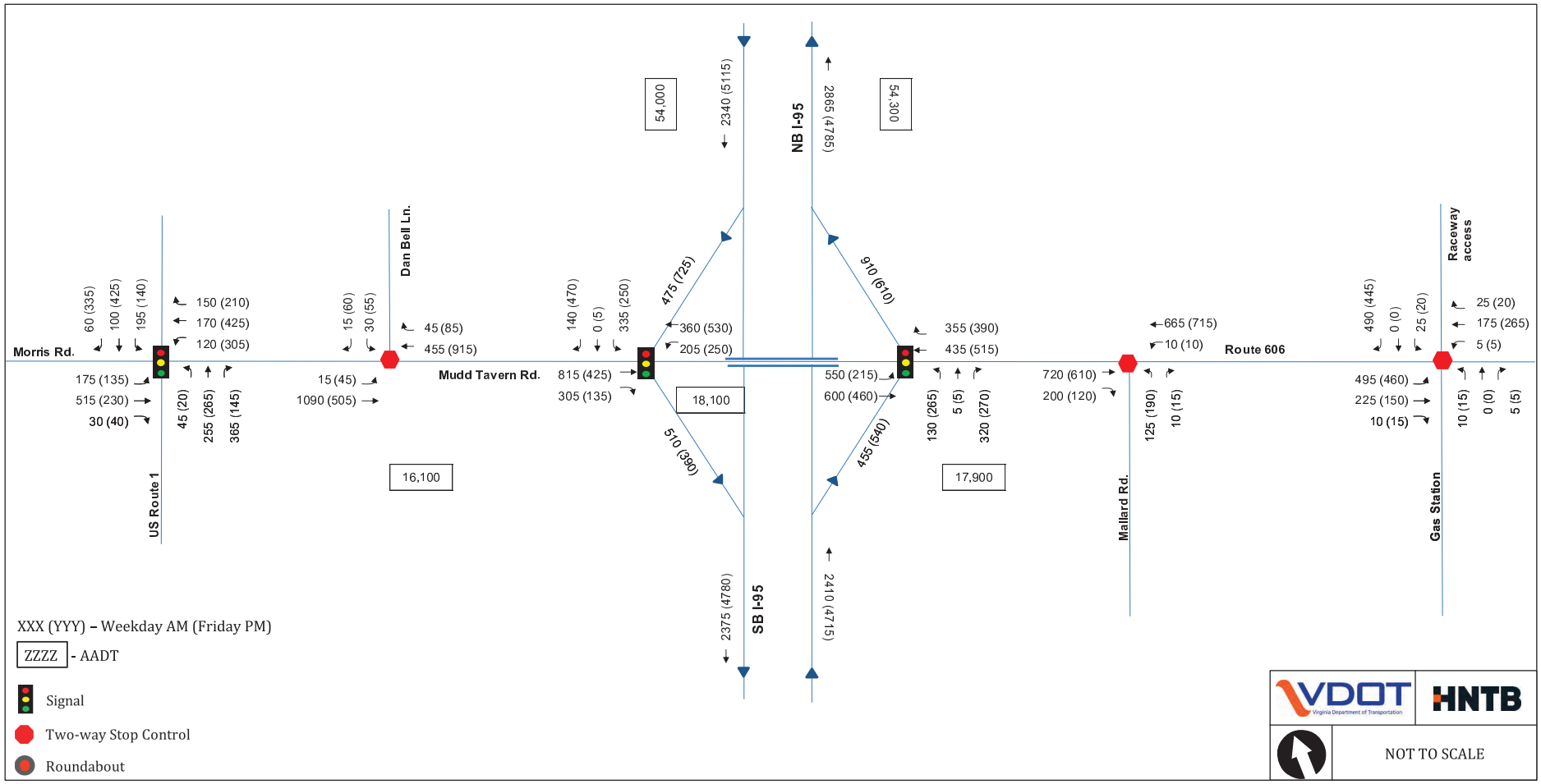
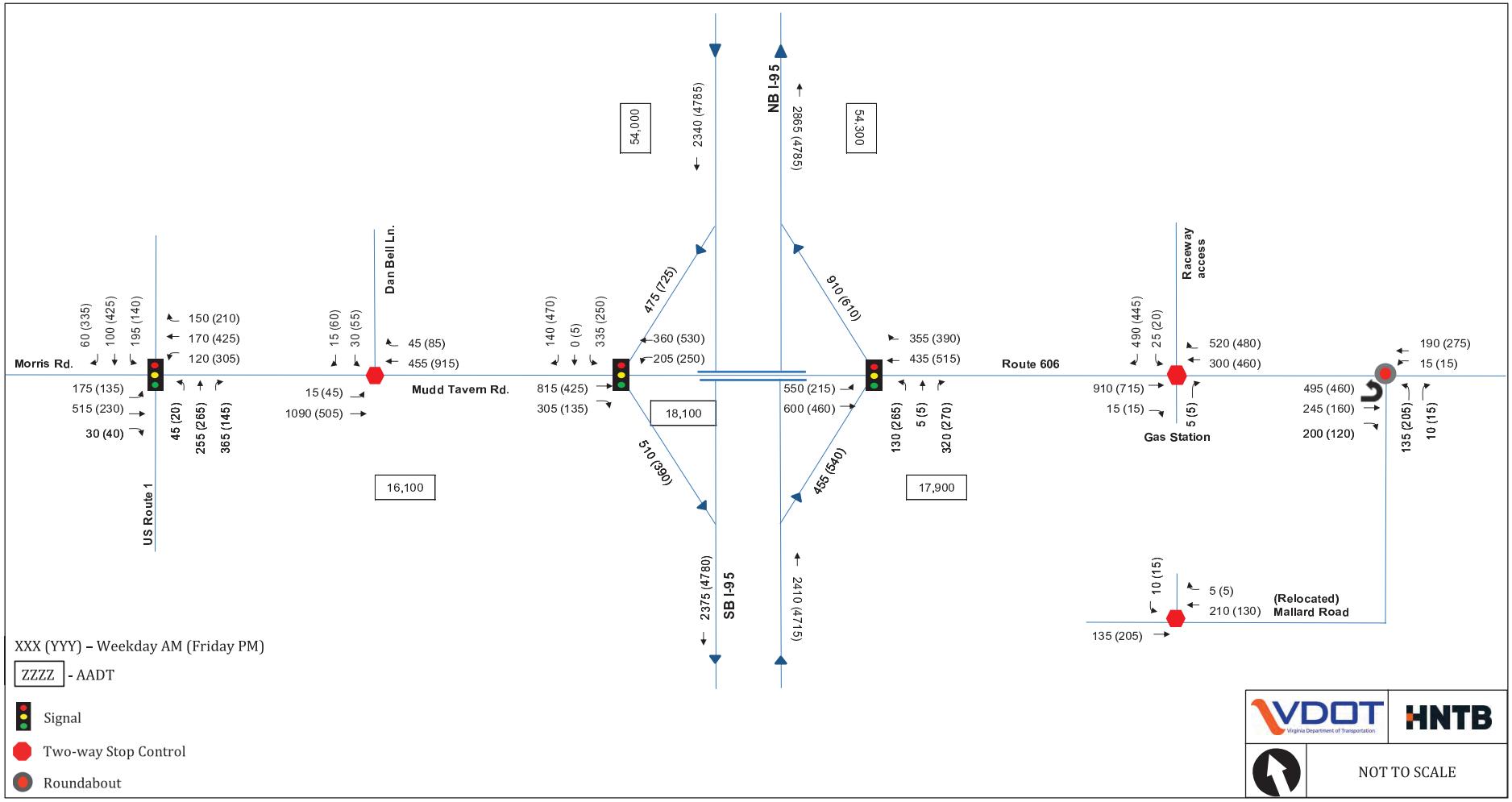


Figure 7-3: 2018 Final Build Alternative Volumes for Weekday AM and Friday PM Peak Hours

Figure 7-3: 2018 Final Build Alternative Volumes for Weekday AM and Friday PM peak hours



7.3.2 Design Year (2038) Traffic Volumes

This project is located in FAMPO's maintenance/nonattainment areas for air quality, although the area is not in a Transportation Management Area (TMA). The FAMPO model was used to develop long-term traffic forecasts because the project is within the model's coverage area. The FAMPO model does not include the Dominion Raceway Development or other potential development in the southeast quadrant and the steps below describe the process used to account for these land-uses. The methodology used to develop volumes for the year 2038 is discussed below.

Step 1: 2038 link volumes for A and PM peak hours were developed by interpolating between the FAMPO model outputs from the years 2030 and 2040.

Step 2: The average annual compounded growth rate on roadway links between FAMPO model output for the year 2010 and 2038 link volumes (from Step 1, above) was computed.

Step 3: This growth rate was applied to the existing volumes to obtain 2038 link volumes on all roadway links.

Step 4: The FRATAR technique was used to develop 2038 intersection turn movement volumes through an iterative process. The existing intersection turning movement counts, existing link volumes and 2038 link volumes (from step 3 above) were used as the seed values.

Step 5: The total trips [9] generated by the raceway development were added to the volumes developed in Step 4. As the raceway property is assumed to be fully developed by 2017, additional growth was is not applied to obtain 2038 raceway trips.

Step 6: The parcels southeast of the interchange were assumed to develop further by 2038. Business/Office Park land uses and fast-food establishments along Mallard Road and Route 606 east of the existing Shell Station were assumed to be 90 percent and 50 percent build-out respectively. The steps involved in developing these trips are described in Step 5 of 2018 Volume Development. The total trips generated by these developments were added to the volumes developed in Step 5, above.

Step 7: Volumes were balanced using the process described in Step 6 of 2018 Volume Development.

Step 8: The balanced 2038 No-Build volumes developed in Step 7 were slightly reassigned to generate volume diagram for the Final Build Alternative. The Modified Final Build Alterative volumes were developed by matching the Final Build Alternative, and re-distributing these volumes utilizing the Origin-Destination information coded into the Final Build Alternative VISSIM files [10]. Volume diagrams. 2038 No-Build, Final Build Alternative, and Modified Final Build Alternative are presented in Figure 7-4, Figure 7-5, and Figure 7-6.

[9] Figure 23.C, Dominion Raceway Supplemental Traffic Impact Analysis, dated April 2013.
[10] Final Build Alternative VISSIM files with detailed Origin-Destination pairings were developed prior to development of the Modified Final Build Alternative.

Figure 7-4: 2038 No-Build Volumes for Weekday AM and Friday PM peak hours

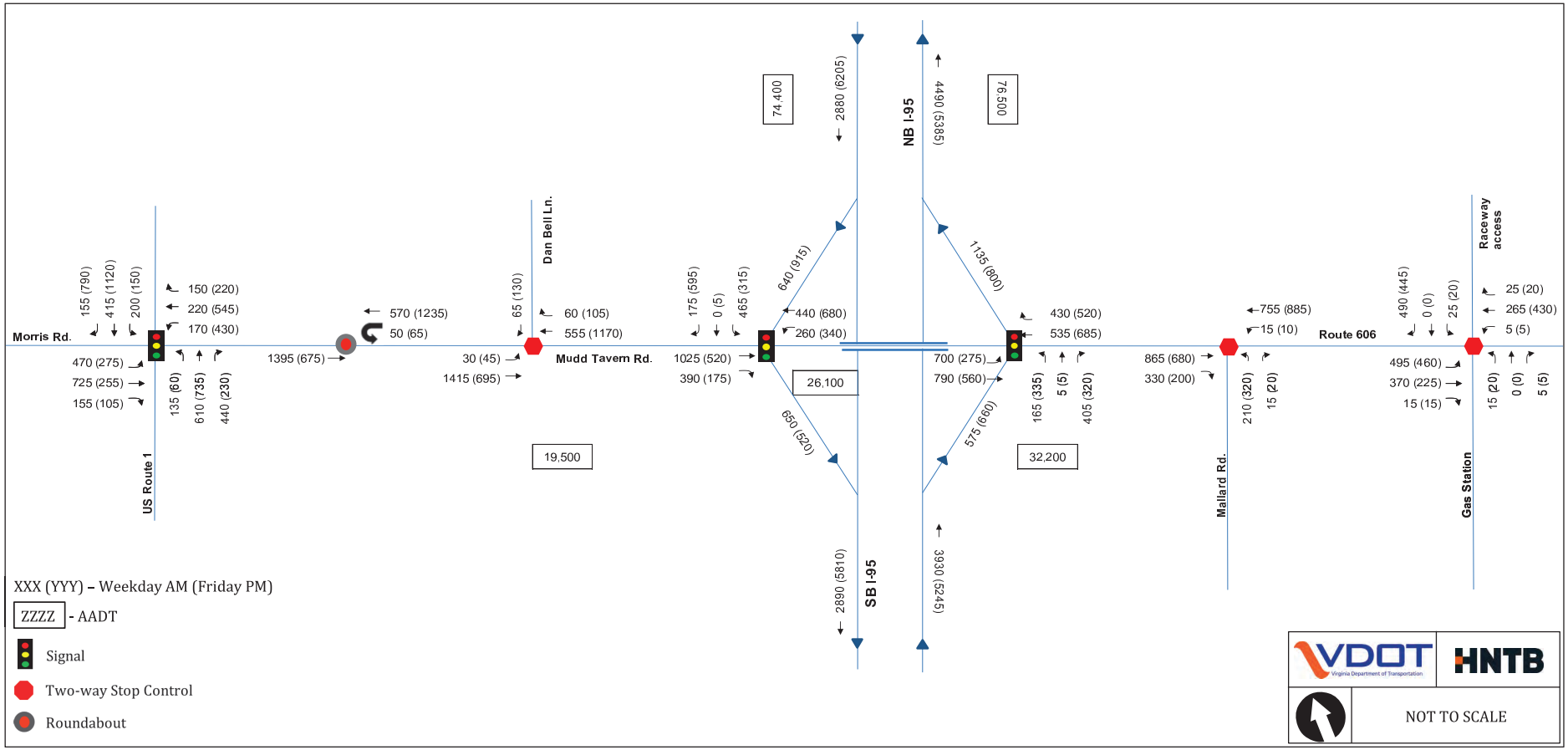


Figure 7-5: 2038 Final Build Alternative Volumes for Weekday AM and Friday PM Peak Hours

Figure 7-5: 2038 Final Build Alternative Volumes for Weekday AM and Friday PM peak hours

