BLUE RAPID TRANSIT LINE

Alternatives Analysis
Final Report

December, 2013

Prepared for the
Indianapolis Metropolitan Planning Organization

INDY CONNECT
CENTRAL INDIANA'S TRANSPORTATION INITIATIVE

BLUE RAPID TRANSIT LINE

Alternatives Analysis

Final Report

prepared for

Indianapolis Metropolitan Planning Organization

prepared by

HNTB Corporation
111 Monument Circle
Indianapolis, Indiana 46204

In association with

Aloft Strategies

Engaging Solutions LLC

MKC Associates

Taylor Siefker Williams Design Group LLC

Transportation Management & Design, Inc.

December, 2013

Contents

1.0 INTRODUCTION 1

1.1 Project Approach 5

1.2 Public Involvement 6

1.3 Prior Studies 7

1.3.1 Indy Connect Long-Range Transportation Plan Update 7

1.3.2 IndyGo Downtown Transit Center Studies 7

1.3.3 Indianapolis MPO Travel Survey 8

1.3.4 IndyGo On Board Survey 9

1.3.5 IndyGo Comprehensive Operations Analysis 9

1.3.6 Local Area Studies 9

1.4 Report Organization 11

2.0 PROJECT VISION AND GOALS 13

2.1 A Transit Vision for Central Indiana 13

2.2 Transit Planning Principles 14

2.3 Characteristics of "Premium Transit" Service 16

2.3.1 Commuter Rail Transit 16

2.3.2 Heavy Rail Transit 16

2.3.3 Light Rail Transit 16

2.3.4 Bus Rapid Transit 17

2.4 Project Goals 17

3.0 PLANNING CONTEXT 19

3.1 Corridor Description 19

3.1.1 Airport 20

3.1.2 Far West Washington 20

3.1.3 Mid West Washington 21

3.1.4 Near West Washington 21

3.1.5 Downtown Indianapolis 22

3.1.6 Near East Washington 23

3.1.7 Mid East Washington 23

3.1.8 Far East Washington 24

3.2 Corridor Land Use and Neighborhood Organizations 25
3.3 Socioeconomic Characteristics 28
3.4 Existing Transit Service 33
3.5 Existing Roadway and Right-of-Way Characteristics 38
3.5.1 West Washington Street Existing Conditions 38
3.5.2 West Washington Street Crash History 42
3.5.3 West Washington Street Pavement Conditions 44
3.5.4 East Washington Street Existing Conditions 45
3.5.5 East Washington Street Crash History 48
3.5.6 East Washington Street Pavement Conditions 49
3.5.7 Washington Street Traffic Conditions 50
4.0 BRT SYSTEM CONCEPTS 53
4.1 BRT Running Way Concepts 53
4.1.1 Added Lanes for Dedicated Transit Use 54
4.1.2 Dedicating Existing Lanes for Exclusive Transit Use 55
4.1.3 Center Reversible Bus-Only Lane 57
4.1.4 Mixed Traffic Transit Operations 57
4.2 Transit Priority Traffic Control Options 59
4.2.1 Transit Signal Priority 59
4.2.2 Queue Bypass Lanes 61
4.3 BRT Station Features 63
4.3.1 Enhanced Station Shelters 64
4.3.2 Level Boarding 65
4.3.3 Off-Board Fare Collection 66
4.3.4 Real Time Information 66
4.4 BRT Station Location and Placement 67
5.0 BLUE LINE MARKET ANALYSIS 71
5.1 Trip Density 72
5.2 Origins and Destinations of Trips 74
5.3 IndyGo Boarding Patterns 77
5.4 Cross District Travel Patterns 80

5.5 Route 8 User Travel Patterns 83
5.6 Peak Travel Demand 85
5.7 Transit Oriented Development Potential 87
5.8 Conclusions for Blue Line System Planning 90
6.0 BLUE LINE ALTERNATIVES DEFINITION 91
6.1 Blue Line Termini 91
6.1.1 Eastern Terminus 92
6.1.2 Western Terminus 92
6.2 Blue Line Preliminary Service Plan 93
6.3 Blue Line Running Way Treatments 94
6.3.1 Dedicated Lanes 94
6.3.2 Mixed Traffic Lanes 97
6.4 BRT Operational Treatments 99
6.4.1 Current Travel Time and Delay 99
6.4.2 Blue Line Transit Stations 100
6.4.3 Fare Collection System 106
6.4.4 Transit Signal Treatments 108
6.4.5 Estimated Travel Time Savings 109
6.5 Estimated Blue Line Ridership 111
6.5.1 Forecasted Blue Line Daily Ridership (Elasticity Model) 112
6.5.2 Forecasted Blue Line Peak Hour Bus Ridership 114
6.6 Blue Line Vehicles 115
6.7 Summary of Blue Line Alternatives for Evaluation 116
6.7.1 Alternative 1 – East Side BRT 117
6.7.2 Alternative 2 – East plus Downtown BRT 120
6.7.3 Alternative 3 – East to North Tibbs BRT 120
6.7.4 Alternative 4 – Crosstown BRT 123
6.7.5 No Build Alternative – Continuation of Existing Route 8 Service 123
6.7.6 Summary of Alternatives 123
7.0 EVALUATION AND RECOMMENDATION 127
7.1 Evaluation of Alternatives 127

7.1.1 Evaluation Performance Measures 127
7.1.2 Estimated Capital Costs 131
7.1.3 Estimated Operating and Maintenance Costs 135
7.1.4 Alternatives Evaluation 135
7.2 Recommended Alternative 140
7.2.1 Alignment 140
7.2.2 Termini 141
7.2.3 Stations 141
7.2.4 Running Way 142
7.2.5 Signal Technology 145
7.2.6 Vehicles 145
7.2.7 Operating Plan 146
7.3 Blue Line Implementation 147
7.4 Other Indy Connect Corridors 148
7.4.1 Near Term Plan for IndyGo Route 8 148
7.4.2 Airport Express Line 148
7.4.3 Plainfield Connector 149

FIGURES

Figure 1.1 Phase 1 Indy Connect Plan 2
Figure 1.2 Blue Line Study Area and Corridor Features 3
Figure 1.3 AA Screening Approach 5
Figure 1.4 Downtown Transit Center Site 8
Figure 3.1 Metropolis Mall, Plainfield 19
Figure 3.2 Weir Cook Terminal 20
Figure 3.3 Festival Flea Market (former Target store) near I-465 20
Figure 3.4 The Steeples on Washington 21
Figure 3.5 Avenue of the Americas District, near Belmont Avenue 21
Figure 3.6 451 Market Project 22
Figure 3.7 Near Eastside Commercial District 23
Figure 3.8 Irvington Lodge, Business District 23
Figure 3.9 Washington Square Mall 24
Figure 3.10 Downtown Cumberland 25
Figure 3.11 District Boundaries 26
Figure 3.12 Current Land Use in the Blue Line Corridor 27
Figure 3.13 Future Land Use Types in the Blue Line Corridor 29
Figure 3.14 Neighborhood Organizations in the Blue Line Corridor 30
Figure 3.15 Population Density 31
Figure 3.16 Employment Density 32
Figure 3.17 Diversity Index 34
Figure 3.18 Median Household Income 35
Figure 3.19 IndyGo Bus Routes (effective 2/10/13) 36
Figure 3.20 Plainfield Connector 37
Figure 3.21 West Washington Street Segments 39
Figure 3.22 Eastward view near Research Way 40
Figure 3.23 Eastward View near Lynhurst Drive 40
Figure 3.24 Eastward View near Warman Ave 40
Figure 3.25 Eastward View near Reichwein Ave 41
Figure 3.26 Eastward View at Indianapolis Zoo 41
Figure 3.27 West Washington Street, eastward View near Capitol Avenue 42
Figure 3.28 East Washington Street Segments 45
Figure 3.29 Eastward View near Park Avenue 46
Figure 3.30 Eastward View near Southeastern Ave 46
Figure 3.31 Eastward View near Oakland Ave 46
Figure 3.32 Eastward View, west of Ritter Avenue 47
Figure 3.33 Eastward View, west of Shadeland Ave 47
Figure 3.34 Eastward View west of I-465 47
Figure 3.35 Eastward View near Washington Square Mall 48

Figure 3.36 Washington Street Traffic Volumes and Service Levels 52
Figure 4.1 Buildings Impacted by Added Lanes on East Washington Street 54
Figure 4.2 Median Bus-Only Lanes 56
Figure 4.3 Shared Curb Lane – Existing Five-Lane Configuration 58
Figure 4.4 Queue Bypass with Special Signal Phase 62
Figure 4.5 Queue Bypass Operation with and without Exclusive Bus Phase 63
Figure 4.6 Cleveland HealthLine BRT Station 64
Figure 4.7 Kansas City MAX Shelter 64
Figure 4.8 York (Toronto) VIVA Shelter 65
Figure 4.9 Level Boarding 65
Figure 4.10 Off-Board Fare Machine 66
Figure 4.11 Passenger Information Display Systems 67
Figure 4.12 Curbside and Median Stations 67
Figure 4.13 Curbside BRT Station with re-routed sidewalk, Healthline, Cleveland 68
Figure 4.14 Curbside Station with Integral Sidewalk, EmX Line, Eugene, Ore. 68
Figure 4.15 Median Station, EmX Line, Eugene, Ore. 69
Figure 4.16 Far-Side, Near-Side, and Midblock Stations 69
Figure 5.1 Daily Trip Ends (All Purposes, All Modes) by District 73
Figure 5.2 Trip Generation and Trip Density (Trips per Acre) by Corridor Area 74
Figure 5.3 Travel Activity Profile 75
Figure 5.4 Corridor Travel Demand Patterns 76
Figure 5.5 Indygo Riders Travel Patterns 76
Figure 5.6 IndyGo Boardings by Stop on Key Routes in Study Area 78
Figure 5.7 IndyGo Boardings by Stop on East-West Bus Routes in Downtown Indianapolis 81
Figure 5.8 All Trip Travel Patterns between Corridor Areas 83
Figure 5.9 IndyGo riders Travel Patterns between Corridor Areas 83
Figure 5.10 IndyGo Rider Travel Patterns 84
Figure 5.11 Route 8 Weekday Directional Passenger Demand by Time Period and Segment 86
Figure 5.12 TOD Opportunity Heat Map 89
Figure 6.1 Shared Curb Lane with Wider Lanes and Landscaped Median 98
Figure 6.2 Landscaped Median Concept 98
Figure 6.3 Typical Route 8 Travel Time Breakdown 100
Figure 6.4 Factors that Influence the Selection of Station Locations 101
Figure 6.5 East Terminal Site Alternatives 105
Figure 6.6 East Blue Line Terminal – Alternative 1 Conceptual Layout 106
Figure 6.7 Estimated Time Savings with BRT Treatments 110
Figure 6.8 Vehicle Designed for BRT use, North American Bus Industries, Inc. (NABI) 116
Figure 6.9 Downtown Circulation with Alternative 1 117
Figure 6.10 Schematic of Alternative 1, Cumberland to the Downtown Transit Center 118
Figure 6.11 Downtown Circulation with Alternative 2 120
Figure 6.12 Schematic of Alternative 2, Cumberland to Harding Street 121
Figure 6.13 Schematic of Alternative 3, Cumberland to North Tibbs Avenue 122

Figure 6.14 Schematic of Alternative 4, Cumberland to Indianapolis International Airport 124
Figure 7.1 Components of a Transit Alternative 140
Figure 7.2 Typical BRT Station 141
Figure 7.3 Curbside Lane Running Way 142
Figure 7.4 Recommended Blue Line BRT Stations 143

TABLES

Table 3.1 West Washington Street Segment Characteristics 39
Table 3.2 Crash Analysis for West Washington Street Segments Excluding Intersections 43
Table 3.3 West Washington Street General Pavement Condition by Roadway Segment 44
Table 3.4 East Washington Street Segment Characteristics 45
Table 3.5 Crash Analysis for East Washington Street Segments (Excluding Intersections) 49
Table 3.6 East Washington Street General Pavement Condition by Segment 50
Table 3.7 Typical Roadway Existing Conditions by Corridor Segment 51
Table 4.1 Comparison of Near-Side, Far-Side, and Midblock Stations 70
Table 5.1 Existing IndyGo Ridership on East-West Routes in Study Area 79
Table 5.2 Assessment Variables for Determining TOD Opportunity 88
Table 6.1 Blue Line Preliminary Service Plan 94
Table 6.2 Volume Guidelines for Exclusive Transit Lanes 95
Table 6.3 Estimated Travel Time Savings (minutes) of Dedicated Bus Lanes 96
Table 6.4 East Washington Street Blue Line BRT Stations 103
Table 6.5 West Washington Street Blue Line BRT Stations 104
Table 6.6 Queue Bypass Locations in the Blue Line Corridor 109
Table 6.7 Existing Rider Distribution to Blue Line and Route 8 112
Table 6.8 Ridership Impacts of Selected BRT Amenities 113
Table 6.9 Forecasted Blue Line and Route 8 Weekday Ridership 114
Table 6.10 Transit Loading Standards 115
Table 6.11 Summary of Blue Line Alternatives 125
Table 7.1 Project Goals and Evaluation Measures 128
Table 7.2 Estimated Capital Cost for Blue Line Alternatives (2013$ millions) 134
Table 7.3 Impact of Street and Sidewalk Work on Alternative Costs (2013$ millions) 134
Table 7.4 Annualized Capital Cost for Each Alternative (2013$) 135
Table 7.5: Operations and Maintenance Unit Costs 136
Table 7.6 Operating and Maintenance Cost for Each Build Alternative (2013$ millions) 136
Table 7.7: Summary of Alternatives Evaluation Results 137
Table 7.8 Preliminary Blue Line Operating Plan 146

ACRONYMS, ABBREVIATIONS AND PHRASES

AA	Alternative Analysis
BRT	Bus Rapid Transit
Bus Plan	Term commonly used for the Comprehensive Operations Analysis
CRT	Commuter Rail Transit
CIRTA	Central Indiana Regional Transportation Authority
COA	Comprehensive Operations Analysis (Identifies future needs of IndyGo system)
DMD	Indianapolis Department of Metropolitan Development
DPW	Indianapolis Department of Public Works
DTC	Downtown Transit Center
FTA	Federal Transit Administration
INDOT	Indiana Department of Transportation
Indy Connect	Regional transit initiative involving public sector
IndyGo	Indianapolis Public Transportation Corporation (City bus service provider)
IRTC	Indianapolis Regional Transportation Council (Policy Committee of the MPO)
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
LRTP	Long Range Transportation Plan (Developed by the Indianapolis MPO)
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012 Federal surface transportation legislation)
MPO	Indianapolis Metropolitan Planning Organization
PIDS	Passenger Information Display System
TSP	Transit Signal Priority
TOD	Transit Oriented Development

1.0 INTRODUCTION

The Indianapolis Metropolitan Planning Organization (Indianapolis MPO), the Indianapolis Public Transportation Corporation (IndyGo), and the Central Indiana Regional Transportation Authority (CIRTA) are preparing an Alternatives Analysis (AA) for proposed transit improvements in the East/West Central Corridor ("Blue Line") located in Marion, Hendricks and Hancock Counties, Indiana. Figure 1.1 identifies the Blue Line in the context of Phase 1 of the Central Indiana Transit Plan of Indy Connect. Figure 1.2 shows some of the key destinations in the Blue Line study area. The 23.5-mile corridor is centered on Washington Street/US 40, from Plainfield to Cumberland, through downtown Indianapolis.

This corridor was established as a regional transportation priority in the well-publicized Indy Connect planning process, which culminated in the approval of the Indy Connect *Transit Vision Plan* by the Indianapolis Regional Transportation Council (IRTC) in February 2011. The *Transit Vision Plan* was adopted as part of the *2035 Long Range Transportation Plan (LRTP)* for the Indianapolis region, which recognized improved transit service in the Blue Line Corridor as a priority investment that could result in significant regional and corridor level benefits.

The analysis uses as its starting point the general concept presented and discussed at an Indy Connect workshop held in November 2011, which identified bus rapid transit (BRT) as the most appropriate transit service type for the corridor in the context of system development plans, anticipated funding constraints, and travel demand levels. The AA serves to validate and/or adjust as appropriate the key assumptions in that BRT concept, particularly those related to the geographic footprint of the service (alignment and terminal locations), progressing to more detailed analysis of service plan options and design features to identify a recommended alternative.

The Blue Line AA is being prepared concurrently with a similar analysis of BRT feasibility in the north-south Red Line corridor from Carmel to Greenwood. Key planning assumptions, including downtown connections, vehicle type, BRT features, and unit costs are coordinated between the studies.

The process takes into account the definition of BRT included in Federal MAP-21 legislation, which establishes a minimum level of service and features to qualify for discretionary Federal funding. The process takes a strategic perspective, seeking to understand potential tradeoffs in service options, maintain flexibility to respond to changing funding or regulatory requirements, minimize local administrative burden and financial risk, and define a project with the potential to meet Federal Transit Administration (FTA) warrants.

This report describes relevant project background data and reviews potential system features. Market studies and ridership forecasts are used to formulate a set of viable alternatives. These are evaluated with respect to project goals, and a recommended alternative is proposed at the conclusion of the report. With this study completed, the project sponsors may request permission from the FTA to enter the project development phase of the Federal New Starts/Small Starts program.

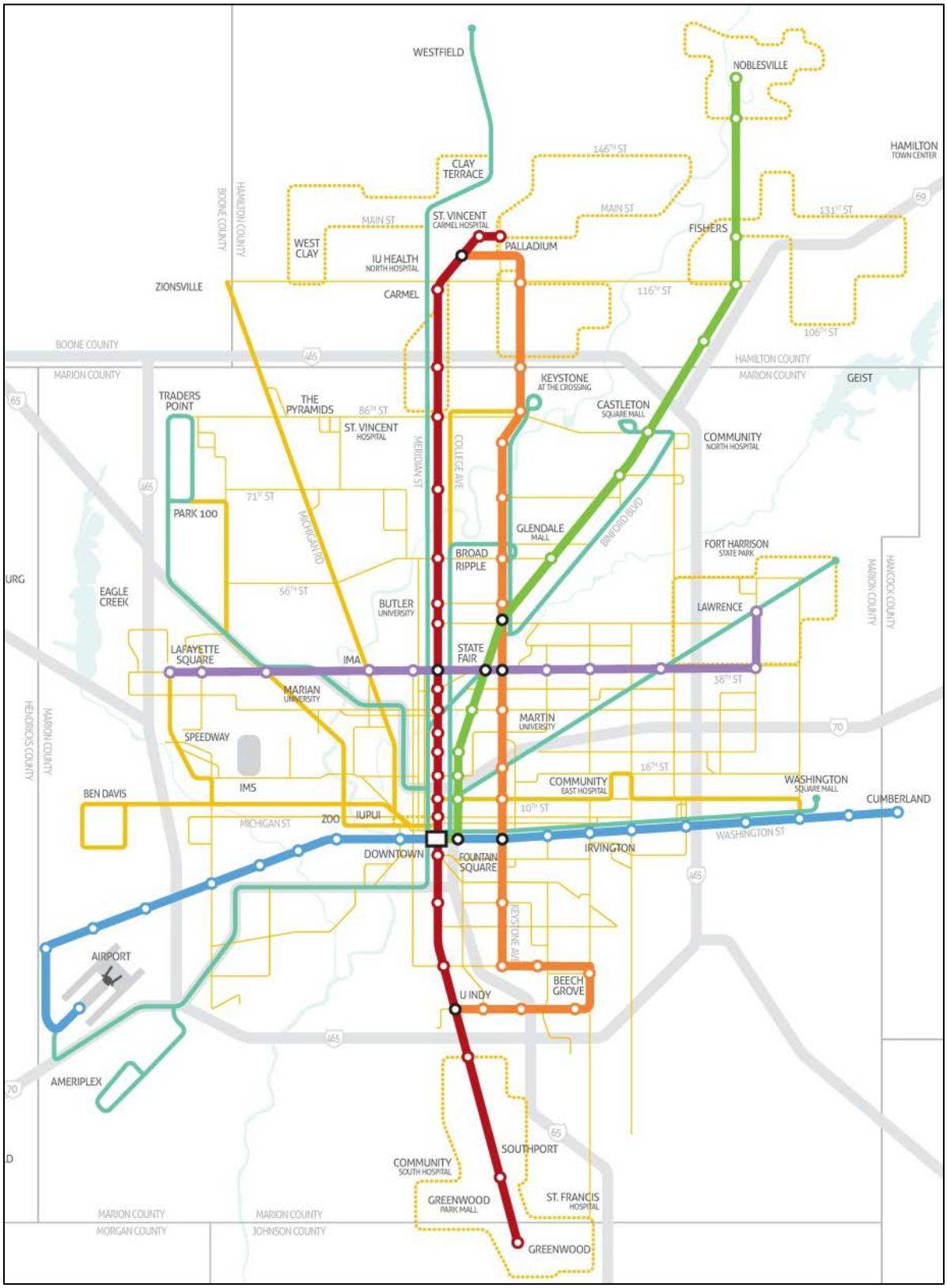


Figure 1.1 Phase 1 Indy Connect Plan

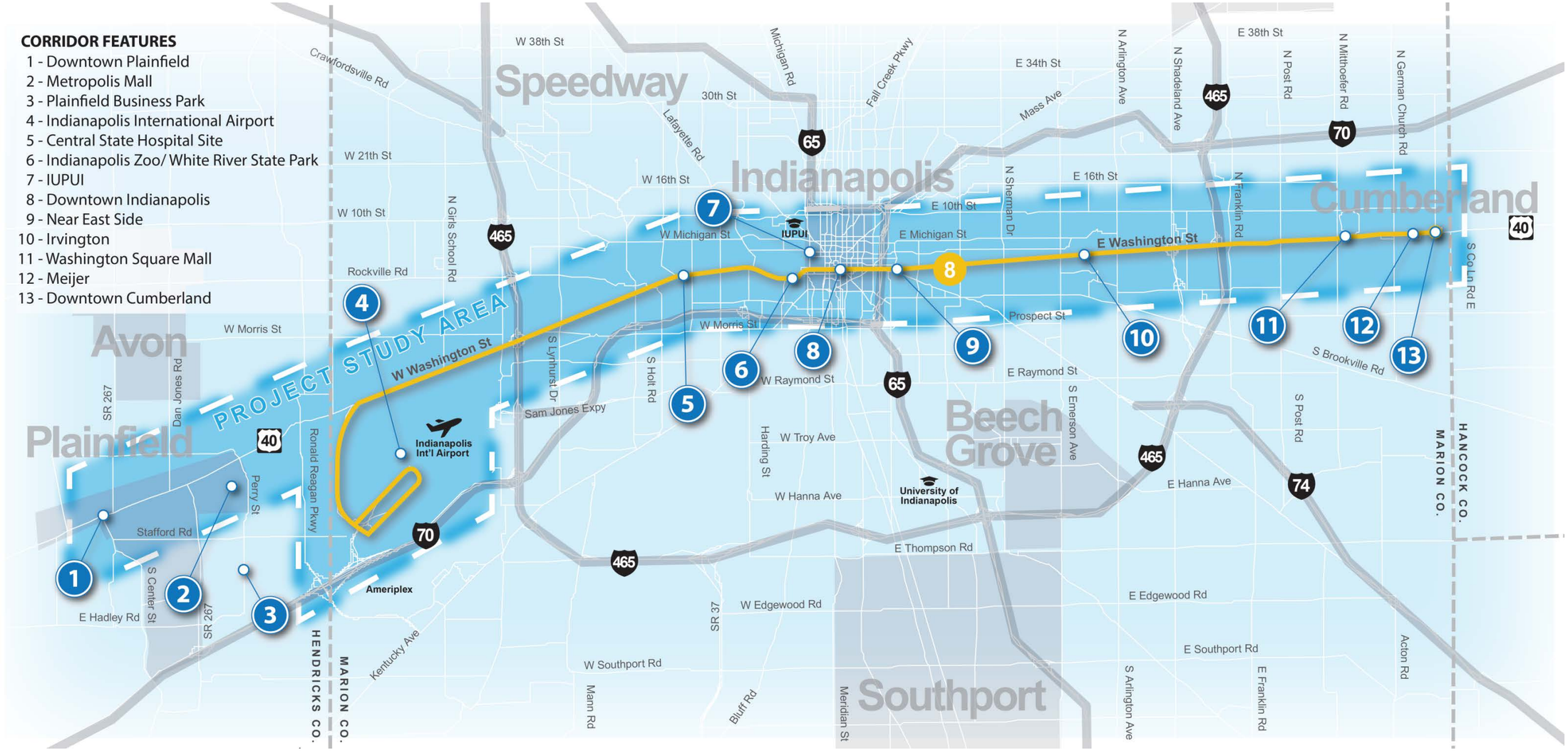


Figure 1.2 Blue Line Study Area and Corridor Features

1.1 *Project Approach*

The planning process employed in this study reflects a simplified AA approach. The primary focus of the AA is to verify initial assumptions from the Indy Connect planning process, evaluate options for transit operating plans and service features, and identify trade-offs associated with various funding strategies. Planning alternatives are structured to position the Blue Line as an early element of the Indy Connect regional transit investment program within the constraints of expected regional funding sources.

In the context of a simplified AA, project definition explores planning issues through an assessment of broad topic areas, then combines the best and most feasible components to define the best alternative. This differs from the traditional iterative process where an array of complete alternatives are fully defined and evaluated. The findings associated with each topic area are used to screen components, and the most viable are used to define a limited set of alternatives for evaluation.

Project definition focuses initially on the corridor, with an objective of defining the geographic footprint where transit service will operate. The corridor is defined by the alignment and the terminals (endpoints). The objective is to narrow the Blue Line project envelope from the broad area described in the FTA grant application to the arterials that would be used by BRT, then identify feasible priority features, station sets, vehicle type and service frequencies. Taken together, these components fully define the project characteristics and operating plans of potentially viable alternatives.

To guide the process in a clear and consistent manner, and to ensure the appropriate focus at each stage, a three-step screening process is employed, as depicted in Figure 1.3. Analysis is undertaken at each stage of the process to define the recommended alternative, as described below:

Project Definition: Topical analysis of alignment, terminals, running way treatment, stations, vehicles, and service frequency is undertaken using a combination of market analysis, traffic analysis, and concept-level planning techniques.

Project Evaluation: One or more alternatives are defined at a level that supports ridership estimates, capital cost estimates, and operations and maintenance cost estimates. The alternatives are evaluated in a matrix format.

Project Refinement: Exploration of trade-offs among design elements is undertaken in the context of financial constraints and implementation strategies to identify a recommended alternative.

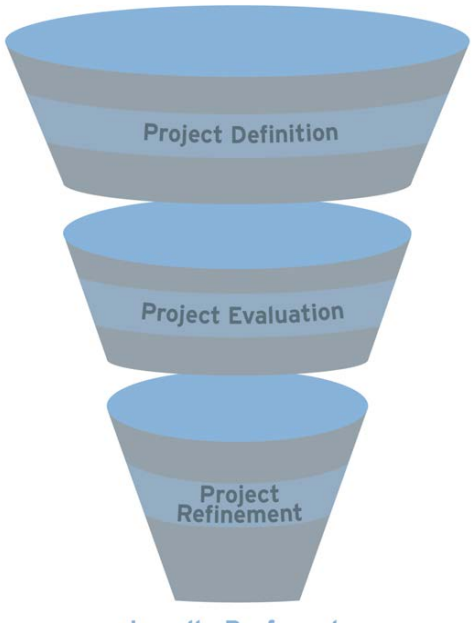


Figure 1.3 AA Screening Approach

1.2 *Public Involvement*

In 2010 the regional transportation planning process known as Indy Connect: Central Indiana's Transportation Initiative established a new standard for public engagement in Central Indiana. The Blue Line Corridor Alternatives Analysis maintained these high expectations for public involvement with coordination of communication and information through the well established Indy Connect brand.

In order to maintain simplicity and transparency of the planning process, the Blue Line Corridor Alternatives Analysis leveraged existing Indy Connect resources, working with the Indianapolis MPO, IndyGo, and CIRTA. Maximizing the equity of the Indy Connect brand allowed for coordination of multiple corridor studies through a single web interface (www.indyconnect.org), joint press releases, shared messaging on multiple social media platforms, webinars, and combined public meetings.

Open public meetings were held in the Blue Line corridor in February and March, 2013 to introduce the project and solicit early public input. A second series of open public meetings was held in August, 2013 to present preliminary findings prior to completing the technical reporting process. Informational webinars were held in February and August, 2013 to describe the project and provide the opportunity for live question and answer sessions. A final public open house was held to present study results on November 14, 2013.

Recognizing that the study area represents a diverse spectrum of socio-economic groups, the public involvement process also utilized committees of neighborhood stakeholders, as well as minority and disadvantaged populations for planning inputs to the process. The Blue Line study area has pockets of dense Latino populations, so targeted outreach and public meetings included Spanish language materials available at all meetings and interpreters at select locations. Public involvement also included business to business outreach with members of the Indy Connect team visiting businesses along the corridor.

The planning process engaged advisory groups to help evaluate conditions and findings in the study process. The feedback from these groups helped refine messages and exhibits used with broader audiences. Each advisory group was assembled to represent specific points of view. The guidance provided by advisory groups contributed to improved understanding of technical information, improved clarity in the presentation of findings, and enhanced contextual understanding of potential impacts related to recommendations.

- **Minority Advisory Committee:** includes representation of minorities and disadvantaged populations including social service groups, citizens, business owners, and leaders.
- **Downtown Advisory Committee:** a combination of downtown property owners and managers, economic development groups, civic and visitor associations, destinations, and parking interests.

The Blue Line Corridor Alternatives Analysis team had several one on one meetings with business and community groups in the study area. These engagements provided opportunities to clarify and understand specific conditions of the corridor, as well as better understand the goals of business and

community groups in the study area. Additionally the project team provided several public updates and progress reports to key stakeholders with the Indianapolis Regional Transportation Council Technical and Policy Committees, the Board of the Central Indiana Regional Transportation Authority, and IndyGo.

In addition to the Indianapolis MPO, IndyGo and CIRTA, the Blue Line corridor represents other unique constituencies such as the Town of Cumberland, Town of Plainfield, and the Indianapolis International Airport. Engagement with these municipal entities was maintained in an effort to balance the diverse needs of the corridor with the various transportation goals in the study area.

1.3 *Prior Studies*

The Central Indiana region has long recognized the need for public transportation improvements, and has undertaken several planning studies that address this issue in recent years. The studies most relevant to transit planning in the Blue Line corridor and their significant findings are summarized in this section.

1.3.1 Indy Connect Long-Range Transportation Plan Update

In February 2010, the Indianapolis MPO initiated a year-long process known as Indy Connect to update the Long-Range Transportation Plan (LRTP), with a forecast year of 2035. Recommendations from the Central Indiana Transit Task Force (CITTF) were used as the starting point for the discussion of the transit element of the plan. Through a series of public meetings and outreach events, the public was tasked with reacting to the CITTF recommendations and encouraged to provide project specific recommendations to the Indianapolis MPO with respect to routes, types of transportation, and funding.

The Indy Connect process provided a consensus-based "blueprint" for moving forward with high priority transit initiatives. The resulting Transit Vision Plan component of the LRTP identifies the Blue Line corridor as a high priority. Additional initiatives include pursuit of a Green Line (Northeast Corridor) DEIS and a Red Line (North/South Central Corridor) AA. These parallel planning efforts are ongoing.

1.3.2 IndyGo Downtown Transit Center Studies

In 2006, IndyGo completed a feasibility study of a Downtown Transit Center, with the purpose of optimizing bus routing in downtown Indianapolis and examining alternate sites for a Downtown Transit Center. The study recommended three potential locations on the south side of downtown for a future transit center, including two sites near Union Station. After the study was completed, focus shifted to the Post Office site on South Street between Capitol Avenue and Illinois Street. The Postal Service was considering relocating the facility. IndyGo confirmed the Post Office site In a new study in 2009. In 2011, however, the Postal Service determined that it would retain the site and a new study was undertaken.

In 2012, IndyGo and the City of Indianapolis selected a publicly-owned site on the south side of Washington Street for the Downtown Transit Center. The site is across Washington Street from the

Indianapolis-Marion County City-County Building between Delaware Street and Alabama Street. The site location is shown on Figure 1.4.

In November 2012, the Indianapolis MPO hosted a regional stakeholder workshop to discuss the implications of the Downtown Transit Center site on the Indy Connect transit system plan, downtown circulation, and economic development opportunities. Several options were evaluated for connecting the Green Line, Red Line and Blue Line rapid transit corridors, a downtown circulator, and local bus services at the Downtown Transit Center. Additional meetings are being held as the Downtown Transit Center plans continue to define the best downtown routing plan to serve the Blue Line as well as other components of the overall Central Indiana transit system.

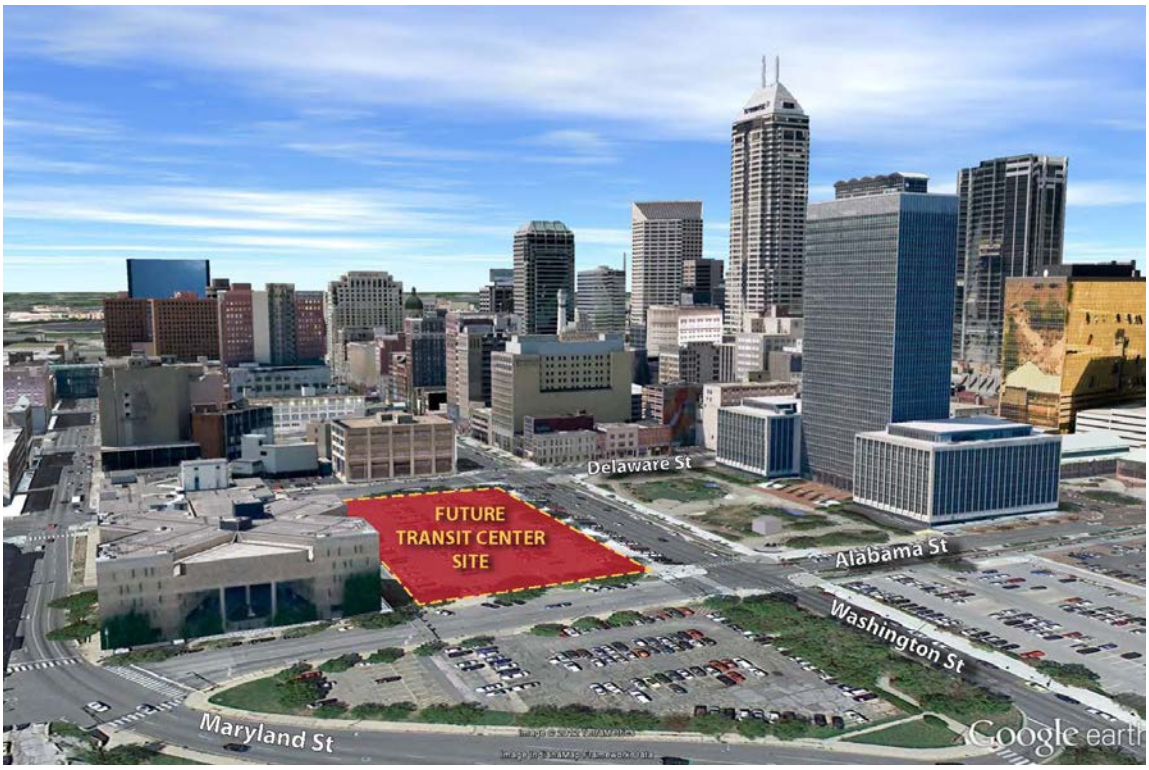


Figure 1.4 Downtown Transit Center Site

1.3.3 Indianapolis MPO Travel Survey

The Indianapolis MPO conducted a major travel survey of Central Indiana in 2009. The survey was the first in-depth study of urban household travel behavior in Central Indiana in more than 40 years. The data collection included telephone interviews beginning with a series of questions concerning the household's size and composition, vehicle ownership and access, and household socioeconomic status. Each household was then asked to complete a travel diary documenting all trips made in a 24-hour day.

The survey included approximately 4,000 households in Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, and Shelby counties.[1]

1.3.4 IndyGo On Board Survey

A survey of riders on IndyGo buses was conducted to provide information on current demographics and travel patterns in support an update of the Indianapolis MPO travel demand model. Coupled with new information on regional travel patterns and roadway system performance, this transit system data will improve the performance of the model and enable it to meet FTA New Starts requirements for evaluation of project ridership and cost effectiveness. This level of supporting data has not been available since the model was first formulated in the mid-1960's.

1.3.5 IndyGo Comprehensive Operations Analysis

In 2010, the Indianapolis MPO and IndyGo conducted a detailed analysis of existing bus transit services, current and future travel patterns, peer transit systems in other cities, route performance, and operational issues. The Comprehensive Operations Analysis (COA), sometimes referred to as the "Bus Plan", made recommendations for the phased development of improved bus services throughout Marion County and its surrounding counties through 2020, including improvements to bus service levels and coverage area. The study recommendations were used to define the priorities for BRT corridors, frequent service corridors, and expansion of local bus services in the Indy Connect transit system plan.[2]

1.3.6 Local Area Studies

West Washington Street Corridor Plan (2012)

Adopted in April, 2012, the West Washington Street Corridor Plan prepared by Indianapolis DMD amends portions of the Comprehensive Plan for Indianapolis-Marion County by providing further direction for development in the area surrounding West Washington Street between North Tibbs Avenue and the west leg of I-465. The West Washington Street Corridor Plan provides land use, zoning, and development recommendations for consideration when new development or revitalization is proposed in the corridor.

The West Washington Street Corridor Plan includes specific recommendations related to transit in the corridor. Alternate routes are reviewed, and Washington Street is identified as the preferred east-west

[1] Indianapolis MPO. "Central Indiana Travel Survey" and "On Board Passenger Survey". Available at http://www.indympo.org/Data/SurveyData/Pages/home.aspx

[2] Indianapolis Public Transportation Corporation (IndyGo), *Comprehensive Operational Analysis,* 2010. Available at http://staging.indygo.net:8080/pages/transit-planning

route through the area. A BRT system is proposed, with retention of IndyGo Route 8 to provide service between BRT stations located approximate one-half mile apart. Suggested transit station criteria are provided, along with recommendations to enhance TOD opportunities, including medium to high density residential uses near stations, maximum building heights, and the provision of mixed use park and ride lots. Bus stop improvements and additional pedestrian access facilities are also recommended.

Town of Plainfield Comprehensive Plan (2004)

The Town of Plainfield's Comprehensive Plan outlines objectives for improved transit services in the US 40 corridor. At the time of adoption of the Comprehensive Plan, light rail, BRT and automated guideway transit were being considered for regional service as part of the 2003 MPO "Directions" study. The Transportation element of the Plainfield plan identifies the following objectives and actions:

- *Study and determine the feasibility and location for a future light rail station in Plainfield*
- *Coordinate transportation improvements with other jurisdictions including…the Indianapolis Metropolitan Planning Organization*
- *Strengthen identified…east-west access in order to implement the future land use plan*
- *US 40 will continue to operate near capacity. Traffic volumes on US 40 are currently near 40,000 vehicles per day on the east side of Plainfield. This demand could approach 50,000 vehicles per day through most of Plainfield.*
- *Consideration should be given to the location of [the] station[s] as well as additional connections from the Town, including pedestrian and bicycle facilities.*
- *If the regional transit plan moves forward, the Town should update the zoning ordinance to encourage transit oriented development.*

Indianapolis Insight: The Comprehensive Plan for Marion County (2002)

As more fully defined in Indy Connect, implementation of regional transit improvements are also consistent with an important Value Statement outlined in the long-term plan for Indianapolis-Marion County:

- *We should continue to improve our transportation system so that it is well-connected, convenient, and safe. We should provide a variety of transportation choices so that all people regardless of age or ability can travel throughout the region. Both the transportation system and the infrastructure system should anticipate and guide growth of the metropolitan area.*

Town of Cumberland Comprehensive Plan (2010)

In its Comprehensive Plan, the Town of Cumberland outlined a number of transit-oriented goals and objectives which are consistent with the plan for improved transit services in the US 40 corridor:

- *Goal #5 – Build a strong sense of community through community driven neighborhoods, parks, trails, and recreation opportunities.*
  - *Objective 8: Engage in transit oriented development planning and ordinances with the City of Indianapolis for areas near bus lines or other types of transit.*

- *Goal #6 - Maintain a safe transportation system and expand multi-modal transportation facilities for the residents of Cumberland.*
  - *Objective 2: Encourage expanded transit opportunities like rail service to downtown Indianapolis.*
  - *Objective 7: Adopt a transit oriented development ordinance to address development near the E. Washington Street transit corridor.*

1.4 ***Report Organization***

The process documented in this report is structured to answer a series of key questions that guide the selection of a recommended alternative for the Blue Line. Initial topical investigations are related to the corridor itself, and assessed primarily through market analysis and traffic analysis, to establish a geographic footprint for the evaluation of operating plan alternatives. Feasible running way treatments and optimum station locations are defined to facilitate the development of operating plans. Vehicles and service frequency are addressed, resulting in a limited set of viable alternatives that are defined in more detail and evaluated. The final screening step further refines the feasible alternatives with regard to operating plans and service features to optimize cost effectiveness in the context of funding strategies.

This report is organized into the following chapters:

- Chapter 2, "Project Vision and Goals", sets the foundation for this study by defining the goals for the Blue Line project in the context of the regional transit vision plan. It reviews the Transit Vision for Central Indiana, associated transit planning principles, and characteristics of premium transit service. The most promising service types for the Blue Line Corridor are identified and specific project goals are defined.

- Chapter 3, "Planning Context", establishes the planning context of the Blue Line corridor. It describes existing land uses and activity centers, socioeconomic conditions, existing transit service, use of existing right-of-way, and current traffic service levels and operations in the corridor. Opportunities and constraints for providing premium transit service are determined by the physical and operational conditions described in this chapter.

- Chapter 4, "BRT System Concepts", describes BRT components that might be provided as part of the Blue Line system. Running way concepts, transit priority signal treatments, potential BRT station features, and station placement options are described. These are core elements of the alternatives evaluated in subsequent chapters.

- Chapter 5, "Blue Line Market Analysis", begins the process of defining Blue Line alternatives by analyzing the transit market served. It reviews regional travel patterns as defined by the MPO regional travel demand model, current trips served by IndyGo users from rider survey results, transit stop activity from IndyGo's GPS-based automatic passenger counter system, and transfer

volumes from IndyGo farebox data. The travel patterns described in this chapter are useful in defining the most important route and segments of Blue Line alternatives and operating plans.

- Chapter 6, “Blue Line Alternatives Definition”, defines Blue Line Alternatives to be evaluated. Components of the alternatives are developed in consideration of the physical constraints of the corridor and the markets to be served. Using existing Route 8 ridership as a base, these components are used to develop estimates of potential future ridership, which drives the definition of preliminary service plans. The alternatives for evaluation are defined by corridor segment served, running way configuration, stations, vehicles and service plan.

- Chapter 7, “Evaluation and Recommendation”, provides an evaluation of the alternatives defined in Chapter 6. The alternatives are evaluated using performance measures that relate to the project goals presented in Chapter 2. Capital and operating costs are defined, and a recommended alternative is identified.

2.0 PROJECT VISION AND GOALS

In February 2011, the Indianapolis Regional Transportation Council (IRTC) Policy Committee adopted a long range vision for transit in Central Indiana, following a year-long process of public outreach and dialogue for the initial Indy Connect effort. The Transit Vision Plan establishes transit as a key component of the region's 2035 Long Range Transportation Plan (LRTP) and identifies objectives, priorities, and guidance for the development of projects, including the Blue Line, in the context of the overall plan.

The adopted vision statement presented in the adopted Transit Vision Plan provides the foundation for the project goals of the Blue Line project.

2.1 *A Transit Vision for Central Indiana*

The transit vision statement introduced in the 2035 LRTP provides a basis for future transit planning in Indianapolis-Marion County and the surrounding counties, reflecting the system-level planning work conducted by the Indianapolis MPO. The statement was informed by broad-based input from citizens throughout the area.[3] The Transit Vision Statement[4] is shown below.

