







Traffic Methodologies for Bus Rapid Transit Corridors: Recommended Guidance

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Recommended Guidance

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INTRODUCTION

TOPIC OVERVIEW

The implementation of Bus Rapid Transit (BRT) projects has increased across the state and nation as a flexible, high-quality, bus-based transit service improvement and congestion relief solution. BRT has proven to be a cost-effective urban transit solution to improve transit travel times and reliability while utilizing existing roadway infrastructure. It also provides a level of design flexibility that is desirable in developing multimodal corridors that are adaptable to specific roadway conditions and user needs, providing an array of transit running way solutions – from exclusive busways, to dedicated lanes to mixed flow bus with general traffic operations which balance transit improvements with other modal needs. Other major elements of BRT corridors may include traffic signal priority, off-board fare collection, elevated platforms, and enhanced stations. Implementation of these features can provide a faster and more reliable transit service that allows buses to avoid typical causes of delay for regular bus services, such as delays due to general traffic congestion and long dwelling times at stops as passengers wait to pay for their trip on board.

Contributing to its advancement in large and mid-size cities across the nation and Florida is the provision of funding for BRT projects through the Federal Transit Administration (FTA) Capital Investment Grant Program (CIG) and its predecessors. This multi-year, multi-step nationally competitive discretionary grant funding source provides a potentially significant level of investment to make BRT capital improvements. As with any proposed federally funded project, federal law mandates the consideration of environmental impacts of a project before a project can be approved to receive federal funding in accordance with the National Environmental Policy Act of 1969 (NEPA). The NEPA process provides a decision-making framework to consider the purpose and need for a proposed project, potential design solutions, projects costs, and the relative benefits and impacts of a proposed project on the natural and man-made environment.

Since BRT projects propose to operate on existing roadways, a key area of analysis in the planning and environmental processes for these projects is an assessment of transportation and other corridor-level issues and impacts, including an analysis of traffic impacts. Current Florida Department of Transportation (FDOT) Transit Concept and Alternatives Review processes and NEPA (for FTA funded projects) and the FDOT Project Development & Evaluation (PD&E) Manual (for state and locally funded projects) provides guidance on these planning processes from early planning and Transit Concept and Alternatives Review (TCAR) to environmental review under NEPA and/or PD&E planning phases. Regardless of whether federal and/or state/local funding is employed for these projects, developing more transparent and consistent traffic methods and analyses is needed to streamline the process from planning to design and construction of these projects.

For federally funded projects, there is also a lack of specific guidance on the level and acceptability of traffic analyses to be conducted through project planning and development. This decision-making is left to coordination and agreements between the agency with jurisdiction over roadway operations and transit agencies or lead agencies in obtaining federal funds, as well as their respective consultants. Even with existing state TCAR and NEPA/PD&E guidance, the level of analysis required and acceptability of the traffic operations impact for a transit project may still vary from transit agency to transit agency, consultant to consultant, and roadway agency to roadway agency. To further the ability of these types of projects to move forward more efficiently, there is a need to provide greater clarity on accepted methods for traffic analysis that may assist both transit agency and FDOT District staff in advancing these projects efficiently and expeditiously.

PURPOSE OF THIS GUIDANCE

This guidance is provided to clarify traffic analysis methods and agency coordination processes for planning-level analyses of BRT projects on arterial roadways in Florida and to facilitate streamlined and consistent approaches for traffic analysis methods and coordination. Additional design and construction-level coordination on traffic will be needed but is not the focus of this guidance. The planning-level guidance herein should provide sufficient data and analyses to inform design-level decisions so that revisiting key concept decisions at late stages of BRT development are not needed.

This guidance is focused on FDOT arterial roadways where proposed BRT improvements require additional coordination and decision-making regarding use of available right-of-way and roadway uses. Additional modal alternatives (e.g., light-rail, streetcar, and others) may also be considered at early planning stages; and there may be some similarities in data collection and traffic methods undertaken to evaluate across modes but that is not the focus of this guidance. This guidance may also be used, as appropriate, to assist local government public works departments coordinate BRT projects on their roadways and should be considered alongside local policies, comprehensive planning, and other transportation provisions. This guide does not provide guidance for BRT on highways, tolled facilities, or already dedicated busway facilities as these types of BRT contain some explicit differences in stop control, provision of dedicated lanes, and other operational and design considerations.

FDOT has provided ample regulatory and guidance materials to date that are referenced directly or indirectly within this document and which should be consulted and understood in any project undertaking. These include, but are not limited to:

- Transit Concept and Alternatives Review (TCAR)
- FDOT Project Development and Environmental (PD&E) Manual
- Complete Streets Policy Context Classification System
- FDOT Complete Streets Handbook
- FDOT Lane Elimination Policy Guidance
- FDOT Public Involvement Handbook
- FDOT Design Manual

This guidance may be used in coordination with these and other more specific manuals and guidebooks and is intended to support state regulatory guidance on this topic. Additionally, some guidelines within this report, such as measures of person throughput rather than traditional approaches that consider a demand-driven and focused approach, may provide additional methods, perspectives and considerations to develop fully multimodal corridors on state arterial roadways. These guidelines do not attempt to replace existing regulations or place further regulatory burdens on these projects. While this guidance provides further clarity on advancing BRT project traffic methods, it is not intended to replace context-specific project corridor methods of analysis or additional data and analysis that may be requested by FDOT District traffic operations staff to address specific corridor-level challenges and opportunities. Coordination with FDOT District engineering and traffic operations staff remains the foundation for determining appropriate methods to be used for projects.

Finally, this guidance is focused on generally accepted and mostly standardized methods and practices in analyzing traffic and traffic-related impacts of BRT projects on state arterial roadways. Additional methods exist in industry-wide research and best practices and may be further considered depending on regional and locally adopted policies to meet these multimodal goals and objectives. Considerations for multimodal level of service analyses, focusing analyses on person-throughput instead of more standardized vehicular levels of service and demand-driven approaches, and other innovative approaches may be deemed appropriate to use instead of some of the methods described herein; advance coordination and approval from FDOT District staff and Central Office is recommended when alternative methods are proposed.

REPORT ORGANIZATION

To aid in the understanding and guidance on traffic analysis methods at each stage of planning for BRT projects, this report is organized into the following major sections and topic areas:

Understanding the Process and Key Concepts: This section provides foundational knowledge on the distinct planning steps and processes for BRT projects, which may represent some departure from methods focused on traditional roadway projects. It provides a framework for understanding key traffic considerations that are common to these types of projects and major stages in the planning process that can inform the level of data collection and traffic analysis conducted at each stage. It also provides the reader with information on the other non-traffic considerations in justifying and evaluating merits of these projects which may be important in developing mutual understanding and agreement between transit and roadway agencies on the merits and needs of a BRT project. Finally, this section provides general information and best practices in establishing consistent and successful agency coordination throughout all planning stages of BRT projects, with a focus on defining mutual project goals, objectives, and measures of effectiveness within a comprehensive planning process framework.

Stage 1 Traffic Analysis During Early Planning and TCAR Processes: This section provides information and methods of analysis undertaken during early planning phases of BRT projects. This early planning process, often termed the "Alternatives Analysis" or "AA" phase provides basic data collection and methods used to support early existing conditions traffic and transportation analyses. The two important outcomes of this early planning process are establishing the project purpose and need and selecting one or more feasible preferred project alternative. The traffic analyses needed for these outcomes are discussed further within this context. The first major outcome of this planning process is to identify the transportation and other problems in the corridor to be solved by the project. This data and analysis help establish the project purpose and need and is important in defining the quantitative and qualitative measures of effectiveness that will be used to evaluate project options and alternatives. It also lays the groundwork for a mutual understanding of the project purpose and merits between roadway and transit agencies as well as the public and stakeholders. The second major outcome of this planning process is to identify and evaluate potential alternatives for BRT improvements and provide guidance on traffic analysis methods and the considerations undertaken during alternatives development. Proposed agency coordination to conclude this stage of planning and prepare for the next planning stage are also discussed.

Stage 2 Traffic Analysis During Environmental and Preliminary Engineering: This section provides data collection and traffic methods and analysis that are typically required as projects move from early planning phases into environmental analysis and documentation required under NEPA and FTA and/or the state of Florida's PD&E manual. During this stage of development, alternatives are refined or determined, and additional engineering and conceptual design are further defined. As such, the traffic analysis at this stage of planning serves to further the early traffic analyses conducted in Stage 1 with more detailed traffic analyses that may be needed to define location-specific designs and confirm findings for environmental impact disclosure and documentation. Recommendations on agency coordination and FDOT district staff involvement and concurrence are also described.

Traffic Analysis for Expedited Project Planning: While most transit and BRT projects in the state have traditionally focused on distinct planning and environmental phases of project development and engineering, federal transportation laws in recent years have focused on streamlining planning and implementation processes and requirements for transit project delivery. This section describes these changes in federal law that may allow for expedited project planning processes and considerations in developing traffic and transportation methods, analyses, and schedules more comprehensively than the distinct stages of traffic analyses described in previous sections. This expedited project planning may combine TCAR and FTA Project Development or FDOT PD&E phases and developing a scope and accepted traffic methods that comprehensively consider project planning.

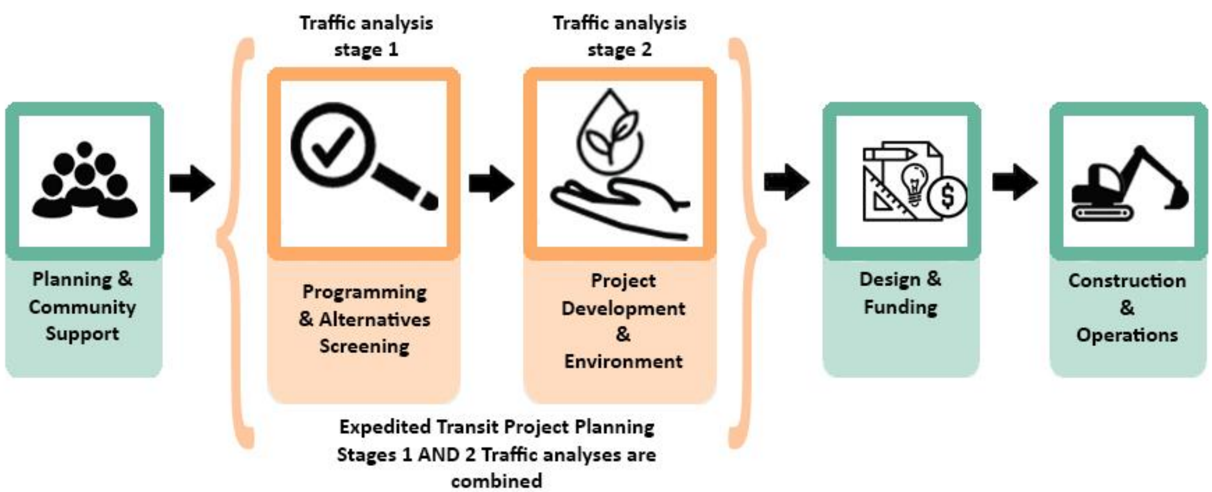
Summary and Conclusions: This section briefly summarizes the stages of traffic and transportation data collection and analysis methods described in earlier sections and provides key take-aways and recommendations on agency coordination and public and stakeholder engagement needed to obtain appropriate consensus for decision-making on BRT arterial roadway projects. It also provides insights and recommendations for further streamlining planning processes and meeting regulatory requirements.

UNDERSTANDING THE PROCESS AND KEY CONCEPTS

THE TRANSIT PROJECT PLANNING PROCESS AND STAGES OF TRAFFIC ANALYSIS

As noted in TCAR guidance, FDOT has a prescribed five-step project evolution process for moving all transportation projects, including both roadway and transit projects, from concept to construction. As shown in **Figure 1**, Traffic analyses during planning (Steps 2 and 3) are the subject of this guidance to provide greater clarity on the levels of analysis that may be appropriate at each major step in transportation project evolution process.

Figure 1: FDOT Transportation Project Evolution and Traffic Analysis Planning Stages



TRAFFIC ANALYSIS DURING PROGRAMMING AND ALTERNATIVES SCREENING (TCAR PROCESS)

For transit projects, FDOT has provided the TCAR process to provide additional guidance on Step 2 of FDOT's transportation project evolution process. TCAR guidance should be consulted as part of any transit project planning project to understand the activities to be conducted for Step 2 of transportation project evolution, and it further outlines the 10 key steps within Step 2 of FDOT's transportation project evolution. Within the TCAR process and Step 2 of FDOT's five-step transportation evolution process, there are three key outcomes that will require input from traffic analysis for BRT projects proposed on FDOT-owned arterial roadways and other transit modal proposals. These key outcomes include: (1) Development of Project Purpose and Need (2) Alternatives Definition and Evaluation and (3) Selection of a Preferred Alternative. How traffic analysis is used in developing these major outcomes are further discussed in greater detail later in this guidance. The goal at the end of this step in the transportation project evolution is to provide sufficient project definition to allow for further evaluating and documenting the potential for environmental impacts from the project and to further develop conceptual engineering and design for the project. Active involvement from FDOT traffic engineering staff during alternatives identification and evaluation processes is needed to aid in developing mutual agreement on a Preferred Alternative. This may require multiple levels of refinement of alternatives, first determining the preferred mode and then if BRT is the selected mode, additional alternatives development and screenings to provide the level of project definition needed to address feasibility concerns. Additionally, early planning and environmental linkages are established during this phase through FDOT Environmental Transportation Decision-Making tools (ETDM) and will need to be coordinated with other technical analyses such as traffic findings in identifying a Preferred Alternative. Details on this early planning and environmental linkage may be found in FDOT's TCAR Guidance and Chapter 14 of the PD&E Manual.

Further details on these outcomes and the coinciding traffic analyses recommended at this stage of BRT transit planning projects are described in greater detail in subsequent sections of this guidance.

TRAFFIC ANALYSIS DURING PROJECT DEVELOPMENT AND ENVIRONMENTAL REVIEW

A determination will be made on the sources proposed to fund the project from the results of the TCAR process. Depending on whether the project will be funded in part through FTA federal CIG funding or through state or local funding mechanisms will define whether the project moves into this step of the planning process through FTA's Project Development process or through traditional FDOT PD&E Manual procedures and processes. Regardless of the process pursued, traffic analysis is a key element during this planning step for BRT projects on arterial roadways. The outcome of the TCAR data and analysis should provide the level of detail required for environmental analysis and documentation; however, additional and more detailed traffic analyses may be desirable at this point in the project to focus on specific intersections and further develop location-specific treatments and design details. The traffic analysis in this step of planning will be used to assist in finalizing the running way configuration (exclusive lane, queue jump or mixed use), station locations and any additional treatments, as well as any appropriate mitigation measures.

During this stage in the planning process, it is essential that there be a mutual understanding of traffic analysis and any design or location-specific details needed for proper documentation of traffic and transportation related impacts for environmental purposes. It is also important that a distinction is made between the environmental analysis and any additional traffic analysis which may be needed to finalize conceptual engineering up to 30% design details.

For environmental purposes, general acceptance on station locations and positioning or options to be considered and evaluated should be determined and finalization of running ways and other treatments such as queue jumps should be validated. Final determination of any proposed mitigation measures for traffic impacts should also be agreed upon based on the detailed level of service analyses. Continued and active involvement from FDOT will help to make these confirmations and validations move more quickly and efficiently towards completion of the environmental documentation and allow for greater work during this stage on operational and design parameters.