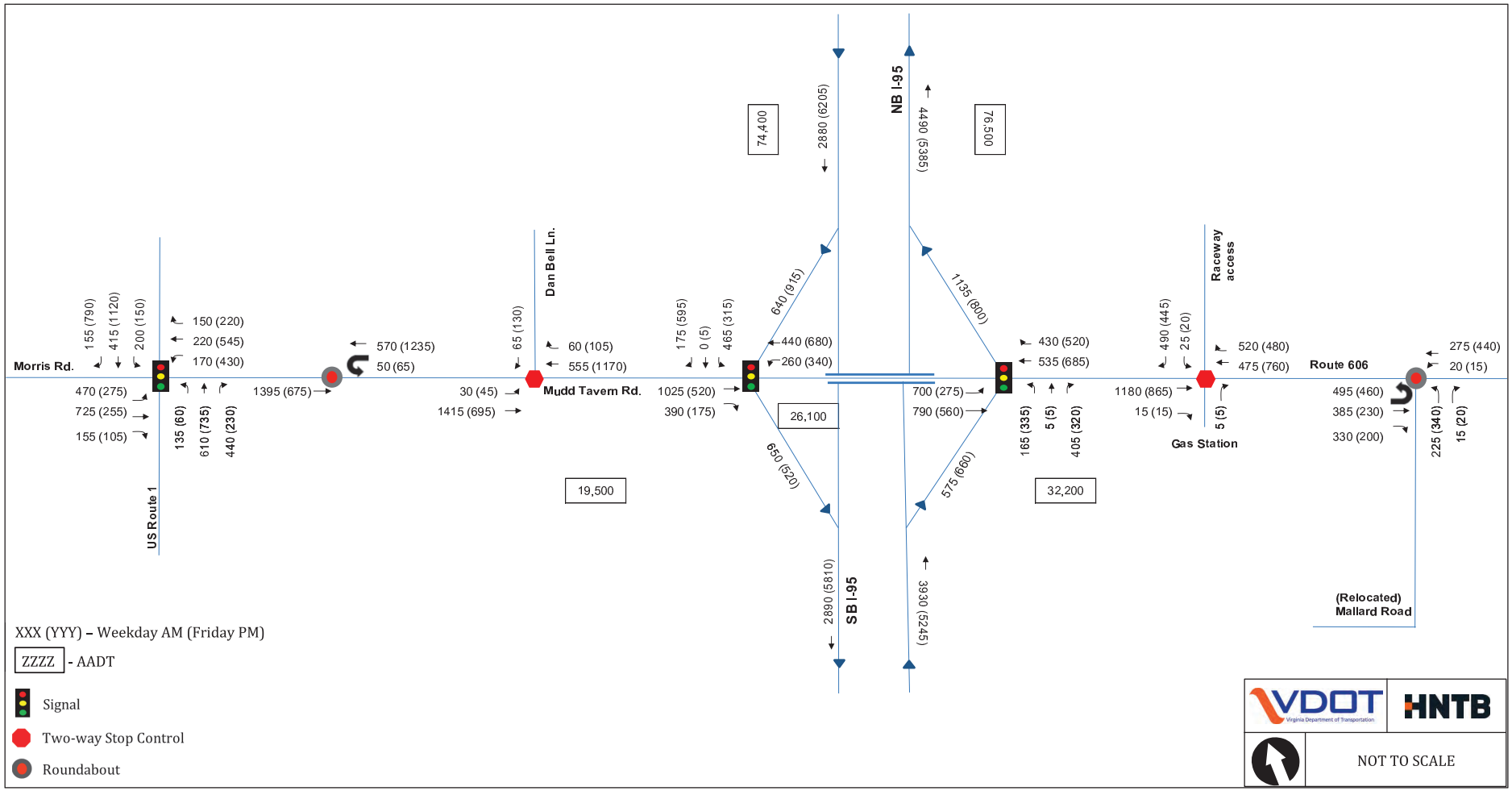
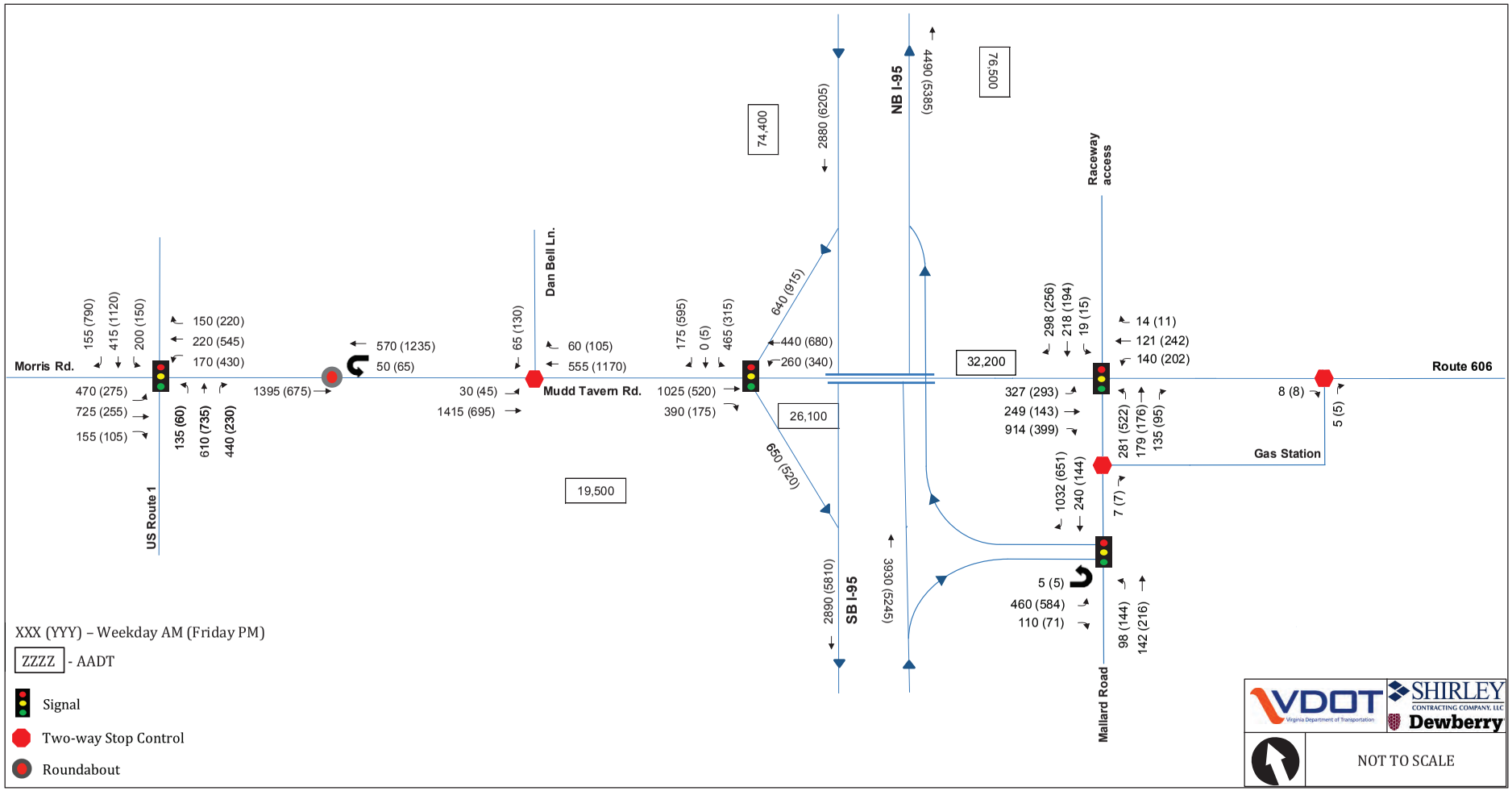


Figure 7-6: 2038 Modified Final Build Alternative Volumes for Weekday AM and Friday PM Peak Hours

Figure 7-6: 2038 Modified Final Build Alternative Volumes for Weekday AM and Friday PM peak hours



8 TRAFFIC OPERATIONAL ANALYSIS

The operational analyses of the subject interchange were conducted for three analysis years: Existing Conditions (2015), Opening Year (2018) and Design Year (2038). The operational analyses focused on the typical weekday AM peak hour and Friday PM peak hour in the study area. All scenarios were analyzed using microsimulation analysis in VISSIM. The microsimulation models were developed based on guidance by FHWA [11]and VDOT[12]. VISSIM was used to develop network wide performance measures including delays, queues, and travel times for the study corridor. VISSIM can assess traffic operations of an overall roadway system and can simulate the effects of queuing and delay experienced in one area of a network on others. This capability of the microsimulation model was important to portray adequately the traffic operations for Existing Conditions as well as for future conditions.

Mainline I-95 was divided into analysis segments following the Highway Capacity Manual (HCM) 2010 methodology to include basic freeway, ramp merge, and ramp diverge. The segmentation of the study corridor and the associated segment ID's are shown in Figure 8-1.

VISSIM reports density as vehicles/mile/lane (v/m/ln) as opposed to pc/m/ln in HCS. For VISSIM, equivalent density thresholds in v/m/ln were calculated using the heavy vehicle percentage on the freeway. Table 8-1 presents the LOS thresholds applied for VISSIM analysis results. The modeling assumptions and calibration process used in VISSIM are presented in Appendix E, included as part of this IMR.

Figure 8-1: Segmentation of the Freeway per HCM Methodology

As the original study was initiated in 2013, field observations were performed in September 2013 during the peak hours for calibration purposes. Queues, traffic patterns, driver behavior, travel speeds and travel times were recorded in the study area. When the Existing Conditions year shifted from 2013 to 2015, the calibrated 2013 models were updated with newer volumes (from 2015) as the traffic pattern did not change.

[11] Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software.
[12] Traffic Operations and Safety Analysis Manual (TOSAM) – Version 1.0, VDOT.

Table 8-1: LOS Criteria for VISSIM

Level of Service	Base Segment	Merge / Diverge Segment	Signal Control	Stop Control / Roundabout
	Density (v/mi/ln)*		Control Delay per Vehicle (sec/veh)	
LOS A-C	≤ 24	≤ 26	≤ 35	≤ 25
LOS D	> 24 - 32	> 26 - 32	> 35 - 55	> 25 - 35
LOS E	> 32 - 42	> 32 - 42	> 55 - 80	> 35 - 50
LOS F	> 42	> 42	> 80	> 50

* *Calculated from HCM 2010 thresholds with 16% heavy trucks*

The following MOEs were used to assess traffic operations:

- Arterial and ramp terminal intersections:
  - Movement, approach and intersection delay (seconds/vehicle);
  - Maximum queues (feet);
- Freeway segments:
  - Travel speed (mph);
  - Traffic flow density (v/m/ln)

Note: Level of Service (LOS) is not a defined MOE per the VDOT TOSAM.

In this Chapter, content consistent with the previously prepared I-95/Route 606 Interchange Improvements Build Alternative Analysis Report presented in Appendix A of this IMR are utilized where applicable.

See Chapter 5 for definitions and descriptions of the alternatives considered, including the "No-Build", the "Final Build Alternative", and the "Modified Final Build Alternative".

8.1 Existing Conditions

An analysis of 2015 Existing Conditions was performed to reflect current traffic operations in the study area. Existing Conditions are used as a baseline scenario against which future scenarios are compared. The MOE's are shown in Table 8-2 for freeway, and Table 8-3 (AM peak) and Table 8-4 (PM Peak) for intersections.

In 2015, all the intersections and freeway segments have light to moderate traffic in the AM and PM peak hours. There are minimal queues throughout the network, which are well under the available storage length. All the approaches at the intersection operate at LOS C or better during both the peak hours except for three movements:

- At the I-95 northbound ramp terminus, northbound left-turn operates at LOS D in the AM peak hour;
- At the I-95 southbound ramp terminus, southbound right-turn operates at LOS F during the Friday PM peak hour;
- At the intersection of US Route 1/Route 606, southbound left-turn operates at LOS D in the PM peak hour.

Table 8-2: Mainline Freeway MOEs (2015 and 2018) during Weekday AM and Friday PM peak hours

AM Peak Hour

Direction	ID	Description	Operati	2015 Existing					2018 No Build					2018 Final Build Alternative				
				Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS
Southbound I-95	B-1	North of VA 606 interchange	Basic	1935	1924	70.4	9.1	A	2340	2350	70.3	11.2	B	2340	2336	70.2	11.1	B
	D-2	SB off-ramp	Diverge	1935	1923	70.2	7.8	A	2340	2347	64.3	13.0	B	2340	2335	69.8	9.6	B
	B-3	Between ramps	Basic	1770	1762	70.2	8.4	A	1865	1868	68.8	9.0	A	1865	1868	70.1	8.9	A
	M-4	SB on-ramp	Merge	2085	2078	69.0	7.8	A	2375	2215	68.5	8.4	A	2375	2341	68.4	8.9	A
	B-5	South of VA 606 Interchange	Basic	2085	2085	70.0	9.9	A	2375	2220	69.8	10.6	B	2375	2349	69.8	11.2	B
Northbound I-95	B-6	South of VA 606 Interchange	Basic	2005	2008	70.3	9.5	A	2410	2394	70.1	11.4	B	2410	2415	70.2	11.5	B
	D-7	NB off ramp	Diverge	2005	2002	70.1	8.2	A	2410	2366	48.2	38.4	E	2410	2410	69.8	10.0	B
	B-8	Between ramps	Basic	1850	1849	70.2	8.8	A	1955	1948	65.7	9.9	A	1955	1963	70.0	9.3	A
	M-9	NB on ramp	Merge	2435	2436	68.4	9.7	B	2865	2542	67.7	10.2	B	2865	2809	66.3	11.6	B
	B-10	North of VA 606 interchange	Basic	2435	2442	69.9	11.7	B	2865	2547	69.6	12.2	B	2865	2810	69.5	13.5	B
Total				20540	20509				23800	22796				23800	23635			
Percent Volume Served				100%					96%					99%				

PM Peak Hour

Direction	ID	Description	Operation Type	2015 Existing					2018 No Build					2018 Final Build Alternative				
				Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS
Southbound I-95	B-1	North of VA 606 interchange	Basic	4640	4651	69.3	22.4	C	5115	5107	66.6	26.3	D	5115	5142	68.9	24.9	D
	D-2	SB off-ramp	Diverge	4640	4647	68.3	19.5	C	5115	5091	57.9	31.1	D	5115	5133	66.6	22.2	C
	B-3	Between ramps	Basic	4170	4186	68.2	20.5	C	4390	4358	64.1	22.8	C	4390	4413	66.8	22.0	C
	M-4	SB on-ramp	Merge	4345	4353	67.8	16.6	B	4780	4645	66.1	18.2	B	4780	4785	65.9	18.6	C
	B-5	South of VA 606 Interchange	Basic	4345	4261	69.2	20.5	C	4780	4662	68.1	22.8	C	4780	4796	68.1	23.5	C
Northbound I-95	B-6	South of VA 606 Interchange	Basic	4250	4264	69.5	20.5	C	4715	3544	19.3	95.2	F	4715	4743	69.2	22.8	C
	D-7	NB off ramp	Diverge	4250	4309	68.4	20.1	C	4715	3394	12.8	120.0	F	4715	4735	67.9	20.2	C
	B-8	Between ramps	Basic	3960	3963	68.7	19.2	C	4175	3066	57.3	17.9	C	4175	4202	68.0	20.6	C
	M-9	NB on ramp	Merge	4215	4210	67.5	16.9	B	4785	3531	63.6	15.1	B	4785	4796	63.9	20.1	C
	B-10	North of VA 606 interchange	Basic	4215	4217	69	20	C	4785	3550	67.5	17.5	C	4785	4799	67.8	23.6	C
Total				43030	43060				47355	40948				47355	47543			
Percent Volume Served				100%					86%					100%				

