SCAN TEAM REPORT

NCHRP Project 20 68A, Scan 17-02

Successful Approaches To Accommodate Additional Modes And Services In Existing Right Of Way

Supported by the

National Cooperative Highway Research Program

The information contained in this report was prepared as part of NCHRP Project 20-68A U.S. Domestic Scan, National Cooperative Highway Research Program.

SPECIAL NOTE: This report IS NOT an official publication of the National Cooperative Highway Research Program, Transportation Research Board, or the National Academies of Sciences, Engineering, and Medicine.

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Acknowledgments

The work described in this document was conducted as part of NCHRP Project 20-68A, the U.S. Domestic Scan program. This program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP). The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Additional support for selected scans is provided by the U.S. Federal Highway Administration and other agencies.

The purpose of each scan, and of Project 20-68A as a whole, is to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies, and identifying actionable items of common interest. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for such sharing and exchange. A scan entails peer-to-peer discussions between practitioners who have implemented new practices and others who are able to disseminate knowledge of these new practices and their possible benefits to a broad audience of other users. Each scan addresses a single technical topic selected by AASHTO and the NCHRP 20-68A Project Panel. Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570.

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Disclaimer

The information in this document was taken directly from the submission of the authors. The opinions and conclusions expressed or implied are those of the scan team and are not necessarily those of the Transportation Research Board or its sponsoring agencies. This report has not been reviewed by and is not a report of the Transportation Research Board or the National Academies of Sciences, Engineering, and Medicine.

Scan 17-02
Successful Approaches To Accommodate Additional Modes And Services In Existing Right Of Way

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
BLE	Blue Line Extension (Charlotte, North Carolina)
BRT	Bus Rapid Transit
Caltrans	California Department of Transportation
CATS	Charlotte Area Transit System
DOT	Department of Transportation
DRPT	Department of Rail and Public Transportation (Virginia)
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GRTC	Greater Richmond Transit Company
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
LOS	Level of Service
LRT	Light Rail Transit
MDOT	Michigan Department of Transportation
MMTF	Multimodal Task Force (AASHTO)
MnDOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
PennDOT	Pennsylvania Department of Transportation
SFMTA	San Francisco Municipal Transportation Agency
SR	State Route
TIGER	Transportation Investment Generating Economic Recovery
UNC	Charlotte University of North Carolina at Charlotte
UVA	University of Virginia
VDOT	Virginia Department of Transportation
VMT	Vehicle Miles Traveled
WSDOT	Washington State Department of Transportation

Executive Summary

A goal of this domestic scan was to examine the design, operation, and policy decisions state Departments of Transportation (DOTs) are faced with when considering the accommodation of additional modes and services within existing right of way. A further goal is to identify findings and recommendations that will advance the institutional capacity of state DOTs to successfully participate and partner in projects to add modes to existing rights of way.

The team for this domestic scan consisted of eight members representing five state DOTs, the Federal Highway Administration and the University of Virginia. Sharon Edgar, who recently retired from the Michigan DOT, chaired the effort. Contact information and biographical sketches of the team members can be found in **Appendix A** and **Appendix B**.

The scan team was particularly interested in projects where existing general-purpose traffic lanes were converted to transit-only service (e.g., bus or rail) or to express toll lanes with bus rapid transit (BRT) or express bus service. After conducting a desk scan of 15 potential project scan sites, the scan team decided to visit seven projects in six cities believed to offer the best opportunity to meet the goals of the scan.

The projects were geographically distributed and utilized a variety of multimodal transportation strategies benefitting bicycle, pedestrian, transit, and automobile users. Transit solutions included streetcar, BRT, light rail transit, and bus-on-shoulder operations. The projects employed a wide variety of partnership arrangements, including state and local partnerships as well as interlocal partnerships. The projects were in Richmond, Virginia; Charlotte, North Carolina; Detroit, Michigan; Minneapolis, Minnesota; San Francisco, California; and Seattle, Washington.

Summary of Findings

After meeting with staff and touring the selected projects over a two-week period, the scan team met and discussed findings and observations it believed would be most helpful to others considering similar projects. Further discussions by the scan team identified recommendations in eight groups of strategies. While several of these recommendations are directed toward state DOT officials involved in similar projects, many other recommendations are directed to all project development officials, including state DOTs, transit agencies, as well as other local city and county officials. The following are the team's recommendations for transforming existing highway rights of way into successful multimodal corridors:

Adopt a Shared Vision

- The state DOT should develop a shared multimodal vision for the corridor with all its partners.
- The state DOT should foster a multimodal philosophy and culture throughout the agency.
- The state DOT should support the development of well-aligned multimodal plans and policies, including Complete Streets policies with its partners.

Define Roles and Responsibilities

- The state DOT should determine the lead federal agency early in the project development process for consistent coordination.
- State DOTs should evaluate their agency's organizational structure and make adjustments to facilitate multimodal decision-making and project delivery.
- Project development officials should insist that staff and managers have a "lean in to get to yes" philosophy – be flexible and nimble.
- The state DOT should consider taking the lead for phases of the project for which the agency has unique skills and abilities not possessed by other partners (e.g., utility relocation, environmental review, federal funding requirements, construction management, etc.).
- Project development officials should establish agreements for maintenance and operations between appropriate parties prior to project implementation.

Planning and Design Considerations

- The state DOT should focus its attention on transit elements that directly impact the state's roadway infrastructure.
- Project development officials should not get locked in to a single or best definition of BRT.
- Project development officials should devote significant effort to determine the optimal location and configuration of transit lanes and stations to improve transit service, roadway performance, and safety.
- Project development officials should give full consideration to using the opportunity of the multimodal project to further community and economic development goals as well as improve operational issues during design.

Seek Opportunities to Improve Transit

- The state DOT should look for ways to integrate transit and other innovative technology improvements with larger infrastructure improvements.
- The state DOT should consider the conversion of existing lanes or the addition of high-occupancy vehicle (HOV) or managed lanes as an initial commitment to dedicate lanes for the priority use of HOVs, including BRT and express buses.
- Project development officials should implement improvements for all modes that improve the overall mobility and safety of motorized and non motorized users of the corridor.
- The state DOT should make an effort to plan and design roadways to accommodate future transit options even if immediate transit funding is uncertain.

Employ Project Controls

- Project development managers should employ appropriate controls to manage risk across project scope, schedule, and budget.
    - Develop a project management plan that includes a defined escalation plan and conflict resolution process.

- With project partners, develop and agree to written protocols that govern how changes can be made to the vision, design, and budget.

- Project development officials should bring in the right staff at the right time.

Communicate and Coordinate with Stakeholders

- Project development officials (i.e., local officials or the transit agency) should develop a robust outreach plan to gather input from and disseminate information to stakeholders to keep them on board.

- Project development officials should plan on providing additional time and attention to coordinate with and meet the needs of certain stakeholders, including universities, hospitals, and railroads, which often have concerns regarding the impact of the improvement to their facilities.

Integrate Connections

- Project development officials should identify and improve connections to all modes operating within the corridor to enhance seamless travel.

- Transit providers need to coordinate/align the new transit service with other existing transit routes and services to ensure that route schedules are synchronized.

- Project development officials should implement roadway improvements that improve overall mobility and safety for all modes, including bikes and pedestrians.

Improve Person Throughput

- Project development officials should consider criteria in addition to level of service, including person throughput, reduced vehicle miles traveled, and safety (traffic, transit, and bicycle/pedestrian) when evaluating the impact of accommodating additional modes within existing right of way.

- Project development officials should look for ways to improve transit service that also help improve traffic flow.

Dissemination of findings and recommendations of scan information began early when Sharon Edgar, scan chair, provided updates to the American Association of State Highway and Transportation Officials Multimodal Task Force during the host site visits. Further efforts to share information will include presentations by scan team members at national, state, and local meetings of transportation officials and other interested groups, as well as conducting further research on the topic.

CHAPTER 1

Introduction

Background

Freeways, expressways and arterials are becoming increasingly congested, resulting in pressure to expand roadways or find alternative ways to improve traffic operations and increase the efficiency of passenger, freight, and other user movements. Because roadway expansion is costly and many times does not significantly reduce long-term congestion, but rather induces demand, transportation officials are considering alternative solutions within existing roadway corridors. Strategies that are being used along with or as viable alternatives to costly roadway widening and added maintenance include bus rapid transit (BRT), light rail transit (LRT), modern streetcar service, high-occupancy vehicle (HOV) lanes or high-occupancy toll (HOT) lanes, bus on shoulder, shoulder running, and bike and pedestrian facilities within the existing rights of way.

The scan for this research was conducted to identify and evaluate planning, policy, design, construction, and operational issues and the solutions identified and utilized during the development of projects that established additional modes of transportation within existing roadway corridors[1]. These projects are typically complex and involve trade-offs and considerations related to the efficient flow of traffic, safety, modal connectivity, historic and community impacts, and economic development.

This scan initially identified 14 projects across the nation that were in various stages of planning, design, construction, or in operation on facilities that have added additional modes of transportation to an existing roadway. A desk scan was conducted to evaluate the suitability of these projects to meet the goals of the scan. Short questionnaires were sent to representatives of each of the candidate projects to obtain more current information and identify the most relevant projects for the scan topic; most of the surveys were completed and returned. Information was also obtained by phone or, in some cases, from sources on the internet. A desk-scan report was prepared that recommended a prioritized list of projects for consideration based on an evaluation of criteria that was prepared by the subject matter expert.

A scan team organizational meeting was held and each of the candidate projects was presented and discussed. Following discussions and research on an additional 15th site proposed at the organizational meeting, seven projects in six different cities were selected for on-site visits and meetings with project personnel. Officials from Arora and Associates, P.C., contacted representatives for these projects and made arrangements for the scan team to meet and discuss

1 17-02 – Successful Approaches to Accommodate Additional Modes and Services in Existing Right of Way, U.S. Domestic Scan Program, http://www.domesticscan.org/17-02-successful-approaches-to-accommodate-additional-modes-and-services-in-existing-right-of-way

the details of the projects. A set of amplifying questions (see **t**) covering topics the scan team wanted to explore was prepared and sent to the scan locations to assist in their preparations for the scan-team visit.

The projects selected for the scan include:

- Pulse BRT Project, Richmond, Virginia
- LYNX Blue Line Extension LRT Project, Charlotte, North Carolina
- QLine Streetcar Project, Detroit, Michigan
- I-35W Orange Line BRT Project, Minneapolis, Minnesota
- Van Ness Avenue BRT Project, San Francisco, California
- I-90 Two Way Transit and HOV Operations and East Link LRT Projects, Seattle, Washington
- I-405/SR 167 Express Toll Lanes and I-405 BRT Projects, near Seattle, Washington

The host agency contact information is provided in **Appendix D**.

Scan Team

An eight-member team from five state departments of transportation (DOTs), the Federal Highway Administration (FHWA), and the University of Virginia (UVA) participated in the domestic scan effort. The team members were:

- Sharon Edgar, Michigan Department of Transportation (MDOT) (American Association of State Highway and Transportation Officials [AASHTO] Chair)
- Elizabeth Bonini, Pennsylvania DOT (PennDOT)
- Dylan Counts, Washington State DOT (WSDOT)
- Ming Gao, PE, Florida DOT (FDOT)
- Matthew Hardy, American Association of State Highway and Transportation Officials (AASHTO) Liaison
- Gary Jensen, FHWA
- James H. Lambert, PE, PhD, F.IEEE, F.ASCE, F.SRA, D.WRE, UVA
- Scott Pedersen, PE, Minnesota DOT (MnDOT)
- Willard Thompson, MDOT
- Dennis Slimmer, PE, Subject Matter Expert

CHAPTER 2

Host Agency Projects

The scan team selected a variety of projects that were geographically distributed and utilized a variety of multimodal transportation strategies benefitting bicycle, pedestrian, transit, and automobile users. Transit solutions included streetcar, BRT, LRT, and bus-on-shoulder operations. The projects employed a wide variety of partnership arrangements, including state and local partnerships as well as interlocal partnerships. Additional consideration was given to projects that were complete or further along in the planning or design phase. Brief sketches of the selected projects are provided in this section to provide context for how a policy or decision applies to specific projects.

Pulse BRT Project; Richmond, Virginia

The Pulse BRT project is located on Broad Street (U.S. 250) and Main Street through the heart of Richmond. The project added 7.6 miles of BRT service within the existing right of way that opened for service on June 24, 2018[2]. The service has 14 stops with level boarding for passengers. It serves employment centers, medical centers, government centers, and institutions of higher learning (i.e., Virginia Commonwealth University and Virginia Union University). Construction of the project reduced the number of general-purpose lanes from three in each direction to two in each direction in the 3.5-mile section in which the center-running BRT operates in bus-only lanes. The project also reconfigured lanes from their original width of 10.5 to 11 feet to provide 9.5- to 10-foot lanes for automobiles and wider lanes for buses in the lanes in which they operate[3] . For additional information on reconfiguration of roadways see FHWA's Road Diet Information Guide[4].

The Virginia Department of Rail and Public Transportation (DRPT) took the lead and cooperated with other project partners, including FHWA, the Federal Transit Administration (FTA), the Virginia DOT (VDOT), the Greater Richmond Transit Company (GRTC), the City of Richmond, and Henrico County to plan and implement the project. The following agencies led efforts for phases of the project:

- Planning – DRPT
- National Environmental Policy Act (NEPA) – DRPT
- Public engagement – initially DRPT, then GRTC and the City of Richmond

2 GRTC Pulse: The Future Arrives June 24, 2018!, GRTC Transit System, YouTube video, https://www.youtube.com/watch?v=DM3ZyiKSuhA

3 10-Foot Lanes for GRTC Bus Rapid Transit Project, Memo from Kimley-Horne to Urban Design Committee, City of Richmond (Virginia), October 15, 2015, http://ridegrtc.com/media/news/21_10_Foot_Lanes_Tech_Memo_101415.pdf

4 Road Diets (Roadway Reconfiguration), Safety, Federal Highway Administration, U.S. Department of Transportation, https://safety.fhwa.dot.gov/road_diets/

- Design – initially DRPT, then GRTC and VDOT for design-build oversight
- Construction – VDOT for construction management
- Operation – GRTC

The Commonwealth of Virginia made this project a high priority, providing significant funding, early leadership, and technical support. While the Pulse BRT project benefitted from strong state leadership, the City of Richmond was also heavily engaged and committed to the project.

The total cost of the project was approximately $65 million. Funding was provided by federal, Commonwealth of Virginia, and local sources, including $24.9 million in FTA Transportation Investment Generating Economic Recovery (TIGER) funds[5].

