STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

OFFICE OF PLANNING AND ENVIRONMENTAL MANAGEMENT

SR 9 (I-95) INTERCHANGE MODIFICATION REPORT RE-EVALUATION

Glades Road (SR 808) Interchange

FPID: 412420-4-52-01

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
DISTRICT 4
3400 WEST COMMERCIAL BOULEVARD
FORT LAUDERDALE, FL 33309

July 2020

Interstate 95 and Glades Road (S.R. 808)

Interchange Modification Report Re-Evaluation

Financial Project No: 412420-4-52-01

Florida Department of Transportation
Determination of Engineering and Operational Acceptability

Acceptance of this document indicates successful completion of the review and determination of engineering and operational acceptability of the Interchange Access Request. Approval of the access request is contingent upon compliance with applicable Federal requirements, specifically the National Environmental Policy Act (NEPA) or Department's Project Development and Environment (PD&E) Procedures. Completion of the NEPA/PD&E process is considered approval of the project location design concept described in the environmental document.

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QUALITY CONTROL CERTIFICATION FOR INTERCHANGE ACCESS REQUEST SUBMITTAL

Submittal Date: 7/10/2020

FM Number: 412420-4-52-01

Project Title: SR 9 (I-95) Interchange Modification Report Re-Evaluation – Glades Road (SR 808)

District: Four

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Document Type: ☐ MLOU ☐ IJR ☒ IMR ☐ IOAR ☐ OTHER (Specify)

Status of Document (Only complete documents will be submitted for review; however, depending on the complexity of the project, interim reviews may be submitted as agreed upon in the MLOU)

Final Submittal

Quality Control (QC) Statement

This document has been prepared following FDOT Procedure Topic 525-030-160 (New or Modified Interchanges) and complies with the FHWA's two policy requirements. Appropriate District-level quality control reviews have been conducted, and all comments and issues have been resolved to their satisfaction. A record of all comments and responses provided during QC review is available in the project file or Electronic Review Comments (ERC) system.

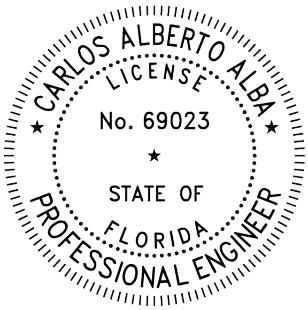
Requestor: DocuSigned by: Vanita Saini D9321186FFC3406... Date: 7/27/2020 | 7:27 AM EDT

IRC: DocuSigned by: Cesar Martinez DC7B7B72D0BD4A2... Date: 7/27/2020 | 8:06 AM EDT

Engineer's Certification

I, Carlos Alba, PE, PTOE, PE number 69023, certify that I currently hold an active Professional Engineer's License in the State of Florida, and I am competent through education or experience to provide engineering services in the civil and traffic engineering disciplines contained in this report. I further certify that this report was prepared by me or under my responsible charge as defined in Chapter 61G15-18.001 F.A.C. and that all statements, conclusions and recommendations made herein are true and correct to the best of my knowledge and ability.

Project Description: SR 9 (I-95) Interchange Modification Report Re-Evaluation – Glades Road (SR 808)



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EXECUTIVE SUMMARY

The primary purpose of the I-95 Interchange Modification Report (IMR) re-evaluation is to obtain safety, operations and engineering (SO&E) acceptability of the Diverging Diamond Interchange (DDI) alternative, proposed during the design-build process. The 2018 IMR was in itself an update of the 2007 Project Development and Environment (PD&E) study for I-95 from south of Glades Road to north of Yamato Road. This IMR re-evaluation is focused on identifying the long-term needs through the year 2040 and to develop a design concept to address traffic operational deficiencies along the Glades Road corridor between Butts Road and NW 10th Avenue/W University Drive, including traffic spillbacks onto I-95, improve interchange ramp terminal intersection operations, reduce congestion, and enhance safety at the study interchange at Glades Road (SR 808).

The preferred concept from the 2007 I-95 PD&E study, referred to as the approved modified partial cloverleaf interchange in the PD&E and as the Request for Proposal (RFP) concept in the body of this report, involved the implementation of four (4) lanes eastbound and westbound from Butts Road to W University Drive. However, the City of Boca Raton and the Palm Beach Transportation Authority (TPA) do not support converting Glades Road into an eight (8) lane corridor between Butts Road and W University Drive. Post the 2007 I-95 PD&E there have been several studies near the study area. As a result of the most recent studies, improvements to I-95 have changed, including the implementation of express lanes. Improvements along Glades Road have also changed due to the removal of the eight (8) lane concept west of the study area. Therefore, a primary need of this IMR re-evaluation was to develop a concept that improves traffic operations while maintaining the current six (6) through-lane configuration of the Glades Road corridor. This IMR re-evaluation details the traffic operations of the RFP concept and a DDI alternative.

Information and analysis from the 2018 IMR indicate that several of the merge, diverge and weaving areas have been designated as high crash locations at some point within the five years of analysis (2011-2015). Similarly, the No-Build alternative produces operational failures at multiple merge, diverge and weave locations along I-95 within the study interchanges. In order to address these deficiencies, this report recommends the following modifications to the interchange:

- Implementing the Proposed DDI concept to improve the Glades Road interchange by providing additional left-turn and right-turn lanes on both the SB I-95 and NB I-95 ramp terminal intersections. This will effectively provide both ramp terminals triple left and triple right turns. This will increase capacity and reduce long vehicular queues. A DDI interchange also has many advantages in comparison to other interchange configurations:
    - Fewer conflict points (14 for DDI, 15 for the RFP and 26 for a diamond interchange)
    - Improved intersection sight distances
    - Reduce construction time
    - Inherent traffic calming

- Shorter pedestrian crossings

FHWA's Policy Points state:

1. *An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).*

The IMR re-evaluation has shown that the DDI concept has a lower number of predicted crashes (147) when compared to the RFP concept (162), which amounts to a crash reduction of 9%. Through analyses of DDIs built throughout the US, it has been determined that there could be a potential 33% reduction in the total number of crashes. The DDI concept also results in equal or better LOS for freeway segments along I-95 and the signalized intersections along Glades Road. Both the weaving segment along northbound I-95 between Glades Road and the ingress point to the express lanes and the merge segment along southbound I-95 at the on-ramp from Glades Road operate at the same Level of Service (LOS) for the RFP and DDI concepts. The signalized intersections on Glades Road at the ramp terminals operate better under the DDI concept when compared to the RFP concept during both the AM and PM peak hours. The intersection at Glades Road and Airport Road have considerable improvements under the DDI concept during the AM peak hour and performs at similar LOS during the PM peak hour.

2. *The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc.*

The report should describe whether future provision of a full interchange is precluded by the proposed design.

This IMR re-evaluation and the consideration of the DDI concept does not propose any new interchanges along I-95. This existing interchange provides access to public roads only. The improvements proposed at the interchange will maintain full access to the existing cross streets and accommodate all movements. No additional right of way takes are required to accommodate the DDI.

1 PROJECT OVERVIEW

1.1 Introduction

At the request of the Florida Department of Transportation (FDOT), and as part of Financial Project ID 412420-4-52-01, a traffic analysis was undertaken to re-evaluate operational needs and address the changes in traffic volumes and design standards when considering alternative improvements at the SR-808/Glades Road study corridor. The study area is located within the City of Boca Raton, Florida. The study area extends along SR-808/Glades Road between Butts Road on the west most limit and W University Drive on the east most limit. The study limits are shown on Figure 1.1.

The SR-808/Glades Road at SR-9/I-95 interchange located within the study area experiences recurring congestion during the peak periods causing safety, operational and engineering issues. The I-95 ramp movements experience deficient Level of Service (LOS) and long vehicular queues during both peak periods. A PD&E study was conducted in 2007 to address potential traffic improvements for the Glades Road corridor between Butts Road and W. University Drive/NW 10th Avenue. The preferred concept from the 2007 PD&E study, referred to as the modified partial cloverleaf interchange in the PD&E and as the RFP concept in the body of this report, involved implementing four (4) lanes along the eastbound and westbound directions of Glades Road from Butts Road to W University Drive. However, the City of Boca Raton and the Palm Beach Transportation Planning Authority (TPA) do not support converting Glades Road into an eight (8) lane corridor between Butts Road and W University Drive.

In 2019, the Department approved the investigation of an Alternative Technical Concept (ATC), which proposed a Diverging Diamond Interchange (DDI) at the Glades Road (SR 808) interchange. The performance of the RFP concept developed in the 2018 approved IMR will be compared against the DDI concept in this re-evaluation.

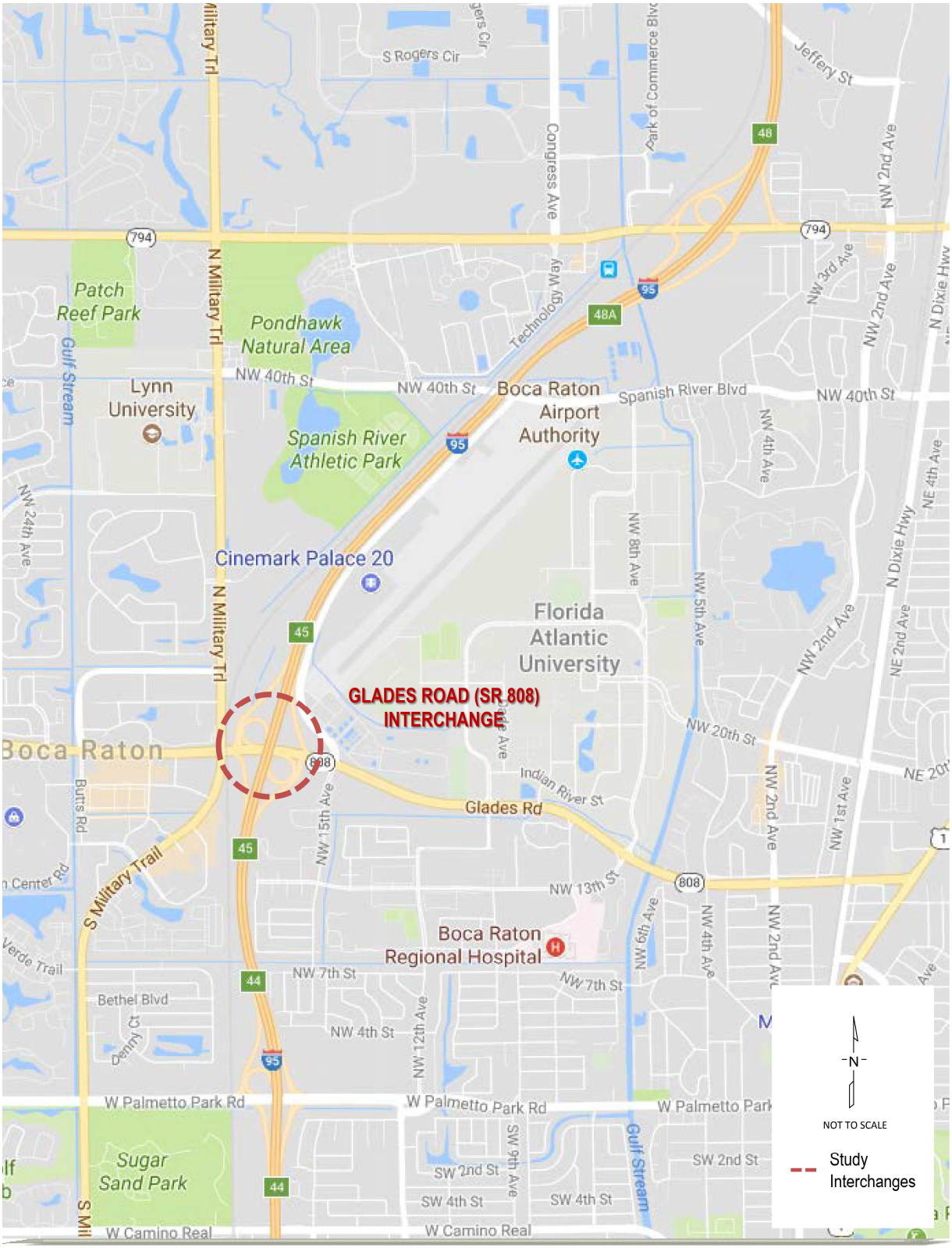
1.2 Purpose and Need for Project

The primary purpose of this IMR re-evaluation is to obtain safety, operational and engineering acceptability of the Diverging Diamond Interchange alternative, proposed during the design-build process. The 2018 IMR was an update of the 2007 PD&E study for I-95 from south of Glades Road to north of Yamato Road. This IMR re-evaluation is focused on identifying the long-term needs through the year 2040 and to develop design concepts to address traffic operational deficiencies along the Glades Road corridor between Butts Road and W University Drive, including traffic spillbacks onto I-95, improve interchange ramp terminal intersection operations, reduce congestion, and enhance safety at the study interchange at Glades Road (SR 808).

1.3 Project Location

The project area is a portion of the Glades Road (SR 808) corridor between Butts Road and W University Drive in Palm Beach County, Florida. Figure 1.1 provides a project location map.

Figure 1.1: IMR Project Location



1.4 Planned and Programmed Transportation Projects

Applicable master plans, Strategic Intermodal System (SIS) Plans, FDOT's five (5) year work program, interchange planning and safety studies performed by FDOT District Four, Palm Beach TPA's Transportation Improvement Program (TIP), Palm Beach TPA 2040 Long Range Transportation Plan (LRTP), local government comprehensive plans, and active Development of Regional Impact (DRI) applications were reviewed and documented in the 2018 I-95 IMR. Additionally, the I-95 Express Lanes Phase 3 was reviewed to identify planned and programmed improvements within the IMR limits. The IMR improvements have been developed consistent with these plans to achieve consistency.

1.4.1 Palm Beach County Transportation Planning Agency Plans

The Palm Beach TPA LRTP cost feasible plan includes all highway, transit, bicycle and pedestrian projects committed for construction within the County's five (5) year road program and the TPA's Transportation Improvement Plan. The LRTP cost feasible plan also includes financially feasible projects out to the year 2040.

The Palm Beach TPA's LRTP 2040 cost feasible plan roadway component identified the following:

- The implementation of auxiliary lanes between Executive Center Drive and NW 13th Street/FAU Boulevard.
- Widen lanes on I-95 at Glades Road.
- Widen Lanes along Glades Road to accommodate pedestrian pathways.

1.4.2 County and Local Agency Plans

No county or local agency plans or projects were identified within the study area.

1.4.3 FDOT Plans and Projects

The FDOT Fiscal Year (FY) 2019 Design Build Acquisition Plan currently lists the SR-9 / I-95 at SR-808 / Glades Road project with projects 433109-5 and 435384-1. The I-95 Express Phase 3B-2 project is currently under preliminary design and was let in FY 2019 as a Design-Build project. This project implements two (2) tolled lanes in place of the existing High Occupancy Vehicle (HOV) lanes.

1.5 Requestor Information

This I-95 Interchange Modification Report re-evaluation has been prepared for the Florida Department of Transportation, District Four. For information on the IMR, please contact the Department's Project Manager at the following address:

Vanita Saini, P.E., Project Manager FDOT- District Four

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2 METHODOLOGY

The methodology applied for the I-95 IMR re-evaluation is documented in the Methodology Letter of Understanding (MLOU), dated December 2019. The MLOU was approved by FDOT District Four and FDOT Central Office. The MLOU outlines the criteria, assumptions, processes, analyses and documentation requirements for the project. The approved MLOU is included in Appendix A for ease of reference. The following summarizes some of the more prominent points covered under the MLOU.

2.1 Area of Influence

2.1.1 Along I-95 Mainline

The Area of Influence (AOI) along I-95 (SR 9) includes the freeway merge/diverge ramps at the adjacent interchanges to the south and north of Glades Road. The adjacent interchange south of Glades Road is Palmetto Park Road and the adjacent interchange north of Glades Road is Spanish River Boulevard. Figure 2.1 provides a graphical representation of the AOI. Since the configuration of most freeway segments does not change between the RFP and DDI concepts, this IMR re-evaluation only analyses the freeway segments that were modified when the DDI combines eastbound and westbound traffic from Glades Road into a single merge point at I-95.

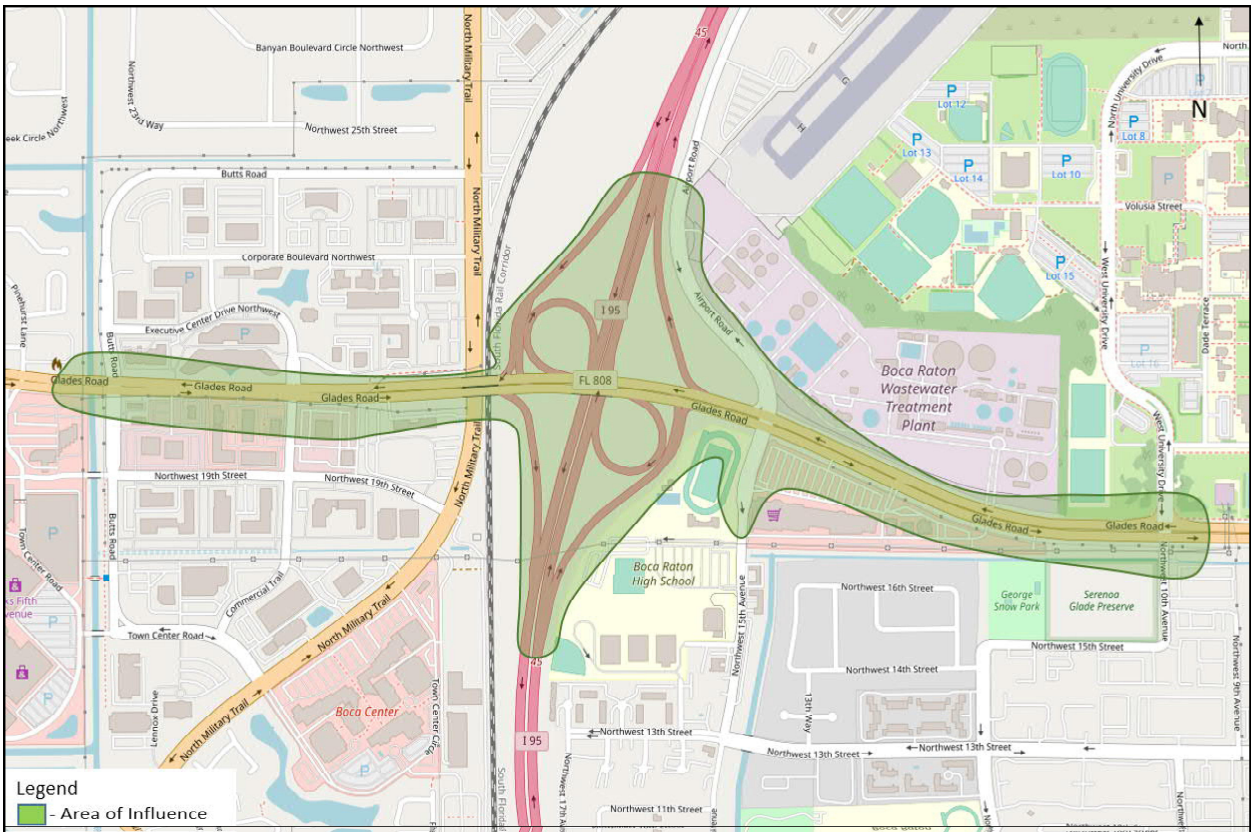
2.1.2 Along Crossroads

The AOI includes signalized intersections between Butts Road and W University Drive including the I-95 (SR 9) interchange ramp terminal intersections. Table 2.1 summarizes the study intersections.

Table 2.1: Study Intersections

Interchange	List of Intersections
Glades Road (SR 808)	• Glades Road at Butts Road • Glades Road at NW Executive Center Drive/NW 22nd Way • I-95 SB ramp terminal at Glades Road • I-95 NB ramp terminal at Glades Road • Glades Road at Airport Road/NW 15th Avenue • Glades Road at W University Drive/NW 10th Avenue

Figure 2.1: IMR Area of Influence



2.2 Analysis Years

As completed in the previous IMR (April 2018), the analysis years for the project traffic forecasting were determined as follows:

- Base year 2010
- Horizon year 2040

As completed in the previous IMR (April 2018), the analysis years for the traffic operational analysis were determined as follows:

- Existing year 2015 (not included in this re-evaluation)
- Opening year 2020
- Design year 2040

2.3 Travel Demand Forecasting

Traffic forecasts for this report were obtained and utilized from the Corridor Traffic Analysis Report (CTAR) FM No 433108-1-32-01; 433109-1-32-01 dated November 19, 2014, that was done for the I-95 Express Phase 3 project. The traffic forecasting procedure included the following:

2.3.1 Selected Travel Demand Model

The modeling efforts have been provided by FDOT on the Corridor Traffic Analysis Report (CTAR) FM No 433108-1-32-01; 433109-1-32-01 (Dated November 19, 2014). The I-95 Corridor Planning Study (I-95 CPS) Model has been used as the basis for future year travel demand forecasts, which is an enhanced version of the Southeast Florida Regional Planning Model (SERPM) 6.5 model. The enhanced model was developed during the I-95 Corridor Planning Study (2009) and was further refined for use in the I-95 PD&E studies (2013). A traffic validation check was performed to understand the traffic growth since the original study. A growth trend analysis was performed using historical AADT information between 2015 and 2018 from the following FDOT traffic monitoring sites located within the area of influence of the project (Sites No. 862507, 932192 and 932220). This analysis returned an annual historic average growth rate of 1.06%, which is close to the growth rate of 1.00% assumed in the original study. For this reason, there will not be a need to adjust the travel demand performed in the original study.