Diverge/Merge – Freeway mainline 1500 feet upstream/downstream of the gore point

Table 8-3: Intersection MOEs (2015 and 2018) during Weekday AM peak hour

Intersection	2015 Existing AM												Intersection	2018 No Build AM												Intersection	2018 Final Build Alternative AM											
	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue		Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue		Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
US 1 & Route 606	Signalized	EBL	160	162	18.9	B	22.0	C	20.2	C	5000	112	US 1 & Route 606	Signalized	EBL	175	179	49.6	D	66.1	E	149.2	F	5000	533	US 1 & Route 606	Signalized	EBL	175	173	66.1	E	104.7	F	107.7	F	5000	1253
		EBT	440	436	23.4	C					650	284			EBT	515	509	72.3	E					650	533			EBT	515	489	118.1	F					650	1253
		EBR	30	29	18.8	B					650	0			EBR	30	29	60.3	E					650	533			EBR	30	30	108.6	F					650	1253
		WBL	65	65	30.1	C	20.8	C			2250	167			WBL	120	86	81.3	F	75.9	E			75	329			WBL	120	119	83.0	F	77.8	E			75	576
		WBT	115	112	31.4	C					2250	167			WBT	170	116	82.0	F					2250	417			WBT	170	163	82.6	F					2250	718
		WBR	110	114	5.2	A					250	13			WBR	150	108	65.0	E					2250	313			WBR	150	150	68.6	E					2250	594
		NBL	40	39	21.8	C	17.1	B			5000	100			NBL	45	21	150.2	F	363.8	F			300	50			NBL	45	44	85.0	F	116.1	F			300	82
		NBT	230	221	21.4	C					5000	100			NBT	255	146	145.8	F					5000	233			NBT	255	238	71.3	E					5000	156
		NBR	300	311	13.3	B					100	119			NBR	365	160	590.2	F					300	3020			NBR	365	342	151.3	F					300	808
		SBL	145	142	29.8	C	22.0	C			5000	125			SBL	195	163	330.3	F	186.9	F			275	634			SBL	195	165	240.2	F	137.5	F			275	524
		SBT	95	101	20.4	C					5000	125			SBT	100	100	48.7	D					5000	80			SBT	100	107	47.2	D					5000	83
		SBR	55	53	4.2	A					100	5			SBR	60	56	15.7	B					275	9			SBR	60	57	11.0	B					275	10
Dan Bell Ln & Route 606	Unsignalized	EBL	15	15	1.0	A	0.7	A	1.1	A	2250	11	Dan Bell Ln & Route 606	Unsignalized	EBL	15	12	33.0	D	51.7	F	53.7	F	2250	2569	Dan Bell Ln & Route 606	Unsignalized	EBL	15	14	27.8	D	35.7	E	35.7	E	2250	2498
		EBT	900	903	0.7	A					2250	11			EBT	1090	823	52.0	F					2250	2569			EBT	1090	979	35.8	E					2250	2498
		WBT	305	305	0.1	A	0.3	A			150	0			WBT	455	326	1.3	A	1.3	A			150	52			WBT	455	457	0.4	A	0.5	A			150	53
		WBR	40	41	1.2	A					100	0			WBR	45	30	1.7	A					100	52			WBR	45	44	1.5	A					100	53
		SBL	30	29	18.5	C	15.3	C			500	33			SBL	30	10	1633.8	F	1421.8	F			500	454			SBL	30	12	1270.2	F	1088.6	F			500	430
		SBR	15	17	9.8	A					500	33			SBR	15	5	1041.8	F					500	454			SBR	15	5	675.4	F					500	430
I-95 SB Ramps & Route 606	Unsignalized	EBT	635	629	1.4	A	1.2	A	2.5	A	150	0	I-95 SB Ramps & Route 606	Signalized	EBT	815	599	17.9	B	17.0	B	78.3	E	150	230	I-95 SB Ramps & Route 606	Signalized	EBT	815	719	13.3	B	13.1	B	18.1	C	180	238
		EBR	295	302	0.7	A					150	0			EBR	305	234	14.8	B					150	218			EBR	305	273	12.7	B					140	226
		WBL	20	19	16.2	C	2.9	A			500	79			WBL	205	118	12.3	B	10.2	B			500	132			WBL	205	205	22.7	C	13.3	B			240	258
		WBT	210	211	1.7	A					500	49			WBT	360	223	9.1	A					500	132			WBT	360	361	8.0	A					525	258
		SBL	30	29	22.6	C	9.3	A			400	42			SBL	335	287	264.1	F	255.7	F			400	1063			SBL	335	327	45.2	D	34.7	C			400	290
		SBT	0	0	0.0	A					1330	0			SBT	0	0	0.0	A					1330	1063			SBT	0	0	0.0	A					1330	290
		SBR	135	134	6.4	A					1330	0			SBR	140	132	237.5	F					1330	1064			SBR	140	140	10.1	B					1330	0
I-95 NB Ramps & Route 606	Unsignalized	EBL	540	538	3.8	A	3.7	A	7.3	A	500	100	I-95 NB Ramps & Route 606	Signalized	EBL	550	415	13.5	B	21.1	C	55.1	E	500	496	I-95 NB Ramps & Route 606	Signalized	EBL	550	496	34.1	C	17.6	B	16.5	C	540	301
		EBT	125	121	3.7	A					500	62			EBT	600	469	27.7	C					500	496			EBT	600	550	2.7	A					540	301
		WBT	100	100	0.3	A	1.8	A			100	1			WBT	435	245	37.0	D	33.2	C			100	246			WBT	435	442	20.4	C	12.2	B			315	359
		WBR	40	46	4.9	A					100	1			WBR	355	186	28.1	C					100	191			WBR	355	357	2.0	A					315	180
		NBL	130	132	29.3	D	27.4	D			40	135			NBL	130	97	192.1	F	173.2	F			40	1832			NBL	130	125	51.2	D	21.6	A			1170	177
		NBT	5	5	17.8	C					1170	54			NBT	5	1	33.7	C					1170	1832			NBT	5	5	37.1	D					1170	177
		NBR	20	21	17.3	C					1170	54			NBR	320	237	166.0	F					1170	1756			NBR	320	323	10.0	A					500	51
Mallard Rd & Route 606	Unsignalized	EBT	90	86	0.2	A	0.1	A	0.9	A	100	0	Mallard Rd & Route 606	Unsignalized	EBT	720	555	1.4	A	1.1	A	49.1	E	100	14													
		EBR	55	56	0.0	A					100	0			EBR	200	151	0.2	A					100	14													
		WBL	5	5	0.7	A	0.2	A			100	0			WBL	10	5	10.1	B	36.2	E			100	353													
		WBT	110	116	0.2	A					100	0			WBT	665	411	36.5	E					100	353													
		NBL	30	30	6.5	A	6.1	A			3000	0			NBL	125	20	1987.0	F	1843.0	F			3000	545													
		NBR	5	4	3.6	A					300	0			NBR	10	2	235.5	F					300	184													
Gas Station & Route 606	Unsignalized												Raceway & Route 606	Unsignalized	EBL	495	384	3.4	A					100	105	Raceway & Route 606	Unsignalized											
		EBT	85	81	0.1	A	0.1	A	0.4	A	100	0			EBT	225	166	0.7	A	2.6	A			100	105			EBT	935	862	0.1	A	0.1	A			300	0
		EBR	10	10	0.0	A					100	0			EBR	10	7	0.0	A					100	105			EBR	10	11	0.1	A					300	0
		WBL	5	5	0.4	A					3500	0			WBL	5	5	19.3	C					3500	6													
		WBT	105	108	0.1	A	0.1	A			3500	0			WBT	175	177	39.9	E	34.3	D	90.5	F	3500	6			WBT	300	314	2.0	A	1.6	A	3.6	A	400	9
															WBR	25	28	1.4	A					260	6			WBR	520	489	1.4	A					300	9
		NBR	5	4	3.3	A	4.7	A			80	16			NBR	5	4	5.2	A	20.7	C			80	20								A					
															SBL	25	13	268.1	F	347.1	F			300	764			SBL	25	22	14.3	B	12.6	B			300	102
															SBR	490	227	351.7	F					300	764			SBR	515	485	12.5	B					300	102
																									(Relocated) Mallard Rd & Route 606	Roundabout	EBU	495	459	3.0	A	2.6	A	3.5	A	380	45
																											EBT	240	237	2.6	A					380	45
																											EBR	200	191	1.8	A					380	45
																											WBL	15	16	8.0	A	5.2	A			2000	27
																											WBT	190	196	5.0	A					2000	27
																											NBL	135	149	6.5	A	6.4	A			500	1
																											NBR	15	3	1.3	A					500	1
Total			5890	5898									Total			11425	8045							Total			10150	9584									
Percent Volume Served			100%										Percent Volume Served			70%									Percent Volume Served			94%									

Queue greater than available storage

Table 8-4: Intersection MOEs (2015 and 2018) during Friday PM peak hour

2015 Existing PM

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
US 1 & Route 606	Signalized	EBL	125	126	31.0	C	32.1	C	24.0	C	5000	120
		EBT	185	186	34.5	C					650	193
		EBR	35	35	23.8	C					650	0
		WBL	245	235	27.5	C	23.0	C			2250	421
		WBT	360	363	27.8	C					2250	421
		WBR	170	175	6.9	A					250	11
		NBL	20	19	30.2	C	20.1	C			5000	98
		NBT	240	237	26.1	C					5000	98
		NBR	110	115	6.1	A					100	21
		SBL	110	108	35.7	D	23.2	C			5000	194
		SBT	385	385	29.5	C					5000	194
		SBR	305	301	10.7	B					100	92
Dan Bell Ln & Route 606	Unsignalized	EBL	40	40	6.3	A	1.8	A	1.9	A	2250	86
		EBT	400	400	1.3	A					2250	86
		WBT	755	755	0.3	A	0.4	A			150	0
		WBR	85	89	1.4	A					100	0
		SBL	50	47	16.4	C	14.6	B			500	54
		SBR	55	57	13.1	B					500	54
I-95 SB Ramps & Route 606	Unsignalized	EBT	315	313	0.7	A	0.6	A	17.7	C	150	0
		EBR	135	135	0.4	A					150	0
		WBL	35	38	4.2	A	1.7	A			500	52
		WBT	390	395	1.5	A					500	24
		SBL	15	14	19.1	C	49.0	E			400	25
		SBT	5	5	14.1	B					1330	46
		SBR	450	449	50.2	F					1330	46
I-95 NB Ramps & Route 606	Unsignalized	EBL	215	212	2.6	A	2.3	A	8.3	A	500	57
		EBT	115	114	1.7	A					500	19
		WBT	165	168	0.4	A	0.7	A			100	0
		WBR	35	38	2.0	A					100	0
		NBL	260	265	20.9	C	20.3	C			40	170
		NBT	5	5	11.8	B					1170	87
		NBR	25	27	16.1	C					1170	87
Mallard Rd & Route 606	Unsignalized	EBT	115	119	0.1	A	0.1	A	1.2	A	100	0
		EBR	25	22	0.0	A					100	0
		WBL	5	5	0.5	A	0.2	A			100	0
		WBT	150	154	0.2	A					100	0
		NBL	50	51	7.0	A	6.8	A			3000	0
		NBR	5	3	3.0	A					300	0
Gas Station & Route 606	Unsignalized								0.5	A		
		EBT	105	108	0.1	A	0.1	A			100	0
		EBR	15	14	0.0	A					100	0
		WBL	5	6	0.8	A	0.1	A			3500	0
		WBT	140	143	0.1	A					3500	0
		NBR	5	5	3.8	A	5.1	A			80	18
Total			6475	6498								
Percent Volume Served			100%									

2018 No Build PM

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
US 1 & Route 606	Signalized	EBL	135	132	60.4	E	63.3	E	43.3	D	5000	369
		EBT	230	227	67.4	E					650	369
		EBR	40	41	49.8	D					650	369
		WBL	305	236	46.4	D	44.2	D			75	718
		WBT	425	343	45.8	D					2250	869
		WBR	210	162	37.6	D					2250	763
		NBL	20	18	77.5	E	38.2	D			300	42
		NBT	265	268	51.9	D					5000	156
		NBR	145	146	8.0	A					300	38
		SBL	140	142	75.6	E	36.3	D			275	214
		SBT	425	431	42.7	D					5000	211
		SBR	335	334	11.3	B					275	107
Dan Bell Ln & Route 606	Unsignalized	EBL	45	47	62.7	F	64.1	F	52.8	F	2250	659
		EBT	505	494	64.3	F					2250	659
		WBT	915	719	1.1	A	1.1	A			150	67
		WBR	85	67	1.6	A					100	67
		SBL	55	38	486.4	F	458.3	F			500	438
		SBR	60	47	435.7	F					500	438
I-95 SB Ramps & Route 606	Signalized	EBT	425	402	30.4	C	28.5	C	63.6	E	150	228
		EBR	135	130	22.9	C					150	216
		WBL	250	175	8.4	A	8.9	A			500	162
		WBT	530	325	9.2	A					500	162
		SBL	250	241	139.3	F	129.0	F			400	1522
		SBT	5	0	0.0	A					1330	1522
		SBR	470	461	123.7	F					1330	1524
I-95 NB Ramps & Route 606	Signalized	EBL	215	201	15.0	B	18.1	B	55.2	E	500	430
		EBT	460	439	19.5	B					500	430
		WBT	515	370	20.1	C	18.2	B			100	242
		WBR	390	258	15.4	B					100	187
		NBL	265	129	235.2	F	225.1	F			40	5720
		NBT	5	1	46.2	D					1170	5720
		NBR	270	146	217.4	F					1170	5644
Mallard Rd & Route 606	Unsignalized	EBT	610	486	1.4	A	1.1	A	61.5	F	100	4
		EBR	120	99	0.1	A					100	4
		WBL	10	7	10.6	B	20.6	C			100	159
		WBT	715	550	20.7	C					100	159
		NBL	190	77	805.9	F	758.2	F			3000	551
		NBR	15	6	184.5	F					300	190
Raceway & Route 606	Unsignalized	EBL	460	360	4.9	A	3.8	A	79.3	F	100	109
		EBT	150	120	0.8	A					100	109
		EBR	15	11	0.2	A					100	109
		WBL	5	4	8.6	A	18.2	C			3500	0
		WBT	265	269	19.8	C					3500	178
		WBR	20	23	1.0	A					260	0
		NBR	5	4	4.0	A	16.1	C			80	22
		SBL	20	11	211.0	F	278.0	F			300	767
		SBR	445	273	280.6	F					300	798
Total			11650	9203								
Percent Volume Served			79%									

2018 Final Build Alternative PM

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
US 1 & Route 606	Signalized	EBL	135	134	56.8	E	60.2	E	43.9	D	5000	351
		EBT	230	233	63.6	E					650	351
		EBR	40	38	51.0	D					650	351
		WBL	305	307	43.4	D	42.3	D			75	1960
		WBT	425	407	43.5	D					2250	2076
		WBR	210	212	38.6	D					2250	1963
		NBL	20	19	70.1	E	41.1	D			300	41
		NBT	265	259	58.4	E					5000	155
		NBR	145	151	7.8	A					300	31
		SBL	140	137	74.8	E	39.6	D			275	202
		SBT	425	430	49.1	D					5000	223
		SBR	335	332	12.7	B					275	118
Dan Bell Ln & Route 606	Unsignalized	EBL	45	46	24.0	C	20.7	C	12.7	B	2250	438
		EBT	505	506	20.4	C					2250	438
		WBT	915	918	2.6	A	2.5	A			150	214
		WBR	85	87	2.1	A					100	214
		SBL	55	49	73.2	F	65.7	F			500	156
		SBR	60	60	59.6	F					500	156
I-95 SB Ramps & Route 606	Signalized	EBT	425	414	15.7	B	15.3	B	19.7	C	180	226
		EBR	135	141	13.9	B					140	215
		WBL	250	240	16.1	B	13.4	B			240	326
		WBT	530	540	12.2	B					525	326
		SBL	250	249	39.1	D	29.9	C			400	337
		SBT	5	5	24.0	C					1330	337
		SBR	470	465	25.1	C					1330	22
I-95 NB Ramps & Route 606	Signalized	EBL	215	208	43.6	D	17.7	B	17.5	C	540	145
		EBT	460	453	5.8	A					540	145
		WBT	515	517	19.0	B	11.4	B			315	369
		WBR	390	393	1.3	A					315	189
		NBL	265	265	48.1	D	7.9	C			1170	286
		NBT	5	3	23.5	C					1170	286
		NBR	270	271	7.8	A					500	18
Raceway & Route 606	Unsignalized								4.7	A		
		EBT	715	711	0.2	A	0.1	A			300	0
		EBR	15	13	0.1	A					300	0
		WBT	460	477	2.2	A	1.9	A			400	3
		WBR	480	479	1.6	A					300	3
		SBL	20	19	21.5	C	17.9	C			300	118
		SBR	445	435	17.8	C					300	118
(Relocated) Mallard Rd & Route 606	Roundabout	EBU	460	453	3.8	A	3.3	A	5.2	A	380	40
		EBT	155	163	3.0	A					380	40
		EBR	120	120	1.5	A					380	40
		WBL	15	17	10.2	B	7.8	A			2000	78
		WBT	275	280	7.6	A					2000	78
		NBL	205	223	8.0	A	7.9	A			500	8
		NBR	15	4	2.7	A					500	8
Total			10195	10168								
Percent Volume Served			100%									

Queue greater than available storage

8.2 2018 No-Build Conditions

In 2018 No-Build Conditions, both freeway and arterial operations are expected to be impacted due to the projected growth in traffic. The majority of intersections fail during both the peak hours with queues spilling back to the Interstate. For geometric layout of this alternative, refer to Figure 5-1. Key findings of the 2018 Opening Year No-Build Conditions:

- As shown in Table 8-2, Table 8-3 and Table 8-4, only 73 percent of the traffic demand on arterial network and 91 percent of the demand on freeway network is served in this alternative;
- The northbound and southbound ramp terminal intersections are expected to operate at LOS E or worse with queues extending to I-95 in both AM and PM peak hours. As a result, I-95 northbound is expected to operate at high to severe congestion south of the study interchange during the peak hours;
- In the AM peak hour, as the eastbound left turn to northbound I-95 is above capacity, queues as long as 3,000 feet extending to Route 1 intersection are expected. This will impact operations along Route 606, at the southbound ramp terminus, Dan Bell Lane, and Route 1;
- Minor approaches at majority of the stop-controlled intersections operate at LOS F as vehicles cannot find gaps to enter Route 606 in the both AM and PM peak hours.