The Pulse project travels through a variety of land uses, including suburban, retail/office, university and museum, dense downtown retail, government, and recreational (see **Figure 2-1**). This variety of land use presented a wide range of needs for the project corridor's design. The fact that the design of the project changes along the corridor based on different needs and available options (buses operating in mixed traffic, center-running and curb-running in various segments of the route) reflects an observation the team made that there is no single or best solution for integrating a BRT system into an existing right of way.

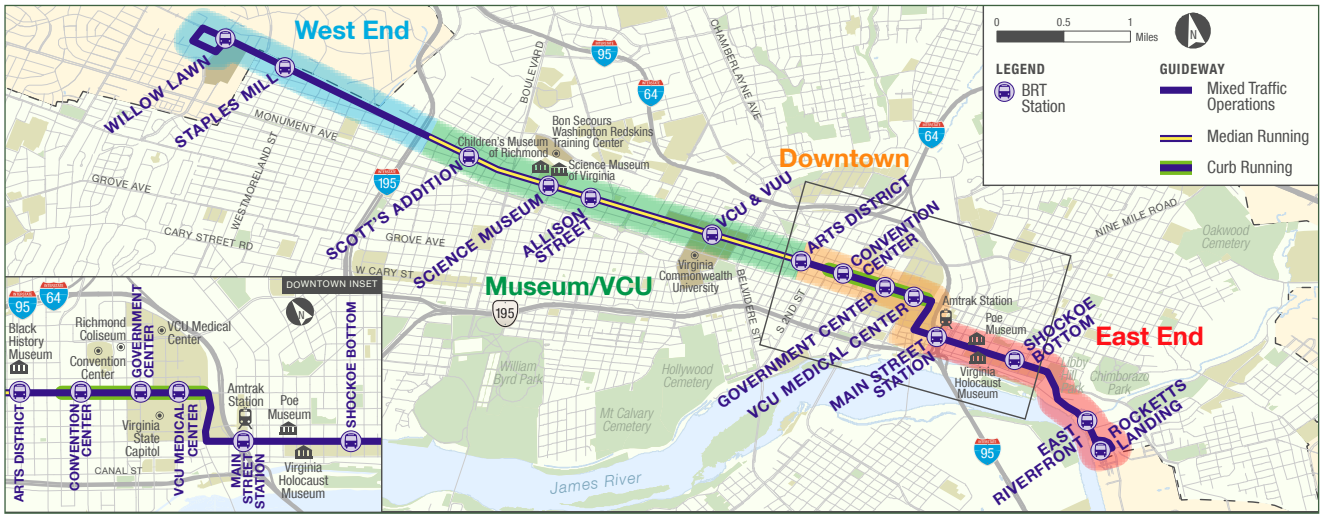

Figure 2-1 Pulse BRT project route map[6]

The project team mentioned that a local group was supportive of the project because it provided access to jobs near the western terminus for individuals living in the highest concentration of poverty in Fulton, near the eastern terminus. This group provided important support for the project throughout the project development process and helped to keep the project moving forward. Decisions for the project were made only after proper public involvement was conducted, including underserved populations[7].

5 Frequently Asked Questions, GRTC Transit System , http://ridegrtc.com/brt/frequently-asked-questions/

6 Pulse Corridor Map, GRTC Transit System, http://ridegrtc.com/media/main/Pulse_Corridor_Map_January_17_2018.pdf

7 J. Mitchell, J. DeBruhl, S. Fisher, et al., Richmond host site meeting for 17-02 on April 16, 2018

The Pulse project team also considered the need of bicyclists and pedestrians as part of the project. FHWA, in cooperation with the City of Richmond, initiated the Richmond, Virginia, Pedestrian and Bicycle Network Improvement Study, which provided important recommendations for bicycle and pedestrian access at seven selected stations along the corridor[8]. Additionally, BRT buses were fitted with bike racks on the front of buses and testing was done to ensure that the buses could navigate the route with bicycles attached.

The Pulse project team indicated that some complications arose when unanticipated repairs to infrastructure adjacent to the project were required. One of these repairs was an aging railroad bridge that needed repair for the project to proceed. To keep the Pulse project on track, the railroad bridge was repaired by a separate state-funded project that benefitted both the railroad (and its customers) and the Pulse project[7].

The project staff also indicated that the routing for the local transit system was being changed to a grid network from a hub-and-spoke system at the same time the Pulse BRT system came on line. While separate from the BRT project, GRTC staff made numerous checks to ensure a smooth transition when the BRT service began operation[7].

LYNX Blue Line Extension LRT Project; Charlotte, North Carolina

The LYNX Blue Line Extension (BLE) LRT opened in March 2018, extending an existing LRT service for 9.3 miles from uptown Charlotte north and east to the University of North Carolina at Charlotte (UNC Charlotte). The project connects UNC Charlotte with Charlotte's downtown and other transportation options (see **Figure 2-2**). The extension begins at the 7th Street Station in uptown Charlotte on former railroad right of way and transitions to the North Carolina Railroad right of way on which Norfolk Southern operates. The alignment runs north and east to Old Concord Road, where it then transitions to the median of North Tryon Street (US 29). At the north end, the line leaves US 29 and travels through a short underpass before terminating at UNC Charlotte[9].

The BLE provides level boarding for passengers at 11 new stations. Vehicle parking is provided at three new parking garages and a park-and-ride lot.

The project redesigned and converted four miles of US 29 to a consistent four-lane section, increased the median width (for the BLE), and added several at-grade LRT crossings along US 29[10]

8 City of Richmond: Bicycle and Pedestrian Network Improvement Study, FWA-HEP-17-074, Bicycle and Pedestrian Program, Federal Highway Administration, U.S. Department of Transportation, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/richmond_nis/

9 LYNX Blue Line Extension Northeast Corridor, Charlotte Area Transit System, City of Charlotte, North Carolina, https://www.charlottenc.gov/cats/transit-planning/blue-line-extension/Pages/overview.aspx

10 K. Goforth, J. Muth, J. Brim, B. Canipe, et al., Charlotte host site meeting on April 17, 2018

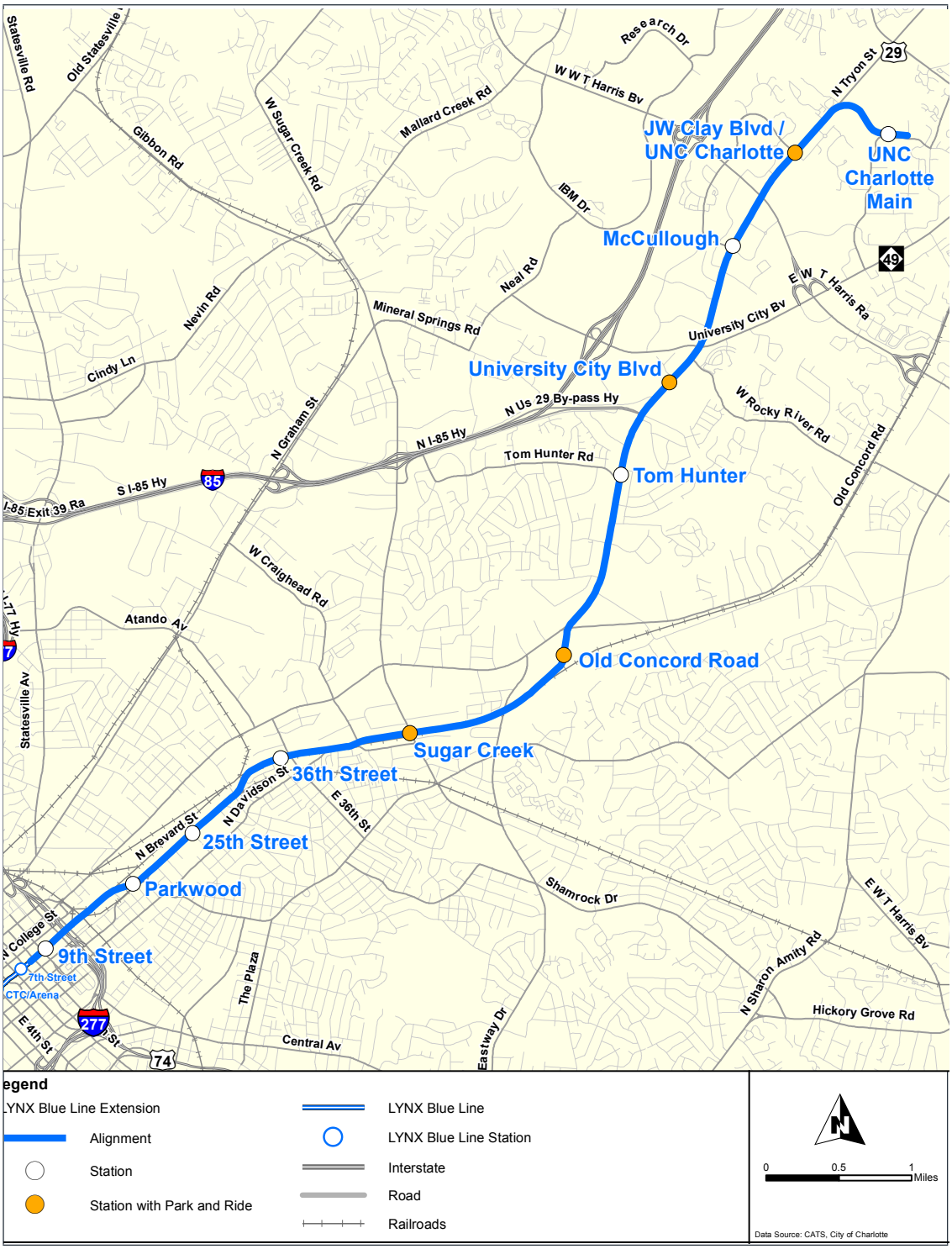

Figure 2-2 LYNX Blue Line Extension route map[9]

Major partners for the project included FTA, the North Carolina DOT, the City of Charlotte, and the Charlotte Area Transit System (CATS). CATS led all phases of the project, including planning, NEPA, public engagement, construction, and operation.

The total cost of the project was $1.16 billion. Funding was provided by federal, state, and local sources, including $580 million in FTA New Starts funds, $299 million in state funding, and $281 million in local matching funds.

Improved bike and pedestrian path facilities were added as part of the project to improve connectivity and multimodal travel along the corridor as shown by the project cross-section in **Figure 2-3**. According to the project team, the effort to add bike and pedestrian facilities to the project was greatly enhanced by the existence of adopted Urban Street Design Guidelines that included a Complete Streets policy that supported the decision[10].

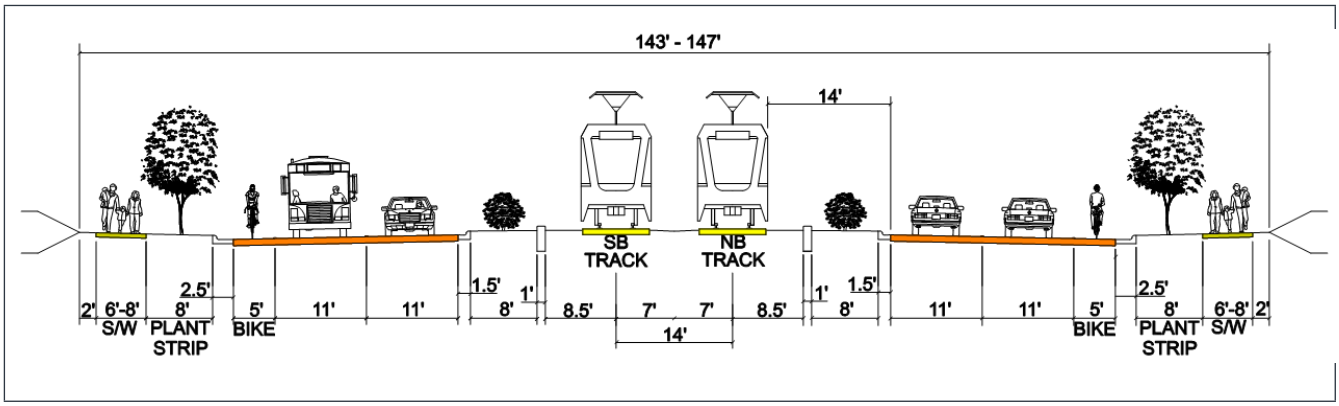

Figure 2-3 North Tryon Street cross-section

The project included an urban design framework as part of the design criteria that provided recommended design treatments, including integrating art, to mitigate visual impacts. The project team indicated that the incorporation of art had the benefit of creating more community support for the project and reduced the incidence of graffiti[10].
The project team noted that the close proximity of staff within the City of Charlotte's Planning, Transportation, and Engineering Departments, and CATS helped expedite reviews and decision-making for the project[10].

QLine Streetcar Project; Detroit, Michigan

The QLine streetcar project is a 3.3-mile modern streetcar line located on Woodward Avenue (state highway M-1) in Detroit (see **Figure 2-4**). The service has 12 stations that make connections to the Detroit riverfront, sports stadiums, cultural institutions, hospitals, and universities in the heart of Detroit. The streetcars operate along the curb for most of the line then move to the median at the north end of the route. The project was constructed within the existing state right of way and was opened for service in May 2017. The name of the service was chosen by Quicken Loans, which purchased the naming rights[11].