ADDITIONAL CONSIDERATIONS FOR TRAFFIC ANALYSIS AND DECISION-MAKING IN TRANSIT PROJECTS

Unlike traditional roadway projects where funding is allocated through the state and district's work program, funding for transit projects often involves a variety of sources and applications for grant funding to support planning and capital and operational investments. These projects often lack full funding certainties, especially at these planning-level stages of the transportation project evolution process, and this may impact the timeline that occurs between these major planning steps in the process. From a traffic analysis standpoint, this can have two unintended and costly impacts on the ability to execute planning and implementation efficiently.

First, the time lapse that may occur between completion of the TCAR process and subsequent entry to FTA Project Development or FDOT PD&E Phases as funding is secured may date traffic data and analyses. Particularly in urban environments, where BRT is often deemed most successful, traffic patterns can change over the course of time and there may be a desire to account for these changes through updates to traffic counts and assumptions. A significant amount of traffic and transportation data is collected during the early TCAR process and care should be taken to allow for re-use of this analysis as much as possible without requiring additional and costly new data collection. An important consideration in completing traffic analyses for these projects is agreeing at early stages the data sources to be used and allowances for the age of the initial data. Determining acceptable assumptions for growing existing and future traffic, rather than having to obtain new traffic counts as planning progresses can save both time and money for these projects.

Secondly, because funding at early planning stages may be uncertain for moving projects forward, the level of priority assigned to FDOT staff devoted to reviewing early planning activities can sometimes be limited. This may mean that at these stages, FDOT may have only assigned planning staff to attend stakeholder and agency coordination meetings and to weigh in on early development of project definition. Since a BRT project may propose to reconfigure available roadway use and the multitude of trade-off decisions that may need to be made, it is important that representatives of FDOT modal development, traffic operations, and design staff be actively involved even at early stages of concept development. Contributions from traffic operational and design staff may be less intensive than at later stages of project development but obtaining their input early in the process and developing a technically feasible and generally agreed upon Preferred Alternative will assist in later stages of planning so as to not revisit feasibility concerns during the FTA Project Development or FDOT PD&E phase.

Unlike traditional roadway projects where funding is allocated through the state and district's work program, funding for transit projects often involves a variety of sources and applications for grant funding for investments. From a traffic analysis standpoint, this can have two unintended and costly impacts on the ability to execute planning and implementation efficiently:

Timing Between TCAR and Environmental Planning Stages

The time lapse that may occur between completion of the TCAR process and subsequent entry to FTA Project Development or FDOT PD&E Phases as funding is secured may date traffic data and analyses. A significant amount of traffic and transportation data is collected during the early TCAR process and care should be taken to allow for re-use of this analysis as much as possible without requiring additional and costly new data collection. Agreement at early stages on data sources to be used is an important consideration in completing traffic analyses for these projects.

FDOT Staff Involvement During Planning

Because funding at early planning stages may be uncertain for moving projects forward, the level of priority assigned to FDOT staff devoted to reviewing early planning actives can sometimes be limited. Given the way in which BRT may propose to reconfigure available roadway use and the multitude of trade-of decisions that may need to be made, it is important that representatives of FDOT Modal Development, Traffic Operations, and Design staff be actively involved even at early stages of concept development

A final concept to be aware of in developing these types of projects which may impact traffic analysis and decision-making are FTA Project Development and grant funding timelines. Should a project decide to pursue federal FTA CIG funds, the first step following the TCAR process will be to apply to enter FTA's Project Development phase. From this point of acceptance into the multi-year, multi-step FTA grant program, there are specific FTA schedule milestones that are required. While additional details on these FTA milestones may be found in FDOT's TCAR process and through FTA's CIG website, there are two that are worth pointing out that may impact traffic analysis and coordination for decision-making. First are deadlines established within the FTA Project Development Phase. Upon acceptance into this phase, applicants have a maximum of two years to complete environmental review and advance conceptual development of the project. For Small Starts applicants, the most common type of CIG funding program used to fund BRT projects, the expectation is that completion of the Project Development Phase will result in sufficient engineering and design to (1) effectively identify, document, and mitigate for any environmental impacts in the NEPA process and resulting from the project and (2) following the NEPA process, apply for and secure a full funding grant agreement from FTA. Further details on this process and requirements may be found in FTA's *Project and Construction Management Guidelines*. From a traffic analysis perspective, this means that major decisions on project impacts, mitigation, and design will all need to be addressed during this step in the transportation evolution process and within this two-year window. Again, early involvement and coordination from FDOT in developing the Preferred Alternative and identifying additional traffic analyses needed during the TCAR process will allow the Project Development or PD&E phases to move more quickly to completion.

Additionally, while project sponsors may apply for entry into Project Development at any point in time, submittal of grant information and evaluation of the project under the FTA discretionary CIG program is typically done once a year, and submittal deadlines are often in the first week of August each year. Understanding and collaborative work between FDOT and transit agency staff to establish project milestones for decision-making to take into consideration these deadlines will be essential to advancing these projects in an efficient way.

FRAMING KEY TRAFFIC CONSIDERATIONS IN BRT PLANNING PROJECTS

One of the advantageous features of BRT projects is their ability to customize configurations and improvements within a project corridor. This means that a BRT project may include:

- Running way improvements -a combination of dedicated center or curb-running lanes, hybrid lanes or business transit access (BAT) lanes, or operations in mixed traffic
- Creation of queue jump lanes,
- Improved stations that could be near or far side of an intersection, and
- Traffic signal improvements including adding Transit Signal Priority (TSP)

Following is a discussion of these improvements may impact traffic. An overview is provided here to identify the major traffic considerations for different BRT treatments and further guidance is provided on traffic methods and analysis at varying stages of project definition and refinement throughout this guidance. While this provides a framework for understanding key traffic considerations, each corridor may present its own unique conditions or challenges and requires continued coordination with FDOT and transit agency staff on the acceptable levels of analysis needed for project decision-making.

BRT RUNNING WAY CONFIGURATIONS

BRT often involves the creation of new dedicated transit lanes, the conversion of existing travel lanes to transit-only lanes, or the conversion of travel lanes to transit-only with allowances for turns. As noted above, projects can utilize one method or a combination of all three along with operations in mixed traffic. Each method provides benefits and drawbacks and has specific considerations in relation to their impact on the traffic environment. Brief descriptions of each type of running way are described below. **Figures 2-5** provide examples of the various options as well as noting critical traffic considerations to consider for each type of running way.

CURBSIDE DEDICATED LANES

Dedicated curbside lanes are separated from traffic and potential congestion, providing greater passenger capacity and more dependable service. Bus stops and amenities are located on the sidewalk and passengers load on the right of the bus (compared to center-running).Although the bus boards/alights from the curb, pedestrian crossings must also be considered most trips are both ways so the patron must cross the entire street for one of the trips.

Figure 2: Curbside Dedicated Lanes – Key Traffic and Other Considerations

Key Traffic Concerns:

- Transit signal priority
- Interaction with bicycle lanes
- Right turn restrictions
- Curbside parking and loading zone removal/replacement

Additional Considerations:

- Traffic diversion from previously dedicated lane
- Lane use enforcement

Curbside Dedicated Lanes

CENTER-RUNNING DEDICATED LANES

Center-running designated lanes provide the traffic separation benefits to transit travel time by operating in the center or median lanes of the roadway. This removes the bus from interactions with bicycles, parking, loading zones and right-turning vehicles. Restrictions to left turns are typically necessary for service reasons. Passenger operations typically occur in the median on the left side of the vehicle (although they can board/alight from the right). As with curbside lanes pedestrian safety crossing the intersection must be addressed as the patron has to cross half the roadway during each trip.

Figure 3: Center-Running Dedicated Lanes – Key Traffic and Other Considerations

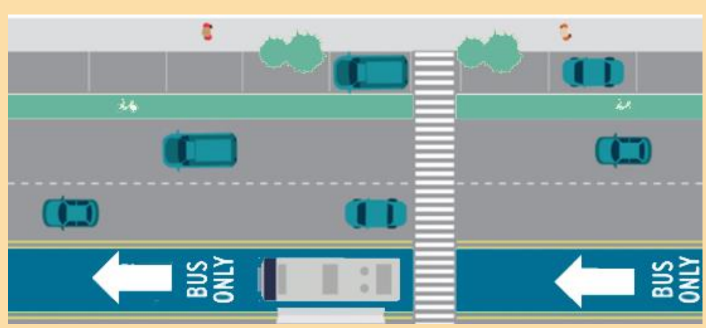
Key Traffic Concerns:

- Transit signal priority
- Left turn restrictions

Additional Considerations:

- Traffic diversion from previously dedicated lane
- Pedestrian safety and accessibility
- Lane use enforcement

Center-Running Dedicated Lanes



HYBRID LANES

Hybrid lanes, sometimes called business access travel (BAT) lanes, balance the benefits of dedicated lanes with the need for turning movements at intersections and potentially parking between intersections. These lanes operate as bus-only lanes for segments between intersections but allow passenger vehicles to enter the lane for turning movements at designated locations. This helps maintain connectivity while still prioritizing transit service efficiency. In addition to the strategies noted here, contraflow and bi-directional lanes are also used based on the project requirements. Contraflow lanes operate the bus in a dedicated lane in the direction opposite to traffic flow. Bi-directional lanes use a single dedicated lane for transit flow when more than one lane is not feasible, typically utilizing stops as points for allowing opposing transit flow to pass. These strategies are less commonly used, though they do not require any different traffic-based analysis beyond more thorough safety considerations.

Figure 4: Hybrid Lanes – Key Traffic and Other Considerations

Key Traffic Concerns:

- Transit signal priority
- Interaction with bicycle lanes
- Curbside parking

Additional Considerations:

- Turn queuing
- Lane use enforcement
- Lane obstructions/loading zone issues

Hybrid or "BAT" Lanes

MIXED FLOW OPERATIONS

When lane dedication is not possible, BRT can be operated in mixed traffic. This limits the efficiency of the service because it is subject to the same traffic conditions as other automobiles, but there are strategies to help mitigate this. As previously discussed, TSP can help keep vehicles moving along with queue jump lanes, which allow the transit vehicle to get a head start on merging back into traffic flow following a stop. Traffic operational issues are similar to those of a typical transit service.

Figure 5: Mixed Flow BRT – Key Traffic and Other Considerations

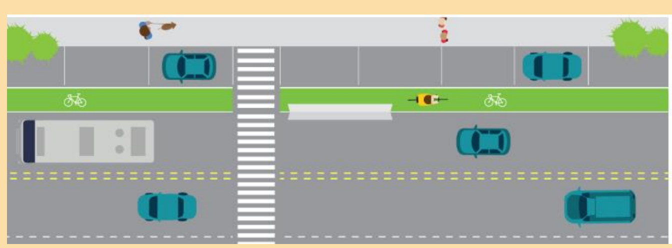
Key Traffic Concerns:

- Transit signal priority
- Interaction with bicycle lanes
- Curbside parking and loading

Additional Considerations:

- Queue jumps
- Crash and safety history

Mixed Flow BRT Operations



BRT STATIONS

A key component of BRT is branded, enhanced stations. These improvements lend a level of permanence to BRT capital investments and promote greater visibility and use of the transit system. Sizing and final locations will be to some degree dependent on the levels of investment and funding anticipated for these projects, but there are some elements that should be coordinated with FDOT and transit agency staff during planning stages. While FDOT staff may defer station placement to transit agency design guidelines, bus operational knowledge, as well as to regulatory requirements in Florida Administrative Code and best practice guidance on station placement such as those found in FDOT's *Accessing Transit: Design Handbook for Florida Bus Passenger Facilities*, traffic related issues such as access management for nearby driveways and business access may require further coordination. While early planning activities during the TCAR process may generally define proposed station spacing and locations, as project planning moves into the FTA Project Development or FDOT PD&E processes, additional details on operations and conceptual station design, footprints, and right-of-way requirements must be coordinated to fully disclose environmental impacts and in advancing conceptual design of stations.

TRANSIT SIGNAL PRIORITY

Another major component of any BRT project is the use of Transit Signal Priority (TSP), which facilitates bus movements through intersections via signal timing and communication between the bus and traffic signal. Coordinated signal timing plans focused on bus movements is termed "Passive" TSP, while "Active" TSP involves communication between the bus and signal that causes the signal to adjust its timing for the bus by either shortening the red time or increasing the green time on the bus's approach. The goal of TSP is most often to help ensure busses stay on schedule, either time or headway so as long as the bus is on time, there is no need to have signal make changes.

Impacts to traffic signal from TSP need to be carefully considered as they can have minimal impact to the overall traffic flow. r Early planning-level coordination on the level of TSP improvements that can be made to optimize bus flows and balance general traffic movements is important in that it determines the level of timing and reliability improvements that may be made. In some projects, active transit signal priority may only be given when buses are a certain number of minutes behind schedule while in other cases more active TSP may be deemed appropriate throughout an entire section or the entirety of the corridor. Decisions like these should be based on sound planning-level analyses that consider TSP improvements against transit reliability and speed improvements, impacts to vehicular delay, and other measures of effectiveness determined at planning stages. Early planning may help to establish the level of investment desired, and also helps to coordinate the level of improvement and costs associated with improvements. General signal upgrades, for instance, may be needed to accommodate new TSP improvements made. This may require additional investments within or outside of the proposed BRT project, and therefore close coordination between FDOT and transit agency staff is needed to determine whether some of these improvements may be considered general operational improvement needed in the corridor or whether they represent improvements needed for a specific BRT project only. In either case, whether as a standalone project or as a combined improvement in the corridor, providing sufficient planning and coordination on operational feasibility and other design-level issues at early stages of analysis will assist in developing successful TSP implementation.

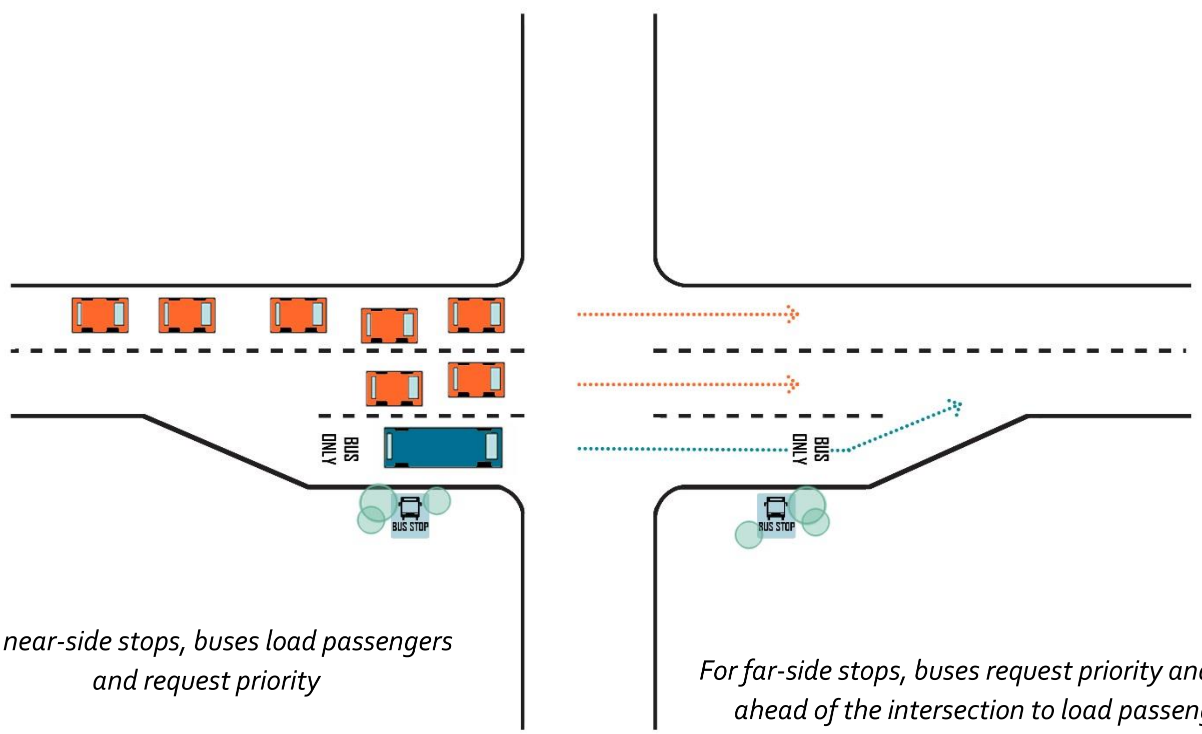
USE OF QUEUE JUMPS

Queue jump lanes combine short dedicated transit facilities typically alongside TSP improvements to allow buses to easily enter traffic flow in a priority position. Successfully implemented, queue jumps serve to reduce transit delays, resulting in BRT running-time improvements and increased BRT service reliability. These treatments are typically most effective on signalized streets where BRT will operate in the right curbside lane, where there are high peak hour volumes for general traffic but relatively low right-turn movements, and at intersections that are operating at a level of service D or worse. These considerations may impact viability and suitability for queue jumps. Methods and thresholds to analyze candidate locations should be coordinated as early as possible since these treatments may help to finalize project definition decision-making.