A Vision for Transit Investment in Central Indiana

Mobility and accessibility in Central Indiana will be enhanced through the development of a comprehensive network of public transit. Building on a strong transportation legacy, attractive alternatives to private automobile use will again be offered to all Central Indiana residents. Rather than continuing to lag behind comparable Midwestern cities in providing sustainable mobility options, Central Indiana will become a model of a comprehensive and efficient provision of public transit. The region as a whole will reap the environmental and economic rewards of a thoughtful and proactive strategy to incrementally create a complete public transit network, and round out the region's transportation system.

[3] The MPO area includes Marion County and portions of Boone, Hamilton, Hancock, Hendricks, Shelby, Morgan and Johnson counties.

[4] "Indianapolis Metropolitan Planning Area, 2035 Long-Range Transportation Plan—Volume 1", February 15, 2011, p. 7-4.

Consistent with the transit vision statement, the 2035 LRTP includes a recommended set of projects based on cost-benefit measures, estimates of potential revenues, and consistency with a set of transit planning principles. One of the key early projects identified in the plan is an east-west BRT line in the vicinity of Washington Street, which is the basis for initiating an Alternatives Analysis for the proposed Blue Line.

2.2 *Transit Planning Principles*

The Transit Vision Plan provides a set of planning principles to guide the design and operation of the planned system.[5] These principles, related to system design, economic development, and sustainability, are presented in their original form below. Some relate to overall system management. Others focus on the development of individual projects such as the Blue Line. Project level elements that are most relevant to the development of goals for this project are highlighted in **bold**. These highlighted project principles served as the basis for generating specific project goals for the Blue Line, which are presented in Section 2.4.

System Design Principles

- Create a comprehensive public transit system incrementally, managing risk by expanding the system in phases that build effectively upon one another and by considering the logistics of providing uninterrupted service during upgrades.
- **Provide initial service upgrades to and between origin-destination markets in which public transit can be competitive with private automobile use, while maintaining and improving essential services in existing transit-dependent areas.**
- Develop the transit system with special consideration for the ease of connections between transit services and travel modes to ensure a user-friendly and efficient system.
- **Attract new transit users by offering high quality, user-friendly, and convenient service that provides an attractive alternative to private automobile use.**
- Balance needs for high capacity limited stop routes and local "last mile" connecting routes, with an appropriate hierarchy of service types and schedules to meet the needs of different types of transit users.
- **Build on the existing IndyGo bus service network to provide more direct, more frequent, and faster travel options throughout the region.**
- Build upon the existing network of underutilized rail rights-of-way and the arterial street network.
- **Select transit technologies that utilize existing technologies in a cost-effective manner.**

[5] "Indianapolis Metropolitan Planning Area, The Indy Connect Transit Vision Plan—Volume 3", February 16, 2011, pp. 12-13.

- **Coordinate efforts to implement traffic signal priority (TSP) technology in Central Indiana as a means to improve emergency response times and traffic safety, in addition to realizing the applicable transit service benefits.**

Economic Development Principles

- **Leverage public investment in transit by providing improved service to established activity centers and areas with economic development potential, in support of broader community goals.**
- **Provide increased service to the downtown as a uniquely pedestrian-friendly destination, thereby reducing the demand for parking spaces in the downtown and providing for additional development opportunities.**
- Expand beyond the historic radial and downtown-centric pattern of the transit system to better serve cross-town travel patterns and non-centralized activity centers.
- **Utilize transit as a catalyst to support economic growth, retain existing businesses, attract new businesses, and stimulate redevelopment efforts.**

Sustainability Principles

- Encourage the development of a hierarchy of activity centers outside the downtown including transit-supportive land use development over time, thereby reducing automobile dependence in places other than the downtown core.
- **Mitigate increasing traffic congestion by enabling a convenient mode shift to transit for many Central Indiana residents.**
- **Encourage increased use of public transit as a key element in regional efforts to improve air quality and reduce greenhouse gas emissions.**

The application of these principles is evident in a range of activities currently underway in the region, including the Indy Rezone project (funded by a HUD Challenge Grant), promotion of transit investment by Indy Connect Now, the Sustainability Initiatives by Indianapolis Mayor Greg Ballard, the Downtown Transit Center development by IndyGo, and transit oriented development (TOD) studies in conjunction with current transit development projects.

All of these initiatives are in concert with the vision put forward by Indy Connect. The Blue Line serves a special role by providing an early example of how these principles can be applied effectively at a project level to provide premium transit for the region. The next section describes the characteristics of premium transit and reviews potential modes for use in the Blue Line corridor. This is followed by the definition of Project Goals.

2.3 *Characteristics of "Premium Transit" Service*

The Indy Connect transit system plan identifies the Blue Line rapid transit corridor among the first of several regional corridors where premium transit will be developed. Premium transit is characterized by customer-friendly features, including defined routes, substantial stations, frequent service, transit signal priority, customer information systems, and special branding. Commuter rail transit (CRT), heavy rail transit (HRT), light rail transit (LRT), and bus rapid transit (BRT) are the most common forms of premium transit in the United States.

2.3.1 Commuter Rail Transit

Commuter rail transit (CRT) systems using locomotive-hauled coaches or diesel multiple unit (DMU) vehicles are ideally suited for railroad use over a long distance where service is typically less frequent than other modes, and station stops are limited. There is no railroad available in the corridor and the development patterns in the corridor call for frequent service with many stops along the route. CRT would not be an effective option for meeting Blue Line project goals due to the type of service provided. Therefore, commuter rail transit is excluded from consideration in this AA.

2.3.2 Heavy Rail Transit

Heavy rail transit (HRT) provides high passenger capacity in dense corridors using electric trains operating on dedicated tracks that avoid grade-level crossings with other modes of transportation. The high capacity provided by this mode requires large capital investment and high ongoing operating costs. The travel demand in the Blue Line corridor does not reach the level required to provide cost-effective HRT service. Furthermore, the high investment levels required are not consistent with the financial resources identified in the Indy Connect plan. Heavy rail transit is therefore excluded from consideration in this AA.

2.3.3 Light Rail Transit

Unlike CRT and HRT, light rail transit (LRT) is capable of operating within street rights-of-way. Today's light rail transit systems offer frequent service with stops that are spaced effectively for an urban setting. The potential attractiveness of LRT in the corridor is reflected in the first Indy Connect plan developed by the Central Indiana Transit Task Force and presented for public discussion in December, 2010. After a year of public dialogue and extensive financial and cash flow analysis, the LRT line was removed from the plan in lieu of the proposed Blue Line corridor BRT line, as the Indy Connect funding assessment found LRT to not be financially feasible before 2035. The adopted Transit Vision Plan calls for bus rapid transit (BRT). Given the potential benefits offered by BRT, and the financial constraints of the program, LRT is also excluded from consideration in this AA.

2.3.4 Bus Rapid Transit

BRT provides the best opportunity to introduce customer-friendly premium transit features that are unavailable on today's system. The success of a high quality BRT line in this corridor would build momentum for the entire Indy Connect program, and the service is "right sized" in the context of the carefully developed Indy Connect financial plan. For these reasons, BRT will be advanced through the detailed alternatives evaluation stages of the AA process. The detailed alternatives will explore trade-offs in system components and operating characteristics for BRT service in the corridor.

The term Bus Rapid Transit (BRT) was defined in the latest federal transportation legislation, MAP-21, to include two varieties with respect to dedicated lanes, referred to as dedicated right-of-way. "Corridor-based BRT" is defined as systems operating with less than 50 percent dedicated right-of-way, while "fixed-guideway BRT" has more than 50 percent dedicated right-of-way. Corridor-based BRT is only eligible for federal funding through the FTA Small Starts program; fixed-guideway BRT is eligible under both Small Starts and New Starts FTA funding programs.

The MAP-21 definition of BRT establishes a minimum service level and feature set needed to qualify for discretionary federal funding under the Section 5309 Small Starts Capital Investment Grant program.[6] Total project cost cannot exceed $250 million, with no greater than $75 million in Small Starts funding requested. The project must operate in a fixed guideway (a dedicated busway) for at least 50% of its length, AND/OR include the following elements: substantial stations, signal priority systems, level boarding vehicles, special branding, 10 minute peak and 15 minute off-peak headways, and service offered at least 14 hours per day. To maintain the option of seeking federal funding, the AA process will identify how a transit service that meets these minimum criteria could be implemented in the Blue Line corridor.

2.4 *Project Goals*

The Transit Vision Plan identifies the Blue Line as one of the best opportunities to achieve overall program goals while improving service to a large number of current IndyGo users in a manner that is cost effective and financially achievable in the near term. As one of the first lines to be provided with enhanced service, the Blue Line will need to set the bar high for a new level of transit service for the region.

A preliminary set of project goals was presented in the Blue Line Conceptual Definition report in June, 2013. In consideration of the overall context of the regional Transit Vision Statement and the transit planning principles listed in Section 2.2, these have been expanded to provide the following set of goals for the Blue Line Corridor Alternatives Analysis:

[6] www.fta.gov/documents/small_starts_fact_sheet.doc

Blue Line Project Goals

1. Improve transit travel times and service frequencies in the corridor.

2. Increase corridor transit ridership.

3. Maintain or improve service levels provided to low-income and zero-car households.

4. Serve areas with high potential for transit-supportive economic development.

5. Introduce customer-friendly transit features to the region as an initial "premium transit" project in a cost-effective manner.

6. Promote sustainability by reducing traffic congestion and improving air quality.

7. Maximize these opportunities within the context of an achievable financial plan.

These goals are intended to guide project development during the current Alternatives Analysis and establish a basis for the Purpose and Need statement to be developed in subsequent environmental studies. The goals will be advanced in the context of the broader set of principles identified in the Transit Vision Plan. To the degree these goals are achieved, the project will be a success in meeting corridor needs and opportunities, while advancing the transit vision for the region.

3.0 PLANNING CONTEXT

3.1 *Corridor Description*

The 23.5-mile Blue Line study corridor is centered on Washington Street/US 40 from Plainfield on the west to Cumberland on the east. US 40 can trace its beginnings to the National Road (or Cumberland Road) which was the first federally funded improved road in the United States, constructed between 1829 and 1834. It began in Maryland and stretched through Indiana to its western terminus in Illinois. US 40 was one of the original US highways developed in the 1920s and originally traversed the country from New Jersey to California. The roadway does not function as a cross country route today, as it has been supplanted by Interstate 70, but it continues to provide a transportation linkage between Indiana's rural areas, suburban nodes and urban centers.

The west edge of the study area is Center Street in the Town of Plainfield, in rapidly developing Hendricks County. According to the US Census, Plainfield grew nearly 50 percent between the year 2000 (population 18,296) and 2010 (population 27,631). Its historic town center, located at the intersection of Center Street and US 40 (Main Street), contains a number of historic buildings dating back to the mid- to late-1800s. These historic buildings are densely spaced and built to the edges of their lots. The small-scale commercial buildings provide for a walkable downtown. There are adjacent grid streets with residential homes from the early 20th century.

As the corridor continues to the east, the land use becomes more suburban and auto-centric. There are a number of fast-food chain restaurants and national retailers in strip malls. These uses are centered around US 40, which functions as a major suburban arterial. A major destination in this area is the Metropolis Mall, which lies at the southwest corner of US 40 and Perry Road. The mall is referred to as a "lifestyle center" which is an open-air complex centered around a walkable core containing a variety of retail and restaurant uses. The mall opened in 2005 and contains a JC Penney, Dick's Sporting Goods, and Carmike Cinemas as its main anchors.

Figure 3.1 Metropolis Mall, Plainfield

A number of warehouses and light industrial facilities are located near the Metropolis Mall in the Plainfield Business Park. This cluster of distribution warehouses is among the largest in the United States and is located immediately west of Indianapolis International Airport and south of US 40, between the Ronald Reagan Parkway and State Route 267. There are major distribution centers for Amazon.com, Eli Lilly & Company, Pep Boys, Dick's Sporting Goods, and JC Penney. Buildings range from 500,000 to over 1,000,000 square feet and are spread out over four square miles.

3.1.1 Airport

Indianapolis International Airport, south of Washington Street/US 40, is one of the most significant destinations in the corridor. It provides 141 daily flights to 33 non-stop destinations on eight major airlines. The airport served nearly 7.5 million passengers in 2011. It is the country's eighth largest cargo center and home to the second largest FedEx operation in the world. The 1.2 million square foot Weir Cook Terminal opened in November, 2008, at a cost of approximately $1.2 billion. About 10,000 people work at the airport each day.

Figure 3.2 Weir Cook Terminal

3.1.2 Far West Washington

East of the airport, US 40 continues as a major arterial and crosses key intersections at Girls School Road and High School Road before intersecting with I-465. Land use is a mix of older commercial property near U.S. 40 and more modern (post World War II) retail areas with large paved areas for parking.

Figure 3.3 Festival Flea Market (former Target store) near I-465

At I-465, the jurisdiction of Washington Street shifts from INDOT to Indianapolis Department of Public Works (DPW), as US 40 follows I-465 around the south leg of the belt highway. Washington Street continues as a four-lane arterial through downtown Indianapolis then joins U.S. 40 again at I-465 on the east side of the study area.

3.1.3 Mid West Washington

This portion of the corridor is characterized by older suburban commercial properties fronting Washington Street. The commercial uses generally have a limited amount of off-street parking in front of the buildings. The surrounding single family residential homes were built in the 1920s and 1930s, and most are on 40-foot by 130-foot lots with detached or no garages. The neighborhoods were built on a grid street system. Major intersections in this area include Lynhurst Drive and Holt Road.

Washington Street crosses Rockville Road and Tibbs Avenue, then passes by the former Central State Hospital site, containing the Indiana Medical History Museum. A number of vacant institutional buildings remain on the 150-acre site since the facility closed in 1994. A 2007 land use plan by the Indianapolis Department of Metropolitan Development outlines urban-style commercial uses along Washington Street, single-family detached urban-style homes in the northeast quadrant, a cultural center in the center, and both active and passive recreational areas throughout the site. In September 2012, a new $20 million 144-unit multi-family apartment complex opened, known as "The Steeples on Washington," soon to be supplemented by a $13 million, 62-unit senior housing complex in 2013.

Figure 3.4 The Steeples on Washington

3.1.4 Near West Washington

Near West Washington Street continues through an older commercial area with multiple driveways and businesses located close to the roadway as was typical of urban state highways prior to the interstate highway era of the 1950s. On street parking is available in some areas on this section.

Near Belmont Avenue, the corridor passes through a commercial district dominated by small locally-owned businesses serving a vibrant Latino community. Identified as the "Avenue of the Americas District", this area is served by older commercial buildings with zero setback in a walkable environment.

Figure 3.5 Avenue of the Americas District, near Belmont Avenue

3.1.5 Downtown Indianapolis

Washington Street passes over White River Parkway and runs along the frontage of the Indianapolis Zoo located within White River State Park before crossing White River and entering the downtown from the west. In addition to functioning as an accredited zoological garden, the Indianapolis Zoo also contains an aquarium and a botanical garden. Nearly half a million people visit the 64-acre zoo every year.

Washington Street splits into a one-way pair with Maryland Street downtown, serving traffic in the eastbound and westbound directions, respectively. Washington Street passes a significant number of cultural resources, including the NCAA Hall of Fame, the Indiana State Museum, the Eiteljorg Museum and the Canal Walk. The IUPUI Campus, educating nearly 30,000 students and employing over 7,000 employees, is located within walking distance (0.3 miles from Washington Street) to the north.

The Washington/Maryland pair contains high-intensity commercial uses, including the Indiana State Government Complex, the Indiana Convention Center and the Circle Centre Mall. The PNC Corporate Center and the Simon Property Group headquarters are major employment land uses in this area. Nearby hotels include the JW Marriott, Marriott Indianapolis, the Hyatt, the Westin and the Conrad. Regional sports facilities, including Lucas Oil Stadium, Bankers Life Fieldhouse and Victory Field, are located within walking distance. The western area of downtown Indianapolis is the region's major concentration of government, convention facilities, and sports venues.

Monument Circle, the prominent public space in Indianapolis, is one block north of Washington Street at Meridian Street. The Ohio Street office core, which contains the highest employment density in the corridor, is two blocks north of Washington Street. This area is a major destination for transit riders in the IndyGo system.

The Downtown Transit Center (Downtown Transit Center), planned as the primary transit hub in the region, will be constructed across from the City-County Building on the south side of Washington Street between Delaware and Alabama Streets. Just to the east on the north side of Washington Street, a 28-story $81 million dollar mixed use tower is planned at the former site of Market Square Arena. The tower is expected to have 300 luxury apartments, 500 parking spaces, and 43,000 square feet of ground floor retail space.

Further east, another mixed use project is being constructed called "451 Market." This six-acre $31 million dollar project is a redevelopment of the former Bank One operations center, with 257 apartment units and 68,000 square feet of commercial space.

Figure 3.6 451 Market Project

3.1.6 Near East Washington

At New Jersey Street, Maryland Street rejoins Washington Street and the two-way roadway passes under I-65/I-70. A number of historic commercial buildings front Washington Street in this area. Further east, many of the retail and light industrial properties have been vacated. Walkable neighborhoods made up of single-family urban homes built in the early 20th century with alleys and detached garages are located within walking distance of Washington Street. The internet firm Angie's List is headquartered east of the intersection with Southeastern Avenue. Willard Park is the major recreational facility in this area.

Figure 3.7 Near Eastside Commercial District

3.1.7 Mid East Washington

The Irvington historic district is along Washington Street east of Emerson Avenue. The area developed as a planned neighborhood that was originally platted as an independent streetcar suburb and was annexed by Indianapolis in 1902. Irvington is the largest district on the National Register of Historic Places in Marion County. There are nearly 11,000 residents in this district. It includes a number of historic properties, such as the Benton House, the Stephenson Mansion, the Irving Theater, Irvington United Methodist Church, Irvington Circle, Ellenberger Park, and Howe High School.

Figure 3.8 Irvington Lodge, Business District

Small local shops are located in a pedestrian-friendly setting fronting on Washington Street, east of Ritter Avenue near the intersection of Audubon Road. In 2012, streetscape enhancements were made in this area, including new pavement, curbs, sidewalks and street lights. While there is some multi-family housing in the area, the neighborhood primarily consists of single-family detached residential structures from the early 20th century. The neighborhood is highly walkable and contains several curvilinear streets within a modified grid.

East of Arlington Avenue, Washington Street passes the Pleasant Run Golf Course and the setting changes with buildings that are located farther from the street. The neighborhood consists of single-family cape and bungalow residential homes with detached garages built in the 1940s.

Washington Street passes over Shadeland Avenue at an access controlled interchange. Shadeland Avenue is essentially a dividing point between urban and suburban development patterns. The area between Shadeland Avenue and I-465 has an auto-oriented form with commercial buildings separated by large setbacks. Two major car dealerships, Indy Hyundai and Ray Skillman Buick GMC, are located along Washington Street in this area. Residential density declines as Washington Street transitions into a commercial strip dominated by national chain fast-food establishments and post-World War II residential subdivisions, with many homes built in the 1950s.

3.1.8 Far East Washington

The pattern of auto-oriented first ring suburbs continues to the east of I-465. The area consists of single-family neighborhoods with low intensity commercial activity fronting Washington Street/US 40. There are a number of underutilized or vacant strip malls from the 1960s and 1970s and abandoned shopping centers from recent decades. A major cross street is Post Road, providing interchange access to I-70 approximately two miles to the north. The area southeast of Post Road and Washington Street contains areas of farmland dotted with subdivisions built since approximately 2000, including Creekside Woods, Cedar Spring, and Irongate. The Memorial Park Cemetery occupies much of the frontage on the north side of Washington Street/US 40 between Post Road and Mitthoefer Road.

Washington Square Mall is located on Washington Street/US40 at Mitthoefer Road. The shopping center serves as a major destination for IndyGo riders on Route 8. When the mall opened in 1974, it included several major anchor tenants, including JC Penney and Macy's. The mall remains the site of national retailers, including Target and Dick's Sporting Goods. The retail concentration at Washington Square Mall could support improved transit service along Washington Street.

Figure 3.9 Washington Square Mall

Washington Park Cemetery East is located on the north side of Washington Street/US 40 east of the mall. German Church Road is the last major arterial that Washington Street/US 40 crosses in the corridor and is the boundary of the Town of Cumberland (population 5,169 per Census 2010). Like Plainfield on the west end of the corridor, Cumberland was a small farming town that was suburbanized after the construction of I-465. A shopping center that includes a Meijer store, a popular destination for residents on the east side of Indianapolis, anchors the east end of the Blue Line corridor in a suburban auto-oriented shopping center area with extended setbacks from the street. A large apartment complex exists to the north. With pedestrian improvements, these land uses could support improved transit service in the corridor.

Figure 3.10 Downtown Cumberland

3.2 *Corridor Land Use and Neighborhood Organizations*

The study area is divided into 15 districts to support the socioeconomic review and market analysis, as shown in Figure 3.11. The districts are structured to capture areas located within walking distance or a short bicycle ride or auto trip of Washington Street. These areas are considered to be the primary markets for transit service in the Blue Line corridor. The study area also includes parallel arterials on 10th Street and Michigan Street, due to their role in serving east-west travel through the study area.

Districts are formed by combining traffic analysis zones (TAZs) that cluster around selected major east-west arterials in the corridor. TAZs are small geographic areas used by the MPO travel demand model to evaluate trips. The districts are defined to distinguish areas with major differences in development density and land use patterns (e.g. relatively walkable neighborhoods inside I-465 and more automobile-oriented suburban areas outside I-465). The regional center is divided into four districts to distinguish the downtown area around Monument Circle and the Downtown Transit Center from the peripheral activity centers around IUPUI, North Meridian Street, and Massachusetts Avenue.

Current land use along the Blue Line Corridor is illustrated on Figure 3.12. The largest single land use is Indianapolis International Airport on the west side of the corridor. Washington Street/US 40 is mostly fronted by commercial property, typically in a narrow band with residential areas located nearby. Concentrations of commercial property are located downtown, near the airport, near Shadeland Avenue, and outside I-465 in the vicinity of Washington Square Mall. Most residential property is low density, though there are areas of medium density residential use at some locations, most notably east of the downtown area. The largest areas of institutional use are downtown and on the west side of Plainfield. Other institutional uses along the corridor are typically cemeteries or schools.

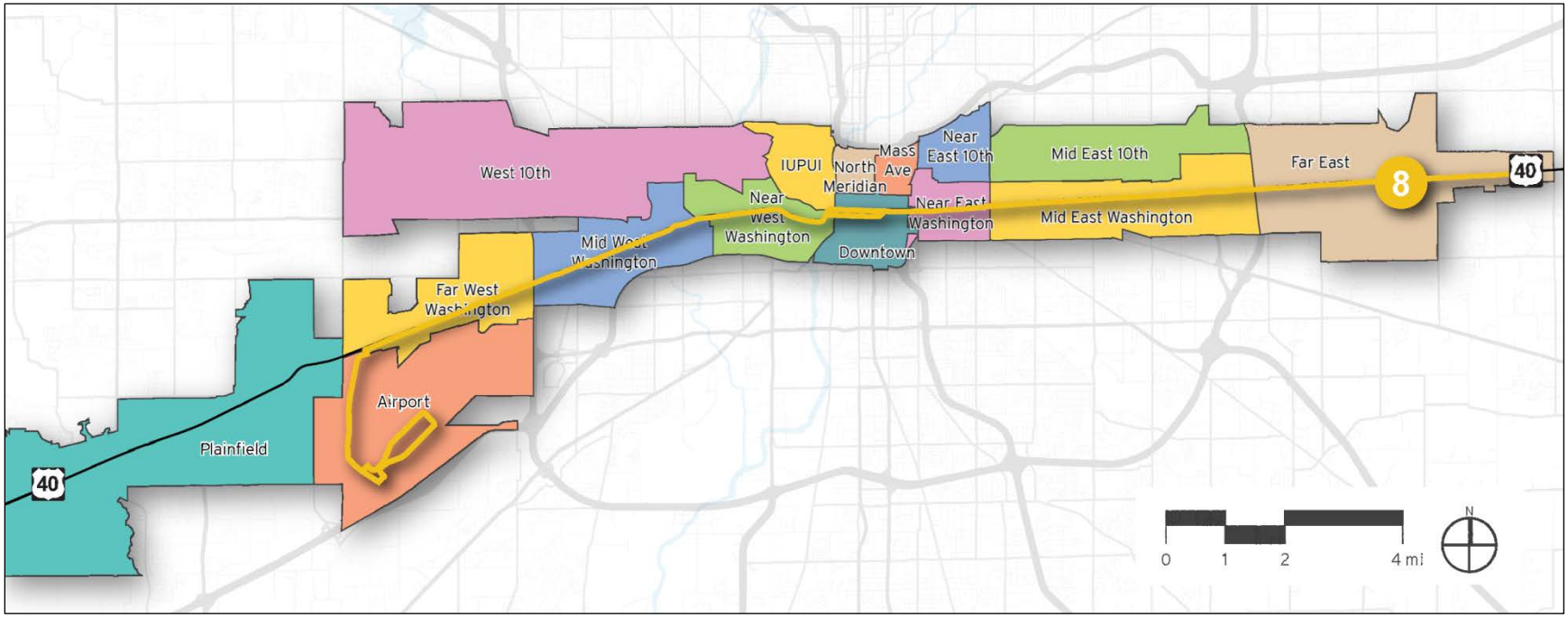


Figure 3.11 District Boundaries

Source: Compilation of traffic analysis zones of the Regional Travel Demand Model of the Indianapolis MPO

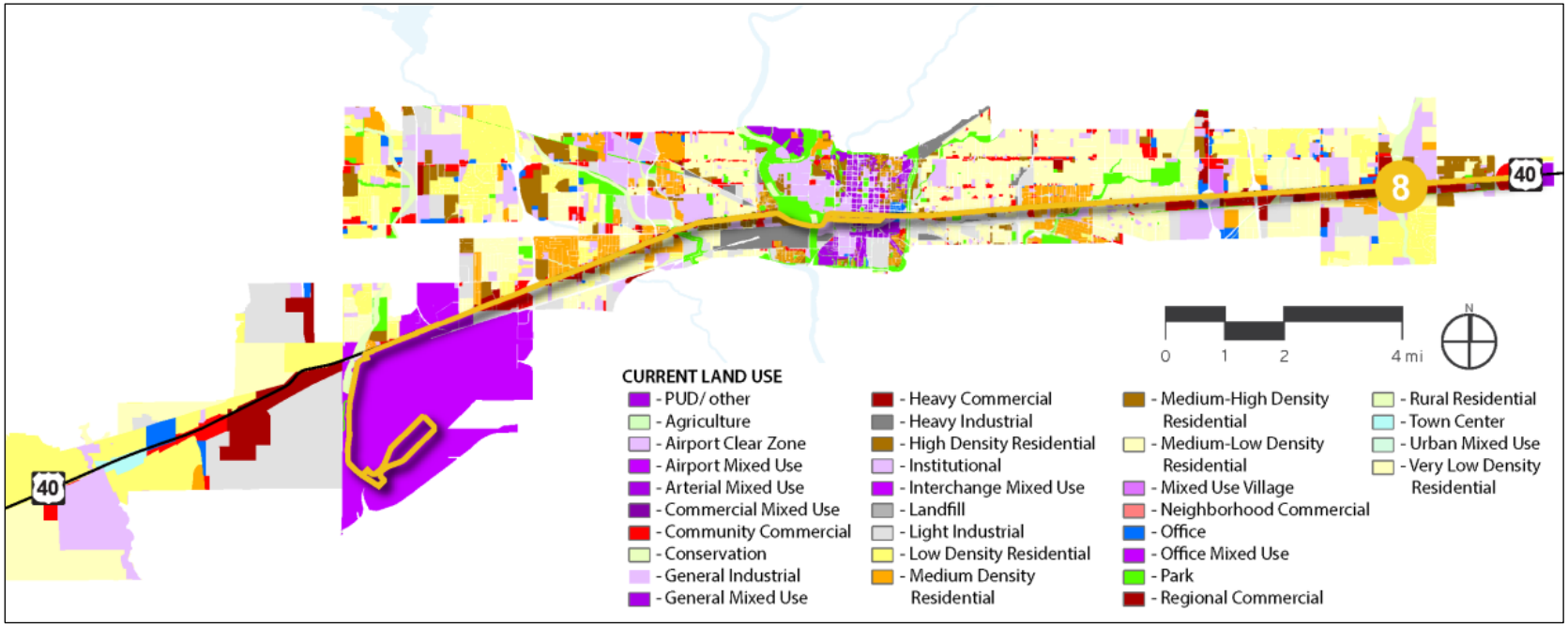


Figure 3.12 Current Land Use in the Blue Line Corridor

Source: Indianapolis Department of Metropolitan Development

Future land use, as presented in the Comprehensive Plans for Marion County and Plainfield is illustrated in Figure 3.13. Large areas of medium density residential use are evident both east and west of downtown. Industrial concentrations are located near downtown to the west and southeast, in Plainfield, and near Shadeland Avenue. Otherwise, the future land use pattern appears much as it does today, with a band of commercial properties fronting Washington Street/US 40 along nearly the full length of the corridor.

The Blue Line Corridor passes through a number of residential neighborhoods. Figure 3.14 shows the many neighborhood organizations that are active, ranging from small homeowners associations to large scale development corporations. Contacts are being made with many of these groups in stakeholder interviews to share information about the Blue Line project.

3.3 *Socioeconomic Characteristics*

As indicated by the range of land uses and neighborhoods in the study area, the corridor between Plainfield and Cumberland has a variety of socioeconomic characteristics. According to Census 2010, there are approximately 133,429 people (52,696 households) living within one-mile of Washington Street along the corridor.

Generally, the areas in the corridor on the south side of Washington Street from downtown east to I-465 have lost population (approximately one percent since 2000). Areas at the east and west ends of the corridor, near Cumberland and Plainfield, grew in population by one to three percent during the same timeframe. These suburbanization patterns are consistent with post-World War II trends of the region.

Figure 3.15 shows the population density in the Blue Line study area. The portion of the study area with the greatest population density, due to its gridded blocks with single-family residential homes on relatively small lots, is on the near east side between downtown Indianapolis and Sherman Drive. Generally, the population density is lower on the west side of the corridor than it is on the east side.

As illustrated in Figure 3.16, employment density shows a very different pattern than population density in the corridor. By far, the greatest concentration of employment in the study area is downtown, with limited employment on the east side, particularly near Shadeland Avenue, and moderate concentrations at the airport and north of the airport along I-465. The dispersed but significant employment of the warehousing and light industrial areas of Plainfield can be seen west of the airport area.

The U.S. Census Bureau uses a measure called the Diversity Index to measure the overall mix of races and ethnic groups in an area. As defined by the Census Bureau, the Diversity Index "represents the likelihood that two persons, chosen at random from the same area, belong to different race or ethnic groups." Values range from 0 (no diversity) to 100 (complete diversity). An area's diversity index increases to 100 when the population is evenly divided into two or more race/ethnic groups.

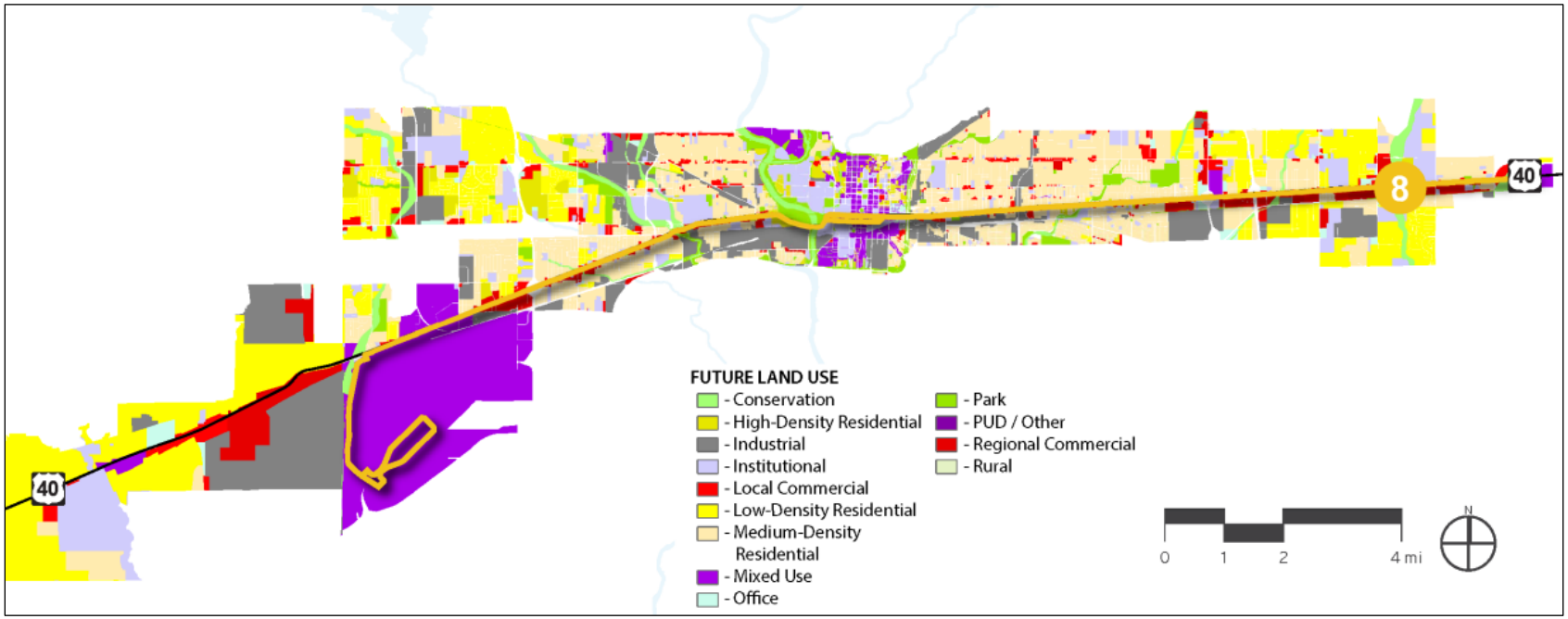


Figure 3.13 Future Land Use Types in the Blue Line Corridor

Source: Indianapolis Department of Metropolitan Development

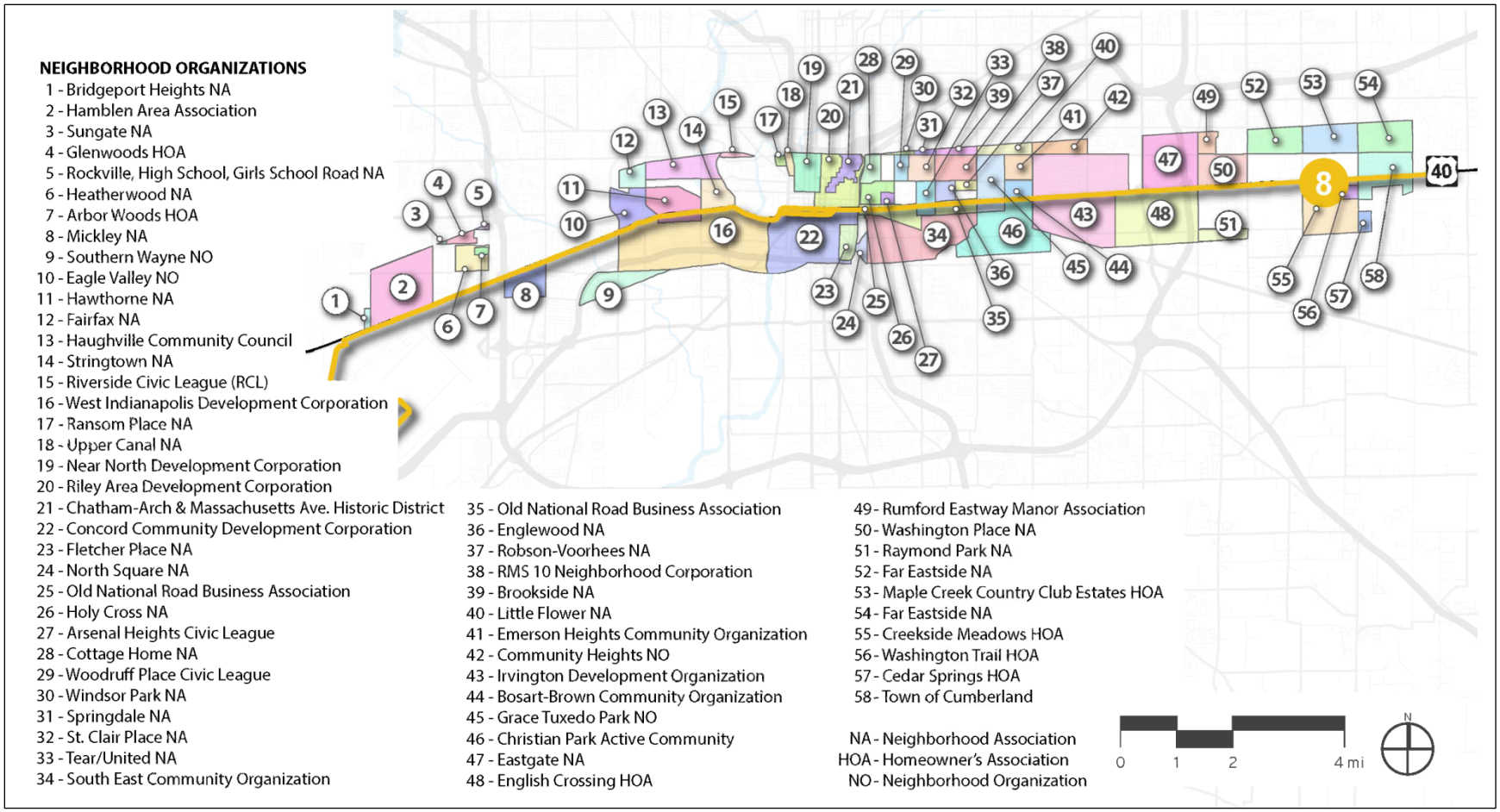


Figure 3.14 Neighborhood Organizations in the Blue Line Corridor

Source: Indianapolis Department of Metropolitan Development

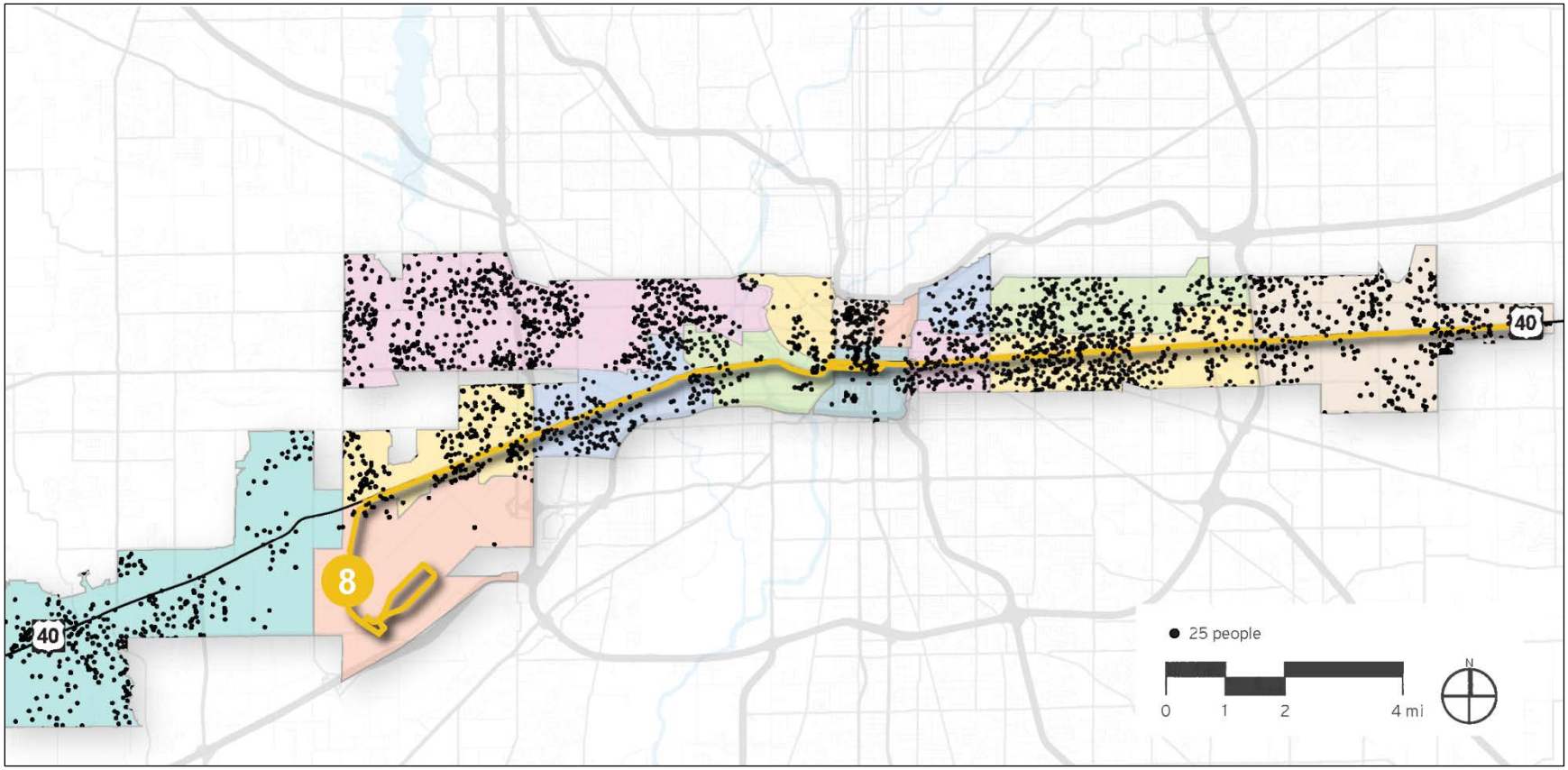


Figure 3.15 Population Density

Source: U.S. Census

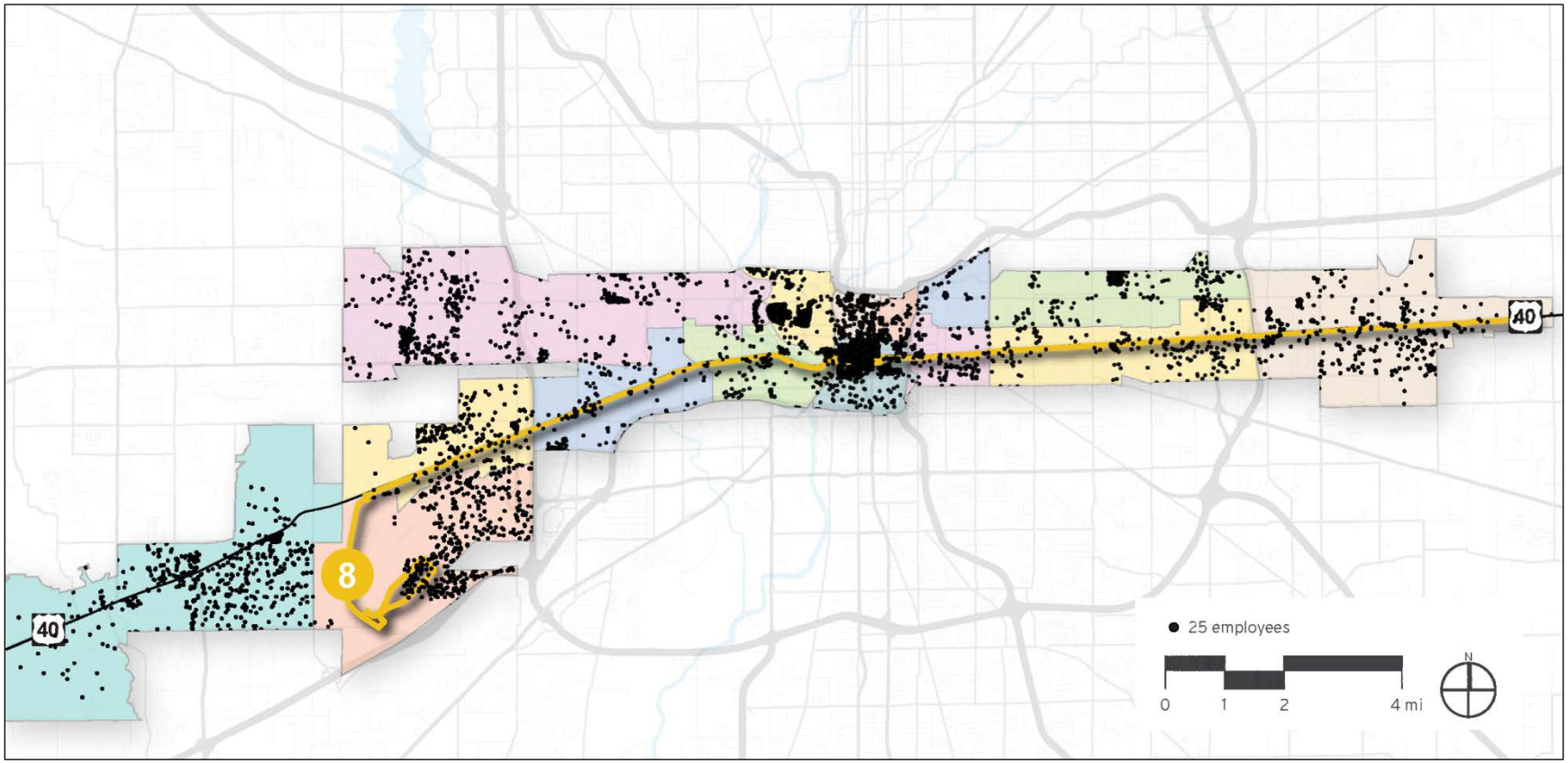


Figure 3.16 Employment Density

Source: U.S. Census

As shown on Figure 3.17, the entire corridor served by the Blue Line is relatively diverse with respect to minority populations. According to the 2010 U.S. Census, the most diverse portion of the corridor (i.e. most balanced mix of races and ethnicities) is the section from downtown to Sherman Drive on the east, as well as at the far east end of the corridor near Mitthoefer Road.