11 T. Kratofil, T. Hoeffner, S. Woods, J. Loree, et al., Detroit host site meeting for 17-02 on April 19, 2018

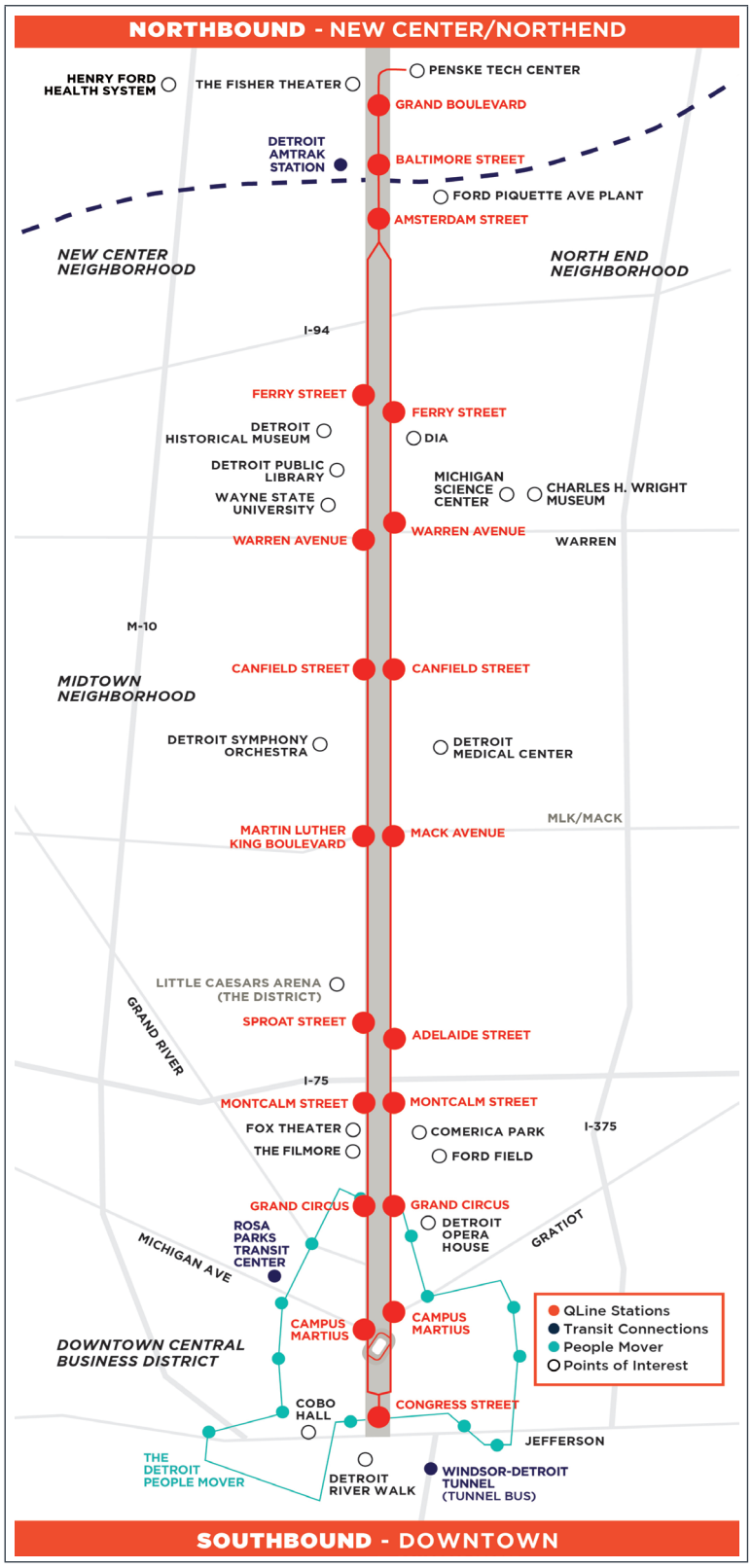

Figure 2-4 QLine streetcar route map[12]

A private group called M-1 Rail led the effort to promote and develop the project. M-1 Rail was

12 FAQ, QLine Detroit, M-1 Rail, https://qlinedetroit.com/ride-guide/faq/

formed by private sector and philanthropic leaders in 2008 following Super Bowl XL, when the need for reliable transit alternatives became evident. Major donors and partners in M-1 Rail include the Kresge Foundation, Penske, Quicken Loans, and others. M-1 Rail will operate the QLine for the first 10 years of service[13].

MDOT initially delayed a previously scheduled state DOT project to resurface Woodward Avenue to better align with the QLine schedule. That project was eventually upgraded to full reconstruction of Woodward Avenue, with replacement bridges over I-75 and I-94 to further support the QLine project. MDOT also provided a great deal of assistance to M-1 Rail with utility relocation and institutional knowledge related to the required roadwork.

Partners for the project included FHWA, FTA, MDOT, M-1 Rail, and the City of Detroit. The following agencies led efforts for specific phases of the project:

- Planning – M-1 Rail
- NEPA – MDOT for supplemental environmental assessment and City of Detroit for Final Environmental Impact Statement
- Public engagement – M-1 Rail
- Construction – M-1 Rail and MDOT
- Operation – M-1 Rail

The cost of the project was approximately $199 million, including reconstruction on Woodward Avenue by MDOT. Funding was provided by federal, state, local, and private/philanthropic sources. Federal funding included two TIGER grants totaling $37 million as well as other FHWA and FTA administered funds. Private and philanthropic funding totaled $90 million.

Bicycle and pedestrian needs were also considered and addressed during project development. Input from bike groups was sought and considered during planning and design. Pedestrian improvements were guided by a previously developed Complete Streets plan.

The QLine vehicles are modern streetcars that operate by batteries for approximately 60% of the route and from overhead electric lines for the remainder. The use of batteries reduces the need for overhead electrical lines along the route[11].

The station stop shown in **Figure 2-5** is one that is located in the median. Note the overhead power used to charge QLine streetcar batteries while at the stop.

13 About M-1 Rail, QLine Detroit, M-1 Rail, https://qlinedetroit.com/about/

Figure 2-5 Median station stop on the QLine

In addition to a goal of moving people attending major events, the QLine was developed to revitalize the Woodward Avenue corridor. More than $7 billion in development has poured into the Woodward Corridor along the QLine since 2013[14].

I-35W Orange Line BRT Project; Minneapolis, Minnesota

In Minneapolis, the scan team met with officials responsible for the I-35W Orange Line BRT project and MnDOT officials planning for associated roadway improvements to I-35W. The METRO Orange Line is a BRT line that will connect the cities of Minneapolis, Richfield, Bloomington, and Burnsville along I-35W (see **Figure 2-6**). This route will upgrade and replace the existing local Route 535 with enhanced service and amenities, and new station features will benefit other transit riders along the I-35W corridor. The Orange Line is planned to be 17 miles in length and will provide all-day transit service in both directions. The project consists of two individual sets of work. The first is for improvements to transit facilities along the corridor. The other set of work is for reconstruction of I-35W and improvement of some significant elements for the Orange Line that will expand existing BRT service in the area[15].

14 Economic Impact, QLine Detroit, M-1 Rail, https://qlinedetroit.com/about/economic-impact/

15 METRO Orange Line, Metro Transit, Metropolitan Council, https://www.metrotransit.org/metro-orange-line

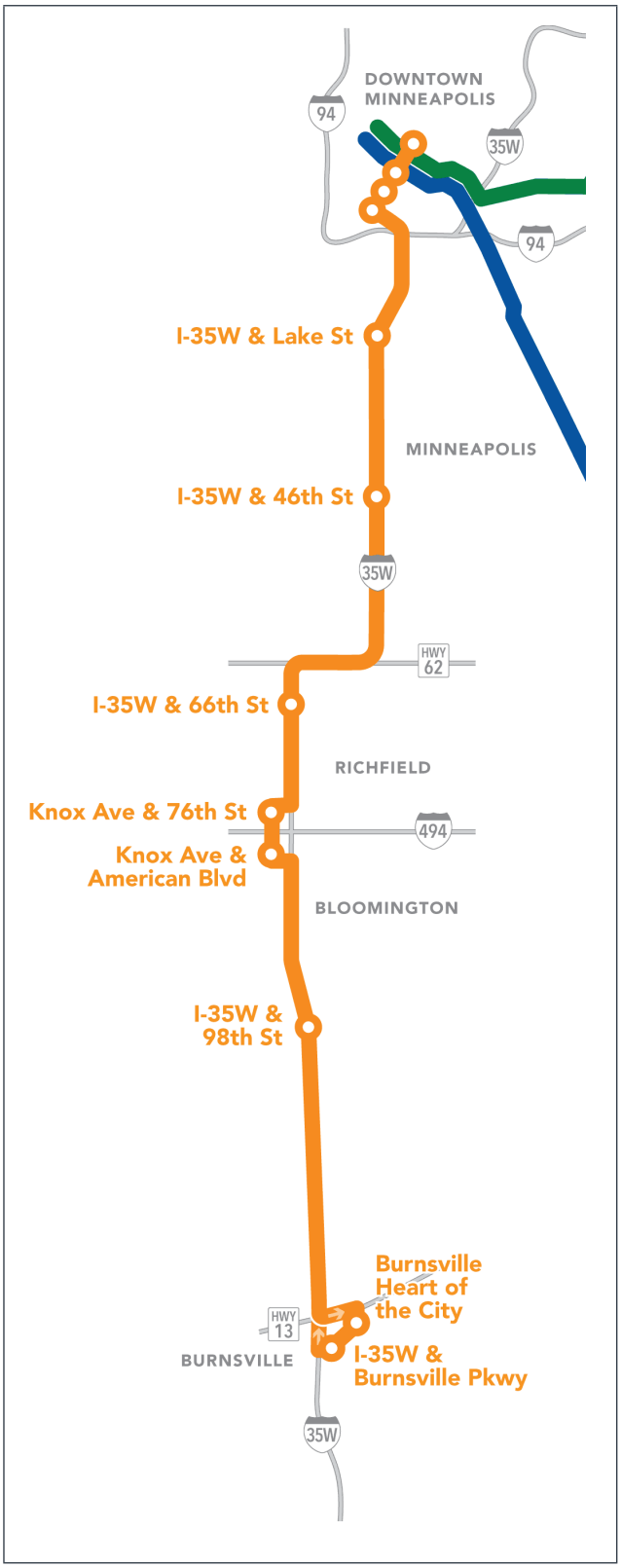

Figure 2-6 Orange Line BRT route map[15]

Major transit work for the Orange Line BRT project is the construction of a new transit station on I-35W at Lake Street and the construction of a new 12th Street direct bus ramp (see **Figure 2-7**) to provide direct access for buses to downtown Minneapolis. Metro Transit is also constructing a new transitway on Knox Avenue under I-494 and station stops at 66th Street, Knox Avenue, 98th Street, and Burnsville Parkway. The in-line stops on I-35W (within the I-35 median) will be Lake Street and 46th Street. The other stops will be located at 66th Street, Knox Avenue, 98th Street, and Burnsville Parkway[16].

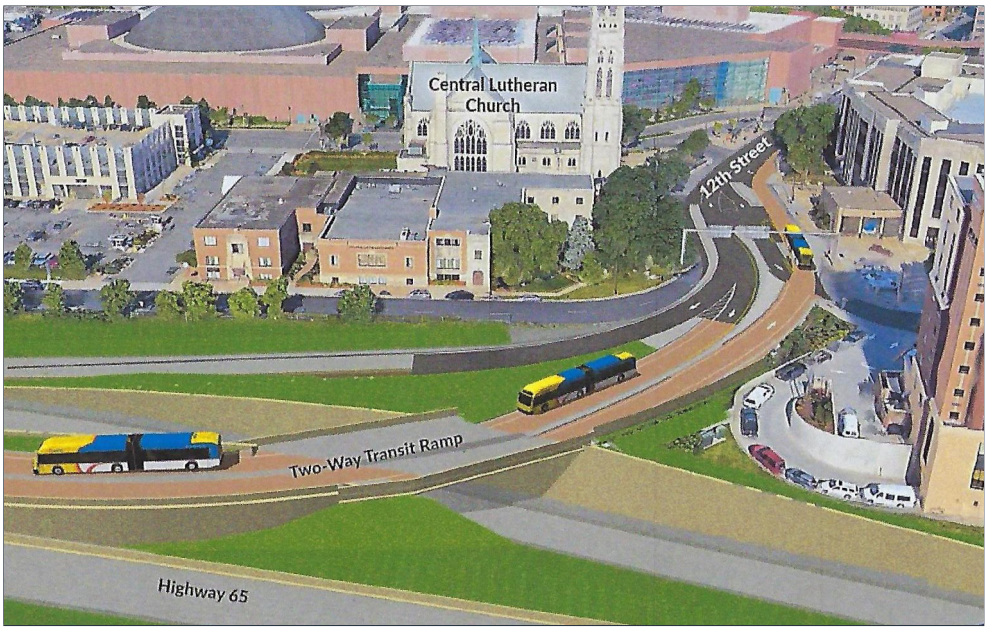

Figure 2-7 Direct bus ramp to 12th Street and downtown Minneapolis[17]

The pavement on I-35W has served its useful life and requires reconstruction. This provides an opportunity to upgrade bus service and transit connectivity along the corridor. Major roadwork will include the reconstruction of I-35W, a new exit to 28th Street, and shared HOV/BRT lanes on I-35W. This work will be accomplished within the existing right of way. Additionally, bike, pedestrian, and local transit connections are being improved at several locations[18].

These projects are particularly relevant to the scan because they illustrate how planning for the roadway work was leveraged to benefit the transit improvements. I-35W from Lakeville to downtown Minneapolis is heavily traveled by both automobiles and transit. The Lake Street and I-35W interchange is in a transit-dependent area. The existing transit station on I-35W at Lake Street has been closed and is not Americans with Disabilities Act (ADA) accessible. The new two-story Lake Street transit station will provide important access to BRT service on I-35W as well as connecting with I-35W Express buses and transit service on Lake Street (see **Figure 2-8** and **Figure 2-9** from the presentation at the Minneapolis host site meeting). While these projects were initially considered separately, by jointly planning the improvements, the results will provide a better solution for all users.

16 E-mail from S. Pedersen, dated July 26, 2018 12th Street Ramp, Metro Transit, Metropolitan Council, https://www.metrotransit.org/12th-street-ramp

17 12th Street Ramp, Metro Transit, Metropolitan Council, https://www.metrotransit.org/12th-street-ramp

18 S. Pedersen, S. McBride, J. Hager, C. Morrison, et al., Minneapolis host site meeting on April 30-May 1, 2018

Figure 2-8 View of Lake Street Station from I-35W

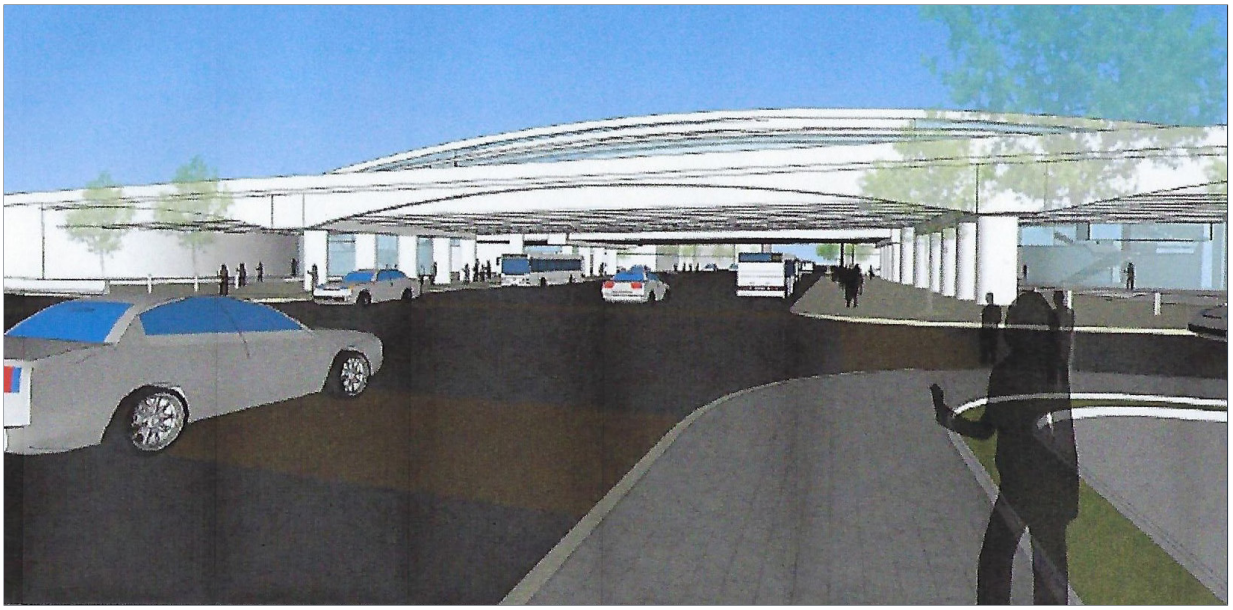

Figure 2-9 View of Lake Street Station from Lake Street

Figure 2-10 shows the planned Knox Avenue Transitway emerging from a tunnel under I-494 and continuing south to a new stop at the Southtown Center. The transitway will connect the Knox Avenue and 76th Street and the Knox Avenue and American Boulevard stations. Additionally, the improvement will include a multiuse trail for pedestrians and bicyclists[19].