Queue jumps may be applied at locations where near-side or far-side BRT stops are proposed, or even at non-stop locations. For near-side application, buses load customers before applying for TSP treatment. For far-side and non-stop application, buses receive TSP to either proceed to the far-side stop or to progress ahead of general traffic flow.

Additional details on analyses of queue jumps are described in the stages of traffic analysis in the following sections of this guidance.

Figure 6: Example Diagram of a Queue Jump



KEYS TO PLANNING FOR BRT PROJECT SUCCESS

The literature review, best practices research and interviews conducted in the development of this guidance revealed several key elements common to BRT projects which established effective planning for implementation at the start. While many of these projects are proposed initially as part of regional long-range planning or transit agency transit development plans and reflect policy and community-level desires for corridor or regional transit, FDOT planning and traffic staff must take a broader perspective than has been traditional for a roadway agency to make these projects successful. A few of these key perspectives that relate to traffic analysis and project decision-making are further described below and provide a framework for understanding the successful evolution of projects during planning and for successful implementation.

WORKING WITHIN THE CONTEXT OF BRT PROJECT JUSTIFICATION AND MERITS

Maintaining and enhancing vehicular capacity and effective vehicular operations has been a traditional approach for owners and operators of roadways, and general traffic movement and flow is often a key objective for standard roadway improvement projects. For BRT projects, however, there may be multiple and competing goals and justifications that have established the desire for this type of roadway and transit improvement. Some of the reasons for BRT projects may reflect local and regional policies to provide alternative modal access, improvements to existing transit service and ridership, or may be based on coinciding land use changes and desired economic development goals or plans. While transportation and traffic performance and safety are critical to developing feasible and thoughtful concepts and designs for BRT and may be a primary concern for FDOT traffic operations and design staff, it is important to weigh many different trade-offs between modes. Determining feasibility and desired levels of investment within limited right-of-way may require detailing of technical analysis, modal trade-offs, and findings alongside stakeholder and public engagement to make informed and supported decisions.

For projects seeking federal FTA discretionary and competitive grant funding under the CIG program, project justification and merits are evaluated from a variety of perspectives rather than strictly traffic capacity enhancing methods and, in fact, maintaining existing levels of service for vehicular traffic may not be the desired outcome for determining and agreeing upon project goals. FTA's CIG program identifies, for instance, several criteria for scoring potential transit and BRT projects across the nation. These include considerations for land use that support transit investment (particularly around station areas), economic development plans and policies, parking provisions, costs, and policies, provisions for affordable housing, ridership and ridership forecasts, transit-dependent populations that may rely on transit in and adjacent to the corridor, and environmental benefits such as air quality improvements and reductions to vehicle miles traveled (VMT). Additional details on these elements and evaluation criteria may be found in FTA's *CIG Program Interim Policy Guidance*. What is important about these project justification and evaluation criteria, is they illustrate the comprehensive approach and perspective needed to meet technical acceptability for roadway and multimodal operations as well as meet broader policy level goals. Understanding these goals and identifying methods for technical analysis and mechanisms to gain stakeholder and public consensus on project elements and definition is therefore extremely important and should not be substituted for rigid adherence to technical analysis alone.

Case Example: Cleveland Healthline BRT

As noted, BRT projects may have specific policy-level goals that need to be considered alongside traffic technical analyses. In Cleveland, for instance, the Healthline BRT has been touted for the economic development that has accrued since implementation of this BRT project. While BRT project definition needs to be based on sound engineering and traffic operations analysis and decision-making, it is important to understand overall project goals in making properly informed and publicly acceptable design decisions for BRT projects. One of the key goals of this project was to enhance economic development in the corridor. Some of those achievements are shown below.

ESTABLISHING A MUTUAL UNDERSTANDING AND ACCEPTANCE OF PROJECT GOALS

From virtually all best practices interviews conducted in the development of this guidance, practitioners noted the importance of establishing a mutual understanding of goals and objectives of a BRT project early on in the planning process. These help to establish the ways in which project decisions and project definition are decided upon. Inherent to these types of projects are goals to improve transit provision, access, speed, and or reliability and there are well-documented ways to quantitatively and qualitatively assess these goals – such as increases in bus frequencies, bus speeds, increased bus reliability and on-time performance, and others. These measures and the different alternatives available can also impact ridership gain potential, and bus operational costs and effectiveness measures.

Because there is often limited right-of-way to accommodate an array of improvements that may be needed such as transit operational and capital improvements, on-street parking (where it exists), on-system bicycle lanes and maintaining existing levels of service for vehicles; there are often trade-offs in technical performance and desired configurations that need to be made. Technical analysis combined with stakeholder and public engagement is suggested in these cases to help make supported decisions at a corridor-level. Developing specific project goals and objectives and providing measurable technical analyses with regard to these goals is recommended to help stakeholders and the public understand decisions requiring their input. Additionally, providing both transit goals and objectives alongside traffic and other mobility goals and objectives or at least establishing thresholds for acceptable levels of impact during planning stages can help achieve greater agreement on tough trade-off decisions and provide defensible documentation of how project decisions were made.

ESTABLISHING EFFECTIVE AGENCY COLLABORATION AND COORDINATION

Finally, the importance of establishing consistent and collaborative agency coordination mechanisms between transit and roadway agencies is foundational These projects often suggest rethinking roadway allocations and uses to provide greater multimodal balances and offers a variety of benefits and challenges that need to be weighed thoughtfully. Far from just a transit agency's project, these are fully multimodal projects and effective collaboration between agency plans and projects is critical to successful design and implementation at further stages of the transportation project evolution processes.

While most agencies tend to decide on less formal, but regular and iterative coordination to make project decisions, agencies may also choose to develop more formalized mechanisms as well to solidify agency roles and responsibilities. Regardless of whether mechanisms of coordination are formalized or less formalized, establishing regular and ongoing communication and documentation of project decisions are recommended. Given the time that may be expected to occur from early planning to design and construction of projects, regular meetings involving FDOT Modal Development, Traffic Operations, and Design staff and documentation of decisions made can help to alleviate any changes in staff over time of the development of a project and any organizational knowledge that would be otherwise lost.

Additionally, working collaboratively from early planning stages through design, construction and operations can help to establish schedules and leverage improvements proposed

Understanding at early phases of project planning what regular resurfacing and maintenance projects are proposed, or other improvements proposed in a corridor and the schedules for these separate projects can result in greater maximization of corridor improvements available and less additional disruption of traffic

Establishing Transit Focused Goals for BRT Project Success

As noted in TCRP's Bus Rapid Transit, Volume 2: Implementation Guidelines, the following are some suggested transit-focused goals and objectives that are recommended to guide BRT decision-making and should be considered alongside traffic impacts and/or thresholds. Public and stakeholder communication of decisions to be made should be clear and based on these measures.

1. BRT should be developed as a permanently integrated system of facilities, services, and amenities. It should improve bus speed, reliability, and identity.

2. The BRT system should adopt the key attributes of rail transit to the maximum extent possible. These attributes include segregated or priority running ways; attractive stations (with off-vehicle fare collection wherever practical); quiet, easily accessible, environmentally friendly, low-floor, multidoor vehicles; ITS technologies; and fast, frequent service.

3. BRT should be complemented by appropriate "Transit First" policies. These include transit-oriented land development, complementary downtown parking policies and adequate park-and-ride facilities at outlying stations, and reservation (or acquisition) of rights-of-way in developing or redeveloping areas. Similarly, BRT should be used to stimulate transit-oriented land use patterns.

4. BRT lines should focus on major travel markets in which ridership and benefits can be maximized. Radial lines should link the city center with outlying population concentrations and provide extensive coverage of downtown employment. Cross-town lines sometimes may be appropriate when they serve "edge cities," large university campuses, major medical centers, or other large attractors.

5. BRT should be rapid. Service should operate on separate rights-of-way wherever possible and use wide, free-flowing streets where dedicated rights-of-way are unfeasible or inaccessible to key transit markets. Street running should be expedited by means of bus priority treatment and transit-sensitive traffic controls, and station stops should be limited (e.g., from 1⁄4 mile in CBDs to no less than 1⁄2 mile in suburban areas).

6. BRT systems should be reasonable in terms of benefits, costs, and impacts. The system should maximize benefits to the community, the urban travelers (especially the transit rider), and the transit agency. Investments should be balanced with present and likely future ridership. The system should be designed to increase transport capacities in heavily traveled corridors, reduce travel times for riders, and minimize total person delay in the corridors served. A basic goal should be to maximize person flow with the minimum net total person delay over the long run. Implicit in achieving this objective is the efficient allocation of corridor road space.

STAGE 1 TRAFFIC ANALYSIS DURING EARLY PLANNING AND TCAR PROCESSES

The FDOT five-step project evolution and TCAR process outline three key outcomes:

(1) Development of Project Purpose and Need
(2) Alternatives Definition and Evaluation and
(3) Selection of a Preferred Alternative.

Each area is discussed in greater detail below. It should be noted that data and analyses needed to meet these outcomes relate to several steps in the 10-step TCAR process, from existing and future conditions analysis to reviewing previous studies and best practices. Defining Stage 1 of traffic analysis during early TCAR planning is focused on these major outcomes that require FDOT and transit agency coordination in establishing data collection needs and mutually accepted methods of analyzing corridor conditions.

The goal at the end of this step in the transportation project evolution and TCAR process is to provide sufficient project definition to evaluate and document potential environmental impacts from the project and to further develop conceptual engineering and design for the project. Additional recommendations provided at the end of this section to closing out this step in the planning process and to advance into FTA Project Development or FDOT PD&E stages.

TRAFFIC AND TRANSPORTATION ANALYSIS DURING PURPOSE AND NEED DEVELOPMENT

FDOT should be a key consulting party at the initial stages of data collection and analysis to establish existing and future conditions and project purpose and need when FDOT-owned roadways are concerned. The project purpose and need may vary from project to project but clearly defining the problems to be solved by a BRT project often relate to more than just making a transit improvement. The corridor-level problems to be solved by the BRT project are often overall traffic and transportation problems that FDOT may have specific concerns about and these may need to be considered and evaluated in developing and evaluating alternatives. These more traffic-related problems in a corridor may relate to existing and future congestion, existing and transitioning roadway and land use context classifications, safety and design related issues, right-of-way and vehicular capacity limitations, traffic operational concerns, and access management, among other areas.

It is important that these considerations and analyses guide development of the project purpose and need in this early planning process because these concerns and issues that the project proposes to solve may impact the ways in which goals and objectives for the project are defined and measured. This also impacts how the alternatives are ultimately developed and evaluated later in this TCAR process. Purpose and need development is more than a declarative statement of needed or desired conditions. Assertions made can relate to transportation and other problems in a corridor to be addressed by a project and these assertions need to be supported by quantitative and qualitative data and analyses.

Goals and objectives can be further defined based on the problems identified to be solved by the project and used to establish purpose and need. The goals and objectives of the BRT project should be clearly identified to determine the appropriate type and level of traffic analysis needed at each stage of the project. The goals of BRT projects will vary, but the objectives of the traffic analysis must reflect the purpose and need for the project and be measurable, so agreeing on analysis methods and assumptions early in the process is vital to success.

Initial traffic analysis will typically consist of three elements: understanding traffic volume in the project corridor, traffic safety analysis and understanding operational issues that need to be improved. The level of detail used for these elements will vary based on the study. Traffic volumes during AM and PM peak hours are a core component in understanding operational characteristics, but at a basic level they also describe the capacity of the corridor. The operational characteristics that are analyzed at this stage may vary based on the goals of the project and the priorities of the project team but are typically evaluated in terms of the saturation of the corridor and can include analysis of Level of Service (LOS), Vehicle Miles of Travel (VMT), travel speed, or person throughput, among other options. Information on congested corridor performance can be gathered through this data collection and provide the means to predict and measure the success of the project.

Some of the system information gathered in this planning and traffic analysis stage can also be useful as concepts develop. Existing transit ridership information provides insight into the potential for BRT system use as well as guidance on the placement and sizing of new or upgraded stations. Safety information can help identify improvements that should be included in new designs as well as potential for the BRT project to mitigate safety issues among various modes. An inventory of available right-of-way within potential corridors establishes the constraints the system will need to work within, providing a clearer picture for potential BRT alternatives as they are identified and developed.

Because BRT projects are fundamentally multi-modal projects, the data collection effort should consider all modes of transportation existing or planned in the corridor. The data collected should also be guided by the goals of the project. Known right-of-way constraints should also be a core component of initial data collection at the purpose and need level to define corridor constraints.

At the alternatives development stage, these data can be used and enhanced to provide further input and in identifying a range of potential options. These include comparing traffic, transit, and other modal benefits from alternatives developed, ensuring alternatives defined are feasible within available roadway widths, and further defining changes and any trade-offs to be discussed in the alternatives evaluation process and outreach to stakeholders and the public.

TRAVEL DEMAND MODEL AND REGIONAL TRAVEL PATTERNS ANALYSIS

Travel demand models are typically used in the broader planning process to: (1) identify major origin-destination patterns to define travel markets served by a project corridor in a regional context of origins and destinations as well as major traffic generators within or adjacent to a corridor, (2) define appropriate study area networks that could be impacted by changes within a corridor and that may require additional analysis at later planning stages, (3) identify congested corridors via traffic volumes, and (4) predict changes in travel patterns and congestion between existing years and planning horizons (typically 20+ years) given programmed transportation improvements, anticipated land use changes, and shares of trips made by different modes.

These factors all help to further identify baseline information on travel demands and patterns in a corridor and/or larger study area and the sufficiency of the existing transportation network and corridor over time to address growth and congestion. As such, travel demand models provide an entry point to defining transportation problems that may need to be solved in a specific BRT corridor and how it relates to the larger regional network of origins and destinations. The models also provide baseline data on regional mode split patterns and assumptions about future changes that may impact network and corridor-level performance and needs.

This also provides a starting point to determine the locations where more detailed analysis may be needed. Florida has particular requirements for the use of travel demand models, and the most recent version of the PD&E manual should be referred to when selecting the appropriate model for the project.

TRAVEL DEMAND MODEL USE

Key Data Collection/Needs:

- *Validated regional travel demand model*

Purpose of Analysis:

- *Identify existing and future regional and corridor-level travel patterns and volumes*
- *Identify key congestion points at a system-wide level that need to be considered for further corridor-level analysis*
- *Understand existing and anticipated modal shift and travel demand (traffic) growth given existing and anticipated land use assumptions*

For purpose and need development, this analysis involves modeling networks of origins and destinations, representing choices regarding travel modes, peak period traffic volumes, and optimal routes. Basic information such as population, employment, and land use are input as elements that influence travel behavior. These elements are also used to define project purpose and need and can be used in later stages of this planning effort to model and evaluate changes that may occur to population, employment, and land use, based on BRT alternatives.