2.3.2 Project Traffic Forecast Development Methodology

Traffic forecasts for the Glades Road corridor were developed for the design year 2040 for both the AM and PM peak hours. For consistency with ongoing projects within the study area, design hour volumes for this report were obtained from the Corridor Traffic Analysis Report (CTAR) FM No 433108-1-32- 01; 433109-1-32-01 dated November 19, 2014. The CTAR used the I-95 Corridor Planning Study (I-95 CPS) SERPM as the basis for future year travel demand forecasts and is an enhanced version of the SERPM 6.5 model. Annual Average Daily Traffic (AADT) for 2040 Build network conditions were estimated directly from the corresponding model assignments. The model assignments were post processed, as necessary, and checked for reasonableness, smoothing and balancing.

The FDOTs conventional process for developing future year peak hour volumes involves the application of K-factors and D-factors to the estimated AADTs. This conventional process was not used for the I-95 PD&E studies. An alternative process involving the use of diurnal factors was applied for the I-95 PD&E studies with direction and coordination with FDOT. The application of diurnal factors for peak hour forecasting involved the following steps:

1) Extracting the AM and PM peak periods traffic forecast from the travel demand models.
2) Developing the highest diurnal factors for the AM and PM peak periods.
3) Applying the AM and PM diurnal factors to the model estimated peak period volumes to develop future peak hour volume estimates.
4) Smooth and balance peak hour volume estimates.

Existing 2015 volumes developed under the approved 2018 IMR and the 2040 volumes from the CTAR were compared and a compound growth rate of less than one percent (1%) was projected for the subject location. The low growth rate was attributed to the fact that a previous project that proposed converting Glades Road into an eight (8) lane arterial west of Butts Road (west of the subject area) was rejected thus preventing further growth from occurring in the vicinity of the subject location. In addition, the construction of the Spanish River interchange also limits growth in the subject area by shifting future traffic volumes from Glades Road onto the newly constructed interchange.

After finalizing the ramp terminal intersection volumes, the remaining intersections along the subject corridor were balanced to the I-95 ramp terminal intersections based on existing distributions and adjusted to reflect diverted traffic due to configuration modifications. Opening year 2020 project traffic volumes were developed by interpolation between existing year 2015 and design year 2040 traffic volumes. Volume figures have been adjusted from the original IMR, where a traffic imbalance was found affecting northbound I-95. This change does not affect the comparison of alternatives presented in this document.

2.4 Traffic Factors

The directional design hour volumes (DDHV) development process for the Glades Road IMR involved the following:

- As previously described, the volumes developed under the CTAR did not use the FDOT's conventional process for developing future year peak hour volumes involving the application of K-factors and D-factors to the estimated AADTs. Instead, an alternative process involving the use of diurnal factors was applied for the I-95 PD&E studies with direction and coordination with FDOT. Standard K values 8.0 for I-95 mainline and 9.0 for Glades Road were utilized.
- Existing traffic factors are shown below in Table 2.2. Peak hour K and D values were used as reference when balancing the network. Since rounding and balancing was conducted, the final K and D may not match the initial values.
- 24T and DHT_f was calculated for each intersection or link based on existing and historical data. A minimum DHT_f factor of 2.0% was used across all options in the Synchro analysis, consistent with the original RFP analysis in the 2018 IMR.

- An intersection PHF of 1.00 was used for the future year analyses per FDOT's traffic analysis procedures and to be consistent with the RFP analysis.

Table 2.2: Existing Traffic Factors

Roadway	K	D	24T	DHTf[1]	PHF [2]
I-95 Mainline	7.20 to 8.95	50.7 to 60.4	5.6 to 7.3	3.0 [3]	0.89 to 0.97
I-95 Ramps	3.4 to 9.1	100	4.0	2.0 to 3.0	0.79 to 0.97
Glades Road	6.2 to 8.2	52.5 to 72.2	2.0 to 4.0	2.0 to 4.0	0.90 to 0.98

Source: AECOM preliminary calculations based on existing and historical volume data.

(1) A minimum DHT_f factor of 2.0% will be used.

(2) An intersection PHF of 1.00 will be used for Future Year Analyses

(3) Based on ½ of 24T since existing data for DHT_f is not available. Resulting DHT_f is constant with values used in previous studies.

2.5 Traffic Operational Analysis

Traffic operational analyses were performed for future RFP and DDI alternatives. Analyses were performed using the Highway Capacity Software (HCS) 2010 version 6.60 and Synchro version 9. The HCS 2010 was used for operational analyses of freeway segments - mainline, ramps, merge, diverge, and weaving segments. Synchro analyses were performed for adjacent signalized intersections and interchange ramp terminal intersections. Synchro software results were reported utilizing the HCM 2000 module output.

The HCS and Synchro operations analyses were performed for the following conditions:

- Year 2020 RFP and DDI Alternatives, AM and PM peak hours
- Year 2040 RFP and DDI Alternatives, AM and PM peak hours

2.5.1 Measures of Effectiveness (MOEs)

FDOT Topic No. 000-525-006-c provides Level of Service (LOS) Targets for the State Highway System (SHS). The following LOS criteria were considered acceptable for the IMR re-evaluation since the study area is an urbanized area over 500,000.

- SIS Facilities – LOS D
- Other State Roads – LOS D

It should be noted that the traffic operational objectives of this IMR re-evaluation are to maintain or improve operation by evaluating and comparing the DDI interchange alternative to the RFP concept. The City of Boca Raton and the Palm Beach TPA do not support converting Glades Road into an eight (8) lane corridor; therefore, the RFP concept may not meet the Department's LOS D target in urbanized areas because of the design constraints.

Analyses of the I-95 system, including the mainline and the interchange ramps, were based on criteria and policies detailed in the FDOT Interchange Access Request User's Guide, January 2018. Freeway and ramp operations analyses were conducted utilizing Highway Capacity Software (HCS 2010). Intersection analyses were conducted using Synchro 9.

In addition to the signalized intersection LOS criteria stated above, operational analysis criteria also included the following:

- Delay (seconds per vehicle)
- Maximum volume-to-capacity (v/c) ratio: Where possible, each intersection movement was designed to have a v/c ratio of 1.0 or less.
- Interchange off-ramp queue length: The 95th percentile queue was utilized to determine the required storage length for all interchange off-ramp queue lengths. The 95th percentile queue was calculated utilizing HCM 2000 methodology, otherwise, the intersection queue report was utilized.

3 EXISTING CONDITIONS AND LAND USE

3.1 Existing Land Use

The Glades Road Interchange is located within the City of Boca Raton. Figure 3.1 presents the City of Boca Raton Zoning Map. The City of Boca Raton zoning map shows the NW quadrants of the Glades Road interchange as zone POI (Professional, Office & Institutional) and RB1 (Motel-Business). The NE and SE quadrant of the interchange is zoned as PL (Public Lands). The SW quadrant of the interchange is zoned as RB1.

3.2 Existing Road Characteristics

The general characteristics of the roadway facilities located within the project limits are described in the sections below. The data below is based on information gathered from the FDOT's Roadway Characteristics Inventory (RCI), Straight Line Diagrams (SLDs), Broward County Metropolitan Planning Organization (MPO), Broward County Traffic and Engineering Division and field reviews. The existing roadway and intersection lane configurations are depicted in Figure 3.2**.** Aerial views of the interchange are presented in Figure 3.3**.**

3.2.1 I-95 from north of Palmetto Park Road to south of Yamato Road

Facility Type: Freeway, limited access, SIS facility
Functional Classification: Urban Principal Arterial - Interstate
Access Management Classification (FDOT): Class 1
Typical Section:

South of Yamato Road Interchange: SB: 3 GP, 1 HOV / BW; NB: 1 HOV, 3 GP
South of Glades Road Interchange: SB: 1 AUX, 3 GP, 1 HOV / BW; NB: 1 HOV, 3 GP, 1 AUX
North of Palmetto Park Road Interchange: SB: 1 AUX, 3 GP, 1 HOV / BW; NB: 1 HOV, 3 GP, 1 AUX

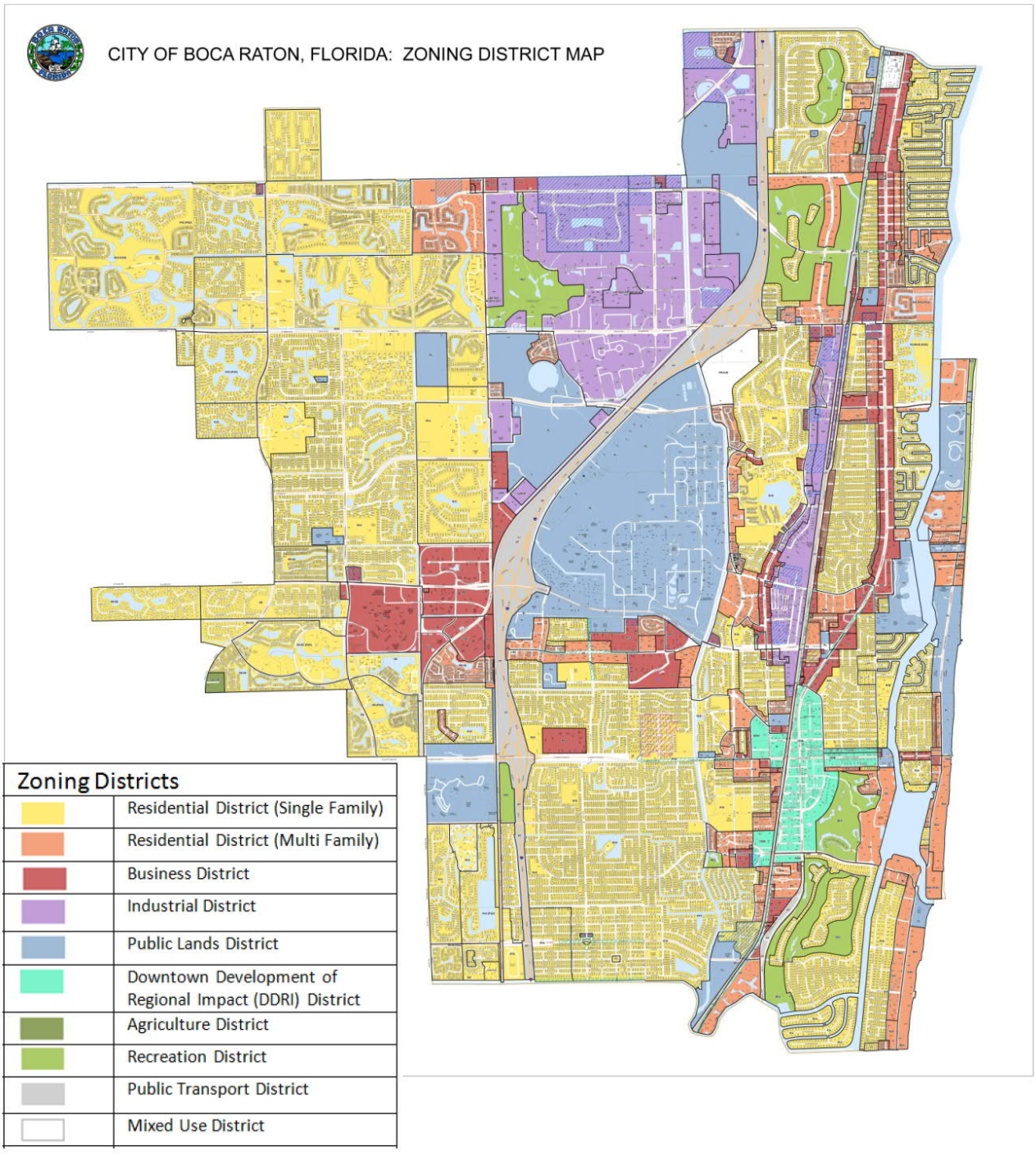
Note: AUX-Auxiliary Lane/GP-General Purpose Lane/HOV-High Occupancy Vehicle Lane/BW-Barrier Wall Median

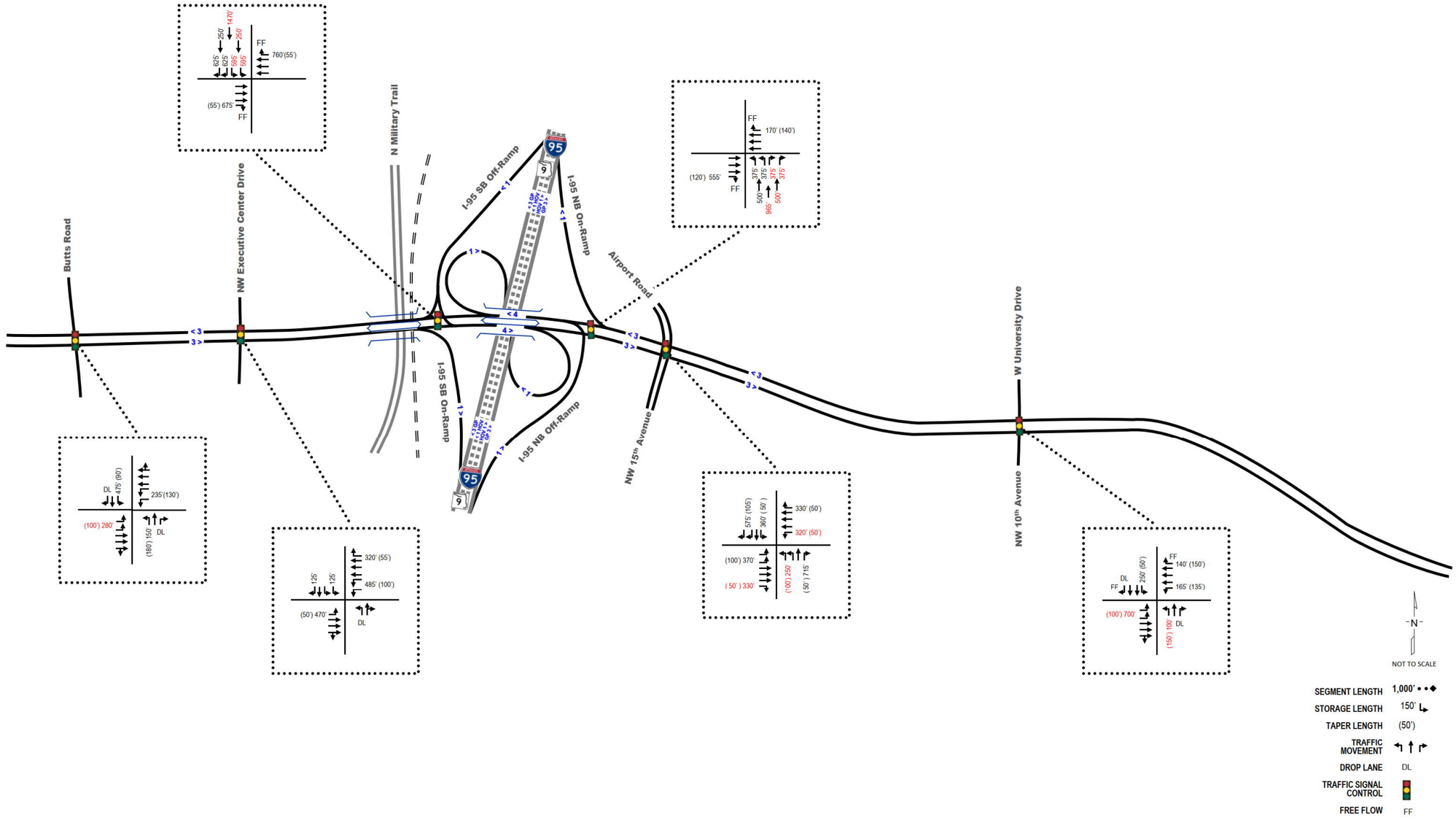
Posted Speed Limit: 65 mph

3.2.2 Glades Road from Butts Road to W University Drive

Facility Type: Arterial
Functional Classification: Urban Principal Arterial - Other
Access Management Classification (FDOT): Class 5
Typical Section: EB: 3 Lanes/ Raised Median / WB 3: Lanes
Posted Speed Limit: 45 mph

Figure 3.1: City of Boca Raton Existing Land Use Map





NOTE: NUMBERS IN RED MEAN THAT STORAGE LANE PROVIDED IS LESS THAN CALCULATED QUEUE IN ANALYSIS.

Figure 3.2: 2015 Existing Year Roadway & Intersection Lane Configuration

Figure 3.3: Aerial View - Glades Road (SR 808)

3.3 Existing Traffic Data

Traffic data was collected or gathered from readily available sources. The following information was gathered within the study area and used as part of the 2018 IMR and this IMR re-evaluation:

- Arterial/Ramp 72-hour bi-directional Automatic Traffic Recorder (ATR) hose counts
- Turning Movement Counts (TMC) in 15-minute intervals (3-hr in the AM and 3-hr in the PM)
- I-95 Mainline travel time run
- I-95 Mainline 24-hour bi-directional vehicle classifications
- I-95 Mainline 48-hour bi-directional vehicle volumes in 15-minute intervals
- Traffic signal information
- Field observations at each signalized intersection

3.3.1 Existing Traffic Volumes

3-day AM and PM peak period turning movement counts were conducted as part of the original PD&E study. The Existing Year 2015 traffic volumes utilized in the analysis were developed by averaging the 3-day counts, applying the appropriate seasonal factors (SF), weekly axle factors (WAF), and balancing them. Detailed existing year analysis was completed in the 2018 IMR. A printout of traffic data is provided in **Appendix B**.

3.4 Existing Crash Data

Crash data was collected as part of the 2018 IMR from the FDOT Crash Analysis Reporting System (CARS) for the five years (from January 2011 to December 2015). Crash data along I-95 was collected between MP 2.170 and 4.010 including ramp segments and terminals. It was further segregated by interchange: Glades Road MP 4.584 – MP 6.646. Crash data for Glades Road (between Butts Road and E University Drive) was also obtained from the FDOT CARS. Historical crash maps and statistical summaries are included in **Appendix C**. Table 3.1 presents the aggregated summary for I-95.

Based on crash severity, of the 1,048 reported crashes, 676 (65%) were property damage only crashes, 369 (35%) were injury type crashes, and 3 (0%) were fatal crashes. There was a total of 342 (33%) night/dusk/dawn crashes reported, which is lower than the statewide average for all roadways of 34 percent; and 367 (35%) of the total crashes occurred under wet/slippery pavement conditions, which is higher than the statewide average for all roadways of 13 percent. Among the contributing causes documented in the crash data, careless driving (446 - 43%) and All Other (274 – 26%) were among the highest. There were 2 and 3 collisions with a pedestrian and bicycle, respectively. These types of crashes are atypical since pedestrians and bicycles are not allowed in access-controlled facilities. Rear end (522 - 50%), sideswipe (159 - 15%) and fixed object (140 - 13%) crash types had the highest frequencies.

A high crash location list review was also conducted. The high crash location lists were obtained from FDOT District Four Traffic Operations. The data was extracted from CARS, which uses crash coefficient levels over 99.95 % and crash rates over 1.00 to establish and rank high crash locations. The high crash locations within the 5-year analysis period for I-95 and Arterials based on the lists provided by FDOT are listed on the following page.

Based on the high crash location list, high crash locations are concentrated within the areas with higher traffic friction (i.e., merge, diverge, and weaving). The safety analysis indicates that rear end, sideswipe and fixed object crash types had the highest frequencies; probable causal factors for these crash types include: congestion/traffic friction, slippery pavement surface, inadequate roadway lighting and fixed objects too close to the roadway. To improve safety along the I-95 study corridor, the following improvements were recommended for consideration: reduce friction areas; improve roadway lighting; improve skid resistance for the pavement surface and provide adequate drainage; remove, relocate or shield fixed objects.