Data from Census 2010 shows that median household income levels generally increase in proportion to the distance from downtown, as shown on Figure 3.18. The lowest median incomes are in the $20,000 per year range, on the near west side of the corridor near the Indianapolis Zoo, and on the near east side from downtown Indianapolis to Sherman Drive. This is less than half of the median household income in the Indianapolis-Carmel Metropolitan Area, which is $50,826 per the U.S. Census American Communities Survey in 2011. The highest median household income levels can be found outside of the I-465 loop on the east and west ends of the corridor and reach as high as $77,000.

3.4 *Existing Transit Service*

Public transit service in the Indianapolis region is provided by the Indianapolis Public Transportation Corporation (IPTC or "IndyGo"). The current system of routes is shown on Figure 3.19. The IndyGo system ranks well below the national average in terms of transit spending per capita. One result is that IndyGo's fleet is made up of vehicles with a wide range of ages. Recurring funding deficiencies have left gaps in the system's capital purchases and many buses are near or beyond the end of their useful life. The federal stimulus program under the American Recovery and Reinvestment Act of 2009 allowed the agency to purchase many new buses, including several hybrids. In 2012, the City of Indianapolis voted to increase funding to IndyGo to add new routes and more frequent bus service. The resulting 2013 service improvements are based upon the Comprehensive Operational Analysis established for bus service in the approved Indy Connect plan.

The Washington Street corridor is served by IndyGo Route 8, the highest-ridership route in the system. Route 8 runs across Marion County from the airport through downtown Indianapolis to a shopping center parking lot in Cumberland. Route 8 sees high weekend ridership compared to other routes due to the concentration of shopping destinations on the far east side.

Route 8 has a longer span of service than any other route in the system, running from 4:45 am to midnight on weekdays. Until recently, Route 8 operated every 30 minutes throughout the day. One of the 2013 service improvements made possible by the funding increase is more frequent service for a portion of Route 8, with fifteen minute headways for most of the day between downtown Indianapolis and Cumberland.

Other IndyGo routes serve adjacent corridors on the east side, including Route 3 on Michigan Street/New York Street and Route 10 on 10th St. These routes are close enough to Route 8 on the east side that they could potentially compete for riders. On the west side, the street network and other bus routes diverge, and thus are less likely to serve an overlapping market.

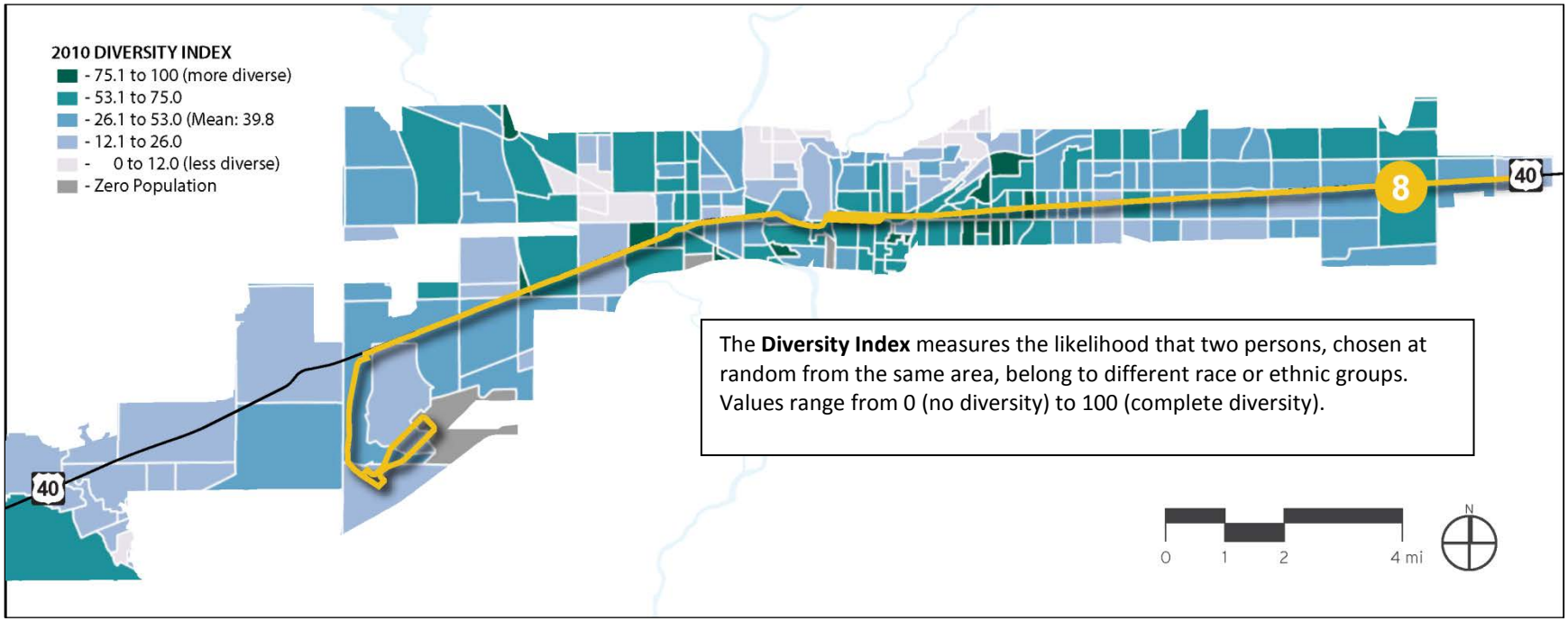


Figure 3.17 Diversity Index

Source: ESRI, U.S. Census

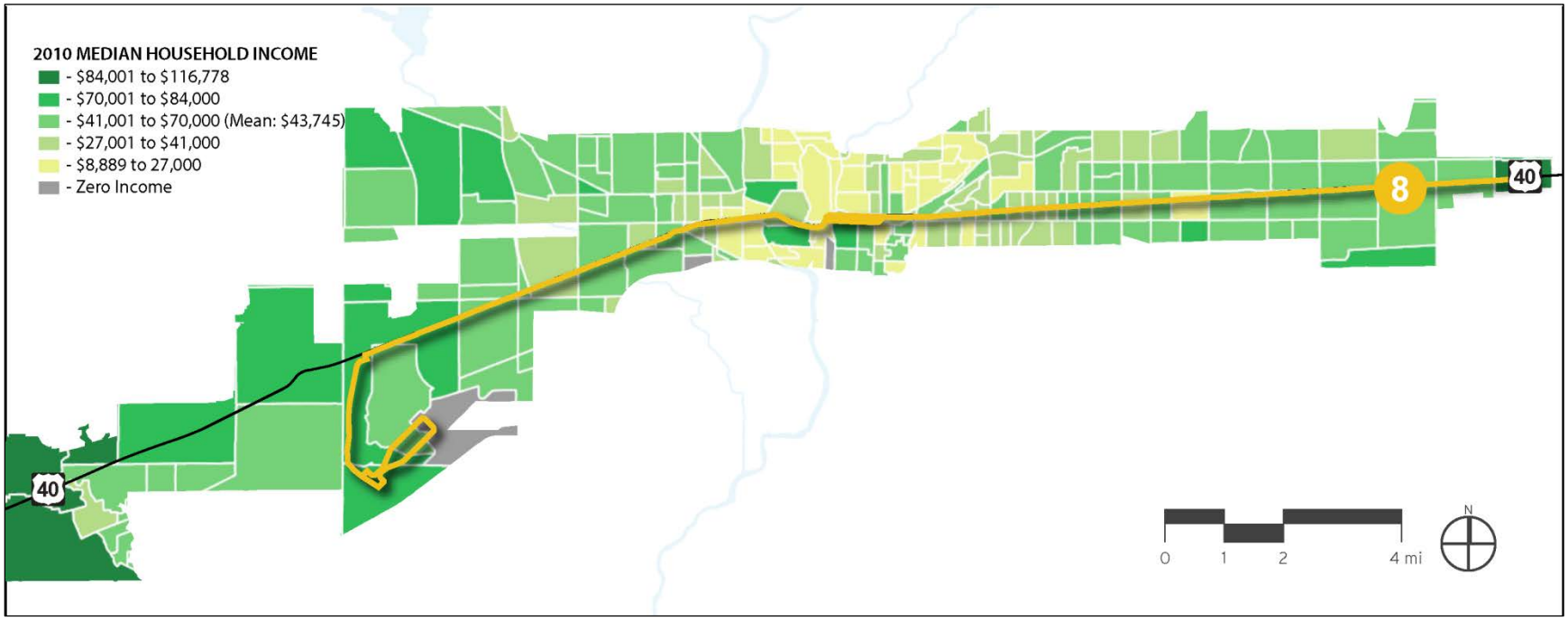


Figure 3.18 Median Household Income

Source: ESRI, U.S. Census

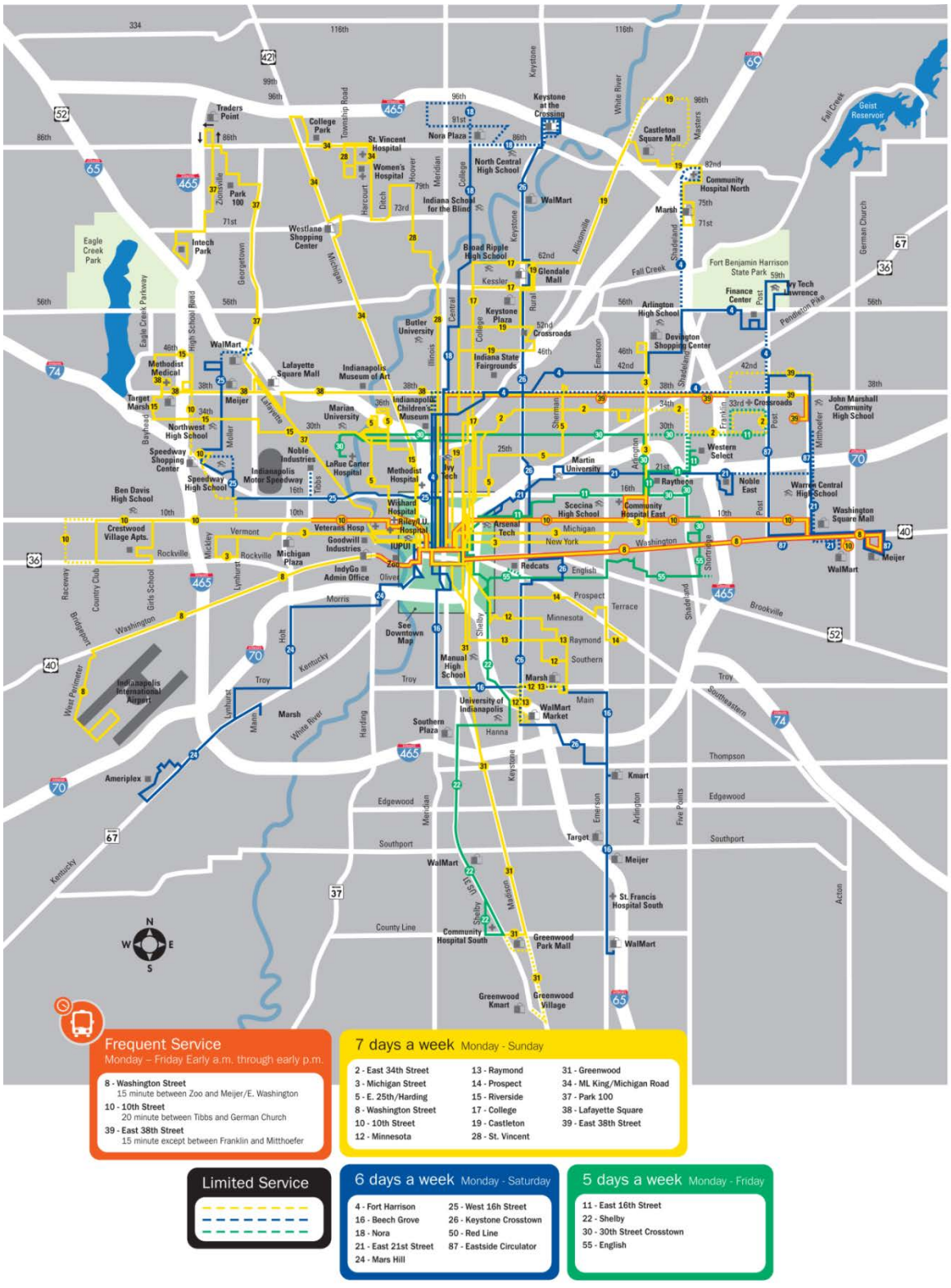


Figure 3.19 IndyGo Bus Routes (effective 2/10/13)

Service to Indianapolis International Airport is provided by Route 8, as well as an express service to downtown. In the fall of 2007, the Indianapolis Public Transportation Corporation (IndyGo) launched the Green Line Downtown/Airport Express, a demonstration service made possible by a non-renewable federal Congestion Mitigation Air Quality (CMAQ) grant. The federally-funded demonstration service focused on assessing the demand for a direct route between the airport and downtown Indianapolis hotels. From the time of its launch in November of 2007, the Green Line delivered more than 170,000 passenger trips. Due to funding limitations when the CMAQ program expired, the IndyGo Green Line was discontinued in 2012 and replaced by an express service provided by a private operator

In October 2012, CIRTA launched a new program called the Plainfield Connector. Passengers board at the IndyGo Route 8 stop at Bridgeport Road near the airport, and vehicles circulate through the Plainfield Business Park before returning to the Bridgeport stop, as shown on Figure 3.20.

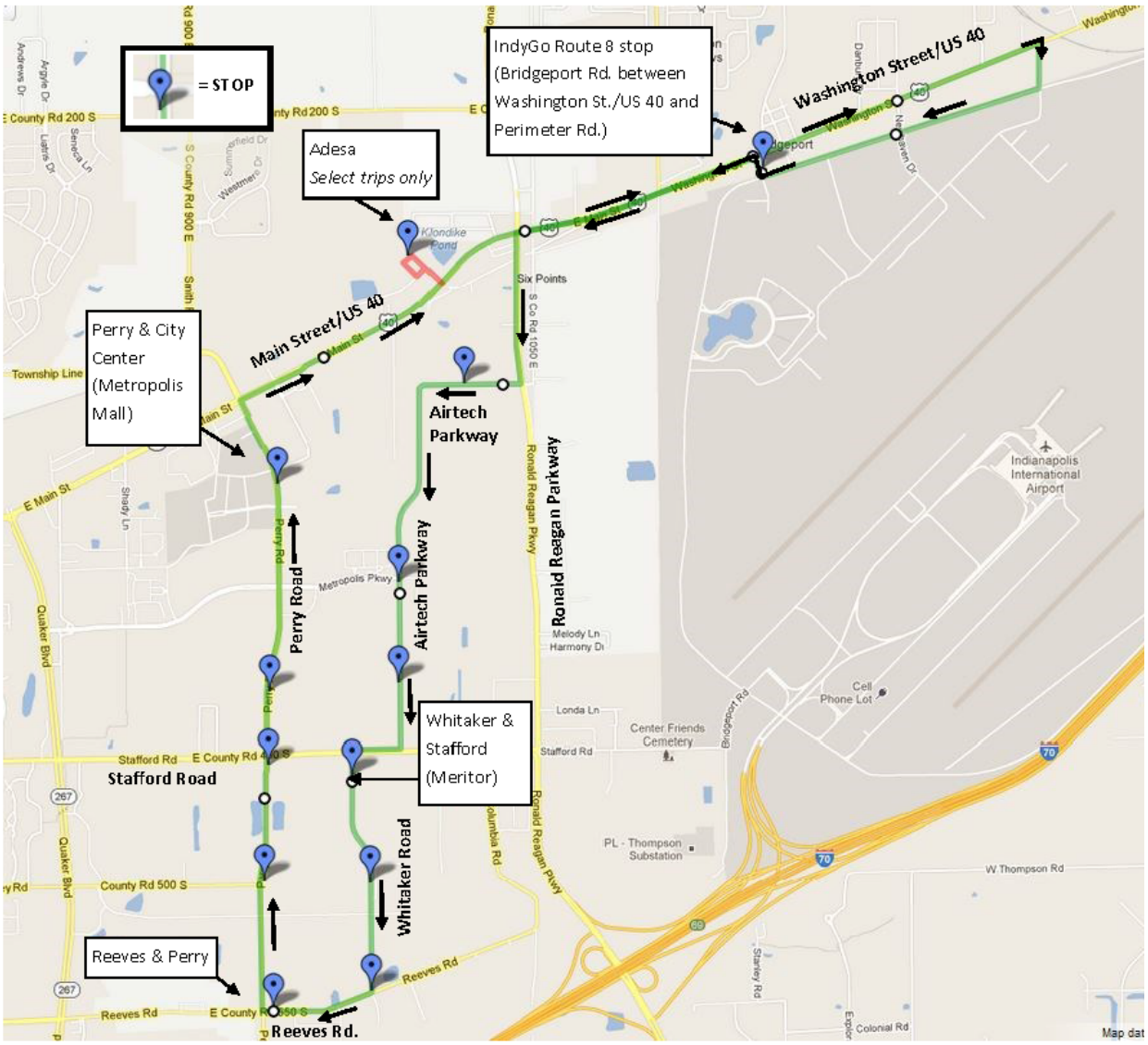


Figure 3.20 Plainfield Connector

Plainfield Connector service runs Monday through Friday, making one early morning stop at 5:15 a.m. in downtown Indianapolis to accommodate warehouse employees whose shifts begin at 6:00 a.m. The service operates every 30 minutes using a 26-seat vehicle between 6:30 am and 8:00 am, and again between 1:30 pm and 8:00 pm. The fare is $3.00 per one-way trip. IndyGo passengers are eligible to receive a $1.00 fare.

CIRTA indicates that ridership increased from about 375 one-way trips in October 2012 to nearly 1,000 trips in December 2012. As seasonal holiday jobs ended, a decrease in trips occurred early in 2013, but ridership grew steadily through 2013 to a new high of 1854 one-way trips in October. The Plainfield Connector program is funded by a three-year federal CMAQ grant with additional local funding. The total program operating costs are approximately $150,000 per year.

As ridership continues to grow, there is a potential for additional service to provide access to continued employment opportunities in Plainfield. Future plans for transit service to the western part of Marion County should reflect opportunities for linkages to the Plainfield Connector.

3.5 *Existing Roadway and Right-of-Way Characteristics*

Originally constructed as part of the National Road, the character of Washington Street through the study area reflects the design standards of an old state highway corridor. There are many areas of uncontrolled access, right of way is relatively narrow, and lane widths are less than those typically constructed today. Washington Street is under the jurisdiction of the City of Indianapolis inside I-465. The segments outside I-465 are a part of U.S. 40 and are under the jurisdiction of INDOT.

Washington Street has a functional classification of “urban principal arterial,” which means that it is intended to serve major regional activity centers and carry high traffic volumes. It has at least four travel lanes throughout the study area, and is served by interchanges with I-465 on the west side of Indianapolis, I-465 on the east side of Indianapolis, and I-65/I-70 in downtown Indianapolis. Through the downtown central business district, Washington Street becomes one-way westbound and is paired with the one-way eastbound Maryland Street. Existing roadway geometry, lane configurations, pavement dimensions, and sidewalk widths are summarized for West Washington Street and East Washington Street in this section.

3.5.1 West Washington Street Existing Conditions

The following subsections describe existing conditions on West Washington Street in terms of physical dimensions, crash experience and pavement condition. The West Washington segment is described first, followed by a similar review of East Washington Street.

For review, the West Washington Street corridor is separated into six segments with common travel lanes and dimensions. Their limits are shown on Figure 3.21. Characteristics of West Washington Street roadway segments are summarized in Table 3.1.

Figure 3.21 West Washington Street Segments

Table 3.1 West Washington Street Segment Characteristics

Segment	Limits	Length	Speed Limit	Road Width	ROW Width	Travel Lanes	Median Type	Sidewalk Width
A	Bridgeport Road to I-465	3.1 mi	45 mph	65 ft	90 ft	4	2-way left turn lane	6 ft, if present
B	I-465 to South Tibbs Avenue	2.5 mi	40 mph	55 ft	90 ft	4	2-way left turn lane	7 ft, if present
C	South Tibbs Avenue to Elder Avenue	1.4 mi	35 mph	60 ft	80 ft	4	2-way left turn lane	6 ft
D	Elder Avenue to White River Parkway	0.5 mi	35 mph	50 ft	80 ft	4	None	5 ft
E	White River Parkway to Schumacher Way	0.9 mi	40 mph	90 ft	140 ft	6	Raised	6 ft
F	Schumacher Way to Downtown Transit Center (Maryland St)	0.9	25 mph	60 ft	90 ft	4	None (1-way)	10 ft
F	Schumacher Way to Downtown Transit Center (Washington St)	0.9	25 mph	50 ft	120 ft	3	None (1-way)	20 ft

3.5.1.1 Segment A, Bridgeport Road to I-465 (3.1mi)

As US Route 40, INDOT controls Washington Street from Bridgeport Road to I-465. This segment has four 12-foot travel lanes and a 17-foot center two-way left turn lane, with curb, gutter and enclosed drainage. Right turn lanes exist at New Haven Drive (unsignalized), Girls School Road, and I-465 entrance ramps. Sidewalks are not typically present and where they do exist, they are adjacent to the curb. Sidewalks are located on the north between High School Road and Victor Street, and near Bridgeport Road. As part of the I-465 reconstruction project, Washington Street was recently reconstructed between High School Road and Morris Street.

Figure 3.22 Eastward view near Research Way

3.5.1.2 Segment B, I-465 to South Tibbs Avenue (3.2 mi.)

Inside of I-465, Washington Street continues with four travel lanes and a center two-way left turn lane. Few right turn lanes exist on this segment. The roadway width is typically 55 feet, with a four to six foot paved shoulder on much of the route. Where curb exists, it is usually less than six inches high. This segment of Washington Street has wide areas of uncontrolled access to adjacent parking lots with no defined driveways.

Figure 3.23 Eastward View near Lynhurst Drive

3.5.1.3 Segment C, South Tibbs Avenue to Elder Avenue (1.4 mi.)

This segment of Washington Street has four travel lanes and a center two-way left turn lane. Road width is typically 60 feet, but it narrows at the CSX underpass near Rockville Road and at adjacent stream bridges. On-street parking is present on the south side of the street between Warman Avenue and Elder Avenue, a distance of approximately 0.65 miles. Right turn lanes are not present at intersections or driveways. Curb and gutter exists throughout this segment, with sidewalks on both sides of the street.

Figure 3.24 Eastward View near Warman Ave

3.5.1.4 Segment D, Elder Avenue to White River Parkway West Drive (0.5 mi.)

This segment of Washington Street has four travel lanes and no median. Washington Street was narrowed through this segment to minimize bridge length for the railroad overpass at Harding Street. There is also a rail grade crossing with the Indianapolis Belt Railroad approximately 1000 feet west of this overpass. This segment has curb and gutter, with sidewalks on both sides of the street. Turn lanes are provided in both directions at the White River Parkway West Drive intersection.

Figure 3.25 Eastward View near Reichwein Ave

3.5.1.5 Section E, White River Parkway West Drive to Schumacher Way (0.9 mi.)

This Washington Street segment was constructed on new alignment during the 1980's to make way for the Indianapolis Zoo and White River State Park. It has three through travel lanes each way, separated by a raised median. Curb, gutter and adjacent sidewalks exist on both sides of the street and on the White River Bridge. Two unsignalized driveways exist on this segment—one at a zoo employee parking lot and another at a parking lot for Victory Field.

Figure 3.26 Eastward View at Indianapolis Zoo

3.5.1.6 Section F, Schumacher Way to Downtown Transit Center (0.9 mi.)

Between Schumacher Way and the Downtown Transit Center site near the City-County Building, Washington Street is a one-way westbound street, with eastbound traffic using the one-way Maryland Street. Washington Street has three through travel lanes at most locations within this core downtown segment. Left and/or right turn lanes are provided at most cross street intersections. Due to high turning volumes, through lanes are reduced to two and double right turns are provided at the Illinois Street intersection, and double left and right turns are provided at the West Street intersection. The Indianapolis Cultural Trail is located on the north side of Washington Street throughout this segment, and most blocks have on-street parking on one or both sides of the street. Maryland typically has four through travel lanes within this segment, with right and/or left turns provided at most intersections. Double left turn lanes are provided at West Street and at Delaware Street due to high demand. Parking exists on both sides of Maryland Street throughout most of the downtown segment.

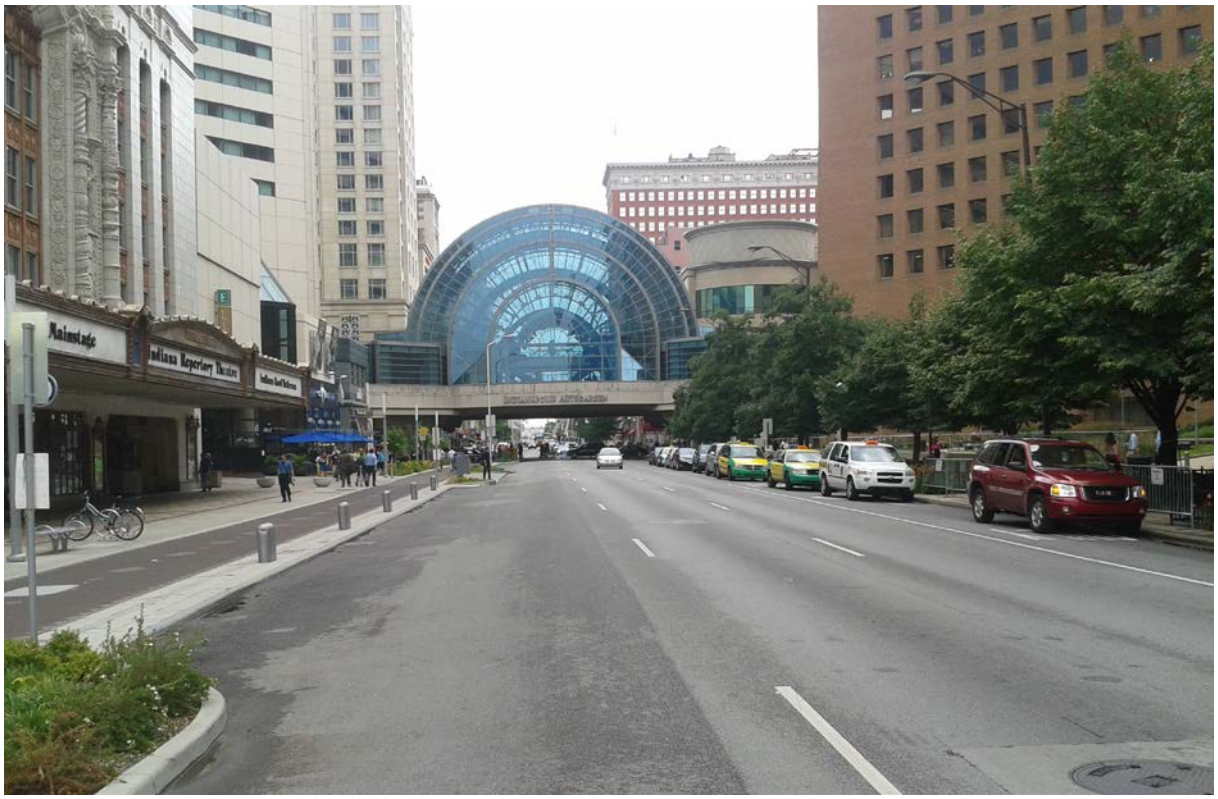


Figure 3.27 West Washington Street, eastward View near Capitol Avenue

3.5.2 West Washington Street Crash History

Crash history review was conducted along Washington Street to identify potential safety problems relevant to the proposed BRT service. Crash patterns associated with the center two-way left turn lane or the numerous uncontrolled driveways in this segment might be relevant to the proposed BRT service.

A three-year crash analysis was performed using an evaluation method developed by Tarko and Kanodia for the Indiana Department of Transportation.[7] The index of crash frequency (I_{cf}), is the metric that best summarizes analysis. An index greater than 2.0 indicates a high crash location and an index between 1.0 or 2.0 indicates a potential high crash location. Table 3.2 provides a summary of crashes by segment over the three-year period, May 2010 to May 2013.

The segment of Washington Street between Schumacher Way and Delaware Street (Segment F) is identified as a high crash segment. Backing, sideswipe, and rear-end crash rates are all higher on this segment than in other parts of the corridor. This is likely related to on-street parking, lane widths and

[7] Tarko, A. and M. Kanodia, *Hazard Elimination Program - Manual on Improving Safety of Indiana Road Intersections and Sections, Volume 2: Guidelines for Highway Safety Improvements in Indiana*, Report FHWA-IN-JTRP-2003-19, February 2004.

the lane changes that are required for vehicles traveling through downtown. Segment D, between Elder Avenue and White River Parkway West Drive, is also identified as a possible high-crash segment. This segment has the highest rate of head-on crashes of any Washington Street segment. There is no median or other separation between the eastbound and westbound travel directions.

In addition to the overall crash review, an analysis of IndyGo Route 8 incident data was performed. There have been significantly fewer crash incidents involving IndyGo Route 8 buses on West Washington Street than on East Washington Street over the past ten years. Most Route 8 incidents involve vehicles striking the bus mirrors, and the wider lanes on West Washington Street alleviate this problem by providing more lateral clearance.

The findings identified one high crash segment and one potential high crash segment. This information will be taken into consideration while developing the running way configuration options. Providing medians or other separation between eastbound and westbound movements would reduce head-on crashes.

Table 3.2 Crash Analysis for West Washington Street Segments Excluding Intersections

Segment	Limits	Length	Total Crashes 2010-2013	Average Daily Traffic Volumes	Typical annual crash frequency[1]	Crash Frequency Index (I_{CF})[1]	High Crash Location?
A	Bridgeport to I-465	3.10 mi	207	30,200	38.99	0.53	No
B	I-465 to South Tibbs	2.50 mi	164	24,300	28.47	0.63	No
C	South Tibbs to Elder	1.40 mi	76	21,200	14.97	0.47	No
D	Elder to White River Parkway	0.50 mi	41	22,000	5.44	1.01	Possible
E	White River Parkway to Schumacher	0.90 mi	21	21,400	9.67	-0.19	No
F[2]	Schumacher to Transit Center	0.90 mi	128	13,600	7.86	2.91	Yes

[1]Source: Reference (Kanodia, 2004). $I_{CF} \geq 2$ is high crash location. $1 \leq I_{CF} \leq 2$ is possible high crash location.

[2] Crash history on Maryland Street, which would be used for eastbound BRT service between Schumacher Way and the Downtown Transit Center, is assumed to be similar to westbound Washington Street.

There have been significantly fewer crash incidents involving IndyGo Route 8 buses on West Washington Street than on East Washington Street over the past ten years. Most Route 8 incidents involve vehicles striking the bus mirrors, and the wider lanes on West Washington Street alleviate this problem by providing more lateral clearance.

3.5.3 West Washington Street Pavement Conditions

Pavement conditions along most of the West Blue Line alignment are fair to good, as shown in Table 3.3. The segment between Glen Arm Road and Morris Street has had new concrete pavement placed within the past two years as part of the I-465 reconstruction project. Pavement on Bridgeport Road and West Perimeter Road at the Indianapolis International Airport is in good condition and currently requires little work. The most significant need is between Morris Street and Harding Street, where the pavement would benefit from either a structurally significant overlay or full reconstruction.

Table 3.3 West Washington Street General Pavement Condition by Roadway Segment

Segment	Limits	Pavement Condition	Comment
A	Bridgeport to I-465	Good	Resurface needed near CSX overpass.
B	I-465 to South Tibbs	Fair	Some reconstruction needed in curbside lane. Resurface remainder. New pavement near I-465.
C	South Tibbs to Elder	Fair	Some reconstruction needed in curbside lane. Resurface remainder.
D	Elder to White River Parkway	Good	Reconstruction/Resurface needed between Elder and Harding.
E	White River Parkway to Schumacher	Good	Minimal work required.
F	Schumacher to Transit Center	Good	Resurface needed near Washington & West intersection.

Sidewalks are present on both sides of Washington Street throughout downtown and as far west as South Tibbs Avenue. Sidewalks between North Tibbs Avenue and Harding Street are generally narrow but in acceptable condition. Sidewalks between South Tibbs Avenue and North Tibbs Avenue are generally in poor condition. Only short segments of disconnected sidewalk exist west of South Tibbs Avenue, and pedestrian movement along Washington Street is not well served. Upgrade or widening of sidewalks would be needed in some areas to meet current design standards and to provide a safe atmosphere for pedestrians. Substantial segments of new sidewalk would be required to provide safe pedestrian movement to transit facilities west of South Tibbs Avenue.

3.5.4 East Washington Street Existing Conditions

The character of East Washington Street changes several times between downtown Indianapolis and Cumberland. To describe existing conditions, the corridor is separated into seven segments with common travel lanes and dimensions as shown in Figure 3.28.

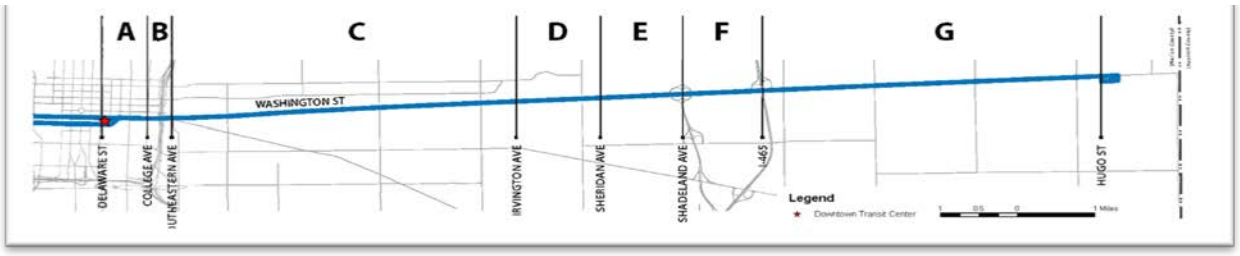


Figure 3.28 East Washington Street Segments

The limits of the East Washington Street segments and a summary of key characteristics of each segment are presented in Table 3.4. An overview of each segment of East Washington Street is provided in subsequent paragraphs.

Table 3.4 East Washington Street Segment Characteristics

Segment	Limits	Length	Speed Limit	Road Width	ROW Width	Lanes	Median Type	Sidewalk Width
A	Transit Center to College Ave	0.5 mi	25 mph	80 ft	120 ft	6	None	20 ft
B	College Ave to Southeastern Avenue	0.3 mi	35 mph	85 ft	110 ft	6	raised	10 ft
C	Southeastern Avenue to Irvington Avenue	3.5 mi	35 mph	50 ft	80 ft	4	two-way left turn	4-7 ft
D	Irvington Avenue to Sheridan Avenue	0.8 mi	35 mph	50 ft	75 ft	4	two-way left turn	7-10 ft
E	Sheridan Avenue to Shadeland Avenue	0.8 mi	35 mph	60 ft	80 ft	4	two-way left turn	4 ft
F	Shadeland Avenue to I-465	0.8 mi	40 mph	75 ft	120 ft	4	two-way left turn	4 ft, if present
G	I-465 to Hugo St	3.4 mi	40 mph	85 ft	110 ft	6	Raised or two-way left turn	6 ft

3.5.4.1 Segment A, Downtown Transit Center to College Avenue (0.5 mi.)

Washington Street and Maryland Street form a one-way pair west of New Jersey Street. There are three or more 10-foot travel lanes each way on this segment, with left turn lanes at all major intersections. Sidewalks at least ten feet wide exist on both sides. There is on-street parking on the north side west of New Jersey Street and on both sides west of Alabama Street. Washington Street passes under the CSX railroad at College Avenue. The structure has a low vertical clearance, abutments within and adjacent to the road, and poor sight distance at the Washington/College intersection.

Figure 3.29 Eastward View near Park Avenue

3.5.4.2 Segment B, College Avenue to Southeastern Avenue (0.3 mi.)

Between College Avenue and Southeastern Avenue, Washington Street passes through a recently constructed interchange with Interstate 65/70. This area has 12-foot lane widths, but operations are constrained by the close spacing of signals and large turning volumes. A limited number of on-street parking spaces are planned for the north side of Washington Street, immediately east and west of Southeastern Avenue.

Figure 3.30 Eastward View near Southeastern Ave

3.5.4.3 Segment C, Southeastern Avenue to Irvington Avenue (3.5 mi.)

This segment of Washington Street has two 10-foot lanes each way plus a 10-foot center two-way left turn lane. Except for a short segment near Audubon Road, there is no on-street parking. Sidewalks exist on both sides throughout this segment. They are typically five to six feet wide, but wider sections are sometimes provided when buildings are located at the back of the sidewalk. Some sidewalks are located adjacent to the curb and others are separated by a grass buffer.

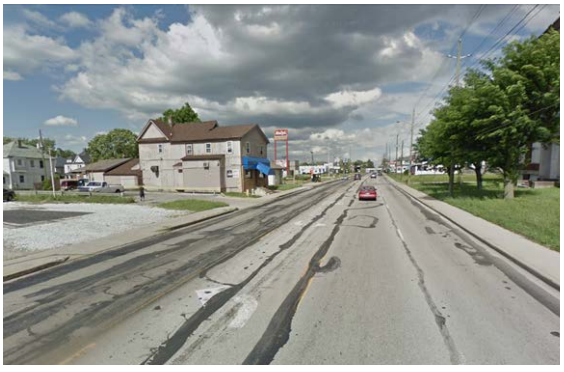


Figure 3.31 Eastward View near Oakland Ave

3.5.4.4 Segment D, Irvington Avenue to Sheridan Avenue (0.8 mi.)

A streetscape project was recently completed in this segment to provide new curb and sidewalks, curb ramps, a planted median, and other aesthetic improvements between Irvington Avenue and Bolton Avenue. An extension of this project west to Emerson Avenue is planned for 2014. Pavement has also recently been resurfaced between Arlington Avenue and Shadeland Avenue. Sidewalks exist on both sides of the roadway. They are typically five to six feet wide and are separated from the curb by a grass buffer.

Figure 3.32 Eastward View, west of Ritter Avenue

3.5.4.5 Segment E, Sheridan Avenue to Shadeland Avenue (0.8 mi.)

Between Sheridan Avenue and Shadeland Avenue, Washington Street maintains two travel lanes in each direction with a center two-way left turn lane. The pavement section is 60 feet in this segment, compared to 50 feet in Segments C and D to the west. Sidewalks are present on both sides of Washington Street west of Edmonson Avenue and on the north side only from Edmonson Avenue through the Washington Street/Shadeland Avenue interchange. Sidewalks are typically four to five feet wide, separated from the street by a grass buffer.

Figure 3.33 Eastward View, west of Shadeland

3.5.4.6 Segment F, Shadeland Avenue to I-465 (0.8 mi.)

This segment continues with two lanes in each direction plus a center two-way left turn lane, but the character becomes more suburban.. Right of way is wider and some intersections have right turn lanes. A four-to five-foot sidewalk is present on one side of the roadway. Between Shadeland Avenue and Mitchner Avenue, the sidewalk is located on the north side. At the I-465 interchange, the sidewalk is on the south side to avoid conflict with the interchange ramps.

Figure 3.34 Eastward View west of I-465

3.5.4.7 Segment G, I-465 to Hugo Street (3.5 mi.)

Figure 3.35 Eastward View near Washington Square Mall

Between Interstate 465 and the end of the corridor near Hugo Street in Cumberland, Washington Street serves as US Route 40. As a state highway, it is controlled by the Indiana Department of Transportation (INDOT). This section was recently reconstructed to include up to three 12-foot travel lanes in each direction. A raised center median or two-way left turn lane is provided throughout the segment. Auxiliary left and right turn lanes are provided at most major intersections, with some intersections having dual left turn lanes. Sidewalks are provided on both sides of Washington Street throughout this segment. They are typically six to eight feet wide and are located immediately behind the curb. Right-of-way lines are generally located at the back of the sidewalk. This sidewalk location (immediately adjacent to roadway travel lanes) does not contribute to a sense of safety for pedestrians.

3.5.5 East Washington Street Crash History

Crash history review was conducted along East Washington Street to identify potential safety problems relevant to the proposed BRT service. Crash patterns associated with the center two-way left turn lane or the numerous uncontrolled driveways in this segment might be relevant to the proposed BRT service.

A three-year crash analysis was performed using an evaluation method developed by Tarko and Kanodia for the Indiana Department of Transportation. Table 3.5 summarizes crashes by segment over the three-year period from May 2010 to May 2013. The index of crash frequency (I_{cf}), is the metric that best summarizes analysis. An index greater than 2.0 indicates a high crash location and an index between 1.0 or 2.0 indicates a potential high crash location.

Table 3.5 Crash Analysis for East Washington Street Segments (Excluding Intersections)

Segment	Limits	Length	Total Crashes 2010-2013	Average Daily Traffic Volumes	Typical annual crash frequency[1]	Crash Frequency Index (I_{CF})[1]	High Crash Location?
A	Transit Center to College	0.5 mi	56	28,100	5.70	1.50	Possible
B	College to Southeastern	0.3 mi	8	29,000	3.24	-0.12	No
C	Southeastern to Irvington	3.5 mi	222	22,200	37.47	0.67	No
D	Irvington to Sheridan	0.8 mi	55	22,200	9.14	0.68	No
E	Sheridan to Shadeland	0.8 mi	37	22,200	8.60	0.30	No
F	Shadeland to I-465	0.8 mi	38	21,200	8.55	0.33	No
G	I-465 to Hugo	3.4 mi	165	20,850	38.43	0.30	No

1 $I_{CF} \geq 2$ indicates high crash location. $1 \leq I_{CF} \leq 2$ indicates possible high crash location.

The short segment of Washington Street between the Downtown Transit Center and College Avenue was identified as a possible high crash location. Crash rates between Southeastern Avenue and Sheridan are also higher than the other segments, especially in the Irvington area. The narrow lanes in this segment may be a contributory factor. IndyGo Route 8 bus incident data indicates a probable correlation between narrow lane widths and crash rates. There have been 112 incidents involving Route 8 buses outside of downtown Indianapolis over the past ten years, a majority of which were sideswipe crashes. Most of those (55%) occurred in the segment of Washington Street with ten-foot wide lanes (Southeastern Avenue to Sheridan Avenue). This is consistent with research indicating that bus sideswipe crashes occur more frequently on roads with lane widths of ten feet or less. (Moses, 2010). Providing wider running way lanes would likely alleviate the high incidence of bus crashes.

3.5.6 East Washington Street Pavement Conditions

Good pavement along the transit running way is an important characteristic of successful BRT service. Just as rail service requires good track conditions, BRT service requires good pavement conditions in order to maintain appropriate operating speeds and provide a smooth ride quality for passengers.

Pavement conditions along much of the East Washington/U.S. 40 Blue Line corridor are good, as shown in Table 3.6. The segment east of I-465 was widened and reconstructed in 2011, and other segments have been reconstructed or resurfaced within the past five years.