The travel demand model should have been validated via the most recent Long-Range Transportation Plan, but there will likely be a need for consensus on whether the model be further calibrated to match corridor or local area conditions. More information on this calibration can be found in FDOT's *Model Calibration and Validation Standards Report*. This can relate to assumptions regarding the use of model outputs, variations in growth patterns based on local knowledge, or planned projects not incorporated into the area wide model. Note that the scenario evaluations should be fully related to the proposed BRT project, not general evaluations of traffic improvements for more efficient operation. Analysis of general capacity changes may be considered part of standard planning processes for FDOT and not required of the transit project under study. Understanding and defining what issues are to be further analyzed and solved by the proposed transit planning study and what requires further study and analysis by FDOT staff is an important element at this stage of planning.

It is important to note that while the travel demand model can provide important information on the purpose and need for a corridor-level BRT or transit enhancement project, it may also provide valuable insights on overall travel patterns and the needs of a more comprehensive multimodal network to meet future demands, particularly in urbanized and growing communities. This data can also be used to demonstrate the purpose and need for a corridor-specific BRT or transit enhancement project.

TRAFFIC OPERATIONS ASSESSMENT

More detailed examinations of existing and projected congested conditions along a corridor and at intersections likely will be needed to further define the purpose and need for a project. The results of this type of analysis can be used as alternatives are identified and considered throughout the process. This is typically done by completing a traffic operations assessment during AM and PM peak hours. This is typically performed as a broad evaluation of LOS using Synchro software. LOS can be characterized at the corridor, intersection, or approach level and coordination between FDOT, transit agencies, and consultants will be needed to define the desired parameters as part of the scope of work for this planning step.

Traffic volumes are the basis of a traffic operations assessment. Analysis can be performed at a high level using average annual daily traffic (AADT) data from a travel demand model or segment volume counts as part of a corridor evaluation. For an intersection level analysis, turning movement counts are needed. These counts establish the existing operational conditions and data from the travel demand model can be used to assist in forecasting future traffic volumes. Note that turning movement counts will also be necessary for more detailed analysis into operational issues and BRT project impacts as the Preferred Alternative is developed. The dates of available traffic counts should be noted and considered given the potential timing of the project at project initiation. This can help avoid needing new counts later in the process therefore slowing the progress down.

The traffic operations assessment can identify the segments or intersections that are currently experiencing issues and will need more detailed attention as BRT alternatives are identified and further evaluated and refined. A traffic operations assessment at the TCAR stage can involve informed estimates of specific data such as turn percentages, classification, speed, etc. Assumptions on base year and horizon years used, AM and PM peak hours, as well as assumptions about growth rates may also be used.

It is important that any of these assumptions or estimates be coordinated closely with FDOT staff and agreed on prior to analysis.

One of the primary outcomes of traffic operations assessment is determination of an intersection Level of Service (LOS). In most urban areas and as defined by FDOT LOS policies, LOS D is a typical standard used for ascertaining whether segments or intersections within a corridor are performing acceptably from a traffic perspective. LOS E or F conditions indicate a breakdown of traffic to unacceptable LOS from standard policy and where additional operational signal timing or geometric changes may need to be further considered. Tabular information on existing and future LOS and volume-to-capacity ratios should be shared with FDOT to review, and information on segments and intersections performing below LOS D should be highlighted.

While LOS E and F, whether in existing conditions or future conditions, define deficiencies, they also help to further define opportunities for new modes and further establish the purpose and need for a BRT project. Where congested conditions already exist and where further widening is not possible, for instance, there exist opportunities for shifting demands to other modes that may offer capacity relief. These congested corridors may also represent strong candidates for a BRT corridor and where more intensive improvements that improve transit travel times may be most beneficial and perform well, providing additional modal shifts and helping to provide additional congestion relief potential.

Initial tabular data may provide a lot of analysis findings in a condensed and understandable way to traffic engineers; however, care should be taken to also provide findings in a more visual format to facilitate discussions on corridor issues and to highlight key issues. This can be helpful for FDOT planners and engineers, transit agency staff, and communicating issues to stakeholders of the general public in an easier to understand way. **Figure 7** shows an example of an extensive corridor LOS evaluation condensed to show only the relevant issues, which helps keep important information from being lost in charts and tables. Looking at this data in relation to other characteristics, such as existing transit boarding and alightings and other safety issues, can expand the picture of current issues that are used in purpose and need development and can be useful in identifying and fully defining alternatives as well.

TRAFFIC OPERATIONS ASSESSMENT

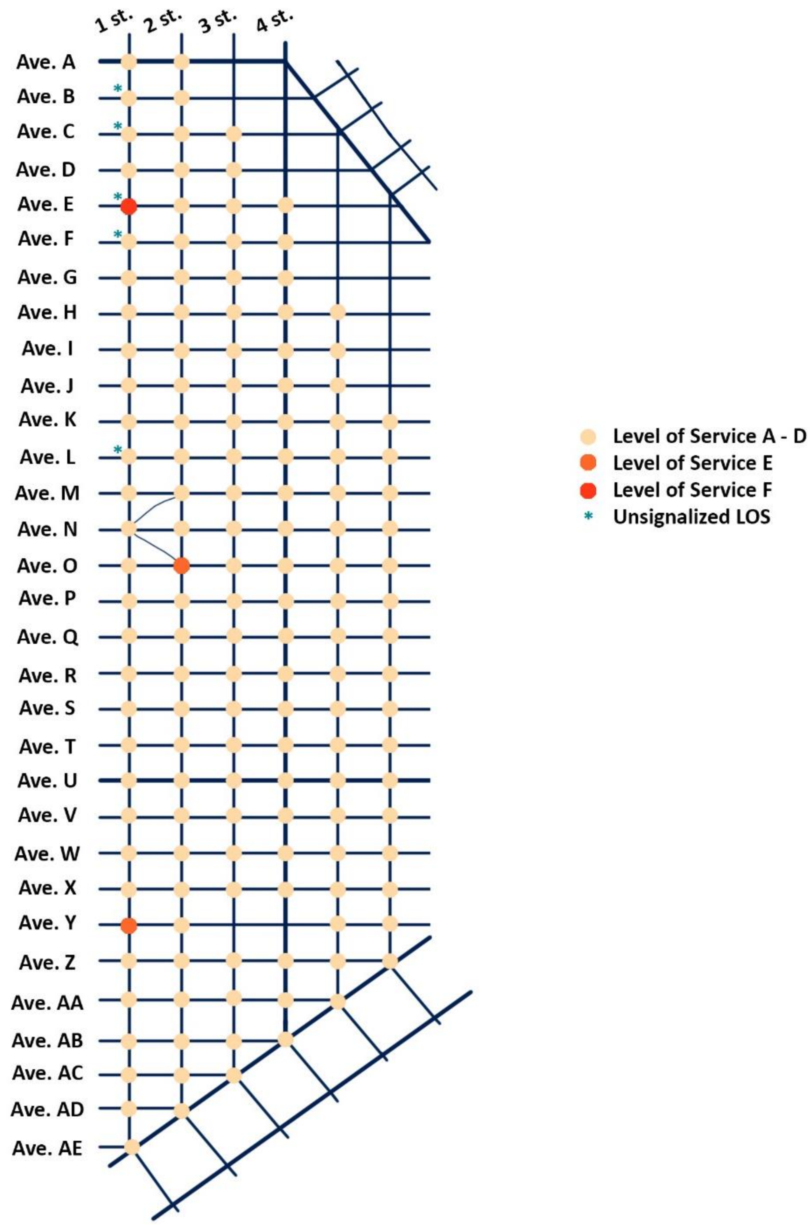
Key Data Collection/Needs:

- Average Daily Traffic
- Turning Movement Counts
- Roadway Characteristics
- Speed Information
- Intersection Control Information
- Bus, Bike, Ped And Parking Conflicts

Purpose of Analysis:

- Describe existing and future traffic conditions without the BRT project (No-Build conditions) to define corridor congestion and problems
- Locate specific segments and intersections that are or will be congested where additional traffic improvements may be considered

Figure 7: Visual Representation of Level of Service (LOS)



Intersection	2007 Existing		2015 No Build	
	Los (Delay)	Critical V/C (Critical Movement)	Los (Delay)	Critical V/C
Ave. A/ 1 St.*	F (76.5)	1.05 (SB)	F (80.3)	1.06 (SB)
Ave. O/ 2 St.	D (45.9)	-	F (86.7)	1.17 (WBL)
Ave. Y/ 1 St.	D (46.1)	-	E (59.3)	1.05 (SBT)

SAFETY AND CRASH ANALYSIS

Safety and crash analysis are important elements in project planning as it can serve to highlight conditions that need to be considered and addressed in making corridor-level improvements. Safety related inputs and data such as concentrated crash locations, bicycle and pedestrian uses in the corridor, and current field observations among others may be used in crafting a purpose and need that reflects multimodal mobility improvements that should be considered as part of subsequent alternatives developed.

Unlike a typical roadway safety analysis, the evaluation of safety data for a BRT project will likely involve more thorough analysis of bike and pedestrian issues and concerns, as well as focus on the causes of these crashes and the rates of occurrence. While detailed crash and incident reports may not be needed, initial analyses should begin with identifying high crash concentrations at locations within the project corridor through five-year crash data, sorted by mode.

Figure 8 shows an example of a simple map of crash data by mode to help quickly and efficiently highlight the areas of the study corridor that may require further attention and evaluation as alternatives are developed. Combined with other data and analysis, such as vehicular LOS, pedestrian and bicycle counts, and existing transit routes, safety and crash data can provide further information to support any overall mobility-related purposes for the project. It can also identify key operational characteristics of the corridor that may be factored into alternatives development or projections of transit reliability.

SAFETY AND CRASH ANALYSIS

Key Data Collection/Needs:

- Five-Year Crash Data
- Bicycle and Pedestrian Infrastructure Data
- Field Conditions

Purpose of Analysis:

- Identify key safety related areas of concern within a corridor
- Provide input into overall mobility improvement needs as part of purpose and need development

Figure 8: Example Crash Map by Mode from Madison Street BRT in Seattle, WA

CONSIDERING PERSON-THROUGHPUT

Shifting trips to more efficient travel modes is important in maximizing limited right-of-way. Traditional measures of system performance like vehicular LOS and speed focus more on the user experience as a metric for how well a roadway is performing and penalizes bicycles, pedestrians and transit as impediments to automobiles. Using person throughput to measure performance places a more direct relationship between the capacity of the roadway and the available modes to meet travel demands from origins to destinations. Because BRT can move people more efficiently than automobiles or traditional bus service, improving BRT service can substantially increase corridor capacity and reduce the average per-person trip time. These inputs can be included alongside other measures such as typical LOS analysis to further demonstrate the purpose and need for the project. Because these two metrics have different priorities, including person-throughput in analyses for transit/BRT improvements provides a more multimodal and measured approach to defining multimodal corridor needs.

Evaluating person throughput requires a different set of data than previous methods, but this data should be possible to collect from travel demand models. Automobile person-trips and transit person-trips are necessary for evaluation and should be available in demand model outputs. Corridor characteristics such as number of lanes, planned dedicated BRT lanes, as well as vehicle characteristics including average speed of buses and automobiles, bus headways, and average vehicle occupancy are all needed.

Analyzing person throughput requires assumptions for average vehicle occupancy and potential maximum capacity. Different vehicle types can carry different numbers of people, so the assumptions of occupancy characteristics that will be used as the basis for determining the number of people being moved through a corridor must be agreed upon between FDOT and the agency responsible for the project. It is also important to note that this type of analysis is focused on the capacity to move people not individual vehicles, therefore the priority will be focused on the efficiency of moving people over the efficiency of moving vehicles.

PERSON THROUGHPUT ANALYSIS

Key Data Collection/Needs:

- Automobile and Transit Person-Trips
- Corridor Lanes and Configurations
- Vehicle Characteristics – Automobile Speeds and Average Vehicle Occupancy
- Bus Characteristics – Bus Speeds, Headways, Load Capacity, Occupancy Assumptions

Purpose of Analysis:

- Describe possible corridor capacity increases from modal shift assumptions
- Provide an additional layer of multimodal considerations in identifying potential project benefits and ability to address project purpose and need

OTHER ANALYSES CONDUCTED FOR PURPOSE AND NEED

Another major component of developing a BRT or transit project purpose and need is to establish the transit conditions and other factors which describe the transit and related problems to be solved by the project. As noted in earlier sections of this guidance, in addition to transit and general transportation problems a BRT project may help to solve, often there are coinciding land use, economic development, and transportation goals that may be part of the purpose and need for the project and which will be further evaluated in alternatives development stages.

TRANSIT CONDITIONS AND RIDERSHIP

A variety of transit conditions and data in and adjacent to a corridor are used in establishing the purpose and need for a proposed transit improvement, regardless of mode. Most of this data should be readily available through ongoing data collection and monitoring efforts of a transit agency and will include: geographic information system (GIS) data on routes, average daily ridership at the route level, on-time performance for the transit system and for route-specific performance, bus travel speeds, headways and schedules by route, other supporting information such as recent on-board surveys and collection of boarding and alighting data at the stop or station level, transit travel time delays within the corridor (from bus driver interviews and in-field observations), station asset management plan and transit amenity data, among others. The data collected at this stage should reflect transit agency knowledge on the bus operational challenges within the corridor so that a complete picture of the problems to be addressed can be identified in purpose and need development. In-field observations on operational issues and other infrastructure-related deficiencies, such as sidewalk, ADA, or other accessibility issues should also be identified through data and in-field investigations.

For purpose and need development, understanding the origin and destination needs of passengers through on-board survey and transfer data as well as available data on transit-dependent populations will help to establish the major purposes, destinations, and travel patterns of existing transit passengers that are important to fully defining the purpose and need for the project.

Travel time and reliability of service are key elements in establishing existing transit conditions in a corridor, purpose and need for projects, and are directly related to transit and overall corridor capacity. These factors directly influence the needs to improve service effectiveness, realize transit operational cost efficiencies, and improvements to transit speed and reliability improvements are major contributors to the ability of transit to serve as an effective transportation alternative and choice of mode for people. Obtaining information for the purpose and need on operating conditions of bus services in and adjacent to the corridor, running times, on-time performance, and identifying causes of transit delay are important in establishing the problems to be solved by a BRT project and they also will provide baseline conditions to compare against alternatives as those are identified and further evaluated.

Ridership projections are typically not needed as part of purpose of need demonstration, however existing ridership and transit-dependent riders served by a corridor is a determining factor on the level to which improvements are expected to immediately accrue through a BRT project. Detailing of existing riders and transit-dependent needs within a corridor are relevant element to include in purpose and need development, and with regard to transit capacity, improvements to bus operational time and reliability are key inputs into for directly related to the capacity and ability of BRT projects to support alternatives to addressing corridor capacity needs. While existing and even projected ridership may not be a full measure of the capacity of transit to address corridor-wide demands, it can provide some useful information to support BRT investments. Where average daily ridership is in excess of 6,500 passengers per day and where capital investments are anticipated to cost between $50 and less than $100 million in total costs, for instance, FTA has established certain guidance and procedures that automatically assign desirable rankings for justifying a project later through the federally funded CIG program. Other ridership "warrant" criteria that may limit the need to develop more costly ridership projection methods are described in further detail in FTA's *CIG Program Final Interim Policy Guidance* and should be referenced as needed, in developing projects that have the potential for applying for federal funds in the future. Coordination between the transit agency and FDOT staff on methods to be employed for ridership projection analysis during the TCAR process is therefore important when developing scopes of work for BRT planning projects. Travel demand models, FDOT's Transit Boardings Estimation and Simulation Tool (TBEST) or FTA's Simplified Trips-On-Transit Software (STOPS) are all available tools to use when estimating ridership and developing projections are desirable for development of purpose and need or in developing and evaluating BRT alternatives.