Listed below are the high crash segment locations on I-95 (SR 9):

- Between MP 2.4 to 3.5

Listed below are the high crash segment locations on Glades Road (SR 808):

- Between MP 4.6 to 4.9
- Between MP 5.4 to 5.8

Table 3.1: Crash Data Summary for I-95 - (2011-2015)

Crash Type	Glades Road Interchange 5 Year Total	Annual Average	Percent(1)
Rear End	522	104	50%
Head On	4	1	1%
Angle / Left Turn / Right Turn	54	11	5%
Sideswipe	159	32	15%
Backed Into	0	0	0%
Collision with Pedestrian	2	0	0%
Collision with Bicycle	3	1	0%
Fixed Object	140	28	13%
Overturned / Rollover	54	11	5%
Other	110	22	11%
Total Crashes	1,048	210	100%
PDO Crashes	676	135	65%
Fatal Crashes	3	1	0%
Injury Crashes	369	74	35%
Daylight	706	141	67%
Dusk	63	13	6%
Dawn	19	4	2%
Dark	260	52	25%
Unknown	0	0	0%
Dry	680	136	65%
Wet	367	74	35%
Others	1	0	0%
Contributing Cause	**Glades Road Interchange 5 Year Total**	**Annual Average**	**Percent**
No Contributing Action	153	31	15%
Careless Driving	446	89	43%
Failed To Yield Right-Of-Way	10	2	1%
Improper Turn	1	0	0%
Followed Too Closely	22	4	2%
Ran Red Light	5	1	0%
Drove too Fast for Conditions	79	16	7%
Improper Passing	9	2	1%
Failed To Keep In Proper Lane	38	8	4%
Ran Off Roadway	11	2	1%
All Other	274	55	26%
Total	1,048	210	100%

(1) Percentages are rounded to the nearest integer.

Listed below are the high crash spot locations on Glades Road (SR 808):

- MP 4.802 (Glades Plaza)
- MP 5.158 (I-95 SB On-Ramp)
- MP 5.183 (I-95 SB Off-Ramp)
- MP 5.369 and 5.376 (I-95 NB Off-Ramp)
- MP 5.512 (Airport Road)
- MP 6.068 and 6.100 (West University Avenue)
- MP 6.576 and 6.582 (NW 13th Street)
- MP 6.631 (approximately 200' east of NW 13th Street)

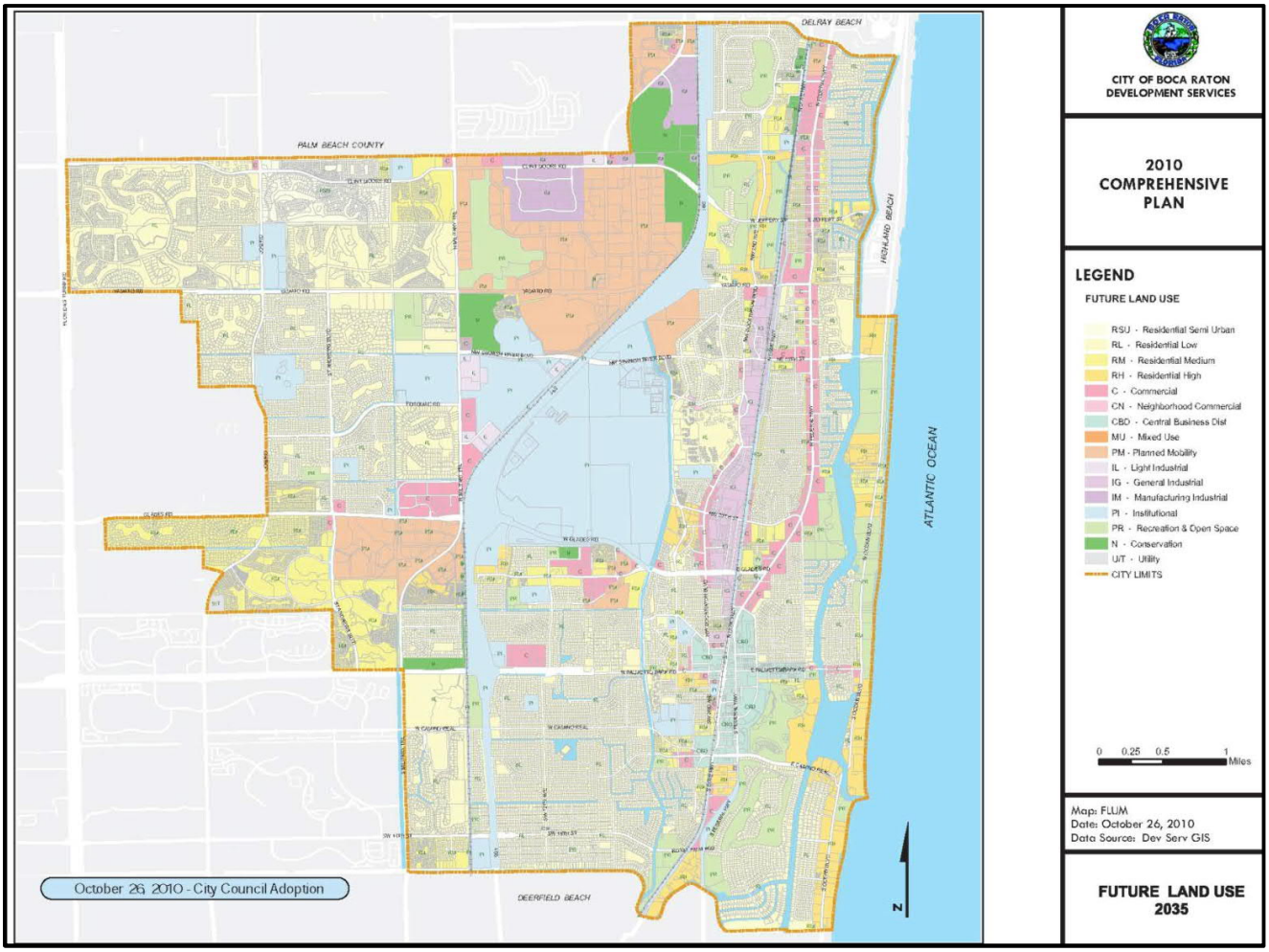
3.5 Future Land Use

As previously stated, the Glades Road interchange is located within the City of Boca Raton. Figure 3.4 presents the City of Boca future land use map. The City of Boca Raton future land use map shows the NW quadrant of the Glades Road interchange as commercial while the NE quadrant is shown as institutional. The SE quadrant shows as institutional and high, medium and low residential. The SW quadrant shows as planned mobility.

3.6 Land Use Changes

No significant future land use changes were identified in the project area. For traffic projection purposes, the base SERPM Version 6.5 model utilizes TPA developed 2005 base year and 2035 LRTP horizon year data; therefore, TAZ data for the 2010 and 2040 analysis years were interpolated/extrapolated from the available 2005 and 2035 data. The interpolated 2010 and extrapolated 2040 TAZ data developed for the I-95 PD&E Study (Stirling Road to Linton Boulevard) was used for this project. The 2040 TAZ data was developed by extrapolation of the TPA-approved 2035 TAZ data, via benchmarking the County control totals to Bureau of Economic and Business Research (BEBR) projections, consistent with previous revisions of the I-95 CPS Model.

Figure 3.4: City of Boca Raton Future Land Use Map



4 RFP CONCEPT

4.1 RFP Concept - Configuration

The preferred concept with Modified Existing Parclo interchange from the 2007 I-95 PD&E study involved implementing four (4) lanes EB and WB on Glades Road from Butts Road to W University Drive. However, the City of Boca Raton and the Palm Beach TPA do not support converting Glades Road into an eight (8) lane corridor between Butts Road and W University Drive. Post the 2007 I-95 PD&E study there have been several studies near the study area. As a result of the most recent studies, improvements to I-95 have changed, including the implementation of express lanes. Improvements along Glades Road have also changed due to the removal of the eight (8) lane concept west of the study area. Therefore, an Enhanced RFP concept was developed as part of 2018 IMR.

Figure 4.1 shows the RFP concept for Glades Road. Figure 4.2 and Figure 4.3 show the lane configuration and traffic volumes for 2020 and 2040 RFP conditions, respectively. These improvements address the traffic operation deficiencies by eliminating failing merge, diverge and weaving segments; and improving safety by reducing congestion. Improvements at the ramp terminal intersections would eliminate queue spillbacks into the I-95 mainline.

Figure 4.1: RFP Concept - Glades Road at I-95

4.2 RFP Concept - Traffic Operational Analysis

Traffic operational analysis was conducted as part of the 2018 IMR to evaluate the RFP concept improvements in the study area for Opening Year 2020 and Design Year 2040. The traffic operational objective assumed for this evaluation was LOS D. The calculated DHT factors under existing conditions were used for the future Build alternative analyses. Peak hour factors of 0.95 for I-95 General Purpose and Express lanes and 1.00 for ramp terminals and intersections were applied in the future condition's operational analysis (Opening Year – 2020 and Design Year – 2040), which is reflective of the expected future conditions with the high overall level of travel demand in the area of influence. Figure 4.2 and Figure 4.3 present the RFP concept intersections lane configuration and traffic volumes for Opening Year 2020 and Design Year 2040, respectively.

4.2.1 2020 & 2040 RFP Concept - Freeway Analysis - I-95

RFP conditions include the implementation of two major programmed improvements: 1) I-95 Express Lanes, and 2) A new I-95 interchange for Spanish River Boulevard.

The mainline/basic, weaving, and ramp merge/diverge analysis results for Opening Year 2020 are summarized in Table 4.1 and Table 4.2, and Figure 4.4 and Figure 4.5 for southbound and northbound directions, respectively. Table 4.3 and Table 4.4, and Figure 4.6 and Figure 4.7 summarize the Design Year 2040 analysis results for southbound and northbound directions, respectively. Documentation of the RFP alternative traffic freeway operational analysis is provided in **Appendix E**. The Design Year 2040 RFP alternative analysis indicates that 5 of the 10 freeway segments in the southbound direction would operate at LOS E during one or both peak hours. Similarly, 6 of the 8 freeway segments in the northbound direction would operate at LOS E or F during one or both peak hours.

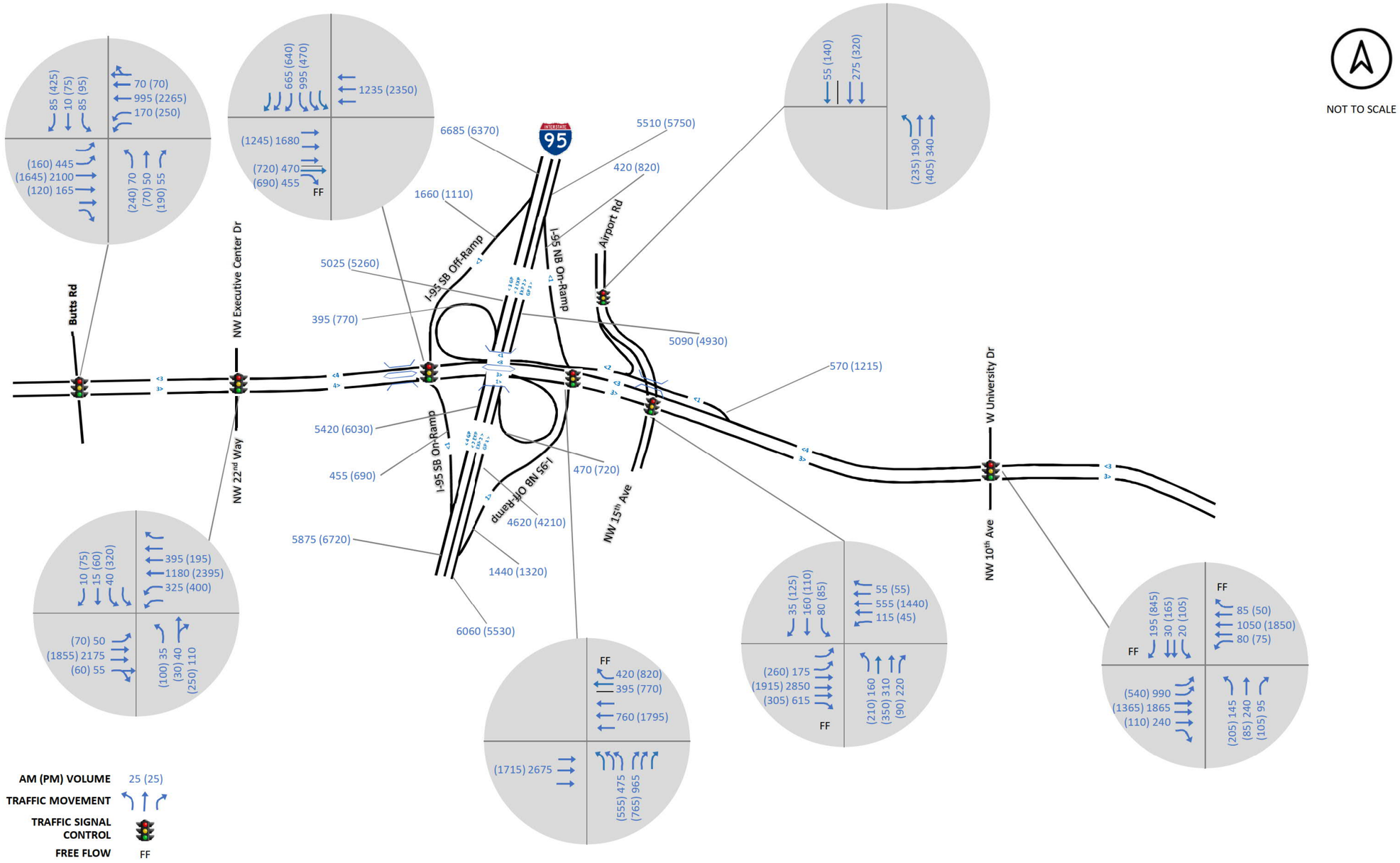


Figure 4.2: 2020 RFP Concept - Intersection Lane Configuration & Traffic Volumes

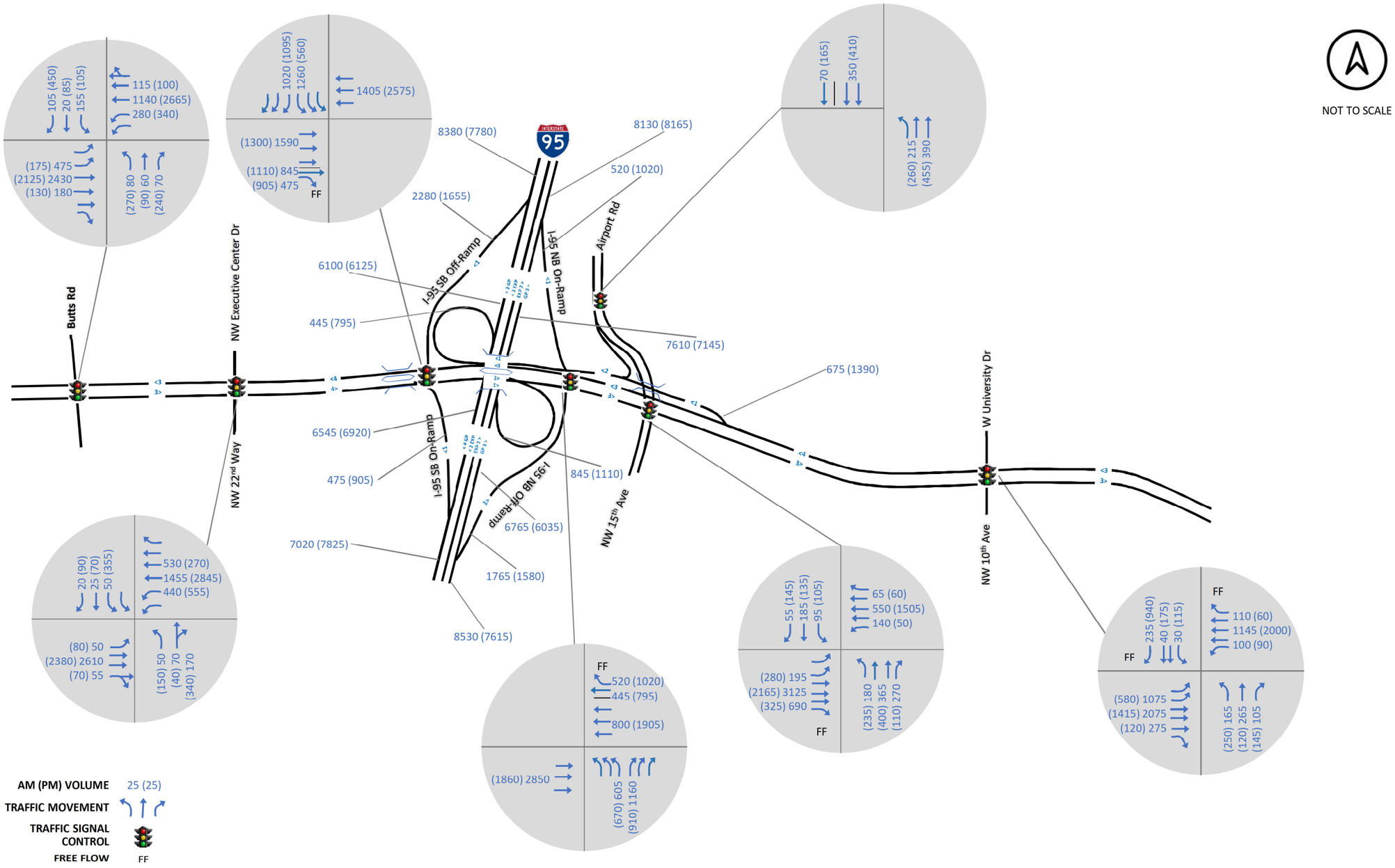


Figure 4.3: 2040 RFP Concept - Intersection Lane Configuration & Traffic Volumes

Table 4.1: 2020 RFP Concept - Freeway Analysis Results - Southbound

I-95 Segment Description	Analysis Type	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
		Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
I-95 SB On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic (1)	6	6,385 (5,790)	2	780 (1,550)	16.2 (14.7)	B (B)
I-95 SB On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic (1)	5	6,385 (5,790)	1	780 (1,550)	19.5 (17.6)	C (B)
I-95 SB Downstream of the On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic	4	6,385 (5,790)	-	-	25.3 (22.4)	C (C)
Between Exit from I-95 Express and SB Off-Ramp to Glades Road EB & WB	Weave	4	6,685 (6,370)	-	-	29.4 (28.3)	D (D)
I-95 SB Off-Ramp to Glades Road EB & WB	Diverge/Drop Lane (2)	4	6,685 (6,370)	1	1,660 (1,110)	31.1 (29.6)	D (D)
Between I-95 SB Off-Ramp to Glades Road EB & WB and I-95 SB On-Ramp from Glades Road WB	Mainline/Basic	3	5,025 (5,260)	-	-	27.0 (28.7)	D (D)
Between I-95 SB On-Ramp from Glades Road WB and I-95 SB On-Ramp from Glades EB	Mainline/Basic Merge/Add Lane (3)	3	5,420 (6,030)	1	395 (770)	20.8 (23.5)	C (C)
I-95 SB On-Ramp from Glades Road EB	Merge	4	5,420 (6,030)	1	455 (690)	21.5 (25.4)	C (C)
Between I-95 SB On-Ramp from Glades Road EB and I-95 SB Off-Ramp to Palmetto Park Road EB & WB	Mainline/Basic	4	5,875 (6,720)	-	-	22.8 (27.1)	C (D)
I-95 SB Off-Ramp to Palmetto Park EB & WB	Diverge/Drop Lane (4)	4	5,875 (6,720)	1	1,020 (1,215)	27.3 (31.3)	C (D)

(1) Merge length more than 1500 feet. Analyzed as a basic freeway segment.

(2) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N).

(3) Merge is lane addition. Analyzed as a basic freeway segment.

(4) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N). The freeway downstream of the ramp is LOS F in PM.