Sidewalks are present through most of the corridor. They are in good condition outside of I-465 due to recent reconstruction. Sidewalks inside I-465 are generally older and narrower, though they are often in

acceptable condition. Upgrading or widening of sidewalks will be needed in some of these areas to meet current design standards and to provide a safe atmosphere for pedestrians. New sidewalks are needed around Shadeland Avenue and I-465 where sections are not continuous on both sides of Washington Street. At some locations inside I-465, embankments of two to three feet are located at the back of potential sidewalk locations. Providing full sidewalks on each side of Washington Street would require regrading, low retaining walls, and construction of steps at some locations.

Table 3.6 East Washington Street General Pavement Condition by Segment

Segment	Limits	Pavement Condition	Comment
A	Transit Center to College	Good	Pavement resurfaced in last 5 years
B	College to Southeastern	Good	Roadway reconstructed in last 5 years
C	Southeastern to Irvington	Poor	Reconstruction of curbside lane desirable, resurface of all other lanes
D	Irvington to Sheridan	Good	Pavement resurfaced in last 5 years
E	Sheridan to Shadeland	Good	Pavement resurfaced in last 5 years
F	Shadeland to I-465	Poor	Reconstruction of curbside lane desirable, resurface of all other lanes
G	I-465 to Hugo	Good	Roadway reconstructed in last 5 years

3.5.7 Washington Street Traffic Conditions

Table 3.7 provides an overview of typical traffic conditions along Washington Street. Figure 3.36 shows the estimated existing "highway capacity level of service" (LOS) during the daily peak hour on each of the road segments. LOS represents the quality of traffic operation experienced by auto and truck traffic, measured on a scale of "A" to "F."

An LOS of "A" through "D" is generally considered to be acceptable for an arterial facility like Washington Street. The east corridor and most of the west corridor currently operate at this service level. The exception is a short segment of Washington Street, where the six-lane section is reduced to four lanes and left turn lanes are not provided west of the Indianapolis Zoo. LOS is reduced in this section of Washington Street by turning vehicles that impede the flow of through traffic.

Overall, LOS values developed with planning-level procedures indicate that Washington Street is operating at an acceptable level of service at nearly all locations. This translates to acceptable levels of delay, even during peak period conditions. Congestion levels and travel times on Washington Street are an important consideration in evaluating potential BRT treatments, as discussed in detail for this corridor in Chapter 6, Blue Line Alternatives Definition.

Table 3.7 Typical Roadway Existing Conditions by Corridor Segment

Street	From	To	Lane Configuration	Speed Limit	Daily Traffic	Peak Hour Traffic	Peak Hour LOS
Main St	Center St	Carr Rd	4 lanes undivided	30	21,600	2,100	D
Main St	Carr Rd	Dan Jones Rd	4 lanes with center left turn lane	30	25,800	2,520	D
Washington St	Dan Jones Rd	I-465	4 lanes with center left turn lane	45	30,200	3,080	C
Washington St	I-465	S. Tibbs Ave	4 lanes with center left turn lane	40	24,300	1,990	C
Washington St	S. Tibbs Ave	N. Elder St	4 lanes with center left turn lane	35	21,200	1,920	D
Washington St	N. Elder st	White River Prkwy W.	4 lanes undivided	35	22,000	2,000	F
Washington St	White River Prkwy W.	Schumacher Way	6 lanes with median	40	21,400	1,950	C
Maryland St (1-way EB)	Schumacher Way	New Jersey St	3-5 lanes one way	25	12,400	1,340	D
Washington St (1-way WB)	New Jersey St	Schumacher Way	3-4 lanes one way	25	13,600	1,330	D
Washington St	New Jersey St	Southeastern Ave	6 lanes with center left turn	35	29,000	3,040	D
Washington St	Southeastern Ave	Shadeland Ave	4 lanes with center left turn lane	35	22,200	1,890	D
Washington St	Shadeland Ave	I-465	4 lanes with center left turn lane	40	21,200	1,950	C
Washington St	I-465	Post Rd	6 lanes with center left turn lane	40	26,400	2,470	C
Washington St	Post Rd	Washington Square	6 lanes with center median	40	19,300	1,740	C
Washington St	Washington Square	Hugo St	4 lanes with center left turn lane	40	19,800	1,820	C
Washington St	Hugo St	County Line Rd	4 lanes with median	40	17,900	1,680	C

NOTE: See **Figure 3.36** *for corresponding graphic.*

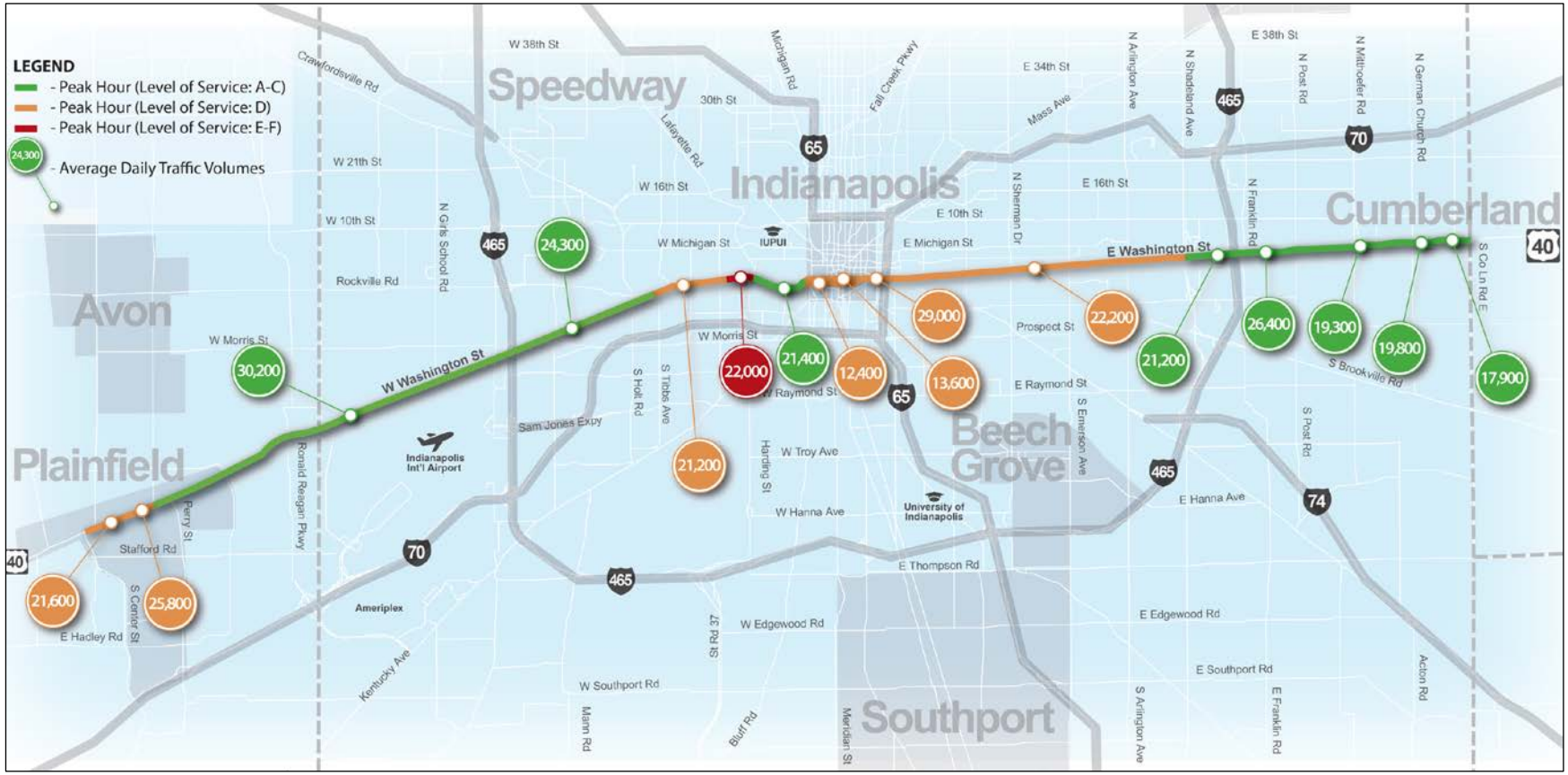


Figure 3.36 Washington Street Traffic Volumes and Service Levels

4.0 BRT SYSTEM CONCEPTS

This chapter describes running way and station components of BRT systems, and identifies those that may be suitable for the Blue Line corridor.

4.1 *BRT Running Way Concepts*

BRT service in arterial corridors often includes enhancements to the transit running way that reduce trip times or improve the passenger experience. These enhancements can include dedicated transit lanes or a separated busway, added lanes, or traffic control features for transit priority at intersections, and roadway pavement upgrades to provide a smoother ride. These features help to enhance the quality of BRT to make it a true premium transit service.

This chapter describes potential running way features and configurations that could be used for BRT service in the Blue Line corridor. To put the review of BRT running way treatments in context, several examples are presented in this chapter for the section of Washington Street east of downtown, generally between Southeastern Avenue and Shadeland Avenue. In addition to serving the highest number of existing transit trips in the corridor, physical conditions of this five-lane section are typical of East and West Washington Street inside I-465.

BRT service on the Blue Line could operate in lanes shared with automobile traffic, just as the existing IndyGo Route 8 service does. Alternatively, the BRT service could operate in exclusive transit lanes separated from other roadway traffic. This separation would allow for preferential treatments to reduce transit running times and improve reliability. Depending on ridership levels and total traffic served, exclusive transit running ways can maximize the total number of person trips served and maintain a high level of service and visibility for transit.

Exclusive transit running ways along an urban street may consist of designated bus lanes or physically separated busways. They can be located adjacent to the outside curb, adjacent to on-street parking, or in the median of a street. Buses in dedicated transit lanes can operate in the same or opposite (contraflow) direction as adjacent mixed-traffic lanes.

A dedicated lane can be provided by taking a lane away from general traffic or by widening a road to build a bus-only lane. With limited exceptions, these lanes are intended for use only by transit vehicles. Dedicated lanes allow transit vehicles to travel independently of general traffic congestion and provide a visual queue for system legibility and perceived permanence. There are several configurations of dedicated transit lanes available, based upon where they operate within the right-of-way.

Dedicated transit lanes can also be designated for priority use during selected periods of the day. “Peak only” lanes are typically used at the curbside where on-street parking is present. Parking is prohibited in

the peak period/peak direction and that space is reserved for transit, allowing transit vehicles to bypass congestion.

4.1.1 Added Lanes for Dedicated Transit Use

Bus lanes could be added in the Blue Line corridor without reducing existing automobile capacity by widening Washington Street. IMAGIS geographic information systems data and aerial photography obtained from the City of Indianapolis were used to help identify whether this might be feasible in the Washington Street corridor.

Between Southeastern Avenue and Shadeland Avenue, the right-of-way width along East Washington Street is between 75 feet and 80 feet. West of Harding Street, most of West Washington Street (75%) has 90 feet of right of way. The remainder of West Washington Street is 80 feet. At least 95 feet of right-of-way would be required for Washington Street to retain the existing five travel lanes, provide two new bus lanes, and maintain sidewalks. Road widening would require substantial acquisition of right-of-way in areas where many buildings have minimal setbacks from the street.

Figure 4.1 shows a snapshot of the East Washington Street Corridor between Southeastern Avenue and Rural Street, with buildings that are located close to the street (and therefore impacted by added lanes) highlighted in red. It is estimated that more than 100 structures could be impacted by widening all the way to Shadeland Avenue. Many of these structures may be considered historic or may have potential environmental contamination issues. Similar impacts would occur on West Washington Street.

Figure 4.1 Buildings Impacted by Added Lanes on East Washington Street

Particularly on the east side, development is not as dense outside I-465, and most buildings are set back farther from Washington Street. Still, additional right-of-way would need to be purchased along much of the route in order to add bus lanes to the existing four to six travel lanes. Due to the recent addition of travel lanes on the east, the existing right-of-way limits are at the back of the sidewalk through much of this segment. Further widening would require several building acquisitions and would entail damage payments for many additional commercial properties due to impacts on site access, parking and

circulation. Conditions on the west side are even more restrictive since right of way is generally only 90 feet wide.

Widening the entire Washington Street corridor (two feet on each side) could improve bus safety and travel times, particularly on East Washington Street where lanes are only ten feet wide inside I-465. The cost and impacts of even this minor widening over an extended length of the corridor, however, would be disproportionate to the benefits. Curb would need to be replaced for the entire length, and sidewalk, storm drains, and overhead utility lines would require relocation, with significant cost impacts.

Based on the major property impacts that would be caused, street widening to add dedicated transit lanes is not considered to be a viable option in the Washington Street corridor. Blue Line running way alternatives will be limited to configurations that are predominantly within existing curb lines.

4.1.2 Dedicating Existing Lanes for Exclusive Transit Use

An alternative to adding transit lanes by widening Washington Street would be to designate existing lanes for exclusive use by transit vehicles. With the limitation of existing pavement width, that means designating either the center lane, outside lanes, or inside lanes for transit only operations.

4.1.2.1 Center Reversible Bus-Only Lane

A single median bus-only lane could be considered within the constrained width of Washington Street inside I-465. This would replace the existing two-way left turn lanes that exist over much of Washington Street. The bus lane could be reversible for use by buses traveling in the peak direction, with off-peak direction buses operating in mixed-use lanes. Alternately, this lane could be shared by buses traveling in both directions, with signaling and operating procedures for bus passing, and scheduling to minimize passing events. Either configuration could enable an exclusive bus lane in at least one direction while maintaining two general purpose traffic lanes in both directions. However, the use of a single median lane would require more space than is available in most existing center two-way left turn lane sections. If shared by buses traveling in both directions, it would also require automated signaling or strict operating procedures to ensure safety. Due to these limitations (and the loss of left turn lanes for mixed traffic), the single median bus lane option is deemed infeasible.

4.1.2.2 Curbside Bus-Only Lane

The simplest method of providing a dedicated transit lane on Washington Street would be to convert the curbside (right) lane in each direction to a bus-only lane. Buses would bypass auto congestion, thus speeding their travel. Automobile traffic would be restricted to the remaining single through travel lane in each direction on four-lane sections inside I-465, and the remaining two through travel lanes in each direction in sections outside I-465 on the east side.

Bus lanes would be separated from the adjacent automobile travel lanes using dashed or solid pavement markings and possibly raised pavement markers. Automobile traffic could still use the bus lanes for right turns at intersections and driveways except where separate turn lanes were provided.

Bus lanes would be enforced at all times, as the peak-period prohibition of traffic from a general use lane would be difficult to enforce and would have significant violation problems.

The minimum width recommended for a bus lane is 11 feet. Implementing curbside bus lanes on some segments of Washington Street east of downtown would require widening of the curb lanes. This could be achieved either by restriping the road to provide 11-foot outside lanes and 9-foot inside lanes or by converting the center two-way left turn lane to a raised median and widening all lanes. Lanes in segments of Washington Street that are at least 11 feet wide would not need to be changed.

Overall, it would be physically feasible to convert existing curbside lanes for dedicated transit use. The question of whether the potential benefits outweigh the impacts is explored in Chapter 6.

4.1.2.3 Median Bus-Only Lane

Converting the existing left lanes of Washington Street to exclusive bus lanes would potentially benefit transit travel in the corridor, but it would have a high cost in terms of traffic impacts. Similar to the curbside bus lane configuration, this arrangement would only leave one lane for general automobile use between downtown and I-465 and two lanes for automobile use in six-lane sections outside I-465 on the east side. Moreover, designating the inside lanes for bus-only operations would significantly restrict left turning opportunities for autos. The concept is shown on Figure 4.2.

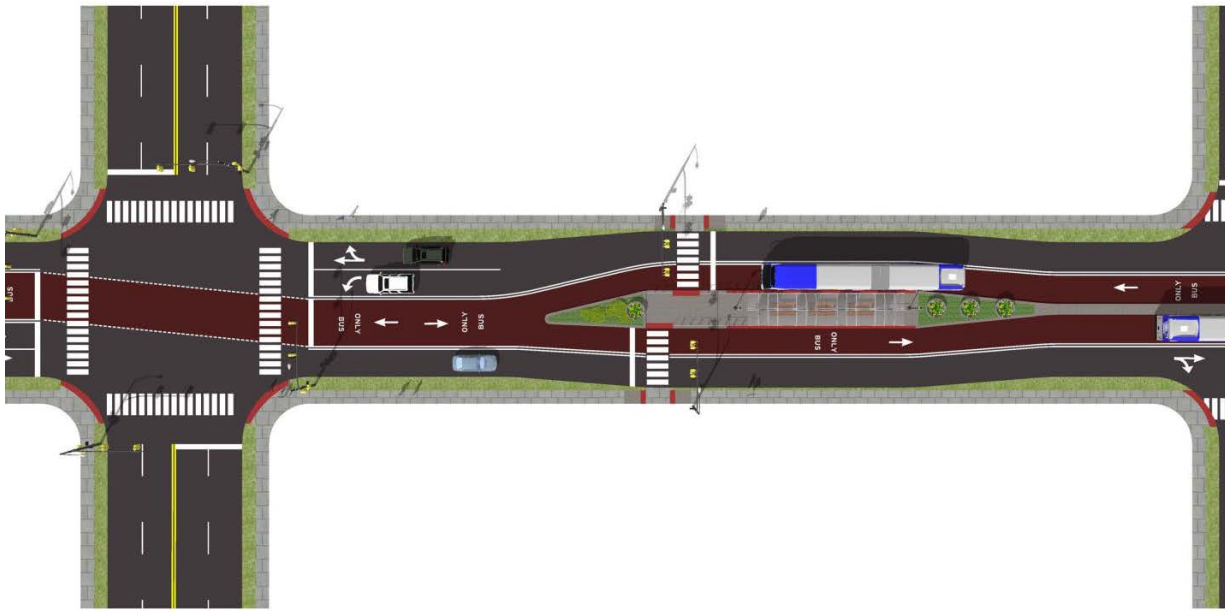


Figure 4.2 Median Bus-Only Lanes

The median bus lane alternative would require the installation of a raised median to prevent automobiles from turning across the bus lanes and to allow for widened lanes on narrow sections. Automobile crossings of the bus lanes would be allowed at signalized intersections only, and all left turns from Washington Street would require a "protected" traffic signal phase to prevent accidents. The

result would be that the bus would not be subject to any delays as a result of automobiles on the roadway.

The dedicated bus lanes would be separated from adjacent automobile travel lanes using solid pavement markings and/or raised pavement markers and could be further delineated by using colored pavement or different paving materials. At most locations, there is insufficient width along Washington Street to employ any physical separation between the bus lanes and adjacent mixed use lanes.

The median bus lanes configuration would require the use of median stations. Minor road widening would be required most station areas to accommodate a 14-foot wide station and two travel lanes in each direction. This could generally be accomplished within existing right of way, but local bus service would need to use the general purpose travel lanes and existing curbside stations due to the lack of left hand doors on local buses.

Dedicated median bus lanes are physically feasible and could be implemented in the Blue Line corridor by eliminating left turn lanes and repurposing a general use lane in each direction. The question of whether the potential benefits outweigh the impacts is explored in Chapter 6.

4.1.3 Center Reversible Bus-Only Lane

Theoretically, a single median bus-only lane could be considered within the constrained width of Washington Street inside I-465. The lane could be reversible for use by buses traveling in the peak direction, with off-peak direction buses operating in mixed-use lanes. Alternately, this lane could be shared by buses traveling in both directions, with signaling and operating procedures for bus passing, and scheduling to minimize passing events. Either configuration could enable an exclusive bus lane in at least one direction while maintaining two general purpose traffic lanes in both directions. However, the use of a single median lane would require more space than is available in most existing center two-way left turn lane sections. If shared by buses traveling in both directions, it would also require automated signaling or strict operating procedures to ensure safety. In addition to these limitations, there would be a loss of left turn lanes for mixed traffic throughout the corridor. For these reasons, the single median bus lane option is deemed infeasible for Blue Line service.

4.1.4 Mixed Traffic Transit Operations

The right of way and pavement widths of the Washington Street corridor are narrow for the number of lanes served and the roadway serves a high volume of mixed traffic. Under these conditions, the opportunity to provide exclusive transit lanes is limited. Nevertheless, BRT can be implemented in the Blue Line corridor by providing a high level of service improvements, new enhanced stations, and other BRT features using the existing configuration. Under this alternative, shown on Figure 4.3, BRT vehicles would share the outside curb travel lanes with other traffic, just as IndyGo buses do today.

A center reversible bus lane is not considered feasible due to right-of-way limitations and the potential cost and complexity of operating a reversible or shared two-way lane.

Figure 4.3 Shared Curb Lane – Existing Five-Lane Configuration

Although transit only lanes are desirable, many of the benefits of BRT can be achieved with mixed traffic operations. Faster service can be provided with a smaller number of stops; quicker boarding due to off-board fair collection, multiple doors, and level platforms; and transit signal priority treatments. High quality station areas and passenger information systems would contribute to the enhanced experience offered by the BRT service. These benefits are independent of dedicated transit lanes.

It should be noted that in this study, only curbside operations are considered for mixed traffic operations. Although it would theoretically be possible to serve median stations from the left lane, there could be safety issues since left side stops would be unexpected and the relatively narrow median stations would be adjacent to mixed traffic on both sides (including large trucks). There are examples in the United States of median stations serving bus traffic in both directions, but they are always dedicated transit lanes. None of them do so from a mixed traffic lane. For these reasons, mixed traffic alternatives in this study assume right lane operations with curb stations.

Regardless of whether transit vehicles operate in exclusive or mixed use lanes, there are traffic control features that can be implemented to make transit service more efficient and predictable. These are described in the next section.

4.2 *Transit Priority Traffic Control Options*

Transit operations can be significantly improved within arterial corridors by reducing delay at signalized intersections. One approach is to provide traffic signal priority for transit vehicles so that they are more likely to get a green signal indication as they approach intersections, particularly when they are behind schedule. Another is to provide the opportunity to move around (bypass) traffic back-ups at congested intersections. Techniques for accomplishing these objectives are described in this section.

4.2.1 Transit Signal Priority

A transit signal priority (TSP) system allows a transit vehicle that is approaching a signalized intersection to receive priority treatment from the traffic signal, thus reducing its delay at the intersection. This reduces the overall transit travel time and improves schedule adherence, especially when the vehicle must travel through many signalized intersections along its route.

BRT systems in North America have typically realized a reduction of 8% to 12% in bus travel times with implementation of TSP.[8] Signal priority for transit vehicles is different than signal preemption, which is sometimes provided for emergency vehicles or trains. Signal preemption interrupts the operation of a traffic signal and has noticeable impacts on traffic flow at the intersection, whereas transit priority generally involves only minor adjustments to signal operation to provide an advantage for the transit vehicle, with much smaller, typically unnoticeable, impacts to other traffic.

The presence of an approaching transit vehicle is usually detected using either pavement loop sensors or radio frequency transmission from the vehicle to the signal infrastructure. Signal priority is then typically implemented by extending an existing green signal until the TSP-equipped vehicle passes through the intersection (green extension), terminating the green signal for a conflicting movement to allow the TSP-equipped vehicle to get an earlier green light (early green), or allowing special transit-only movements by providing special signal phases (queue bypass).

Most transit agencies use TSP in conjunction with stations located just after the vehicle travels through the intersection (referred to as far-side stations) or a station in the midblock. Bus stops or stations located before the vehicle enters the intersection referred to as near-side stations) make TSP more difficult to implement and more impactful to other traffic because the system must allow for transit vehicles approaching the intersection to stop at the station first.

Far-side, near-side, and midblock stations are further described in Section 4.4, BRT Station Location and Placement.

[8] Kittleson & Associates, *TCRP Report 118: Bus Rapid Transit Practitioner's Guide*, Transportation Research Board, Washington, D.C., 2007, Page 4-32

TSP systems can restrict priority calls based on the time of day or intersection traffic conditions. They can also be integrated with the automated vehicle location (AVL) systems that track the position of transit vehicles. AVL systems make it possible to implement conditional priority based on the schedule adherence and/or passenger loading of the approaching transit vehicle. Conditional priority based on schedule adherence can help to alleviate problems with bunching of transit vehicles and minimize traffic disruption by only providing priority to transit vehicles that are behind schedule.

Transit signal priority systems are most beneficial where they can provide a positive time savings for transit without causing a significant negative impact on other traffic at the intersection. When determining the applicability of TSP at a particular intersection, the following factors should be considered:

- Bus service. Service should be frequent and well used so that TSP can provide significant person-minutes of travel time savings. However, service with very short headways— less than two or three minutes—may not allow the recovery of normal signal operation between priority events, which would be very disruptive to automobile traffic. The impacts of TSP on parallel and crossing transit routes that also use the intersection should be considered.

- Traffic Volumes and Delay. TSP provides the most benefit where intersection traffic volumes are moderate to heavy, but the intersection is not operating near its capacity. If the intersection volumes are too high, then the reduction in time allotted to non-priority movements may cause delays to automobile passengers that more than offset the savings to transit users on a per-person basis. If traffic volumes for the non-priority movements are very light, then traffic actuation for these movements will assure that the priority movement is usually green anyway, and TSP may not provide much additional benefit.

- Signal Operation. Intersections with many approach legs or complex signal operation can be poor candidates for TSP because the non-priority movements may not have enough excess time to yield to transit vehicles. In downtown Indianapolis, there are many 5-leg and 6-leg intersections that are not TSP-friendly. Wide pavement sections east of I-465 may have restricted signal timing flexibility due to the relatively longer pedestrian crossing times. TSP could also cause excessive traffic disruption of the downtown Indianapolis grid network or where progressive traffic signal plans are complex and less flexible.

- Stop Location. Intersections where stations must be placed on the near side may not be good candidates for TSP since the presence of a transit vehicle might trigger a green indication while the vehicle is loading passengers. Transit vehicles stopping at a far-side or midblock station would not trigger a priority request at the next downstream intersection.

IndyGo has an operational AVL system, and preliminary discussions with IndyGo and the City of Indianapolis Department of Public Works indicate that a conditional priority TSP system based on schedule adherence is a viable option for the Blue Line corridor.

4.2.2 Queue Bypass Lanes

When transit vehicles travel in lanes shared with other traffic, queue bypass lanes can be used at signalized intersections or other bottleneck locations to give the transit vehicles priority over other queued vehicles.

Queue bypass lanes can be either exclusive bus lanes or lanes shared with turning traffic. The use of queue bypass lanes is generally considered as an alternative to transit signal priority in which the bus remains in the shared through lanes. Queue bypass lanes can operate using either of two different methods, depending on whether special bus-only phasing is used at traffic signals.

The first method uses a special signal phase to allow the bus to proceed through the intersection before other traffic. In this method, the bus approaches the intersection and uses either a dedicated bus lane or a right-turn lane shared with automobiles that allows buses to bypass automobile traffic queued in the through lanes. The bus triggers a special signal phase that allows it to proceed through the intersection before other through vehicles.

If the bus is using a shared turn lane, then the turning traffic in the lane will proceed at the same time, but only the bus will be allowed to proceed straight through the intersection from the turn lane. Only after the bus is through the intersection and has merged back into the through travel lanes is other through traffic allowed to proceed.

This queue bypass method can work well with a near side station, as the bus can stop at the platform and load passengers while the signal is red and then send a priority request when the doors close. It does require a special signal phase with no opposing traffic, however, which can cause minor delay for other traffic at the intersection. The queue bypass lane must extend far enough from the intersection that standing queues do not block the bus from entering the lane.

A special signal phase is not generally used to provide an advanced green to buses when a station is located on the other side of the intersection because the buses would then either immediately block a downstream through lane to stop at the station or could have difficulty merging back into through traffic if a bus pullout is used at the station.

Figure 4.4 shows a queue bypass with special signal phase currently used by IndyGo buses in downtown Indianapolis. These queue jumps make it easier for buses to cross several lanes of traffic with minimal interference as they move from a right curbside bus stop to make a left turn at a downstream intersection.

Figure 4.4 Queue Bypass with Special Signal Phase

The second method of implementing a queue bypass lane does not require special signal phasing. As in the first method, the bus approaches the intersection and uses either a dedicated bus lane or a lane shared with turning automobiles to bypass traffic queued in the through lanes. In this method, the bus proceeds through the intersection at the same time as other through traffic. The bus must have a receiving lane downstream of the intersection, from which it merges back into the general traffic lanes.

This queue bypass method can be used with a station located at the far side of the intersection, where the bus receiving lane serves as a bus pullout. Again, the queue bypass lane must extend far enough from the intersection that standing queues do not block the bus from entering the lane. This concept is illustrated on Figure 4.5.

Locations where a shoulder exists or can be easily provided on both sides of the intersection, and where a far side station can be used, offer the best opportunities for queue bypass operations in the Blue Line corridor. These opportunities are explored in Chapter 6.

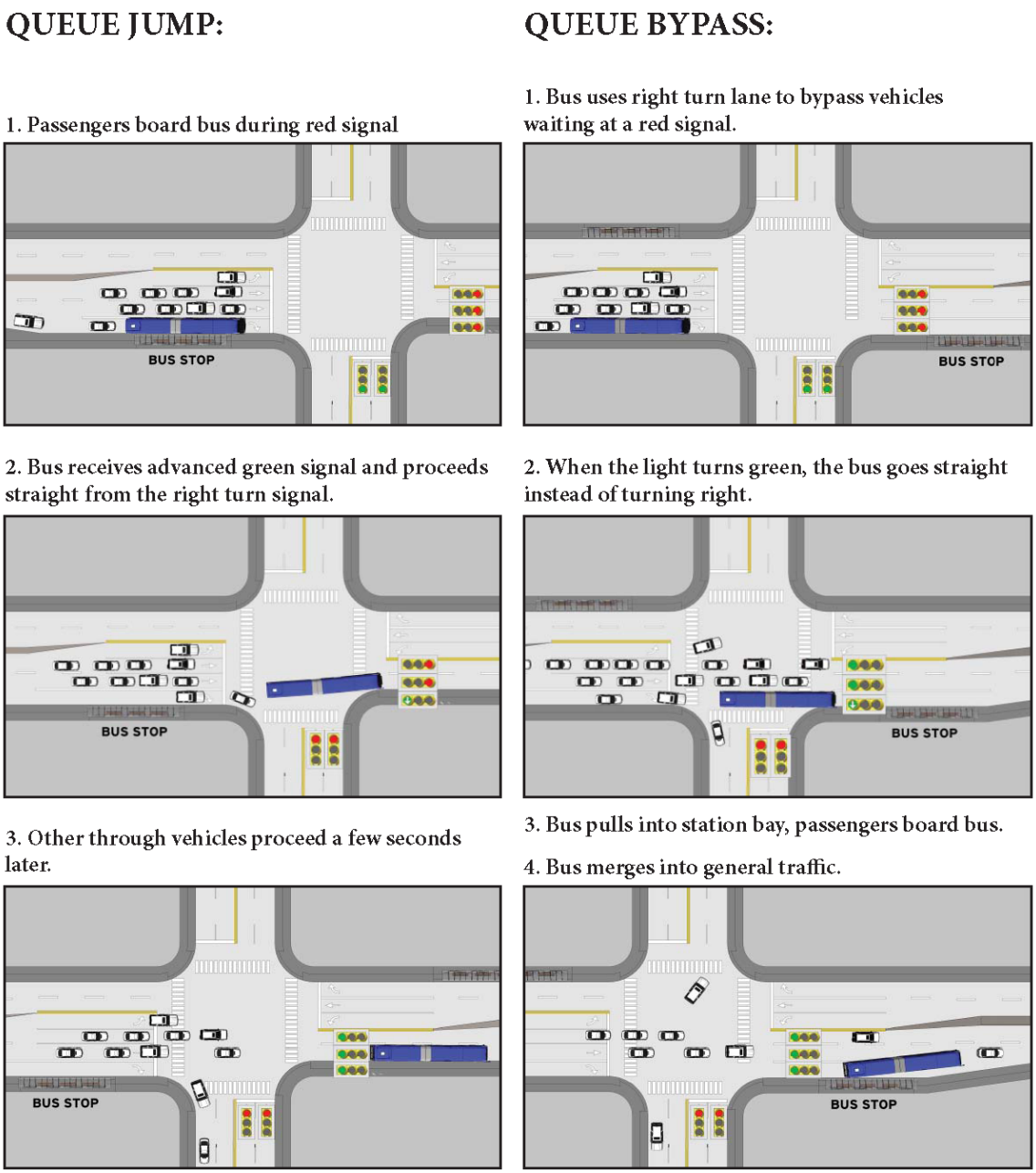


Figure 4.5 Queue Bypass Operation with and without Exclusive Bus Phase

4.3 *BRT Station Features*

Stations may be the most recognizable elements of a BRT system. The goal is to blend elements of a high-quality station experience with the high quality service of BRT. The FTA identifies "substantial transit stations" as a key requirement for providing Small Starts funding for non-fixed guideway BRT projects. This can include branded shelters with seating and other comfort features, in addition to the

service-oriented features of improved system operations. This section describes and illustrates the potential elements to be included at Blue Line BRT stations.

It is important for the public to view the Blue Line as a backbone of a progressive and cost-effective rapid transit system for Central Indiana. Providing a high quality BRT station experience which emulates light rail will distinguish the Blue Line as a premium transit service and encourage greater ridership. Most BRT systems use substantial or unique stations and additional amenities to differentiate them from traditional bus stops. This section provides an overview of station features that achieve this goal.

4.3.1 Enhanced Station Shelters

Of all of the station amenities, a distinct shelter design is the most important feature, as it is the most visual element of the BRT experience. In addition to providing protection from the elements, BRT station shelters are a critical element of service branding. They serve as visual cues to the rider that the service is premium transit. The stations should have consistent architecture, form, layout, materials, and colors.

Figure 4.6 Cleveland HealthLine BRT Station

As shown on Figure 4.6, the Cleveland HealthLine has some of the most substantial BRT shelters in the United States. These enclosed shelters mirror those of light rail systems. Their modern, sleek architecture conveys an image of a premium transit system and enhances the character of the surrounding area. The shelters use sloped, gray steel roofs and large glass windows as a branding hallmark of the system.

Other BRT systems use station shelters with simpler design, while still providing a comfort and establishing an identifier for the system. Kansas City MAX (Figure 4.7) and York Toronto VIVA (Figure 4.8) shelters are good examples. The most notable element of the MAX station is the distinctive sign, towering 15 feet above grade and providing unique, prominent branding. Unlike the Cleveland HealthLine, the MAX system utilizes standard level boarding and on-board fare collection, but the functional and distinctive shelter design and prominent signage provide an enhanced experience for system users.

Figure 4.7 Kansas City MAX Shelter

Certain core amenities, such as benches, leaning bars, trash receptacles, and system maps, are essential within the shelters to provide a premium transit experience. A decision will need to be made as to whether a shelter should be primarily open with canopies (i.e. Los Angeles) or more of an enclosed structure (i.e. Cleveland). It is advisable to at least provide a shelter with a panel perpendicular to the roadway to protect the riders from wind (i.e. Kansas City MAX). In response to the cold winters and hot summers of Indianapolis, an option could be to provide heaters and overhead misters. Emergency telephones and CCTV could be provided to enhance security.

Figure 4.8 York (Toronto) VIVA Shelter

4.3.2 Level Boarding

One of the main differentiating factors between traditional bus service and light rail service is the way passengers board the vehicle. To board a regular bus, passengers typically have to step up from the curb onto the bus, and those using a wheelchair need a ramp with a lift. This process increases travel time by making stops longer and less efficient. Level boarding, as shown on Figure 4.9, eliminates the need for having wheelchair lifts and steps on the bus, and allows boarding and deboarding to occur faster and more conveniently.

Figure 4.9 Level Boarding

Typical roadway curbs are six inches high. Regular buses usually have an eight or nine inch gap from the floor to the curb. Thus, a curb and platform would need to be 14 to 15 inches high to accommodate level boarding, assuming a low-floor bus is utilized[9].

[9] *Bus Priority Treatment Guidelines*, National Capital Region Transportation Planning Board, April 2011.

The *Americans with Disabilities Act Accessibility Guidelines* (ADAAG) (2000) require that between the vehicle and the platform, no more than a 5/8" vertical gap occur and no more than a three inch horizontal gap occur. While these guidelines apply specifically to rail, they should also be applied in a BRT level boarding situation. Optical guidance docking systems or electromagnetic guidance systems are available for use in BRT, but they may not be necessary. One transit agency, the Regional Transportation Commission of Southern Nevada (Las Vegas), abandoned use of the system when it was shown that skilled drivers could successfully position the buses close enough to the platform. An innovative item to consider using is a sloped Kassel curb, which is a concave curb aiding the driver in platform alignment without damaging the vehicle. Additionally, a standard bridge plate could be automatically deployed from the bus to the curb to ensure level boarding.

4.3.3 Off-Board Fare Collection

Many BRT systems require passengers to pay their fare in advance at a machine inside the BRT shelter, as shown on Figure 4.10. This greatly reduces vehicle boarding times as it is much more efficient than collecting fares on-board. Providing off-board fare machines not only lowers travel time, but it also conveys a modern and efficient system image to the general public. Machines provide magnetic cards or smart cards (which utilize an embedded computer chip), and newer models allow for the use of cash, coins, or credit/debit cards to pre-purchase fares. To enforce fare collection, many transit providers conduct periodic fare inspections while the bus is in motion, requiring the addition of staff. Passengers without a valid fare are subject to a fine. This is referred to as a proof of payment (POP) system. Further discussion of this is contained in Section 6.4.3.

Figure 4.10 Off-Board Fare Machine

4.3.4 Real Time Information

A key element of a quality transit experience is real-time information via a Passenger Information Display System (PIDS) on the status of the next arriving vehicle. Studies have shown that real-time information reduces the perceived wait times by riders and increases confidence in the system. By utilizing a GPS location device on a bus, the information can be communicated via an Automatic Vehicle Location (AVL) system to the central dispatch center and placed on a display board at the station. Typically, the information is displayed on a digital reader board. Many systems also make real-time information available on personal electronic devices, giving the riders convenient access to information regardless of where they are. Example PIDS are shown on Figure 4.11.

Figure 4.11 Passenger Information Display Systems

Full color LCD screens showing bus arrivals and other useful messages (i.e. weather, news, etc.) are also emerging for use in transit systems, particularly in Australia and Europe. LCD screens would present the image of a high-tech customer friendly system and could allow for advertising opportunities. This, coupled with a verbal audio announcement, would enhance the premium transit experience.

4.4 *BRT Station Location and Placement*

key attribute of BRT service is faster service due to fewer stops. The smaller number of stops also allows a transit agency to focus capital investment at fewer locations to provide the amenities described in the last section. Unlike traditional local busses that may stop at every corner, BRT stations are typically spaced one-half mile apart in recognition of a commonly accepted ¼ mile comfortable walking distance for most people. The particular placement of specific BRT stations can vary with respect to the street, adjacent sidewalk, and nearby intersections. Each potential configuration has advantages and disadvantages, as described below.

As shown on Figure 4.12, stations can be placed on the curbside to serve a single direction of travel, or if a median exists, they can be placed in the center to serve both directions. Curbside stations are used by IndyGo and most bus agencies with operations providing local bus service in general purpose lanes. Median stations are typically used where dedicated transit lanes are provided on inside lanes. Median stations require vehicles with left hand doors to serve two-way operations.

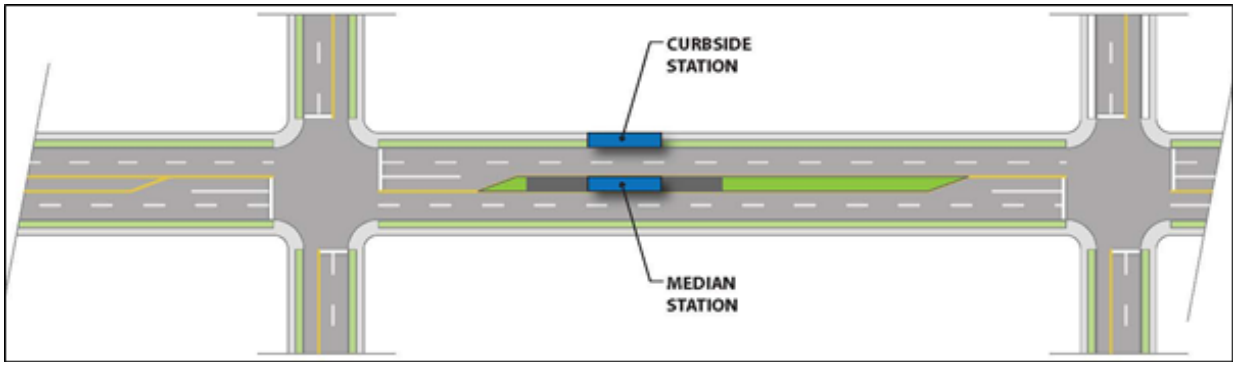


Figure 4.12 Curbside and Median Stations

When designing a curbside station, especially when level boarding is to be provided, the station platform can create an obstacle for pedestrian use of the sidewalk. If sufficient right-of-way exists or can be acquired, the ideal method of accommodating both uses is to place the station at the curb and re-route the sidewalk behind it, as shown in Figure 4.13 for the Cleveland Healthline system. In this instance, the station should be at least ten feet wide and the sidewalk should be at least six feet wide.

Figure 4.13 Curbside BRT Station with re-routed sidewalk, Healthline, Cleveland

If adequate right-of-way is not available, an alternate design allows the sidewalk to pass through the station, as shown in Figure 4.14. These combined station-sidewalks should be at least 12 feet wide in order to allow transit passengers and pedestrians to comfortably pass by one another. Regardless of layout, sufficient space needs to be available for passenger information displays and a ticket vending machine if off-board fare collection is used.

Figure 4.14 Curbside Station with Integral Sidewalk, EmX Line, Eugene, Ore.

Median stations, as shown on Figure 4.15, do not conflict with sidewalks, but they need to be at least 14 feet wide to allow for comfortable boarding and alighting of a bus on each side. Median stations would

normally be located away from intersections and thus require a separate pedestrian crossing signal and high-visibility crossing to ensure that drivers yield. Because these stations serve two directions of travel, two separate passenger information displays are needed. Both directions can share a single ticket vending machine for off-board fare collection.

Figure 4.15 Median Station, EmX Line, Eugene, Ore.

With respect to intersections, the three typical categories of placement are near-side, far-side, and midblock, as shown on Figure 4.16. With near-side placement, the transit vehicle stops at the station before entering the intersection. Far-side stations are located just after the intersection. Midblock stations are located a few hundred feet before or after the intersection. The issues related to these three station placement alternatives are described below and are summarized in Table 4.1.

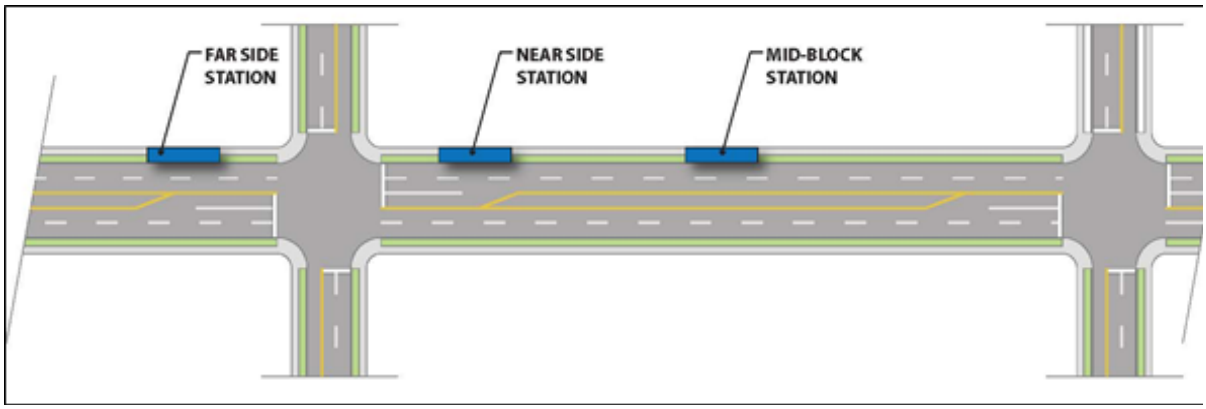


Figure 4.16 Far-Side, Near-Side, and Midblock Stations

Table 4.1 Comparison of Near-Side, Far-Side, and Midblock Stations

Issue	Near-Side Station Advantage	Far-Side Station Advantage	Midblock Station Advantage
Roadway Impacts		●	●
Bus Efficiency		●	●
Pedestrian Access	●	●	●
System Legibility	●	●	
Flexibility	●	●	●

Roadway Impacts: Buses stopped at either near or far-side stations have the potential to block a lane into or out of the intersection while the signal is green, impeding automobiles at the point that most delay occurs on arterial streets. Midblock stations typically require special midblock crosswalks, often with pedestrian traffic signals, which can introduce additional delay to roadway users.