19 Knox Avenue Transitway, Metro Transit, Metropolitan Council, https://www.metrotransit.org/knox-avenue-transitway

Figure 2-10 View of the planned Knox Avenue Transitway[19]

The I-35W corridor has a long history of transit. It was the first freeway in the Twin Cities to have express bus service that started in 1972[20]. Transit improvements in the Twin Cities area are handled by Team Transit (a partnership between MnDOT, Metro Transit, and the Metro Council) [18].

The lead agencies for the Orange Line transit project are Metro Transit and the Metropolitan Council. Lead agencies for the I-35W roadway and transit work were Hennepin County and Minneapolis, with MnDOT and Metro Transit in partnership. Other partners include FHWA, FTA, the City of St. Paul, area transit providers, and metro-area counties and municipalities. Design for this project is nearly complete. The finished project should be open for service in 2021[21] .

The following agencies led efforts for phases of the Orange Line transit project:

- Planning, NEPA, public engagement, construction, and operation – Metro Transit and Metropolitan Council
- Additionally, the following agencies led efforts for phases of the I-35W roadway and transit improvements:
  - Planning and NEPA – Hennepin County and Minneapolis led with MnDOT and Metro Transit partnership
  - Public engagement – Hennepin County, Minneapolis, MnDOT, and Metro Transit
  - Construction – MnDOT
  - Operation – MnDOT and Metro Transit[22]

20 Wikipedia "Metro Orange Line (Minnesota)." Available at https://en.wikipedia.org/wiki/Metro_Orange_Line_(Minnesota)
21 Metro Transit "Metro Orange Line – Frequently Asked Questions," Available at https://www.metrotransit.org/orange-line-faqs
22 E-mail from S. Pedersen dated September 5, 2018

Van Ness Avenue BRT Project; San Francisco, California

In San Francisco, the scan team met with the San Francisco Municipal Transportation Authority (SFMTA) project team working on the Van Ness Avenue BRT project. The two-mile improvement along highway U.S. 101, San Francisco's major north-south travel route, will have nine stops and will operate on dedicated center-running bus-only lanes between Lombard and Mission Streets (**Figure 2-11**). The Van Ness BRT is currently under construction and is anticipated to be complete in 2020[23].

Figure 2-11 Van Ness Avenue BRT route map[24]

The Van Ness Avenue project is particularly noteworthy as it requires a reduction in the number of general-purpose traffic lanes to provide the maximum improvement for the new dedicated BRT service. Roadway work includes reconstruction and reconfiguring lanes from three general-purpose lanes in each direction to two general-purpose lanes and center-running transit lanes in each direction. Left turns are being eliminated along the corridor to keep traffic moving and reduce a leading cause of vehicle-pedestrian crashes. Numerous pedestrian safety improvements are being incorporated into the project consistent with the mayor's Vision Zero initiative[24].

Figure 2-12 shows a typical cross-section with two general-purpose lanes in each direction and center-running transit-only lanes with passenger platforms on the side[24].

23 S. Yeong, K. McCarthy, B. Ahmadzadeh, et al., San Francisco host site meeting on May 2, 2018

24 Presentation materials at San Francisco host site meeting on May 2, 2018

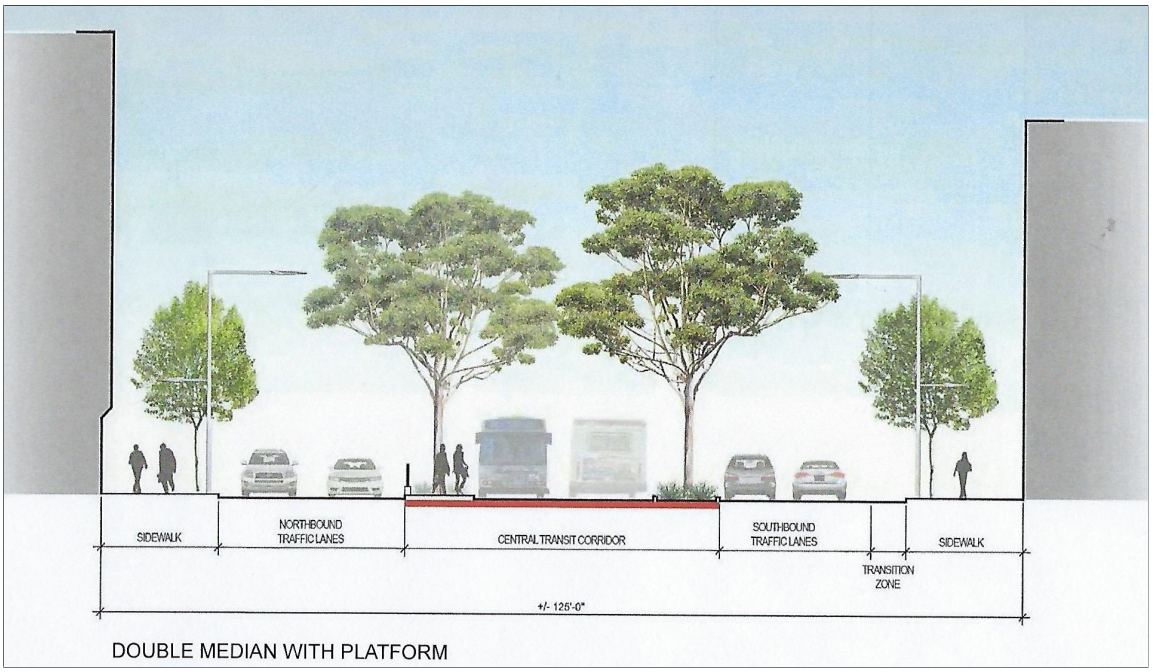

Figure 2-12 Typical section showing center-running transit lanes

A major criticism projects face that use existing general-purpose traffic lanes to accommodate transit service is the impact it will have on existing traffic operations. The California Department of Transportation (Caltrans) indicated that the 2012 Final Environmental Impact Statement for the Van Ness Avenue BRT project showed that the level of service (LOS) on the Van Ness Avenue corridor was rated D, with certain intersections rated E under different design alternatives. Values for LOS range from A (free traffic flow) to F (characterized by stop-and-go waves, poor travel times, low comfort and convenience, and increased accident exposure).

In the past, LOS was considered a primary indicator for accepting a project; however, in recent years Caltrans has started to consider person throughput and vehicle miles traveled (VMT) reduction as additional evaluation criteria[25]. In the case of the Van Ness Avenue BRT project it was determined beneficial to improve person throughput by improved transit service and to slow vehicular traffic and improve pedestrian safety.

It is important to keep in mind that the establishment of a BRT service was only one of many reasons for this project. The roadway pavement had deteriorated and was in need of major reconstruction. Major utility lines, including water, sewer, and electrical, also needed repair or replacement. Electric service is particularly important to the corridor since some of the vehicles providing BRT service on Van Ness will be electric trolley buses that use power from a municipal hydroelectric power system. The remainder of BRT coaches will be hybrid compressed natural gas vehicles[26].

25 E-mail from W. Lew, Caltrans, on July 17, 2018

26 E-mail from K. McCarthy, SFMTA, on July 24, 2018

Partners for the project are FHWA, FTA, Caltrans, SFMTA and the San Francisco County Transportation Authority. SFMTA is currently the lead agency for the project

The total cost of the project is approximately $316 million. State funding was approximately $7.5 million. FTA Small Starts funding is $75 million. Other federal funding amounts to $44.2 million. The remainder is from local fund sources[24].

I-90 Two-Way Transit and HOV Operations and East Link LRT Projects; Seattle, Washington

The scan team visited Seattle to observe policies, best practices, and challenges associated with two sets of projects that incorporate multimodal aspects into existing highways. One set of projects included improvements to I-90 between Seattle and Bellevue, Washington, followed by a separate project to construct the East Link Extension LRT. Roadwork on I-90, referred to as the Two-Way Transit and HOV Operations project, was planned and constructed first and is now complete. For this project, the WSDOT and Sound Transit added HOV lanes to both directions of the I-90 mainline between Seattle and Bellevue (see **Figure 2-13**). The project preserved the three existing general-purpose lanes in each direction while adding all-day HOV lanes as well as direct access ramps for transit, carpools, and vanpools. With new direct-access ramps, carpools, vanpools, and buses access the freeway directly to or from HOV lanes without merging across three or more lanes of traffic[27].

Figure 2-13 I-90 Two-Way Transit and HOV Operations project map[28]

27 I-90 - Two-Way Transit and HOV Operations - Complete June 2017, Washington State Department of Transportation, http://www.wsdot.wa.gov/Projects/I90/TwoWayTransit/default.htm

28 I-90 - Two-Way Transit and HOV Operations - Project Timeline, Washington State Department of Transportation, https://www.wsdot.wa.gov/Projects/I90/TwoWayTransit/timeline.htm

Major partners for the I-90 Two-Way Transit and HOV Operations project included FTA, FHWA, Sound Transit, and WSDOT. The following agencies led efforts for phases of the project:

- Planning – Sound Transit and WSDOT
- NEPA – Sound Transit
- Public engagement – Sound Transit and WSDOT
- Design, Construction, and Operation – WSDOT

Sound Transit was created in 1993 to develop a regional rapid transit network. It was formed by a partnership of three Washington counties (King, Pierce, and Snohomish). The agency has passed three major programs to fund improvements to the regional transit network. The most recent, Sound Transit 3, will provide $53.8 billion to expand and improve the existing Link light rail system. The local portion of the measure will be partially funded by increases in sales tax, motor vehicle excise tax, and property tax[29].

Construction on the final stage of the Two-Way Transit project between Mercer Island, Washington, and Seattle was completed in 201728. The total cost of the project was approximately $283 million, with funding coming from a variety of sources, including FTA, Sound Transit, and WSDOT[29].

The East Link LRT project is a 14-mile light rail line extension that will connect the downtown Seattle Transit Tunnel to Mercer Island, Bellevue, and downtown Redmond with 10 stations (see **Figure 2-14**)[30]. The project extends the Link light rail system that currently runs between Sea Tac Airport and downtown Seattle, as well as the University Link Extension that is now in operation. The East Link improvement to Bellevue is scheduled to be open in 2023, with the extension to downtown Redmond open in 2024[31]. A major engineering challenge for this project will be the construction of the light rail facility on a floating bridge over Lake Washington[32].

29 Sound Transit, Wikipedia, https://en.wikipedia.org/wiki/Sound_Transit

30 East Link Extension, Wikipedia, https://en.wikipedia.org/wiki/East_Link_Extension

31 East Link Extension, Sound Transit, t

32 D. Counts, P. Rogoff, P. Rubstello, J. Edwards, et.al., Seattle host site meeting on May 3, 2018

Figure 2-14 East Link LRT project route map showing major connections[33]

Figure 2-15 illustrates the lane configurations at the completion of the East Link LRT project with full-time HOV lanes and the East Link LRT in the center[34].

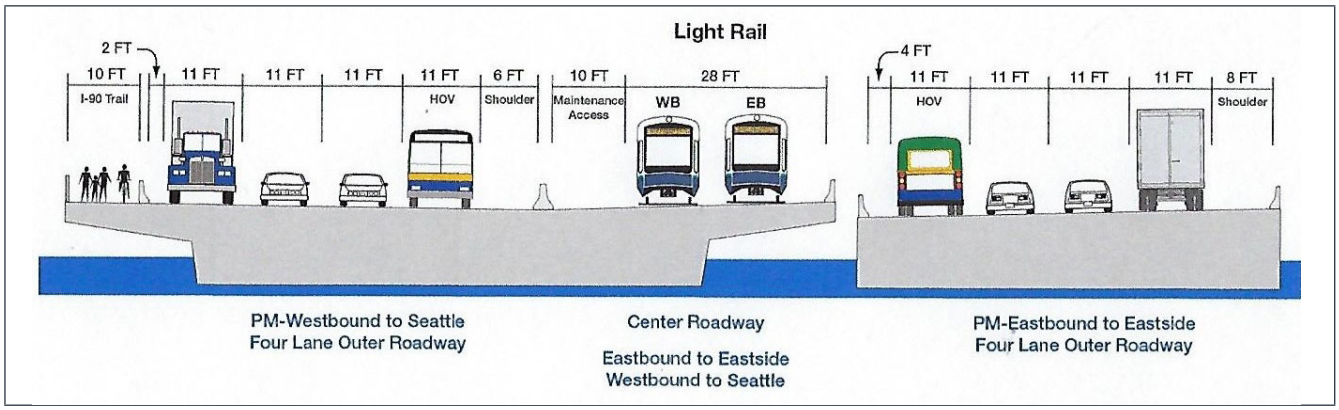

Figure 2-15 Cross-section showing lane configurations at completion of the East Link LRT project

Partners for the project are FHWA, FTA, WSDOT, and Sound Transit. Lead agencies are WSDOT and Sound Transit. The following agencies led efforts for phases of the East Link LRT project:

- Planning – Sound Transit
- NEPA – Sound Transit and WSDOT
- Public engagement – Sound Transit
- Design – Sound Transit
- Construction – Sound Transit and WSDOT
- Operation – Sound Transit

33 East Link Benefits, East Link Extension, Sound Transit, June 2017, https://www.soundtransit.org/sites/default/files/project-documents/east-link-light-rail-benefits.pdf

34 Presentation materials from Seattle host site meeting on May 3, 2018

The budget for the East Link project is $3.7 billion. It is funded mainly by tax revenue and bond proceeds from the Sound Transit 2 package passed by voters. In addition, the FTA provided a $1.33 billion Transportation Infrastructure Finance and Innovation Act loan, $74.7 million in FTA funds, and $14 million in TIGER funds. The City of Bellevue also committed $185 million for construction of a downtown tunnel for the project[35].