8.3 2018 Final Build Alternative Conditions

For the 2018 Final Build Alternative, all the intersections in the study area except US Route 1/Route 606 operate at LOS C or better. For geometric layout of this alternative, refer to Figure 5-2.

The MOE's for the Final Build Alternative are shown in Table 8-2 for freeway, and Table 8-3 (AM peak) and Table 8-4 (PM Peak) for intersections. As shown in these tables over 97 percent of the projected traffic demand is served in this alternative. The higher throughput, especially in the westbound direction when compared to No-Build Alternative results in longer queues at some locations. Key findings of the 2018 Final Build Alternative are listed below:

- I-95 Southbound and Northbound: All the freeway segments operate at LOS C or better except I-95 southbound, north of the interchange. This location operates at LOS D during the PM peak hour due to volume and is not influenced by the operations at the interchange of Route 606. With 2018 Final Build Alternative, there will be free-flow conditions on I-95 in both directions with travel speeds around 65 mph;
- US Route 1/Route 606 Intersection: This intersection operates at LOS F in the AM peak hour with multiple failing movements during both the peak hours. Queues at multiple movements on westbound and eastbound approaches are expected to exceed the available storage length during the peak hours. In the AM, queue in the eastbound direction at the I-95 Southbound Ramp Terminal Intersection extends to this intersection. This issue will be addressed in Route 606 widening project on the west side;

- Route 606/Dan Bell Lane Intersection: The overall intersection operates at LOS E during the AM peak hour, with the southbound left turn from Dan Bell Lane at LOS F. In the morning peak hour, queue in the eastbound direction at the I-95 southbound ramp terminal intersection extends to this intersection resulting in high delays. This issue will be addressed in Route 606 widening project planned on the west side;
- I-95 Southbound Ramps/Route 606 Intersection: The overall intersection operates at LOS C or better during both the peak hours with all the movements at LOS C or better except, southbound left-turn movement, which operates at LOS D in the AM and PM peak hours. Maximum queues are expected to exceed the available storage on the eastbound approach extending to US Route 1 intersection. Currently, the eastbound approach has one lane limiting the capacity of this approach even though the bridge has three receiving lanes. With the planned widening of Route 606 on the west side of the interchange, this issue will be addressed. Westbound left-turn movement has maximum queues exceeding the storage length during the PM peak hour. However, queue clears completely every cycle;
- I-95 Northbound Ramps /Route 606 Intersection: The overall intersection will operate at LOS C during both the peak hours. Northbound left-turn movement during both the peak hours and eastbound left-turn movement during the PM peak hour operate at LOS D. Maximum queues are projected to be higher than the available storage on westbound through movement with the end of the queue reaching Dominion Raceway Avenue occasionally. However, queue clears completely every cycle;
- Route 606/Dominion Raceway Avenue Intersection: This intersection is expected to operate at LOS A or better, with all the movements at LOS C or better. Queues are contained within available storage on all approaches;
- Route 606/Relocated Mallard Road Intersection: The roundabout operates at an overall LOS A during the peak hours with all movements at LOS A. Queue lengths are within available storage on all approaches.

8.4 2038 No-Build Conditions

By 2038, Route 606, west of the subject interchange is anticipated to be widened to two lanes in each direction through a separate project. As this IMR was completed during VDOT's Route 606 Corridor Study, geometry to the west of the interchange may not show all the improvements proposed. Refer to the VDOT corridor planning study for all the improvements proposed. The geometric layout of this alternative the subject interchange and Route 606 east of the interchange will remain the same, as shown in Figure 5-1.

MOE's for No-Build Alternative are shown in Table 8-5 for freeway and Table 8-6 (AM peak) and Table 8-7 (PM peak) for intersections. In the No-Build Conditions, the majority of intersections fail during both the peak hours with queues spilling back to the interstate at all the ramp termini. There are several capacity constraints in the roadway network that impact the operations throughout the network:

- As shown in MOE tables, less than 85 percent of the traffic demand is served in this alternative;
- During the AM peak, eastbound motorists turning left from Route 606 to northbound I-95 block the through traffic on Route 606. Queues longer than 3,000 feet extending beyond Route 1 are expected in the eastbound direction;
- During the PM peak, the northbound off-ramp and southbound off-ramp operate at LOS F with queues extending onto the mainline I-95 in both directions resulting in LOS F on I-95 at multiple locations.

Table 8-5: 2038 Freeway MOEs During Weekday AM and Friday PM peak hours

AM Peak Hour																	
Direction	ID	Description	Operation Type	2038 No Build					2038 Final Build Alternative								
				Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS
Southbound I-95	B-1	North of VA 606 Interchange	Basic	2880	2847	59.3	22.0	C	2880	2877	70.0	13.7	B	2880	2874	68.0	15.2	B
	D-2	SB off-ramp	Diverge	2880	2729	31.4	71.6	F	2880	2874	69.4	11.8	B	2880	2865	67.7	16.8	B
	B-3	Between ramps	Basic	2240	2157	61.9	11.6	B	2240	2241	69.8	10.7	B	2240	2243	68.6	12.1	B
	M-4	SB on-ramp	Merge	2890	2630	66.9	10.2	B	2890	2884	68.0	11.0	B	2890	2885	67.7	13.8	B
	B-5	South of VA 606 Interchange	Basic	2890	2638	69.1	12.7	B	2890	2892	69.5	13.9	B	2890	2894	68.9	14.2	B
Northbound I-95	B-6	South of VA 606 Interchange	Basic	3930	2903	17.5	115.8	F	3930	3934	69.6	18.8	C	3930	3933	69.6	18.4	C
	D-7	NB off ramp	Diverge	3930	2705	10.2	136.2	F	3930	3927	68.5	16.6	B	3930	3931	67.2	18.1	B
	B-8	Between ramps	Basic	3355	2400	61.4	13.2	B	3355	3356	68.9	16.2	B	3355	3351	67.0	15.1	B
	M-9	NB on ramp	Merge	4490	3236	65.4	13.5	B	4490	4476	63.2	19.2	C	4490	4481	64.1	19.4	C
	B-10	North of VA 606 Interchange	Basic	4490	3257	68.7	15.8	B	4490	4483	68.0	22.0	C	4490	4480	66.8	20.8	C
Total				33975	27501				33975	33943				33975	33937			
Percent Volume Served				81%					100%					100%				

PM Peak Hour																	
Direction	ID	Description	Operation Type	2038 No Build					2038 Final Build Alternative								
				Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS	Volume Input	VISSIM Thruput	Speed (m/hr)	Density (v/m/ln)	LOS
Southbound I-95	B-1	North of VA 606 Interchange	Basic	6205	6241	62.2	34.8	E	6205	6254	65.4	32.1	D	6205	6239	66.5	33.8	D
	D-2	SB off-ramp	Diverge	6205	6215	55.2	35.4	E	6205	6247	60.0	30.7	D	6205	6220	62.1	30.5	D
	B-3	Between ramps	Basic	5290	5302	61.8	28.7	D	5290	5330	63.0	28.3	D	5290	5304	64.2	27.8	D
	M-4	SB on-ramp	Merge	5810	5652	62.0	23.3	C	5810	5827	59.0	25.0	C	5810	5816	62.6	21.9	C
	B-5	South of VA 606 Interchange	Basic	5810	5663	65.8	28.7	D	5810	5844	64.2	30.4	D	5810	5815	64.4	27.2	D
Northbound I-95	B-6	South of VA 606 Interchange	Basic	5245	3960	15.0	118.9	F	5245	5261	68.7	25.5	D	5245	5252	67.6	25.1	C
	D-7	NB off ramp	Diverge	5245	3776	12.4	128.9	F	5245	5251	66.2	23.1	C	5245	5248	62.8	23.8	C
	B-8	Between ramps	Basic	4585	3344	60.7	18.5	C	4585	4600	66.3	23.1	C	4585	4590	64.8	24.0	C
	M-9	NB on ramp	Merge	5385	3935	63.7	16.7	B	5385	5383	57.8	25.3	C	5385	5393	61.7	24.2	C
	B-10	North of VA 606 Interchange	Basic	5385	3948	68.0	19.4	C	5385	5393	65.3	27.5	D	5385	5391	64.2	27.6	D
Total				55165	48037				55165	55390				55165	55268			
Percent Volume Served				87%					100%					100%				

Diverge/Merge - Freeway mainline 1500 feet upstream/ downstream of the gore point

Table 8-6: 2038 Intersection MOEs during Weekday AM peak hour

2038 No Build AM														2038 Final Build Alternative AM														2038 Modified Final Build Alternative AM													
Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue	Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue	Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
US 1 & Route 606	Signalized	EBL	470	428	14.7	B	98.2	F	110.1	F	650	2612	US 1 & Route 606	Signalized	EBL	470	472	49.3	D	45.3	D	46.7	D	650	475	US 1 & Route 606	Signalized	EBL	470	472	49.3	D	45.3	D	46.7	D	650	475
		EBT	725	633	145.5	F					5000	2612			EBT	725	724	44.6	D					5000	475			EBT	725	724	44.6	D					5000	475
		EBR	155	134	141.8	F					650	2007			EBR	155	155	36.4	D					650	475			EBR	155	155	36.4	D					650	475
		WBL	170	113	62.2	E	45.9	D			2250	238			WBL	170	178	77.7	E	60.4	E			2250	380			WBL	170	178	77.7	E	60.4	E			2250	380
		WBT	220	147	56.5	E					2250	238			WBT	220	223	70.8	E					2250	380			WBT	220	223	70.8	E					2250	380
		WBR	150	102	12.6	B					75	111			WBR	150	155	25.7	C					75	250			WBR	150	155	25.7	C					75	250
		NBL	135	113	98.1	F	129.1	F			300	328			NBL	135	134	69.6	E	45.5	D			300	187			NBL	135	134	69.6	E	45.5	D			300	187
		NBT	610	499	92.0	F					5000	1814			NBT	610	611	52.9	D					5000	493			NBT	610	611	52.9	D					5000	493
		NBR	440	346	192.8	F					300	1465			NBR	440	446	28.1	C					300	397			NBR	440	446	28.1	C					300	397
		SBL	200	123	481.1	F	142.6	F			275	1112			SBL	200	198	66.0	E	40.8	D			275	259			SBL	200	198	66.0	E	40.8	D			275	259
		SBT	415	345	62.0	E					5000	372			SBT	415	413	41.6	D					5000	198			SBT	415	413	41.6	D					5000	198
		SBR	155	129	36.2	D					275	786			SBR	155	153	6.0	A					275	37			SBR	155	153	6.0	A					275	37
Dan Bell Ln & Route 606	Unsignalized	EBL	30	21	74.4	F	69.8	F	51	F	2250	2747	Dan Bell Ln & Route 606	Unsignalized	EBL	30	29	21.6	C	23.3	C	16.4	B	2250	604	Dan Bell Ln & Route 606	Unsignalized	EBL	30	31	3.5	A	4.4	A	3.3	A	2250	92
		EBT	1365	1080	69.8	F					2250	2747			EBT	1415	1422	23.3	C					2250	604			EBT	1415	1407	4.4	A					2250	92
		WBT	555	358	0.2	A	0.2	A			150	1			WBT	555	564	0.2	A	0.2	A			150	0			WBT	555	559	0.05	A	0.05	A			150	0
		WBR	60	41	0.4	A					100	1			WBR	60	61	0.2	A					150	0			WBR	60	67	0.07	A					150	0
						A	43.1	E												16.5	C												7.9	A				
		SBR	15	68	43.1	E					500	111			SBR	65	68	16.5	C					500	67			SBR	65	67	7.9	A					500	63
I-95 SB Ramps & Route 606	Signalized	EBT	1025	765	29.0	C	26.3	C	110.1	F	150	251	I-95 SB Ramps & Route 606	Signalized	EBT	1025	1023	24.5	C	22.6	C	23.9	C	180	245	I-95 SB Ramps & Route 606	Signalized	EBT	1025	1,021	12.5	B	10.4	B	13.1	B	180	269
		EBR	390	304	19.7	B					150	237			EBR	390	397	18.0	B					140	222			EBR	390	390	4.9	A					140	145
		WBL	260	176	67.2	E	57.9	E			500	541			WBL	260	257	30.3	C	17.8	B			240	228			WBL	260	253	16.5	B	12.6	B			280	167
		WBT	440	273	51.9	D					500	541			WBT	440	450	10.7	B					525	228			WBT	440	468	10.3	B					670	167
		SBL	465	322	370.6	F	361.7	F			400	2912			SBL	465	460	41.7	D	33.5	C			400	336			SBL	465	457	24.8	C	19.8	B			1000	382
		SBT	0	0	0.0	A					1330	2912			SBT	0	0	0.0	A					1330	336			SBT	0	0	0.0	A					400	0
		SBR	175	126	339.1	F					1330	2912			SBR	175	175	11.8	B					1330	0			SBR	175	180	6.5	A					400	238
I-95 NB Ramps & Route 606	Signalized	EBL	700	519	22.4	C	24.4	C	49.0	D	500	624	I-95 NB Ramps & Route 606	Signalized	EBL	700	688	49.2	D	25.6	C	23.4	C	540	539	Mallard Rd and Route 606	Signalized	EBL	327	336	20.1	C	11.6	B	16.9	B	300	205
		EBT	790	566	26.3	C					500	624			EBT	790	785	4.9	A					540	539			EBT	249	240	21.5	C					670	209
		WBT	535	379	16.7	B	17.7	B			100	247			WBT	535	538	29.2	C	19.2	B			315	428			EBR	914	902	5.9	A					670	159
		WBR	430	310	18.9	B					100	192			WBR	430	437	6.8	A					315	252			WBL	140	144	14.1	B					175	88
		NBL	165	72	266.5	F	240.8	F			40	5785			NBL	165	168	47.4	D	25.1	C			1170	252			WBT	121	132	23.2	C	17.4	B			N/A	153
		NBT	5	1	34.0	C					1170	5785			NBT	5	5	38.8	D					1170	252			WBR	14	13	0.4	A					200	0
		NBR	405	179	231.0	F					1170	5785			NBR	405	405	15.7	B					500	109			NBL	281	277	21.2	C					415	127
Mallard Rd & Route 606	Unsignalized	EBT	865	545	1.5	A	1.1	A	47.6	E	100	14																	NBT	179	182	32.7	C	27.3	C			415	371
		EBR	330	200	0.2	A					100	14																	NBR	135	144	32.9	C					415	371
		WBL	15	10	10.8	B	17.1	C			100	351																	SBL	19	22	32.6	C					300	274
		WBT	755	635	17.2	C					100	351																	SBT	218	215	33.6	C	20.2	C			300	274
		NBL	210	53	1064.4	F	1020.3	F			3000	554																	SBR	298	302	9.3	A					300	86
		NBR	15	3	152.5	F					300	193																										
Raceway & Route 606	Unsignalized	EBL	495	309	5.4	A	3.4	A	70.2	F	100	112	Raceway & Route 606	Unsignalized							0.4	A	3.5	A			Mallard Rd and I-95 NB Off-Ramp	Signalized	EBL	465	472	18.5	B	18.9	B	12.2	B	540	347
		EBT	370	230	0.8	A					100	112			EBT	1180	1176	0.4	A					300	0			EBR	110	109	20.9	C					540	347
		EBR	15	9	0.8	A					100	112			EBR	15	14	0.1	A					300	0			NBL	98	95	21.0	C	13.9	B			200	84
		WBL	5	5	10.0	B	17.6	C			3500	2																	NBT	142	144	8.9	A					N/A	88
		WBT	265	271	19.3	C					3500	2			WBT	475	492	3.0	A	2.7	A			400	21			SBT	240	232	12.6	B	8.8	B			400	264
		WBR	25	27	1.9	A					260	2			WBR	520	513	2.3	A					300	21			SBR	1,032	1,036	7.8	A					315	241
		NBR	5	5	5.5	A	16.0	C			80	24																										
		SBL	25	20	176.8	F	212.3	F			300	764			SBL	25	25	13.0	B	12.3	B			300	89														
		SBR	490	357	214.3	F					300	764			SBR	490	482	12.3	B					300	89														
													(Relocated) Mallard Rd & Route 606	Roundabout	EBU	495	482	3.2	A	2.9	A	5.0	A	380	65														
															EBT	385	401	3.2	A					380	65														
															EBR	330	324	2.2	A					380	65														
															WBL	20	21	10.9	B	8.3	A			2000	73														
															WBT	275	281	8.1	A					2000	73														
															NBL	225	242	11.2	B	11.1	B			500	58														
															NBR	15	8	6.8	A					500	58														
Total			15480	10988									Total			13945	13988									Total			13707	13759								
Percent Volume Served			71%										Percent Volume Served			100%									Percent Volume Served			100%								