Bus Efficiency: Near-side stations make Transit Signal Priority (TSP) systems less effective because the bus must stop at the station as it approaches the signal. Far-side and midblock stations enable the TSP system to predict when a bus will be passing through the signal.

Pedestrian Access: High quality pedestrian access with well-marked crosswalks, handicapped accessible curbs, and pedestrian signal indications are essential for all transit stations, regardless of placement. Near-side and far-side stations utilize the pedestrian crossing elements of the nearby intersection. Midblock stations require dedicated pedestrian crossing features.

System Legibility: Stations located at an intersection are generally visible to more potential riders.

Flexibility: Far-side and midblock stations make TSP systems more effective, but all curbside placement strategies could be used by local buses, even those without TSP.

Blue Line stations, wherever possible, will be at far-side locations adjacent to intersections. This will allow Blue Line stations to maximize the benefits of Transit Signal Priority while also utilizing the existing pedestrian crossing at the intersection. Midblock stations also enable full TSP benefits if they are far enough upstream from a signalized intersection. Generally, near-side stations adjacent to intersections will only be used where far-side and midblock applications are infeasible or less desirable due to constraints of local land use or developments.

5.0 BLUE LINE MARKET ANALYSIS

This chapter explores the travel market that would be served by the Blue Line, including total trip demand, existing transit trip patterns, and potential for transit oriented development (TOD). Defining travel market and TOD potential provides the basis for defining the most responsive and effective transit service. A series of measures are presented with conclusions that, in combination, define the travel market being served in this corridor. Drawing from these conclusions, recommendations for system planning are provided at the end of the chapter.

The analysis relies on four primary sources of information. Each source is indicated with a distinctive visual cue, as shown in the source descriptions below:

-

Regional Travel Patterns are identified from the Indianapolis MPO regional travel demand model. The travel demand model combines information on population, households, and employment to generate estimates of total trips produced and attracted within each traffic analysis zone (TAZ). The resulting data are used to identify travel activity throughout the corridor. This analysis is particularly important because it evaluates not only existing transit ridership, but also the *potential* for transit ridership in the corridor based on all travel activity, independent of how the transit service is used today. The model output used in this analysis represents all trip purposes, all travel modes, and all time periods from a typical weekday, using a 2010 model base year.
-

Transit Rider Survey Results from the 2009 IndyGo on board travel survey are used to identify travel patterns of people who currently use existing IndyGo services in the corridor. Unlike farebox and passenger count data, the survey data provides information on the actual origins and destinations of each respondent's trip, irrespective of existing transit routing.
-

Boardings and Alightings by Stop for the IndyGo bus services in the corridor are obtained from IndyGo's GPS-based automatic passenger counter (APC) system. The data is used to identify the number of people who board or alight at each stop in the corridor, indicating the intensity of exiting transit use by location. The dataset covers selected typical days in September 2012 and thus does not reflect 2013 service improvements on IndyGo Route 8 east of Harding Street.
-

Transfer Volumes between IndyGo bus routes are obtained from IndyGo bus farebox data. The data was reported as monthly total transfers between routes, and are used to identify major travel patterns of IndyGo riders using the existing bus system. The dataset covers October 2012.

5.1 *Trip Density*

Population and employment density within the study area is described in Chapter 3. Figure 3.15 (population density) shows a cluster of population in the downtown area, with the highest population densities outside that area in the Near East and Mid East districts. East of I-465 and most of the West Side have substantially lower population densities. Figure 3.16 (employment density) shows that downtown Indianapolis has the dominant concentration of employment activity in the study area. Other areas with higher employment density include IUPUI, the vicinity of Indianapolis International Airport, Plainfield, and the Washington Square Mall area.

This section explores the related measure of trip density in the study area. It reviews the relationships between downtown and other corridor activity centers in terms of travel patterns derived from the Indianapolis MPO regional travel demand model and transit usage data provided by IndyGo.

High trip density means that a large number of trips are generated in a concentrated area. Because transit works best when large numbers of people can easily walk to and from stops to access a variety of destinations, trip density is a strong indicator of the potential for transit ridership.

Figure 5.1 shows the magnitude of total trip ends (productions or attractions) and trip end density for each district in the study area, as derived from the travel demand model. The figure only includes data for trips with both an origin and a destination within the study area. These types of trips have the highest potential for transit use.

Four districts combine to form the regional center: Downtown, North Meridian, IUPUI, and Mass Ave. Together, these four districts generate 44 percent of the study area trips. The Downtown district alone generates 24 percent of study area trips.

In addition to generating a large number of trips, the regional center displays a high level of trip density, making it attractive for transit service from throughout the region. Trip density in the Downtown and North Meridian districts is more than double the next two strongest districts (Massachusetts Avenue and IUPUI) and is significantly higher than other districts in the study area.

The largest number of trips outside the regional center occur in the West 10th district, a sprawling area extending from IUPUI west to I-465. Trips begin or end in a sizeable geographic area, so trip density is low. The next three largest generators of trips are east of downtown.

The East Side has consistently higher trip densities than the west. The Airport district generates a higher number of trips than other west side districts, but it has low trip density due to the district's large land area. Most trips are generated at several key locations associated with airport operations.

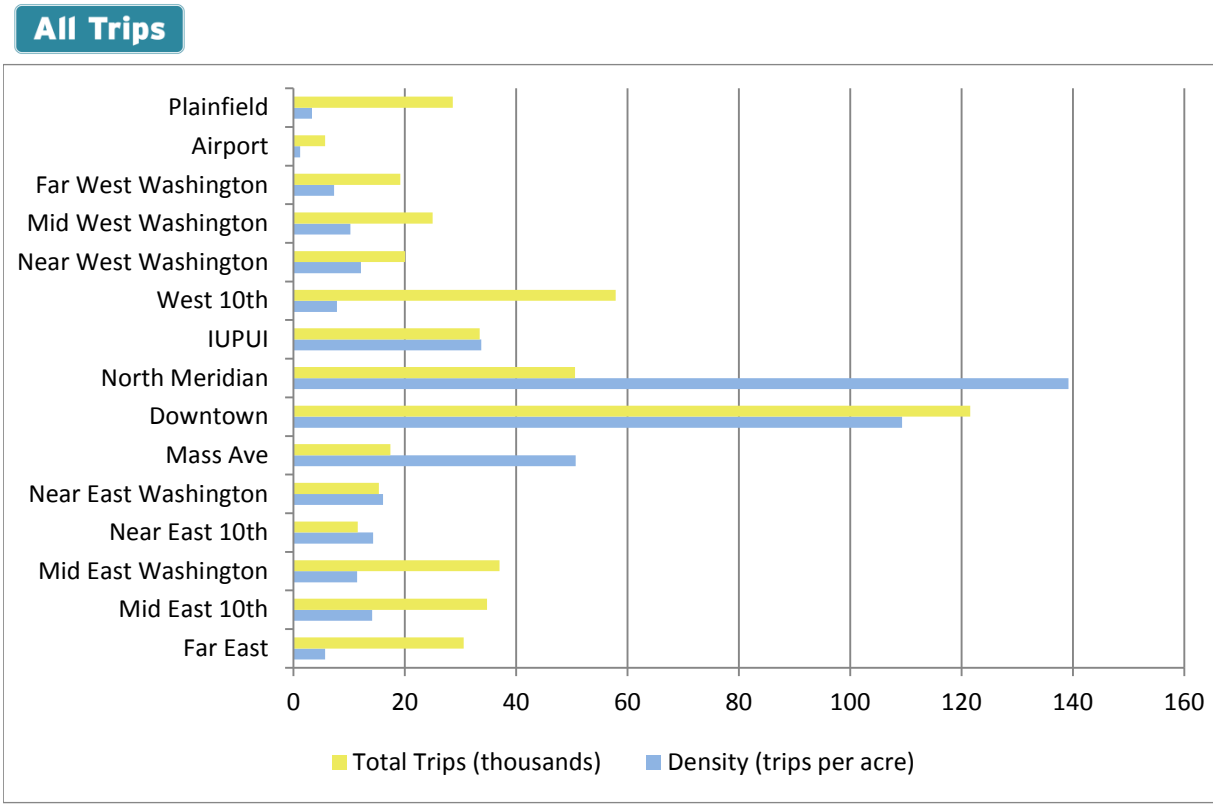


Figure 5.1 Daily Trip Ends (All Purposes, All Modes) by District

To better understand how the trip end data presented in Figure 5.1 might translate into potential routing for premium transit service, the districts shown above were consolidated into five "district groups", corresponding to four corridor areas emanating from downtown, plus the regional center. The four corridor areas are East 10th, West 10th, East Washington, and West Washington, while the regional center is comprised of the IUPUI, North Meridian, Downtown, and Mass Ave districts.

Figure 5.2 shows the same trip generation and trip density data presented in Figure 5.1 consolidated into district groups. For each district group, the total trip generation is shown, with the trip density (in trips per acre) shown in parentheses. To provide a better comparison between the West 10th Street (fully inside I-465) and West Washington Street (extending beyond I-465) corridor areas, the Airport and Plainfield districts are excluded in Figure 5.2.

As shown in Figure 5.2, West Washington Street has the highest trip density outside the regional center at 9.5 trips per acre. West 10th and East Washington have similarly high trip density levels. East 10th has the lowest trip density at 5.3 trips per acre. As expected, the regional center has the highest density of trips generated and attracted, at over 79 trips per acre. Overall, more trips are generated on the east side than on the west side.

Figure 5.2 Trip Generation and Trip Density (Trips per Acre) by Corridor Area

Conclusions

- The regional center has by far the highest trip density in the region.
- Outside the regional center, the east side has higher trip density than the west side.
- Trip density is considerably lower outside of I-465.

5.2 *Origins and Destinations of Trips*

Another way to look at the intensity of travel demand is to review the beginning and ending points of trips (productions and attractions) by direction. Areas with relatively high levels of all-day trip activity are the best candidates for improved transit service. A travel activity profile was developed to identify the locations through the corridor where the MPO travel demand model reflects the highest total daily trip volumes by all modes and for all purposes.

The travel activity profile on Figure 5.3 shows trip activity at each point along the corridor as measured at traffic analysis zones (TAZs). The locations where travelers enter or leave the corridor are mapped by eastbound (purple) and westbound (orange) direction. Trips produced from a location (trip origins) are shown above the corridor line, and trips attracted are shown below (trip destinations).

The profile illustrates again the dominance of downtown and the regional center. Most of the largest attractors of both eastbound and westbound trips are within the regional center. There is substantial activity as far west as West Street and as far east as I-65/I-70. Beyond these points the number of trip ends drops significantly.

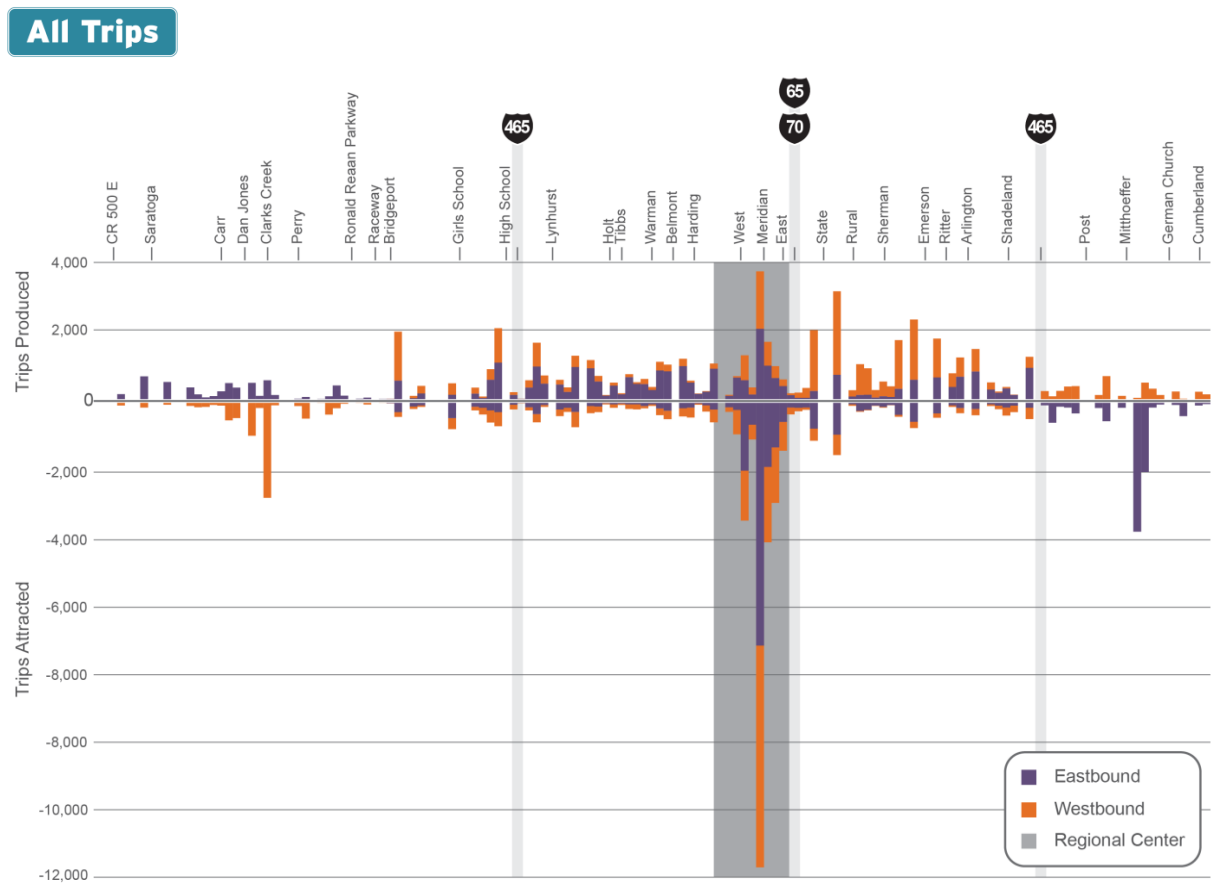


Figure 5.3 Travel Activity Profile

Beyond the regional center, most trip activity occurs inside I-465. On East Washington Street, demand is robust although somewhat uneven, with areas of high travel demand interspersed with gaps of lower demand. On West Washington Street there is a more consistent level of modest travel demand between the Indianapolis Zoo and I-465, with a slight decline west of Tibbs Avenue. Outside the I-465 beltway, Washington Square Mall on the east and the airport on the west are major attractions. A close review of trip production patterns indicates a significant number of eastbound trips originating on the East Side, indicating "local" trip patterns associated with commercial areas outside I-465. The same pattern exists to a lesser degree toward the airport on the west side.

Figure 5.4 and Figure 5.5 illustrate the level of travel demand within each of the four district groups outside the regional center. Figure 5.4 shows the daily total trip volume within each of the four corridor areas, per the MPO travel demand model. Figure 5.5 shows the daily trip volume within each of the four corridor areas based on the IndyGo travel survey. In each figure, the upper illustration includes trips to and from the regional center, while the lower illustration includes onto trips contained entirely within one corridor area. To provide a better comparison between the West 10th Street (fully inside I-465) and West Washington Street (extending beyond I-465), the Plainfield and airport districts west of I-465 are excluded.

Both the travel demand model and ridership surveys indicate that the east corridor of Washington Street is the area of highest travel demand and ridership. Much of this demand is local (not to/from downtown). The west side has lower demand and fewer local trips.

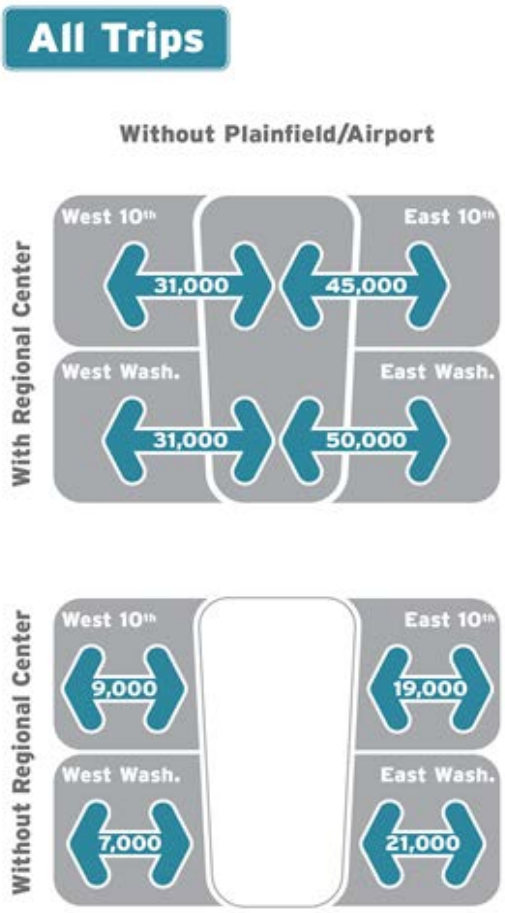


Figure 5.4 Corridor Travel Demand Patterns

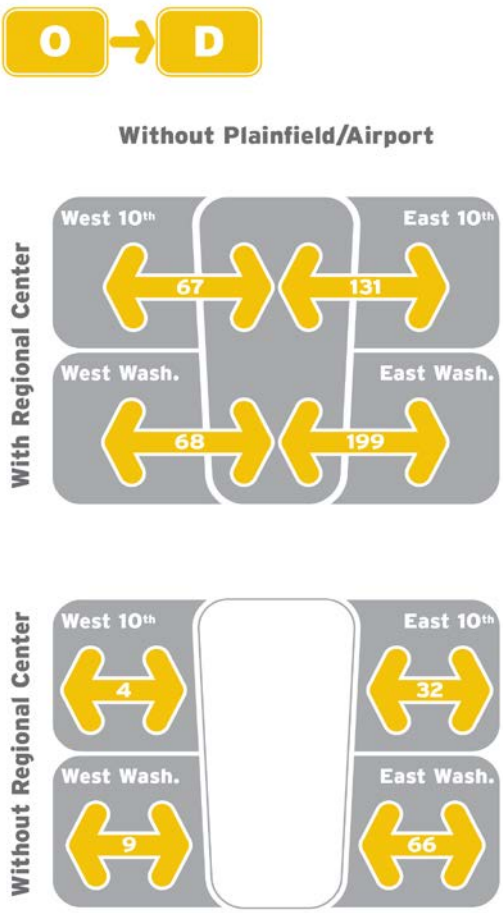


Figure 5.5 Indygo Riders Travel Patterns

Conclusions

- The regional center has by far the most productions and attractions of trips, in all directions.
- The airport on the west and the commercial area in the vicinity of Washington Square Mall on the east are significant attractors of trips.
- The highest travel demand is in the East Washington Street corridor and over 33% of these trips are local (i.e. outside the regional center).
- The travel demand model showed relatively similar levels of travel demand on Washington Street and 10th Street, while the IndyGo travel survey showed stronger demand on Washington Street, particularly on the east side.

5.3 *IndyGo Boarding Patterns*

A key indicator of future transit ridership on the Blue Line is the existing transit ridership in the study area. Figure 5.6 shows average daily boardings on the following IndyGo routes:

- 3 (Michigan Street)
- 8 (Washington Street)
- 10 (10th Street)
- 50 (Downtown/IUPUI Circulator).

The figure is based on one year of data for the period of October 2011 through September 2012.

As expected, downtown Indianapolis has the largest number of transit boardings in the region due to its high concentration of walkable origins and destinations. In addition, IndyGo's radial transit system focuses transfer activity downtown. Transfers account for approximately 30 percent of the total system boardings. This highlights the importance of the planned Downtown Transit Center, which will accommodate connections to other IndyGo routes and future rapid transit lines, as well as serving the east side of downtown directly.

East of downtown Indianapolis, transit demand remains relatively stable and consistent as far east as Shadeland Avenue. Ridership generally declines further east with the exception of several key trip generators.

West of downtown, boardings decline substantially in the vicinity of the Indianapolis Zoo, which currently attracts few transit trips. Further west, several intersections between Harding Street and Tibbs Avenue generate substantial ridership, followed by a consistent level of lower ridership to I-465, and a further decline west of I-465.

Significant activity centers outside downtown include the following:

- **IUPUI** – The university campus and hospitals have the largest concentration of bus ridership outside downtown on the selected east-west routes serving the study area. The stops on Route 10 serving IUPUI along North Street have a combined total of 350 daily boardings.
- **Washington Square Mall** – The shopping center has 230 daily boardings utilizing Route 8 and Route 10 combined, the highest number on the East Side.
- **Airport** – The airport has 130 daily boardings at the western terminus of Route 8.
- **Cumberland** – The Meijer shopping center has 130 daily boardings at the eastern terminus of Route 8.

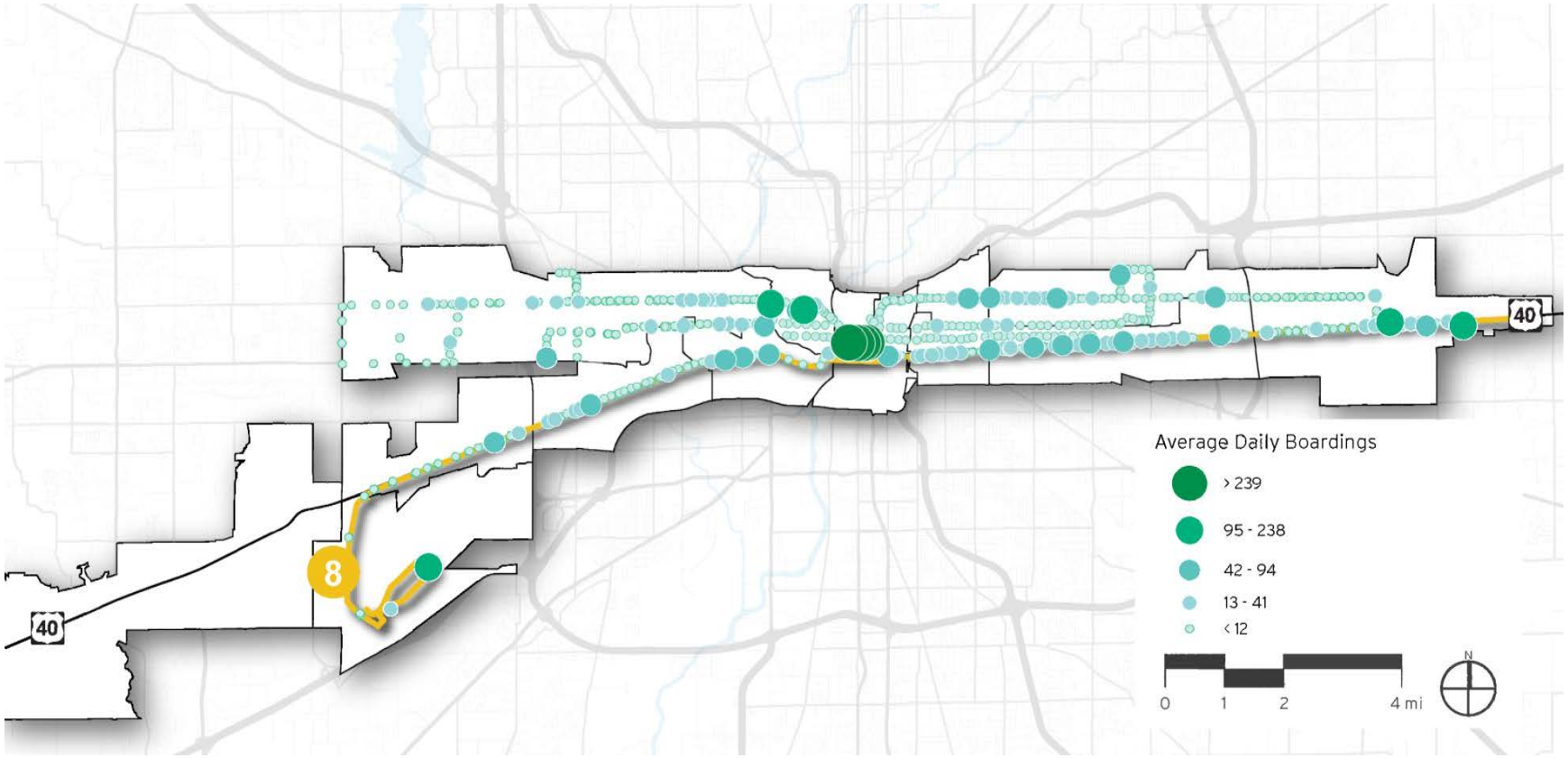


Figure 5.6 IndyGo Boardings by Stop on Key Routes in Study Area

Figure 5.7 presents downtown boardings on the key study area routes in greater detail. The figure also differentiates eastbound and westbound boardings, shown in orange and purple, respectively. The highest concentration of boardings occurs on Ohio Street, where the majority of IndyGo's routes converge and where most transfers occur, but the concentration of boardings on Capitol Avenue is almost as high. This stop serves the west side of downtown, including the Indiana State Government complex and Indiana Convention Center area.

Downtown bus stops on IndyGo Routes 3, 8, 10, and 50 have a combined total of more than 3,000 daily boardings, about 10 percent of total IndyGo system ridership, through the Ohio Street/Capitol Avenue corridor near Monument Circle.

High boarding activity is evident in the IUPUI area on both Route 10 and Route 50, and on Route 8 near the City-County Building on the east side of downtown. On West Washington Street, a relatively large number of eastbound boardings occur on Route 8 just west of Harding Street, which coincides with IndyGo's operations and administration facility. It is likely that most of these boardings are by IndyGo staff and/or visitors.

In addition to showing downtown boarding detail by stop, Figure 5.7 shows all other boardings on the four IndyGo routes represented. Route 8 has the highest number of boardings within and outside of downtown in both directions, though ridership on Route 10 is comparable east of downtown and nearly identical west of downtown. When all IndyGo boardings are considered, daily boardings on the two routes (including transfers) are approximately equal across the full study area, as shown in Table 5.1. Considering east and west segments separately, Route 8 boardings to the east are significantly higher.

Table 5.1 Existing IndyGo Ridership on East-West Routes in Study Area

Route	West Side	Downtown (Capitol to Alabama)	East Side	*Total*
3	414	631	454	**1,499**
8	1,110	1,878	2,072	**5,059**
10	1,502	2,133	1,520	**5,156**
50	162	141	0	**303**
Total	**3,188**	**4,783**	**4,046**	**12,017**

Source: IndyGo Automatic Passenger Counts, September 2012

Conclusions

- The downtown area has the highest concentration of transit boardings in the region.
- Ohio Street stops have the greatest concentration of boarding activity, followed closely by Capitol Avenue. The two sets of stops work together to fully serve the downtown and Near West Washington areas.
- IUPUI has the highest concentration of transit boardings outside the downtown area.
- Other areas of high boarding activity are the airport to the west, and Washington Square Mall and Cumberland to the east.
- Total Route 8 and Route 10 boardings are nearly equal across the full corridor, but on the east side, Route 8 boardings are significantly higher.

5.4 *Cross District Travel Patterns*

Using the previously defined district groups, Figure 5.8 shows total district-to-district trips as determined by the MPO travel demand model. Figure 5.9 shows the same trip interactions for IndyGo riders as indicated by the 2009 IndyGo rider survey. In both cases, the largest number of trips between corridor areas occurs between East Washington and West Washington Streets, where the travel demand model showed approximately 2,700 .crosstown trips. Trips between West 10th and East Washington, and between East 10th and West Washington, showed similar levels of travel demand, with 2,100 trips and 2,200 trips, respectively.

The smallest number of crosstown trips occurred between East and West 10th Street. The IndyGo travel survey results showed twice as many passengers traveling between East and West Washington Street than any other pair of district groups.

Figure 5.8 and Figure 5.9 indicate that among potential crosstown corridors, service strictly on Washington Street is the best alternative for full east-west service across the study area. However, it is important to note that the overall level of crosstown travel demand is very low. While Figure 5.8 shows 8,900 total crosstown trips traversing the four district groups, Figure 5.4 shows 157,000 trips that remain within one district group or travel to or from the regional center. On Washington Street, the 2,700 crosstown trips represent fewer than 4% of total Washington Street travel demand in the study area.

The IndyGo travel survey shows a somewhat higher proportion of crosstown travel, with the 22 Washington Street trips representing approximately 7.5% of the 289 total Washington Street trips. However, this is still relatively insignificant compared with local movements and trips to and from the regional center.

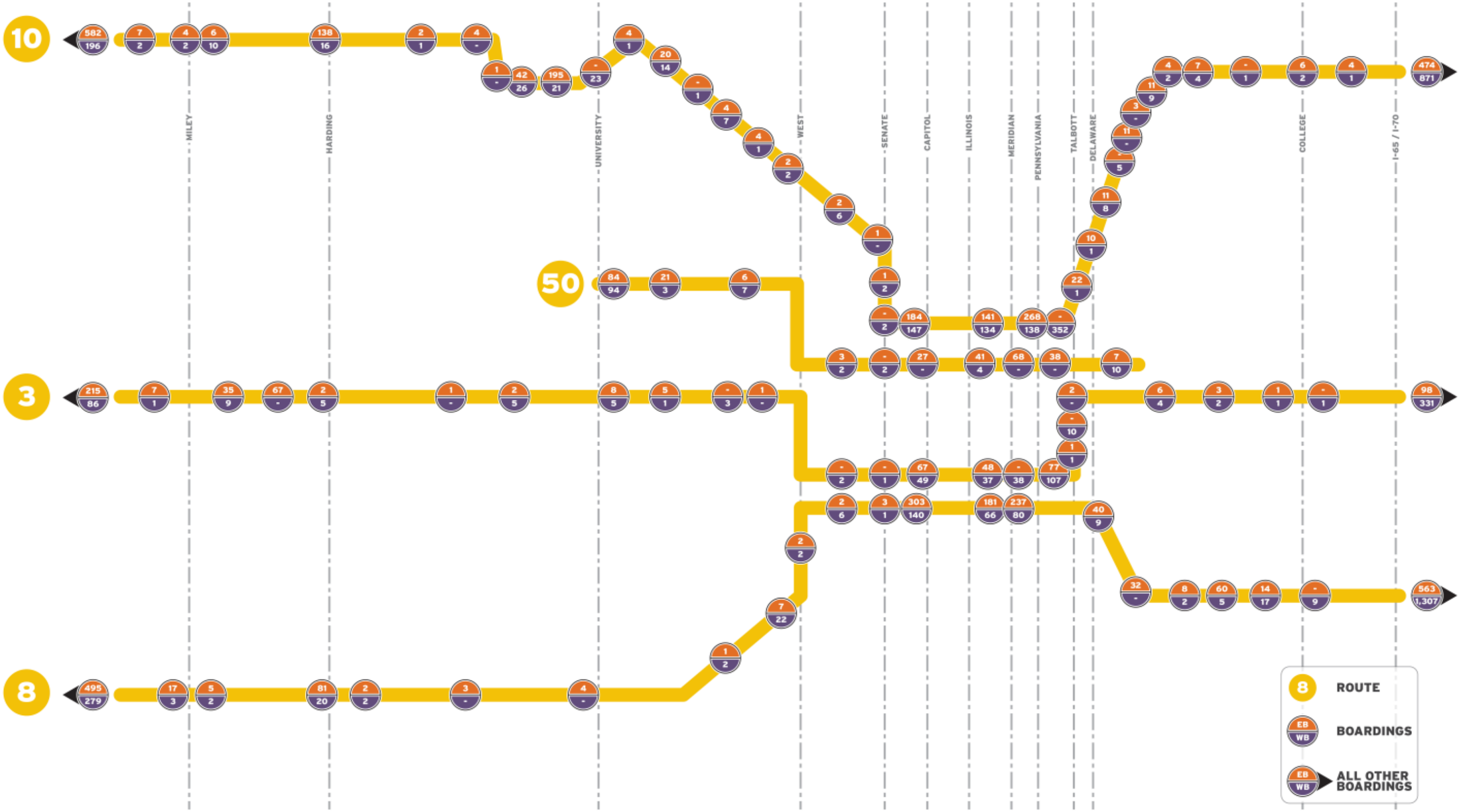


Figure 5.7 IndyGo Boardings by Stop on East-West Bus Routes in Downtown Indianapolis

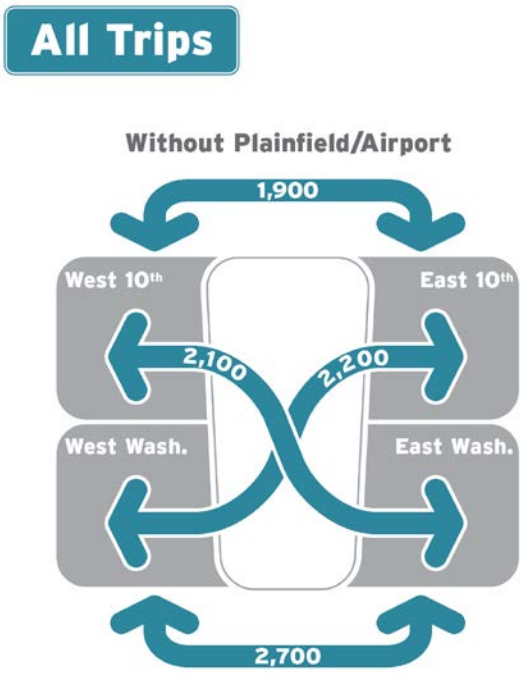


Figure 5.8 All Trip Travel Patterns between Corridor Areas

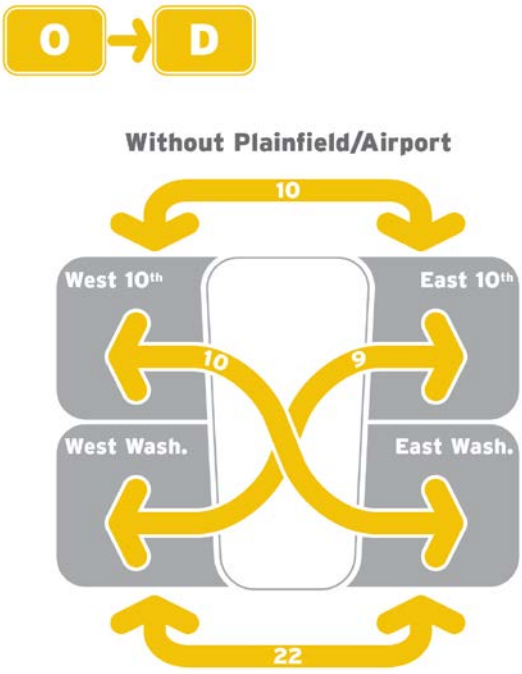


Figure 5.9 IndyGo riders Travel Patterns between Corridor Areas

Conclusion:

- The largest number of crosstown trips in the study area occur between the East Washington Street and West Washington Street corridor areas.
- Most trips in the Washington Street corridor have the regional center as one end of the trip, indicating limited demand for crosstown service.
- The IndyGo travel survey data suggests that a larger number of transit passengers make crosstown trips as compared with the study area population as a whole, though the proportion is still low.

5.5 *Route 8 User Travel Patterns*

Having identified Washington Street as the preferred alignment for the Blue Line BRT service, existing transit travel patterns were examined to determine the ultimate origins and destinations of existing Route 8 passengers.

Figure 5.10 shows the distribution of trips with origins or destinations in either the West Washington (left side of the figure) or East Washington (right side) to or from locations throughout the region, based on the IndyGo on-board survey. The figure specifically identifies the four districts comprising the regional center (Downtown, IUPUI, North Meridian, and Mass Ave), as well as East 10th, West 10th, and

the Central Northside area served by IndyGo routes 38 and 39. East and West Washington trips connecting to points elsewhere are not shown visually, but their percentage is noted on the figure.

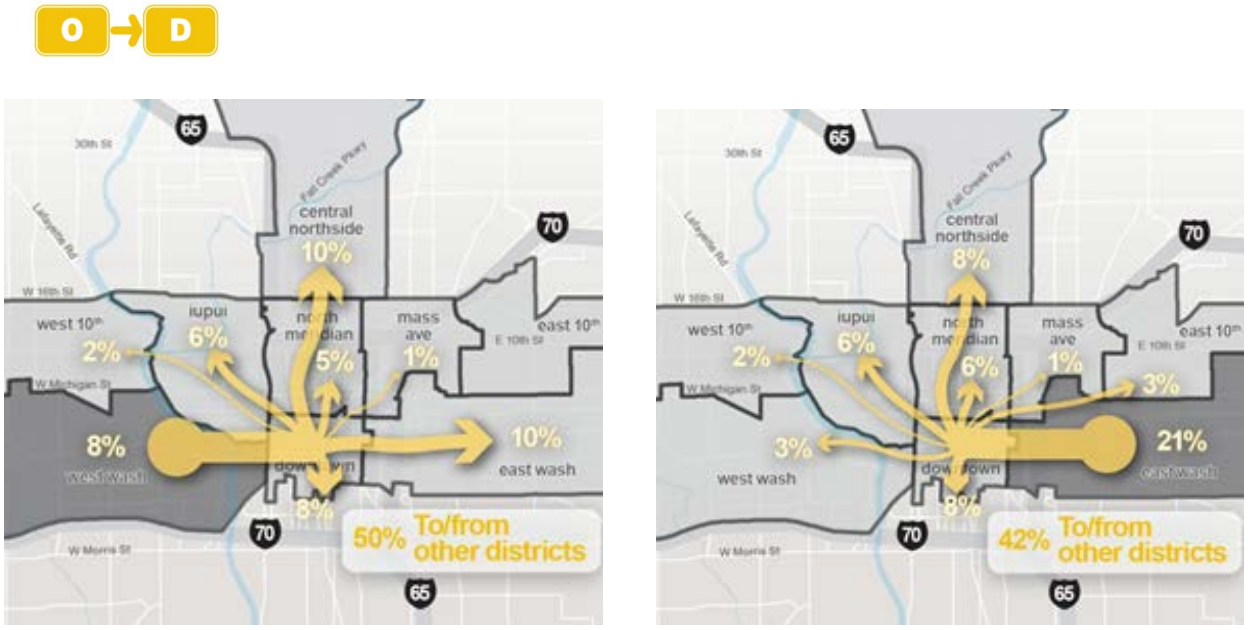


Figure 5.10 IndyGo Rider Travel Patterns

The left side of the figure shows approximately 20% of West Side travelers connect to the four regional center districts. An additional 22% transfer to or from other IndyGo routes to reach West 10th, East Washington, or the 38/39 district. Eight percent stay on the West Side, and the remaining 50% connect to points elsewhere not specifically shown on the figure.

The right side of Figure 5.10 shows a similar overall distribution for travelers to and from the East Washington corridor. As indicated, 21% of trips are to or from the regional center, with a relatively even distribution of trips to Downtown, IUPUI, and the North Meridian district. As compared with the 8% of West Side trips that remain on the West Side, a much larger share (21%) of East Side trips have both their origin and destination within the East Washington corridor. An additional 16% connect to West Washington, West 10th, East 10th, or the 38/39 district, and the remaining 41% connect to locations not specifically shown on the figure.

Conclusions

- IndyGo travel patterns suggest that similar numbers of travelers use IndyGo Route 8 to reach downtown Indianapolis, IUPUI, North Meridian, and destinations further north. These destinations generate equal or greater demand as compared with crosstown trips on the Washington Street corridor. No one district stands out among the others.

- The majority of trips to and from districts outside of Washington Street and the downtown area require transfers to other IndyGo routes, reinforcing the importance of the Downtown Transit Center as a key focal point of the Blue Line.
- A significant number of trips connect between Washington Street and the corridor to be served by the proposed Red Line BRT. This suggests an opportunity to coordinate transfers between these two BRT corridors, as well as the potential to through-route buses between the Blue and Red Lines if both corridors initially terminate at the Downtown Transit Center.

5.6 *Peak Travel Demand*

Moving Ahead for Progress in the 21st Century Act (MAP-21), the federal funding authorization for surface transportation projects, states that BRT systems shall provide "short headway bidirectional services for a substantial part of weekdays and weekend days."[10]. FTA has not yet issued more specific guidance on service frequency under MAP-21. However, under the previous federal transportation bill, SAFTEA-LU, Very Small Starts projects were required to provide "10 minute peak/15 minute off peak headways or better while operating at least 14 hours per weekday."[11]

Current service on Route 8 runs from approximately 5:00 a.m. through 12:00 a.m. On weekdays, east side service operates at 15-minute intervals between approximately 7:00 a.m. and 7:00 p.m., with longer waits outside those hours and on weekends. Less frequent service is provided between Harding Street and Indianapolis International Airport. To determine whether the demand level in the corridor is sufficient to justify the higher service frequency required under this definition, an evaluation of peak-period directional transit travel demand was conducted.

Figure 5.11 shows hourly boarding data for eastbound and westbound Route 8 based on September 2012 passenger count data. Downtown boardings are grouped with the downstream direction of travel, assuming that the majority of passengers who arrive downtown will alight from the bus to either reach a destination within walking distance or transfer to another route.

As shown, the peak demand on Route 8 typically occurs in the afternoon, between 2:00 pm and 5:00 pm depending on the segment and direction of travel. Of the four directions and segments shown, the eastbound service from downtown to the East Side had the highest demand, peaking at 217 total boardings in the hour beginning at 4:00 pm. Throughout the remainder of the day between approximately 6:00 am and 6:00 pm, boardings in both directions of travel are relatively stable at between 50 and 75 boardings per hour on the west side, and between 100 and 125 boardings per hour on the east side.

---

[10] Transportation Research Board. (2013). "BRT Workshop." http://www.nbrti.org/docs/ppt/TRB2103_BRT_Workshop/FTA_Workshop_slides.pdf

[11] Federal Transit Administration (FTA). (2007). "Updated Interim Guidance and Instructions, Small Starts Provision of the Section 5309 Capital Investment Grants Program." http://www.fta.dot.gov/documents/tpeNewStarts_20070720_smallStartsGuidanceAndInstructions.pdf

Assuming that the peak demand shown in Figure 5.11 is spread evenly over four buses (one every 15 minutes), peak hour eastbound passenger loads on the east side in September 2012 were sufficient to fill 40-foot buses to their seated capacity. This was part of the justification for providing service every 15 minutes during the peak afternoon period on the east side even before the 2013 service improvements. In contrast, peak-hour westbound buses on the west side carry approximately one-third the passenger volume. Based on this demand, a consistent level of service is warranted throughout the morning and midday. Higher frequencies, potentially combined with larger vehicles, may be justified to satisfy peak travel demand, particularly if ridership in the corridor increases upon implementation of enhanced BRT service.