Table 4.2: 2020 RFP Concept - Freeway Analysis Results - Northbound

I-95 Segment Description	Analysis Type	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
		Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
I-95 Off-Ramp to Spanish River Blvd	Diverge	4	4,770 (5,150)	1	600 (320)	24.8 (24.8)	C (C)
Between Entry to I-95 Express and Off-Ramp to Spanish River Blvd.	Mainline/Basic	4	4,770 (5,150)	-	-	18.1 (19.7)	C (C)
Between I-95 NB On-Ramp from Glades Road WB and Entry to I-95 Express	Weave	4	5,510 (5,750)	-	-	24.0 (25.1)	C (C)
I-95 NB On-Ramp from Glades Road WB	Mainline/Basic Merge/Add Lane (1)	3	5,090 (4,930)	1	420 (820)	21.2 (22.2)	C (C)
Between I-95 NB On-Ramp from Glades Road EB and I-95 NB On-Ramp from Glades Road WB	Mainline/Basic	3	5,090 (4,930)	-	-	27.4 (26.3)	D (D)
I-95 NB On-Ramp from Glades Road EB	Merge	3	4,620 (4,210)	1	470 (720)	29.4 (29.5)	D (D)
Between I-95 NB Off-Ramp to Glades Road EB & WB and I-95 NB On-Ramp from Glades Road EB	Mainline/Basic	3	4,620 (4,210)	-	-	24.1 (21.6)	C (C)
Between I-95 NB On-Ramp from Palmetto Road EB & WB and I-95 NB Off-Ramp to Glades Road EB & WB	Weave	4	5,960 (5,485)	-	-	N/A (N/A)	F (F)

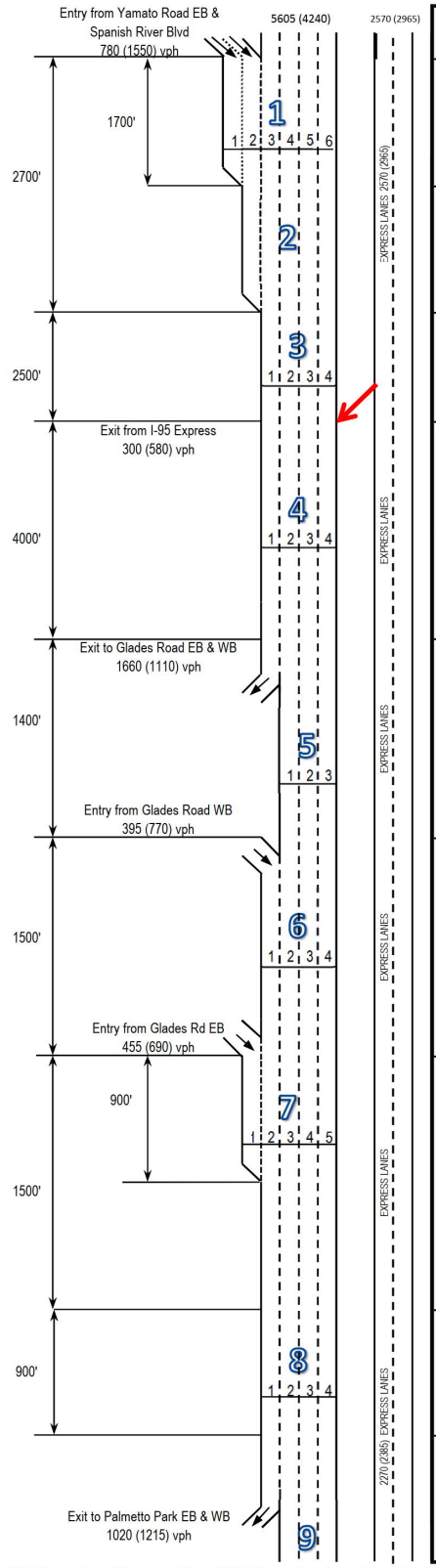
(1) Merge length more than 1500 feet. Analyzed as a basic freeway segment.

(2) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N).

(3) Merge is lane addition. Analyzed as a basic freeway segment.

(4) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N). The freeway downstream of the ramp is LOS F in PM

Figure 4.4: 2020 RFP Concept - Freeway Analysis Results - Southbound



Segment	Fwy VPH AM (PM)	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Major Merge from Yamato Road EB & Spanish River Boulevard (1)	6385 (5790)	B (16.2)	B (14.7)
Major Merge from Yamato Road EB & Spanish River Boulevard (1)	6385 (5790)	C (19.5)	B (17.6)
Basic Freeway	6385 (5790)	C (25.3)	C (22.4)
Weave From I-95 Express Lane to Glades Road EB & WB	6685 (6370)	D (29.4)	D (28.3)
Basic Freeway	5025 (5260)	D (27.0)	D (28.7)
Basic Freeway	5420 (6030)	C (20.8)	C (23.5)
Merge from Glades Road EB	5420 (6030)	C (21.5)	C (25.4)
Basic Freeway	5875 (6720)	C (22.8)	D (27.1)
Diverge (Drop Lane) to Palmetto	5875 (6720)	C (27.3)	D (31.3)

1) Merge length more than 1500 feet. Analyzed as a basic freeway segment.

Figure 4.5: 2020 RFP Concept - Freeway Analysis Results – Northbound

Segment	FwyVPH AM (PM)	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Diverge to Spanish River Blvd	4770 (5150)	C (24.8)	C (24.8)
Basic Freeway	4770 (5150)	C (18.1)	C (19.7)
Weave from Glades Road WB to I-95 Express Lanes	5510 (5750)	C (24.0)	C (25.1)
Basic Freeway	5090 (4930)	D (27.4)	D (26.3)
Merge from Glades Road EB	5090 (4930)	D (29.4)	D (29.5)
Basic Freeway	4620 (4210)	C (24.1)	C (21.6)
Weave Palmetto Park EB & WB to Glades Road EB & WB	5960 (5485)	F (N/A)	F (N/A)

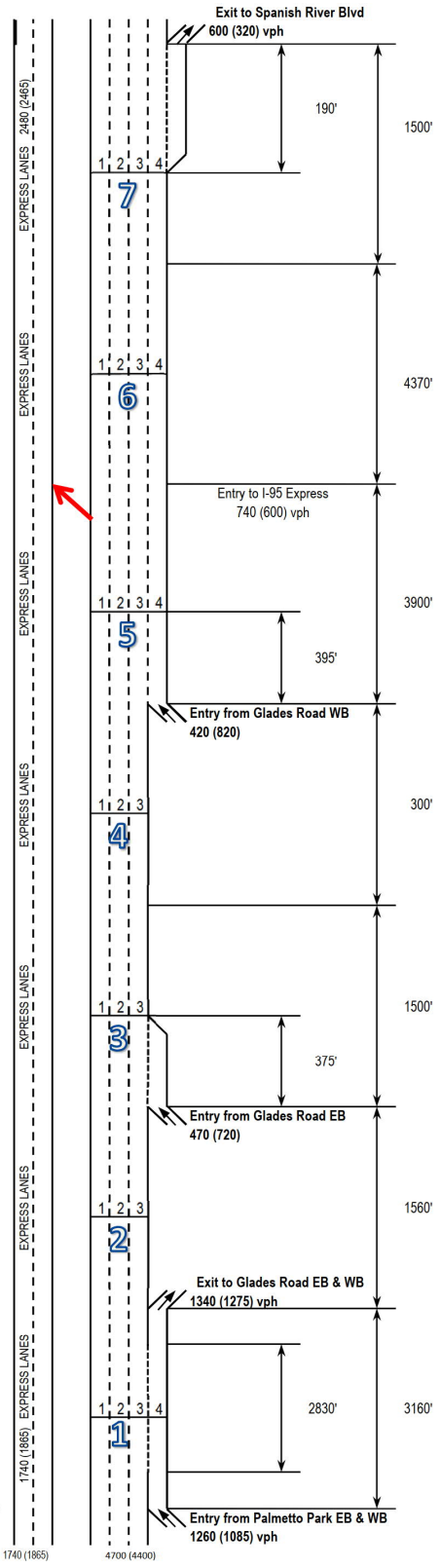


Table 4.3: 2040 RFP Concept - Freeway Analysis Results - Southbound

I-95 Segment Description	Analysis Type	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
		Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
I-95 SB On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic (1)	6	8,010 (7,070)	2	1,500 (2,070)	20.4 (17.9)	C (B)
I-95 SB On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic (1)	5	8,010 (7,070)	2	1,500 (2,070)	25.4 (21.8)	C (C)
I-95 SB Downstream of the On-Ramp from Yamato Road EB & Spanish River Boulevard	Mainline/Basic	4	8,010 (7,070)	-	-	35.5 (29.1)	E (D)
Between Exit from I-95 Express and SB Off-Ramp to Glades Road EB & WB	Weave	4	8,380 (7,780)	-	-	38.3 (35.9)	E (E)
I-95 SB Off-Ramp to Glades Road EB & WB	Diverge/Drop Lane (2)	4	8,380 (7,780)	1	2,280 (1655)	39.0 (36.2)	E (E)
Between I-95 SB Off-Ramp to Glades Road EB & WB and I-95 SB On-Ramp from Glades Road WB	Mainline/Basic	3	6,100 (6,125)	-	-	36.5 (36.8)	E (E)
Between I-95 SB On-Ramp from Glades Road WB and I-95 SB On-Ramp from Glades EB	Mainline/Basic Merge/Add Lane (3)	3	6,545 (6,920)	1	445 (795)	26.1 (28.2)	D (D)
I-95 SB On-Ramp from Glades Road EB	Merge	4	6,545 (6,920)	1	475 (905)	25.4 (30.1)	C (D)
Between I-95 SB On-Ramp from Glades Road EB and I-95 SB Off-Ramp to Palmetto Park Road EB & WB	Mainline/Basic	4	7,020 (7,825)	-	-	28.8 (34.1)	D (D)
I-95 SB Off-Ramp to Palmetto Park EB & WB	Diverge/Drop Lane (4)	4	7,020 (7,825)	1	1,340 (1,400)	32.7 (36.4)	D (E)

(1) Merge length more than 1500 feet. Analyzed as a basic freeway segment.

(2) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N). The ramp downstream of the diverge is LOS F in AM.

(3) Merge is lane addition. Analyzed as a basic freeway segment.

(4) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N).

Table 4.4: 2040 RFP Concept - Freeway Analysis Results - Northbound

I-95 Segment Description	Analysis Type	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
		Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
I-95 Off-Ramp to Spanish River Blvd	Diverge	4	7,220 (7,425)	1	660 (350)	34.8 (34.0)	D (D)
Between Entry to I-95 Express and Off-Ramp to Spanish River Blvd.	Mainline/Basic	4	7,220 (7,425)	-	-	30.0 (31.3)	D (D)
Between I-95 NB On-Ramp from Glades Road WB and Entry to I-95 Express	Weave	4	8,130 (8,165)	-	-	37.7 (37.7)	E (E)
I-95 NB On-Ramp from Glades Road WB	Mainline/Basic Merge/Add Lane (1)	3	7,610 (7,145)	1	520 (1,020)	36.4 (36.7)	E (E)
Between I-95 NB On-Ramp from Glades Road EB and I-95 NB On-Ramp from Glades Road WB	Mainline/Basic	3	7,610 (7,145)	-	-	61.3 (51.2)	F (F)
I-95 NB On-Ramp from Glades Road EB	Merge	3	6,765 (6,035)	1	845 (1,110)	45.0 (41.5)	F (F)
Between I-95 NB Off-Ramp to Glades Road EB & WB and I-95 NB On-Ramp from Glades Road EB	Mainline/Basic	3	6,765 (6,035)	-	-	44.9 (35.8)	E (E)
Between I-95 NB On-Ramp from Palmetto Road EB & WB and I-95 NB Off-Ramp to Glades Road EB & WB	Weave	4	8,015 (7,395)	-	-	N/A (N/A)	F (F)

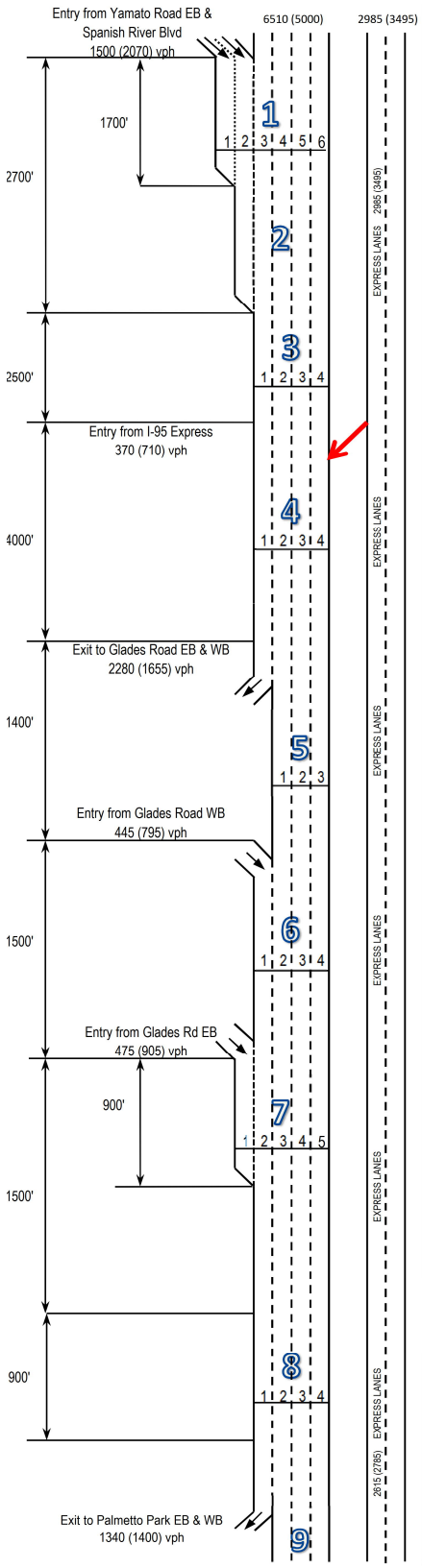
(1) Merge length more than 1500 feet. Analyzed as a basic freeway segment.

(2) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N). The ramp downstream of the diverge is LOS F in AM.

(3) Merge is lane addition. Analyzed as a basic freeway segment.

(4) Density upstream of the drop lane using Equation 13-26 of HCM 2010. (D_{MD}= 0.0175 (v_F/N).

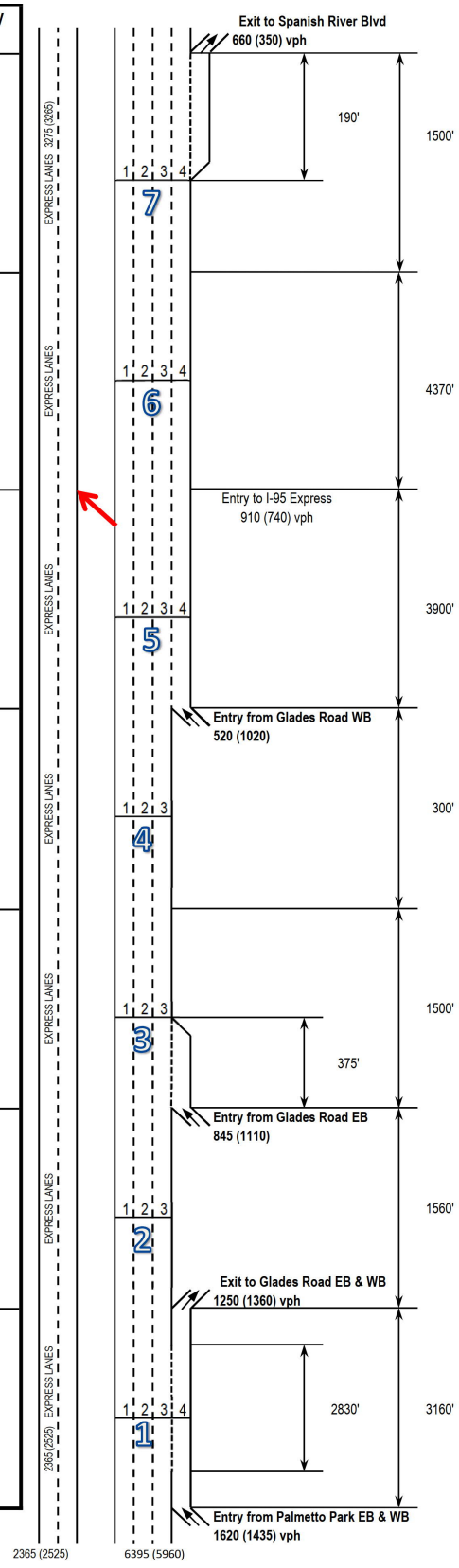
Figure 4.6: 2040 RFP Concept - Freeway Analysis Results - Southbound



Segment	VPH AM (PM)	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Major Merge from Yamato Road EB & Spanish River Boulevard	8010 (7070)	C (20.4)	B (17.9)
Major Merge from Yamato Road EB & Spanish River Boulevard	8010 (7070)	C (25.4)	C (21.8)
Basic Freeway	8010 (7070)	E (35.5)	D (29.1)
Weave From I-95 Express Lane to Glades Road EB & WB	8380 (7780)	E (38.3)	E (35.9)
Basic Freeway	6100 (6125)	E (36.5)	E (36.8)
Basic Freeway	6545 (6920)	D (26.1)	D (28.2)
Merge from Glades Road EB	7020 (7825)	C (25.4)	D (30.1)
Basic Freeway	7020 (7825)	D (28.8)	D (34.1)
Diverge (Drop Lane) to Palmetto	5680 (6425)	D (32.7)	E (36.4)

Figure 4.7: 2040 RFP Concept - Freeway Analysis Results – Northbound

Segment	VPH AM (PM)	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Diverge to Spanish River Blvd	7220 (7425)	D (34.8)	D (34.0)
Basic Freeway	7220 (7425)	D (30.0)	D (31.3)
Weave from Glades Road WB to I-95 Express Lanes	8130 (8165)	E (37.7)	E (37.7)
Basic Freeway	7610 (7145)	F (61.3)	F (51.2)
Merge from Glades Road EB	7610 (7145)	F (45.0)	F (41.5)
Basic Freeway	6765 (6035)	E (44.9)	E (35.8)
Weave Palmetto Park EB & WB to Glades Road EB & WB	8015 (7395)	F (N/A)	F (N/A)



4.2.2 2020 & 2040 RFP Concept - Intersection Analysis - Glades Road

Intersection analysis for ramp-terminals and adjacent intersections was performed in a similar manner as for the existing conditions. The RFP alternative includes the No-Build alternative plus proposed improvements to mitigate some of the deficiencies identified in the No-Build alternative. The improvements at these intersections were shown in Figure 4.2 and Figure 4.3 for 2020 and 2040 RFP conditions, respectively. Signal timing was optimized using Synchro to reflect routine maintenance operations with a maximum allowable cycle length of 180 seconds, equivalent to the existing conditions. Network offsets were also optimized, and uncoordinated signals were not permitted. **Appendix F** presents the intersection analysis worksheets.

Table 4.5 summarizes the results of the RFP alternative signalized intersection analyses during the AM and PM peak hours for the Opening Year 2020 and Design Year 2040 conditions. The table results include approach and intersection delay (in seconds per vehicle) and approach and intersection level of service. The 2040 Design Year results indicate that the intersection at Airport Road/NW 15th Avenue is expected to operate at LOS E during the AM peak hour. Likewise, the intersection at NW 22nd Way is expected to operate at LOS E during the PM peak hour. All remaining intersections are expected to operate at LOS D or better.

Table 4.5: 2020 & 2040 RFP Concept - Intersection Analysis Results

	Build (RFP) Scenario Year 2020						Build (RFP) Scenario Year 2040					
	AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
Intersection	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS
Glades Rd & Butts Rd	25.6 / C	EB	26.6 / C	31.3 / C	EB	35.4 / D	33.3 / C	EB	34.8 / C	47.3 / D	EB	36.0 / D
		WB	11.1 / B		WB	13.0 / B		WB	18.0 / B		WB	31.0 / C
		NB	69.2 / E		NB	53.5 / D		NB	71.6 / E		NB	110.4 / F
		SB	67.6 / E		SB	79.3 / E		SB	71.0 / E		SB	109.5 / F
Glades Rd & NW 22nd Way	19.0 / B	EB	10.9 / B	34.8 / C	EB	17.2 / B	33.7 / C	EB	21.7 / C	60.1 / E	EB	47.6 / D
		WB	22.8 / C		WB	30.9 / C		WB	40.9 / D		WB	49.2 / D
		NB	63.5 / E		NB	62.0 / E		NB	74.5 / E		NB	89.9 / F
		SB	68.4 / E		SB	114.2 / F		SB	68.3 / E		SB	168.9 / F
Glades Rd & I-95 SB Ramps	14.4 / B	EB	11.7 / B	17.8 / B	EB	12.3 / B	17.6 / B	EB	17.9 / B	30.3 / C	EB	14.1 / B
		WB	5.3 / A		WB	16.3 / B		WB	9.8 / A		WB	31.5 / C
		NB	-		NB	-		NB	-		NB	-
		SB	23.9 / C		SB	27.3 / C		SB	22.1 / C		SB	41.1 / D
Glades Rd & I-95 NB Ramps	27.6 / C	EB	18.2 / B	21.4 / C	EB	16.2 / B	36.1 / D	EB	26.7 / C	30.4 / C	EB	26.9 / C
		WB	12.7 / B		WB	7.8 / A		WB	17.7 / B		WB	11.9 / B
		NB	52.9 / D		NB	46.8 / D		NB	59.8 / E		NB	56.8 / E
		SB	-		SB	-		SB	-		SB	-
Glades Rd & Airport Rd/NW 15th Ave	33.7 / C	EB	29.6 / C	23.9 / C	EB	15.2 / B	58.8 / E	EB	57.8 / E	30.5 / C	EB	24.7 / C
		WB	29.3 / C		WB	23.9 / C		WB	57.2 / E		WB	20.0 / C
		NB	58.3 / E		NB	54.9 / D		NB	68.5 / E		NB	67.4 / E
		SB	36.6 / D		SB	28.1 / C		SB	50.6 / D		SB	45.3 / D
Glades Rd & W University Dr	33.9 / C	EB	25.4 / C	41.2 / D	EB	41.5 / D	36.4 / D	EB	25.5 / C	45.2 / D	EB	41.7 / D
		WB	52.2 / D		WB	56.3 / E		WB	58.5 / E		WB	60.7 / E
		NB	54.2 / D		NB	46.4 / D		NB	62.9 / E		NB	64.3 / E
		SB	11.9 / B		SB	11.9 / B		SB	13.3 / B		SB	16.2 / B
Airport Rd & I-95 Access	11.1 / B	EB	-	12.3 / B	EB	-	12.0 / B	EB	-	16.3 / B	EB	-
		WB	-		WB	-		WB	-		WB	-
		NB	0.5 / A		NB	3.1 / A		NB	0.5 / A		NB	4.6 / A
		SB	31.6 / C		SB	30.8 / C		SB	32.9 / C		SB	38.2 / D

(1) Delay and LOS reported from Synchro-HCM 2000

Table 4.6 summarizes the results of the off-ramp signals back of queue analyses for the AM and PM peak hours. Synchro 95th percentile queues are being reported. These queues were taken from the intersection report in Synchro. The available storage length was calculated from the stop bar at the ramp terminal intersection to the start of the turning lane taper. For the RFP, the tapers are 400 feet long for each northbound movement and 670 feet long for each southbound movement. The analysis indicates that there are long queues exceeding the available storage length for the eastbound approach of the intersection at Airport Road.