BICYCLE AND PEDESTRIAN CONDITIONS

Bicycle and pedestrian connections should be examined in developing the purpose and need as well. Connecting transit to bicycle and pedestrian networks effectively can help to identify and address first and last mile issues that may impact the effectiveness and ability to use transit in and adjacent to a corridor. Additionally, concentrated pedestrian and bicycle facilities can represent additional key destinations to be noted in detailing the project definition and needs in developing alternatives. Obtaining pedestrian and bicycle counts, as recommended in safety and crash analysis, can help identify non-motorized use within and adjacent to the corridor. In a number of cases, existing traffic signals may already have cameras that can allow for bicycle and pedestrian counts and help further identify hours of service. Combined with an understanding of land uses, major traffic generators, and community or other facilities in and around the corridor can help to further contextualize non-motorized travel in the corridor. A variety of quantitative and qualitative methods exist for measuring the effectiveness of the bicycle and pedestrian environment, including FDOT's Quality/Level of Service Handbook (QLOS), Walk and Bike Score data, and others. Determining the appropriate data and level of analysis needed should be coordinated with FDOT staff to provide consistent ways of measuring these factors and to better understand corridor purpose and need.

LAND USE AND DEMOGRAPHICS

Land use, both existing and future, as well as socio-economic data is a particularly important component in the early analysis stages and in identifying additional project purpose and need supporting information. Existing and proposed land uses help to indicate major origins and destinations that the project proposes to serve and may support transit focused improvements by providing data and analysis on how land uses, particularly around stations, further support transit investment needs. This process typically involves developing maps of existing and future land uses with potential walking and bicycling buffers around a corridor (See **Figure 9** for an example) as well as identifying corresponding land uses, transit-oriented development plans, legally-binding affordable housing restricted provisions and units available, and other transit-supportive policies within and adjacent to the study corridor that help to establish the purpose and need.

An understanding, particularly of new or proposed transit-oriented development, or other major residential or employment generators that create new growth or development directly adjacent to or within a corridor all help to further demonstrate project purpose and need.

These elements of analysis may also be used in subsequent planning steps when pursuing FTA CIG ratings and funding. Developing walking, bicycling and bike-share buffers (¼-mile, 1/2-mile and possibly greater) around existing and planned growth can further help to identify transit rider capture potential.

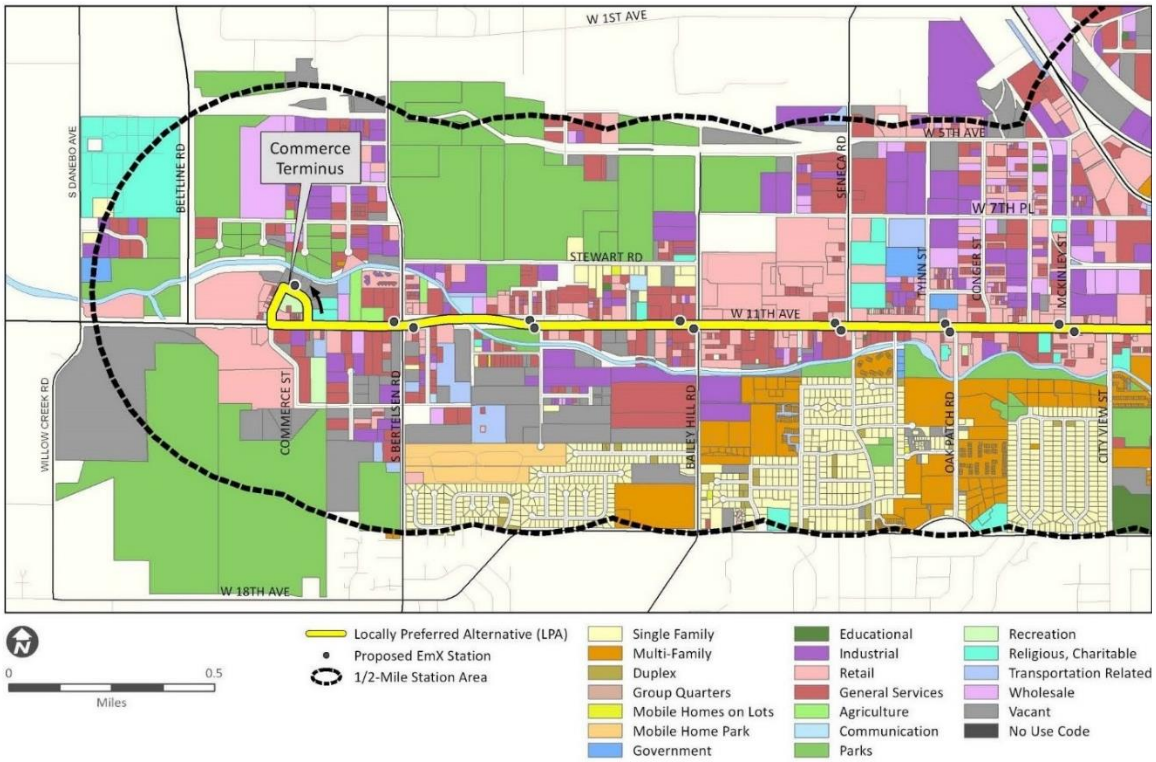
When used in conjunction with field analysis, it can identify any gaps and needs to pedestrian or bicycle access that may be important in addressing first and last-mile issues for potential users of a transit/BRT corridor improvement.

Land Use, Development and Demographics in BRT Purpose and Need Development

Developing maps of existing and future land uses with potential walking and bicycling buffers around a corridor (See **Figure 9** for an example) as well as identifying corresponding land uses, transit-oriented development plans, legally-binding affordable housing restricted provisions and units available, and other transit-supportive policies within and adjacent to the study corridor help to establish important elements of a BRT project purpose and need .

These elements of analysis are directly linked to measures FTA uses in rating the merits of a potential transit investment. See FTA's CIG Program Policy Guidance for additional information on these measures.

Figure 9: Example of BRT Land Use Analysis Around Stations from Eugene, Oregon



Source: Lane Transit District, West Eugene EmX BRT Extension Project, 2012

Demographic analysis also supports the development of the purpose and need for a project. This requires an understanding of population, housing and employment densities that may support transit investment. Additionally, this analysis will help identify other demographics in a corridor, such as environmental justice which include low-income or minority populations and other transit-dependent populations. Other relevant demographics include zero-car households, over 65 and under 18 years of age populations and other measures that may further support proposed transit/BRT investments. Analyzing buffer areas for these socio-economic factors around the corridor or study area as well as around potential major intersections where station improvements may be further considered can provide important data about the potential latent demands in a corridor that a transit project may help address. Similar to land use factors, it is recommended that this data be used in conjunction with any in-field data on gaps or needs with regard to pedestrian and bicycle access to the corridor so that those are captured, as appropriate in the purpose and need, and further considered in identifying and further defining alternatives and improvement needs.

MASTER PLANNING AND OTHER POLICY LEVEL CONSIDERATIONS

Finally, a variety of master planning and other policy decisions in or around a corridor may help to support the purpose and need for a project. These may include proposals for BRT or transit investments in long-range plans, comprehensive plans, community master plans, transit development plans, and other land use, zoning or policy decisions, such as designations for multimodal transportation districts, or overlays. FDOT's *Context Classification System* may also be consulted as part of this analysis to identify any proposed changes to transportation decision-making and traffic considerations that may further support the purpose and need for the project. Consideration of bicycle and pedestrian master planning efforts and facilities may be considered here as well to provide supporting information on additional multimodal accessibility and connectivity needs.

For projects that ultimately apply for rating and evaluation under FTA's CIG program, this information may not just support purpose and need development but may be subsequently used in developing materials for grant rating submissions. In particular, economic development criteria under FTA's rating system for the CIG program looks at the potential impacts to VMT that land use, zoning, and other transit-supportive policies may be expected to have. Combining data from travel demand models on VMT and adjustment to land use in the model based on transit-supportive policies, land uses, and zoning may help to quantify environmental and other benefits of proposed investments.

TRAFFIC ANALYSIS FOR ALTERNATIVES DEVELOPMENT AND EVALUATION

With a solid understanding of the background data and analysis findings that establish the purpose and need and problems to be addressed within a proposed BRT or transit corridor, planning for alternatives evaluation can occur. This step comes before actual identification of alternatives and should involve developing project goals and objectives from the purpose and need and defining measurable quantitative and qualitative data that will allow for proper development and evaluation of a series of alternatives. In addition to purpose and need related criteria, often costs – both capital and operational costs for proposed alternatives – are also included. FDOT modal development, as well as traffic operations staff and transit agency staff should work collaboratively to develop goals, objectives and measures of effectiveness to provide a mutual understanding and agreement in this part of the planning process.

Several elements of purpose and need will, by definition of it being a transit improvement project, be focused on transit-related performance and not making a traffic improvement in the corridor. However, traffic-related concerns, thresholds, or performance measures that specifically impact the *feasibility* of transit alternatives should be discussed, and incorporated into evaluation criteria, as deemed appropriate. The purpose of this coordination should not be to eliminate examination of a wide array of BRT alternatives; rather, it should be to make sure there is an understanding of the issues and trade-offs that may need to be considered in evaluating the performance of alternatives. As such, use of vehicular LOS thresholds or standards are not recommended, but being able to identify changes in vehicular travel times against transit travel time or reliability improvements may be desirable to understand comparative changes between modes as a result of alternatives identified. These types of trade-offs require more than technical traffic engineering judgment, and successful alternatives evaluations allow for ease of understanding of these trade-offs and changes for further community, public, and stakeholder outreach and input in selection of a Preferred Alternative.

While this guidance focuses on analyses and evaluation of BRT alternatives, a transit alternatives analysis may consider a variety of modal alternatives to address the purpose and need. As such, it may be appropriate to develop a multi-level screening process where modal considerations are addressed as part of initial alternatives development screening. This allows for a high-level screening and evaluation of differences between modal options to address the purpose and need and provides for more detailed alternatives to be developed once a mode choice has been defined or narrowed down. For BRT, in particular, there are a variety of running way configurations and treatments that may be further considered and evaluated against measures of effectiveness. As related to traffic concerns, each configuration may have unique traffic considerations to evaluate as part of defining feasibility and evaluating alternatives. At a minimum, there may need to be areas identified for further data analysis following selection of a Preferred Alternative and further advancement of conceptual engineering and design.

Measures and analysis to be conducted as part of alternatives evaluation processes will differ from project to project and should reflect the agreed upon the purpose and need and goals and objectives. Some commonly found evaluation measures for both transit and traffic analyses are provided below. Additionally, some discussion is provided on additional data collection and analysis that may be needed based on corridor features and that are important to analyze for further input from the community, stakeholders, and the general public.

In determining a Preferred Alternative, community input – their values, goals, and other adopted policy objectives – is just as essential as technical analyses. The technical analysis should be seen to offer the public an informed ability to weigh changes and trade-offs that are offered by different alternatives. In many cases, achieving consensus and support is one of the most important elements that will determine whether a proposed transit investment moves forward into implementation. Waiting until later stages of environmental planning to disclose roadway and other impacts of alternatives can therefore have detrimental consequence to BRT project success. While all design-level impacts may not yet be known, taking care in the alternatives development process to weigh decisions thoughtfully is highly recommended.

ADDITIONAL TRAFFIC ANALYSIS AND CONSIDERATIONS IN DEVELOPING AND EVALUATING ALTERNATIVES

When developing and evaluating alternatives, there are certain traffic aspects of the corridor that need to be considered to ensure that the alternative is feasible. While a BRT project may prioritize the operation of the bus, it is supposed to be part of a multimodal planning perspective and should not adversely affect the mobility of other corridor users. The first step in this process is identifying RIGHT-OF-WAY constraints because they define the available space for alternatives. **Figure 10** shows an example of an illustration of the variation of right-of-way within a proposed corridor. An illustration like this helps to quickly compare available width with capacity to determine where space may be available for dedicated lanes.

Figure 10: Example of Corridor Existing Right-of-Way from Seattle, WA

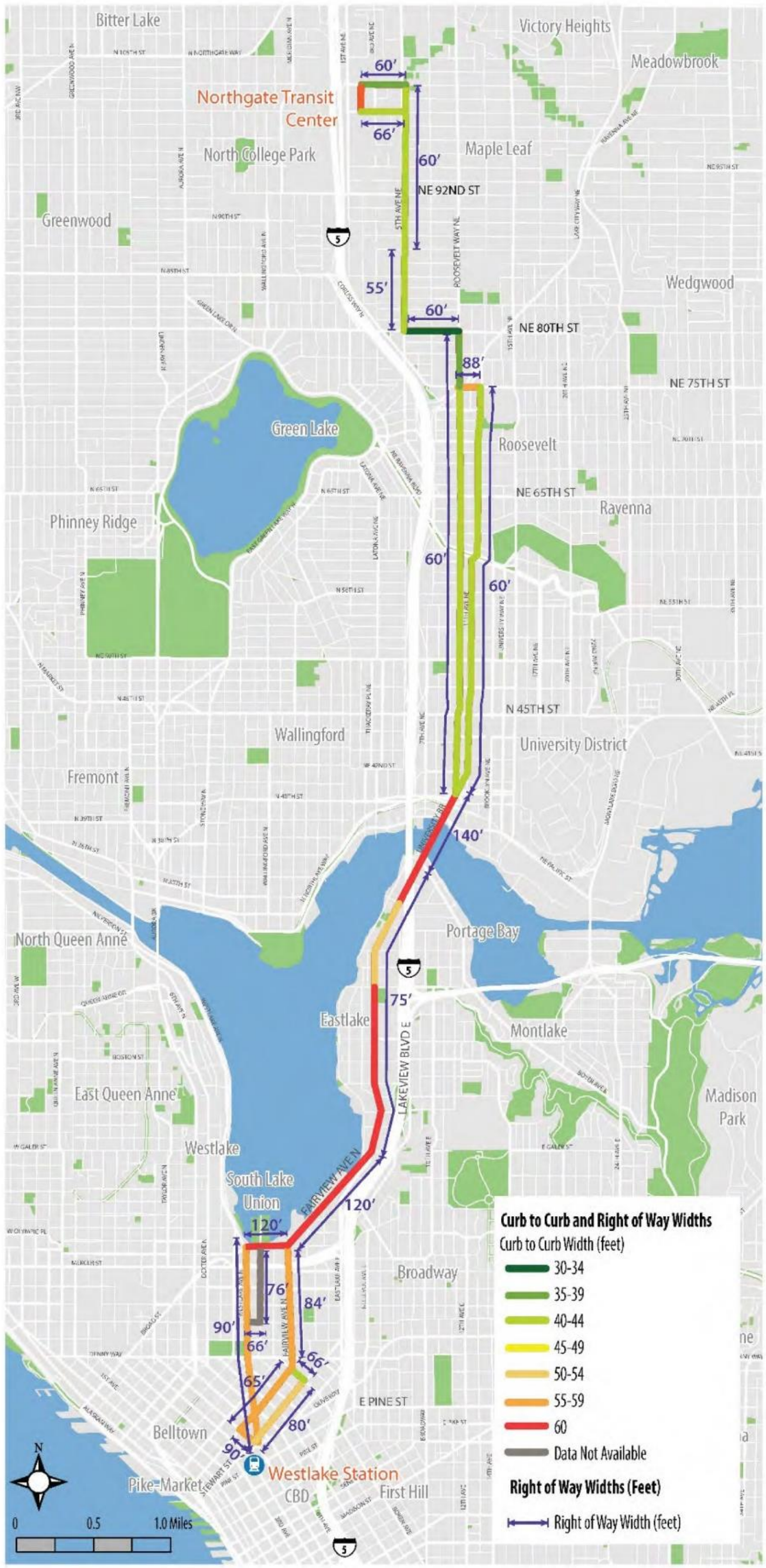


Table 1: Example of Alternatives Evaluation Based on Ability to Retain Existing Turning Movements

Intersection	Alternative 1 (No-Build)	Alternative 2 (Curbside BRT)	Alternative 3 and 4 (Center Lane BRT)
Washington Street	✓	✓	✓
Adams Street	✓	✓	✓
Jefferson Street	✓	✓	✓
Madison Street	✓		
Monroe Street	✓		
Quincy Street	✓	✓	✓
Jackson Street	✓		
Van Buren Street	✓		
Harrison Street	✓		
Tyler Street	✓		
Polk Street	✓	✓	✓
Taylor Street	✓	✓	✓

Notes: Checkmarks represent ability to retain existing intersection turning movements

Changes to turning movements is one example where the consideration of movements that may be eliminated or can be replaced should be included in the evaluation and clearly communicated to decision-makers and the public. A simple table such as the one shown in **Table 1** can emphasize the level of impact between alternatives and elicit important feedback about the operational effects of the changes.