Queue greater than available storage

Table 8-7: 2038 Intersection MOEs during Friday PM peak hour

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
2038 No Build PM												
US 1 & Route 606	Signalized	EBL	275	278	1.3	A	29.0	C	47.5	D	650	0
		EBT	255	254	56.9	E					5000	203
		EBR	105	107	34.7	C					650	203
		WBL	430	345	46.6	D	41.1	D			2250	448
		WBT	545	420	44.9	D					2250	448
		WBR	220	176	21.0	C					75	310
		NBL	60	58	82.2	F	39.5	D			300	96
		NBT	735	731	43.5	D					5000	427
		NBR	230	236	16.4	B					300	77
		SBL	150	140	90.8	F	60.5	E			275	478
		SBT	1120	1089	58.8	E					5000	2280
		SBR	790	765	57.3	E					275	1949
Dan Bell Ln & Route 606	Unsignalized	EBL	45	43	15.2	C	9.4	A	4.4	A	2250	211
		EBT	630	676	9.1	A					2250	211
		WBT	1170	901	0.2	A	0.2	A			150	0
		WBR	105	80	0.4	A					100	0
						A	7.9	A				
		SBR	65	128	7.9	A					500	61
I-95 SB Ramps & Route 606	Signalized	EBT	520	506	12.9	B	13.3	B	50	D	150	227
		EBR	175	170	14.8	B					150	227
		WBL	340	198	20.1	C	15.1	B			500	329
		WBT	680	400	12.6	B					500	329
		SBL	315	309	117.5	F	101.3	F			400	1813
		SBT	5	0	0.0	A					1330	1813
		SBR	595	581	92.7	F					1330	1813
I-95 NB Ramps & Route 606	Signalized	EBL	275	270	16.0	B	20.3	C	44.6	D	500	485
		EBT	560	547	22.5	C					500	485
		WBT	685	396	16.2	B	15.3	B			100	248
		WBR	520	319	14.2	B					100	193
		NBL	335	202	154.0	F	147.8	F			40	6239
		NBT	5	1	15.9	B					1170	6239
		NBR	320	194	141.6	F					1170	6136
Mallard Rd & Route 606	Unsignalized	EBT	680	571	2.4	A	1.9	A	44.7	E	100	32
		EBR	200	169	0.3	A					100	32
		WBL	10	8	5.7	A	15.8	C			100	169
		WBT	885	680	16.0	C					100	169
		NBL	320	34	1562.7	F	1500.1	F			3000	549
		NBR	20	2	176.5	F					300	187
Raceway & Route 606	Unsignalized	EBL	460	376	12.0	B	8.6	A	76.3	F	100	146
		EBT	225	183	2.0	A					100	146
		EBR	15	12	2.5	A					100	146
		WBL	5	5	11.3	B	22.6	C			3500	86
		WBT	430	438	23.6	C					3500	367
		WBR	20	19	4.7	A					260	86
		NBR	5	4	9.0	A	19.4	C			80	33
		SBL	20	10	267.4	F	351.3	F			300	766
		SBR	445	226	355.0	F					300	797
Total			15870	13043								
Percent Volume Served			82%									

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
2038 Final Build Alternative PM												
US 1 & Route 606	Signalized	EBL	275	260	141.6	F	94.6	F	61.4	E	650	476
		EBT	255	249	66.7	E					5000	476
		EBR	105	105	44.2	D					650	70
		WBL	430	432	57.7	E	51.8	D			2250	715
		WBT	545	525	53.7	D					2250	715
		WBR	220	222	35.7	D					75	572
		NBL	60	58	106.1	F	39.0	D			300	108
		NBT	735	737	41.2	D					5000	368
		NBR	230	236	15.6	B					300	69
		SBL	150	134	95.2	F	68.7	E			275	697
		SBT	1120	1048	65.8	E					5000	3543
		SBR	790	733	68.1	E					275	3542
Dan Bell Ln & Route 606	Unsignalized	EBL	45	42	17.5	C	5.4	A	2.6	A	2250	89
		EBT	695	678	4.7	A					2250	89
		WBT	1170	1167	0.2	A	0.2	A			150	2
		WBR	105	102	0.2	A					150	2
							11.2	B				
		SBR	130	128	11.2	B					500	81
I-95 SB Ramps & Route 606	Signalized	EBT	520	506	31.0	C	27.1	C	23.1	C	180	203
		EBR	175	173	15.9	B					140	183
		WBL	340	338	23.0	C	15.6	B			240	245
		WBT	680	676	11.9	B					525	245
		SBL	315	319	35.6	D	28.2	C			400	445
		SBT	5	5	22.1	C					1330	445
		SBR	595	593	24.3	C					1330	24
I-95 NB Ramps & Route 606	Signalized	EBL	275	271	49.8	D	19.6	B	19.1	B	540	200
		EBT	560	554	4.9	A					540	200
		WBT	685	680	21.6	C	14.0	B			315	429
		WBR	520	516	4.1	A					315	251
		NBL	335	335	44.1	D	27.4	C			1170	418
		NBT	5	4	28.4	C					1170	418
		NBR	320	326	10.2	B					500	45
Raceway & Route 606	Unsignalized											
		EBT	865	866	0.4	A	0.4	A	3.3	A	300	0
		EBR	15	14	0.1	A					300	0
							3.6	A				
		WBT	760	755	3.8	A					400	67
		WBR	480	483	3.3	A					300	67
		SBL	20	18	12.5	B	7.9	A			300	90
		SBR	445	438	7.7	A					300	73
(Relocated) Mallard Rd & Route 606	Roundabout	EBU	460	452	4.9	A	4.1	A	13.6	B	380	63
		EBT	230	235	4.0	A					380	63
		EBR	200	203	2.5	A					380	63
		WBL	15	19	33.8	D	30.5	D			2000	426
		WBT	440	444	30.3	D					2000	426
		NBL	340	341	15.4	C	15.3	C			500	113
		NBR	20	8	9.6	A					500	113
Total			14510	14269								
Percent Volume Served			98%									

Intersection	Control	Movement	Volume Input	VISSIM Thruput	Delay (sec)	LOS	App. Delay (sec)	LOS	Int. Delay (sec)	LOS	Storage	Max. Queue
2038 Modified Final Build Alternative PM												
US 1 & Route 606	Signalized	EBL	275	260	141.6	F	94.6	F	61.4	E	650	476
		EBT	255	249	66.7	E					5000	476
		EBR	105	105	44.2	D					650	70
		WBL	430	432	57.7	E	51.8	D			2250	715
		WBT	545	525	53.7	D					2250	715
		WBR	220	222	35.7	D					75	572
		NBL	60	58	106.1	F	39.0	D			300	108
		NBT	735	737	41.2	D					5000	368
		NBR	230	236	15.6	B					300	69
		SBL	150	134	95.2	F	68.7	E			275	697
		SBT	1120	1048	65.8	E					5000	3543
		SBR	790	733	68.1	E					275	3542
Dan Bell Ln & Route 606	Unsignalized	EBL	45	44	8.1	A	1.6	A	1.1	A	2250	60
		EBT	695	697	1.2	A					2250	60
		WBT	1170	1159	0.2	A	0.2	A			150	25
		WBR	105	107	0.1	A					150	25
							7.7	A				
		SBR	130	129	7.7	A					500	92
I-95 SB Ramps & Route 606	Signalized	EBT	520	530	11.9	B	9.8	A	13.4	B	180	155
		EBR	175	169	3.9	A					140	96
		WBL	340	328	14.9	B	12.8	B			280	189
		WBT	680	695	11.7	B					670	189
		SBL	315	305	25.8	C	16.9	B			1000	305
		SBT	5	3	14.2	B					400	305
		SBR	595	591	12.2	B					400	305
Mallard Rd & Route 606	Signalized	EBL	293	289	18.7	B	12.6	B	19.0	B	300	172
		EBT	143	133	23.9	C					670	195
		EBR	399	391	4.1	A					670	0
		WBL	202	204	14.9	B	20.7	C			175	122
		WBT	242	243	26.5	C					N/A	215
		WBR	11	10	0.4	A					200	0
		NBL	522	524	24.1	C	24.7	C			415	216
		NBT	176	179	28.4	C					415	336
		NBR	95	92	21.4	C					415	336
		SBL	15	13	28.1	C	19.1	B			300	180
		SBT	194	196	30.1	C					300	180
		SBR	256	259	10.4	B					300	168
Mallard Rd and I-95 NB Off-Ramp	Signalized	EBL	589	588	19.8	B	19.6	B	11.8	B	540	396
		EBR	71	75	18.3	B					540	396
		NBL	144	148	17.9	B	13.8	B			200	127
		NBT	216	221	11.2	B					N/A	158
		SBT	144	147	7.6	A	4.5	A			400	130
		SBR	651	645	3.8	A					315	58
Total			14053	13853								
Percent Volume Served			99%									

Queue greater than available storage

8.5 2038 Final Build Alternative Conditions

The geometric layout of this alternative at the subject interchange and east of the interchange is as shown in Figure 5-2. To the west of the interchange, Route 606 will be widened to two lanes in each direction by 2038 through a separate project. Refer to VDOT's Route 606 Corridor Study for all the improvements proposed west of the interchange.

The MOE's for Final Build Alternative are shown in Table 8-5 for freeway, and Table 8-6 (AM peak) and Table 8-7 (PM Peak) for intersections. As shown in these tables over 99 percent of the projected traffic demand is served in this alternative. The higher throughput, especially in the westbound direction when compared to No-Build Alternative results in longer queues at some locations. Key findings of the 2038 Final Build Alternative are listed below:

- I-95 Southbound and Northbound: In the AM peak hour, freeway operates at LOS C or better. During the Friday PM, due to high mainline volume, multiple locations on freeway mainline operate at LOS D. LOS D is a result of I-95 mainline volume and not the influence of operations at the interchange of Route 606. Travel speeds are above 57mph during both the peak hours;
- US Route 1/Route 606 Intersection: The intersection operates at LOS D in the AM with a couple of movements at LOS E. In the PM, the overall intersection operates at LOS E with some movements at LOS F. However, these movements do not impact operations at rest of the study area. Maximum queues exceed the storage length on some movements, but do not extend to the subject interchange. For this study, the intersection is assumed to have one additional lane in each direction between US Route 1 and the subject interchange. Refer to VDOT's Route 606 Corridor Study for all the improvements proposed at this intersection;
- Route 606/Dan Bell Lane Intersection: Based on VDOT's Route 606 Corridor Study, left-turning movements from Dan Bell Lane will be prohibited by 2038. These vehicles will turn right and make a U-turn at a proposed roundabout (between US Route 1 and Dan Bell Lane) to go eastbound on Route 606. As a result, the overall intersection operates at LOS B or better with minimal queues, with all approaches also operating at LOS C or better. In the AM peak hour, (as observed in the simulation) occasionally queues from the southbound ramp terminal intersection reach Dan Bell Lane resulting in 600-foot queues in the eastbound direction;
- I-95 Southbound Ramps /Route 606 Intersection: The overall intersection operates at LOS C during both the peak hours. All the movements operate at LOS C or better except, southbound left-turn movement (at LOS D). Maximum queues are expected to exceed the available storage on the eastbound approach extending beyond Dan Bell Lane. Westbound left-turn movement also has queues exceeded the storage length during the peak hours. However, queue clears completely every cycle;
- I-95 Northbound Ramps /Route 606 Intersection: The overall intersection is expected to operate at LOS C or better during the peak hours. Northbound left-turn and eastbound left-turn movements during both the peak hours operate at LOS D. Maximum queues on all the movements are within the available storage length, except westbound through movement, with the end of the queue reaching Dominion Raceway Avenue occasionally. However, queue clears completely during each cycle;

- Route 606/Dominion Raceway Avenue Intersection: This intersection operates at LOS A during both peak hours studied, with all the movements at LOS B or better. Queues do not exceed the available storage on any movements. Dominion Raceway Avenue has two outbound lanes and operates with a stop-controlled right-turn lane and a shared left/right lane onto Route 606. The Final Build Alternative includes directional signing on this approach regarding motorist destinations and lane use. Motorists oriented to I-95 northbound will need to be in the right-most right turn lane; motorists oriented elsewhere will be able to use either of the two right turn lanes;
- Route 606/Mallard Road Intersection: The roundabout will operate at LOS B or better during both the peak hours. On days with racetrack events scheduled for Friday evenings, the westbound approach of the roundabout is expected to operate at LOS D resulting in a maximum queue length of 426 feet.