Table 4.6: 2020 & 2040 RFP Concept - Off-Ramp Signals Queuing Analysis Results

				Build (RFP) Year 2020		Build (RFP) Year 2040	
				AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Intersection	Approach	Movement	Available Storage (ft)	Queue 95th (ft)	Queue 95th (ft)	Queue 95th (ft)	Queue 95th (ft)
Glades Rd & NW 22nd Way	WB	L/T (WB)	1400	#254	#777	#395	#1361
Glades Rd & I-95 SB Ramps	SB	L (EB)	1,245	181	88	223	116
		R (WB)	1,245	158	#162	244	#382
Glades Rd & I-95 NB Ramps	NB	L (WB)	810	161	169	212	246
		R (EB)	810	429	282	#609	426
Glades Rd & Airport Rd	EB	L/T (EB)	500	#1167	237	#1413	583

Notes:
~ Volume exceeds capacity, queue is theoretically infinite
# 95th percentile volume exceeds capacity, queue may be longer
Queue shown is maximum after two cycles

Note: Queue lengths exceeding available storage are shown in RED.

5 DDI CONCEPT

5.1 DDI Concept - Transportation Network

The DDI concept takes into consideration roadway improvements identified in the No-Build alternative and planned transportation projects identified by Palm Beach County, the Palm Beach County TPA, and FDOT (refer to Section 1.4 of this report). The DDI alternative maintains the typical section from the No-Build alternative along I-95 between interchanges (i.e., no through lanes along I-95 are added).

5.2 DDI Concept - Traffic Forecast

Traffic projections were provided by the I-95 Corridor Design Consultant (CDC). The traffic forecasting and directional design hour volumes procedures were described in Section 2.3-Travel Demand Forecasting of this IMR re-evaluation. The projected volumes remain the same as the No-Build alternative and the RFP concept. However, manual adjustments were implemented to account for the different geometry. In fact, under the RFP concept, vehicles in the northbound approach of the intersection at Airport Road had to drive north and go through an additional signalized intersection with a hairpin turn to be able to access the I-95 ramps. Under the DDI, these vehicles have a direct access to I-95 from Glades Road.

5.3 DDI Concept - Configuration

The current changes proposed to the RFP concept include:

- Conversion of interchange to a DDI concept, which incorporates:
  - Four lanes in each direction along Glades Road on the bridge span
  - A single turning lane onto southbound I-95 from both directions
  - A single turning lane onto northbound I-95 from westbound Glades Road
  - A dual turning lane onto northbound I-95 from eastbound Glades Road
  - Both northbound I-95 and southbound I-95 off-ramps to comprise of 3 left turn lanes and 3 right turn lanes
  - Southbound I-95 on-ramp from Glades Road has been modified from a one-lane on-ramp as presented in the MLOU to a two-lane on-ramp to improve the traffic operation of the merge segment.
- Modifications to the Glades Road and Airport Road intersection include:
  - An additional eastbound through lane
  - Retaining dual southbound right turn lanes as present in the existing configuration
  - An additional westbound through lane
  - Modifying the westbound right turn lane to a shared through/right lane

The proposed DDI layout will reduce left turn conflicts and has been proven to improve safety where it has been implemented. Figure 5.1 shows the DDI alternative for Glades Road.

Figure 5.3 and Figure 5.4 show the lane configuration and traffic volumes for 2020 and 2040 DDI conditions, respectively. These improvements will address the traffic operation deficiencies by

eliminating failing merge, diverge and weaving segments; and improving safety by reducing congestion. Improvements at the ramp terminal intersections will likely eliminate queue spillbacks into the I-95 mainline. In addition, pedestrian and bicycle mobility is improved by the addition of a seven (7) foot buffered bicycle lane through the interchange and the new ten (10) foot wide pedestrian walkway likely to be used by recreational cyclists.

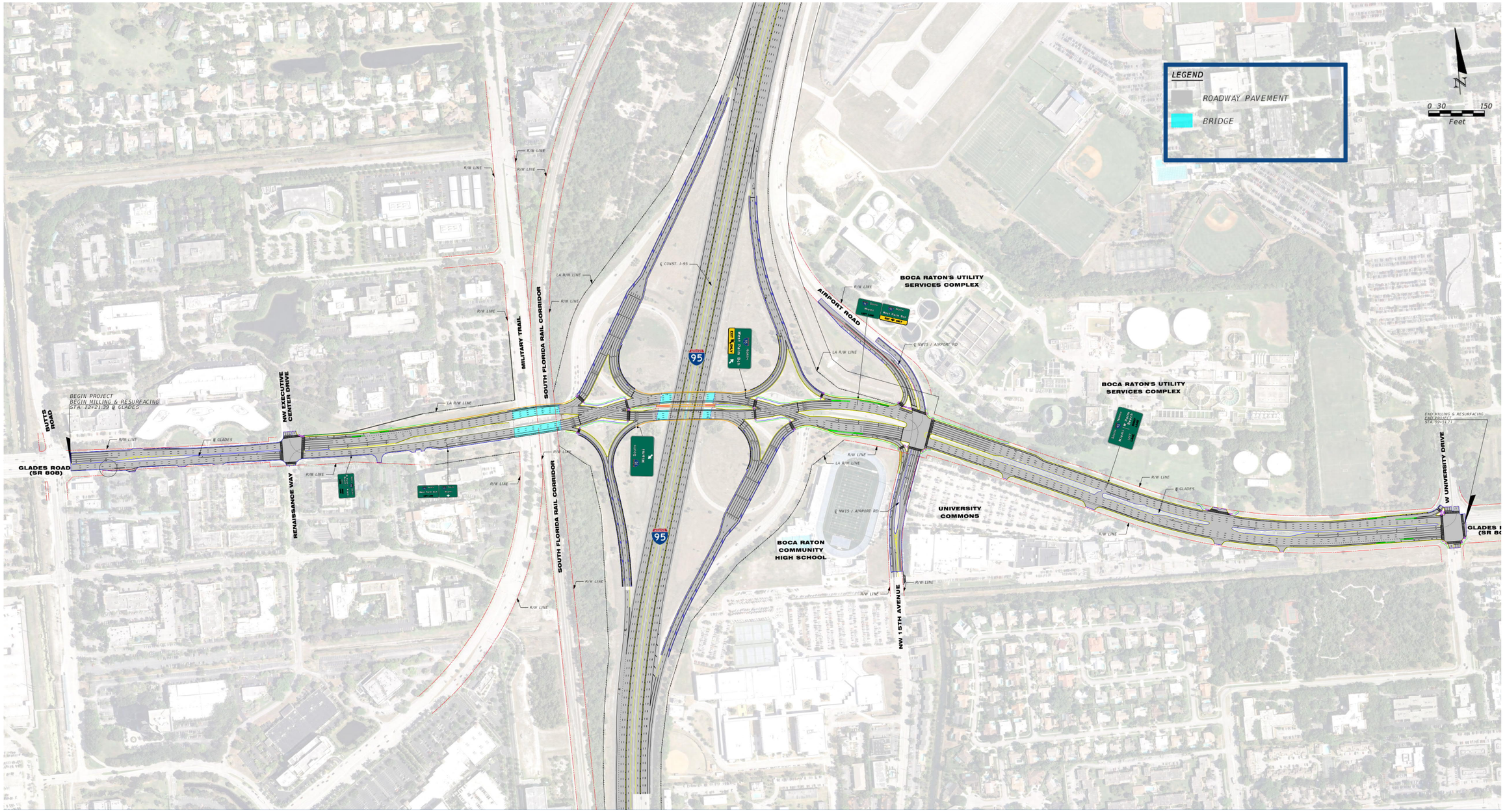


Figure 5.1: DDI Concept - Glades Road at I-95

5.4 DDI Concept - Traffic Operational Analysis

Traffic operational analysis was conducted to evaluate the DDI alternative improvements in the study area for Opening Year 2020 and Design Year 2040. The evaluation of intersection operations was performed in a similar manner as for the existing conditions. The traffic operational objective assumed for this evaluation was LOS D. The calculated DHT factors under existing conditions were used for the Build alternative analyses. Peak hour factors of 0.95 for I-95 General Purpose and Express lanes and 1.00 for ramp terminals and intersections were applied in the future conditions operational analysis (Opening Year – 2020 and Design Year – 2040), which is reflective of the expected future conditions with the high overall level of travel demand in the area of influence.

Figure 5.3 and Figure 5.4 present the DDI intersection lane configuration and traffic volumes for Opening Year 2020 and Design Year 2040, respectively.

5.4.1 2020 & 2040 DDI Concept - Freeway Analysis - I-95

Due to the freeway operations of the DDI alternative being similar to those of the RFP alternative, it was stated in the MLOU that duplicate analysis would not be undertaken at locations for freeway segments where the design did not change. However, at the Glades Road interchange, the number of ramps has been reduced, as there will only be a single on-ramp in each direction for the DDI interchange. Therefore, an analysis has been undertaken for freeway segments affected by the ramp modifications to make sure that traffic operation for these facilities is equal or better than the RFP concept. The freeway analysis for the DDI scenario for the freeway segments in question is shown in Table 5.1. Outputs from HCS are included in Appendix E.

As shown in Figure 5.2 the configuration of the proposed merge segment along southbound I-95 from Glades Road under the DDI concept has a unique configuration that does not meet the definition of a traditional two-lane on-ramp in the Highway Capacity Manual (HCM). What makes this a unique merge segment is that it has only one acceleration lane (lane No. 1) that drops into an auxiliary lane (identified in yellow/lane No. 2). After discussing the issue with McTrans (developers of HCS) and consulting with the District, it was decided that the best way to evaluate this merge segment in HCS was to consider it as a one-lane on-ramp and shift half of the demand from the on-ramp to a freeway section with four lanes rather than three lanes. This was done because the auxiliary lane in this particular situation behaves similar to a traditional freeway lane and vehicles are likely to experience similar friction as if they were in a one-lane on-ramp facility.

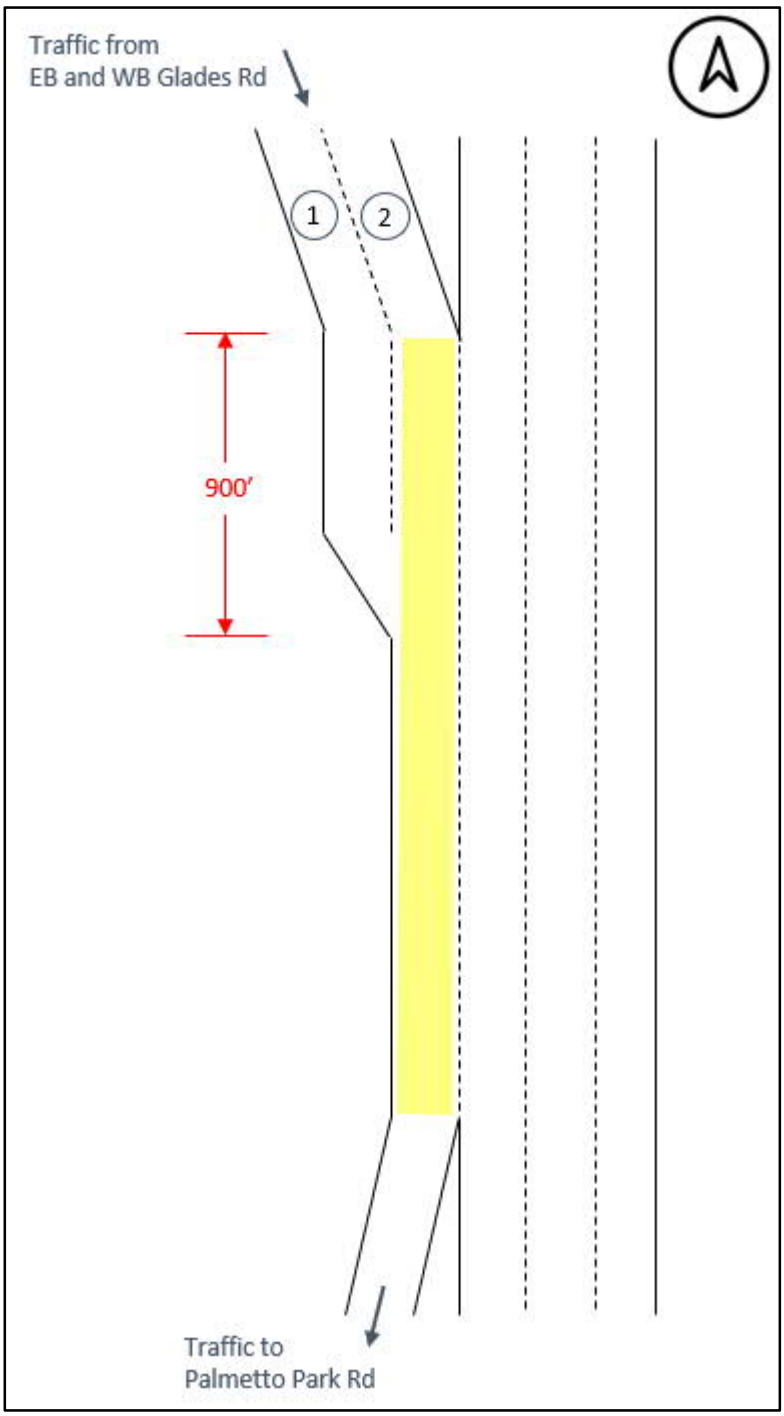


Figure 5.2: SB I-95 Merge Segment from Glades Road - DDI Concept

Table 5.1: 2020 & 2040 DDI Concept - HCS Analysis

I-95 Segment Description	Analysis Type	Build (DDI) Scenario Year 2020						Build (DDI) Scenario Year 2040					
		Freeway		Ramp		Density AM (PM)	LOS AM (PM)	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
		Lane	DDHV AM (PM)	Lane	DDHV AM (PM)			Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
Northbound I-95													
Basic between Glades Rd off-ramp and on-ramp	Basic	3	4,620 (4,210)	-	-	24.1 (21.6)	C C	3	6,765 (6,035)	-	-	44.9 (35.8)	E E
Weaving between Glades Road and ingress point to express lanes	Weaving	4	5,510 (5,750)	-	-	24.9 (26.1)	C (C)	4	8,130 (8,165)	-	-	40.2 (40.1)	E (E)
Southbound I-95													
Basic between Glades Rd off-ramp and on-ramp	Basic	3	5,025 (5,260)	-	-	27.0 (28.7)	D D	3	6,100 (6,125)	-	-	36.5 (36.8)	E E
On-ramp from EB and WB Glades Rd (with two-lane ramp)	Merge	3	5,025 (5,260)	2	850 (1,460)	21.3 (25.6)	C (C)	3	6,100 (6,125)	2	920 (1,700)	25.3 (29.8)	C (D)