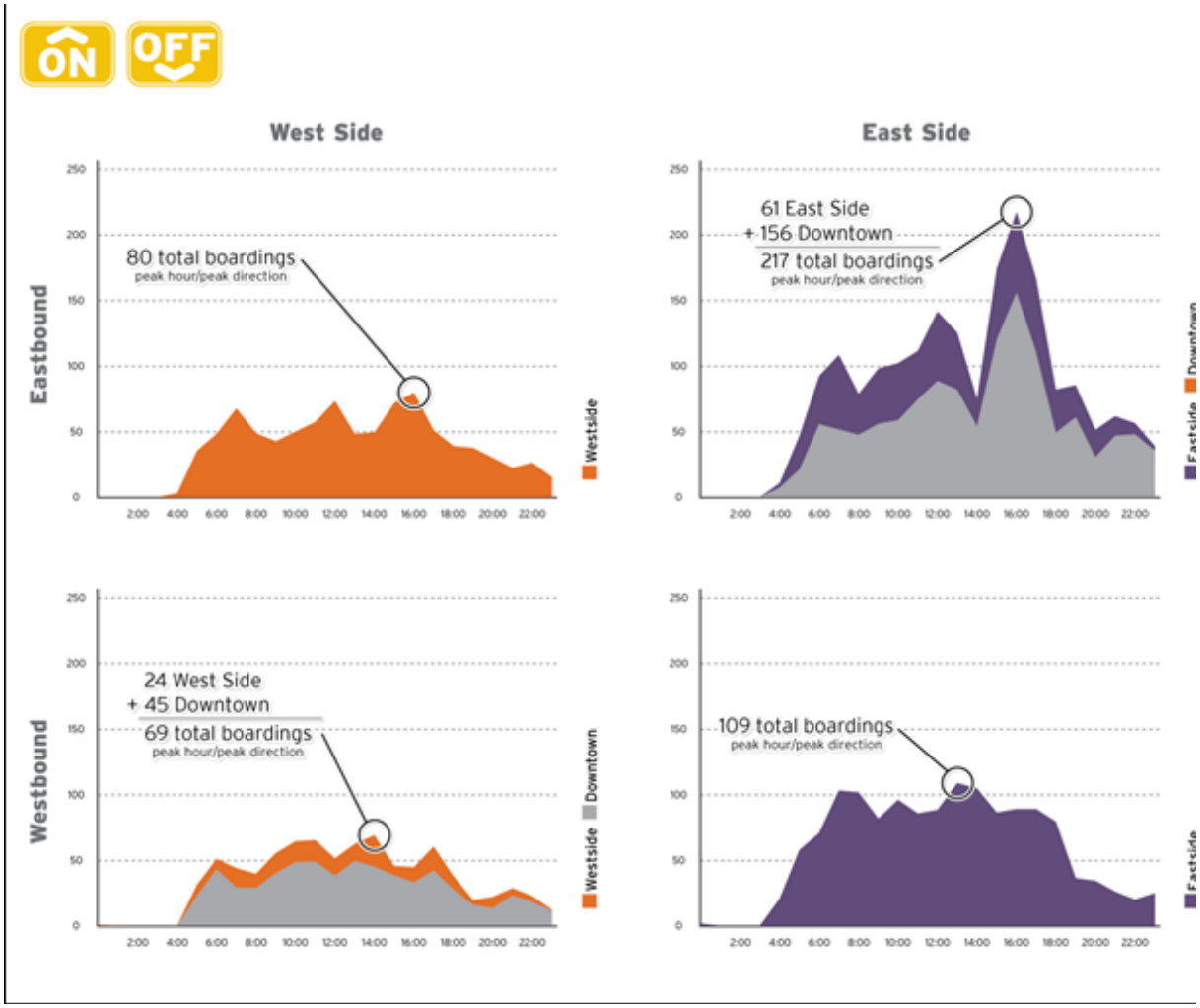


Figure 5.11 Route 8 Weekday Directional Passenger Demand by Time Period and Segment

Conclusions

- Peak hour Route 8 ridership on the east side is already approaching the seated capacity of a typical 40-foot transit bus.
- Higher frequencies and/or longer vehicles could alleviate crowding during peak hours.
- FTA guidelines also call for peak hour headways of no more than 10 minutes.

5.7 *Transit Oriented Development Potential*

Recent work evaluating TOD opportunities in the corridor was used to provide additional insight on the potential for ridership increases and economic development along the Blue Line corridor. In 2012, Greenstreet Ltd. and Anderson + Bohlander LLC conducted a study of the opportunities for TOD along the Blue Line and Red Line rapid transit corridors.[12]

The study area for the Blue Line corridor centered around Washington Street/US 40 through Marion County, plus the towns of Plainfield and Avon, Indianapolis International Airport, and the Town of Cumberland. The study assessed land use and market characteristics of the region and individual nodes in relation to each other using a methodology based on research and approaches developed by the Center for Transit-Oriented Development (CTOD).

The scoring process analyzes various data for regional market dynamics and land use characteristics to assess the potential for TOD within the Central Indiana region. A total of 132 nodes located at key intersections within the Blue and Red Line corridors are analyzed to assess how the nodes relate within a given corridor, and how the corridors relate to each other within the region. A radius of one-half mile is analyzed around each node.

Of the 132 nodes assessed, 48 are on the Blue Line corridor. The nodes are scored on 19 variables, which are listed in Table 5.2. The variables are weighted on a scale of 1 to 10 according to their impact as drivers of market strength and transit supportiveness. Generally, the highest weighted variables address the demographic and market characteristics of the area, followed by physical conditions.

A composite score is provided for each node as calculated from the 19 weighted variables. The composite scores for all nodes range from 43 to 245. Scores are classified into eight categories, ranging from no TOD potential to the highest TOD potential, to show the range of scores and the relative strength of TOD opportunities across all corridors. A score of less than 80 indicates that there is very little TOD potential. Areas with strong TOD potential are those that scored 110 or more.

[12] *2012 Interim Report, Central Corridors TOD Strategic Plan.* Prepared for the Indianapolis MPO by Greenstreet LTD and Anderson + Bohlander LLC, December 2012.

Table 5.2 Assessment Variables for Determining TOD Opportunity

Variable	Weight
Employment Density	10
Employment Density with Transit Preference	10
Population per Square Mile	6
Walk Score	5
Percentage of Baby Boomers + Millennials	4
Gross Residential Density	4
Sidewalk to Street Ratio	3
Intersections per Square Mile	3
Distance to CBD	3
Housing + Transportation Affordability™	3
Land Assembly	3
Residential Vacancy Rate	2
Average Block Length	2
Physical Barriers	2
Retail Sales	2
Median Household Income	1
Average Rent	1
Median Home Value	1
Major Trip Generators	1

The results of the TOD analysis are depicted graphically in Figure 5.12 The colors depicted represent the range of TOD potential along the Red and Blue Line corridors, with red being strongest and light blue being weakest. As shown, the areas of highest intensity TOD potential extend similar distances east and west of the Downtown Transit Center, approximately between West Street and East Street. Beyond those limits, however, aggregate TOD potential is substantially stronger on East Washington Street than on West Washington Street. This is evidenced by both higher intensity TOD potential on the east side, and a larger segment over which such intensity exists.

On East Washington Street, areas of modest TOD potential extend as far east as Shadeland Avenue, approximately six miles from the Downtown Transit Center, with an additional modest area of TOD potential in the Washington Square Mall area. On West Washington Street, TOD potential remains modest as far west as North Tibbs Avenue, approximately three miles from the Downtown Transit Center, with an additional node in the vicinity of I-465. Comparing these two segments, the East Washington corridor between downtown and Shadeland Avenue has a higher average node-level TOD score as well.

Figure 5.12 TOD Opportunity Heat Map

Source: Greenstreet Ltd. and Anderson + Bohlander LLC, September 2013.

5.8 *Conclusions for Blue Line System Planning*

- The highest trip density in the study area is the regional center. It should be served by any planned service.
- Washington Street is the preferred corridor for Blue Line service both east and west of the regional center.
- Travel demand and existing transit ridership are higher on the east side than on the west side. Therefore "east side only" service should be considered. BRT service to the west side should be considered only in conjunction with east side service. "West side only" service should not be considered.
- Given the disparities in travel demand, phased implementation may also be an option, in which BRT on East Washington Street commences prior to providing service to West Washington Street.
- The eastern terminus for any Blue Line corridor should be Cumberland. Demand levels throughout East Washington Street are relatively strong, with a high number of local trips occurring within that corridor area.
- If service extends to the west side, termini as far west as Indianapolis International Airport should be considered.
- If BRT serves primarily East Washington Street, potential western termini at the Downtown Transit Center or west of downtown should be considered. A short extension west of the Downtown Transit Center would potentially serve trips currently using the Route 8 stops on Capitol Avenue.
- Consideration should be given to Blue Line transfers to the north (IndyGo Routes 38 and 39) and to IUPUI, since these are the districts with the highest numbers of trips outside the corridor.
- Anticipated peak loadings warrant higher service frequencies and/or the use of 60-foot buses.

6.0 BLUE LINE ALTERNATIVES DEFINITION

In the context of a simplified AA, alternatives definition explores planning issues through an assessment of broad topic areas that relate site conditions and travel markets with the best and most feasible BRT components to define a limited set of viable alternatives for evaluation. This focus on linking conditions, needs, and components differs from the traditional iterative process where a number of independent alternatives are defined and evaluated.

This chapter builds upon the findings of the market analysis presented in Chapter 5 and the BRT system concepts presented in Chapter 4 to define system components and combine them to define alternatives for evaluation and identification of a recommended alternative in Chapter 7.

The definition of alternatives begins with the identification of the project termini based on the market analysis of Chapter 5. This is followed by development of a preliminary service plan, consistent with existing ridership patterns of IndyGo Route 8, and a review of potential running way treatments including dedicated lanes for buses.

Recognizing the importance of improved travel time, a range of BRT operational treatments are reviewed, beginning with a definition of travel time and delay elements of existing service. Station design/spacing, fare collection strategies, transit signal priority treatements, and queue bypass lanes can all contribute to improved travel time and each is considered in this review. Estimated travel time improvements over existing Route 8 guide the selection of BRT components to carry forward in alternatives.

With termini, preliminary operating plans, running way treatments and BRT operational components defined, ridership estimates are developed to support cost estimating, service planning, and alternatives evaluation.

The final components of alternatives definition are station locations and vehicle type. These elements are identified, then combined with termini, service plans, running way treatments, and BRT operational components to fully define the alternatives for evaluation. They are summarized in maps and tables at the end of this chapter.

6.1 *Blue Line Termini*

The market analysis presented in Chapter 5 identifies the appropriate corridor for Blue Line BRT service as Washington Street. Furthermore, the analysis shows that crosstown trips represent a small share of overall ridership on Route 8 and that east side generates higher travel demand than the west side. The Downtown Transit Center and its immediate vicinity are the focal point for transit boardings and deboardings throughout the region, but significant activity also occurs all along the segment between Schumacher Way and I-65/I-70. In particular, the segment between Capitol Avenue and West Street

generates substantial travel demand, and a large share of trips to and from East Washington Street connect with locations in this section of downtown Indianapolis.

The market analysis clearly shows that a "west side only" configuration is not a reasonable alternative because West Washington Street generates significantly lower travel demand than East Washington Street. Therefore, all Blue Line alternatives to be evaluated include East Washington Street. Service west of the regional center is evaluated as part of one or more crosstown alternatives that include service to East Washington Street.

6.1.1 Eastern Terminus

As shown on Figure 5.6, travel demand on East Washington Street is fairly consistent throughout the area between downtown Indianapolis and I-465. Demand east of I-465 is lower, with several key destinations generating most of the ridership, particularly Washington Square Mall and the Meijer store in Cumberland. Therefore, all of the detailed alternatives evaluated in Chapter 7 have an eastern terminus at the Meijer location in Cumberland, in the vicinity of the current Route 8 eastern terminus.

6.1.2 Western Terminus

Four western terminus alternatives are defined for evaluation, as follows:

- **Downtown Transit Center:** As discussed in the previous chapter, an "**East Side BRT**" alternative should be considered due to the higher trip density, overall travel demand, and high level of existing transit ridership on the east side. A western terminus at the Downtown Transit Center would enable the Blue Line to serve the majority of existing Route 8 passengers on East Washington Street.

  Whether as a permanent western terminus or interim solution until West Washington Street service is implemented, a Blue Line terminus at the Downtown Transit Center would create the potential to link the Blue Line directly to other destinations such as IUPUI or North Meridian Street. Any such linkage must be considered in the context of the proposed downtown circulation system in coordination with other corridor studies, and with special consideration for system identity and the Blue Line brand.

- **Harding Street/IndyGo:** As presented in Sections 5.2 and 5.3, downtown travel demand and transit boardings are high throughout the area between I-65 and West Street. There are also a large number of boardings at Harding Street associated with the IndyGo headquarters facility located there. Harding Street is the location where the current 15-minute service on Route 8 ends. Consistent with the current level of enhanced service east of Harding Street, and to serve the western portion of downtown effectively, this "**East Side plus Downtown BRT**" alternative will be evaluated. It would provide one-seat service to nearly all current Route 8 passengers connecting to and from the east side, while also extending the premium BRT concept to the Indiana Convention Center area, which attracts substantial tourist and other visitor activity.

- **North Tibbs Avenue:** While the previous alternative provides service to a number of key destinations immediately west of the Downtown Transit Center and to the Indianapolis Zoo, there is also considerable travel demand immediately west of that alternative's terminus at Harding Street, as shown in Figure 5.6. This "**East Side to North Tibbs BRT**" alternative would capture the majority of travel demand within I-465 while adding only about a mile to the "East Side plus Downtown BRT" project length.

- **Indianapolis International Airport**: Beyond Harding Street, travel demand is relatively consistent as far west as I-465. Beyond I-465 the airport is the largest generator of transit demand, and is the terminus of the existing Route 8 service. This will be evaluated as the western terminus for a "**Crosstown BRT**" Blue Line alternative. This alternative constitutes full Blue Line service from Cumberland to Indianapolis International Airport.

6.2 *Blue Line Preliminary Service Plan*

Current service on Route 8 runs from approximately 5:00 a.m. through 12:00 a.m. On weekdays, service between Harding Street and Cumberland operates at 15-minute intervals between approximately 7:00 a.m. and 7:00 p.m., with longer headways outside those hours and on weekends. Between Harding Street and Indianapolis International Airport, service is less frequent during peak periods when headways remain at 30 minutes. To qualify for FTA Small Starts funding, MAP-21 requires that corridor-based BRT services operate at least every 10 minutes in peak periods and every 15 minutes in off-peak periods for at least 14 hours per day.

Route 8 ridership data presented in Chapter 5 shows that westbound ridership remains fairly consistent throughout the morning peak, midday, and afternoon peak periods. In the eastbound direction, there is a more discernible afternoon peak east of the Downtown Transit Center. Total boardings (East Side, downtown, and West Side combined) remain at or above 125 per hour in both directions between 6:00 a.m. and 6:00 p.m. Based on this data, a consistent level of service throughout the morning and midday is warranted, with higher frequency service during the afternoon commuting period.

Table 6.1 shows the proposed headways and span of service for Blue Line. It is anticipated that the IndyGo Route 8 would continue to operate under the local service brand, separate and distinct from the Blue Line BRT brand. Vehicle conflicts at BRT stations would be minimal as the local bus would not be arriving frequently.

Retaining Route 8 service would ensure access to public transit for riders who are unwilling or unable to walk to BRT stations at half-mile increments. Route 8 local service would be provided at all existing stops, plus BRT stations, at 30- to 60-minute headways during the entire span of service, 7 days a week, from 5:00 a.m. to 1:00 a.m.

Table 6.1 Blue Line Preliminary Service Plan

SERVICE PERIODS	SERVICE FREQUENCY		
	NO-BUILD	BUILD	
	ROUTE 8[1]	BRT	ROUTE 8
Weekday (19 service hours)			
5:00am – 6:00am	30	30	60
6:00am – 3:30pm	15	15	30
3:30pm - 6:30pm	15	10	30
6:30pm – 8:00pm	30	15	30
8:00pm – 12:00am	60	30	60
Saturday (18 service hours)			
6:00am – 7:00am	30	30	60
7:00am – 9:00pm	30	15	30
9:00pm – 12:00am	60	30	60
Sunday (14 service hours)			
7:00am – 9:00pm	30	15	30

[1]The service frequencies shown for the no-build Route 8 scenario are currently only provided east of Harding Street. West of Harding Street, 30-minute frequencies are provided between 6:00 am and 8:00 pm on weekdays, 7:00 am and 9:00 pm on Saturdays, and all day on Sundays. 60-minute frequencies are provided at all other times.

6.3 *Blue Line Running Way Treatments*

As indicated in Chapter 4, Blue Line running way alternatives are limited to configurations that are predominantly within existing curb lines due to existing right of way limitations and the proximity of structures to the back of the sidewalk at many locations along the corridor. Since added travel lanes are infeasible on Washington Street, this section focuses on how best to use the existing roadway to serve the needs of the Blue Line.

6.3.1 Dedicated Lanes

One approach would be to convert an existing lane in each direction for bus-only use, either all day or during peak periods. Several documents are available that provide guidance on the conditions that would support successful implementation of dedicated bus lanes. The guidelines focus on identifying locations where:

- Transit vehicle and passenger volumes are sufficient to justify implementation and avoid negative perception
- Significant transit travel time savings and reliability improvements can be achieved
- roadway characteristics would support implementation without disproportionate negative impacts
- Local community and agencies would support reallocation of road space and enforcement of necessary regulations

Exclusive transit running ways could be provided without meeting these conditions if the objective is to improve the visibility of transit and encourage long-term mode shift. However, these situations should be carefully considered, as they may not achieve the desired public benefits and may generate strong negative reaction from motorists who perceive an underutilized facility during congested periods.

When bus volumes and transit riders served are too low, the travel time savings to transit passengers from exclusive lanes do not offset the negative impacts to other travelers, and the lanes may be perceived by the public to be underutilized. As summarized in Table 6.2, Transit Cooperative Research Project (TCRP) Report 100 provides general guidelines for the transit volumes that justify the consideration of exclusive running way treatments on urban streets.[13] Bus lanes that have low bus volumes and are not physically separated from adjacent general purpose lanes are likely to experience high violation rates from automobiles, especially if there is congestion in the adjacent lanes.

Table 6.2 Volume Guidelines for Exclusive Transit Lanes

Treatment	Minimum 1-Way Peak Hour Bus Volumes	Minimum 1-Way Peak Hour Passenger Volumes
Curb bus lanes, CBD main street	50-80	2,000-3,000
Curb bus lanes, non-CBD	30-40	1,200-1,600
Median bus lanes	60-90	2,400-3,600
Contraflow bus lanes, short segments	20-30	800-1,200
Contraflow bus lanes, extended	40-60	1,600-2,400

Source: Reference, Kittleson & Associates, Reference 15, Exhibit 4-37

Bus and passenger volumes for the Washington Street corridor are not expected to approach the thresholds identified in Table 6.2 . Based on the service plan presented in Table 6.1, the peak volume of buses in the corridor would be six BRT vehicles and two IndyGo buses per hour. Existing ridership peaks at fewer than 300 passengers per hour. It is not realistic to expect ridership increases under even the most favorable conditions to approach the thresholds for exclusive lanes

It is not surprising that the Blue Line does not reach the thresholds for exclusive transit lanes presented in Table 6.2 since the lanes would be used by only a single BRT route, supplemented by infrequent service on Route 8. Exclusive transit lanes are more likely to be warranted in corridors shared by multiple bus routes, which would increase both bus volumes and passengers served.

[13] Kittleson & Associates, Inc., KFH Group, Inc., Parsons Brinckerhoff Quade and Douglass, Inc., and K. Hunter-Zaworski. *TCRP Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition.* Washington, D.C. Transportation Research Board. 2003

Although vehicle and ridership criteria would be well below the guidelines of TCRP for providing exclusive bus only lanes, the transit lanes could be implemented based on potential travel time benefits and a policy decision to enhance transit visibility and demonstrate high community priority for transit in the corridor.

To evaluate the potential travel time benefits of dedicated bus lanes, the existing travel time conditions were analyzed based on the existing Route 8 schedule and travel time runs conducted during peak and off-peak periods. While the bus schedule defines the existing transit running time, the travel time runs helped to parse that running time into various components of travel time and delay. The study identifies delay according to type, including passenger stops, traffic signals, and traffic congestion. Since the primary benefit of bus-only lanes would be to bypass traffic congestion, this measure was used to evaluate potential travel time savings.

The results of the travel time savings analysis are shown in Table 6.3. As shown, a curbside bus lane would save up to 1 minute of transit running time on East Washington Street, and up to 2.2 minutes on West Washington Street. These time savings amount to between 2% and 2.5% of existing IndyGo running times for a curbside bus lane, and between 6% and 6.5% of existing running time for a median bus lane.

Table 6.3 Estimated Travel Time Savings (minutes) of Dedicated Bus Lanes

Running Way Type	East Washington Street		West Washington Street	
	Peak	Off Peak	Peak	Off Peak
Median Bus Lane	2.8	2.7	2.8	2.7
Curbside Bus Lane	1.0	0.9	2.2	2.1

Synchro 8 traffic analysis software was used to estimate the traffic operation impacts of converting one of the two existing travel lanes in each direction to transit-only use from Southeastern Avenue to I-465. The analysis showed that extensive negative traffic impacts would occur unless a significant amount of Washington Street traffic (more than 20%) diverted to other routes, and the added delay experienced by automobile passengers would outweigh the reduced delay to bus passengers. Additional delay would be experienced by vehicles traveling on the diversion routes.

Although dedicated lanes would be a desirable feature of the Blue Line corridor in terms of system branding and maximizing the benefits of BRT, they are not recommended for the following reasons:

- Physical constraints in the corridor preclude widening the roadway. Likewise, there are no parking lanes on the east side and few on the west side that could be converted to transit use, even if only during peak periods.
- Bus volumes and ridership levels would be significantly lower than industry standard for dedicated lanes. This relates to the fact that only a single transit line is being served.

- Dedicated bus lanes are most successful where several lines are served. The small volume of buses from a single transit line, even at peak 10-minute headways, would prompt an "empty lane syndrome", resulting in negative perceptions and enforcement challenges.
- Travel time in existing mixed traffic lanes is not greatly impeded by congestion, even during peak periods, so there would be minimal travel time benefit from dedicated lanes.
- Eliminating a through lane from general traffic use would create congestion issues on Washington Street and force diversion of existing traffic to other parallel roadways.

6.3.2 Mixed Traffic Lanes

One operational issue that could be addressed while still operating BRT in mixed lanes on Washington Street is minimal lane width. As described in Chapter 3, most of East Washington Street inside I-465 operates with five 10-foot lanes. This contrast with West Washington Street which operates at most locations with 11-foot lanes, and East Washington Street east of I-465, with 12-foot lanes.

As buses are usually 10 ½ feet wide including side-view mirrors, 10-foot lanes constrain bus speeds and contribute to a high incidence of sideswipe crashes. Buses generally travel below posted speed limits and are regularly passed by automobiles. Widening the outside travel lane to 10½ or 11 feet and narrowing the inside lanes to less than 10 feet could provide some operational improvement for buses.

Analysis of IndyGo crash records indicates that a bus crash occurs at an average frequency of six times per year where lane widths are 10 feet (see Chapter 3). Implementing the proposed BRT service plan without widening these lanes would increase expected bus crashes to an average of 14 per year. Widening these lanes could reduce the crash rate to only three crashes per year, similar to the remainder of IndyGo Route 8. While typically minor in terms of damage, these bus crashes impede general traffic flow, force a bus out of service, and require all riders to transfer to the next bus.

Because of utilities and limited right-of-way, any widening of Washington Street would have a large cost impact. Lanes could be widened within the existing curb limits of East Washington Street by eliminating the center two-way left turn lane and replacing it with an eight-foot wide raised center median. The median would improve safety and capacity by eliminating left turns and the width of this median would allow the curb travel lanes (used by buses) to be widened to 11 feet. Turn lanes would be provided at major intersections. This configuration would provide landscape opportunities that do not exist with the existing five-lane section. The concept is illustrated in Figure 6.1.

Raised medians are commonly used as an access management tool to eliminate safety and operations problems of unregulated access to closely spaced driveways. However, medians can be controversial and disruptive in a corridor that is already built out because of their impact on existing property access.

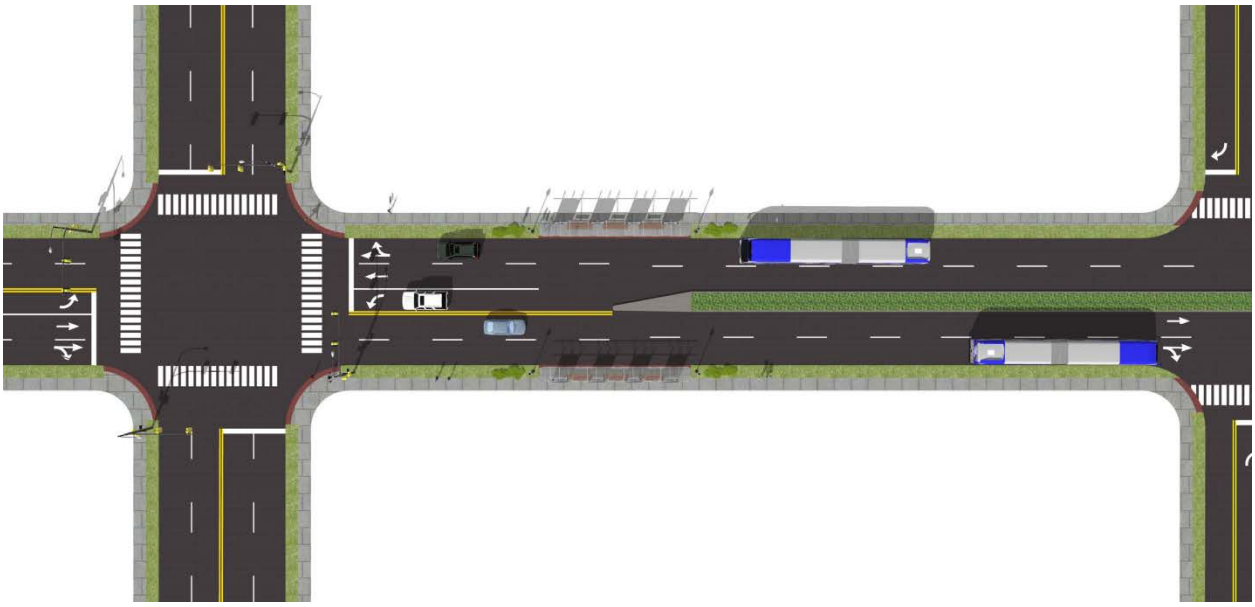


Figure 6.1 Shared Curb Lane with Wider Lanes and Landscaped Median

Most driveways and streets would have only right-in, right-out access, and drivers may need to make a U-turn or circle the block for access. If implemented along the full length of the East Blue Line corridor inside I-465, direct left turn access would be restricted at up to 200 driveways and 73 local streets.

Under the median concept, existing left and right turn lanes would be maintained at signalized intersections, and increased left turn and U-turn movements would be expected at these intersections due to the left turn restrictions. The width of Washington Street is insufficient to accommodate most truck U-turns, so some commercial vehicles would have to adjust their access routes. Turn restrictions would also impact emergency services providers and school bus routes.

Figure 6.2 illustrates how a raised median might appear on East Washington Street. An eight-foot median would provide a pedestrian refuge area and would be of sufficient width to install landscaping, including small shrubs or trees that could significantly improve the attractiveness of the Washington Street corridor. This may warrant selective median construction where left turn impacts are less severe even if the concept is not implemented over the full length of the corridor.

Figure 6.2 Landscaped Median Concept

Ultimately, the safety and aesthetic benefits of a raised median must be balanced against the potential impacts on neighborhoods and existing properties. The large number of driveways on Washington Street makes widespread installation infeasible, but a landscaped median and widened curbside lane should still be considered where practical, even for short segments, due to the potential safety and streetscape benefits.

Wherever a raised median is not implemented, it is assumed that widening of the curbside lane will be accomplished by reducing the width of the inside through lane. This basic section will be assumed and incorporated into the cost and operating statistics under all Build Alternatives.

6.4 *BRT Operational Treatments*

Even in shared lanes, transit service can be improved significantly by addressing major sources of delay with BRT operational treatments. As described in this section, a combination of fewer stops with quicker boarding and deboarding, and traffic signal priority treatments would address the primary sources of delay in the Washington Street corridor. Current operating conditions are reviewed, and BRT operational treatments are defined for the alternatives.

6.4.1 Current Travel Time and Delay

Base travel time conditions were established based on the existing IndyGo Route 8 schedule and travel time runs conducted by test vehicles on Washington Street. While the bus schedule defines the existing transit running time, the travel time runs helped to parse that running time into components, including base unimpeded travel time, congestion delay, signal delay, station dwell time, and vehicle-related delay associated with buses traveling at lower speeds than automobiles, particularly in segments with narrow lanes. This data provides a basis of comparison with auto speeds and identifies the sources of delay that might be mitigated by the BRT operational treatments.

Travel time surveys were also conducted on board Route 8 buses in both directions and during all periods of the day. Recordings were made of running time, dwell time (time stopped at stops or stations), and traffic signal delay over the full route. As expected, conditions varied by direction and time of day as traffic conditions and passenger loading levels changed, with the greatest delay during peak periods.

The results of the travel time analysis for Route 8 are shown on Figure 6.3. As shown, bus transit operates at free flow speeds with other traffic about 58% of the time. About 20% of the time, buses are standing idle at stops or stations (dwell time). Intersection delay, primarily from traffic signals accounts for about 16% of the time a bus is operating. Non-intersection delay accounts for only about 6% of current travel time. To be effective, BRT operational treatments for the Washington Street corridor need to reduce dwell time and traffic signal delays. This is accomplished by station selection and design, adjusted fare collection strategies, and traffic operations strategies, as described in subsequent sections.

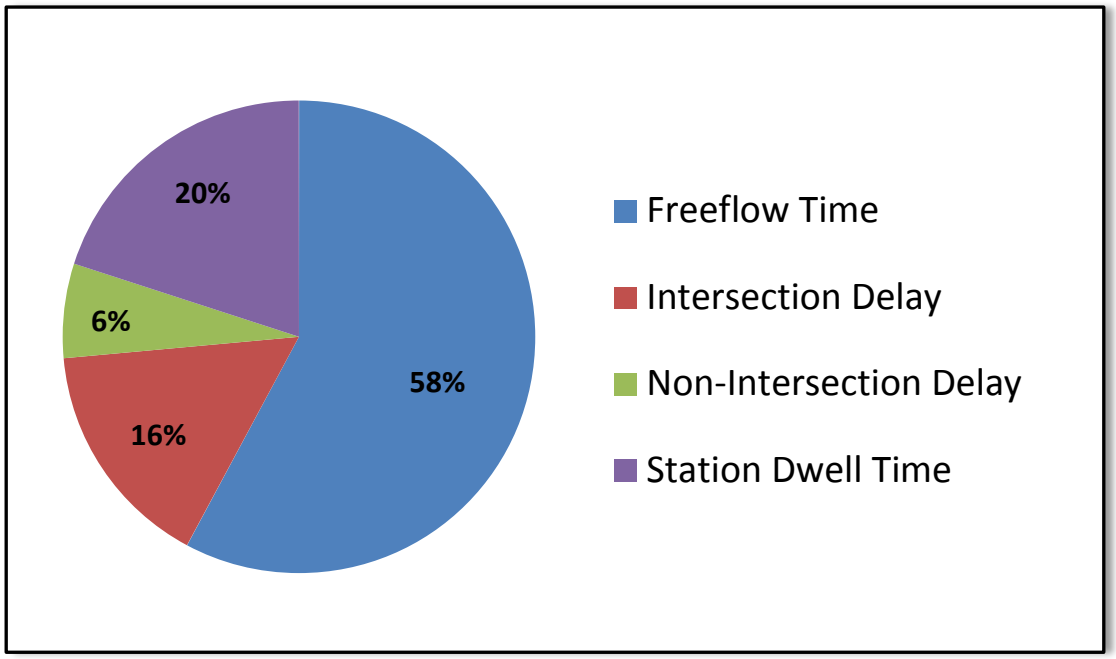


Figure 6.3 Typical Route 8 Travel Time Breakdown

6.4.2 Blue Line Transit Stations

Currently, IndyGo serves 132 stops on Route 8 between Cumberland and Indianapolis International Airport. This large number of stops is typical for a local transit service. One of the basic BRT operational treatments in any corridor is to reduce the number of stops and replace them with a smaller number of enhanced stations spaced further apart. This will be a key element of all Blue Line alternatives. Making fewer stops and conducting them more quickly is central to the potential success of the Blue Line.

Since a ¼ mile is generally considered acceptable for walk access, ½ mile station spacing is assumed as a planning guideline for the Blue Line system. Factors that influence the selection of station locations are illustrated on Figure 6.4. They include major roadway intersections along the route, 2012 ridership at IndyGo Route 8 bus stops, and intersections with other IndyGo routes, and TOD score. The most used Route 8 stops (serving 80% of current ridership) are also identified. These factors and the ½ mile spacing guideline suggest the potential station locations shown as shaded bands on the schematics.

Based on this analysis, 20 stations are recommended for the East Washington Street corridor, including the Downtown Transit Center, 18 intermediate stations, and an eastern terminal in Cumberland. The proposed stations east of downtown are spaced slightly more than one-half mile (.57 miles) apart on average. The majority of the proposed stations are at or near locations that account for the majority of existing demand in the corridor. Stations are also recommended where there is a modest to high TOD potential, such as at Lasalle Street, and where general station spacing criteria warranted stops. The preliminary locations of proposed stations for East Washington Street are listed in Table 6.4.

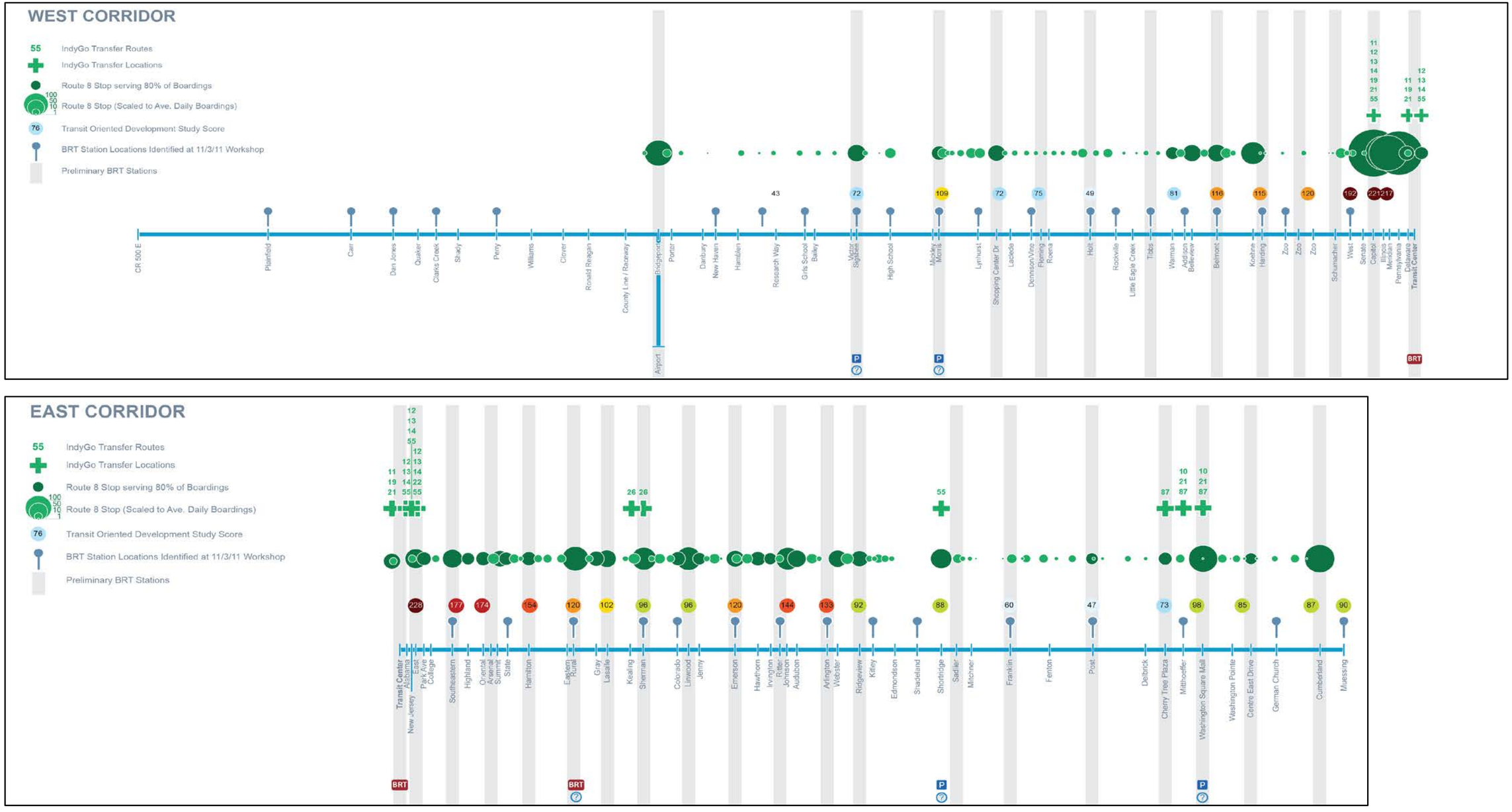


Figure 6.4 Factors that Influence the Selection of Station Locations

Table 6.4 East Washington Street Blue Line BRT Stations

Station	Nearest Cross Street	Westbound Station Placement	Eastbound Station Placement
	Downtown Transit Center	Transit Center	
1	East Street	Far	Far
2	Southeastern Avenue	Far	Far
3	Arsenal Avenue	Mid	Mid
4	Hamilton Avenue	Far	Mid
5	Rural Street	Near	Mid
6	LaSalle Street	Far	Far
7	Sherman Drive	Far	Far
8	Linwood Avenue	Far	Far
9	Emerson Avenue	Far	Far
10	Ritter Avenue	Far	Near
11	Arlington Avenue	Far	Far
12	Ridgeview Drive	Far	Far
13	Sadlier Drive	Far	Far
14	Franklin Road	Far	Far
15	Post Road	Far	Far
16	Cherry Tree Plaza	Far	Far
17	Washington Square Mall	Far	Far
18	Centre East Drive (Wal-Mart)	Far	Far
19	Cumberland (East Terminal)	Off-Street	

As shown on Table 6.5, recommended station spacing for West Washington Street is slightly larger, owing to several segments in which both existing demand and the potential for future demand are low. The west side is generally characterized by a smaller number of demand generators which account for the majority of both ridership and growth potential. In addition to the Downtown Transit Center, West Washington Street contains 11 intermediate stations and the western terminus at Indianapolis International Airport.

In order to verify physical feasibility, field visits and site inventories were made at each proposed station location. The preliminary designations of near-side, far-side, and midblock station locations are presented in consideration of these site-specific factors.

Far-side locations are favored in both directions of travel where there are no conflicts or if only one of two or more curb cuts on a parcel would be closed. If a far-side station would conflict with a building at the right-of way line or block a parcel's only curb cut, the station is shown near-side or at the nearest midblock location, with associated midblock pedestrian signal.

Table 6.5 West Washington Street Blue Line BRT Stations

Station	Nearest Cross Street	Westbound Station Placement	Eastbound Station Placement
	Downtown Transit Center	Transit Center	
1	Capitol Avenue	Far	Far
2	West Street	Far	Far
3	Harding Street/IndyGo	Far	Far
4	Belmont Avenue	Far	Far
5	North Tibbs Avenue	Far	Far
6	Holt Road	Far	Far
7	Fleming Street	Far	Far
8	Westgate Plaza	Far	Far
9	Morris Street	Far	Far
10	Sigsbee Street	Far	Far
11	Bridgeport Road	Near	Far
12	Airport Terminal	At Col. H. Weir Cook Terminal	

Selected locations are recommended to have one or more mid-block stations, including Arsenal, Hamilton, and Rural on the east side, and the Indianapolis Zoo on the west side. These mid-block locations were selected due to right-of-way constraints such as driveway access and building encroachments. Because mid-block curbside stations may lead to jaywalking issues, any mid-block curbside stations should include a signalized pedestrian crossing.

Because of the potential to cause substantial congestion at intersections, near-side stations adjacent to intersections should typically only be used where neither far-side nor mid-block applications are feasible. Near-side stations are recommended for use at Rural and Ritter on the East Side, and Bridgeport on the West Side, due to building and driveway conflicts that preclude far-side or mid-block stations. At Ritter, the near side station will also provide better access to the adjacent grade school.

It is assumed that for underlying local Route 8 service, stops will remain at current locations except for stops in close proximity to BRT stations, which should be consolidated. This will enhance system legibility and help passengers transfer between local and BRT service. All station locations are subject to adjustment based on more detailed investigations and conditions existing at the time of system design.

6.4.2.1 East Terminal Site Concept

As a terminal station, the eastern terminus of the Blue Line in Cumberland would be more substantial than other BRT stations. It should include an off-street turnaround/layover facility that can accommodate up to two BRT vehicles, convenient passenger drop-off and boarding, and a park-and-ride lot to draw ridership from further east. Creation of a signature terminal facility can accommodate these needs and “brand” the Blue Line service.

A number of potential sites for a terminal facility were reviewed along Washington Street between German Church Road and the Marion-Hancock County line (Carroll Road). Two alternative terminal facility sites were identified as the best for Blue Line Service, as shown on Figure 6.5. One is near the existing terminal in the Meijer shopping center parking lot on the south side of Washington Street. The other is directly across the street just east of the existing Woodlark Drive intersection.

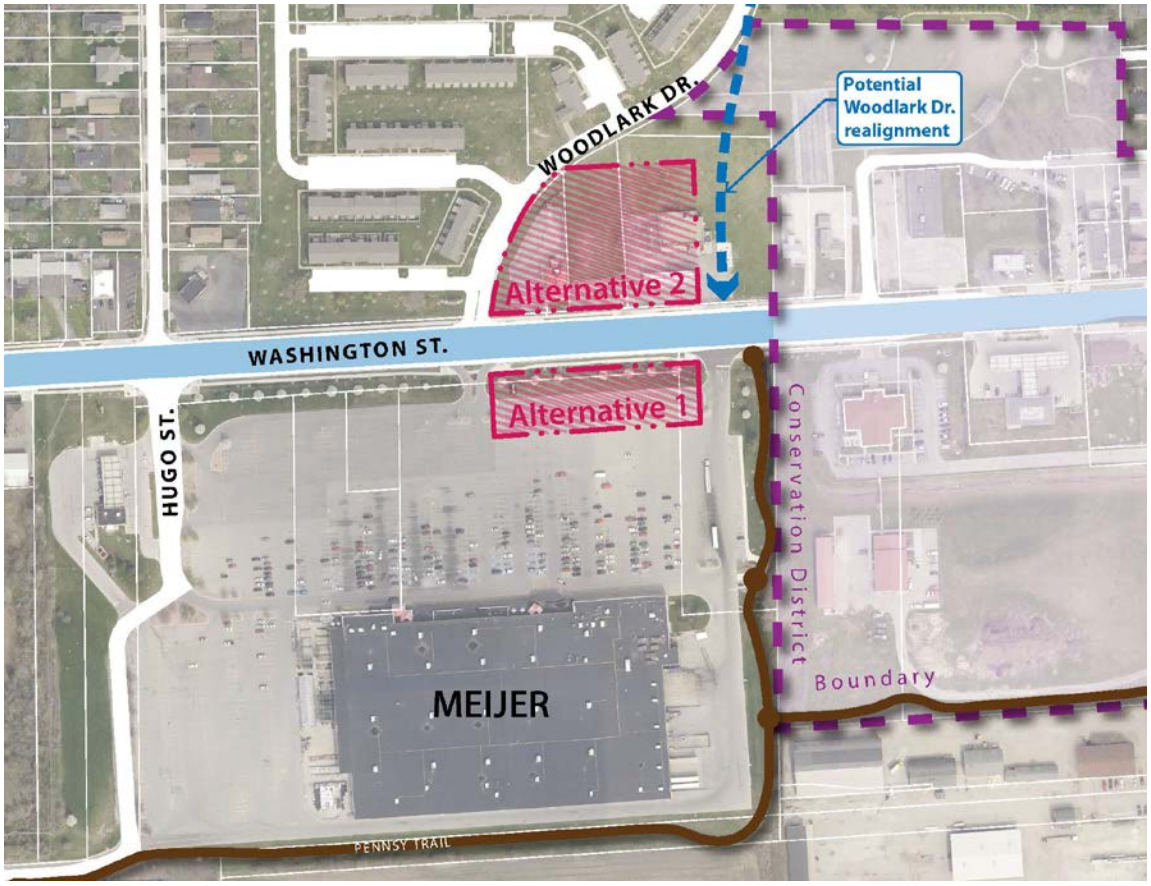


Figure 6.5 East Terminal Site Alternatives

With either option, the terminal facility is sited within walking distance of the Muessing Street - Washington Street intersection in the historic downtown area of Cumberland. Alternative 1 assumes right-in ingress at the east end of the parking lot, and egress at the existing signalized Hugo Street intersection. No new traffic signals would be needed under this alternative. Several variations are possible pending discussions with the Town of Cumberland and shopping center stakeholders. One potential layout is shown on Figure 6.6.

Access to the Alternative 2 site would be provided via a realigned Woodlark Drive (east of its current location) with secondary auto access from the existing Woodlark Drive. While offering more convenient access to nearby multi-family residential development, this alternative would be more costly since it would require land acquisition, roadway construction, a new traffic signal, and additional upgrades to pedestrian crosswalks.