Identifying intersections or driveways with a significant volume of turning movements can also be critical in evaluating potential stop locations, as the choice to place the stop on the near or far side can be determined by the number of conflicting turns that will be encountered and is especially important in corridors with poor access management. The preliminary analysis of intersection LOS can also highlight improvements that can be included in the proposed alternative, though the improvement should be clearly identified as a needed element of the alternative rather than a supplement added for convenience. Safety and crash data analyzed in the early stages of the project can identify deficiencies that can be addressed in alternatives, particularly with respect to station locations and pedestrian safety. Adding crosswalks, upgrading pedestrian signalization and making sidewalk improvements are all elements that would ideally be applied at all stops, but it is worth highlighting that the project will make these improvements.

The perspective on the impacts of a BRT project are not the same as a typical roadway project, and evaluation of alternatives will not necessarily focus on traditional measures of effectiveness. Evaluation of delay is a typical traffic method that can be used and compared with previous analysis, particularly when comparing the use of a dedicated lane versus mixed flow operation. A volume-to-capacity ratio is a typical traffic measure of effectiveness that would not be used because these values would not be substantially different between alternative BRT types. Travel speed can vary by type, so evaluating travel speed gives insight into the benefits and tradeoffs of the proposed alternative. This information can be estimated through travel demand models or Synchro analysis, providing travel time estimates over the length of the project corridor. This analysis is not intended to focus solely on the overall travel time change for traffic as would typically be evaluated in a corridor study; rather, this information can show the impact to general traffic with respect to the improvement in transit travel time and reliability, emphasizing the effective tradeoff. Evaluating person throughput similarly focuses on the benefits of the alternatives with respect to general traffic, emphasizing the increase in throughput inherent in BRT projects.

ADDITIONAL TRANSIT ANALYSIS CONSIDERATIONS IN DEVELOPING AND EVALUATING ALTERNATIVES

Key considerations in developing and evaluating potential alternatives for BRT projects include measures of differences in bus travel times and reliability that may result. Congested traffic conditions within a corridor not only lowers bus speeds, but it can also increase bus running time variability, or reliability of the bus service.

Bus running time variability can have direct impacts on operational costs for a transit agency as well due to the need to build in increased recovery times into bus route schedules. Congested conditions in a corridor as well increased or unreliable bus dwell times for passenger loading and unloading, among others, can impact bus travel time reliability. Identifying and evaluating BRT alternatives that can address these reliability issues, such as dedicated lane provision, TSP, off-board fare collection, or a combination of these strategies provides important information during this planning stage.

With regard to bus speed improvements, removing sources of delay for bus operations and considering coinciding changes to street design are the prevailing goal rather than simply raising corridor travel speeds. Measuring existing sources of delay for buses and identifying design and operational alternatives that provide varying levels of improvements is important in an informed evaluation of alternatives. Curbside or center-running, for instance, both provide dedicated lanes but often have different levels of benefits in terms of speed and reliability improvements that should be considered in the alternatives evaluation.

Both of these factors have direct impact on the viability and success that transit improvements can offer and will influence demands for service. If making a trip by transit takes significantly more time than travel by other modes or if there is a lack of predictability and reliability in the time it takes to make a trip, travelers are less likely to use transit. As such, one of the primary goals for BRT projects are to improve travel time and reliability, and to influence transit use and modal shifts through these improvements. These are often much more important measures for BRT projects than use of existing ridership and projections of ridership and represent a somewhat different way of thinking about transit capacity and demand.

While addressing existing and future projected capacity in terms of ridership versus capacity for a bus route may be a problem for some highly urbanized BRT corridor projects, the majority of small and mid-size transit systems are not initiating a BRT project to address capacity constraints alone. In these corridors, transit mode share may still be minimal compared to single-occupancy vehicle use and enhancing bus travel speeds and reliability are needed to make existing services more efficient and attractive to potential riders. Time saved by BRT improvements that reduce the traffic congestion delays experienced can help to postpone the need for adding more service to maintain existing bus headways and frequencies. As noted in the *Transit Capacity and Quality of Service Manual*, this provides additional positive outcomes for transit service provision, as it results in either (a) delaying additional operating costs for services, or (b) postponing the need to cut bus service into future years. The latter positive outcome is particularly important to transit agencies, who often already struggle to obtain the budgets needed to accommodate operational costs.

Table 2 provides an example of comparative information on changes to bus travel times by alternative and may be used along with other quantitative transit measures and other measures in evaluating BRT alternatives. Because bus speed and reliability are related to both design and operational characteristics of a BRT, it is important that alternatives identification and evaluations consider both design and operational improvements and, as appropriate, combinations of strategies.

Table 2: Example of Alternatives Evaluation of Transit Reliability

Alternative	Running Time		Percent Savings	
	NB AM	**SB PM**	**NB AM**	**SB PM**
Existing Local Service	36.0	39.0	N/A	N/A
Alt 1 – BRT Mixed Traffic without TSP	29.3	32.7	21%	19%
Alt 2 – BRT Mixed Traffic with Basic TSP	29.3	32.1	21%	20%
Alt 3 – BRT Mixed Traffic with Off-Board Fare Collection	29.2	31.9	21%	21%
Alt 3 – BRT Dedicated Lane without TSP	29.3	32.1	21%	20%
Alt 4 – BRT Dedicated Lane with TSP	26.2	29.1	29%	28%

PARKING AND LOADING CONSIDERATIONS

Parking and loading zones can be especially important to businesses in urban cores where space is limited and where alternative parking is not available.

When BRT alternatives consider assigning dedicated curbside lanes or consider BAT lanes along the curbside of a corridor where there is existing on-street parking, implementation may require the removal of on-street parking or, in the case of BAT lanes, may at minimum require restricting parking during AM and PM peak hours where BRT services are proposed.

Additionally, in considering repurposing existing lanes for center-running BRT and shifting traffic lanes to maintain regular vehicular lanes, there may be trade-offs between retaining through lanes for regular traffic and removal of on-street parking. These types of alternatives may also result in some disruption of loading zones for businesses located directly adjacent to a corridor. At the same time, not using a fully or at least partially dedicated BRT-only lane may result in less improvement to transit travel times and reliability, which is one of the highlights of the service.

It is very important to engage the surrounding community, business owners, stakeholders, and the general public early in the TCAR process regarding the tradeoffs of removing parking and loading zones for transit benefit. This does not necessarily mean providing detailed analysis, but instead being able to clearly communicate the benefits of the project and the effort that will be put into providing parking or loading alternatives. It's important to recognize that at this stage there may be multiple alternatives and those alternatives may be not be fully defined, so engaging interested parties to build support should be the focus over trying to provide detailed technical evaluations. **Table 3** shows a table comparing the parking affected by various alternatives. The net change may be an estimate at this point based purely on assumed RIGHT-OF-WAY needs, but it can help facilitate a discussion that will draw out how important it will be to maintain existing facilities.

Table 3: Parking Supply and Demand Comparison Amongst Alternatives

	PARKING SUPPLY			NET CHANGE +/(-)			
	METERED, NON-METERED, AND GREEN SPACES	COLORED ZONE SPACES	TOTAL SPACES	METERED, NON-METERED, AND GREEN SPACES	COLORED ZONE SPACES	TOTAL SPACES	% SPACES
No Build	356	86	442	-	-	-	-
BRT Alternative 1	328	81	409	-28	-5	-33	-7
BRT Alternative 2	304	70	374	-52	-16	-68	-15
BRT Alternative 3	339	72	411	-17	-14	-31	-7
BRT Alternative 4	325	72	397	-31	-14	-45	-10
BRT Alternative 5	378	77	455	22	-9	13	3

Of the groups, it may be most important to establish communication with local agencies and the business community. Local governments may have public processes and requirements when on-street parking removal is proposed that need to be understood prior to selecting a Preferred Alternative. Outreach to business owners and the ability to define and frame the benefits of the service in a way that connects with business owner needs and attracting and maintaining customer access may be an important tradeoff to quantify so that consensus is reached. This may mean highlighting the positive effect on economic development and community growth, established as part of early purpose and need analysis as well as other defined measures of effectiveness.

Keep in mind that more detailed analysis of parking and loading facility capacity and utilization will be required as alternatives are refined. Field investigations will be needed to gather this data, and research into nearby parking or loading zone alternatives will need to be performed. Whether this data is needed early or later in the process, the analysis can significantly help pro-actively address concerns over the loss of parking and enhance the ability to compare alternatives comprehensively for their relative benefits with relation to the goals and objectives of the project and a full range of measures of effectiveness.

SELECTING THE PREFERRED ALTERNATIVE

As noted in the additional traffic considerations during alternatives evaluation, in defining the range of alternatives possible, it is important to consider technical feasibility. This is a screening process at this stage because all conceptual engineering and design details may not be known, and many traffic operational concerns may be addressed as subsequent engineering and design planning advance. Doing this at the alternatives identification and evaluation stage will result in greater agency consensus on selection of a Preferred Alternative.

If there are specific additional traffic engineering and conceptual engineering that will need to be further coordinated, such as additional queue length assessments or diversion analyses or others, these items should be documented for further scoping and analysis in the next planning step of FTA's Project Development or FDOT PD&E phases; however, consensus on general conceptual plans for the Preferred Alternative should be obtained between FDOT, transit agencies, and through stakeholder and public involvement processes and prior to adoption of the Preferred Alternative.

Finally, an important consideration in FDOT's traffic analysis process and before a Preferred Alternative is selected and adopted is whether the project will incorporate the FDOT Lane Elimination Process. If so, this process needs to be started early because it requires input from multiple FDOT departments. FDOT currently uses a formal process outlined in Chapter 126 of the FDOT Design Manual to request the elimination of a lane on a state highway to reconfigure an existing cross section to allow other uses. The process is typically begun with the District Lane Elimination Coordinator and involves coordinated reviews with planning, environmental management, modal development, design, and traffic operations before obtaining a final decision from the FDOT District.

Should the lane elimination process be chosen, it is essential to start the process early to avoid delays and to determine the essential data and analysis that should be collected up front Although the project may still be in a planning phase, multiple disciplines outside of planning will need to be involved as subsequent planning is conducted

This guidance does not recommend lane elimination processes be required unless there are specific circumstances within a corridor that FDOT deems it necessary. One of the key outcomes of effectively using the guidance herein is to provide active input and coordination between FDOT and transit agency staff in the planning and development of BRT projects. If done effectively, this provides the level of technical analysis needed to weigh feasibility of concepts pursued and subsequent engineering and conceptual design phases provide continued mechanisms to conduct similar reviews as the formal lane elimination process.

Current lane elimination guidance does not fully address the role of this process for BRT projects. Projects in which lanes are eliminated are characterized in the FDOT Design Manual as intending "to reduce the number of travel lanes and effective width of the road," which may not necessarily apply to BRT projects. BRT projects reduce the capacity of the road for personal vehicles without reducing the effective width of the road and are intended to increase the capacity of the travel lane in terms of person throughput. A typical project involving lane elimination reduces the capacity of the roadway without restoring capacity elsewhere; a BRT project does not. Specifically, for BAT lane concepts and alternatives, which may be seen more as continuous right turn lane provisions than dedicated lane provisions, lane elimination studies may not be desired given the time and staff resources associated with this process.

However, should this lane elimination process be determined to be warranted, FDOT's *Statewide Lane Elimination Guidance* describes a conceptual framework for evaluating lane reductions for dedicated transit lanes. The technical analysis of the proposed project should evaluate existing and future roadway capacity, delay, and person throughput, as well as traffic impacts on adjacent roadways. These processes are similar to ones described above in developing the project purpose and need and identifying and evaluating alternatives, so care should be taken in not repeating analysis required or re-review of analysis and findings provided within the TCAR process.

PREPARING FOR PD&E OR FTA PROJECT DEVELOPMENT PHASE

In concluding this step of the planning process (the TCAR process), a Preferred Alternative is selected, and sufficient project definition should be determined to allow the project to either move forward into FTA's Project Development Process or FDOT's PD&E process depending on funding sources anticipated to construct the project. Selection of the Preferred Alternative should ultimately be agreed upon between FDOT and the transit agency following public and stakeholder outreach, and at the end of this stage the Preferred Alternative is recommended to be adopted by their respective MPO and included in the cost feasible long-range transportation plan. There should be sufficient project definition at the conclusion of this process for project sponsors to apply for entry into Project Development with FTA if the project is anticipated to be funded through federal CIG funds.

Additional project engineering and traffic operational analysis will continue to be refined as part of the next stage of planning; however, basic alignment features and running ways proposed (miles of dedicated versus non-dedicated lanes), any proposed elimination of on-street parking or changes to geometrics, generalized station locations, and feasible locations for additional improvements such as queue jumps are the desired outcome of this stage. Traffic analyses conducted at this stage should help to identify specific intersections and other locations where more detailed traffic analyses and data may be required in the next stage of traffic analysis to advance location-specific conceptual design and to fully determine turning movement needs and other operational-level criteria for overall multimodal mobility in the corridor.

Additionally, while it is expected that station locations will be generally identified, there may still be some levels of detail on site specific locations that will be determined as engineering and conceptual design is advanced. It is common at the next step of planning for some movement of station platforms and locations as design is further developed; however, it is important that a footprint is established to allow for sufficient disclosure of environmental impacts.

At or near the completion of this phase and prior to scoping of the next phase, it is recommended that a meeting be held between FDOT planning, traffic operations, consultants, and design staff and the transit agency to solidify understanding of data collection and traffic analysis methods and needs for the FTA Project Development or FDOT PD&E planning phase.

This meeting will help provide transit agency staff, in particular, with adequate information to allow for development of any requests for proposals or scope of work with regard to traffic analyses anticipated. As scopes of work are developed for the next phase of planning, transit agencies are encouraged to share draft scopes of work with FDOT staff to further enhance coordination and to minimize the potential for additional changes, costs, or schedules for completing project planning.

Preparing for the PD&E or FTA Project Development Phase

In concluding this step of the planning process (the TCAR process), a Preferred Alternative is selected, and sufficient project definition should be determined to allow the project to either move forward into FTA's Project Development Process or FDOT's PD&E process

Additional project engineering and traffic operational analysis will continue to be refined as part of the next stage of planning; however, basic alignment features and running ways proposed (miles of dedicated versus non-dedicated lanes), any proposed elimination of on-street parking or changes to geometrics, generalized station locations, and feasible locations for additional improvements such as queue jumps are the desired outcome of this stage.