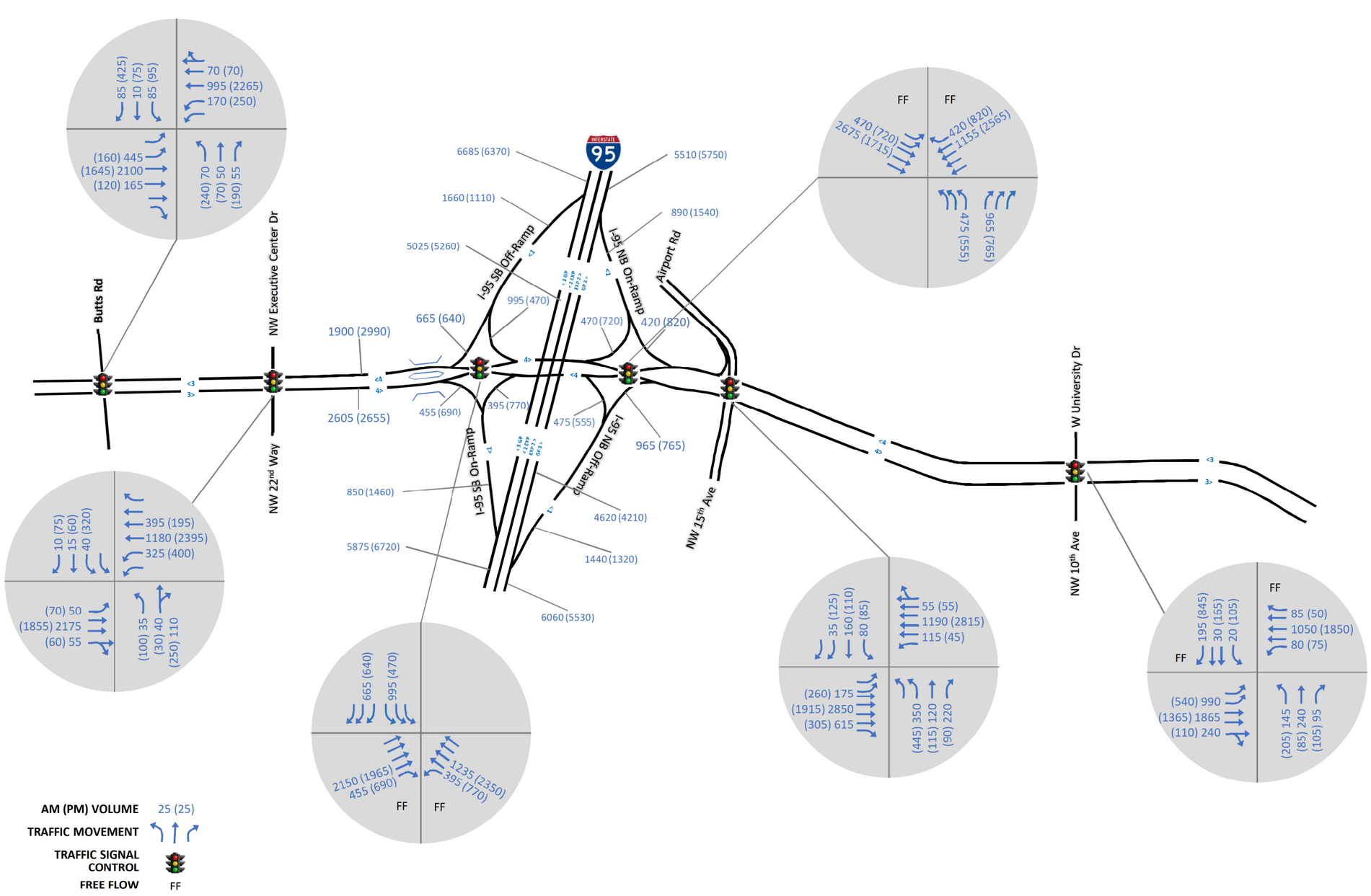


Figure 5.3: 2020 DDI Concept - Intersection Lane Configuration & Traffic Volumes

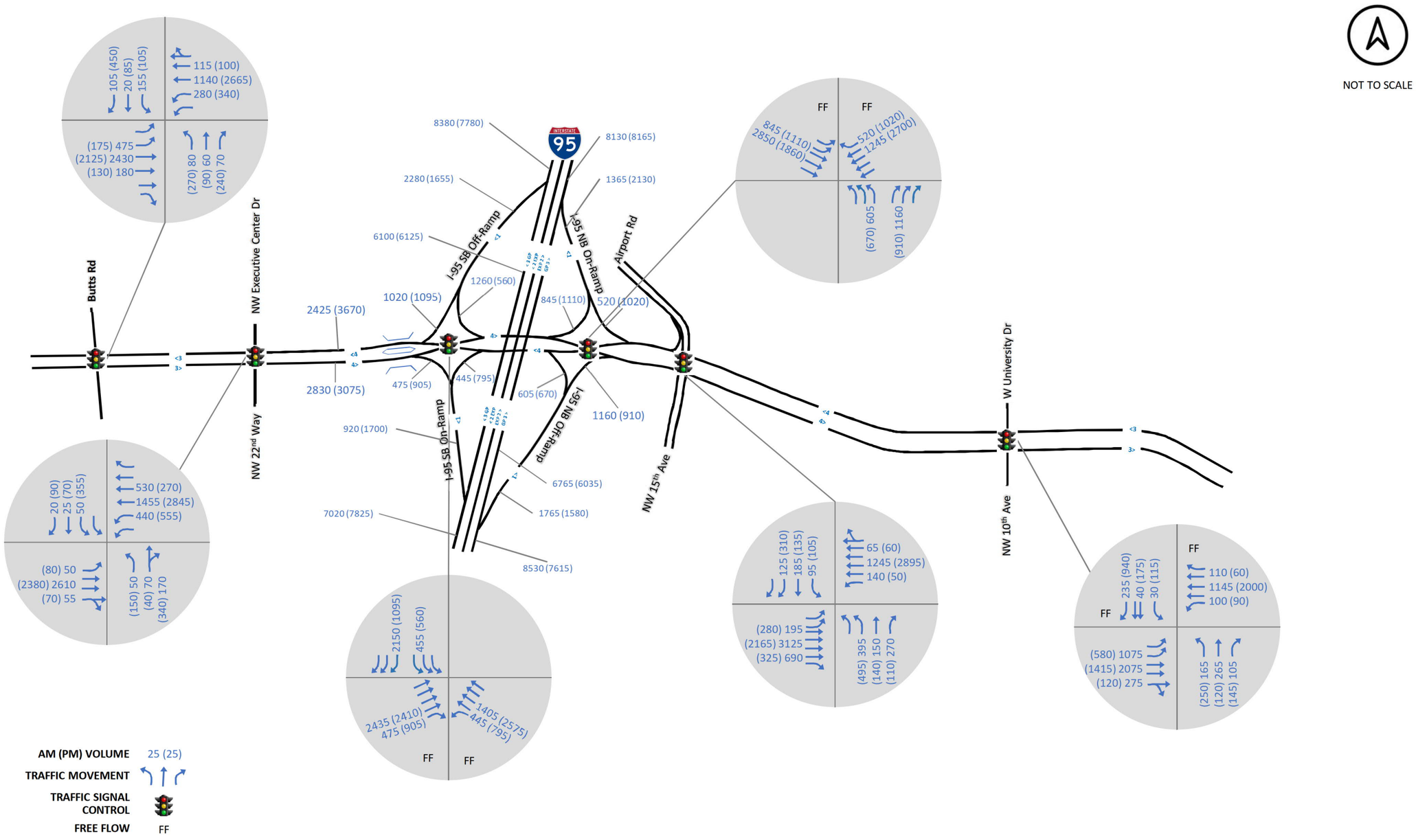


Figure 5.4: 2040 DDI Concept - Intersection Lane Configuration & Traffic Volumes

5.4.2 2020 & 2040 DDI Concept - Intersection Analysis - Glades Road

Intersection analysis for ramp-terminals and adjacent intersections was performed in a similar manner as for the existing conditions. The DDI alternative includes the No-Build alternative plus proposed improvements to mitigate deficiencies identified in the No-Build alternative. The improvements at these intersections were shown in Figure 5.3 and Figure 5.4 for 2020 and 2040 DDI conditions, respectively. Signal timing was optimized using Synchro to reflect routine maintenance operations with a maximum allowable cycle length of 180 seconds, equivalent to the existing conditions. Network offsets were also optimized, and uncoordinated signals were not permitted. **Appendix G** presents the intersection analysis worksheets.

Table 5.2 summarizes the results of the DDI alternative signalized intersection analyses during the AM and PM peak hours for the Opening Year 2020 and Design Year 2040 conditions. The table results include approach and intersection delay (in seconds per vehicle) and approach and intersection level of service. The 2040 Design Year results indicate that no intersections are expected to operate at LOS E during the AM peak hour and during the PM peak hour, only the intersection at NW 22nd Way would operate at LOS E. All remaining intersections are expected to operate at LOS D or better. These results are significantly better than the RFP results with reduced delays at the interchange. It is also important to note that the DDI concept eliminates the new intersection at Airport Road and the I-95 Access proposed as part of the RFP concept, which reduces overall delay.

Table 5.2: 2020 & 2040 DDI Concept - Intersection Analysis Results

	Build (DDI) Scenario Year 2020						Build (DDI) Scenario Year 2040					
	AM Peak Hour			PM Peak Hour			AM Peak Hour			PM Peak Hour		
Intersection	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS	Intersection Delay (sec/veh) / LOS	Approach	Approach Delay (sec/veh) / LOS
Glades Rd & Butts Rd	29.4 / C	EB	26.0 / C	30.3 / C	EB	35.7 / D	33.7 / C	EB	32.6 / C	41.5 / D	EB	43.5 / D
		WB	25.6 / C		WB	10.5 / B		WB	23.2 / C		WB	27.0 / C
		NB	69.2 / E		NB	52.4 / D		NB	66.5 / E		NB	69.0 / E
		SB	67.6 / E		SB	80.9 / F		SB	78.0 / E		SB	78.6 / E
Glades Rd & NW 22nd Way	23.8 / C	EB	27.6 / C	35.8 / D	EB	17.2 / B	40.2 / D	EB	47.6 / D	60.4 / E	EB	42.5 / D
		WB	14.4 / B		WB	32.9 / C		WB	27.4 / C		WB	53.2 / E
		NB	59.9 / E		NB	62.0 / E		NB	69.6 / E		NB	89.9 / F
		SB	61.7 / E		SB	114.2 / F		SB	63.8 / E		SB	168.9 / F
Glades Rd & I-95 SB Ramps	16.7 / B	EB	8.1 / A	17.8 / B	EB	18.3 / B	19.0 / B	EB	11.3 / B	25.0 / C	EB	21.6 / C
		WB	16.6 / B		WB	14.2 / B		WB	13.1 / B		WB	21.6 / C
		SB LT	37.6 / D		SB LT	19.4 / B		SB LT	40.3 / D		SB LT	27.3 / C
		SB RT	13.7 / B		SB RT	28.6 / C		SB RT	19.0 / B		SB RT	39.6 / D
Glades Rd & I-95 NB Ramps	25.2 / C	EB	16.6 / B	20.8 / C	EB	18.6 / B	27.9 / C	EB	18.1 / B	29.3 / C	EB	27.6 / C
		WB	31.2 / C		WB	20.7 / C		WB	25.9 / C		WB	29.4 / C
		NB LT	11.0 / B		NB LT	25.7 / C		NB LT	13.0 / B		NB LT	32.7 / C
		NB RT	48.9 / D		NB RT	22.6 / C		NB RT	61.7 / E		NB RT	29.8 / C
Glades Rd & Airport Rd/NW 15th Ave	29.9 / C	EB	24.3 / C	26.0 / C	EB	17.4 / B	41.3 / D	EB	37.7 / D	33.3 / C	EB	23.4 / C
		WB	14.8 / B		WB	20.3 / C		WB	17.5 / B		WB	19.9 / B
		NB	64.8 / E		NB	63.3 / E		NB	77.1 / E		NB	81.0 / F
		SB	90.4 / F		SB	67.9 / E		SB	89.8 / F		SB	91.9 / F
Glades Rd & W University Dr	31.4 / C	EB	22.5 / C	36.1 / D	EB	34.2 / C	36.8 / D	EB	27.7 / C	42.4 / D	EB	37.5 / D
		WB	47.9 / D		WB	48.3 / D		WB	54.8 / D		WB	55.1 / E
		NB	56.4 / E		NB	46.2 / D		NB	62.8 / E		NB	66.6 / E
		SB	12.2 / B		SB	14.5 / B		SB	14.3 / B		SB	18.5 / B

(2) Delay and LOS reported from Synchro-HCM 2000

Table 5.3 summarizes the results of the off-ramp signals back of queue analyses for the AM and PM peak hours. Synchro 95th percentile queues are being reported. These queues were taken from the intersection report in Synchro. The available storage length was calculated from the stop bar at the ramp terminal intersection to the start of the turning lane taper. For the DDI, the tapers are 100 feet long for each movement. While there are long queues on the eastbound approach of the intersection at Airport Road for the DDI, when compared to the RFP concept, such queues are much shorter during the AM peak hour and equally long during the PM peak hour. It is also important to note that the DDI queues are shorter than the No-Build and RFP queues on average.

Table 5.3: 2020 & 2040 DDI Concept - Off-Ramp Signals Queuing Analysis Results

				Build (DDI) Year 2020		Build (DDI) Year 2040	
				AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Intersection	Approach	Movement	Available Storage (ft)	Queue 95th (ft)	Queue 95th (ft)	Queue 95th (ft)	Queue 95th (ft)
Glades Rd & NW 22nd Way	WB	L/T (WB)	1400	#252	#760	#381	#1363
Glades Rd & I-95 SB Ramps	SB	L (EB)	725	256	62	385	132
		R (WB)	735	52	189	188	471
Glades Rd & I-95 NB Ramps	NB	L (WB)	685	0	120	16	191
		R (EB)	705	407	164	#582	286
Glades Rd & Airport Rd	EB	L/T (EB)	500	670	323	#945	553

Notes:
~ Volume exceeds capacity, queue is theoretically infinite
# 95th percentile volume exceeds capacity, queue may be longer
Queue shown is maximum after two cycles

Note: Queue lengths exceeding available storage are shown in RED.

5.5 Safety Analysis of the DDI Alternative

An analysis of the predicted number of crashes along mainline I-95 was conducted for both the RFP and the DDI concepts to assess and compare the safety conditions between the two. The study area limits for the safety analysis on I-95 are:

- I-95 between W Palmetto Park Road (northbound entrance ramp gore point) and Yamato Rod (southbound entrance ramp gore point)

The analysis was done for 2040 conditions.

5.5.1 Data Collection

- The 2040 traffic volumes for all the basic freeway segments and ramps were used.
- All the required geometric design and traffic control data were obtained from the design files that were provided.

5.5.2 Methodology

The analysis followed the procedures from Chapters 18 and 19 of the Highway Safety Manual (HSM) – 1st Edition Supplement 2014 by the American Association of State Highway and Transportation Officials (AASHTO). The Enhanced Interchange Safety Analysis Tool (ISATe) was used for performing the analysis. The methodology discussed in the ISATe user manual was followed in the current analysis.

5.5.3 Analysis

The project was divided into freeway segments and ramps segments. All the freeway segments within the study limits were included in the freeway analysis whereas the ramps at the interchange were included in the ramp analysis. However, the ramp terminals were not included in the analysis. The RFP alternative was segmented into 24 freeway and 9 ramp segments. The DDI alternative was segmented into 21 freeway and 8 ramp segments. The results from the analysis are summarized in Table 5.4**.**

Table 5.4: RFP and DDI Concepts - Summary of Predicted Crashes (2040)

Crash Severity Type	FDM Crash Distribution Factors (Freeway)	FDM Crash Distribution Factors (Ramps)	Predicted Crashes			
			RFP Concept		DDI Concept	
			Freeway	Ramp	Freeway	Ramp
K	0.006	0.004	0.93	0.03	0.85	0.02
A	0.035	0.032	5.40	0.25	4.98	0.15
B	0.113	0.107	17.45	0.83	16.09	0.51
C	0.206	0.210	31.81	1.64	29.33	1.01
PDO	0.641	0.647	98.97	5.05	91.28	3.11
	Total (Rounded)		**162**		**147**	

As presented in Table 5.4, the DDI concept is predicted to have 147 crashes within the study area whereas the RFP concept is predicted to have 162 crashes. The DDI concept is predicted to have 15 less crashes, which equates to a 9 percent crash reduction when compared to the RFP concept.

5.5.4 Assumptions and Limitations

- A calibration factor of 1.00 was used for both the concepts.
- A 30-feet clear zone was assumed for both the designs.
- Freeway free flow speed of 65 mph was used for both the designs.
- The analysis did not include the ramp terminals due to the limitations of the HSM in predicting crashes at a DDI interchange ramps terminals.

5.5.5 Safety Research on DDIs

The HSM and ISATe tool do not account for the unique configuration of a DDI and therefore, ISATe methods could not be used to predict the safety benefits for the ramp terminal intersections at Glades Road. Since there are no other tools that account for the DDI configuration either, the safety benefits of the DDI based on previous researches are summarized below:

The key safety benefits of the DDI configuration include:

- Reduction of conflict points (14 conflict points and 2 crossing points, compared to the 26 conflict points found in the conventional diamond interchange) and improved sight distance at the turns.
- Reduction in crash severity due to lower design speeds compared to other interchange designs.
- Traffic calming effect that reduces vehicular speed (while maintaining the capacity) due to the small geometric deflection introduced by the DDI for through traffic.
- Elimination of the wrong-way movements into ramps from the DDI interchange design.
- Crash reduction associated with the elimination of loop ramps, where applicable.

Several research papers and before-after studies support the safety benefits of the DDIs. Hummer, Joseph E., et al.[1] recommended a Crash Modification Factor (CMF) of 0.67 for conversion of a conventional Diamond Interchange to a DDI. This implies that the DDI design is estimated to reduce crashes by 33 percent compared to the conventional Diamond Interchange. The research team analyzed seven of the earliest DDIs in the US - four of which were in Missouri and the rest in Kentucky, New York, and Tennessee. The team collected over 28 site-years of "before" (conversion to DDI) data and over 19 site-years of "after" (conversion to DDI) data. The overall crash reduction was found to be 33 percent, while the reduction in injury crashes was found to be 41 percent. Additionally, the analyses indicated that DDI installation could reduce angle and turning crashes substantially. The research team recommended that agencies consider DDI strongly as replacements for conventional diamonds. The Glades Road interchange is not completely a conventional diamond due to its loop ramps. Based on the study by Elvik, Rune, et al.[2], replacing the loop ramps with straight ramps or short ramps would reduce the crashes by 45 percent and 30 percent respectively.

This CMFs from these studies can be found in the Crash Modification Factors Clearinghouse, developed by the US Department of Transportation (USDOT) Federal Highway Administration

(FHWA) and maintained by the University of North Carolina Highway Safety Research Center (UNC HSRC).

5.5.6 Conclusions

The DDI configuration at Glades Road results in reduced ramp access points along the I-95 freeway. Based on the ISATe analysis results, the DDI concept is predicted to have 15 less crashes, which equates to a 9 percent crash reduction when compared to the RFP concept. The before and after comparison presented in the research study indicates that the DDIs (in comparison to the conventional Diamond Interchanges) are predicted to reduce the overall crashes by 33 percent while significantly reducing the injury crashes. Additionally, the elimination of the existing loop ramps would further improve the safety conditions for the DDI. Therefore, the DDI configuration at Glades Road is predicted to have lower than the total number of predicted crashes as well as reduce the severity of crashes.

5.5.7 References

1. Hummer, Joseph E., et al. "Safety evaluation of seven of the earliest diverging diamond interchanges installed in the United States." Transportation research record 2583.1 (2016): 25-33.
2. Elvik, Rune, et al. "Traffic Control', The Handbook of Road Safety Measures." (2009): 397-541.

6 OTHER CONSIDERATIONS

6.1 Potential Design Exceptions and Variations for the DDI Concept

Improvements along the I-95 mainline and ramps will require a border width variation, as there are several locations where the 94’ minimum width cannot be achieved without further right-of-way acquisition, and a horizontal alignment variation due to several curves which do not meet the minimum curve length of 400’.

Improvements along Glades Road will require a border width variation at two locations where the minimum 8’ cannot be established, a cross slope variation due to varying cross slopes outside the 1.5% to 4% allowable range, a longitudinal grade variation at several locations where the minimum 0.3% grade is not maintained, a median width variation at one location where the minimum 19.5’ width is not provided, a Vertical Alignment variation for the crest curve over Military Trail and the South Florida Regional Transportation Authority (SFRTA) railroad which does not meet the minimum K value of 98, and a vertical clearance variation for the bridge over the SFRTA railroad which does not provide the minimum 23’ 6” clearance.

All other improvements along the mainline, ramps and Glades Road should be designed using minimum standards established in the latest editions of AASHTO’s A Policy on Geometric Design of Highways and Streets and FDOT’s Plans Preparation Manual.

6.2 Design Considerations for the DDI Concept

The design speed of the Glades Road arterial will be maintained at 45 mph, with a design speed of 35 mph through the interchange. Crossover angles will be equal to 30 degrees. The smallest radii curve in the DDI is 1,146’, which is consistent with normal crown requirements for 35 mph. Lane widths throughout the study area will be 11’.

7 PROJECT JUSTIFICATION

7.1 FHWA's Policy on Access to the Interstate System

This policy replaces the policy of August 27, 2009 on "Access to the Interstate System," published at 74 Federal Register 43743. The changes in this policy are made to ensure this policy focuses on safety, operational, and engineering issues. The consideration of social, economic, and environmental impacts discussed in the 2009 policy are removed from this policy. However, the removal from this policy does not eliminate the need to consider those matters. Those issues will be addressed under the National Environmental Policy Act and other statutes and regulations applicable to the approval process.

This policy is effective as of May 22, 2017.

It is in the national interest to preserve and enhance the interstate system to meet the needs of the 21st Century by assuring that it provides the highest level of service in terms of safety and mobility. Full control of access along the Interstate mainline and ramps, along with control of access on the crossroad at interchanges, is critical to providing such service. Therefore, the Federal Highway Administration's (FHWA) decision to approve new or revised access points to the interstate system under Title 23, United States Code (U.S.C.), Section 111, must be supported by substantiated information justifying and documenting that decision. The FHWA's decision to approve a request is dependent on the proposal satisfying and documenting the following requirements:

Considerations and Requirements

1. *An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).*

The IMR re-evaluation has shown that the DDI concept has a lower number of predicted crashes (147) when compared to the RFP concept (162), which amounts to a crash reduction of 9%. Through analyses of DDIs built throughout the US, it has been determined that there could be a potential 33% reduction in the total number of crashes. The DDI concept also results in equal or better LOS for signalized intersections along Glades Road and freeway segments along I-95. Both the weaving segment along northbound I-95 between Glades Road and the ingress point to the express lanes and the merge segment along southbound I-95 at the on-ramp from Glades Road operate at the same Level of Service (LOS) for the RFP and DDI concepts. The signalized intersections on Glades Road at the ramp terminals operate better under the DDI concept when compared to the RFP concept during both the AM and PM peak hours. The intersection at Glades Road and Airport Road have considerable improvements under the DDI concept during the AM peak hour and performs at similar LOS during the PM peak hour.

2. *The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.*

This IMR re-evaluation does not propose any new interchanges along I-95. This existing interchange provides access to public roads only. The improvements proposed at the interchange will maintain full access to the existing cross streets and accommodate all movements.

8 CONCEPTUAL FUNDING*

A funding plan for the proposed project has been developed. A right of way phase has also been programmed. The interchange improvements will be constructed in total with the I-95 Express Lanes Phase 3B-2 construction segment. The exact scope is not yet finalized; however, expectations are as follows:

- Contract Letting – March 2019
- Contract Execution – April 2019
- Open to Traffic – July 2022

In addition, the interchange has been added to the Strategic Intermodal System Funding Plan, FM number 412420-4 has been assigned, and has been added to the work program for funding of design, right of way, utility and design build phases in FY 2020 through FY 2025. The total estimated construction cost is $25 million. Cost estimates have been developed based on an engineer's opinion of probable cost using current FDOT Long Range Estimates (LRE) base costs.

The Express Lanes Phase 3B-2 project construction is underway, with anticipated opening year to traffic in 2024.

*Prior to design-build award

9 CONCLUSION AND RECOMMENDATION

The primary purpose of this IMR re-evaluation was to obtain safety, operational and engineering acceptability for the Diverging Diamond Interchange alternative, proposed during the design-build process. This IMR re-evaluation focused on identifying the needs through the year 2040 in the study area and developing a design concept to address traffic operational deficiencies along the Glades Road corridor between Butts Road and W University Drive, including traffic spillbacks onto I-95, improve interchange ramp terminal intersection operations, reduce congestion, and enhance traffic safety.