8.6 2038 Modified Final Build Alternative Conditions

The geometric layout of the Modified Final Build Alternative at the subject interchange and east of the interchange is as shown in Figure 5-3. As with the Final Build Alternative, to the west of the interchange, Route 606 will be widened to two lanes in each direction by 2038 through a separate project. Refer to VDOT's Route 606 Corridor Study for all the improvements proposed west of the interchange.

With the Modified Final Build Alternative, Relocated Mallard Road and the proposed roundabout are eliminated by widening and upgrading Mallard Road to a commercially viable roadway that accommodates 2038 traffic demands. To accommodate improved Mallard Road, the Dominion Raceway Avenue is shifted to the west and aligned with Mallard Road to create a four-approach intersection at Route 606. Given the proximity of this intersection to the existing I-95 northbound ramps, the ramps are re-configured to connect directly to Mallard Road as opposed to Route 606. West of I-95, the operational characteristics match the Final Build Alternative (number of lanes, turn lanes), with geometric differences limited to the bridge being shifted further north to address constructability constraints.

Signalized intersections are provided at the intersection of Route 606 and the I-95 southbound ramps (matching the Final Build Alternative), the intersection of Route 606/Mallard Road/Dominion Raceway Avenue, and at the intersection of Mallard Road and the I-95 northbound ramps. Both the Route 606/Mallard Road/Dominion Raceway Avenue and Mallard Road/I-95 northbound ramps signals are not included in the Final Build Alternative, while the Final Build Alternative signal at Route 606 and the I-95 northbound ramps is eliminated due to the ramp reconfiguration. All signalized exclusive single left turn lanes are anticipated to operate as protected / permissive, and traffic signals will be coordinated which allows for the optimized flow of traffic from the I-95 ramps onto and off of Route 606.

With the Modified Final Build Alternative, direct connections for Dominion Raceway and Mallard Road are now provided. Along eastbound Route 606 a dedicated left turn lane is provided to Dominion Raceway Avenue, allowing for direct access without the need to by-pass the entrance and U-turn at the roundabout included in the Final Build Alternative. In addition, Dominion Raceway Avenue traffic to and from I-95 northbound is provided with a direct thru movement at Mallard Road, minimizing travel distances and travel times.

For the heavy eastbound Route 606 to I-95 northbound movements, the Modified Final Build Alternative allows for a free-flow movement from Route 606 to Mallard Road and another free-flow movement from Mallard Road to the northbound on-ramp, eliminating the delay associated with the signalized double left turn included in the Final Build Alternative. Exiting northbound I-95, traffic will first enter Mallard Road via double left turn lanes and then continue north to Route 606, where three lanes are provided (dual lefts and a shared thru/right). These multiple lanes minimize travel times while also ensuring that turn lane queue distances are accommodated within the available storage area.

The MOE's for the Modified Final Build Alternative are shown in Table 8-5 for freeway, and Table 8-6 (AM peak) and Table 8-7 (PM Peak) for intersections. As shown in these tables over 99.5 percent of the projected traffic demand is served. The results show that I-95 is anticipated to perform at much higher levels of service than the No-Build and with similar levels of service as the Final Build Alternative. The results also show that for the intersections, the Modified Final Build Alternative is anticipated to perform better than both the No-Build and the Final Build Alternative, with less delay (all intersections east of Route 1 operate at LOS A or B) and smaller queues than the Final Build Alternative. Key findings of the 2038 Modified Final Build Alternative are listed below:

- I-95 Southbound and Northbound: Similar to the Final Build Alternative, in the AM peak hour, freeway operates at LOS C or better. Also similar to the Final Build Alternative, during the Friday PM, due to high mainline volume, multiple locations on freeway mainline operate at LOS D. LOS D is a result of I-95 mainline volume and not the influence of operations at the interchange of Route 606. Specifically, for traffic exiting I-95 northbound, maximum queues are several hundred feet short of mainline I-95. Travel speeds are above 61 mph during both the peak hours. Nearly the same results along I-95 are found with the Modified Final Build Alternative and the Final Build Alternative as geometric configurations along I-95 are identical for both alternatives;
- US Route 1/Route 606 Intersection: This intersection is located approximately 0.5 miles west of the subject interchange, on the opposite side of the planned Route 606 widening (by others). Therefore, with the same volumes and configuration as the Final Build Alternative, the Modified Final Build Alternative results are expected to be the same for the Final Build Alternative results, and are therefore carried over from the Final Build Alternative. Specifically, the intersection operates at LOS D in the AM with a couple of movements at LOS E. In the PM, the overall intersection operates at LOS E with some movements at LOS F. However, these movements do not impact operations of the subject interchange. Maximum queues exceed the storage length on some movements, but do not extend to the subject interchange. For this IMR, the intersection is assumed to have one additional lane in each direction between US Route 1 and the subject interchange. Refer VDOT's Route 606 Corridor Study for all the improvements proposed at this intersection;

- Route 606/Dan Bell Lane Intersection: Based on VDOT's Route 606 Corridor Study, left-turn from Dan Bell Lane will be prohibited by 2038. These vehicles will turn right and make a U-turn at a proposed roundabout (between US Route 1 and Dan Bell Lane) to go eastbound on Route 606. As a result, with the Modified Final Build Alternative, the overall intersection operates at LOS A with minimal queues, with all approaches also operating at LOS A. In the AM peak hour, (as observed in the simulation) occasionally queues from the I-95 southbound ramp terminal intersection reach Dan Bell Lane, yet these queues do not result in operational concern, as they do not block any movements at the Dan Bell Lane intersection (see Section 8.7 for an expanded discussion);
- I-95 Southbound Ramps/Route 606 Intersection: The overall intersection operates at LOS B during both the peak hours. All approaches operate at LOS B or better, with all individual movements also operating at LOS B or better except southbound left-turn movement (at LOS C). Maximum queues are expected to exceed the available storage on the eastbound approach extending beyond Dan Bell Lane in the AM peak (similar to the Final Build Alternative where this condition existed in both the AM and PM peaks). Although this queue extend through Dan Bell Lane, it will not result in the undesirable condition of turn lanes blocking thru lanes, as this queue is the thru movement queue. No other queues exceeded the storage length during the peak hours;
- Mallard Road/Route 606 Intersection: The overall intersection is expected to operate at LOS B or better during both peak hours while providing full direct access to and from all four approaches. All approaches operate at LOS C or better, with all individual movements also operating at LOS C or better. The heaviest AM movement (eastbound left turn) is served by a free-flow right, resulting LOS A operations. Maximum queues on all the movements are within the available storage length;
- I-95 Northbound Ramps/Mallard Road Intersection: The overall intersection is expected to operate at LOS B or better during both peak hours. All approaches operate at LOS B or better, with all individual movements operating at LOS C or better. The heaviest movement in both the AM and PM peak (southbound right turn) is served by a free-flow right, resulting LOS A operations. The movement exiting I-95 northbound to Route 606 (eastbound left turn) also operates at LOS B in both peaks with maximum queues only reaching 73% of capacity (as compared to LOS D for these movements (northbound left turn) for both peaks with the Final Build Alternative). Maximum queues on all the movements are within the available storage length, with maximum queues for traffic exiting I-95 northbound several hundred feet short of mainline I-95. Furthermore, this queue length is likely over-reported, as VISSIM codes some slow moving traffic as queued traffic. For normal operations, this signal will be phased to "rest" on green for this off-ramp approach, minimizing the occurrence of regular queuing.

The weaving segment on southbound Mallard Road (between Route 606 and the I-95 northbound ramps) and the merge segment on the northbound I-95 exit ramp were also assessed, as these are unique to the Modified Final Build Alternative. In the weaving section, traffic from Route 606 destined for Mallard Road south of the northbound I-95 ramp terminals and traffic from westbound Route 606 destined for I-95 perform a lane change in this section. In the merge area, traffic from northbound Mallard Road making a signalized left onto the ramp merges into traffic from southbound Mallard Road making the free flow right, forming a single lane.

As seen in Table 8-8, the weave operates adequately, with acceptable speeds and has no spill-back onto Route 606 (as can be seen on Tables 8-6 and 8-7). Furthermore, as seen in the table below, this southbound approach to the northbound I-95 ramp processes vehicles well, with an LOS of C in the AM, an LOS of A in the PM, and queues below the storage capacity. As seen in Table 8-9 the merge also processes vehicles well, given the relatively low northbound left turn volumes, with LOS D in the AM and LOS B in the PM.

Table 8-8: Southbound Mallard Road Weaving

	Speed (mph)		Density (v/mi/ln)	
	AM	**PM**	**AM**	**PM**
Right Lane	15.6	17.9	59.1	28.7
Left Lane	14.1	21.8	25.5	9.6

Table 8-9: Northbound I-95 On-Ramp (Ramp B) Merge

	Speed (mph)		Density (v/mi/ln)	
	AM	**PM**	**AM**	**PM**
Right Lane	15.3	15.8	59.3	29.8
Left Lane	12.6	12.3	4.4	5.1

8.7 SUMMARY OF FINDINGS

Both the Final Build Alternative and the Modified Final Build Alternative focused on improving Route 606 at and east of the subject interchange without impacting operations on I-95 mainline. Based on the findings described above, all the intersections at and east of the interchange operate at LOS C or better for the Final Build Alternative (LOS B or better for the Modified Final Build Alternative) under Build Conditions when compared to failing conditions of the No-Build Alternative. Under Build Conditions for both the Final Build Alternative and the Modified Final Build Alternative, freeway segments within the study area operate at free-flow speed with minimal congestion. These results validate that both the Final Build Alternative and the Modified Final Build Alternative have better LOS throughout the study area when compared to the No-Build Conditions.

To compare the Final Build Alternative to the Modified Final Build Alternative, Table 8-9 below presents a summary of operational differences at and east of the subject interchange for the MOE's presented in Tables 8-6 thru 8-7. As detailed in this Section, the Modified Final Build Alternative operates better than the Final Build Alternative.

Table 8-10: Measure of Effectiveness (MOE) Comparison

MOE	**Final Build Alternative (FBA)**	**Modified Final Build Alternative (MFBA)**	**Better Operations**
I-95 Movements LOS	14 Segments at LOS C or better 7 Segments at LOS B or better	15 Segments at LOS C or better 7 Segments at LOS B or better	MFBA (nearby equal)
Intersection Delay LOS (AM)	3 at LOS C 2 at LOS A or B	0 at LOS C 4 at LOS A or B	MFBA
Movement Delay LOS (AM)	4 at LOS D 6 at LOS C 22 at LOS A or B	0 at LOS D 11 at LOS C 19 at LOS A or B	MFBA
Queue Exceeding Storage (AM)	3 Movements	2 Movements	MFBA
Intersection Delay LOS (PM)	1 at LOS C 4 at LOS A or B	0 at LOS C 4 at LOS A or B	MFBA
Movement Delay LOS (PM)	5 at LOS D 8 at LOS C 19 at LOS A or B	0 at LOS D 8 at LOS C 22 at LOS A or B	MFBA
Queue Exceeding Storage (PM)	5 Movements	0 Movements	MFBA

As shown in Tables 8-6 and 8-7, the Modified Final Build Alternative Level of Service for all intersections is equal to or better than the Final Build Alternative. All Modified Final Build Alternative intersections for both periods operate at LOS A or LOS B, while for the Final Build Alternative, three intersections operate at LOS C in the AM Peak and one intersection operates at LOS C in the PM peak. Looking deeper into the results at individual movements, the Modified Final Build Alternative has no approaches or movements operating at an LOS D or worse for either peak period.

With the Final Build Alternative, four movements operate at LOS D in the AM Peak and five movements operate at LOS D in the PM peak. Also, for the highest volume individual movement (Route 606 eastbound to I-95 northbound), the signalized double left with 49 seconds of delay per vehicle (LOS D) with the Final Build Alternative is replaced with free-flow right turn movements in our concept (LOS A), providing a substantial improvement for this highest volume movement.

Regarding queues, the Modified Final Build Alternative queue lengths are also improved compared to the Final Build Alternative as follows:

- In the AM peak, there are only two queue lengths associated with the Modified Final Build Alternative that exceed the available storage (compared to three with the Final Build Alternative). It should be noted that the 180 feet eastbound thru and 140 feet eastbound right turn storage distances listed in the tables for these two movements will in fact not exceed available turn bays. These distances purely represent the distance to the next intersection (Dan Bell Lane), which is a half intersection with no minor approach thru movements with the only left turn movement being eastbound left turn (turn movement allowed and EBL, WBR, SBR). This eastbound left from Route 606 onto Dan Bell Lane is not blocked by these queue lengths at the I-95 southbound ramps intersection, as the eastbound left turn bay starts at a point approximately 300 feet west of the stop bar (greater than the queue distance of 269 feet). Therefore, this queue does not result in operational concern;
- In the PM peak, no queue lengths associated with the Modified Final Build Alternative exceed the available storage (compared to five with the Final Build Alternative). Furthermore, the Final Build Alternative has queues exceeding storage capacity and movements with LOS D for delay at both of the I-95 ramp intersections, while the Modified Final Build Alternative eliminates these undesirable conditions.

9 SAFETY ANALYSIS

This Section presents the safety analysis for the Existing Conditions, No-Build, Final Build Alternative, and Modified Final Build Alternative. The analysis is based on reported crash data available for the section of I-95, surface streets, and intersections in the study area for the three-year period from 2014 thru 2016, the latest three years of available data at the time of this report. The analysis is performed in accordance with the methods identified FHWA's Interstate System Access Informational Guide.

The study area for the safety analysis is shown in Figure 3-1. For the No-Build and Build scenarios, a qualitative analysis of roadway safety is presented in the narrative that follows.

9.1 HISTORICAL CRASH DATA

Three years of crash data (From January 2014 thru December 2016) were obtained from VDOT in GIS format for the entire study area. The data contained crash information by route number, location, date, time, crash type, severity, and other factors associated with each crash. Crashes were segregated by the facility type that they occurred on, including freeways, ramps, arterial streets and intersections as shown in Table 9-1. The crash data was also geographically analyzed, shown in Figure 9-1, to identify potential contributing factors like geometric design features, traffic operations, and accesses that might influence the safety performance of the corridor. Full detail of the crash data is found in Appendix G of this IMR.

A detailed review of the crash types and patterns, presented in the following Section, was conducted to identify key contributing factors.