I-405/SR 167 Express Toll Lanes and I-405 BRT Projects; near Seattle, Washington

While in the Seattle area the scan team also visited the I-405/SR 167 express toll lanes and I-405 BRT projects. Because I-405 is one of Washington's most congested corridors, WSDOT has worked with cities, counties, federal agencies, transit agencies, and community groups to develop a consensus on a long-term vision for the multimodal development of the I-405 corridor. It was decided to take a balanced approach that uses a mix of transit, roadway, non motorized, and environmental improvements.

Roadway improvements on the 40-mile I-405/SR 167 corridor include building one additional lane in each direction on I-405 and combining that lane with the existing HOV lane to provide a two-lane HOT system in each direction from SR 167 north to Lynnwood. Additionally, improvements to SR 167 will extend the existing northbound and southbound HOT lanes south from the I-405 interchange to near the King-Pierce county line (see **Figure 2-16**)[36].

The SR 167 express toll lanes were opened in 2008[37] and improvements to I-405 between Bellevue and Lynnwood were opened in 2015. Work on the corridor continues and future work to add dual express lanes between Renton and Bellevue is currently in the design phase[36].

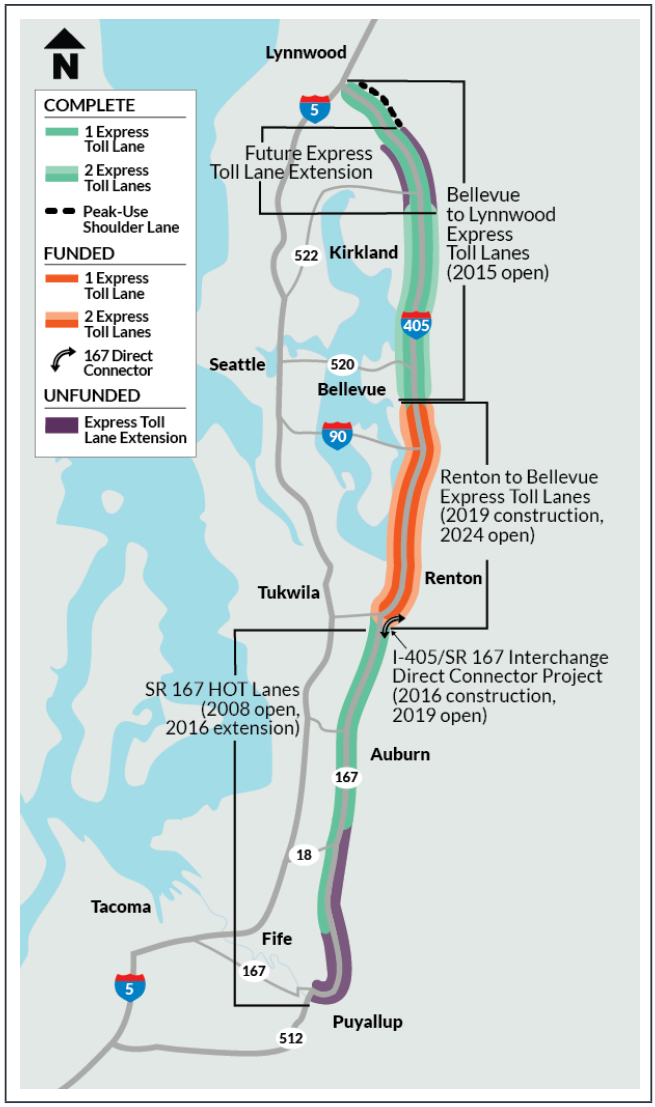

Figure 2-16 I 405/SR 167 express toll lanes project map[36]

35 East Link Extension, U.S. Department of Transportation, https://www.transportation.gov/tifia/financed-projects/east-link-extension

36 I-405 and SR 167 Eastside Corridor Tolling, Washington State Department of Transportation, https://www.wsdot.wa.gov/Tolling/EastsideCorridor/default.htm

37 SR 167 HOT Lanes, Washington State Department of Transportation, https://www.wsdot.wa.gov/Tolling/SR167HotLanes/default.htm

Improvements to the corridor also include work on bike and pedestrian trails. One of those trails is the Eastside Rail Corridor Regional Trail that will be improved as part of the I-405 Renton to Bellevue widening and express toll lanes project. This work is planned to be complete by 2020 and is being coordinated with another trail, the Mountains to Sound Greenway trail[38].

Planning and oversight for the I-405/SR 167 express toll lanes project is conducted by an executive advisory group that represents cities and counties along the corridor, state legislators, transit agencies, WSDOT, and the FTA. This group showed its commitment to the project by endorsing a map depicting improvements on the corridor (see **Figure 2-17**)[39].

Figure 2-17 Showing the corridor map endorsed by the Executive Advisory Group

38 Community invited to see designs for two sections of the Eastside Rail Corridor Regional Trail in Renton and Bellevue, Washington State Department of Transportation, https://www.wsdot.wa.gov/news/2018/05/17/community-invited-see-designs-two-sections-eastside-rail-corridor-regional-trail

39 Presentation materials from Bellevue host site meeting May 4, 2018

Figure 2-18 illustrates the projected improved service on the corridor following completion of the improvements. Areas shown as black have average travel speeds less than 20 mph. Areas of red have speeds between 20 and 35 mph.

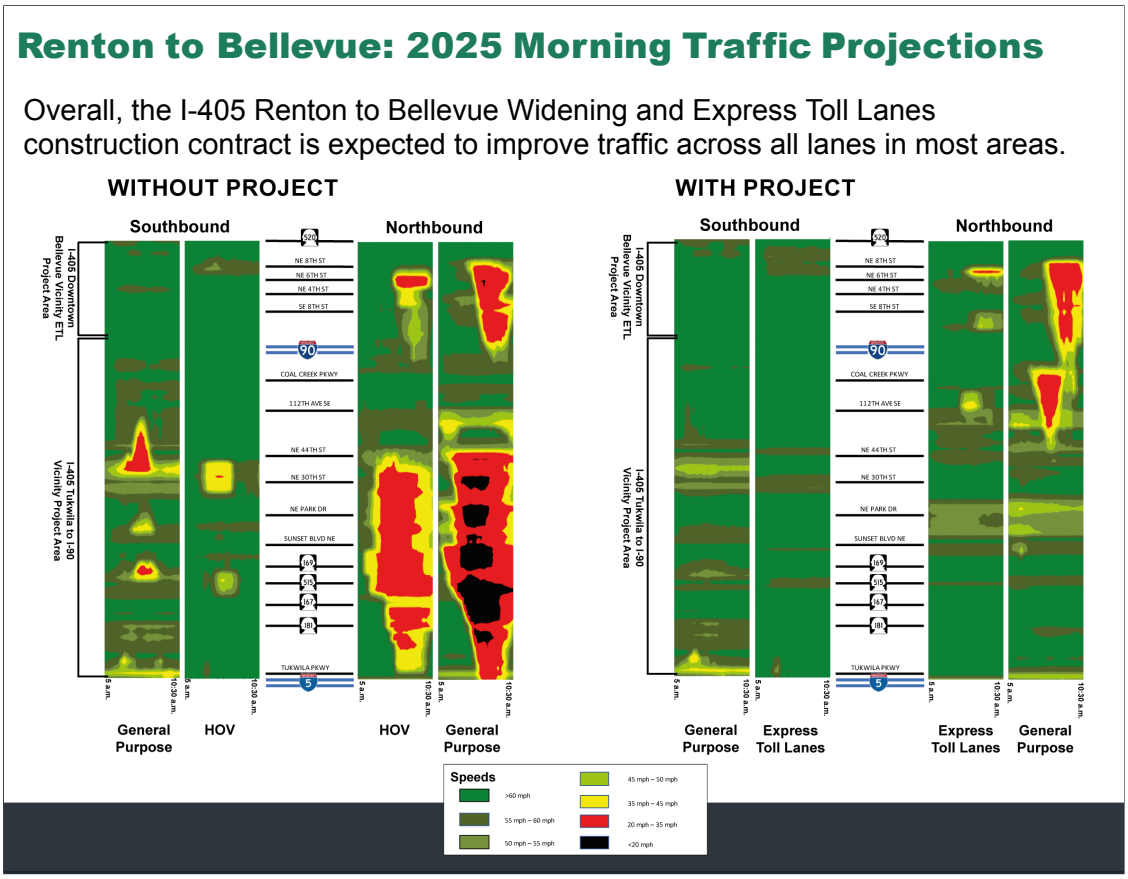

Figure 2-18 2025 morning traffic level-of-service projections: Renton to Bellevue

Major partners for the I-405/SR 167 express toll lanes project include FTA, FHWA, King County DOT, Sound Transit and WSDOT. The following agencies led efforts for phases of the I-405/SR 167 express toll lanes project:

- Planning – WSDOT and the Executive Advisory Group
- NEPA, public engagement, design, construction, and operation – WSDOT

Funding for the I-405/SR 167 express toll lanes project was financed by state transportation and toll bond funds as well as by federal highway funds. In addition, approximately $100 million was provided by Sound Transit for direct access ramp construction.

The I-405 BRT project being planned by Sound Transit will utilize a variety of managed, HOV, bus-only and general-purpose lanes on a 37-mile corridor from Lynnwood to Burien along I-405 and SR 518 (**Figure 2-19**). The project will provide 11 in-line BRT stations in seven cities, a new bus fleet, three parking facilities, and a transit center. The service will provide convenient connections to area light rail service and is projected to begin operations in 2024[40] .

40 I-405 BRT, Sound Transit, https://www.soundtransit.org/system-expansion/i-405-brt

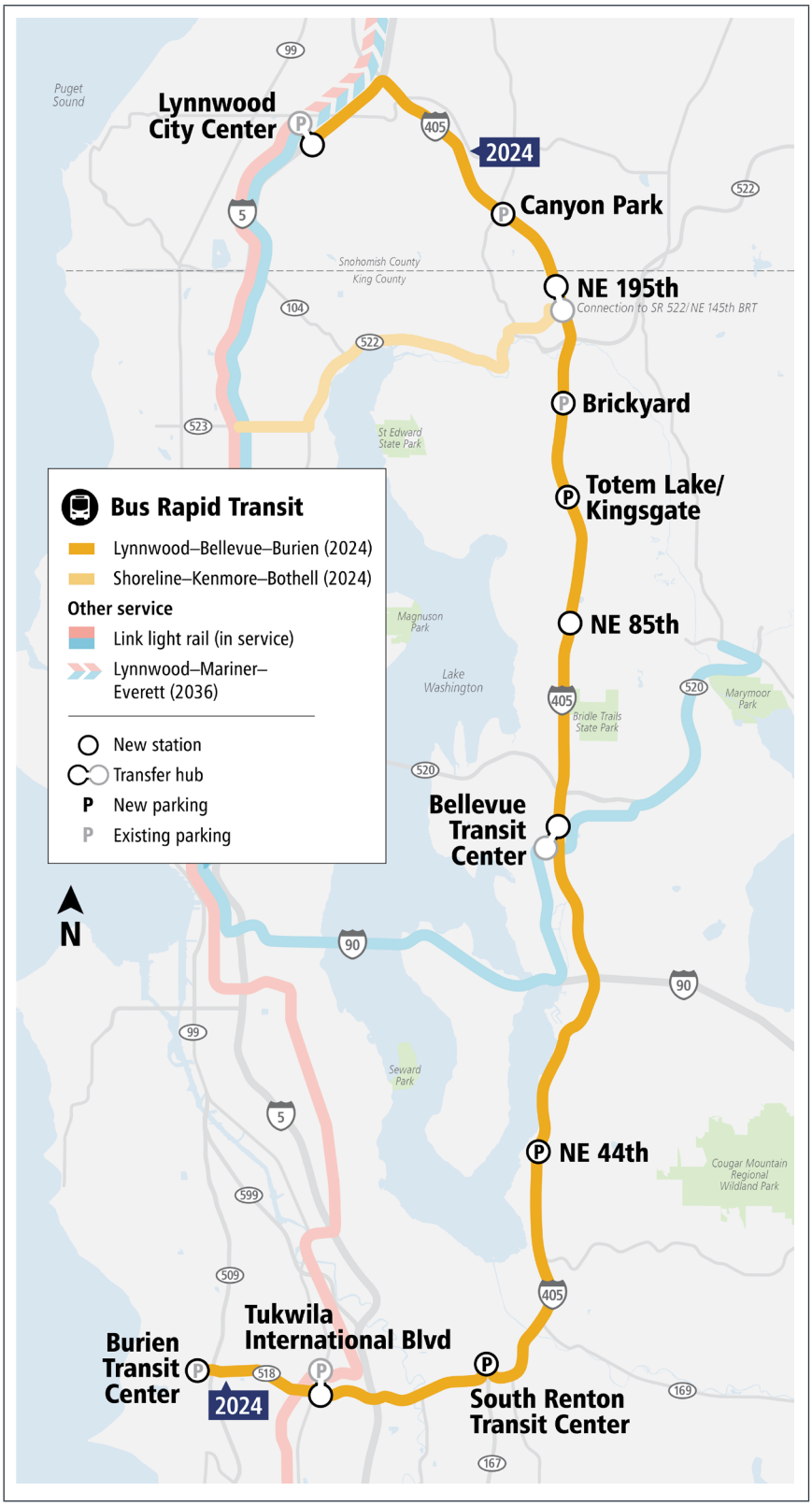

Figure 2-19 I-405 BRT project map

Major partners for the project include the FTA, FHWA, King County DOT, Sound Transit, and WSDOT. The following agencies or groups led efforts for phases of the I-405/SR 167 BRT project:

- Planning, NEPA, public engagement – Sound Transit
- Design, construction – undetermined at this time
- Operations – Sound Transit

Funding for the I-405 BRT project is provided by Sound Transit 3 with approximately $1.2 billion in system expansion program funding.

CHAPTER 3

Scan Findings and Observations

Immediately following visits to the host project sites, the scan team met to discuss policies, procedures, and other actions the host project teams had taken that were believed to contribute to the successful accommodation of additional modes and services, including transit as well as bike and pedestrian facilities within the existing rights of way. Despite the significant variation in the type of transit (i.e., streetcar, BRT, or LRT) being added, the cost and extent of the projects and the role the state DOT played in the project development, several common themes emerged as best practices.