The review of the crash data indicates that several of the merge, diverge and weaving segments have been designated as high crash locations at some point within the five years of analysis (2011-2015). In order to address some of these deficiencies, this report recommends implementing the proposed DDI concept to improve the Glades Road interchange by providing additional left-turn and right-turn lanes on both the southbound and northbound I-95 ramp terminal intersections, which increases capacity and reduces long vehicular queues. A DDI interchange has many additional advantages in comparison to other interchange configurations:

- Fewer conflict points (14 for the DDI, 15 for the RFP and 26 for diamond interchange)
- Improved intersection sight distances
- Reduce construction time
- Inherent traffic calming
- Shorter pedestrian crossings

The traffic projections and the lane configuration along I-95 mainline and the ramps remain unchanged between the RFP and the DDI concepts, and consequently, there is very small variation in the levels of service of the freeway segments between concepts.

Due to the freeway operations of the DDI alternative being similar to those of the RFP alternative, the IMR re-evaluation concentrated on evaluating the freeway segments affected by the removal of the loop ramps in the RFP concept and the merge points in the DDI concept that combines traffic from both directions of Glades Road into one access point. Table 9.1 and Table 9.2 shows a comparison of the traffic operation of the freeway segments affected by the modification of the ramps configuration.

The RFP concept shows that some of the freeway segments along the northbound direction will be operating at LOS F in 2040, whereas those segments are estimated to operate at LOS E under the DDI concept. There is basically no difference between the RFP and the DDI concepts as far as the performance of the other freeway segments analyzed. Figure 9.1 through Figure 9.8 graphically illustrate the comparison of the alternatives.

Table 9.1: 2020 & 2040 RFP Concept - HCS Analysis - AM and PM Peak Hours

I-95 Segment Description	Segment ID	Analysis Type	Build (RFP) Scenario Year 2020						Build (RFP) Scenario Year 2040					
			Freeway		Ramp		Density AM (PM)	LOS AM (PM)	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
			Lane	DDHV AM (PM)	Lane	DDHV AM (PM)			Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
Northbound I-95														
Basic between off-ramp to Glades Rd and on-ramp from EB Glades Rd	1	Basic	3	4,620 (4,210)	-	-	24.1 (21.6)	C C	3	6,765 (6,035)	-	-	44.9 (35.8)	E E
On-ramp from EB Glades Rd	2	Merge	3	4,620 (4,210)	1	470 (720)	29.4 (29.5)	D D	3	6,765 (6,035)	1	845 (1,110)	45.0 (41.5)	F F
Basic between on-ramp from EB Glades Rd and on-ramp from WB Glades Rd	3	Basic	3	5,090 (4,930)	-	-	27.4 (26.3)	D D	3	7,610 (7,145)	-	-	61.3 (51.2)	F F
Weaving between Glades Road and ingress point to express lanes	4	Weaving	4	5,510 (5,750)	-	-	24.0 (25.1)	C (C)	4	8,130 (8,165)	-	-	37.7 (37.7)	E (E)
Southbound I-95														
Basic between off-ramp to Glades Rd and on-ramp from WB Glades Rd	5	Basic	3	5,025 (5,260)	-	-	27.0 (28.7)	D D	3	6,100 (6,125)	-	-	36.5 (36.8)	E E
Basic between on-ramp from WB Glades Rd and on-ramp from EB Glades Rd	6	Basic	4	5,420 (6,030)	-	-	20.8 (23.5)	C C	4	6,545 (6,920)	-	-	26.1 (28.2)	D D
On-ramp from EB Glades Rd	7	Merge	4	5,420 (6,030)	1	455 (690)	21.5 (25.4)	C (C)	4	6,545 (6,920)	1	475 (905)	25.4 (30.1)	C (D)

Table 9.2: 2020 & 2040 DDI Concept - HCS Analysis - AM and PM Peak Hours

I-95 Segment Description	Segment ID	Analysis Type	Build (DDI) Scenario Year 2020						Build (DDI) Scenario Year 2040					
			Freeway		Ramp		Density AM (PM)	LOS AM (PM)	Freeway		Ramp		Density AM (PM)	LOS AM (PM)
			Lane	DDHV AM (PM)	Lane	DDHV AM (PM)			Lane	DDHV AM (PM)	Lane	DDHV AM (PM)		
Northbound I-95														
Basic between Glades Rd off-ramp and on-ramp	1	Basic	3	4,620 (4,210)	-	-	24.1 (21.6)	C C	3	6,765 (6,035)	-	-	44.9 (35.8)	E E
Weaving between Glades Road and ingress point to express lanes	2	Weaving	4	5,510 (5,750)	-	-	24.9 (26.1)	C (C)	4	8,130 (8,165)	-	-	40.2 (40.1)	E (E)
Southbound I-95														
Basic between Glades Rd off-ramp and on-ramp	3	Basic	3	5,025 (5,260)	-	-	27.0 (28.7)	D D	3	6,100 (6,125)	-	-	36.5 (36.8)	E E
On-ramp from EB and WB Glades Rd (with two-lane ramp)	4	Merge	3	5,025 (5,260)	2	850 (1,460)	21.3 (25.6)	C (C)	3	6,100 (6,125)	2	920 (1,700)	25.3 (29.8)	C (D)