Traffic analyses conducted at this stage should help to identify specific intersections and other locations where more detailed traffic analyses and data may be required in the next stage of analysis to advance location-specific conceptual design and to fully determine turning movement needs and other operational-level criteria for overall multimodal mobility in the corridor.

STAGE 2 TRAFFIC ANALYSIS DURING ENVIRONMENTAL REVIEW AND PRELIMINARY ENGINEERING

At the start of this stage of the BRT traffic analysis for BRT projects, a Preferred Alternative has been selected and adopted by regional planning officials and, depending on the funding pursued, the project may now move into either FTA's Project Development process or FDOT's PD&E process. For proposed FTA CIG-funded projects, an application letter and supporting materials for entry into Project Development must be submitted to FTA and accepted. Acceptance by FTA formally begins the two-year timeline for completion of the Project Development phase. Completion of this phase, particularly for BRT projects funded under FTA's Small Starts program, will involve completion of environmental review under NEPA in coordination with FTA and approximately 30 percent engineering plans.

With the Preferred Alternative accepted and adopted, the key outcomes for BRT projects at this planning step will include additional detailed planning for conceptual running ways, finalization of station placement and locations, further details on the level of TSP to be implemented, and finalization of locations for other BRT treatments such as queue jumps or other treatments. From a traffic engineering point of view, traffic improvements and mitigation measures will also be developed at this stage. While the Preferred Alternative provides a sufficient level of project definition to move forward into this planning stage and evaluate environmental impacts, these elements all contribute to further additional conceptual engineering and design plans. As concepts are further refined with engineering details, appropriate buffers are established at the environmental review stage to evaluate and document environmental impacts as well. For proposed FTA CIG-funded projects, this planning step also includes submitting grant materials for project evaluation and ranking and submitting for final funding as NEPA is completed.

At the start of the environmental review phase, either FTA or the FDOT District Environmental Management Office (EMO) will help to determine the appropriate environmental Class of Action for environmental processes to be followed. This Class of Action determines the level of analysis and mitigation that may be required or considered in a BRT project.

From a traffic analysis perspective, there are several items that must be established and decided upon during this planning step. At this stage, traffic analysis will focus on disclosing and documenting potential traffic-related environmental impacts of the project, and traffic mitigation measures needed. and Analysis will also address more detailed operational and safety-related issues in refining concepts in preliminary engineering and conceptual design.

Discussions of BRT station placement and addressing traffic operational and access management concerns will also occur at this stage. In addition, more detailed discussions can occur on TSP, including technology, upgrades to infrastructure that may be needed, right-of-way needs, and levels of transit priority anticipated. These early discussions on TSP will be less related to environmental impact analyses but are important in laying the groundwork for future design plans and will impact the speed and reliability proposed for the BRT project. In some cases, TSP improvements may be made as separate projects by FDOT to improve overall mobility in a corridor or may be proposed and included in the BRT project itself. Regardless of how TSP is implemented, coordination with the BRT project plans and agreeing on the level of priority to be assigned will clarify the level of improvements needed to enhance BRT operations.

Because environmental review and conceptual engineering are both involved in this planning step, it can sometimes be confusing to determine which elements of traffic analysis and decision making are related to environmental considerations and disclosure and which are more related to design and operational levels of discussion. Early FDOT and transit agency coordination is recommended to appropriately scope and further delineate analyses for environmental and design-related decision-making. This will ultimately help facilitate completing of NEPA and advancing engineering and design plans within reasonable timeframes. Details on agency coordination and traffic analysis and methods at this stage of traffic analysis are discussed below.

AGENCY COORDINATION AND ESTABLISHING AGREEMENTS

Continued and enhanced FDOT agency coordination may be needed at this stage of project planning for BRT projects. Engaging the same FDOT District staff that have been involved at the TCAR stage, modal development, traffic engineering and operations, staff will help ensure that project definition and purpose and need do not need to be revisited. It will also facilitate a general understanding up front about the analyses and desired outcomes from this planning step. At this step of the planning process, FDOT design staff should also be actively engaged at key points through development of engineering and conceptual design planning. This can ensure FDOT Design standards are considered at the outset and that any variances can be discussed and agreed upon.

Transit agencies are encouraged to coordinate with FDOT and share scopes of work ahead of execution of securing consultant services for this planning step. The closure meeting at the end of the TCAR process (Stage 1 traffic analysis) can aid in providing documentation of issues and recommendations to guide discussion and agreement on additional data collection needs, and the level of detailed traffic and other analysis needed for this planning step. Formalized agreements between FDOT and transit agencies are not required, but conducting early kick-off meetings can outline the steps to be taken for this stage of traffic analysis, identify traffic analysis milestones and decision-making needed, and provide critical information on how the traffic analysis findings and recommendations work with the overall project planning. In addition, establishing public and stakeholder outreach strategies can help establishing joint expectations and responsibilities at the start of this process. Review of the goals and objectives which were established as part of the TCAR process, at this early coordination kick-off, can solidify joint goals and objectives for project decision-making.

TRAFFIC AND TRANSPORTATION IMPACT METHODS

DETAILED MACROSIMULATION (SYNCHRO) TRAFFIC ANALYSIS

At this stage, the No-Build LOS conditions should be available from the TCAR process and the Preferred Alternative should be defined well enough to begin comparing LOS conditions with and without the project. This analysis will require more detailed evaluations of intersection operations, so early coordination between agencies and those performing the traffic analysis is important to ensure additional data needs are identified and reflected in the scope of work. The results FDOT will need for evaluation should be outlined so correct data will be collected, and any field observations can be accounted for. If Synchro is to be used, parties should agree on assumptions regarding volume balancing, signal timing at volume-density based intersections, irregular operations that are not represented in Synchro, and the capacity analysis method to be used.

Macrosimulation tools like Synchro use site specific characteristics to provide detailed analysis about traffic operations at intersections. The data collection for this effort typically includes turning movement counts during peak periods, roadway characteristics, speed information, intersection control information, and multimodal counts. This analysis can provide useful information such as anticipated queue lengths and the percentage of capacity being used, which can help identify the viability of dedicated versus hybrid lanes. It can also highlight the movements critically affecting operation at an intersection as well as the potential bottle necks in a corridor. Synchro cannot be used to analyze uninterrupted flow and it cannot be used to determine the effects of spillover congestion from one intersection to another. It also cannot model active TSP to evaluate the benefits of its use in an alternative. It provides information about issues at individual intersections, and this information can be used to determine the impact of bus travel on typical traffic movements, the impact of operational changes that prioritize transit, and to compare the impacts of different alternatives.

The analysis results will typically show AM and PM peak period intersection LOS results for No Build and Build conditions. Intersections with LOS E or F should be noted as intersections

DETAILED MACROSIMULATION ANALYSIS

Key Data Collection/Needs:

- Peak Period Turning Movement Counts
- Roadway Characteristics
- Speed Information
- Intersection Control Information
- Bus, Bike, Ped And Parking Conflicts

Purpose of Analysis:

- Compare existing No-Build and future traffic conditions with the BRT project to define project-generated issues
- Locate specific intersections or critical movements where additional traffic improvements should be considered
- Identify locations where detailed operational assessments are needed

where greater analysis will be needed, similar to the example shown in **Table 4**. Highlighting the intersections on a map can also help provide spatial context to aid in understanding bottlenecks or the degree to which capacity issues are concentrated. When mixed use BRT treatments are proposed, this level of analysis may be enough to satisfy FDOT requirements given the minimal level of investment and degree of changes needed to operate the BRT service.

Table 4: Example Intersection Level of Service and Delay Table

	No Build Condition		Alt 1 BRT – No TSP		Alt 2 BRT – Basic TSP		Alt 3 BRT - Full TSP		Alt 4 BRT - Dedicated Lane	
	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
27th St	81.1	F	18.4	B	18.7	B	18.0	B	14.0	B
31st St	14.5	B	11.4	B	11.4	B	11.2	B	11.0	B
Linwood Blvd	20.6	C	15.3	B	15.5	B	15.1	B	14.0	B
39th St	13.2	B	12.8	B	12.2	B	12.4	B	12.3	B
Gregory Blvd	80.6	F	65.3	E	54.0	D	54.6	D	45.7	D

Generally, the macrosimulation results obtained at this level of analysis are sufficient for environmental documentation purposes, and more detailed microsimulation analysis or evaluations of special operational scenarios are not required. What is critical is that LOS information has been prepared to evaluate environmental impacts with respect to the project definition.

This is important because LOS results of E or F do not necessarily mean the project is not viable, and the purpose of the environmental review stage is only to define these issues. More detailed operational evaluations may be needed to determine mitigation options to maintain overall mobility, but this is secondary to fulfilling the requirements of environmental documentation. The BRT project has likely been proposed in response to congestion concerns as an alternative method of addressing capacity and demand issues, and poor LOS may be the result of any proposed alternative; the point is to determine the most efficient mitigation strategy.

Depending on the project definition, FDOT may require more detailed analysis of project effects such as changes in delay, projected queue lengths at turning movements, or effects on capacity. At this point it is important to discuss the degree to which the transit project needs to mitigate poor LOS. The before and after analysis can highlight poor conditions that existed or would occur regardless of the project.

Initial recommendations for potential improvements should clarify whether they are specific results of the BRT project, such as traffic signal upgrades or queue jump lanes or to define impacts that should be addressed as part of the project, or whether those that fall under separate FDOT projects to improve corridor conditions. Agreement should be reached with FDOT on proper improvement treatments. If FDOT has specific needs or requirements at specific locations, those should be outlined early to avoid analysis iterations and to streamline decision making.

In the early stages of the TCAR process, queue jump lanes may be discussed as part of an alternative in a congested corridor, but the proper implementation may not have been clear until further data analysis was completed. Application of a queue jump can greatly enhance the travel time and reliability of the BRT service by giving it them a head start on congestion. As detailed analysis of alternatives progress, locations that are prime candidates for queue jump lanes should become more apparent. Thresholds for the application of queue jumps may not be clearly defined, so coordination with FDOT is key in outlining traffic analysis to be used. Typical thresholds may be a minimum hourly volume of curbside vehicles or intersection operation at LOS D or worse. These factors have minimal or no impact on environmental documentation, however, so a separate memo describing candidate locations and preliminary recommendations as well as special meetings specific to this topic may be desired. Once locations are determined, consultants and FDOT design staff will need to evaluate right-of-way and other design related considerations that may limit their applicability, particularly if there is a high volume of right turns at the location.

The TCAR stage will also provide a general sense of where BRT stations should be located based on desired headways and potential travel speed. Considerations of critical traffic movements and access management may affect the desired locations, however. At this point it is important to establish an appropriate buffer for environmental analysis of stations to identify and disclose any potential environmental considerations for station placement. As the recommendations are refined, it is important to consider the combination of operational improvements and proposed locations to determine how changes will overlap and identify potential conflicts. Some of the macro level analysis may help in identifying conflicts with traffic operations and proposed station locations; for example, an intersection with high turning movement volumes may require a far-side stop location instead of a near-side one. Also consider that access management practice may be based on field observations, design standards, local standards, and accessibility considerations, so coordination with relevant agencies is key in understanding what changes can be made.

USE OF MICROSIMULATION TOOLS

Macrosimulation tools provide the substantive information often needed to evaluate traffic performance and identify potential improvements or mitigation measures to be employ for specific intersections. However, they are limited in their ability to analyze dynamic network or system effects and interactions between modes. These modal interactions may be particularly important to planners, engineers and designers at locations with high multimodal movements to consider when developing safe and efficient engineering and design plans.

At specific locations additional microsimulation models and tools may be desirable, and Vissim is the most commonly used tool in BRT projects. These analyses are more related to operational and design-related challenges to be addressed in further refining engineering plans and are not necessarily required for environmental disclosure of impacts. Microsimulation may help as a visual tool to communicate and describe conditions to the general public in addition to technical analysis purposes. Determining whether microsimulation will be used should be coordinated as part of scoping this stage of traffic analysis since the time and effort involved are considerable.

Microsimulation models are designed to emulate the traffic behavior in a transportation network over time and space to replicate system performance of existing conditions and predict performance of proposed alternatives. The value in microsimulation comes from its ability to represent more complex traffic scenarios and multimodal performance, provide a broader array of measures of effectiveness, and model compounding effects of operational deficiencies. Examples of modeling capabilities relevant to BRT projects include:

- Intersections or signals with atypical signal phasing
- Specialized signal applications like Transit Signal Priority
- Intersections with unique road geometry such as queue jump lanes
- Transit-specific performance measures such as improvements to transit travel times
- Modeling of multiple modes and multimodal networks

Challenges in microsimulation modeling are that they require a large amount of preparation, error checking, and calibration of driver characteristics to actual field conditions, which also means that experience with the software is important. Compared to macrosimulation, this can be a complex and time-consuming process requiring more resources in terms of computer processing, storage and cost. Additionally, the process the model uses in assigning vehicles and simulating driver behavior is random, meaning the simulations produce different results with each run and must be run several times to provide an accurate representation of network performance. Due to the level of effort needed, it is important to communicate and agree on calibration parameters at the beginning of the modeling process to minimize the amount of time spent adjusting the model to reflect field-observed conditions.

MICROSIMULATION ANALYSIS

Key Data Collection/Needs:

- intersection Control
- Traffic Signal Control Plans
- Origin-Destination Data
- Bicycle and Pedestrian Volumes
- Bicycle and Transit Lane Dimensions
- Corridor Travel Times
- Bus Route and Stop Location Data
- Bus Service Frequency, Dwell Times

Purpose of Analysis:

- Provide validation of Synchro intersection LOS findings
- Provide comparative traffic and bus travel time changes and information
- Evaluate impacts of TSP
- Evaluate impacts on pedestrian movements
- Model complex multimodal interactions

Microsimulation models typically require three types of input: information about the network (lane geometry, movement layouts, intersection control), traffic signal control plans, and origin-destination information. This information will likely have been collected at earlier stages of analysis and can even be imported from some software like Synchro. The additional data needed to reflect multimodal operations include bike/pedestrian volumes, bike lane dimensions, transit lane dimensions, measured corridor travel times, and bus service information including routes, stops, service frequency, and dwell times. While data collection and analysis needs may be greater, the analysis can help to confirm Synchro findings and provide comparative performance between modes and scenarios which can be important to decision-making.