Table 9-1: Study Area Crash Summary

Parameter	Crashes by Year			Annual Average
	2014	2015	2016	
Segments				
I-95 Northbound Mainline	7	12	11	10
I-95 Southbound Mainline	9	6	2	6
Route 606 – West of Northbound Ramps *	4	5	3	4
Route 606 – East of Northbound Ramps *	1	1	1	1
Intersections				
US Route 1/Route 606	12	5	**	9
Dan Bell Lane/Route 606	2	2	2	2
I-95 Southbound Ramps/Route 606	2	5	2	3
I-95 Northbound Ramps/Route 606	5	2	3	3
Mallard Road/Route 606	3	0	2	2
Ramps				
I-95 Ramps at Route 606 Interchange	1	2	2	2
Total	**46**	**40**	**37**	**41**

* *EXCLUDES CRASHES THAT ARE WITHIN 200 FEET OF THE INTERSECTIONS*

** *INCOMPLETE INTERSECTION INFORMATION AVAILABLE FOR 2016, 2016 TOTAL BASED ON AVERAGE*

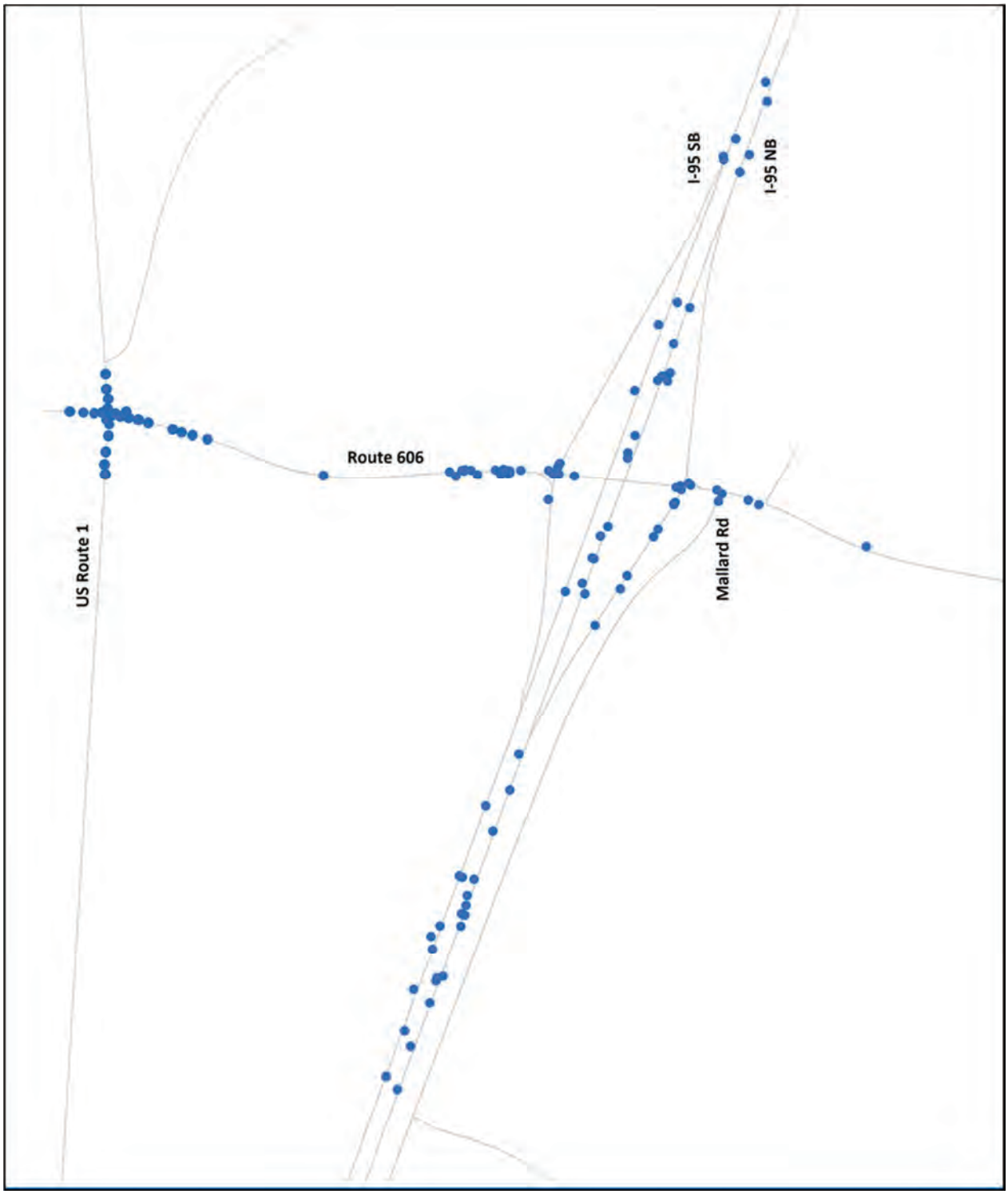


Figure 9-1: Study Area Crashes between 2014 and 2016

9.2 Crash Analysis by Facility

9.2.1 Freeway Mainline

A total of 47 crashes were reported to have occurred on the I-95 mainline travel lanes within the study area from 2014 to 2016. Figure 9-2 summarizes the annual crash frequencies (crashes per year) by freeway direction for the I-95 corridor. In 2014 more crashes occurred in the southbound direction, while more crashes occurred in the northbound direction in 2015 and 2016.

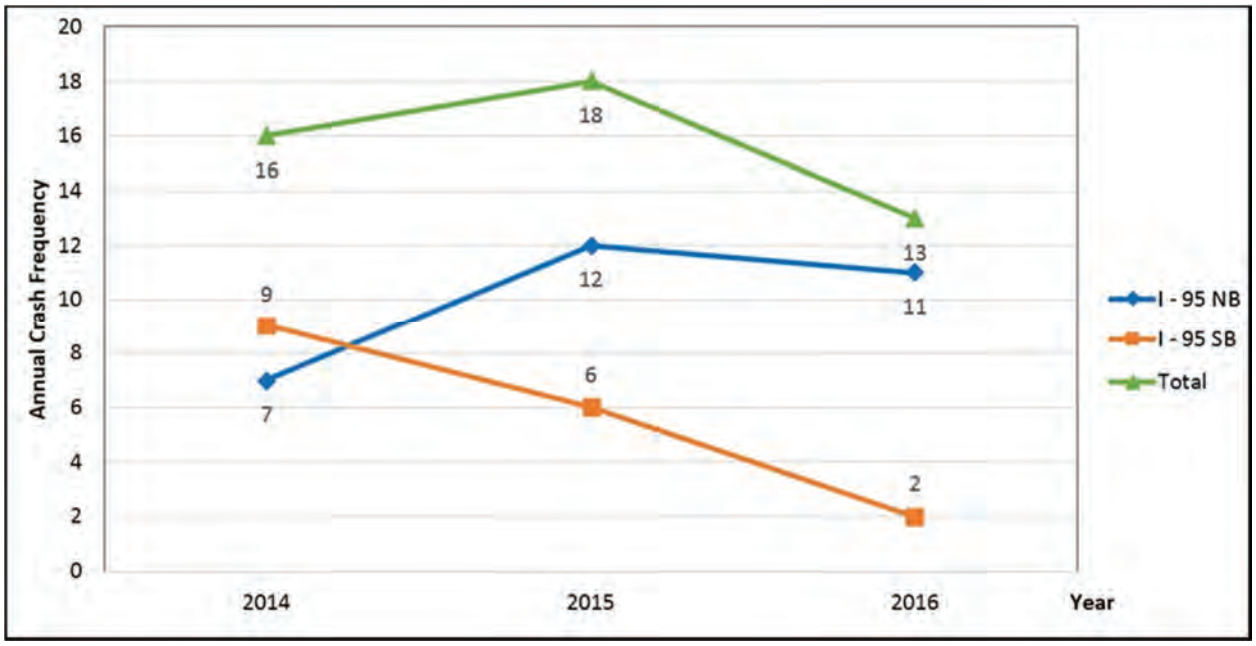


Figure 9-2: Annual Crash Frequencies on the I-95 Corridor

During the three-year period studied, no crashes on I-95 resulted in fatalities while 15 crashes (32 percent) resulted in injuries. Of these injury crashes, there were a total of 23 injuries (average of 1.5 injuries per crash). The remaining crashes resulted in property damage only. Figure 9-3 summarizes the crash severity for all the crashes on I-95 in the study area over the three-year period.

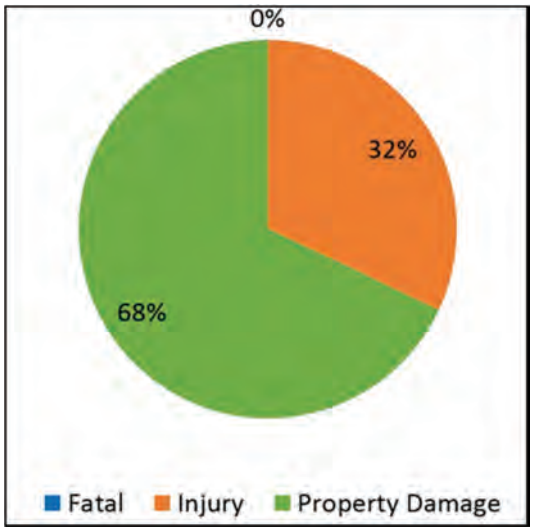


Figure 9-3: Crash Severity on I-95

The crash rate, the number of crashes per hundred-million vehicle miles of travel (HMVMT), was calculated by freeway direction for I-95 within the study area using the annual number of crashes and the Annual Average Daily Traffic (AADT). These directional crash rates for I-95 are summarized in Table 9-2. The average crash rates on I-95 northbound is higher than the statewide rural interstate average of 42.3 crashes per HMVMT, while the crash rate on I-95 southbound is lower than the statewide average. This rate is likely skewed by the short length of the freeway segment studied (approximately one mile), or the presence of an interchange in the study segment.

Table 9-2: Annual Crash rate on I-95

	I-95 Northbound		I-95 Southbound	
	AADT	**Crash Rate**	**AADT**	**Crash Rate**
Year 2014	46,500	41	47,500	52
Year 2015	48,500	68	49,000	34
Year 2016*	49,500	61	50,000	11
Average AADT**	48,167		48,834	
Length (mi)	1		1	
Crashes	30		17	
Average Crash Rate	57		32	
Statewide Average Crash Rate	42.3			

Crash Rate HMVT = (# of Crashes Per Year x 100,000,000) / (AADT x 365 x Segment Length)

**Estimated based on historic growth rates*

*** Weighted average of AADT on either side of the subject interchange*

Crash experience on I-95 by collision type is shown in in Figure 9-4. The most common crash type was rear-end crashes (21) which accounts for 45 percent of all crashes. These crashes are predominately in the northbound direction (14). Fixed object-off road (11) are the next most common collision type, accounting for 23 percent of the total, followed by both angle (8) at 17 percent of the total and side-swipe same direction (6) at 13 percent of the total. There was one deer crash that accounted for 2 percent of mainline crashes.

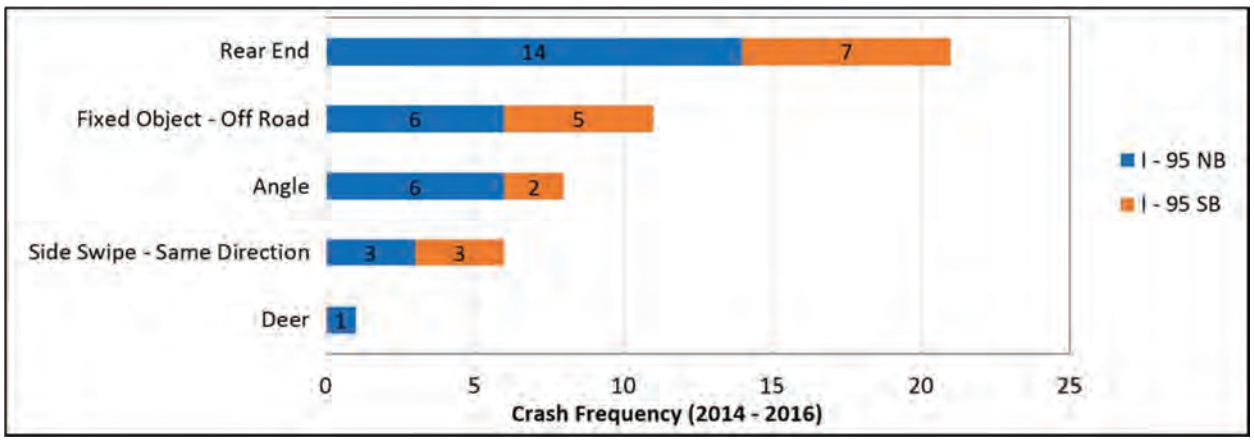


Figure 9-4: Number of Crashes on I-95 by Type (2014 - 2016)

Figure 9-5 summarizes the number of crashes by time of the day. For both directions, more crashes occurred during the afternoon and evening hours than any other time of day.

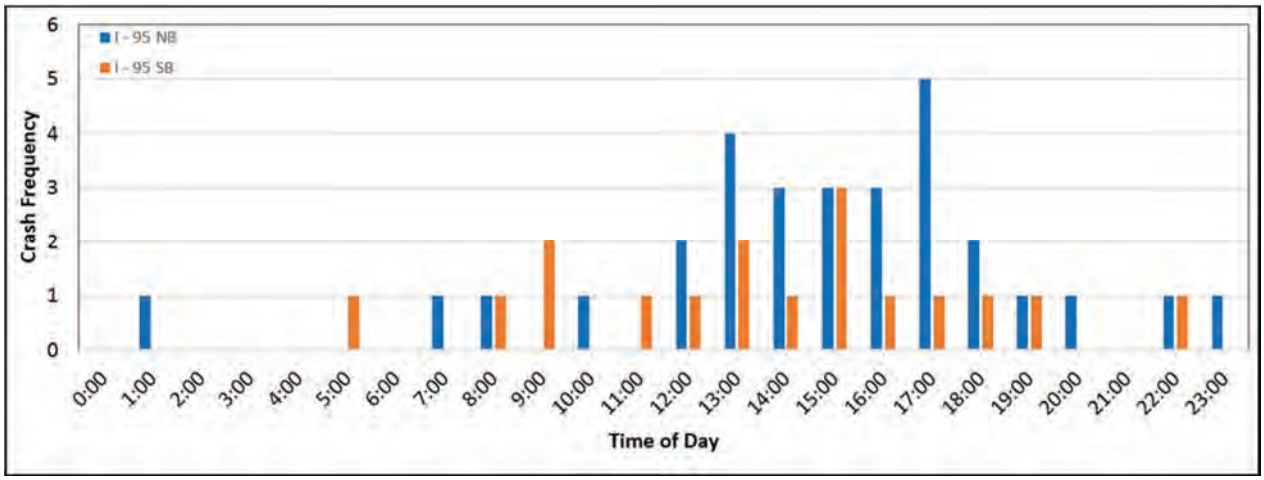


Figure 9-5: Crash Frequency by Time of Day (2014 - 2016)

9.2.2 Interchange Ramps

There were five crashes reported on the ramps at the interchange of I-95 and Route 606 between 2014 and 2016, all along the I-95 northbound off-ramp. A fixed object – off road (tree) crash occurred in 2014 and four rear end crashes occurred on this ramp (two in 2015 and two in 2016). These northbound off-ramp crashes are an indication of existing queuing present at this location in the PM peak hour, which is further evidenced by Figure 9-5 displaying crashes by time of day. Crashes within 200 feet of intersections were analyzed as part of the corresponding intersection.

9.2.3 Route 606

A total of 15 crashes occurred in three years on Route 606 excluding the crashes that occurred with the intersection areas of influence, which measures 200 feet on each approach. Of these crashes, eight were angled, five were rear ends, one was sideswipe – same direction, and one was fixed object – off road (tree). The majority of these crashes were concentrated at the access points to/from the businesses along Route 606. The rear end crashes are likely due to vehicles slowing down/stopping on Route 606 to enter these businesses. Angle crashes are possibly due to aggressive turns made by drivers exiting the businesses with insufficient gaps in the traffic flow on Route 606.

Twelve of the 15 crashes occurred west of the interchange, where there are 12 access points (ap) along Route 606 within 1,320 feet of the southbound ramp terminal intersection, which equate to an access point density of 48.7 ap/mi. East of the interchange, three crashed were reported on Route 606 between 2014 and 2016. With five access points located within 1,320 feet of the northbound ramp terminus, this roadway segment has an access point density of 20.3 ap/mi.

9.2.4 Intersections

A total of 47 crashes occurred at the five intersections located within the study area between 2014 and 2016. Of these crashes, a majority occurred at the US Route 1/Route 606 intersection, with an annual average of 9 crashes per year, compared to the next closest average of 3 per year.