The scan team organized findings and observations into strategies that can be applied throughout project development. The overall strategies that will be discussed in the following sections include:

- Adopt a shared vision
- Define roles and responsibilities
- Planning and design considerations
- Seek opportunities to improve transit
- Employ project controls
- Communicate and coordinate with stakeholders
- Integrate connections
- Improve person throughput

Adopt a Shared Vision

The project sites that were visited all demonstrated commitment to a shared vision for the project by partners within the corridor. In some cases a shared vision existed between project partners while in other cases a shared vision emerged over the course of the project's development. As a major partner in most of these projects, it is helpful if the state DOT has a cultural philosophy that is supportive of multimodal transportation solutions. This was observed most prominently during the scan visits to projects in Minneapolis and Seattle. However, even for projects where the commitment to a multimodal philosophy was less prevalent, the projects were successful when strong state DOT executive leadership was provided.

While upper level commitment at the state DOT is important, similar commitments by leadership from all partners is equally critical to the adoption of a shared vision and ultimate project success. How that commitment is demonstrated can vary. In some situations, the state DOT commitment

started early by participating in the development of a shared vision (such as sponsoring a corridor plan); in others it came later as the project moved into the design phase. For some projects the DOT commitment was demonstrated by a significant funding commitment (e.g., Richmond, Detroit, and Charlotte), and in others the commitment came in the form of reviews and approvals local agencies needed to implement the project. In Washington, the I-405/SR 167 Executive Advisory Group made up of representatives from the Washington State Transportation Commission and local city and county officials along the corridor signed a map illustrating improvements they agreed to along the route to signal adoption and commitment to the plan (see **Figure 2-17**).

The statewide transportation planning process is key to adopting a vision that drives the plan and leads to projects. Additionally, having preexisting local and regional transportation plans and policies was a beneficial starting point or foundation for a shared project vision. State DOT grants that provided funding for these plans and policies in Seattle helped local communities develop local and regional transportation plans before project planning for the work on the I-405/SR 167 corridor began.

Preexisting Complete Streets policies in Charlotte and Detroit helped those communities incorporate bicycle and pedestrian improvements that met the goals of the community for enhanced non motorized access and connections[10]. Such policies help to facilitate discussions regarding the benefits of not only improved access and connections for bike and pedestrian users but the accommodation for non motorized transportation within the corridor.

The Virginia Department of Rail and Public Transportation shared a tool with the scan team that state DOTs and local partners can use for multimodal planning and design. The Multimodal System Design Guidelines[41] provides a framework for multimodal planning with a step-by-step process of identifying centers of activity, designating connected networks for all travel modes, and designing and retrofitting specific corridors that fit with the surrounding context. This process can be applied to plan connected regional transportation networks to serve all travel modes.

Local jurisdiction involvement was seen to be important in project planning. As these projects can impact several local jurisdictions, it is important that the needs and goals of those jurisdictions be considered during planning. The state DOT can help local jurisdictions maximize the benefits of the project by providing planning grants and technical assistance. This was demonstrated in Minneapolis as MnDOT helped address the Healy Block Historic District's concerns while meeting the current and future needs of the Midtown Greenway historic railroad alignment, including improved accessibility[42].

A best practice that was observed while visiting projects in Charlotte, Minneapolis, and Seattle was the close proximity of project staff with the staff of the other project partners. Their close proximity greatly improved communication and coordination. In Charlotte, the planning,

41 Multimodal Guidelines, Virginia Department of Rail and Public Transportation, http://www.drpt.virginia.gov/planning/multimodal-guidelines/

42 Presentation materials from Minneapolis host site meeting on April 1, 2018

transportation, and engineering departments and CATS are located in the same building, resulting in quicker turn around for reviews and approvals for that project[10]. In Minneapolis and Seattle, the state DOTs and the transit agencies co-located the roadway and transit project teams[18, 32], which resulted in better communication and understanding between project team members.

The success of these projects appeared to depend a great deal on the willingness of the agencies and communities to accept alternative solutions to transportation needs. All the host sites have gone through a process that has required time and effort to come to a consensus. In some cases (e.g., Seattle and Minneapolis), the process of generating acceptance has been in place for many years. In the case of the Pulse BRT in Richmond, the discussions have been more recent. In Detroit, the need for improved rapid transit was highlighted by the Super Bowl, which drove a private group to push the issue forward[11]. Regardless of how recent the decision has been to embrace multimodal solutions, it is important that the underlying shared vision for the corridor is adopted by all partners during the project development process.

Define Roles and Responsibilities

Projects that accommodate additional modes into existing rights of way often require a different set of skills and knowledge than a typical highway improvement project. These projects often include transit (e.g. bus or rail) and bicycle and pedestrian elements that have unique requirements. Additionally, the regulations for transit projects are administered by the FTA and therefore additional federal coordination is required.

To expedite multimodal decision-making and project delivery WSDOT modified its organizational structure. As a result, the agency formed teams that cross traditional boundaries of responsibility or "stove pipes." These teams expedited the development and review of multimodal projects and sped up their delivery[43]. Additionally, WSDOT and Sound Transit have adopted a philosophy that encourages staff and managers to "lean in and get to yes" when trying to resolve issues related to project development. Similarly, both agencies have also encouraged project staff to be less rigid in their thinking and to be flexible and nimble."[44].

Because these projects involve the accommodation of additional modes there is a need for project staff with knowledge of the regulations and requirements associated with those modes. Staff must also be able to understand the issues that are important to users and appropriate methods to address those needs. This experience also benefits other staff who will carry this knowledge into future projects. When the team visited the QLine project, staff indicated that they believed the experience they gained from the modal aspects of the project benefited them and made them a more valuable employee[45].

The lead role for the projects that were visited was sometimes adopted by the state DOT and sometimes by a local partner, often the transit agency; both approaches were observed to work.

43 P. Rubstello, Seattle host site meeting on May 3, 2018

44 P. Rogoff, Seattle host site meeting on May 3, 2018

45 J. Loree, Michigan Department of Transportation, at Detroit host site meeting on April 21, 2018

The ownership of the right of way does not necessarily determine what agency should lead in the project development. While all the projects on the scan were on state highways, the Pulse BRT project was on city right of way and most of the project development was led by DRPT and VDOT. The projects in Charlotte and San Francisco were on state DOT rights of way while city agencies and CATS led the project development. The projects in Minneapolis and Seattle were also on state DOT rights of way but were jointly developed by the state DOT and the transit agency.

There are situations where the state DOT is better equipped to handle a particular phase or aspect of work. This was the case in Detroit for the QLine project, where MDOT assumed a lead role for the roadway reconstruction and relocation of utilities along Woodward Avenue, as the DOT had more experience than M-1 for those items of work. MDOT's institutional knowledge of utilities and the use of 3D mapping and lidar (light detection and ranging) technology were both beneficial for the QLine project as problems were identified at an early stage[11].

Funding requirements often make these projects more challenging than typical roadway projects. Because funding often comes from a variety of local, state, and federal sources, each with their own regulations and reporting requirements, it is important to have a funding plan. The project teams in Detroit and Charlotte both stressed the importance of a funding plan and dedicating qualified staff to tracking and administering project funds. Prompt and accurate reporting helps to keep partners informed and confident in the project's progress.

Another aspect of funding is the importance of state DOT flexibility to reprogram funds to advance a project at critical stages. For the QLine project, MDOT was able to reprogram funding for improvements to accommodate the streetcar project, including reconstruction of Woodward Avenue and the replacement of overpasses at I-75 and I-94[11]. Without this funding and programming flexibility it is doubtful that the project would have been completed as planned.

Several of the project teams stressed the importance of agreements being signed by all project partners that would be responsible for operational and maintenance issues associated with the project. Such agreements are important to clearly define who is responsible for items including, but not limited to, snow removal, station maintenance, landscape maintenance, and train/traffic signals. In one instance, there was confusion regarding maintenance responsibility when a lane was changed from general-purpose traffic to bus-only. It should not be assumed that ownership necessarily translates to maintenance responsibility. Prior to project implementation, responsibilities for routine maintenance, resurfacing, and reconstruction should be clearly outlined in an agreement.

A project can be further complicated when more than one federal agency is involved. Most federally funded roadway projects fall under the purview of the FHWA. When federal transit funding is included, the FTA may be involved or take the lead. It is important for the project team to be proactive in engaging with federal agencies. A project management plan should identify the interests of the FHWA and FTA and how they will be addressed. While the FHWA and FTA typically coordinate with each other regarding their roles on a project, the project teams visited strongly suggested independently verifying and understanding which federal agency will take the lead and how each will interact with the project.

Planning and Design Considerations

Several considerations should be addressed during project development. To begin, it is important to recognize that multimodal integration projects are different than a typical roadway improvement in that the multimodal projects frequently add transit elements to the roadway. This can create problems since an agency's highway design manual does not typically address some transit elements. The WSDOT addressed this situation by developing a model that evaluates the level of interest and effort that should be directed to elements of the transit improvement. This helped to obtain design approval and bridge the gap between the highway design manual and the transit infrastructure by limiting the DOT's focus to those transit elements that would have a direct impact on the roadway.

The scan team observed several variations of transit design for the projects that were visited. In each case, the project team customized its own vision based on the needs of the corridor. It was observed that there is no single best solution for BRT projects. The Pulse project serves a variety of businesses and centers as it passes through areas that vary in density from suburban to urban downtown. The design of the Pulse service varies from buses in mixed traffic to center-running bus-only lanes to curb-running lanes. It is a good example of how different design solutions can be employed throughout the corridor depending on need. It is important for the partners to clearly define their needs and use the flexibility provided by BRT to meet those needs.

The location of transit lanes and the configuration of station stops have specific impacts on transit service, roadway performance, and the safety and efficiency of other modes. In San Francisco, the designers of the Van Ness Avenue BRT project studied the location of station stops and decided to reduce the number of stops on the route, resulting in improved service speed[46]. Designers for the Van Ness Avenue project also settled on center-running bus-only lanes that improved transit service speed. While reducing the number of general-use lanes will result in slower general-use traffic, the elimination of left turns on the corridor will help to keep traffic moving. Overall, this solution will improve person throughput while reducing VMT, slowing general-use traffic, and reducing the potential for vehicle-pedestrian crashes.

When transit service runs along the curb, designers need to address issues of parking, business access, and curbside management (e.g., Uber, Lyft, and mobility service providers). If these issues are not adequately addressed the speed of the transit service can be negatively impacted. In Detroit, the QLine service experienced significant slowdowns near a sports stadium associated with drop-offs and pickups for events. That problem was addressed by moving the locations for drop-offs and pickups and "coning off" the lane in front of the station for transit use only[11].

In Charlotte, implementation of the light rail facility in the median required CATS, the City of Charlotte DOT, and the North Carolina DOT to address several design issues, such as grade separations, signalized crossings, lane configurations, clearance distance between the rail vehicle

46 First Step for Van Ness BRT: Consolidating Bus Stops to Save Travel Time, SFMTA, https://www.sfmta.com/blog/first-step-van-ness-brt-consolidating-bus-stops-save-travel-time

and travel lane, distances and clear zones, and lowering the speed limit for traffic. Agreement was reached that the project would address the impacts of light rail, but not deficiencies due to traffic growth[10].

Another issue to be considered is the potential impact of the facility on the safety of bicyclists in the corridor. Consideration should be given for bicycle safety related to transit rails and crossings. In Richmond and Detroit, where curb-running transit is operated, planners identified parallel routes for bicycles to avoid conflicts between vehicles and infrastructure where bicycle tires can become easily wedged in the gaps adjacent to rails. In San Francisco, the project team also identified parallel corridors for bikes since bikes are not allowed on state highways in California.

Project teams at all the host sites mentioned the importance of considering operational issues during the design phase. It is easier and less expensive to address many of these issues during design than trying to handle them once the service is operational. Some of the operational issues that should be considered include:

- Provisions for transit power outage
- Elimination of left turns to improve transit efficiency and vehicular traffic flow
- Transit signal prioritization (can improve transit efficiency and traffic flow)
- Conflicts in shared lanes, including conflict points between transit vehicles, automobiles, and bicycles
- Gates to prevent cars from following transit buses into stations
- Gates to prevent left turns across light rail lines
- Pedestrian refuge areas for safety and comfort
- Removing parking spaces and loading zones to improve transit service
- Reducing lanes or lane widths for roadway traffic may be required to significantly improve the efficiency of the transit service
- Education to help pedestrians, drivers, and cyclists understand new signage and how to safely operate within an improved transit corridor
- Operations and maintenance of transit stations

A couple of the project teams mentioned the importance of considering all projects planned for the corridor in the next few years. In Richmond, designers of the Pulse project made an effort to identify adjacent projects that may affect the Pulse[7]. In Detroit the QLine project team was aware of large construction projects in the vicinity of the QLine project. An effort was made to determine if laydown areas used by each project during construction might be in conflict. Project staff from each of the projects were consulted to coordinate efforts[11].

The projects that were visited used a variety of contract mechanisms during development. While most used a design-build contractor, the project in Detroit used a general manager/construction contractor and hired a consultant as an owner's representative. For those projects that used a design-build process, the scan team was advised that the design-build contractor should be brought in before design is too far along. It was suggested that 30% of design is an appropriate time to bring a design-build team onboard so that its expertise can be utilized and avoid costly rework[11].

Because of the strong connection between land use and transit ridership, it is important to consider land use and economic development when planning for a project. Special effort should be made to consult with partners with land use and transportation decision-making authority along the alignment. The project team in Charlotte consulted with the planning and economic development department early in the project-planning phase. The project included active-use space to be leased for retail, office, or other uses as part of the transit-oriented development zoning requirements associated with the parking structures that benefit the project[10]. Because the utilization of parking facilities cannot be known with certainty, it is important for public officials to enter discussions with a clear understanding of the governmental costs and responsibilities.

Seek Opportunities to Improve Transit

The scan team noted that road improvements are often critical components of a transit project in which some form of improved or rapid transit is added to a corridor. Roadway improvements including managed lanes, dedicated access ramps, dedicated transit lanes, removal of left turns at intersections, and transit stations within the right of way as well as improved bicycle and pedestrian access – all are important components that allow transit service to achieve more frequent and reliable transit service.

In Minneapolis and Seattle, the scan team observed the state DOTs using the addition of HOV or managed lanes as an opportunity to accommodate the addition of new or improved BRT service. For the projects that were visited, both DOTs worked with a regional transit agency to accommodate new or improved BRT service in coordination with the roadway improvement. In this way the effectiveness of the roadway improvement was further enhanced by also improving transit service along the corridor.