One potential layout for the East Terminal site layout is shown in Figure 6.6. This alternative assumes that the vacant parking area at the northeast quadrant of the Meijer property could be used for a terminal facility. This site is currently the terminal for the IndyGo Route 8 line, but future use of this area for the Blue Line would need to be discussed with Meijer, IndyGo, and municipal representatives. In fact, the Town of Cumberland has expressed preliminary interest in exploring Alternative 2 in greater detail.

A final decision regarding location and layout of the East Terminal will be made during the engineering design phase.

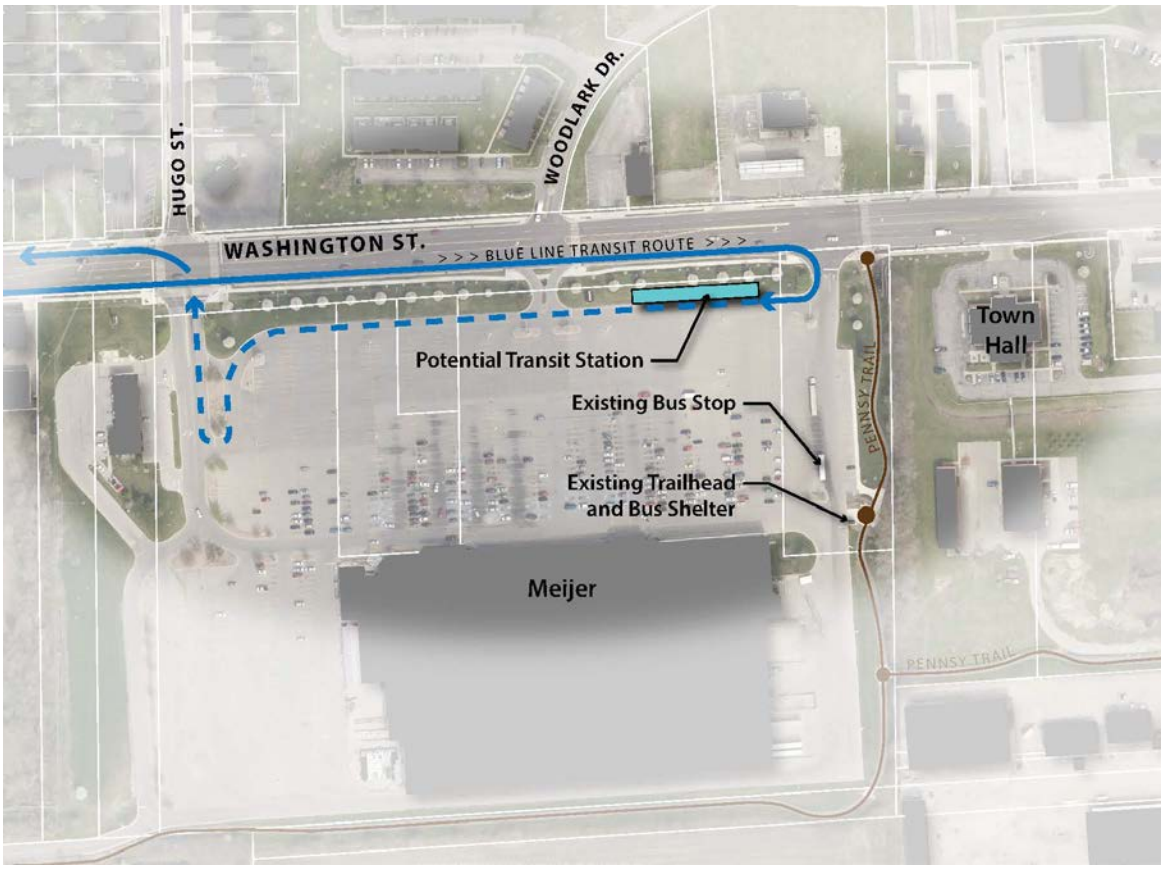


Figure 6.6 East Blue Line Terminal – Alternative 1 Conceptual Layout

6.4.3 Fare Collection System

Operating with fewer stations, as recommended in the last section, would have a significant impact on running times, but the benefit will not be fully achieved unless the dwell time spent at each station is minimized. A range of actions will be assumed in the BRT alternatives to speed boarding and deboarding, including a level boarding platform, multiple doors, on-board bicycle racks, and improved guidance for riders. A particularly important component to speed the boarding process is off-board fare collection, which would be a departure from current IndyGo operations.

Off-board fare collection is administered in one of two ways. One method, typically used for heavy rail systems, uses barriers such as fare gates or turnstiles that require fare payment prior to entry. The second method does not use barriers and passengers move freely on and off vehicles. All passengers are expected to pay in advance and are subject to verification upon request. This is referred to as a proof of payment (POP) system.

While there are international examples of barrier systems for BRT fare collection (Curitiba, Brazil and Bogota, Colombia), POP systems are much more widespread in the United States. POP systems require much less investment and space than barrier systems, and they are more flexible, with a station requiring only a standard ticket vending and/or validating machine. Clearly, a proof of payment system is the most reasonable approach for off-board fare collection on the Blue Line.

To identify the best POP fare collection strategy for the Blue Line, a peer review was performed as part of this study. The review found that POP systems are commonly with BRT, and customers tend to have a neutral to favorable response. A range of potential fare collection options were identified for the Blue Line, from maintaining the existing on-board payment system to an off-board ticket validation system enforced through random inspections. Based on this review, two potential options are recommended for initial use on the Blue Line:

1. A full POP system could be deployed, whereby passengers validate a prepaid ticket or pass at a station before boarding the transit vehicle. Passengers purchase a ticket from a ticket vending machine (TVM) at the station before boarding. Ticket validation would either be incorporated into the TVM or be conducted with a separate machine. Random fare inspections would be conducted by a small dedicated staff with the authority to enforce and levy fines.

2. A hybrid system could be implemented allowing both prepayment and payment on board. Fare incentives could be provided to encourage prepayment. TVMs would be supplied at some or all stations, while ticket and pass validation would take place on-board the vehicle instead of at the station. This option would still allow boarding through multiple doors by placing ticket validation scanners at all entrances. Like the previous option, enforcement would be accomplished by a small dedicated staff.

The second option is recommended for initial use. It can be phased in with TVMs only being deployed initially at higher-volume stations. At lower volume stations without a TVM, passengers could still purchase their fare onboard the bus. Fewer TVMs would be needed per station since passengers can still pay on board if a machine is out of order. A hybrid system such as this on Indianapolis's first BRT line could meet the objective of speeding boarding on the Blue Line while introducing the benefits of POP, with the goal of eventually converting the system to full-fledged POP operation.

The key is to greatly reduce the time for boarding and deboarding so that dwell time at stations is minimized. Reduced time for fare collection, coupled with fewer station stops, addresses the primary source of delay for current transit operations in the Blue Line corridor.

6.4.4 Transit Signal Treatments

The second highest source of delay for transit operations in the Washington Street corridor is traffic signal delay at intersections. Some intersection delay is inevitable, but traffic engineering technologies and strategies are available to optimize operating conditions for transit. Their application to the Blue Line is explored in this section.

6.4.4.1 Transit Signal Priority

As described in Section 4.2, transit signal priority (TSP) systems allow transit vehicles approaching a signalized intersection to receive priority treatment from the traffic signal, thus reducing its delay at the intersection.

Synchro 8 traffic signal analysis software was used to estimate the impacts of transit signal priority on both bus travel times and delay to automobiles at key intersections on Washington Street. An optimized traffic signal plan was developed for existing afternoon peak hour traffic volumes as a baseline. Signal timings were adjusted to reallocate nine seconds of green time to the Washington Street to simulate transit signal priority operations.

With signal priority, the average additional auto delay through the 11 modeled intersections was less than one second per vehicle. Based on a peak BRT headway of 10 minutes on the Blue Line, signal priority would delay automobile traffic by less than 0.5%. The speed and reliability benefits for BRT would be significant. There are no Washington Street intersections where TSP would cause excessive traffic delays.

Transit signal priority (TSP) is recommended at all signalized intersections in the Blue Line corridor outside downtown. TSP is not appropriate downtown due the complex progressive traffic signal patterns of the grid street network. The cost of implementation would be minimal at about $10,000 per intersection.

6.4.4.2 Queue Bypass Lanes

Queue bypass lanes provide an opportunity to bypass traffic waiting at a traffic signal. Queue bypass lanes allow buses to proceed straight through an intersection from a lane normally reserved for right turns, or from a lane reserved for buses. Constructing dedicated queue bypass lanes in the Blue Line corridor is not recommended, but extending right turn lane sections at selected locations could improve travel time while strengthening the Blue Line brand as an enhanced, higher-speed transit option.

A traffic simulation analysis was conducted to assess the benefits of queue bypass lanes at selected locations. Table 6.6 identifies intersections in the Blue Line corridor where existing lane configurations, road geometry and the presence of an adjacent transit station or stop would support implementation of queue bypass operations.

Table 6.6 Queue Bypass Locations in the Blue Line Corridor

Intersection	Direction	Lane Used	Condition
Cherry Tree Plaza	Eastbound	Right Turn	Far-side Station
Washington Square	Eastbound	Right Turn	Far-side Station
Washington Square	Westbound	Right Turn	Far-side Station
Wal-Mart (Centre East)	Eastbound	Right Turn	Far-side Station
Harding Street	Eastbound	Right Turn	Near Side Station

Traffic impacts of these queue bypass lanes would be minor since exclusive bus signal phases are not proposed. In most cases, buses would move through the intersections at the same time as other traffic and only certain traffic movements would be delayed due to queue bypass. Right turn on red would need to be prohibited from the side street to avoid buses that are crossing the intersection.

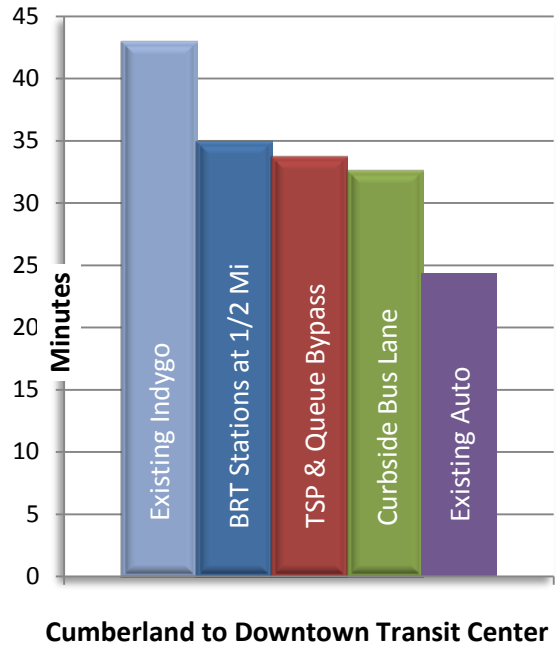
The benefits of queue bypass should be re-evaluated by location during project design. Even if travel time savings are intermittent, they would certainly occur during peak holiday periods and they would provide a visible reminder of transit priority. In addition to locations listed in Table 6.6, Cherry Tree Plaza, Washington Square and Wal-Mart (Centre East) drives should be evaluated. Travel time runs suggest that queue bypass might reduce bus delay by an average of about five seconds per location.

Queue bypass at recommended locations would require the installation of bus exception signage for the mandatory right turn movement. An illuminated “No Turn on Red” sign on the side street, activated by an approaching bus, could maintain operational efficiency and safety for approaching vehicles.

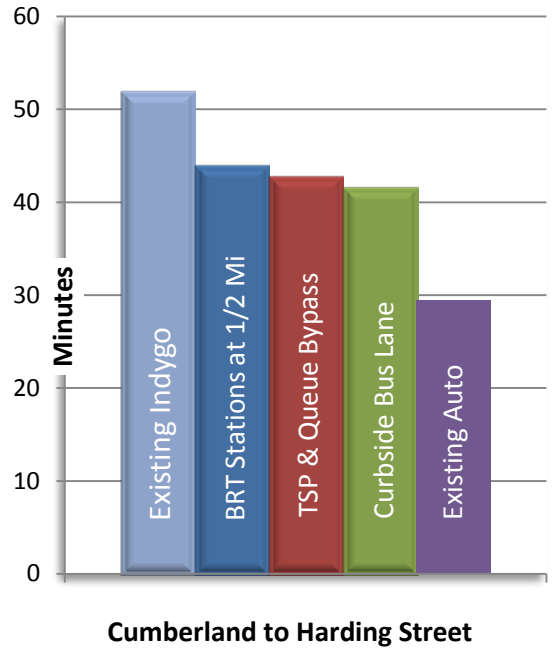
6.4.5 Estimated Travel Time Savings

The travel time savings of the proposed BRT operational treatments can be estimated by adjusting the delay components of the current trip as determined in the base travel time analysis described in Section 6.4.1. For this analysis, assumed BRT features include ½-mile station spacing, level boarding and off-board fare collection, transit signal priority, and queue bypass lanes as described in previous sections. Associated time savings were applied to the IndyGo Route 8 schedule to reflect these changes.

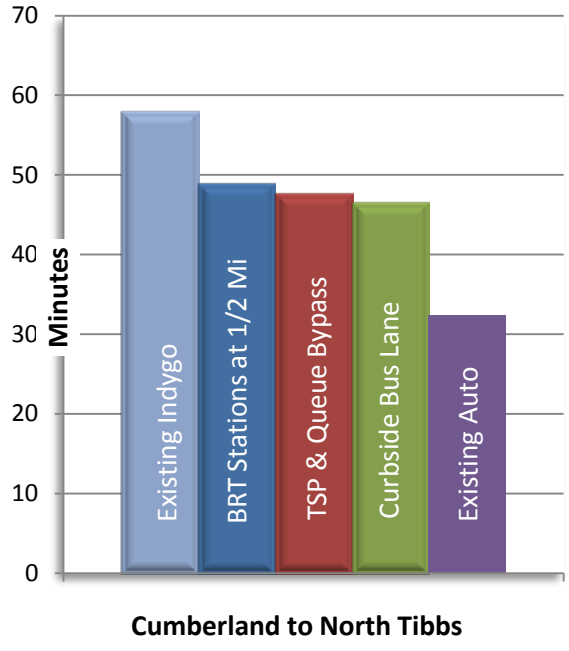
Although dedicated lanes are not recommended for the Blue Line, the potential time savings of bypassing non-intersection related congestion is included in the analysis for illustration. The results of the analysis are shown in Figure 6.7 for the corridor segments described in Section 6.1. Travel times in the figures are cumulative, beginning with fewer/enhanced stations, adding TSP with bypass lanes, and adding dedicated lanes. Generally, the times represent peak period conditions. Existing IndyGo Route 8 running time and auto travel time are shown for comparison.



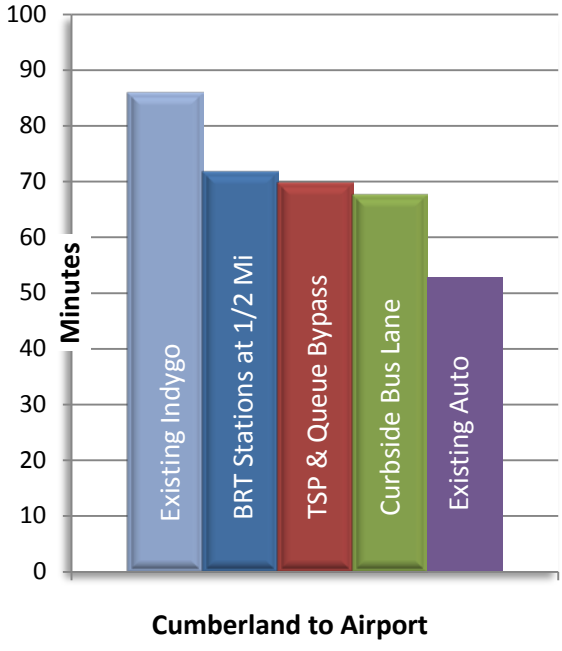
Cumberland to Downtown Transit Center



Cumberland to Harding Street



Cumberland to North Tibbs



Cumberland to Airport

Figure 6.7 Estimated Time Savings with BRT Treatments

The "BRT Stations, ½ Mile" travel times shown in Figure 6.7 reflect the consolidation of stations and other station-related improvements, but no running way improvements. The "TSP and Queue Bypass" travel times include these station improvements along with signal priority and queue bypass at the locations identified in this chapter. Both station improvements and TSP/queue bypass are assumed in the travel times shown for the bus lane alternatives.

As shown in the graphs, among the proposed BRT treatments in the corridor, enhanced stations with spaced further apart results in the largest share of travel time benefits, accounting for 15% to 20% reduction in overall estimated running time. A 20-second dwell time is assumed, similar to that achieved for most rail systems. With off board fare collection and multiple doors available to passengers, some BRT systems have achieved dwell times as short as 10 seconds, so there is little doubt that this savings is achievable.

Traffic signal priority strategies and queue bypass lanes add some time savings and they would improve schedule reliability. As expected, little additional benefit would be provided by installing dedicated curbside bus lanes since there is currently minimal non-intersection delay experienced on Washington Street.

6.5 *Estimated Blue Line Ridership*

With the basic elements of Blue Line BRT components defined, ridership can be estimated. In addition to being a key parameter in the FTA project evaluation process, ridership is a key determinant of service plans and vehicle requirements. Ridership levels are driven by numerous factors including the area served, the speed and frequency of service, and premium amenities provided. Estimated ridership on the Blue Line is presented in this section.

Two methods were considered for estimating ridership on the Blue Line. One method, referred to as an *elasticity model,* starts with existing ridership and makes adjustments based on improved service and amenities. The second method uses a regional travel demand model, based on population and employment forecasts from throughout the region to assign trips to the overall transportation network, including roadways as well as transit routes. Since the Blue Line corridor is already served by an existing transit line, the elasticity model approach is utilized for this Alternatives Analysis.

The greatest strength of the elasticity model approach is the detailed and reliable foundation provided by existing ridership information for Route 8. The "real world" trip patterns, including actual boarding and alighting data by stop, can be associated directly with existing service parameters. One limitation of the elasticity method is that it is not well suited to developing long-range ridership forecasts. It is most suitable for estimating opening day ridership. This satisfies FTA guidelines, but may not provide the information needed to support a typical regional long range transportation plan such as the one maintained by the Indianapolis MPO, which may have a planning horizon of 20 years or longer. This will require follow-up with the travel demand model.

6.5.1 Forecasted Blue Line Daily Ridership (Elasticity Model)

Elasticity methods to estimate ridership involve the application of industry average sensitivity factors to scale existing ridership up or down based on proposed changes to service. The approach is described in detail in *TCRP Report 118: Bus Rapid Transit Practitioner's Guide*[14], which also provides the sensitivity factors applied to produce Blue Line forecasts. There are several major changes in service associated with the implementation of Blue Line BRT service: reduced travel time, increased service frequency, fewer stops, and additional service amenities on the Blue Line, and reduced frequency on Route 8.

A two-part method is employed to estimate total corridor ridership: first, existing Route 8 riders are assigned either to the BRT route or the remaining Route 8 service; and second, the increased frequency and travel time savings offered by the new BRT service were assumed to attract new riders to transit. Because ridership data was collected in September 2012 when Route 8 service operated at peak headways of 30 minutes, the 2012 service level and ridership were assumed as the base for this exercise.

Assignment of existing Route 8 riders to either Route 8 or the Blue Line was performed using a utility function that compared the tradeoff between longer walk distances to and from BRT stations with the shorter wait times and travel time savings offered by the BRT service. Table 6.7 presents the assumed distribution of existing ridership between the Blue Line and Route 8 for each of the Blue Line alignment alternatives.

Table 6.7 Existing Rider Distribution to Blue Line and Route 8

	East Side BRT	East Side plus Downtown BRT	East Side to Tibbs BRT	Crosstown BRT
Existing Route 8 Ridership:	**4,301**	**4,301**	**4,301**	**4,301**
Switch to Blue Line:	*2,880*	*2,991*	*3,084*	*3,519*
Remain on Route 8:	*1,421*	*1,310*	*1,217*	*782*

Following the assignment of existing Route 8 riders to either the Blue Line or IndyGo Route 8, the additional ridership resulting from enhanced transit service was estimated using elasticity values from TCRP Report 118. Values are provided for a variety of potential BRT service amenities, as shown on Table 6.8.

[14] Kittleson & Associates, Inc., *Transit Cooperative Research Program Report 118: Bus Rapid Transit Practitioner's Guide*, Transportation Research Board, Washington, D.C., 2007.

Table 6.8 Ridership Impacts of Selected BRT Amenities

Component		Percentage
1.	Running Ways (not additive)	20
	Grade-separated busways (special right-of-way)	(20)
	At-grade busways (special)	(15)
	Median arterial busways	(10)
	All-day bus lanes (specially delineated)	(5)
	Peak-hour bus lanes	-
	Mixed traffic	-
2.	Stations (additive)	15
	Conventional shelter	-
	Unique/attractively designed shelter	2
	Illumination	2
	Telephones/security phones	3
	Climate-controlled waiting area	3
	Passenger amenities	3
	Passenger services	2
3.	Vehicles (additive)	15
	Conventional vehicles	-
	Uniquely designed vehicles (external)	5
	Air conditioning	-
	Wide multi-door configuration	5
	Level boarding (low-floor or high platform)	5
4.	Service Patterns (additive)	15
	All-day service span	4
	High-frequency service (10 min or less)	4
	Clear, simple, service pattern	4
	Off-vehicle fare collection	3
5.	ITS Applications (selective additive)	10
	Passenger information at stops	7
	Passenger information on vehicles	3
6.	BRT Branding (additive)	10
	Vehicles & stations	7
	Brochures/schedules	3
Subtotal (Maximum of 85)		*85*
7.	Synergy (applies only to at least 60 points)	15
Total		*100*

NOTE 1: Applies to a maximum of 10-min travel time bias constant (e.g., percentage of 10 min)
NOTE 2: Applies to a 25% gain in ridership beyond that obtained by travel time and service frequency elasticities
Source: TCRP Report 118, Exhibit 3-22

There are three major changes in service associated with the implementation of Blue Line BRT service: reduced travel time, increased service frequency, and additional service amenities. For changes in travel time, TCRP Report 118 sites an elasticity factor of -0.4 as an industry average, meaning that for a 10% reduction in travel time an increase of 4% in ridership should be expected. For changes in service frequency, an elasticity factor of 0.4 is used, meaning that an increase in frequency of 10% would yield a 4% increase in ridership.

Based on the preliminary service plan, roadway configuration, and enhanced amenities defined in the preceding sections of this chapter, the TCRP Report 118 guidelines were used to generate an estimate of additional Blue Line ridership attracted to the corridor. Adding these riders to existing riders resulted in the total corridor ridership summarized in Table 6.9 for each of the four alternatives.

Table 6.9 Forecasted Blue Line and Route 8 Weekday Ridership

	East Side BRT	East Side plus Downtown BRT	East Side to Tibbs BRT	Crosstown BRT
Existing Riders continuing to use Route 8:	1,421	1,310	1,217	782
Existing Riders changing to Blue Line:	2,880	2,991	3,084	3,519
New Riders, using the Blue Line:	1,874	2,225	2,437	2,536
Total Blue Line Ridership	**4,754**	**5,216**	**5,521**	**6,055**
Total Blue Line + Route 8	**6,175**	**6,526**	**6,738**	**6,837**

6.5.2 Forecasted Blue Line Peak Hour Bus Ridership

In addition to the daily ridership estimates presented in Table 6.9, it is useful to develop a forecast of peak-hour passenger loads to ensure that proposed frequencies will be sufficient to handle anticipated demand and that the vehicles proposed for service will be appropriate for the number of passengers served.

The existing ridership patterns presented in Figure 5.11 indicate that in the peak hour and direction (4:00 pm, eastbound), slightly fewer than 300 passengers board Route 8. Of these passengers, 156 board the bus downtown, and another 61 board east of downtown. With the addition of a small number of crosstown trips from the west side, the maximum hourly passenger load is approximately 225 passengers. For the purposes of this analysis it was assumed that peak hour ridership as a percentage of the total weekday would maintain a fixed proportion. Therefore, based on an estimated 4,754 daily passengers on the Blue Line when operating on East Washington Street only, it is estimated that peak hour loading on the Blue Line east of downtown would be approximately 250 passengers per hour, or approximately 10% above existing Route 8 peak loads.

6.6 *Blue Line Vehicles*

A key question in any BRT system is vehicle selection. Many systems use 60-foot articulated vehicles due to the availability of multiple doors for boarding and deboarding, the space to carry bicycles on board, and the overall comfort level provided. The use of these larger vehicles can also be warranted based on ridership and level of service. That topic is addressed in this section.

The *Transit Capacity and Quality of Service Manual* publishes level-of-service (LOS) ratings based on transit vehicle load factors – defined as the number of passengers on board the vehicle divided by the number of seats. Based on an assumed seated capacity of 35 passengers per 40-foot low-floor bus and 60 passengers per 60-foot articulated bus, these LOS ratings are tabulated for both vehicle types and shown in Table 6.10. Generally, LOS C is desirable and LOS D is acceptable for daily operating conditions.

Table 6.10 Transit Loading Standards

Level of Service	Passenger Load (P/Seat)	40-Foot Low-Floor Bus (35 Seats)	60-Foot Low-Floor Bus (60 Seats)
A	0.00 – 0.50	0 – 17	0 – 30
B	0.50 – 0.75	18 – 26	31 – 45
C	0.76 – 1.00	27 – 35	46 – 60
D	1.01 – 1.25	35 – 43	60 – 75
E	1.26 – 1.50	44 – 55	75 – 90
F	> 1.50	> 55	> 90

Source: *Transit Capacity and Quality of Service Manual, 2nd Edition. TCRP Report 100. Transportation Research Board, 2003*

As discussed in the previous section, maximum peak hour loadings on the existing Route 8 reach approximately 225 passengers per hour in the eastbound direction east of downtown. At the current peak hour headway of 15 minutes with 40-foot buses, buses are operating at or near capacity. At an increased 10-minute peak headway, as proposed for the Blue Line, this would equate to an average peak load of nearly 40 passengers per bus during the peak hour. This passenger load would consume the majority of the seated capacity on a 40-foot bus, resulting in LOS D, as shown in Table 6.10.

The forecasted Blue Line ridership is approximately 10% greater than existing Route 8 ridership on East Washington Street. Any such increase during the peak hour would bring passenger loads on a 40-foot bus at or close to LOS E, depending on peaking during the hour. A 60-foot bus would operate at LOS C

under this load, providing superior passenger comfort during periods of peak demand. Therefore, even under the East Side Only BRT option, a 60-foot bus would be warranted based on peak passenger loads.

Indy Connect outreach efforts, including exhibits at the Indiana State Fair (2011 and 2012) have introduced stylized 60-foot articulated BRT vehicles with a distinctive appearance, such as the type shown in Figure 6.8. In addition to the passenger capacity considerations discussed above, such a vehicle would lend a distinctive appearance to the Blue Line which would clearly designate the Blue Line as an enhanced premium transit corridor. Peer systems, such as the MAX line in Las Vegas and the EmX in Eugene, Oregon, opened with articulated vehicles to both accommodate growth and distinguish the service from traditional local buses.

Figure 6.8 Vehicle Designed for BRT use, North American Bus Industries, Inc. (NABI)

Based on the anticipated ridership range on East Washington Street, the opportunity to provide premium service to BRT users, and to establish distinctive branding for the rapid transit system, a 60-foot articulated hybrid diesel bus is assumed for all alternatives.

6.7 *Summary of Blue Line Alternatives for Evaluation*

This section draws from the series of parameters identified in this chapter to define the Blue Line alternatives to be carried forward for evaluation in the next chapter. The principal difference between the alternatives is the extent of service west of the Downtown Transit Center and the location of a western terminus. The different western termini also impact how the Blue Line would operate through downtown.

To support the evaluation of alternatives, a "No Build" alternative is included that assumes that no action is taken and Route 8 IndyGo service continues to operate along the Washington Corridor at the

2013 service level in its current form. A description of the build alternatives and the No Build alternative is provided below.

6.7.1 Alternative 1 – East Side BRT

Under this alternative, BRT service would operate between the Downtown Transit Center and Cumberland, as shown on Figure 6.10. There would be 18 intermediate stations for an average station spacing of approximately 0.57 miles. The terminal stations would be comprised of single stations at which eastbound and westbound buses change directions, rather than opposing pairs of stations.

Service improvements would come from increased frequency and reduced running times – largely due to fewer stops along the corridor, faster boarding and deboarding, and the implementation of transit signal priority at all signalized intersections. Route 8 service would be retained, with reduced service frequencies of 30 minutes during peak periods and 60 minutes during other times.

Proposed Blue Line routing through downtown under Alternative 1 is shown on Figure 6.9. The figure also shows the proposed routing for the north-south Red Line BRT based on preliminary results of the Red Line Alternatives Analysis. As shown, passengers could transfer from the Blue Line to northbound or southbound Red Line service at the Downtown Transit Center.

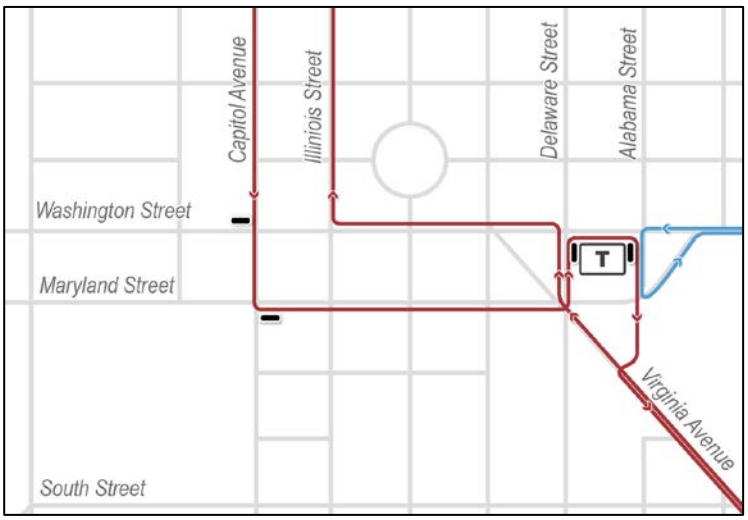


Figure 6.9 Downtown Circulation with Alternative 1

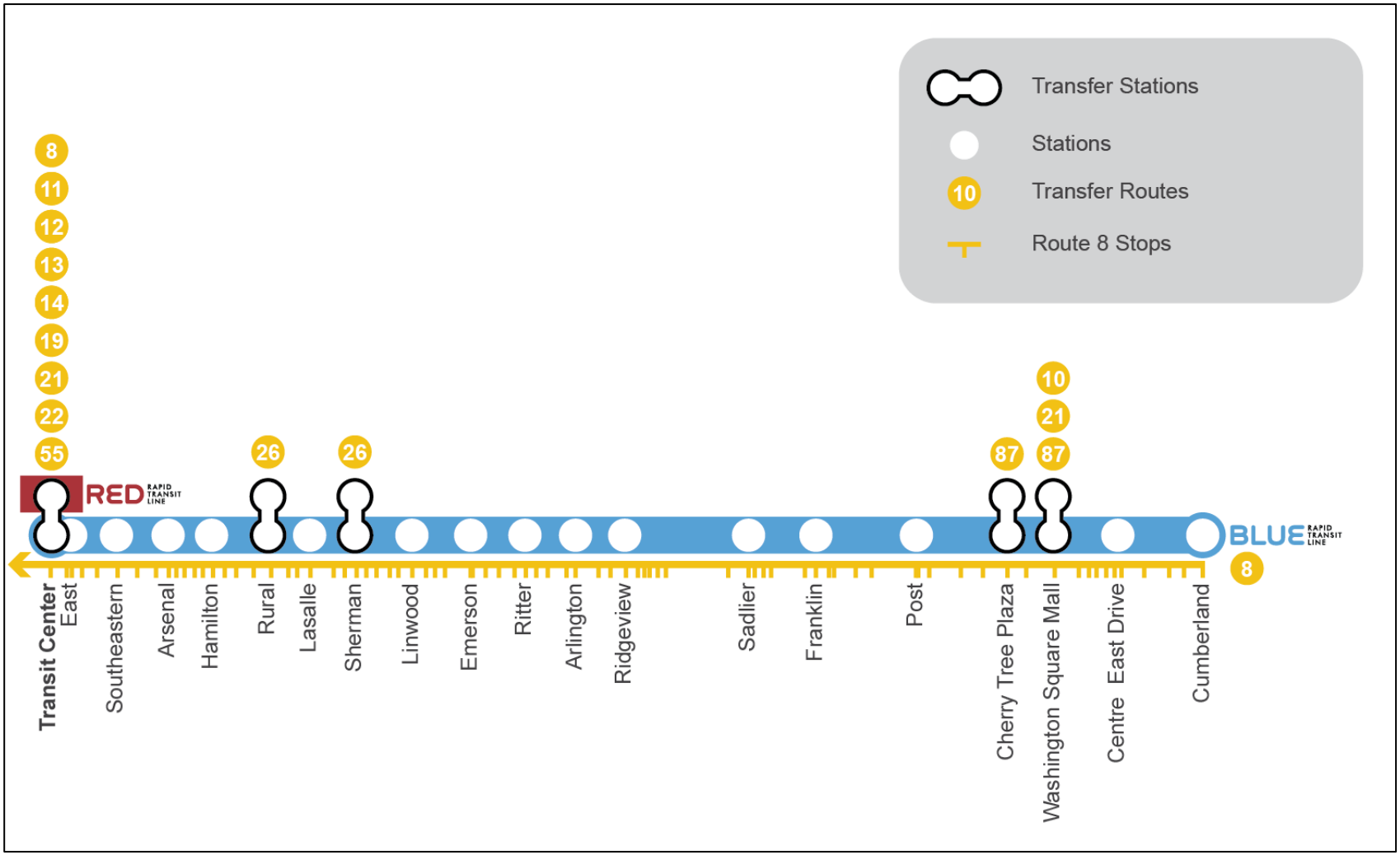


Figure 6.10 Schematic of Alternative 1, Cumberland to the Downtown Transit Center

6.7.1.1 Operating Plan

The proposed operating plan for Alternative 1 is presented in Table 6.1. The service span would be 19 hours on weekdays, 18 hours on Saturdays, and 14 hours on Sundays. Weekday service would include a three-hour afternoon period with 10-minute frequency and eleven hours with 15-minute frequency. The remaining service hours would have 30-minute frequencies. Saturday and Sunday peak service would be 15-minute frequency for 14 hours, with 30-minute service for an additional four hours on Saturday.

Local Route 8 service would revert to 30-minute peak headways, consistent with current Route 8 service west of Harding Street. This service level was provided throughout the corridor before 2013 frequency improvements on the eastern portion of the route. Local Route 8 would supplement Blue Line BRT service, providing slower but more frequent stops for users who need or prefer this service.

6.7.1.2 Alignment and Running Way

Alternative 1 assumes buses operating in the mixed traffic curb lanes of Washington Street, as described in Section 6.3.2. Inside I-465, limited lane widening is assumed within existing curb lines, either by narrowing the inside lane or by replacing the center two-way left turn lane with a raised median where feasible.

6.7.1.3 Priority Features

Alternative 1 would include transit signal priority features at all signalized intersections as described in Section 6.4.4. Queue jumps are recommended east of I-465 at three eastbound locations and one westbound location, as shown in Table 6.6.

Substantial station facilities and customer-friendly design would be provided as described in Section 4.3. Station facilities would feature consistent architecture, form, layout, materials, and colors that incorporate branded elements. At a minimum, stations would have benches, leaning bars, trash cans, and system maps. Passenger Information Display System (PIDS) would display real-time information on the status of the next arriving bus. Station platforms would be 14 to 15 inches above the roadway to accommodate level boarding with the low-floor buses. Stations would also feature off-board fare collection to allow passengers to purchase their fare in advance at a machine.

A moderate degree of pavement and sidewalk reconstruction is assumed in project cost estimates. These are subject to adjustment as a part of final project definition in the preparation of a competitive FTA funding application.

6.7.1.4 Vehicles

As described in Section 6.6, based on the range of anticipated ridership in the East Washington Street segment of the Blue Line and the desire for distinctive BRT branding, a 60-foot articulated hybrid diesel bus is assumed for Alternative 1.

6.7.2 Alternative 2 – East plus Downtown BRT

Alternative 2 is depicted schematically on Figure 6.12. Under this alternative, Blue Line service would continue beyond the Alternative 1 western terminus at the Downtown Transit Center, serving major downtown destinations further to the west, including the Indiana Convention Center and the Indianapolis Zoo. The western terminus would be located at IndyGo headquarters, at the intersection of Washington Street and Harding Street

Three additional intermediate stations would be constructed at Capitol Avenue, Schumacher Way, and the Indianapolis Zoo. The Downtown Transit Center would become an intermediate station, served by a pair of stations rather than a single turnaround point as in Alternative 1. In total, Alternative 2 would feature 22 intermediate stations in addition to termini at Cumberland and IndyGo headquarters. The operating plans, running way treatments, priority features, and vehicles would be identical to Alternative 1.

Proposed Blue Line routing through downtown under Alternative 2 is shown on Figure 6.11. As with Alternative 1, eastbound Blue Line passengers could transfer directly to both northbound and southbound Red Line service at stations en route, while westbound Blue Line passengers could access the Red Line in the vicinity of the Downtown Transit Center by means of a short walk.

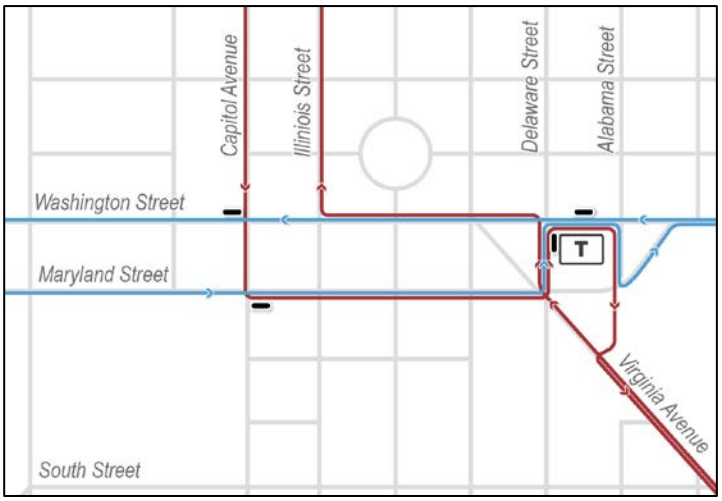


Figure 6.11 Downtown Circulation with Alternative 2

6.7.3 Alternative 3 – East to North Tibbs BRT

Alternative 3 is depicted schematically on Figure 6.12. This alternative would extend Blue Line service approximately 1.5 miles west of Harding Street to a terminus at North Tibbs Avenue. An additional intermediate station would be constructed at Belmont Avenue. In total, Alternative 3 would feature 24 intermediate stations in addition to termini at Cumberland and North Tibbs Avenue. Downtown circulation under Alternative 3 would be identical to Alternative 2, as shown on Figure 6.11. The operating plans, running way treatments, priority features, and vehicles would be identical to Alternatives 1 and 2.

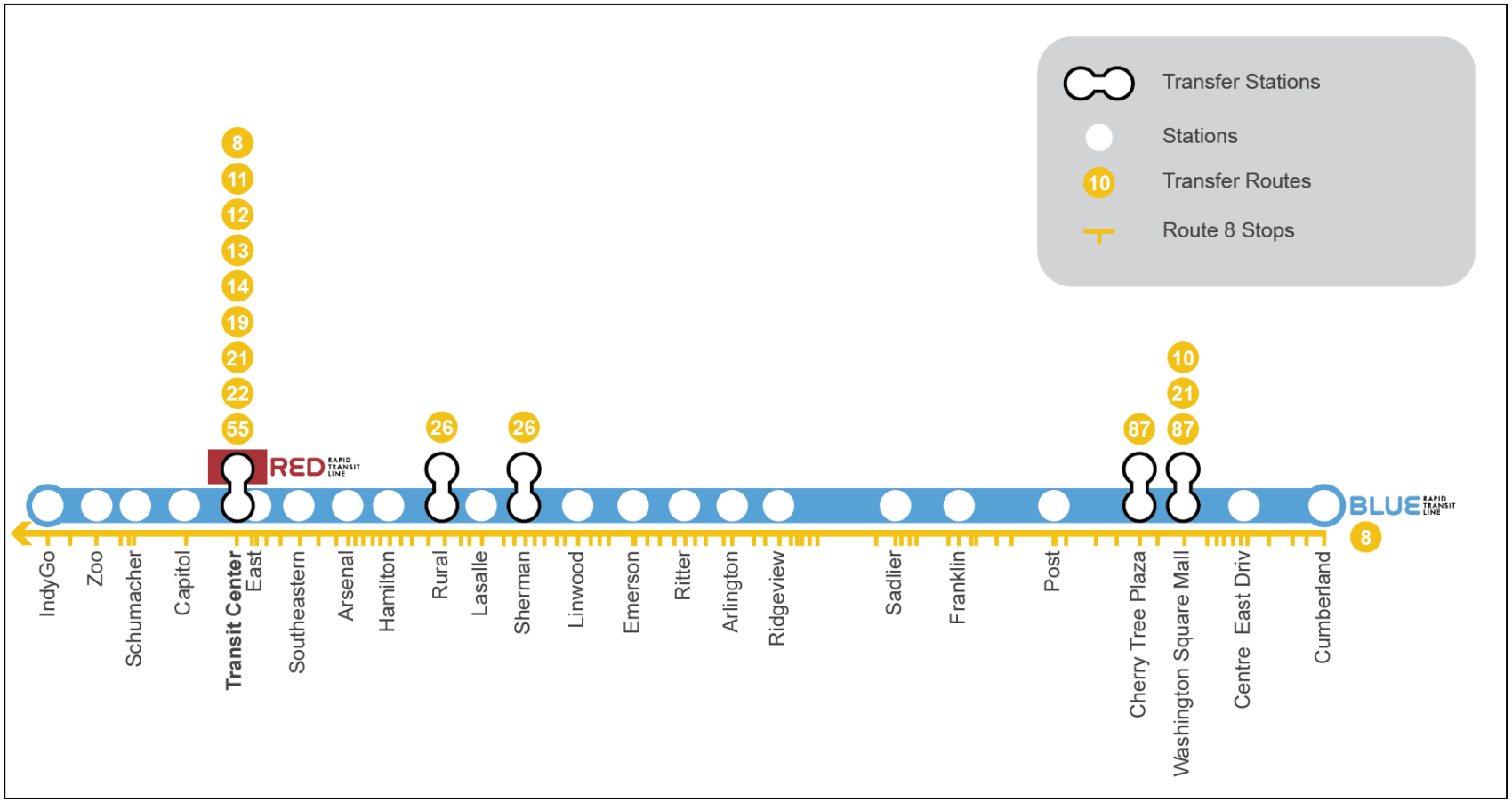


Figure 6.12 Schematic of Alternative 2, Cumberland to Harding Street

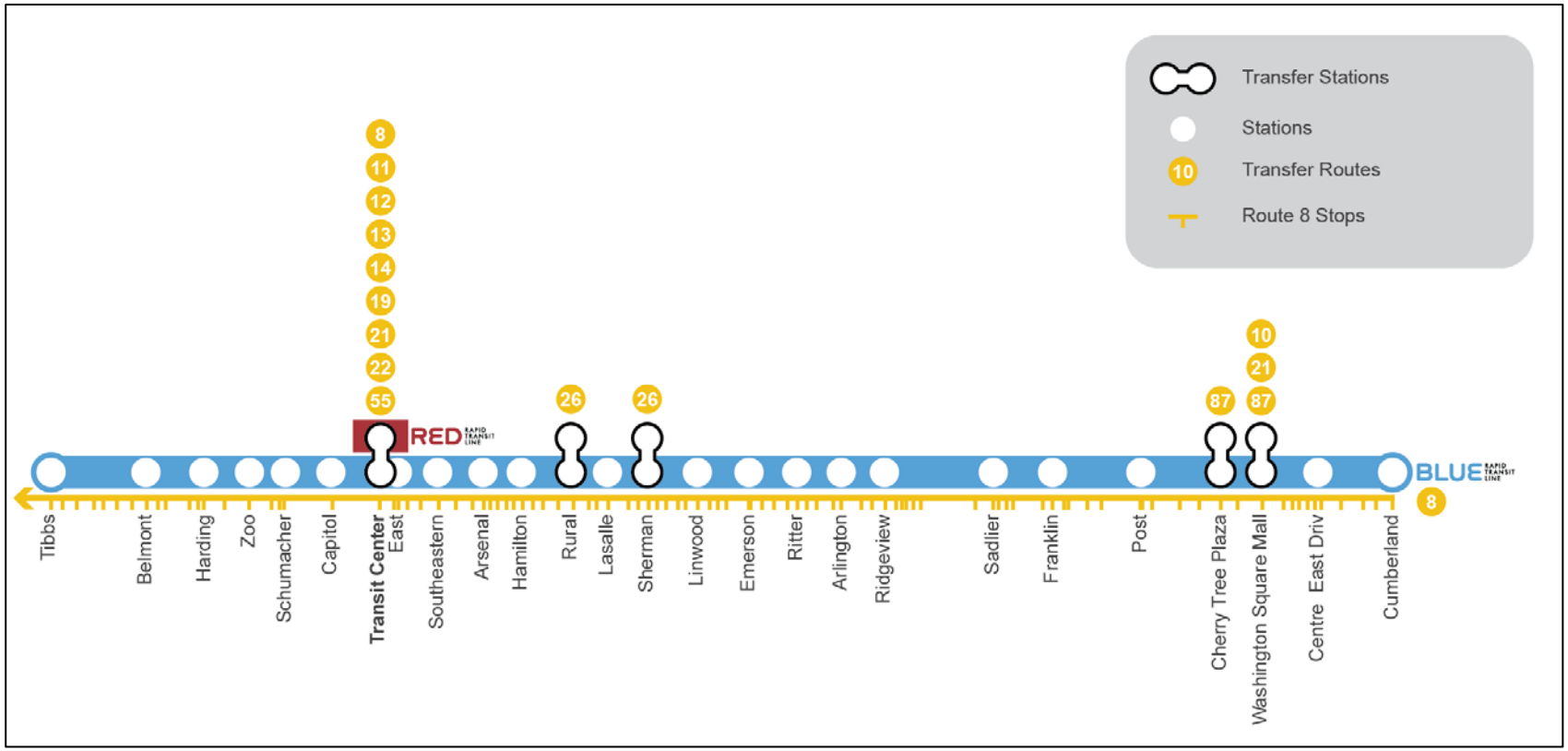


Figure 6.13 Schematic of Alternative 3, Cumberland to North Tibbs Avenue

6.7.4 Alternative 4 – Crosstown BRT

Under Alternative 4, Blue Line service would cover the entire route of the existing Route 8 service on Washington Street, from Cumberland to Indianapolis International Airport. The eastern section would be identical to Alternatives 1 through 3. The western terminus would be Weir Cook Terminal at the airport, a major anchor of travel to and from the west side. Six additional intermediate stops would be constructed between North Tibbs Avenue and the airport. In total, Alternative 4 would feature 31 intermediate stations, plus termini at Cumberland and the airport. The operating plans, running way treatments, priority features, and vehicles would be identical to Alternatives 1 through 3. Alternative 4 is depicted schematically on Figure 6.14. Downtown circulation under Alternative 4 would be identical to Alternatives 2 and 3, as shown on Figure 6.11.