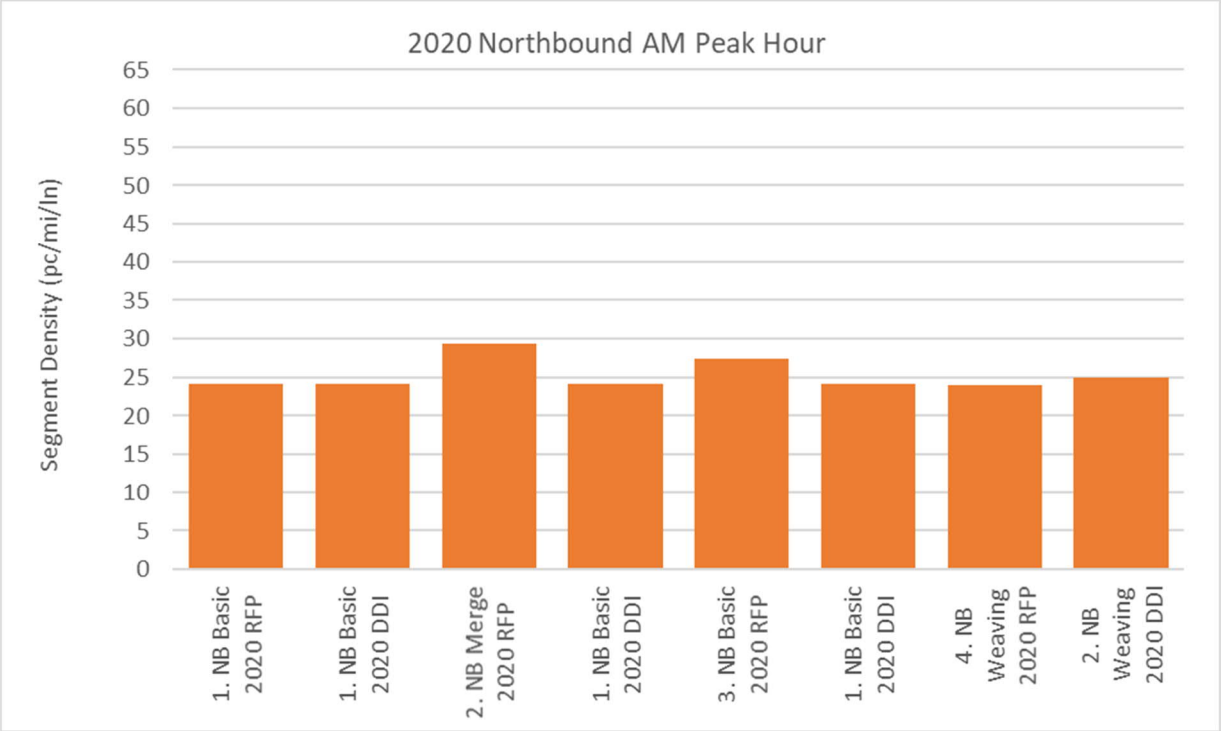


Figure 9.1: 2020 Northbound HCS Analysis Results - AM Peak Hour

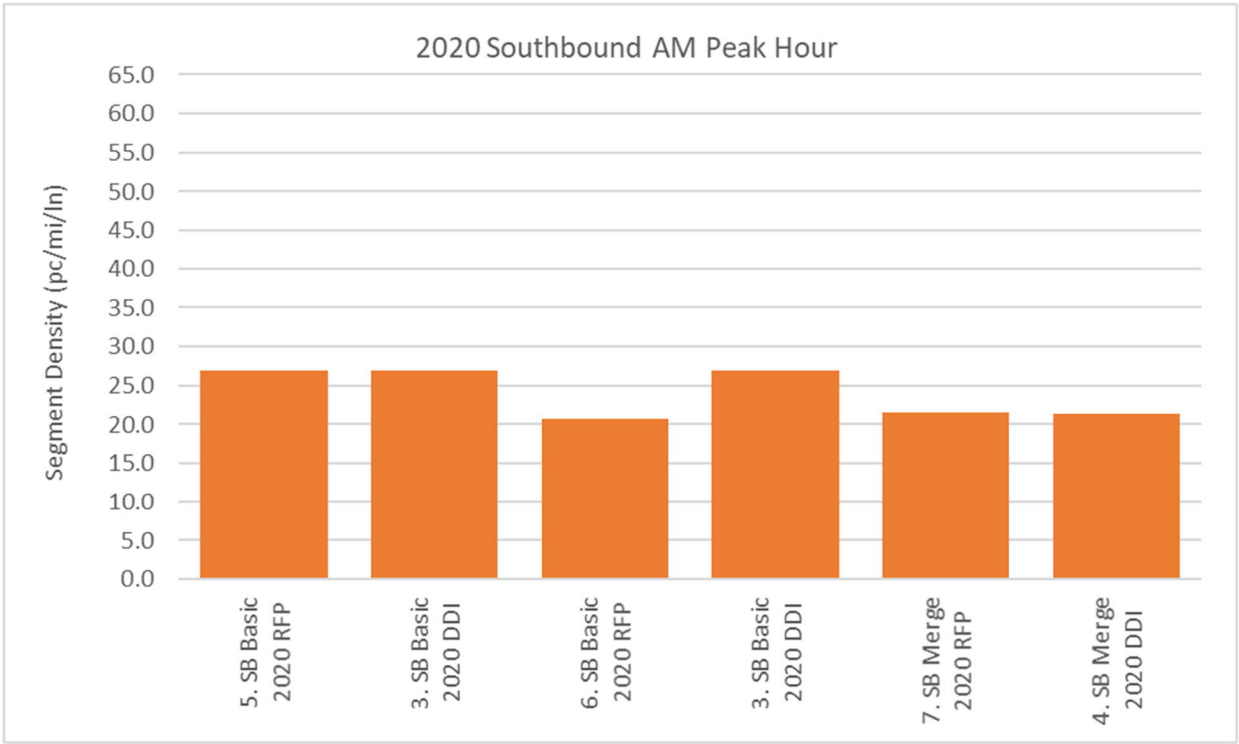


Figure 9.2: 2020 Southbound HCS Analysis Results - AM Peak Hour

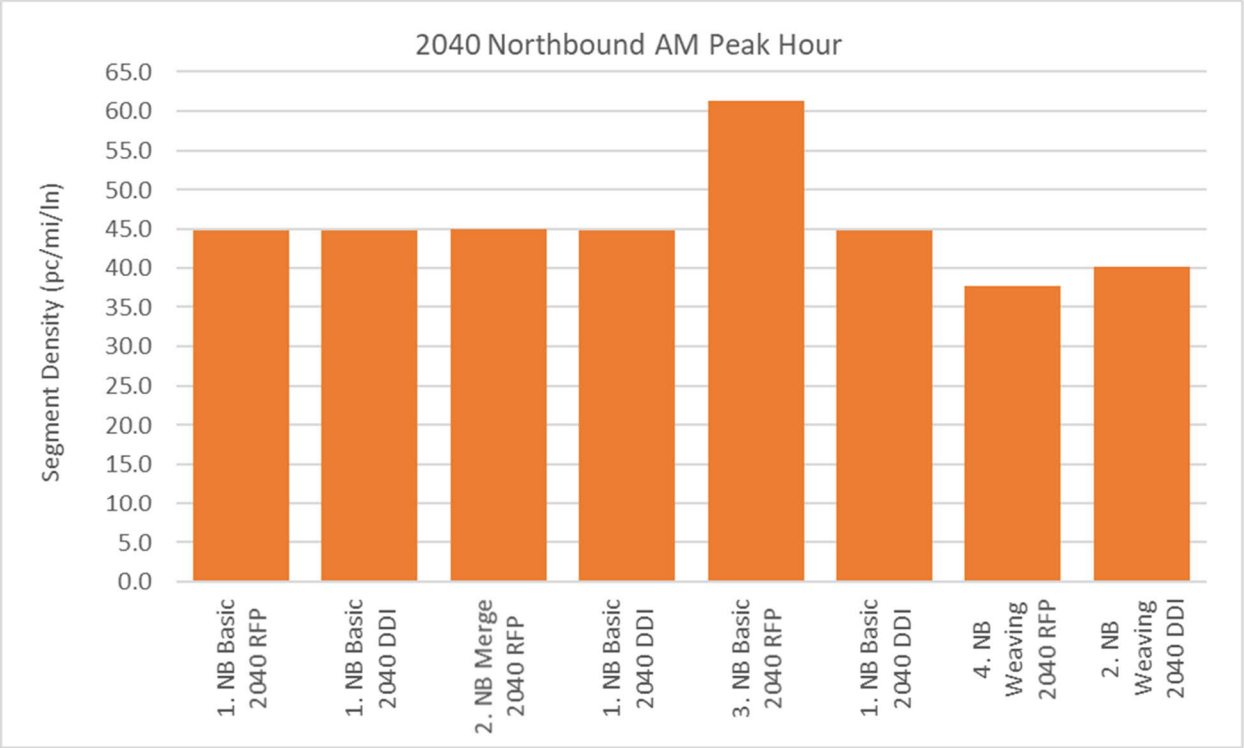


Figure 9.3: 2040 Northbound HCS Analysis Results - AM Peak Hour

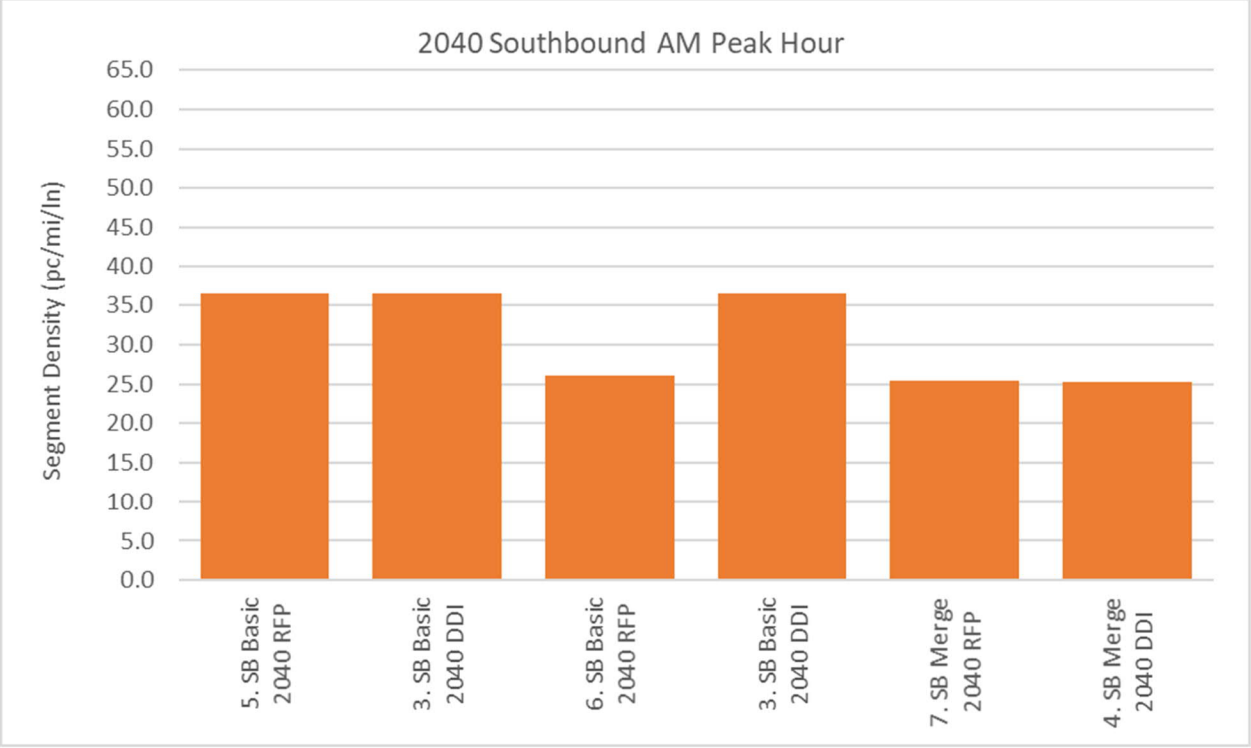


Figure 9.4: 2040 Southbound HCS Analysis Results - AM Peak Hour

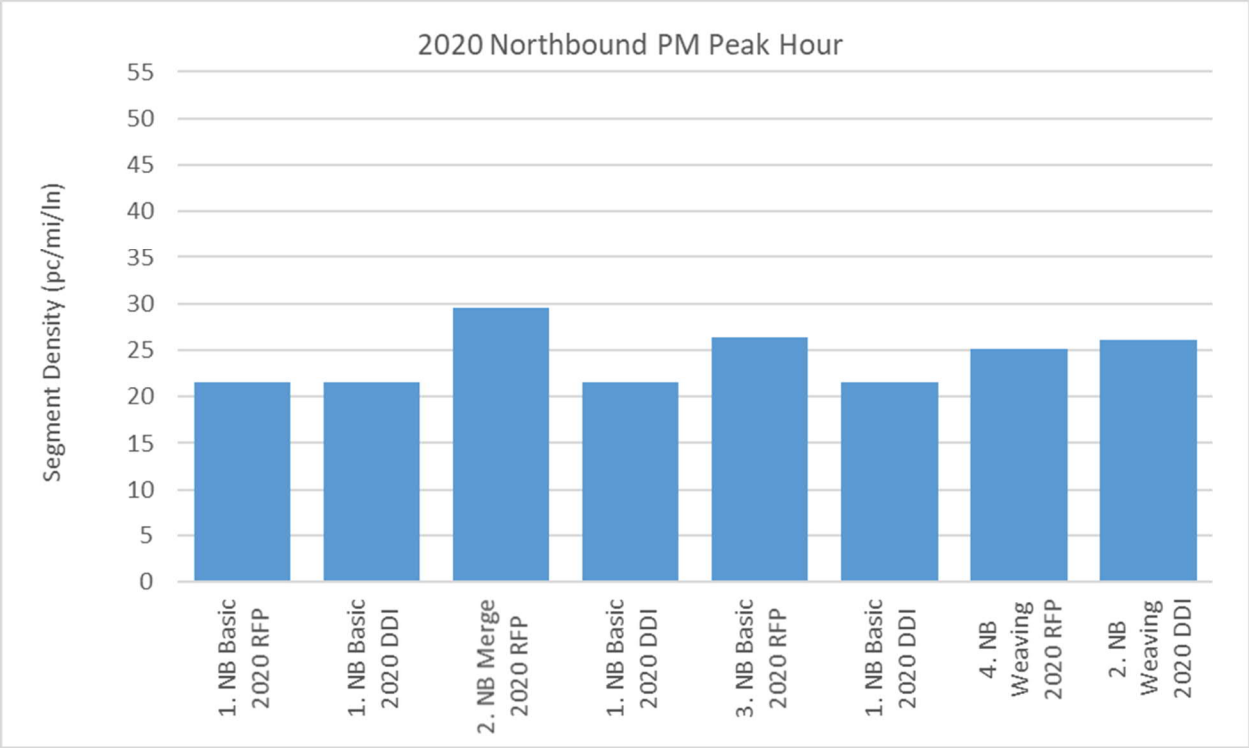


Figure 9.5: 2020 Northbound HCS Analysis Results - PM Peak Hour

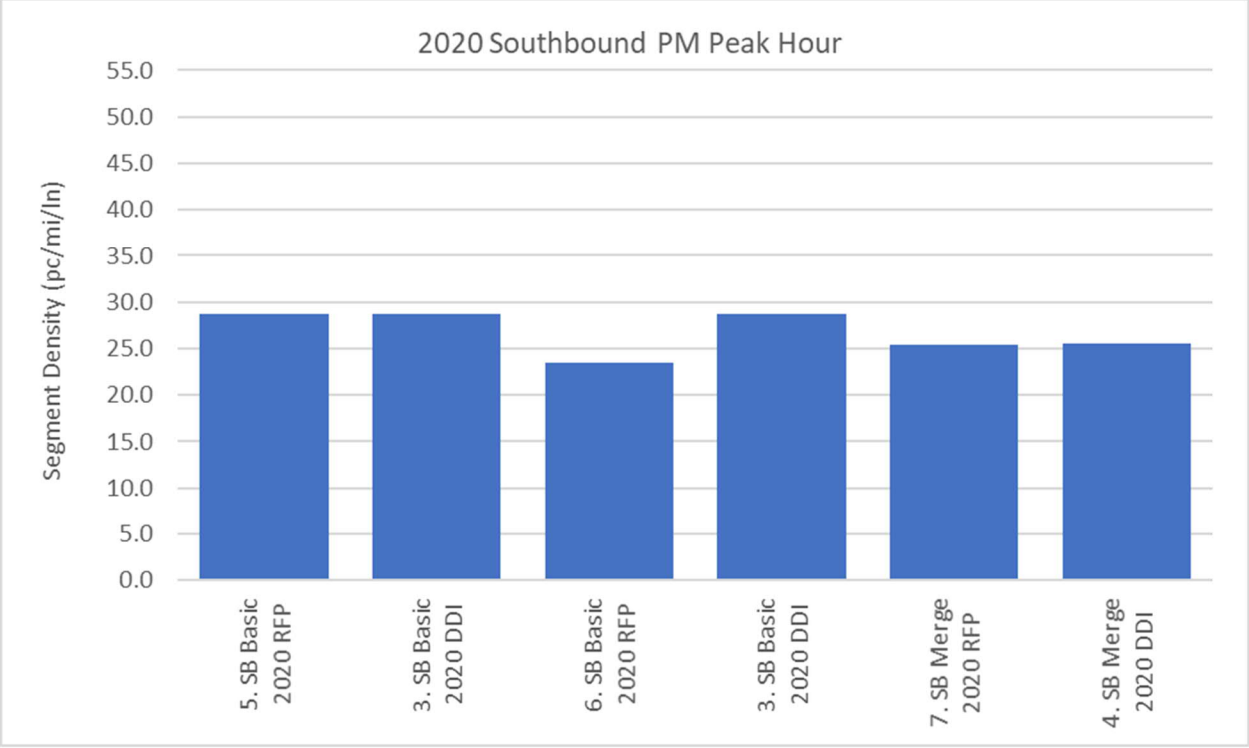


Figure 9.6: 2020 Southbound HCS Analysis Results - PM Peak Hour

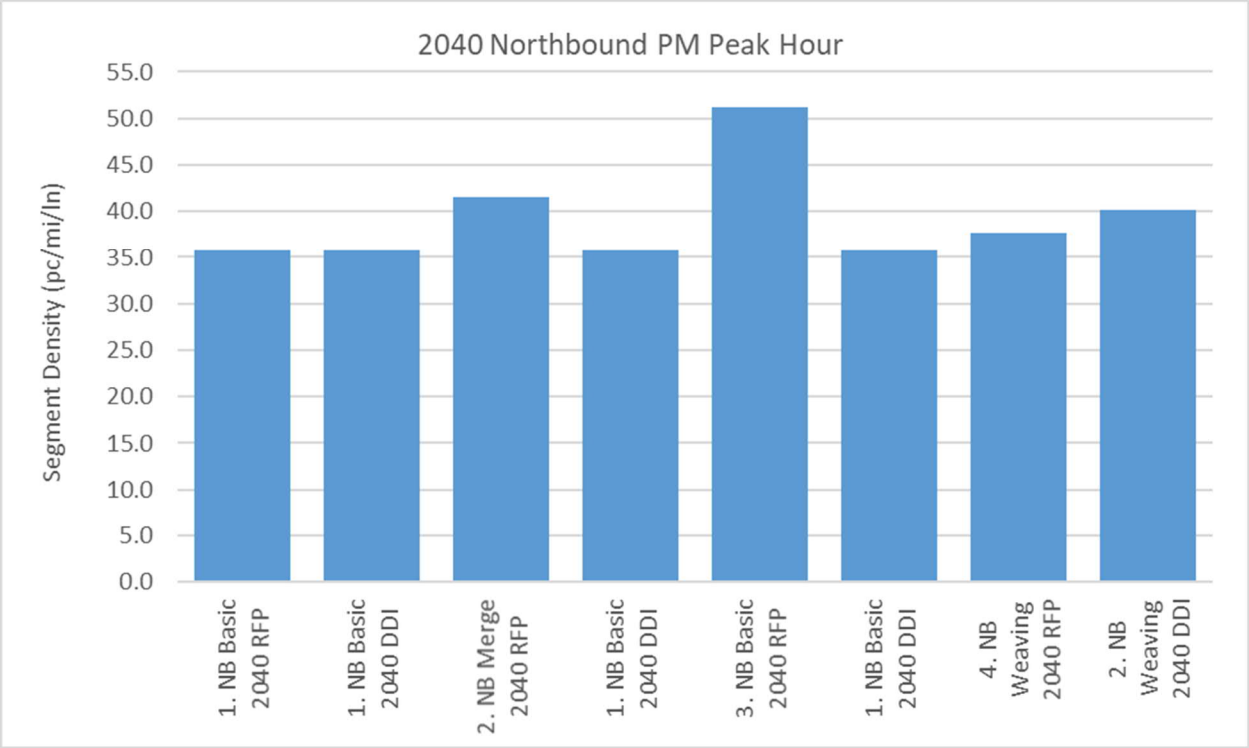


Figure 9.7: 2040 Northbound HCS Analysis Results - PM Peak Hour

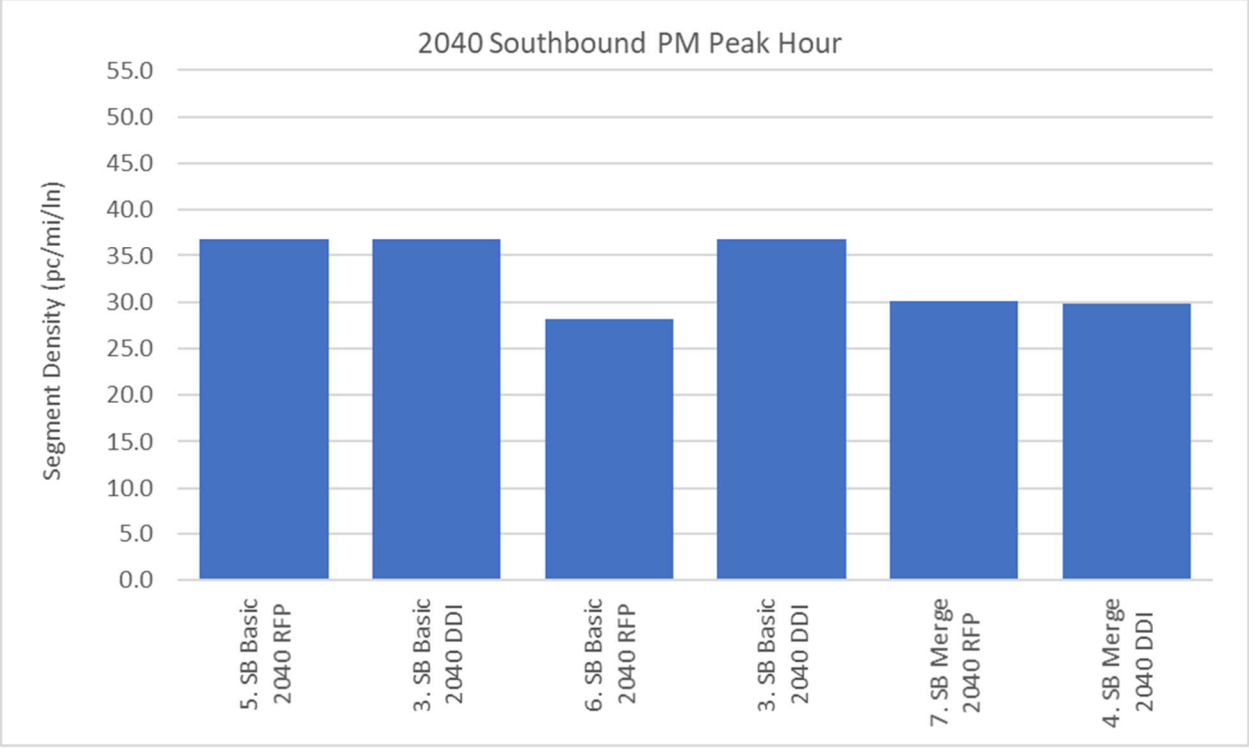


Figure 9.8: 2040 Southbound HCS Analysis Results - PM Peak Hour

The proposed improvements at the off-ramp terminal intersections at Glades Road would significantly improve the off-ramp operations and potentially eliminate the off-ramp queues backing on to the I-95 mainline. Table 9.3 and Table 9.4 provide a comparison of the off-ramp queuing analysis results. The analysis indicates that under the DDI alternative only the northbound to eastbound right-turn movement during the 2040 AM peak hour may have a queue exceeding the storage length. The northbound queue spilling on to the mainline in 2040 can be addressed through fine tuning of the signal timing plans and through installation of ramp queue detectors to flush the ramp when activated. However, these solutions should only be implemented when such a queue is indeed experienced in the field in 2040. It is also important to note that the DDI queues are shorter than the RFP alternative on average.

Table 9.3: RFP & DDI Concepts - Off-Ramp Queuing Analysis - AM Peak Hour

AM	Glades Rd & I-95 SB Ramps Queues (feet)		Glades Rd & I-95 NB Ramps Queues (feet)	
	SBL	SBR	NBL	NBR
Build 2020 RFP concept	181	158	161	429
Build 2020 DDI concept	256	52	0	407
Build 2040 RFP concept	223	244	212	609
Build 2040 DDI concept	385	188	16	582

Table 9.4: RFP & DDI Concepts - Off-Ramp Queuing Analysis - PM Peak Hour

PM	Glades Rd & I-95 SB Ramps		Glades Rd & I-95 NB Ramps	
	SBL	SBR	NBL	NBR
Build 2020 RFP concept	88	162	169	282
Build 2020 DDI concept	62	189	120	164
Build 2040 RFP concept	116	382	246	426
Build 2040 DDI concept	132	471	191	286

Table 9.5 and Table 9.6 provide a comparison of intersection analysis results which are also shown graphically in Figure 9.9 and Figure 9.10. The advantages of the DDI concept are evident during the AM peak hour. In fact, the intersection at the northbound I-95 ramp terminal as well as the intersection at Airport Road show an important reduction of the intersection delay and

improvement of the level of service. The performance of the intersections during the PM peak are very similar between alternatives.

In addition to the direct comparisons at intersections, the DDI has a more direct route for traffic entering the freeway due to the removal of the loop ramps, reducing travel time. Additionally, vehicles approaching the interchange from the northbound approach of the intersection at NW 15th Avenue do not need to travel through an additional intersection in the DDI concept as it is the case for the RFP concept. Delays in the RFP concept may also be higher due to the grade of the additional westbound ramp flyover and the tight turning radius of the intersection at Airport Road and the I-95 access.

Table 9.7 and Table 9.8 display the comparison of the volume over capacity (V/C) ratios for the RFP and DDI alternatives. The DDI alternative has only one intersection operating over capacity in 2040, while the RFP shows three intersections will be operating over capacity.

Table 9.5: RFP & DDI Concepts - Intersection Analysis Results - AM Peak Hour

AM	Glades Rd & Butts Rd		Glades Rd & NW 22nd Way		Glades Rd & I-95 SB Ramps		Glades Rd & I-95 NB Ramps		Glades Rd & Airport Rd /NW 15th Ave		Airport Rd & I-95 Access		Glades Rd & W University Dr	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Build 2020 RFP concept	25.6	C	19.0	B	14.4	B	27.6	C	33.7	C	11.1	B	33.9	C
Build 2020 DDI concept	29.4	C	23.8	B	16.7	B	25.2	C	29.9	C	-	-	31.4	C
Build 2040 RFP concept	33.3	C	33.7	C	17.6	B	36.1	D	58.8	E	12	B	36.4	D
Build 2040 DDI concept	33.7	C	40.2	D	19.0	B	27.9	C	41.3	D	-	-	36.8	D

Delay and LOS reported from Synchro-HCM 2000

Figure 9.9: RFP & DDI Concepts - Intersection Analysis Results - AM Peak Hour

Table 9.6: RFP & DDI Concepts - Intersection Analysis Results - PM Peak Hour

PM	Glades Rd & Butts Rd		Glades Rd & NW 22nd Way		Glades Rd & I-95 SB Ramps		Glades Rd & I-95 NB Ramps		Glades Rd & Airport Rd /NW 15th Ave		Airport Rd & I-95 Access		Glades Rd & W University Dr	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Build 2020 RFP concept	31.3	C	34.8	C	17.8	B	21.4	C	23.9	C	12.3	B	41.2	D
Build 2020 DDI concept	30.3	C	35.8	D	17.8	B	20.8	C	26.0	C	-	-	36.1	D
Build 2040 RFP concept	47.3	D	60.1	E	30.3	C	30.4	C	30.5	C	16.3	B	45.2	D
Build 2040 DDI concept	41.5	D	60.4	E	25.0	C	29.3	C	33.3	C	-	-	42.4	D

Delay and LOS reported from Synchro-HCM 2000

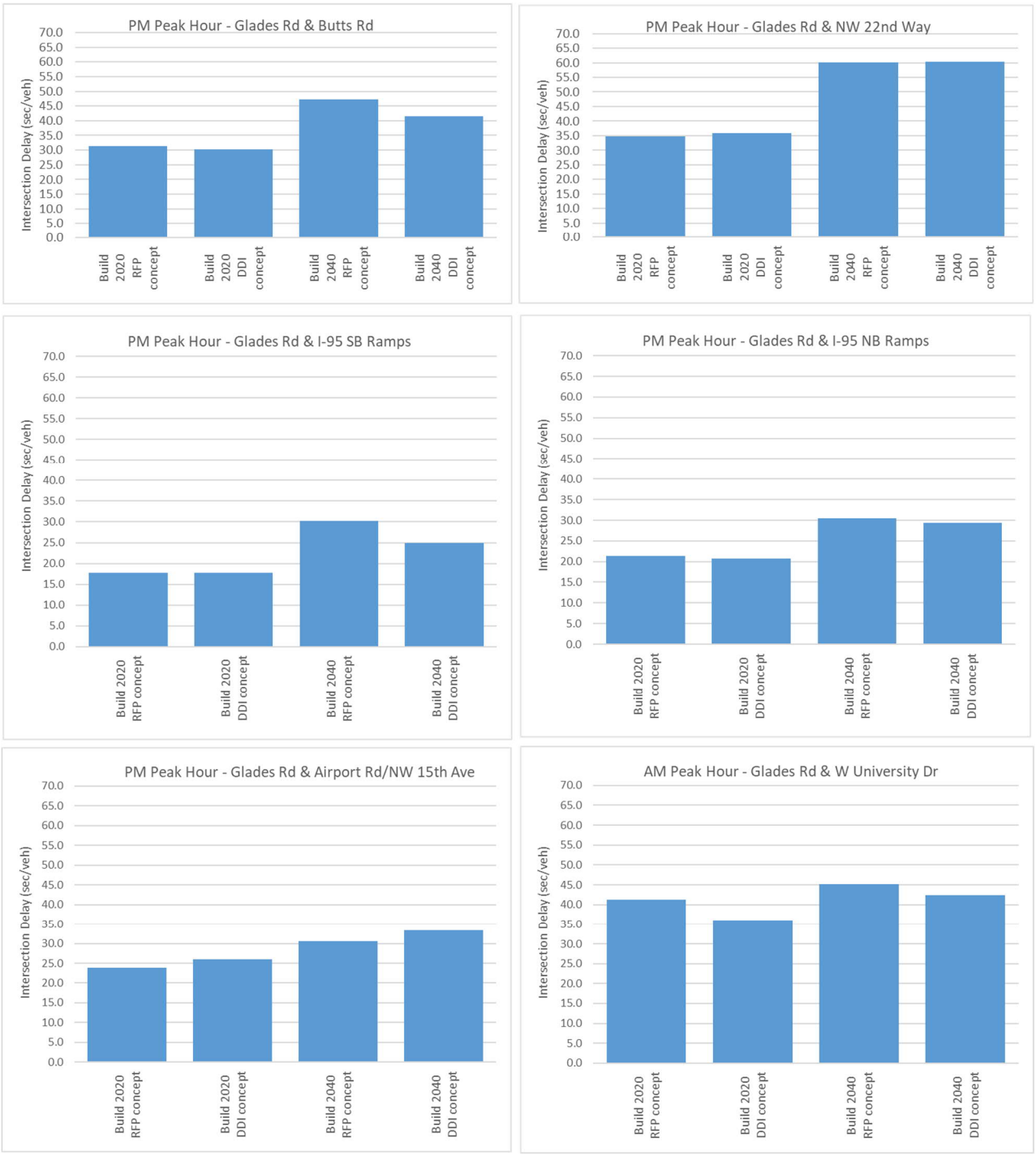


Figure 9.10: RFP & DDI Concepts - Intersection Analysis Results - PM Peak Hour

Table 9.7: RFP & DDI Concepts - V/C Ratios - AM Peak Hour

AM Peak Hour	Glades Rd & Butts Rd	Glades Rd & NW 22nd Way	Glades Rd & I-95 SB Ramps	Glades Rd & I-95 NB Ramps	Glades Rd & Airport Rd /NW 15th Ave	Airport Rd & I-95 Access	Glades Rd & W University Dr
	V/C	V/C	V/C	V/C	V/C	V/C	V/C
Build 2020 RFP concept	0.64	0.71	0.65	0.85	0.95	0.20	0.80
Build 2020 DDI concept	0.64	0.72	0.57	0.76	0.85	-	0.82
Build 2040 RFP concept	0.82	0.92	0.72	0.94	1.06	0.24	0.87
Build 2040 DDI concept	0.82	0.93	0.64	0.81	0.94	-	0.88

Table 9.8: RFP & DDI Concepts - V/C Ratios - PM Peak Hour

PM Peak Hour	Glades Rd & Butts Rd	Glades Rd & NW 22nd Way	Glades Rd & I-95 SB Ramps	Glades Rd & I-95 NB Ramps	Glades Rd & Airport Rd /NW 15th Ave	Airport Rd & I-95 Access	Glades Rd & W University Dr
	V/C	V/C	V/C	V/C	V/C	V/C	V/C
Build 2020 RFP concept	0.91	0.88	0.79	0.60	0.75	0.25	0.91
Build 2020 DDI concept	0.91	0.88	0.74	0.81	0.79	-	0.88
Build 2040 RFP concept	1.07	1.02	0.95	0.66	0.79	0.28	0.92
Build 2040 DDI concept	1.00	1.02	0.83	0.84	0.85	-	0.90

The key safety benefits of the DDI concept include:

- Reduction of conflict points and improved sight distance at the turns.
- Reduction in crash severity due to lower design speeds compared to other interchange designs.
- Traffic calming effect that reduces vehicular speed (while maintaining the capacity) due to the small geometric deflection introduced by the DDI for through traffic.
- Elimination of the wrong-way movements into ramps from the DDI interchange design.

A summary of the predicted crashes in Table 9.9 displays the safety advantages of the DDI design.

Table 9.9: RFP & DDI Concepts - Summary of Predicted Crashes (2040)

Crash Severity Type	Predicted Crashes			
	RFP Concept		DDI Concept	
	Freeway	Ramp	Freeway	Ramp
K	0.9	0.1	0.8	0.0
A	2.3	0.2	2.1	0.1
B	15.2	1.0	14.1	0.5
C	26.7	1.7	24.8	1.0
PDO	109.3	4.8	100.5	3.0
Total (Rounded)	**162**		**147**	

The IMR re-evaluation has shown that the DDI concept has a lower number of predicted crashes (147) when compared to the RFP concept (162), which amounts to a crash reduction of 9%. Through analyses of DDIs built throughout the US, it has been determined that there could be a potential 33% reduction in the total number of crashes. The DDI concept also results in equal or better LOS for signalized intersections along Glades Road and freeway segments along I-95. Both the weaving segment along northbound I-95 between Glades Road and the ingress point to the express lanes and the merge segment along southbound I-95 at the on-ramp from Glades Road operate at the same Level of Service (LOS) for the RFP and DDI concepts. The signalized intersections on Glades Road at the ramp terminals operate better under the DDI concept when compared to the RFP concept during both the AM and PM peak hours. The intersection at Glades Road and Airport Road have considerable improvements under the DDI concept during the AM peak hour and performs at similar LOS during the PM peak hour.

This IMR re-evaluation does not propose any new interchanges along I-95. The existing interchange provides access to public roads only. The improvements proposed at the interchange will maintain full access to the existing cross streets and accommodate all movements. No additional environmental issues are expected with the construction of the DDI from the ones identified and documented in the original IMR. This is due to the fact that the DDI interchange stays within the envelop of the RFP interchange concept and no additional right of way takes are required. The project is currently moving through the process to get a Type 2 categorical exclusion determination.