In Charlotte and Detroit, the team saw examples of transit projects facilitating important road improvements that would not have otherwise been completed in the same time frame. In Charlotte, the BLE LRT project also provided an opportunity for significant improvements to the bicycle and pedestrian network that enhanced non motorized transportation along the corridor.

Regional, systemwide, multimodal improvements provide users with more options and benefit all modes of transportation. In Minneapolis, Charlotte, and Seattle, the scan team saw examples of partners working to develop a corridor-wide or systemwide approach to encourage improvements to other modes, including bikes and pedestrians, and to help transit passengers make efficient connections to and from the new transit service.

Finally, another bit of advice was shared with the scan team during its visits to Charlotte and Minneapolis. That is, given the uncertainty of transit funding at times, it is advised to continue to design the roadway portion of a project to not preclude the addition of transit later. In Charlotte, the project team noted that a segment of North Tryon Street that was scheduled for intersection improvements prior to the light rail project was designed with a wide median to provide space for the future light rail[10]. Maintaining the flexibility to add a transit component later makes sense and can avoid costly rework[18].

Employ Project Controls

Because these projects typically involve several partners that need to be kept informed it is important that decision processes are clear and understandable. The project team for the BLE in Charlotte stressed that a project management plan is needed that includes a defined escalation plan and conflict resolution process. To keep the project on track and within scope it was suggested that a documented process for sign offs on both the project design and on changes was advisable. In San Francisco the project staff stressed that it is important to identify who makes the final decisions for each partner.

In some situations, the project team may include staff from more than one partner. For these cases, it may be beneficial to relocate staff to convenient facilities. These teams should develop clear lines of authority and address other personnel issues as needed.

A couple of the project teams mentioned that it is important for each partner to bring in staff for project planning and design at the right time. An example given was the need to have transit and/or roadway operations staff review plans early in the process to identify potential operational problems before design is too far along[11].

Communicate and Coordinate with Stakeholders

As would be expected, these projects need a robust outreach plan with dedicated staff focused on the initiative. All the host projects described their outreach efforts, which were well planned. In Detroit, outreach was led by the M-1 private group that was leading the project together with MDOT. In most cases, while the state DOT is a critical partner, community outreach is largely an effort led by the transit agency or city/county representatives.

Several host site teams indicated that some stakeholders will probably need additional coordination throughout the project. An example of additional coordination may be a need for extra time for review and comment and/or to “agree” with the project. For other stakeholders there may be a request for some customization of the project. Some of the stakeholders that may require additional coordination in addition to required federal public involvement processes for low-income and minority communities include railroads, universities, hospitals, and certain community groups.

Railroads were a major stakeholder in the Charlotte BLE project since a significant portion of the project is located on Norfolk Southern Railway right of way. Because it was important that the project meet all applicable railroad rules and regulations, the project team made an additional

effort to be sure that Norfolk Southern Railway officials were consulted and their requirements met to receive their sign off. It is important to keep in mind that railroads have their own decision processes and are required to adhere to specific rules and regulations for their industry.

Universities and hospitals are often major stakeholders and customers of transit services. Because station stops are often located on or near university or hospital properties, there is often strong interest regarding the footprint and function of these stations. The project teams in Richmond, Charlotte, Detroit, and Seattle all noted the importance of spending significant effort to understand and meet the needs of universities and hospitals.

Community groups are also important stakeholders that may require additional attention during project development. In Minneapolis, significant effort was made to address the needs of a historic neighborhood (the Healy Block Historic District). After listening to community input, the freeway alignment was adjusted to avoid further encroachment on the neighborhood. Several other accommodations were also made involving a historic railroad alignment trail and pedestrian overpasses that are important to the community[18]. Ultimately, these accommodations are a critical part of the design process to ensure that the project serves the communities through which it passes.

A method some projects have used to build community support is to give them a voice in artwork selection at station stops. Artwork at station stops for the BLE project in Charlotte was selected by the local community from nominations by public artists. The community has taken great pride in the artwork and, as a result, the scan team was advised there is believed to be less of a problem with graffiti "tagging" by vandals[10].

Integrate Connections

The projects that were visited each devoted considerable effort to ensure the improvement served the needs of all users, including those traveling by motorized vehicles, bicycles, and walking, and those using wheelchairs or motorized scooters. It is important to have adequate bicycle and pedestrian facilities along the corridor and efficient, accessible connections between the modes at transit stops and stations. It is also important to have efficient connections between transit routes and for those traveling by motorized vehicles who want to transfer to transit for a segment of their trip.

To increase the benefits of an improved transit service along a corridor it is important to provide adequate connections to local bus routes in the area. Provisions should be made to make safe and efficient access for local bus routes at new BRT or LRT stations. The geometry of the station stop needs to provide enough room for buses to access stations and transfer users. Parking needs for those arriving by motorized vehicles should also be considered, as well as temporary parking for pickups and drop offs by Uber, Lyft, and other ride-hailing services.

It is also important to consider the needs of bicyclists and pedestrians. Provisions for carrying bikes on the transit vehicle should be made so riders can continue a trip after departing the transit vehicle. Research or testing should be done to be sure that the bike racks do not interfere with the operation of the BRT (e.g., testing was done on the Pulse in Richmond to ensure that the bus could

navigate the route with the bike racks in place). In other situations, bicyclists may want to park or store their bike at a station. Adequate storage for bikes, such as racks or storage lockers, should be considered, as well as provisions for bike-sharing services. Finally, connections and facilities must be ADA accessible.

While it is important to provide physical connections to local bus routes, it is also important that route schedules of the services are synchronized. This was emphasized when the scan visited the Pulse BRT project in Richmond. The Commonwealth of Virginia funded development of the Richmond Transit Network Plan, which restructured the GRTC bus network to integrate with the BRT service. While separate from the BRT project, GRTC staff made numerous checks to ensure a smooth transition and implemented the network changes on the same day the Pulse started operations[7].

Improve Person Throughput

A challenge that is faced by project teams attempting to accommodate additional modes within the existing right of way is to accomplish it in a way that does not negatively impact the LOS on the roadway. This is particularly challenging when general-purpose lanes are dedicated to transit-only use without providing additional widening.

Nearly half of the Pulse BRT route in Richmond used existing general-purpose lanes in each direction dedicated to bus-only service. This was not seen as a concern because the existing roadway had adequate capacity and the existing LOS was not a problem. Additionally, efforts were made to reduce the impact of fewer general-purpose lanes, including eliminating several parking spaces along the route, eliminating some left turns at intersections, and including transit signal priority for buses[7].

In San Francisco, the Van Ness Avenue BRT project dedicated one general-purpose lane in each direction to transit-only service. This reduced general-purpose lanes on Van Ness Avenue from three lanes to two in each direction. Normally, any deterioration in LOS would have been deemed as unacceptable. However, because the project provides BRT service in a heavily traveled corridor, it was decided to also consider additional criteria, including people throughput, reduced VMT, and safety (i.e., traffic, transit, and bicycle/pedestrian), instead of just considering LOS. Because no guidance was available to determine an acceptable trade-off between LOS and the additional criteria, executives at the partner agencies decided to accept the design. By reducing the number of general-purpose lanes and dedicating lanes in each direction to BRT service, the speed of the transit service will be increased, VMT will be decreased, and overall safety on the corridor will be improved. While vehicular traffic will be slowed somewhat due to the loss of general-purpose lanes, that reduction should be partially offset by the elimination of left turns and the use of transit signal priority.

Other Findings and Observations

In addition to the observations associated with the previously outlined strategies, the scan team identified other findings that were considered important and should be beneficial to officials planning to undertake similar projects.

Project teams in Detroit and San Francisco both noted that visits to other locations that have planned/implemented similar transit projects was a helpful part of the initial visioning/planning process. The team in San Francisco mentioned that its visits were done very early in the process but did not include the "road" partners that would have benefitted from being involved[24].

A common practice used on several of the projects was the use of duct banks. These structures provide a consolidated (small) area to relocate multiple utilities and allow the utility companies to proceed with relocation independently.

In Detroit and San Francisco, addressing outdated utilities was an important part of the projects' purpose and need. Major utility lines, including water, sewer, and electrical needed repair or replacement as well as relocation. The utility upgrades will provide improved service and reliability and therefore will be a significant benefit to the public and new development the transit line will support that go beyond the benefits to transportation.

For several projects TIGER grants (recently replaced by the Better Utilizing Investments to Leverage Development Transportation Grants program) were a critical piece of the funding puzzle that advanced the project. As such, these funds were a helpful part of the funding package. Applying for these or similar funds is advisable.

Several projects sought FTA New Starts or Small Starts funding (currently referred to as Capital Investment Grants) that is awarded on a competitive basis and can be uncertain during the early phases of a project. The uncertainty of these federal transit funds can make it difficult to obtain commitments from other partners. The project team for the I-405/SR 167 BRT project indicated that, for future projects, it will avoid these funds or be very strategic in how they are used (i.e., only for vehicles and not for other infrastructure)[32].

Sponsorships and private funding can be an important revenue source for the construction and operation of a project. Hospitals and universities were sources of sponsorship for the projects in Richmond and Charlotte. The use of station sponsors is common for transit projects but can impact design features. In San Francisco, Clear Channel Communications provides funding by sponsoring station stops but requires a basic design that limits the ability to customize stations[24].

The QLine Streetcar project in Detroit received substantial private funding. The group that provided the funding also took a leadership role in the project but didn't have experience with roadway project work. This put more pressure on the state DOT to provide experience and expertise for the project[11].

Finally, it is important to take into consideration any unique uses of the roadway that might conflict with the operation of new transit service. In Detroit, an annual festival and parade requires overhead electric lines used by the streetcars to be moved to allow passage of floats and balloons along the parade route. Consideration should be given during project development for how similar events can be accommodated[11].

CHAPTER 4

Recommendations

The following are the scan team's recommendations for transforming existing highway rights of way into successful multimodal corridors based on observations and findings from the scan. While several of these recommendations are directed toward state DOT officials involved in similar projects, many other recommendations are directed to all project development officials including state DOTs, transit agencies, as well as other local city and county officials.

Several of these recommendations emanate from the team's observations that these projects presented unique opportunities to make multimodal improvements within the corridor as well as on connecting and/or parallel corridors. By their very nature, transit projects require the consideration of connections for transit riders arriving and departing by a variety of modes, including by bicycle and on foot. Therefore, the team expected to see bike and pedestrian improvements as part of the projects. However, because these transit projects required roadway improvements, opportunities emerged to address the needs of pedestrians and bicyclists throughout the corridor, including improvements above and beyond what was necessitated for transit riders. For some of the projects, the desire to secure modal improvements beyond the new transit service was part of the initial project vision; for others the opportunities emerged as the project evolved. However, for all projects, the team was impressed by the wide range of modal benefits that resulted from the projects

Adopt a Shared Vision

- The state DOT should develop a shared multimodal vision for the corridor with all its partners.
- The state DOT should foster a multimodal philosophy and culture throughout the agency.
- The state DOT should support the development of well-aligned multimodal plans and policies, including Complete Streets policies with its partners.

Define Roles and Responsibilities

- The state DOT should determine the lead federal agency early in the project development process for consistent coordination.
- State DOTs should evaluate their organizational structure and make adjustments to facilitate multimodal decision-making and project delivery.
- Project development officials should insist that staff and managers have a "lean in to get to yes" philosophy – be flexible and nimble.
- The state DOT should consider taking the lead for phases of the project for which it has unique skills and abilities not possessed by other partners (e.g., utility relocation, environmental review, federal funding requirements, and construction management).

- Project development officials should establish agreements for maintenance and operations between appropriate parties prior to project implementation.

Planning and Design Considerations

- The state DOT should focus its attention on transit elements that directly impact the state's roadway infrastructure.
- Project development officials should not get locked in to a single or best definition of BRT.
- Project development officials should devote significant effort to determine the optimal location and configuration of transit lanes and stations to improve transit service, roadway performance, and safety.
- Project development officials should give full consideration to using the opportunity of the multimodal project to further community and economic development goals as well as improve operational issues during design.

Seek Opportunities to Improve Transit

- The state DOT should look for ways to integrate transit and other innovative technology improvements with larger infrastructure improvements.
- The state DOT should consider the conversion of existing lanes or the addition of HOV or managed lanes as an initial commitment to dedicate lanes for the priority use of HOVs, including BRT and express buses.
- Project development officials should implement improvements for all modes that improve the overall mobility and safety of motorized and non motorized users of the corridor.
- The state DOT should make an effort to plan and design roadways to accommodate future transit options even if immediate transit funding is uncertain.

Employ Project Controls

- Project development managers should employ appropriate controls to manage risk across project scope, schedule, and budget.
    - Develop a project management plan that includes a defined escalation plan and conflict resolution process.
    - With project partners, develop and agree to written protocols that govern how changes can be made to the vision, design, and budget.
- Project development officials should bring in the right staff at the right time.

Communicate and Coordinate with Stakeholders

- Project development officials (i.e., local officials or the transit agency) should develop a robust outreach plan to gather input from and disseminate information to stakeholders to keep them on board.

- Project development officials should plan on providing additional time and attention to coordinate with and meet the needs of certain stakeholders, including universities, hospitals, and railroads, which often have concerns regarding the impact of the improvement to their facilities.

Integrate Connections

- Project development officials should identify and improve connections to all modes operating within the corridor to enhance seamless travel.
- Transit providers need to coordinate/align the new transit service with other existing transit routes and services to ensure that route schedules are synchronized.
- Project development officials should implement roadway improvements that improve overall mobility and safety for all modes, including bicyclists and pedestrians.

Improve Person Throughput

- Project development officials should consider criteria in addition to LOS, including person throughput, reduced VMT, and safety (i.e., traffic, transit, and bicyclist/pedestrian), when evaluating the impact of accommodating additional modes within existing right of way.
- Project development officials should look for ways to improve transit service that also helps improve traffic flow.

CHAPTER 5

Implementation Strategy

The transportation community provides several opportunities at local, state, regional, and national meetings and conferences to share the findings and recommendations of this scanning tour. In most cases these opportunities are regularly scheduled meetings. In other cases, new opportunities will arise as the situation warrants.