Of the crashes reported at the intersection of Route 606/US Route 1, nine were angled and four were rear end. The left-turning movements on US Route 1 are permissive with no protected green time. Driver uncertainty is a key contributing factor for angle crashes, as left-turning vehicles have to cross three travel lanes on the mainline. The rear end crashes can be attributed to the shared left and thru movements on US Route 1 and westbound Route 606. The potential for these crashes will likely be reduced into future years with the recent intersection improvements by VDOT completed in 2016. These improvements added exclusive left turn lanes on Route 1 (with a signalized protected turn phase utilizing protected / permissive phasing with a flashing yellow area), added a physical median on Route 1, and relocated South Roxbury Mill Road away from the intersection of Route 606/US Route 1.

At the Route 606/Dan Bell Lane intersection, a total of six crashes were reported between 2014 and 2016. All six of these crashes were angled. This intersection is stopped-controlled on the minor approach (Dan Bell Lane), which includes retail establishments. Similar to the crashes at driveways, these crashes are likely due to vehicle exiting from Dan Bell Lane trying to find gaps in the free flowing traffic.

At the Route 606/I-95 southbound ramp terminal intersection, there were nine reported crashes. Five of these crashes were rear end while two were angled and two were a fixed-object – off road. The southbound exit ramp from I-95 is stop controlled. Conservative drivers are less likely to find gaps in traffic on Route 606, while the drivers behind them assume they are turning and collide with vehicle ahead resulting in rear end crashes. Aggressive drivers who turn without sufficient gaps on Route 606 may cause angle crashes.

The Route 606/I-95 northbound ramp terminal intersection had ten reported crashes between 2014 and 2016. Of these crashes, five were rear end crashes and five were angled collisions. Similar to the southbound exit ramp, the northbound exit ramp from I-95 is also stop controlled. Conservative drivers are less likely to find gaps in traffic on Route 606, while the drivers behind them assume they are turning and collide with vehicle ahead resulting in rear end crashes. Aggressive drivers who turn without sufficient gaps on Route 606 may cause angle crashes.

At the Route 606/Mallard Road intersection, a total of five crashes were reported. Five of these crashes were angled, and one was rear-end. This intersection is stopped-controlled on the minor approach (Mallard Road), and angled crashes are likely due to vehicle exiting Mallard Road trying to find gaps in the free flowing traffic.

9.3 2038 No-Build Safety Conditions

The roadway geometry and intersection control changes to the study network in the No-Build are presented in Section 6.1. The following crash patterns are estimated for the No-Build Conditions using Crash Modification Factors (CMF) from the Highway Safety Manual (HSM) wherever applicable and engineering judgment for other locations:

- On Route 606, west of the interchange, there are numerous driveways and stop-controlled intersections. The access point density does not change, but with increased traffic, angle and rear end crashes will increase;
- On Route 606, east of the interchange, access point density is similar to Existing Conditions at 20.3 ap/mi. However, in the No-Build Conditions, the traffic volume at most of these access points is much higher;
- With VDOT's recent improvements to the intersection of Route 606/US Route 1:
    - Left-turn bays on northbound and southbound approaches has a CMF 0.67 (for all types of crashes) which results in reduction of crash frequency by 33 percent. Protected left-turn phasing on Route 1 which will particularly reduce the angle crashes;
    - Lengthening the right-turn bays on the northbound and southbound approaches will reduce the potential for queues to block adjacent thru lanes, and therefore potentially improve traffic operations (no CMF available);
- Signalization of the ramp termini (CMF 0.56) is expected to reduce overall crashes by 44 percent at each intersection, especially the angle crashes. However, rear end crashes are expected to increase (CMF 1.58);
    - Even with signalization of the ramps under No-Build Conditions, it is expected that the ramp queues from the ramp termini will extend back onto the mainline I-95, which will increase rear end and sideswipe crashes at the exit ramp gore points;
- As Route 606 will be a single lane without left-turn bays at the ramp termini, left-turning vehicles unable to find gaps block the lanes resulting in queues extending to Route 1 in the eastbound direction and beyond the study area in the westbound direction. This will result in higher crash frequency on Route 606;

- The raceway development (Dominion Raceway Avenue) is located approximately 170 feet from intersection of Mallard Road and approximately 350 feet from the existing northbound ramp terminus (measured centerline-to-center of roundabout). During raceway events, the queue for the left turn movement from eastbound Route 606 into the raceway is expected to extend to the Mallard Road intersection. This condition has the potential to increase crash frequency;
- In the study area, traffic is expected to grow due to planned/forecast land development projects. As a result, the number of crashes per year is expected to increase on I-95. Additionally, queues from the exit ramps in the northbound and southbound directions will result in unsafe conditions on the freeway, likely further increasing crash rates.

9.4 2038 Final Build Alternative Safety Conditions

The following presents the expected crash patterns in the future from implementing the proposed improvements associated with the Final Build Alternative. Also identified are safety countermeasures taken, with corresponding CMF, which will potentially improve safety as compared to the No-Build Conditions:

- On Route 606 east of the interchange, the Final Build Alternative relocates Mallard Road, closes three access points, and reconfigures two access points into a right-in/right-out operation. Based on the Highway Safety Manual (HSM), reducing the access point density on a suburban arterial is expected to reduce the crash potential by 31 percent (CMF 0.69);
- As the intersection of Route 606/US Route 1 will have the same geometry as the No-Build, refer to Section 9.3 of this IMR;
- The Final Build Alternative provides an exclusive left-turn lane in westbound direction (CMF 0.85) at the southbound ramp terminal intersection. Exclusive turn lanes reduce the potential for rear end collisions, and by reducing the possibility of the through movement to be blocked by turning traffic;
- At the northbound ramp terminal intersection, dual left-turn lanes are proposed in the eastbound direction where no turn lanes exist in No-Build Conditions. Exclusive turn lanes will reduce the crash potential by 15 percent (CMF 0.85). By adding a second left-turn lane, 29 percent reduction in all crashes for that movement may be realized based on the 2004 FHWA document “Signalized Intersections: Informational Guide”. As a result, a dual turn-lane at this location results in an overall crash reduction of over 40 percent;
- Converting the intersection of Mallard Road from a stop controlled intersection to a roundabout has the potential to reduce the crash rate by 44 percent (CMF 0.56). The Mallard Road intersection at Route 606 would be relocated approximately 650 feet east of its present location. This improvement, in concert with access control measures along Route 606, would prevent queues from reaching the interchange ramps during raceway events.

9.5 2038 Modified Final Build Alternative Safety Conditions

Matching the format of the Final Build Alternative safety conditions (Section 9.4), this Section presents the expected crash patterns in future from implementing the proposed improvements in the Modified Final Build Alternative. Also identified are safety countermeasures taken, with corresponding CMF, which will potentially improve safety as compared to the No-Build Conditions:

- On Route 606 east of the interchange, the Modified Final Build Alternative re-configures Dominion Raceway Avenue to align with Relocated Mallard Road creating a four-approach signalized intersection, eliminates the intersection of Route 606 and the I-95 northbound ramps, closes two access points, and reconfigures one access point into a right-in/right-out operation. Based on the Highway Safety Manual (HSM), reducing the access point density on a suburban arterial is expected to reduce the crash potential by 31 percent (CMF 0.69);
- For the intersection of Route 606/Mallard Road/Dominion Raceway Avenue described above, the proposed signalization in the Modified Final Build Alternative has the potential to reduce the crash rate by 44 percent (CMF 0.56);
- As the intersection of Route 606/US Route 1 will have the same geometry as the No-Build, refer to Section 9.3 of this IMR;
- The Modified Final Build Alternative provides an exclusive left-turn lane in the westbound direction (CMF 0.85) at the southbound ramp terminal intersection. Exclusive turn lanes reduce the potential for rear end collisions, and by reducing the possibility of the through movement to be blocked by turning traffic;
- The existing northbound ramp terminal intersection at Route 606 is eliminated with the Modified Final Build Alternative, as I-95 northbound ramp traffic is re-configured to intersect Mallard Road. The removal of this intersection will eliminate the potential for intersection related crashes (there were 10 reported in the past three years);
- While the existing I-95 northbound ramp terminal intersection at Route 606 is eliminated, a new intersection with the northbound ramp termini is created along Mallard Road. Compared to the existing northbound ramp terminal intersection with no turn lanes on the major approach, Mallard Road will be upgraded to have both left and right turn lanes to enter the ramps. Compared to the existing access conditions of no turn lanes, the addition of the left turn lane to access I-95 has the potential to reduce the crash rate by 15 percent (CMF 0.85), while the addition of the right turn lane to access I-95 has the potential to reduce the crash rate by 4 percent (CMF 0.96). Entering the I-95 northbound on-ramp, a merge condition is introduced, which may introduce crash potential on this ramp. Any potential crashes introduced here will be relatively low-speed and same direction, which generally are less severe. This potential increase is offset by the elimination of the I-95 northbound ramps and Route 606 intersection described above, which would have exhibited potential for high severity angled crashes, and which also would have had a ramp merge condition from two lane to one. Queuing on the modified I-95 northbound exit ramp is not expected to be a concern, as the modified ramp has excess capacity in the design year (See Section 8.6 for discussion).

9.6 Summary of Crash Data Analysis

Under Existing Conditions, the calculated crash rate on I-95 northbound is higher than the statewide rural interstate average, while the crash rate on I-95 southbound is lower than the statewide average. However, the elevated crash rate is likely attributable to the short length of the study area (one mile) and the operational effects of the interchange ramps where crash rates can be higher than those experienced on longer interstate segments. The leading type of crashes on the mainline within the study area is rear-end crashes, followed by fixed object-off road, and then both angle crashes. A majority of the crashes along Route 606 and at its unsignalized intersections are angle and rear-end crashes. These crashes are likely due to numerous closely spaced driveways, lack of exclusive turn-lanes and stop-controlled intersections along Route 606.

Under 2038 No-Build Conditions, improvements throughout the corridor associated with proffers from the raceway development and Route 606 widening on the west side of the study interchange are in place. Improvements in geometry and signal phasing at the US Route 1/Route 606 intersection, as well as signalization of the ramp terminal intersections, will result in reduced crash potential and improved traffic operations at those locations. However, to the east of the study interchange, several key movements will still experience severe delay during peak hours and long queues on eastbound and westbound Route 606 are expected to result in elevated crash potential. Queues on the ramp approaches to Route 606 are expected to extend back to I-95 mainline, affecting freeway operations and increasing the potential for crashes on the mainline.

The 2038 Final Build Alternative Conditions incorporates substantial geometric improvements, including widening the bridge over I-95 and incorporating exclusive left-turn bays, reducing access point density, replacing two-way stop controlled operations with a roundabout at the Route 606/Mallard Road intersection, and increasing the capacity of Route 606. Improvements along Route 606 are expected to result in free-flow conditions in the eastern section of the corridor, and reduce the potential for crashes. Exclusive turn lanes at the ramp terminal intersections are also expected to significantly reduce the crash potential along Route 606.

The 2038 Modified Final Build Alternative Conditions builds on the geometric improvements of the Final Build Alternative to provide further conflict resolution for heavy volumes of traffic entering / exiting northbound I-95, delay reduction, and driver navigation improvements. This alternative also includes widening the bridge over I-95 and incorporating exclusive left-turn bays with permissive / protected (p/p) phasing, reducing access point density, and increasing the capacity of Route 606. Furthermore, the Modified Final Build Alternative eliminates a full intersection along Route 606 (the I-95 northbound ramp intersections) by replacing the heavy eastbound double left turn movement with a free flow right turn movement to access I-95 northbound, reducing the potential for crashes. Exclusive turn lanes at the ramp terminal intersections are also expected to significantly reduce the crash potential along Route 606.

Also with the 2038 Modified Final Build Alternative, driver navigation improvements include more direct, intuitive movements (such as for eastbound drivers destined to Dominion Raceway, westbound drivers destined for Mallard Road, and northbound Mallard Rod drivers destined for Route 606). While some movements are subject to additional turns (such as westbound Route 606 destined for northbound I-95), the low volume associated with this movement is outweighed by the simplified high volume movement from eastbound Route 606 to northbound I-95.

In summary, both the 2038 Final Build Alternative and the 2038 Modified Final Build Alternative are expected to significantly reduce the crash potential in the corridor. Table 9-3 and the following discussion below tabulates the conflict points and compares these two alternatives. In comparing the 2038 Final Build Alternative to the 2038 Modified Final Build Alternative east of Dan Bell Lane (where there are geometric differences in the alternatives), no significant difference in crash potential is predicted.

Table 9-3 FBA and MFBA Safety Comparison

Feature	Final Build Alternative (FBA)	Modified Final Build Alternative (MFBA)	Less Crashes Likely
Intersections / Access Points Along Route 606	2 Signalized 1 Un-signalized 1 Roundabout	2 Signalized 0 Un-signalized 0 Roundabout	MFBA
Left Turns Along Route 606	Exclusive Turn Lanes Protected or p/p	Exclusive Turn Lanes Protected or p/p	Equal
Mallard Road Intersections	0 Signalized Intersections 1 stop intersection	1 Signalized Intersection 0 stop intersections	Equal
Mallard Road Weaving	0 Weaves	1 Weave	FBA
I-95 Operations	2 Single Lane Merges 2 Single Lane Diverges	2 Single Lane Merges 2 Single Lane Diverges	Equal
I-95 Ramps	1 merge (NB on-ramp)	1 merge (NB on-ramp)	Equal

- For intersections and access points along Route 606, the FBA includes 2 signalized intersections, 1 un-signalized intersection (Dominion Raceway), and 1 roundabout (Mallard Access Rd), while the MFBA includes 2 signalized intersections, 0 un-signalized intersections and 0 roundabouts. With the consolidation and elimination of intersections along Route 606, the MFBA is likely to have less crashes;
- For left turns along Route 606, both the FBA and MFBA are to have protected or permissive / protected left turn phasing;
- For intersections along Mallard Road, the FBA has one un-signalized intersection while the MFBA has one signalized intersection. Conversion to a signalized intersection has a CMF of 0.95, but since the MFBA intersection carries additional volume, neither alternative is anticipated to have predictable differences;
- For Mallard Road weaving, the MFBA introduces a weave condition (see Section 8.6 for analysis). Although crash severity is likely to be low (side-swipe), the MFBA has increased crash potential;
- For I-95 Operation, both the FBA and MFBA will retain the existing merge / diverge conditions;
- For I-95 Ramps, both the FBA and the MFBA will have a single merge on the northbound I-95 entrance ramp (two lanes to one). Although classified as equal on the table, and argument can be made that the MFBA will likely have less crashes, as traffic entering this merge will be more distributed over time (with the FBA the merge originates from signalized double left turn lanes, where vehicles entering the merge will be concentrated at the same time when presented with the left turn phase, likely increasing crash potential).

10 Environmental Compliance

The Modified Final Build Alternative is located within existing and proposed public right-of-way and entirely within the National Environmental Policy Act (NEPA) study limits and Area of Potential Effect (APE) of the Final Build Alternative. The Environmental Re-Evaluation, provided as Appendix D with this IMR, offers an updated summary of the project's environmental impacts as well as updated database reviews from the regulatory agencies. All necessary environmental documentation for compliance with NEPA and all necessary federal, state and local permits, certifications and approvals will be obtained for the proposed interchange improvements prior to project construction.

11 Appendices

Appendix A: I-95/Route 606 Interchange Improvements Build Alternative Analysis Report;

Appendix B: Access Management Spacing Waiver (AM-W);

Appendix C: Categorical Exclusion (Federal Project #: STP-5111(272) (UPC 105463)) and Programmatic Categorical Exclusion (Federal Project #: BR-5111(237) (UPC 100829));

Appendix D: Environmental Re-Evaluation;

Appendix E: VISSIM Assumptions and Calibration Methodology;

Appendix F: Comparison of Forecasts Memorandum;

Appendix G: 2014-2016 Crash Data.