DETERMINING TRAFFIC DIVERSION ANALYSIS NEEDS

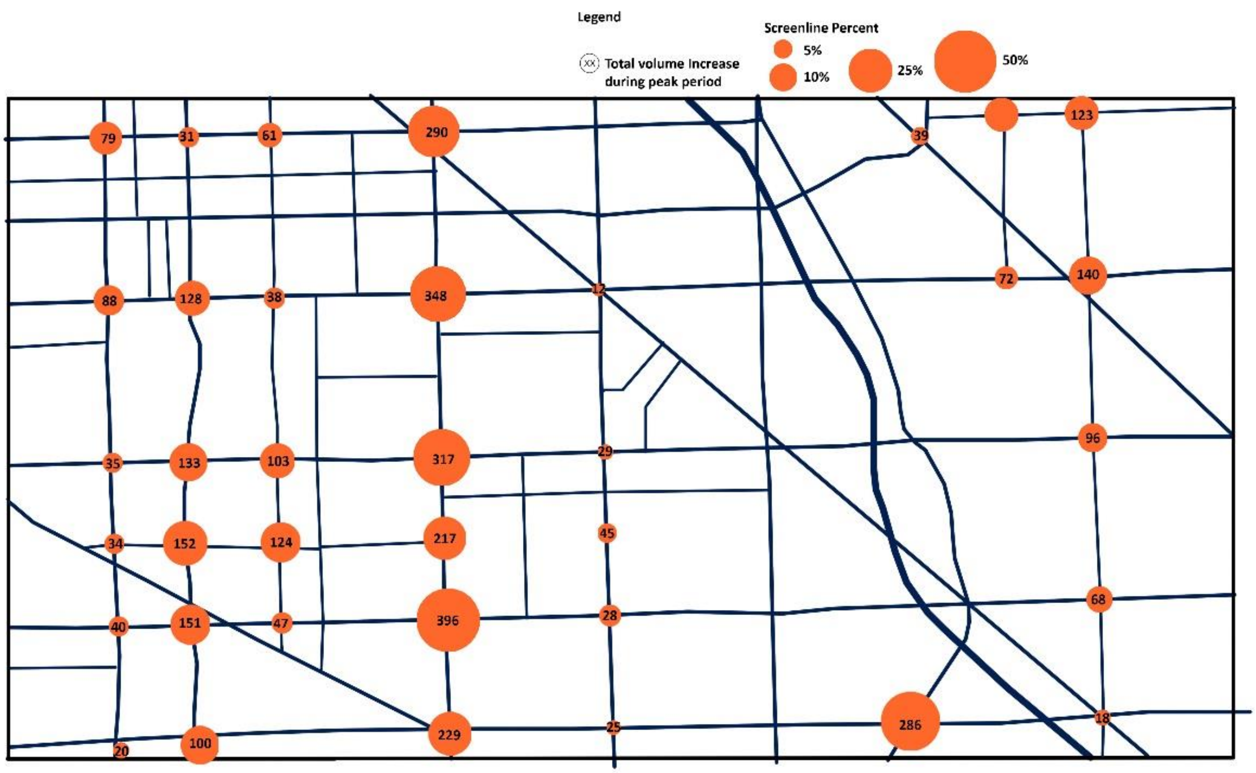
Traffic diversion analysis, which includes modeling how traffic may divert to parallel or adjacent roadways, is not a standard level of traffic analysis undertaken for BRT projects. It may be considered on a project-specific basis when a strong traffic grid pattern with multiple routes possible is present, where congested conditions exist on the BRT corridor and adjacent parallel roadways, and/or where traffic diversion concerns are raised during public involvement in early planning stages.

When FDOT determines that traffic diversion analysis is needed by, it can relate to documentation and disclosure of potential indirect or cumulative impacts from a project. The results of this analysis can identify nearby intersections or corridors to monitor or improve based on these expected changes. This level of analysis and recommendations for improvements may not always be part of the corridor BRT project, but rather would assist FDOT in continued management of the regional traffic network. As such, care should be taken in determining whether this type of analysis is appropriate for the BRT project or should be addressed through other planning study and analysis by FDOT staff directly.

When employed, diversion analysis can be accomplished with a regional or sub-area travel demand model, through agency knowledge of travel patterns, additional in-field data assumptions, and often a combination of these methods. Anticipating changes based on agency experience can be an effective method where the roadways have been built within a strong grid system, making it easier to identify alternative routes. Because methods employed may vary from project to project and rely at least in part on local knowledge for inputs, the assumptions to be used for this type of analysis should be agreed on in advance between FDOT, the transit agency, and consultant teams. Travel demand models can predict changes by reducing the available capacity, which will provide information on new route choices based on alternative facilities in the surrounding network that can accommodate traffic diversion. Traffic diversion is a complex subject, requiring assumptions about how people make travel decisions at specific times and locations based on an array of decision-making processes. Compounded with the complexity in making assumptions on human route choice decision is the dynamic nature and difficulty in simulating continually changing traffic patterns. As a result, the method used will depend on the conditions of the project, corridor conditions, and requires a clear understanding between agencies from the start about the concerns to be addressed through the analysis. Without this early agreement on methods and goals of the analysis, the amount of effort for this type of analysis can easily escalate based on the level of detail desired.

Because traffic diversion analysis can require extensive effort, it should only be used when specific circumstances are present that may impede BRT project implementation. Results of the analysis can be displayed as appropriate to the goals of the analysis. A starting point of analysis and displaying results may include showing tabular results of diversion to the overall network with a color-coded map of the changes in the traffic network. Additional and more detailed mapping of the corridor and the surrounding transportation network and diversion impacts may also be desirable in communicating diversion analysis findings. **Figure 11**, for example, shows the impact of diversion by providing the expected additional traffic volume to be added at adjacent intersections as well as representing the increase compared to existing traffic. Separate mapping of AM and PM peak hour diversion results can help identify diversion results by peak hours as well.

Figure 11: Example of Diversion Map Showing Diverted Volumes for an AM Or PM Peak Hour



PARKING, LOADING, AND BICYCLE FACILITIES CONSIDERATIONS

When on-street parking, loading, and bicycle lanes considerations are present in a study corridor, capacity and utilization data for these three components is needed, and may have been collected during the TCAR process. Counts and existing configuration data establish the degree of usage of the facility and the impact between project and facility. Identifying these conditions early can help clarify potential problems that will need to be addressed. Once a preferred alternative is selected it should become clearer whether facilities will need to be replaced or removed and detailed capacity and utilization data can help highlight underused facilities or more clearly delineate the capacity that will need to be replaced. Keep in mind that local governments may have public processes and requirements when on-street parking removal is proposed, which should have been clarified in the TCAR stage.

This is more significant when RIGHT-OF-WAY is limited. Dedicated curbside lanes or hybrid lanes may not be possible if these facilities cannot be removed or relocated because they can be shown to be heavily used and valuable to the community. From a technical viewpoint, their removal may represent limited environmental impact, but they may be highly important to the community, especially business owners. In this case the BRT service may need to operate in mixed traffic for portions of the project segment, which is a less optimal solution from the transit service perspective but a worthwhile tradeoff to keep the overall project. This is where public engagement is especially important, and maintaining that engagement to continuously communicate the benefits of the project can make a difference

Bike lanes may be easier to work around as they consume less space and are part of the traffic flow, so they can be rerouted if necessary or allowed in a transit-only lane. Safety considerations should be highlighted when discussing changes to bike lanes because the design proposals should be guided by good safety practices for interactions between modes. While safety evaluations are important in general, the interactions between buses and bicyclists place the cyclist at much greater risk than another vehicle. Highlighting the safety components of concepts shown to the public can help to clarify difficult design tradeoffs and build support.

FINALIZING THIS STEP IN THE PLANING PROCESS

Whether the BRT project uses FTA's Project Development process or FDOT's PD&E process, the desired outcomes of this stage will be to finalize and approve environmental documentation under NEPA or state PD&E requirements and to advance preliminary engineering and conceptual design plans. The level of detail for design plans may depend upon the process employed but is generally anticipated to provide sufficient engineering detail to advance into design and construction stages.

For environmental review purposes, concurrence or consensus on the documentation of the level of impact to the transportation network, any appropriate mitigation measures to be employed and any commitments for future phases of design and/or construction is needed. While formalized agreements may not be required, documenting this agreement in some form is highly recommended to solidify mitigation measures and commitments for future phases of design and/or construction. It is important to note that while technical analyses will help to solidify these agreements between agencies, often the impacts and proposed changes to the transportation network may ultimately be a policy-level decision. As such, continued and active public engagement should occur throughout all levels of planning for BRT projects and issues raised should be addressed to the extent possible during planning stages to provide continued public and agency support. When more formalized concurrences from FDOT are needed for finalizing environmental decision-making, it is recommended that agreement and sign-off occur at both higher levels of FDOT District staff as well as from technical staff reviewing environmental documentation and who have been involved in traffic and operational decision-making. This level of agreement within FDOT from both higher policy level positions and other technical staff can help to solidify support from the agency as design and construction occur.

TRAFFIC ANALYSES FOR EXPEDITED PROJECT PLANNING

Each of the previous steps and the outcomes they produce are important to developing successful transit and BRT project. Federal and state processes and regulations guide the requirements for these stages.

At the same time, federal surface transportation laws, from the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2009, the Moving Ahead for Progress in the 21st Century Act (MAP-21) of 2013, and the most recently adopted Fixing America's Surface Transportation Act (FAST Act) of 2015 have emphasized the desire for accelerating and streamlining project delivery, where possible. Where earlier legislation specifically called out an Alternatives Analysis as a required element of transit projects, more recent legislation has noted the ability to combine the steps of an Alternatives Analysis with overall environmental processes in selecting and adopting a Preferred Alternative, effectively linking planning and environmental stages and removing the requirement for a standalone Alternatives Analysis. This does not change the order of operations needed to complete each step of the Alternatives Analysis (TCAR Process), adherence to FTA's Project Development process or FDOT's PD&E process and requirements. It provides ways to streamline these steps and processes into a more comprehensive planning study that includes all of these steps and major outcomes.

Projects pursuing this more streamlined approach must be supported by funding needed to complete both TCAR processes and either FTA's Project Development phase or FDOT's PD&E phase and processes. It must also conform to FTA's required two-year timeline for entering and completing FTA's Project Development process for federally funded CIG projects and consider the appropriate time at which to request entry into Project Development. Having local project champions, support from the public for proposed transit improvements, and FDOT and transit agency support is essential to pursue an expedited project planning approach. With these considerations come significant benefits. Benefits to expedited project planning may include expedited completion of project planning timelines and quicker ability to move into engineering and construction phases as well as planning-level cost savings realized by data and analyses remaining current and up to date for project decision-making. With relation to traffic analyses, this can be very important in making sure that data and analysis are collected and conducted once and do not require updated assumptions or additional new analyses in moving through the planning process. Because funding for transit projects and planning are not as guaranteed and programmed like typical state and federal roadway projects with Work Programs and formula-based grants to support projects, time between early TCAR planning and subsequent FTA Project Development or FDOT PD&E steps can be over one year or more in some cases. As additional time is added between completion of these steps, traffic data and analysis can sometimes become dated and require further work to update assumptions and findings, especially in more urbanized and growing corridors where traffic performance and projections may be in flux. Being able to combine planning steps into one comprehensive study can therefore help develop traffic analysis and assumptions for continued relevance in decision-making and also provides a more continuous level of involvement from the same FDOT and transit agency staff throughout planning steps.

Should expedited planning be pursued, the steps and order of operations identified in traffic analysis Stages 1 and 2 contained in this guidance should continue to be followed. TCAR processes and FTA Project Development or FDOT PD&E processes should still be followed more generally. The only difference is that certain traffic analyses and decision-making can be conducted within a continuum of one planning study and schedules for overall decision-making may be further expedited.

SUMMARY/CONCLUSIONS

Implementing BRT projects on state arterial roadways can be transformational to communities and should be planned for and designed as part of a systematic solution to addressing corridor and regional congestion, enhancing access and opportunities for transit, linking planning to environmental concerns, and other community and policy-driven goals. For these projects to be successful, FDOT and transit agency staff need to work collaboratively through the planning process to develop feasible, implementable corridor solutions and requires active involvement by both FDOT and transit agencies in developing comprehensive multimodal solutions.

Traffic analysis stages in the planning process help to facilitate agency momentum for these projects and communicate and address technical concerns during planning so that design and construction of the project can move forward efficiently. While differing BRT running ways and other treatments may require distinct considerations in terms of facilitating traffic and other modal operations and determining a full range of corridor improvements, in general the traffic analysis and elements described herein provide the basic levels of analyses that are common to BRT projects and the range of applications and improvements that may be considered. Some distinct traffic operational considerations that may be considered and evaluated through traffic analyses depending on running ways and other treatments proposed are detailed within this report as well to offer further insights in determination of traffic analyses methods to be employed.

This guidance provides details on data collection and traffic analyses conducted for BRT projects at ach key planning step, defines the purposes of these analyses and how they tie to decision-making within planning outcomes. Two basic levels of planning-level traffic analyses are identified and described in greater detail throughout this report: during early alternatives development and selection processes conducted as part of FDOT's TCAR process and during subsequent environmental review and additional preliminary engineering and conceptual design phases as part of FDOT PD&E or FTA Project Development processes. **Figure 12** and **Figure 13** provide summary information on the planning process and guidance and regulations to be followed, key planning study outcomes, traffic and transportation analyses conducted, and key take-aways concerning traffic and transportation analyses conducted at each stage.

Stage 1 traffic and transportation analyses conducted under FDOT's TCAR process help to define the scope of the project purpose and need, identify and guide evaluation of alternatives possible, and results in identifying and adopting a Preferred Alternative for additional detailed analyses. Close coordination throughout this early planning process between FDOT and transit agencies is needed at each of these major steps in the study so that there is agreement about the overall goals of the project and measures to be used to evaluate a range of alternatives, and so that the identification and selection of a Preferred Alternative concept is technically feasible and supported by all agencies.

Figure 12: Stage 1 Traffic Analysis Process Summary

Figure 13: Stage 2 Traffic Analysis Process Summary

Involvement from FDOT planning and traffic operations staff are needed at this stage to provide sufficient consideration of technically feasible improvements and to identify where further analysis will be needed in future planning efforts. Subsequent analysis on both traffic and multimodal operational details, identification of further corridor-level improvements needed to support overall mobility in the corridor, and further analysis and coordination on station placement and traffic or asset management considerations will still be needed following this planning study; however, completion of this stage of traffic analysis will help to identify where further analysis and greater coordination and agreement on location-specific design decisions are needed.

Stage 2 traffic and transportation analyses conducted through FDOT's PD&E or FTA's Project Development processes provides greater detailed traffic and transportation operational features of a BRT project to be further developed. This often includes both macro- and micro-simulation techniques to further evaluate location-specific treatments and to inform further conceptual engineering and design project improvements. Additional considerations that impact the performance of the overall transportation network and to address specific trade-offs and details of a project, such as parking, loading and other multimodal facilities, are also a part of this level of analysis and planning and can affect public and stakeholder support for project decisions.

Determining elements of analysis that are related to analyzing and documenting environmental impacts of a BRT project compared to other analyses that may be conducted to further address operational changes to be made as part of additional engineering and design of the project should be coordinated between FDOT and transit agency staff. During Stage 2 analyses, in addition to FDOT planning and traffic operations staff, FDOT design staff should also be involved in this planning analysis. This will reduce the need for revisiting decisions as projects move into further engineering, design and construction and can help identify commitments and needs for future design and implementation of a BRT project.

The stages of traffic analyses described herein should build sufficient information at each distinct planning step in the planning process to inform project decision-making and allow FDOT and transit agencies to develop comprehensive multimodal corridor improvements as part of a BRT project. While most projects may conduct these planning steps into two distinct studies (a TCAR study and subsequently an FDOT PD&E or FTA Project Development study).

Depending upon the level of public support and momentum and the ability to define project funding sources, this guidance also outlines the potential for expediting project planning conducted in each planning step into one more comprehensive planning study. The positive effect this can have for traffic analysis is that it reduces the need for updates to traffic data collected between planning steps and analyses conducted. This may also aid in further streamlining planning schedules and enhance interagency coordination by providing a level of iterative detailing of project definition and conceptual design with continuous feedback from key staff within both FDOT and transit agency staff.

This guidance is recommended for use by FDOT and transit agency staff along with other FDOT and FTA guidance and should be used in coordination with other regulations in developing these projects. Each project and corridor may have distinct traffic related issues to address and the guidance provides several key points throughout planning to work collaboratively to address unique traffic analysis that may be needed.

While the main purpose of the guidance is to clarify traffic analysis methods and agency coordination processes for planning-level analyses of BRT projects on arterial roadways, there is no greater guidance than the experience that comes from state and transit agency staff in conducting these types of projects. A final recommendation of this guidance is to document best practices and lessons learned through project experience to aid in future projects. Additionally, as FDOT conducts these studies and BRT projects are implemented, analyzing and documenting traffic and transportation before and after data can offer further insights and lessons learned to guide success.