- Completed activities
  - E-mail updates regarding the scan visits, including an introduction and short descriptions of the actual scan visits, to the Multimodal Task Force (MMTF) of the Subcommittee on Policy of the AASHTO Committee on Planning.
- Short term
  - Presentations at scheduled meetings/conferences
  - National/regional conferences
    - Mid America Association of Transportation Officials Annual Meeting, August 27-29, 2018, Traverse City, MI
    - Railvolution National Conference, October 21-24, 2018, Pittsburgh, PA
    - Transportation Research Board BRT Conference, June 2018, Los Angeles, CA
    - Southern Association of State Highway and Transportation Officials Annual Meeting, August 4-8, 2018, Houston, TX
    - Northeast Association of State Transportation Officials Annual Meeting, July 9-11, 2018, National Harbor, MD
    - AASHTO Active Transportation Committee, July 17-19, 2018, Spokane, WA
    - American Public Transit Association, September 23-26, 2018, Nashville, TN
    - Northeast Corridor Coalition
  - State-level meetings
    - Annual Highway Operations Conference/High-Impact Projects, MDOT
    - Transportation Bonanza, Michigan
    - Annual Consultant Conference, Michigan
    - FDOT Executive Committee
    - FDOT District Design Team

- Kansas Transportation Engineering Conference, April 2019
- Minnesota Transportation Conference, February 2019
- Washington State Design Construction Conference
- Women's Transportation Seminar, Pennsylvania Chapter
- Pennsylvania Public Transit Association, 2019
- PennDOT District Executive Meetings

- Long term
  - Develop and conduct a full webinar for the AASHTO Planning Committee sponsored by the MMTF (within 60 days of publishing the full report)
  - Develop and conduct mini webinars for select AASHTO committees and subcommittees sponsored by the MMTF (over the course of 2019)
  - Develop and conduct a virtual or on-site workshop that brings together state DOT staff and project staff from scan locations with state DOT and project staff from other locations that are considering accommodating major transit investments within existing rights of way (mid- to late 2019)
  - Develop and distribute topical fact sheets (in conjunction with workshop) on specific topics and/or project locations (mid- to late 2019)
  - Assist in developing problem statements for NCHRP

Appendix A: Scan Team Contact Information

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Appendix B: Scan Team Biographical Sketches

SHARON EDGAR (AASHTO CHAIR) retired June 25, 2018, from the Michigan Department of Transportation, where she served as administrator of its Office of Passenger Transportation for over 15 years. This office is responsible for distributing state and federal financial assistance to the state's 78 transit agencies. She worked with MDOT's region staff to accommodate new transit services within MDOT right of way, including bus rapid transit and streetcar, and cosponsored MDOT's Multimodal Development and Delivery initiative, which is aimed at ensuring MDOT's policies and procedures allow for multimodal decision-making. Prior to retiring, Edgar was a member of the executive committee of the AASHTO Council on Public Transportation and served for several years as chair of the CPT's Multi -State Technical Assistance steering committee, which provides state-to-state technical assistance to state DOT transit offices. She served on the steering committee of the Multimodal Task Force of the AASHTO Planning Committee and chaired the NCHRP 20-65 project panel, which oversees research that benefits state DOT transit programs. She continues to serve on several NCHRP/TCRP research panels. Edgar has a master's degree in natural resources administration from the University of Michigan and a bachelor's degree in resource administration from Michigan State University.

ELIZABETH BONINI is the director of the Pennsylvania Department of Transportation's Ports and Rail Office. She is responsible for the oversight and management of programs and projects for the preservation, rehabilitation, and development of the state's three ports, freight railroads, and rail-served businesses. In addition, she directs the operations of the passenger rail service provided by Amtrak, leads the construction of station improvements along the Keystone Corridor, and manages Pennsylvania's State Safety Oversight Program for rail transit. She previously managed over $1 billion annually to support the operations and capital development of public transportation organizations throughout the state. Bonini received both her bachelor's degree in economics and master's degree in industrial and labor relations from the Indiana University of Pennsylvania.

DYLAN COUNTS is the Director of the Regional Transit Division for the Washington State Department of Transportation. Dylan leads a team of engineers, planners, real property managers, and a traffic engineer responsible for access and integration of highways and public transportation infrastructure, as well as, operations; including light rail, bus, train, and park-and-rides. Community engagement is a large part of his work specifically as the need for transit-oriented development has grown. Dylan has been at WSDOT for 36 years and has had the opportunity of rotating between highway design, inspection, planning, and policy though-out his career.

MING GAO, PE, is the modal development administrator for the Florida Department of Transportation (FDOT), District 7, and has been with FDOT for over 26 years. His previous experience in FDOT included traffic operations, design, project management, environmental management, and multimodal planning. In his current role, he is responsible for the development and implementation of the district's public transportation programs that support aviation, rail, seaport, transit, freight, and intermodal connection. For the past 10 years, he has been working with local agencies on accommodating premium transit services within FDOT rights of way. Two of the projects (one BRT and one streetcar) are currently in the Federal Transit Administration's Small Starts process. He is currently working on a BRT project that runs in a combination of interstate highway shoulders and express toll lanes. Gao is a graduate of the University of South Florida and is a licensed professional engineer in Florida.

GARY JENSEN is a team leader in the Federal Highway Administration's (FHWA's) Office of Human Environment, leading programs and activities that advance the integration of human environment and community considerations in transportation program delivery to enhance the quality of life where people live, work, and recreate. His team leads multimodal, bicycle, and pedestrian programs and activities that improve safety, connectivity, accessibility, and convenience of walking and bicycling for all users. This includes increasing transportation choices for individuals, expanding access to essential services for people in communities across the U.S., improving connectivity for citizens to jobs, health care, and other critical destinations, particularly for rural communities, and otherwise addressing quality of life. He has been with the FHA for 24 years and has been involved in various transportation planning and environmental programs, both at headquarters and in the field. He is a graduate of the University of Idaho with a bachelor's degree in civil engineering.

JAMES H. LAMBERT, PE, is a professor of systems and information engineering at the University of Virginia. He is an adjunct professor at both the University of Southern Denmark and the University of Chinese Academy of Sciences. He is editor-in-chief of the Springer journal Environment Systems & Decisions, and an area editor of the Wiley journal Risk Analysis. He is a past president (2015-2016) of the Society for Risk Analysis (SRA), chair of the SRA Annual Meeting (2015), and chair of the SRA Fifth World Congress on Risk (Cape Town, South Africa, 2019). He has served on panels and committees of the Transportation Research Board, U.S. National Science Foundation, National Academies, and the World Roads Association (PIARC). He has been a principal investigator for transportation research sponsored by the Federal Highways Administration, Virginia Transportation Research Council, Virginia Department of Transportation, Department of Homeland Security, U.S. Army Corps of Engineers, and National Science Foundation. He has a doctorate degree and a master's degree from the University of Virginia and a bachelor's degree from Princeton University. He is a Fellow of the IEEE, Fellow of the American Society of Civil Engineers, Fellow of the Society for Risk Analysis, Diplomate of the American Academy of Water Resources Engineers, and a licensed professional engineer.

SCOTT A. PEDERSEN, PE, is the Metro District Project Management Manager for the Minnesota DOT. Scott graduated from the University of Minnesota in 1996 with a Bachelor of Science in Civil Engineering. He has worked for the Minnesota Department of Transportation for 30 years with responsibilities ranging from contract administration to his current position. Scott was the Program Delivery Project Manager for a project on I-35W in the City of Minneapolis that included two critical elements of a regional Bus Rapid Transit facility on Interstate 35W from the City of Lakeville to the City of Minneapolis. He is a licensed professional engineer in Minnesota.

WILLARD (WILL) THOMPSON is the Lansing Transportation Service Center manager for the Michigan Department of Transportation (MDOT). In his role he leads a team of professionals that provide a wide variety of customer services including planning, design, permitting and construction oversight on state roadways. He has recent experience coordinating MDOT efforts with on a bus rapid transit project in the downtown Lansing area. He is currently working on efforts to build a stronger multi-modal culture at MDOT. Thompson is a graduate of the University of Michigan and holds both a Bachelor's and Master's Degree in Civil Engineering. He is a licensed professional engineer in Michigan.

DENNIS SLIMMER, PE, (SUBJECT MATTER EXPERT) retired from the Kansas Department of Transportation in 2015 after serving 45 years with the agency. In his final assignment he was the bureau chief of Transportation Planning, where he oversaw units responsible for traffic data collection, mapping/GIS, freight/rail, public transit, bike/pedestrian, metropolitan planning, corridor management, and geographic and data reporting. During his career he served as a design engineer in the Bridge Section, estimating engineer in Headquarters Construction, and construction engineer for the Topeka office of District One and various positions in the Division of Planning and Development. Slimmer represented Kansas on the Standing Committee on Planning and served on several committees dealing with reauthorization of federal surface transportation legislation. He earned a bachelor's degree in civil engineering from Kansas State University and a master's degree from Washburn University. He is a life member of ASCE and a professional engineer licensed in Kansas.

Appendix C: Amplifying Questions

Domestic Scan 17-02 is being conducted to advance the institutional capacity of state DOTs to participate/partner in projects that add modes or services to existing highway rights of way. These projects may involve the dedication of existing lanes to transit as part of a Federal Transit Administration (FTA) Capital Investment Grant (CIG) project, the addition of high-occupancy vehicle or high-occupancy toll (HOT) lanes, and bike or pedestrian access. Your answers to the following questions plus any supporting documents will be used to provide informal "road maps" and case studies for highway, transit, and other modal agencies as similar projects are being considered.

Planning, Design and Construction

Scope

1. Briefly describe a project in which your agency participated that accommodated additional modes or services within existing right of way.
2. When the additional mode or service was proposed was there a road project planned or pending?
3. Which party initially requested that a mode or service be added to the existing right of way? What modes or services were requested to be added?
4. Was the initial request for the addition of a single mode or service? Did additional modes get added later?
5. What factors and considerations were important in determining the scope of the improvement? Please include factors and considerations for the addition of the mode or service and for other improvements within the right of way.
6. Was there an effort to coordinate the development of this project with community planning efforts?
7. Was the final scope of the project significantly different from the original vision for this project? What contributed to the changes? Explain what you believe were the major reasons for arriving at the final scope of improvement.
8. Were there issues with "scope creep"? How were they addressed?
9. Were there any technical issues associated with the planning, design, construction or maintenance/operation of the project that were particularly challenging? Describe how they were addressed.

Pre-project Conditions

10. What was the pavement condition prior to the improvement?
11. When was the most recent pavement project or significant improvement on the facility? Describe that improvement.
12. What was the level of service on the facility in the area of this improvement?
13. What modes operated on the facility prior to the improvement?
14. What was the existing land use adjacent to the project?

Right of Way

15. Which entity is the owner of the right of way where the project is located? Is there another entity that manages the right of way?
16. Was the project able to be completed within the existing roadway footprint or was some incidental widening required? Please describe.
17. Were lane configurations modified as part of the improvement? Please describe.
18. Were there any issues involving usage rights for right of way?

Participants/Roles and Responsibilities

19. List all local, state, federal, and private entities that were involved in the planning, design, construction (other than contractors performing work), operation, or maintenance of the project. Which entity initiated the project? Briefly describe the involvement of each party and indicate whether they had a lead or a cooperating role in various phases of the project (e.g., planning, design, construction, or operations).
20. From your agency's perspective list all cooperating agencies, stakeholders, and community and interest groups. For each, describe their "stake" in the project. For each, indicate if they had a formal approval role in the project (i.e., their approval was needed on some aspect of the project for it to proceed) and what that approval was.
21. Were there interest groups that provided important input?
22. Describe the size, responsibilities (functions), and overall budget for the office or department that has planning, design, maintenance, or operational responsibility for the above-referenced project.
23. Provide an organization chart for the state transportation agency and identify where responsibility for the above-referenced project resides.
24. What processes were used to consult with stakeholders regarding the scope of the project? What role did stakeholders play?
25. Describe any coordination between federal modal agencies during the planning, design, construction, or operation of the project. Did one of the federal agencies facilitate this coordination, was it a joint effort, or was another entity responsible for this coordination?
26. Were there any formal or informal agreements between the state DOT and local entities or stakeholders? Provide a copy if one is available.

Public Involvement

27. Describe any community outreach used during the planning, design, construction, and operational phases of the improvement. Which agencies were involved and which had a lead role?

Oversight

28. Describe the state DOT's role and responsibilities for construction oversight.
29. Were any significant challenges experienced during the planning, design, or construction phases of the project? Describe how they were addressed.

Technology

30. Describe how technology is being used to improve the efficiency of new modal services.
31. Was ITS used on adjacent roadways to enhance the efficiency of the project or to mitigate any negative impacts?

Administration

Funding

32. Describe the sources of funding for the project. Provide information on the initial and final financing plans.
33. Were any innovative finance or funding techniques used for this project? Please describe.

Policy and Regulations

34. Did the project require modifications to any state or local laws or regulations? Was there any resistance to these changes? How was any resistance handled?
35. List the specific manuals, specifications, guidebooks, and policies that were used to design, construct, or evaluate the proposal to accommodate the additional mode. Do these documents anticipate multimodal improvements? Were these documents helpful in decision-making for this project? What specific content of these documents was helpful in addressing the multimodal needs of this project? What specific content made it difficult to address the needs of this project? Were exceptions or waivers required and, if so, who made them and what criteria were used?
36. Were there any federal regulations or policies that made it more difficult to accomplish the project?

Organizational Issues

37. Did any phase of the project cause organizational challenges for state DOT staff? How were they resolved

Performance Measures

Project Impacts

38. Did the project impact (positive or negative) the operations or traffic flow of the existing roadway facility? What methods and criteria were used to estimate the impact and make decisions regarding the scope of improvement? If traffic flow or operations were estimated to be negatively impacted, how were these impacts addressed?
39. What metrics were used to measure the performance of the improvement? Provide any summary data that indicates how the project has performed.
40. In addition to modal impacts, were any beneficial impacts to surrounding businesses or quality-of-life improvements observed for those persons who use the facility?
41. Have any financial estimates been made showing return on investment? Provide any summary information.
42. Which measures have been most effective in “selling” the benefits of this project?

Operations, Maintenance, and Sustainability

43. What entity(ies) is (are) responsible for maintenance and operation of the improvement?
44. Do operations and maintenance require any special equipment or materials or new technologies? Is additional staff with special skills required?
45. Which entity is funding operations and maintenance? Are any of these costs shared between various entities? Please describe.
46. Describe any network or secondary impacts on nearby corridors or systems. Were these impacts anticipated and planned for during project planning?
47. Were issues of environmental sustainability important to stakeholder or public acceptance of this project?
48. Does this project improve livability for residents of adjacent or at-risk neighborhoods?

Safety and Security

49. Describe how issues of safety and security were addressed for this project. Please be specific to each mode.

Overall/Other

50. Please share any lessons learned that you believe may help others to implement a similar project.
51. What suggestions do you have for someone who is developing a similar project?
52. What did we forget to ask?
53. Please provide any relevant reports or documents.

Appendix D: Key Contacts

Virginia

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