6.7.5 No Build Alternative – Continuation of Existing Route 8 Service

The No Build Alternative assumes that BRT service is not implemented along the Washington Street corridor and that IndyGo's Route 8 service continues to operate to its current termini with no change in service levels. This alternative provides a baseline for comparison in evaluating all of the Build alternatives. Service characteristics reflect current (2013) Route 8 operations. The only change that could occur would be a realignment of downtown service upon completion of the Downtown Transit Center, or as part of an overall reconfiguration of downtown circulation.

6.7.6 Summary of Alternatives

A summary of characteristics of the four Build Alternatives and the No Build Alternative for the Blue Line is shown in Table 6.11. In the next chapter, these alternatives are evaluated and compared against one another using a series of objective evaluation criteria which seek to measure how well each alternative advances the project goals. Cost factors are considered in conjunction with the evaluation results to define a recommended alternative at the end of the chapter.

.

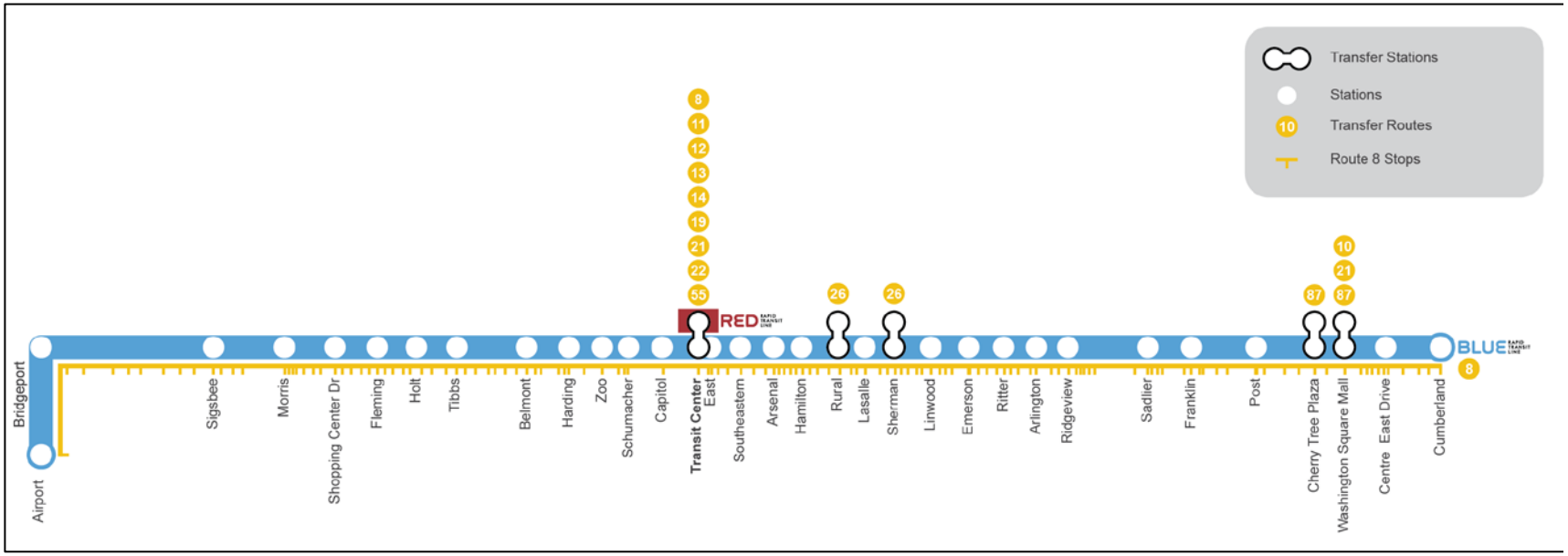


Figure 6.14 Schematic of Alternative 4, Cumberland to Indianapolis International Airport

Table 6.11 Summary of Blue Line Alternatives

System Characteristics	No Build Alternative	Build Alternative 1 East BRT	Build Alternative 2 Downtown + East BRT	Build Alternative 3 East to North Tibbs BRT	Build Alternative 4 Crosstown BRT
Route Length **(approx. miles)**	24.4	10.3	12.5	13.6	24.1
West Terminal	Airport	Alabama Street (Downtown Transit Center)	Harding Street (IndyGo headquarters)	North Tibbs Avenue	Airport
East Terminal	Cumberland	Cumberland	Cumberland	Cumberland	Cumberland
Lane Configuration	n/a	Widened lanes between Southeastern and Sheridan; existing elsewhere; shared curb lane	Widened lanes between Southeastern and Sheridan; existing elsewhere; shared curb lane	Widened lanes between Southeastern and Sheridan; existing elsewhere; shared curb lane	Widened lanes between Southeastern and Sheridan; existing elsewhere; shared curb lane
Transit Signal Priority	No	Yes	Yes	Yes	Yes
Pavement Improvements	No	Yes	Yes	Yes	Yes
Stations	n/a	18 curbside pairs, single Downtown Transit Center station, single Cumberland station	22 curbside pairs single IndyGo station, single Cumberland station	25 curbside pairs, single Cumberland station	31 curbside pairs, single Airport station, single Cumberland station
Station Features					
Real-Time Info	No	Yes	Yes	Yes	Yes
Level Boarding	No	Yes	Yes	Yes	Yes
Off-Board Fare Payment	No	Yes	Yes	Yes	Yes
Enhanced Shelter	No	Yes	Yes	Yes	Yes
Vehicle Type	Existing	60 foot, articulated, hybrid	60 foot, articulated, hybrid	60 foot, articulated, hybrid	60 foot, articulated, hybrid
BRT Vehicles Needed in Maximum Service	n/a	9	11	12	17
Annual BRT Vehicle Revenue Hours	n/a	36,600	45,000	54,800	70,700
Annual BRT Vehicle Revenue Miles	n/a	519,000	615,900	681,900	1,199,500
Service Characteristics					
Mon - Fri Frequency (Minutes)	15/30/60	10/15/30	10/15/30	10/15/30	10/15/30
Mon - Fri Span (Hours)	12.5/2.5/4	3/11/5	3/11/5	3/11/5	3/11/5
Saturday Frequency (Minutes)	30/60	15/30	15/30	15/30	15/30
Saturday Span (Hours)	15/3	14/4	14/4	14/4	14/4
Sunday Frequency (Minutes)	30/60	15	15	15	15
Sunday Span (Hours)	14/0	14	14	14	14
Route 8 Frequency (Minutes)	n/a	30/60	30/60	30/60	30/60

7.0 EVALUATION AND RECOMMENDATION

7.1 *Evaluation of Alternatives*

The alternatives shown in Table 6.11 are evaluated and compared against one another using a series of objective evaluation criteria designed to measure how well each alternative advances the project goals described in Section 2.4. The project goals were formulated by distilling key elements of the Transit Planning Principles of the Indy Connect Transit Vision Plan.

7.1.1 Evaluation Performance Measures

The evaluation criteria presented in this chapter were selected based on their consistency with the project goals and their suitability in distinguishing the alternatives from one another. Table 7.1 lists the project goals and associated measures used for evaluation of the alternatives. A brief description of each measure and how it is applied is provided below. A completed evaluation matrix for the alternatives is presented in Table 7.7.

Measure #1: BRT Segment Travel Times, Blue Line versus Local Route 8

The travel time savings of the Blue Line compared to existing local Route 8 service are evaluated for the length of the Blue Line segment, which varies under each alternative. Travel times for Route 8 are based on the published route schedule. Blue Line travel times are based on the operating plan presented in Table 6.1, consistent with the travel time savings shown in Figure 6.7. Service frequencies and average wait times are not included directly, as they are identical for the Blue Line under all alternatives.

Measure #2: Daily Linked Trips

Linked trips are the basis for two of the evaluation criteria established by the FTA Small Starts program: Mobility Benefits and Cost Effectiveness. "Linked" trips are those that use the Blue Line service, for any part of the trip, including transfers. Trips on the Blue Line and Route 8 are combined to compute a corridor total. This differs from the FTA evaluation criteria, which would include only Blue Line Ridership. Ridership estimates are based on the methodology and results described in Section 6.5.

Measure #3: Trips Made by Members of Low-Income Households

The Mobility Benefits criterion of the FTA Small Starts evaluation process applies extra weight to trips made by "transit dependent" persons. The FTA allows two definitions for identifying a transit dependent household: (1) households with no cars, or (2) households in the lowest income bracket as defined locally. For the FTA funding application, trips made by low-income households will be determined using either the regional travel demand model, which stratifies trip data by both mode and by income level, or using the FTA's Simplified Trips-on-Project (STOPS) model.

Table 7.1 Project Goals and Evaluation Measures

Goal 1. Improve transit travel times and service frequencies in the corridor.
Measure 1: BRT Segment Travel Times, Blue Line versus Local Route 8
Goal #2: Increase Corridor Transit Ridership
Measure 2: Daily Linked Trips
Goal #3: Maintain or Improve Service Levels Provided to Low-Income and Zero-Car Households
Measure 3: Low-Income Households Served by Transit
Measure 4: Zero-Car Households Served by Transit
Goal #4: Serve Areas with High Potential for Transit-Supportive Economic Development
Measure 5: Average TOD Score of Nodes within Project Area
Measure 6: Percent of Stations within Economic Development Areas
Goal 5: Introduce Customer-Friendly Transit Features as an Initial "Premium Transit" Project in a Cost Effective Manner
Measure 7: Cost Effectiveness Ratio
Measure 8: Boardings per Route-Mile
Measure 9: Boardings per Revenue-Hour
Goal #6: Promote Sustainability by Reducing Traffic Congestion and Improving Air Quality
Measure 10: Reduction in Vehicle Trips
Measure 11: Dollar Value of Environmental Benefits
Goal #7: Maximize These Opportunities within the Context of an Achievable Financial Plan
Measure 12: Total Capital Cost
Measure 13: Total Operations and Maintenance Cost

In this study, low-income households may be a more conclusive measure of transit dependent travel since the overall number of zero-car households in this region is well below the national average.[15] The number of low-income households served by the Blue Line under each build alternative is assessed using demographic data from the regional travel demand model. Households served are defined as those within one-half mile of a proposed Blue Line station.

It should be noted that estimated transit service for low-income households represents an important market segment for transit, but the measure will also be needed for any environmental justice (EJ) assessments conducted as part of environmental impact studies for the project.

[15] U.S. Census Bureau, 2007-2011 American Community Survey, Table B08141 "Means of Transportation to Work by Vehicles Available".

Measure #4: Zero-Car Households Served by Transit

Zero-car households constitute a major market segment for IndyGo, particularly on Route 8. The 2009 IndyGo On Board Survey indicated that over 60% of Route 8 riders did not have access to a private automobile, compared to data from the American Community Survey indicating that fewer than 3% of households in Marion County had no access to a vehicle.[16]

The number of zero-car households served by the Blue Line under each Build Alternative is assessed using data from the regional travel demand model, in order to be consistent with the other measures under this goal. Households served are defined as those within one half mile of a Blue Line Station.

Measure #5: Average TOD Score of Nodes within Project Area

As one of the first premium transit corridors in Central Indiana, it will be important for the Blue Line to be a high-impact project not only in terms of mobility, but also with respect to economic development. As discussed in Section 5.7, the Indianapolis MPO recently commissioned a study of TOD potential along the Red and Blue Line BRT corridors. The TOD study identified nodes along the entire Washington Street corridor and assigned each node a "TOD Potential" rating based on 19 factors addressing the built environment, density of uses, and demographics. The ratings are shown on Figure 6.4.

For this measure, the aggregate TOD potential for each of the build alternatives is estimated based on the average TOD score for all nodes that fall within each of the four alternative configurations.

Measure #6: Percent of Stations within Economic Development Areas

The Indianapolis Department of Metropolitan Development has established a number of Redevelopment Areas and Economic Development Corridors at various locations throughout the city, primarily emanating from the periphery of downtown. These areas are subject to a comprehensive assessment of their assets and needs, and receive targeted investments from the city. Budgeted investments fall into three categories: infrastructure investments supporting economic development such as job creation, job retention, and reuse of public property; infrastructure investments in streetscape and mobility improvements; and commercial and neighborhood services development.

Two of these economic development areas overlay the Washington Street corridor. West of downtown is the West Washington Street Economic Development Corridor,[17] and east of downtown is the Near Eastside Redevelopment Area.[18] Locating transit improvements within an established economic

[16] Ibid.

[17] *Economic Development Plan for the West Washington Street Corridor*. City of Indianapolis, Department of Metropolitan Development, Division of Planning. September 1, 2011. http://www.indy.gov/eGov/City/DMD/Documents/Econ/WWASH_01_RedevelopmentPlan_complete-sm.pdf

[18] *Expansion of the Near Eastside Redevelopment Area.* City of Indianapolis, Department of Metropolitan Development, Division of Planning. September 1, 2011.

development area can leverage the resources already committed by the City of Indianapolis to maximize the mutual benefits in terms of improved transit service and overall economic development in the corridor. This measure reports the percentage of Blue Line stations under each build alternative that falls within one of the city's designated economic development areas.

Measure #7: Cost Effectiveness Ratio

"Cost Effectiveness" is one of the criteria for evaluating FTA Small Starts funding requests. The FTA defines cost effectiveness for Small Starts projects as the federal share of the project's annualized capital cost divided by the estimated annual number of trips on the project.[19] As such, the computed value and the associated FTA rating reflect not only cost and ridership, but also on the requested Federal funding share. In this report, the cost effectiveness ratio for the purposes of Blue Line Alternatives comparison is computed based on the *entire cost of the project*. The intent here is to compare alternatives rather than to support an FTA funding application.

Estimated costs of the build alternatives are presented in Section 7.1.2. The cost for BRT components only are used for the cost effectiveness measure. Ridership is estimated as described under Measure #2 above, but for this measure includes only ridership on the Blue Line, not on the existing Route 8 service. The annualized project capital cost is based upon the life cycle of the project's various components (guideways, stations, vehicles, etc.). The annualization factors used are consistent with those used for FTA funded projects. The discount rate of 2% is also the same as that specified by the FTA.

Measure #8: Boardings per Route-Mile

One measure of the productivity of a transit line is total passenger boardings per route-mile of service. For this measure, only Blue Line boardings are included, and route-miles include only the Blue Line, not Route 8.

Measure #9: Boardings per Revenue-Hour

Ridership per revenue-hour is another measure of a transit line's productivity, addressing not only the density of ridership along the route's geography but also the level of ridership over the course of an entire day. As with the previous measures, only the Blue Line, and not local Route 8 service, is included in the calculation of this measure.

Measure #10: Reduction in Vehicle Trips

To estimate the reduction in vehicle trips, the total ridership in the Washington Street corridor (including Route 8 and the Blue Line) in each of the build alternatives is compared against the Route 8

---

http://www.indy.gov/eGov/City/DMD/Documents/Econ/Neareastside_01_RedevelopmentPlan_02-complete-sm.pdf

[19] *New Starts and Small Starts Evaluation and Rating Process, Final Policy Guidance*, prepared by the Federal Transit Administration, August 2013.

ridership in the No Build Alternative. Based on the assumption that all new transit person-trips correspond with a reduction in trips by private automobile, the increase in transit ridership in each build alternative is divided by the estimated average passenger car occupancy rate to produce an estimate of vehicle trip reduction. Average vehicle occupancy is derived from the regional travel demand model.

Measure #11: Dollar Value of Environmental Benefits

Environmental Benefits are another of the core project justification criteria established by the FTA in rating proposed Small Starts projects. Environmental benefits include the change in four specific pollutants, greenhouse gas emissions, total energy consumption, and safety. The FTA has established guidelines for estimating the change in each of these parameters resulting from a project, as well as the monetization factors for each category. The four categories of pollutants included in the FTA guidelines are: carbon monoxide (CO), nitrous oxide (NO_x), particulate matter ($p.m._{2.5}$), and volatile organic compounds (VOCs). Safety benefits include assumed reductions in injuries and fatalities resulting from traffic accidents.

FTA provides spreadsheets for estimating the environmental benefits of a transit project. The primary driver for all calculations is vehicle miles of travel (VMT) of private vehicles and buses. For each build alternative, the change in private car VMT is estimated based on average trip lengths in the corridor, as derived from the travel demand model, multiplied by the increase in transit ridership. Transit bus VMT is based on revenue-miles of transit service, derived from the service characteristics and route-miles of Blue Line and local Route 8 service in each Build Alternative. Based on these VMT inputs, the FTA-provided spreadsheets generate estimated changes in each environmental category, and use published monetization factors to generate a dollar value associated with the environmental benefits, whether they be positive or negative, of each project.

Measure #12: Total Capital Cost

The total capital cost is estimated for each alternative using FTA cost categories. The lower value in the range is for BRT only. The higher value includes pavement overlay and sidewalk. See Section 7.1.2.

Measure #13: Total Operations and Maintenance Cost

Total estimated operations and maintenance (O&M) cost is estimated for each alternative based on revenue miles and vehicle miles of service. The O&M cost estimating process and results are described in Section 7.1.3.

7.1.2 Estimated Capital Costs

Capital cost estimates are developed by segmenting the Blue Line alignment into lengths of different existing typical sections and conditions. Costs are identified for the implementation of BRT in each segment based on existing conditions, the proposed typical section, the type and number of proposed stations, the location of signal priority treatments, and other special site considerations.

Unit costs for work elements are based on recent road construction costs obtained from the City of Indianapolis and the Indiana Department of Transportation, as well as cost data from other BRT systems in the United States. Overall system costs for vehicles, project development and engineering, and other "soft" costs are added separately. Unit costs and soft cost assumptions have been coordinated between the current Blue Line and Red Line studies. Capital costs are assigned to the following Standard Cost Categories (SCC) identified by the Federal Transit Administration:

10. Guideway and track elements
20. Stations, stops, terminal, intermodal
30. Support facilities: yards, shops, administration
40. Sitework and special conditions
50. Systems
60. Right-of-way, land, existing improvements
70. Vehicles
80. Soft costs: engineering, management, start-up costs, etc.
90. Financing
100. Contingency

Guideway

As shown in Table 3.3 and Table 3.6, reconstruction or significant structural resurfacing would be beneficial for some segments of Washington Street due to poor pavement conditions. Sidewalk repair and improvements would also be beneficial at many locations in the corridor. The full cost of addressing all existing pavement and sidewalk deficiencies along Washington Street is not included in the cost estimates used for alternatives evaluation since it is assumed that many of these elements might be funded separately. These costs are provided for information, however, later in this chapter.

For purposes of project definition and evaluation, it is assumed that the Blue Line project will include milling and overlaying of the lanes to be use by BRT, construction of approximately 1/3 mile of center median on East Washington Street, and sidewalk repair and landscaping along 10% of the project length.

Stations

Stations are generally assumed to include a concrete bus pad and a raised passenger boarding platform with partially enclosed transit shelter, static signage, real-time passenger information systems, benches, trash cans, lighting, security cameras, emergency phone, and bike racks. Cost allowances are included for station area landscaping, pedestrian and bicycle access improvements. Most locations would have one station in each direction, except for the east terminus, west terminus and Downtown Transit Center station, which would serve both directions of travel from a single platform.

Fare collection is assumed to be "proof of payment," with one automatic ticket vending machine located at each station platform. The cost estimates account for a basic vending machine that is capable of handling both cash and credit payment methods.

Park and ride facilities are assumed to be located at Cumberland (200 spaces), Franklin Road (200 spaces), North Tibbs Avenue (50 spaces), and Kroger West (200 spaces). The capital cost estimates include costs for constructing these facilities, and for purchasing or leasing the required right-of-way.

Vehicles

BRT vehicles are assumed to be stylized, 60-foot articulated BRT vehicles, equipped with automatic vehicle location (AVL) equipment and traffic signal priority (TSP) equipment. Vehicle cost estimates are based on information provided by vehicle manufacturers. Vehicle cost estimates also include an allowance for spare parts and an allowance for non-revenue vehicles for maintenance and recovery, both of which are estimated at 1% of the vehicle costs.

Systems

The costs of traffic signal upgrades and signal timing improvements are included in this category. Roadside and vehicle equipment for traffic signal priority and queue bypass is also included.

Support Facilities

No costs are included for new maintenance, operation or vehicle storage facilities. It is assumed that these facilities will be funded separately when needed for all Indy Connect projects.

Soft Costs

Soft Costs include design, management, financing, and start-up costs that are necessary to move the system from concept through opening day. Soft costs are included in the Blue Line capital cost estimate based on FTA guidelines and experience of similar BRT systems. These include the costs for the following items, with the percentage of the total system construction cost shown in parentheses:

- Project development (10%)
- Project management for design and construction (6%)
- Construction administration and management (7%)
- Professional liability and other non-construction insurance (2%)
- Legal and permitting and review fees (1%)
- Survey, testing and inspection (0.5%)
- Start-up costs (0.5%)

Finance Costs

No finance costs are included in the estimates in this phase. Financing considerations will be evaluated as the Locally Preferred Alternative is defined and assessed in subsequent phases.

Contingencies

In conformance with FTA capital cost estimating procedures, both allocated and unallocated contingencies are included in the Blue Line capital cost estimates. A 20% contingency is included in the cost of roadway items, 15% contingency is included in the cost of signal items, 20% contingency is included in the cost of station items, and 5% contingency is included in the cost of vehicles. In addition, an unallocated contingency of 10% is added to the total cost of all items. Together, these contingencies cover unforeseen conditions, general risks, and contract reserve during construction.

Summary of Capital Costs

Table 7.2 provides a summary of the estimated capital cost for each Blue Line alternative. These estimates assume moderate pavement and sidewalk improvements as described previously.

Table 7.2 Estimated Capital Cost for Blue Line Alternatives (2013$ millions)

Cost Category	Build Alternative 1	Build Alternative 2	Build Alternative 3	Build Alternative 4
Guideway	$4.6	$5.6	$5.9	$8.9
Stations	$10.9	$13.2	$14.4	$18.3
Support Facilities	--	--	--	--
Sitework & Special Conditions	$8.3	$9.8	$10.6	$14.5
Systems	$2.9	$3.5	$3.8	$4.6
Right of Way	$1.9	$1.9	$2.1	$2.8
Vehicles	$8.8	$10.8	$11.8	$16.7
Professional Services	$8.1	$10.5	$12.3	$16.9
Unallocated Contingency	$4.6	$5.5	$6.1	$8.3
Finance Charges	--	--	--	--
Total Cost	$50.1	$60.8	$67.0	$90.8

The potential cost impact of various levels of street and sidewalk work is shown in Table 7.3. Assumptions range from pavement and sidewalk work only in station areas to correcting all observed pavement and sidewalk deficiencies. The higher estimate also includes a raised median through the entire segment between Southeastern Avenue and Sheridan Avenue.

Table 7.3 Impact of Street and Sidewalk Work on Alternative Costs (2013$ millions)

Level of Street and Sidewalk Work	Build Alternative 1	Build Alternative 2	Build Alternative 3	Build Alternative 4
Station area improvements only	$40.4	$48.2	$52.5	$69.0
Resurface BRT lanes, Improve 10% of sidewalk (assumed in alternatives)	$50.1	$60.8	$67.0	$90.8
All recommended road & sidewalk repairs	$73.2	$84.2	$91.5	$130.6

Annualized Capital Cost

Annualized capital costs developed for each alternative support the comparison of their cost effectiveness. The annualized costs shown in Table 7.4 are developed from the FTA Standard Cost Category workbooks, including assumptions about the useful life of individual transit system components. To provide an equal basis of comparison, each alternative is assumed to commence service in 2017. A 3.5% annual inflation rate in project costs is assumed.

Table 7.4 Annualized Capital Cost for Each Alternative (2013$)

No Build Alternative	Build Alternative 1	Build Alternative 2	Build Alternative 3	Build Alternative 4
--	$2,412,000	$2,971,000	$3,265,000	$4,503,000

7.1.3 Estimated Operating and Maintenance Costs

Operations and maintenance cost is dependent on service provided, along with station components and other project elements. A model was developed to estimate cost based largely on the cost profile of existing IndyGo service as reported in the 2011 National Transit Database (NTD), escalated to 2013 dollars.

In the absence of existing comparable BRT service by IndyGo, some additional detail was required for new BRT-related system components and operations. This included fuel and maintenance costs for 60-foot vehicles, as well as maintenance and servicing costs for station amenities such as ticket vending machines, electronic signage, and other items. Table 7.5 shows the unit costs used in the model.

Using the service characteristics defined for each alternative and the unit costs in Table 7.5, a total operating and maintenance cost has been estimated for each alternative. The results are shown in Table 7.6. Because each alternative includes the continuation of some local Route 8 service, costs are reported for both BRT and local bus service. Cost estimates for local bus were derived from the same unit costs, with BRT-specific features excluded.

7.1.4 Alternatives Evaluation

Table 7.7 presents a comparison of the four build alternatives and the No-Build Alternative according to thirteen performance measures listed in Table 7.1. The intent of the matrix is to provide objective information to support a qualitative review of each alternative. Ultimately, other considerations such as funding availability and public policy priorities will be considered by the Indianapolis MPO, IndyGo, CIRTA, local units of government and other project stakeholders as final project details are defined for an FTA funding application.

Table 7.5: Operations and Maintenance Unit Costs

Cost Category	Unit Cost	Unit	Source description
Vehicle operations			
40-ft bus	$47.37	Vehicle revenue-hours	IndyGo 2011 NTD reported
40-ft bus fuel	$0.88	Vehicle revenue-miles	IndyGo 2011 NTD reported
60-ft bus fuel upcharge	$0.21	Vehicle revenue-miles	TCRP Synthesis 75
Proof-of-payment inspections	$101,250	Inspection FTEs	Interviews with comparable agencies, number used represents 75% value range
Vehicle WiFi	$500	Buses (including spares)	Verizon Wireless
Vehicle maintenance			
40-ft bus base cost	$1.29	Vehicle revenue-miles	IndyGo 2011 NTD reported
60-ft bus upcharge	$0.45	Vehicle revenue-miles	TCRP Synthesis 75
Non-vehicle maintenance			
Basic bus service cost	$13,626	Peak vehicles	IndyGo 2011 NTD reported
Station maintenance	$5,500	Stations	Interviews with Kansas City Area Transportation Authority (KCATA)
Station lighting	$1,000	Stations	KCATA
Station infrared heating	$6,000	Stations	KCATA
Station WiFi	$500	Stations	Same cost structure as vehicle WiFi (above)
Electronic signs	$500	Signs	Vendor estimate
TVM maintenance	$93,750	Maintenance FTEs	Interviews with comparable agencies, number used represents 75% of value range
TVM spare parts/inventory	$9,250	TVM	Source: TCRP report 118, number used represents 75% of value range
TVM support/license	$11,800	TVM	Vendor estimate
Park and ride	$30	Parking space	Central Ohio Transit Authority (COTA), Columbus, Ohio. Includes cost for pavement maintenance, snow removal, landscaping.
General Administration			
General administration	$82,400	Peak vehicles	IndyGo 2011 NTD reported

Table 7.6 Operating and Maintenance Cost for Each Build Alternative (2013$ millions)

Cost Category	No Build Alternative	Build Alternative 1	Build Alternative 2	Build Alternative 3	Build Alternative 4
BRT	$0	$5.7	$6.8	$7.6	$11.0
Local Bus	$5.9	$3.9	$3.9	$3.9	$3.9
Total	*$5.9*	*$9.6*	*$10.7*	*$11.5*	*$14.9*

Table 7.7: Summary of Alternatives Evaluation Results

Project Goals and Performance Measures		No Build Alternative	Build Alternative 1	Build Alternative 2	Build Alternative 3	Build Alternative 4
Segment		**Cumberland to Airport**	**Cumberland to Alabama**	**Cumberland to Harding**	**Cumberland to North Tibbs**	**Cumberland to Airport**
Segment Length		**24.4 Miles**	**10.3 Miles**	**12.5 Miles**	**13.6 Miles**	**24.1 Miles**
Goal 1	**Improve Transit Travel Times and Service Frequencies**					
Measure 1	BRT Segment Peak Period Travel Times (Minutes)					
	Route 8	*99*	*44*	*53*	*59*	*86*
	Blue Line	*N/A*	*35*	*44*	*48*	*73*
	Minutes Saved	N/A	9 (26%)	9 (20%)	11 (23%)	13 (18%)
Goal 2	**Increase Corridor Transit Ridership**					
Measure 2	Daily Linked Trips (Blue Line + Route 8)	4,867	6,175	6,526	6,738	6,837
Goal 3	**Maintain or Improve Service Levels Provided to Low-Income and Zero-Car Households**					
Measure 3	Low-Income Households Served by Premium Transit	N/A	4,136	4,352	5,271	6,440
Measure 4	Zero-Car Households Served by Premium Transit	N/A	1,314	1,409	1,667	1,921
Goal 4	**Serve Areas with High Potential for Transit-Supportive Economic Development**					
Measure 5	Average TOD Score of Nodes within Blue Line Corridor	N/A	113	125	123	114
Measure 6	Blue Line Stations within Economic Development Areas	N/A	7/20 (35%)	8/23 (35%)	10/25 (40%)	15/32 (47%)
Goal 5	**Introduce Customer-Friendly Transit as an Initial "Premium Transit" Project in a Cost-Effective Manner**					
Measure 7	Cost Effectiveness Ratio, Annualized Capital Cost (BRT only) per Annual Passenger	N/A	$1.78	$1.93	$2.01	$2.52
Measure 8	Blue Line Boardings per Route-Mile	N/A	440	412	409	250
Measure 9	Blue Line Boardings per Revenue-Hour	N/A	38	34	30	25
Goal 6	**Promote Sustainability by Reducing Traffic Congestion and Improving Air Quality**					
Measure 10	Annual Reduction in Vehicle-Trips	N/A	363,000	460,000	519,000	546,000
Measure 11	Dollar Value of Annual Change in Emissions	N/A	-$227,000	-$317,000	-$382,000	-$1,155,000
Goal 7	**Maximize these Opportunities Within the Context of an Achievable Financial Plan**					
Measure 12	Total Capital Cost	N/A	$50.1 Million	$60.8 Million	$67.0 Million	$90.8 Million
Measure 13	Total Operations and Maintenance Cost	$5.9 Million	$9.6 Million	$10.7 Million	$11.5 Million	$14.9 Million

As expected, most of the performance measures reflect the strength of the east corridor (East BRT alternative) in achieving project goals. This is consistent with current ridership patterns on IndyGo Route 8. The evaluation matrix provides additional insight about whether the full crosstown corridor should be served initially or if the service should be phased, and if it is phased, how far west should it extend initially? These questions are explored below.

In order to put the evaluation measures in perspective, it is useful to note the length of BRT service for the alternatives. The entire corridor, as currently served by Route 8, is just over 24 miles long. Alternative 1, from Cumberland to Alabama Street is 10.3 miles long. Extending the service through downtown to Harding Street (Alternative 2) adds 2.2 more miles, and is roughly half the length of full Crosstown BRT service (Alternative 4). Extending the service further west to North Tibbs Avenue (Alternative 3) adds another 1.1 miles.

All of the alternatives provide a travel time advantage over local bus service. The greatest time savings is achieved by Alternative 1 on the east side, with Alternatives 2 and 3 also showing at least 20% time savings. Alternatives 1, 2, and 3 show a much greater ridership potential per mile than Alternative 4. In fact, Alternative 3 accounts for 98% of the daily linked trips that would be provided under Alternative 4 while covering slightly more than half the distance.

In terms of low income households and zero-car households, about two-thirds of the potential full crosstown total is served by Alternative 1, with incremental changes as service is extended westward. TOD scores are highest with Alternatives 2 and 3, reflecting the high potential for economic development in and near the downtown area. Extending the service over the full length of the corridor would touch the most economic development areas.

Boardings per route mile and boardings per revenue hour of operation are highest in the east corridor and drop slightly as the service is extended west to North Tibbs. These rates are significantly lower when the service is extended over the full corridor. This is reflected in the cost-effectiveness ratio (cost per passenger), which is fairly steady for Alternatives 1 through 3, but increases by about 25% when service is extended to the airport.

Due to the additional route miles of service, capital cost and operations and maintenance cost are significantly higher for full crosstown service with implementation of Alternative 4 compared to the other three alternatives.

While evaluation of the alternatives does show that full implementation of the Blue Line corridor from Cumberland to Indianapolis International Airport is feasible, it also shows that most of the benefits in terms of performance measures can be achieved by focusing initial service on the east corridor under Alternatives 1, 2 or 3. Alternative 1 provides downtown service for the most concentrated area of ridership in the corridor. Alternative 2 extends the service to more destinations by allowing Blue Line service to pass through the downtown area rather than stopping short of the Monument Circle area.

The cost is incrementally higher than alternative 2 to extend service further west to North Tibbs Avenue (Alternative 3), but there are commensurate benefits. Specifically, there would be a 3% increased travel time savings, a 21% increase in low-income households served, 18% increase in zero-car households served, a 12.8% increase in the annual reduction of vehicle-trips and a 20.5% increase in the dollar value of annual change in emissions by implementing Alternative 3 over Alternative 2. For these reasons, Alternative 3 should be advanced as the first phase of the Blue Line BRT service.

The full Blue Line BRT corridor should be retained in the Indy Connect Plan, and service improvements and amenities should be provided between North Tibbs and the airport at or near the time Blue line BRT service is initiated. These improvements, coupled with the increased ridership on the initial BRT segment will enhance the opportunities to extend Blue Line BRT service in a subsequent phase.

7.2 *Recommended Alternative*

Transit alternatives are composed of a number of components, as illustrated in Figure 7.1. These range from the location and physical elements to the operating plan of the service. Each of these components are summarized in this section in terms of full Blue Line BRT and the recommended initial phase between Cumberland on the east and North Tibbs Avenue on the west.

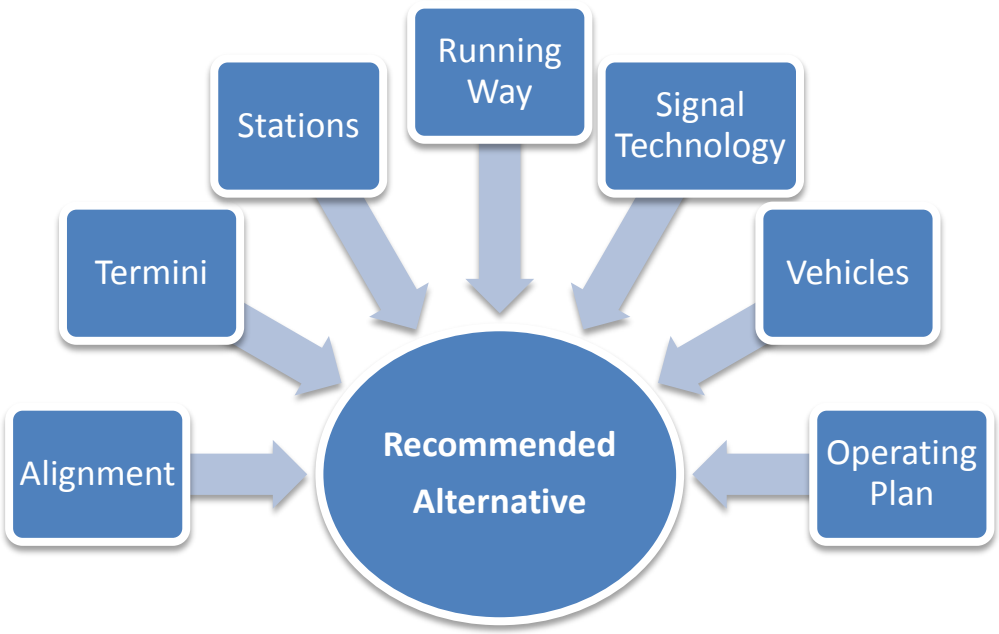


Figure 7.1 Components of a Transit Alternative

7.2.1 Alignment

The proposed alignment for the Blue Line is Washington Street, where IndyGo Route 8 currently operates. Route 8 currently serves the highest ridership on the IndyGo system, with particularly high

transit demand east of downtown. Route 10, which serves the parallel 10th Street corridor, was also reviewed and found to be nearly as attractive for service. It should be considered for frequent service enhanced amenities as service improvements are implemented by IndyGo.

The only variation that might be explored for the Blue Line alignment is the route through the downtown area. This study assumes that the Blue Line will utilize the Washington Street/Maryland Street one-way pair to travel east-west and serve the Downtown Transit Center. This could vary based on operational experience or by a future downtown transit circulation plan.

7.2.2 Termini

Due to the attractiveness of commercial destinations in the Washington Square Mall and Cumberland areas as indicated by Route 8 ridership, the eastern terminus of all alternatives considered for the Blue Line is Cumberland. The west terminus of full Blue Line service is Indianapolis International Airport, but a range of evaluation measures indicate that service between Cumberland and North Tibbs Avenue would be an effective first phase for implementation. The 13.6 mile length of this service is just over half of the full 24.1-mile Blue Line corridor, but it would capture approximately 98% of the projected ridership. IndyGo Route 8 service would continue to the airport until full Blue Line service is implemented.

7.2.3 Stations

Stations are a key component of any BRT system. On the Blue Line, they will be much fewer in number than current IndyGo stops, allowing for a significant improvement in transit travel time through the corridor. The stations will be designed to maximize the speed of boarding and deboarding, similar to rail lines, and will provide a high degree of comfort and convenience for passengers.

Figure 7.2 Typical BRT Station

As illustrated in Figure 7.2, the Blue Line BRT stations would be more substantial than typical existing IndyGo bus stops. Distinctive enhanced station shelters would be provided, including benches, lighting, trash receptacles, security cameras, and emergency phones. Ticket vending machines would be provided at most stations

for off board fare collection, as well as real-time information signs showing the arrival time of the next bus, and raised curb heights would facilitate level boarding from the station to the BRT vehicle.

Including the Downtown Transit Center, total of 32 stations are recommended for the full Blue Line BRT service, as shown on Figure 7.4. In the initial phase, 25 stations would be provided between Cumberland and North Tibbs Avenue. The station locations shown on Figure 7.4 were selected based on a range of factors. These include current ridership, desired spacing (approximately ½ mile), potential for transit oriented development, location of major roadway intersections, transfers to other IndyGo routes, apparent site feasibility, and public input. The recommended locations are subject to adjustment during project design.

Most stations would feature a pair of curbside platforms on either side of the street – or in the case of the Washington -Maryland couplet, on parallel streets. At the Airport and Cumberland termini there would be a single terminal station with provision for layover and turnaround of BRT vehicles. The North Tibbs Avenue terminal station in the initial implementation phase would feature a pair of curbside stations with provision for bus turnaround.

7.2.4 Running Way

The Blue Line will operate in mixed traffic, utilizing the curbside lane throughout its run from East Washington Street to West Washington Street via downtown Indianapolis, as shown in Figure 7.3.

Figure 7.3 Curbside Lane Running Way

Alternatives Analysis: Recommended Alternative

STATIONS:

EAST SIDE STATIONS:

1 East Street
2 Southeastern Avenue
3 Arsenal Avenue
4 Hamilton Avenue
5 Rural Street
6 Lasalle Street
7 Sherman Drive
8 Linwood Avenue
9 Emerson Avenue
10 Ritter Avenue
11 Arlington Avenue
12 Ridgeview Drive
13 Sadlier Drive
14 Franklin Road
15 Post Road
16 Cherry Tree Plaza
17 Washington Square Mall
18 Wal-Mart
19 Meijer / Cumberland

WEST SIDE STATIONS:

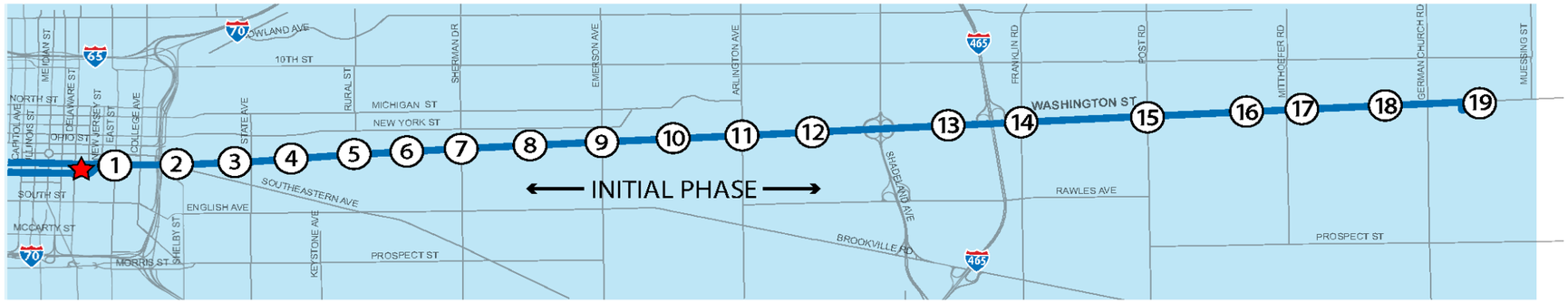
1 Capitol Avenue
2 West Street
3 Harding Street
4 Belmont Avenue
5 N. Tibbs Avenue
6 Holt Road
7 Fleming Street
8 Westgate Plaza
9 Morris Street
10 Sigsbee Street
11 Bridgeport Road
12 Indianapolis International Airport

Legend

Downtown Transit Center
Initial Phase
Future Phase

1 0.5 0 1 Miles

EAST SIDE STATIONS



WEST SIDE STATIONS

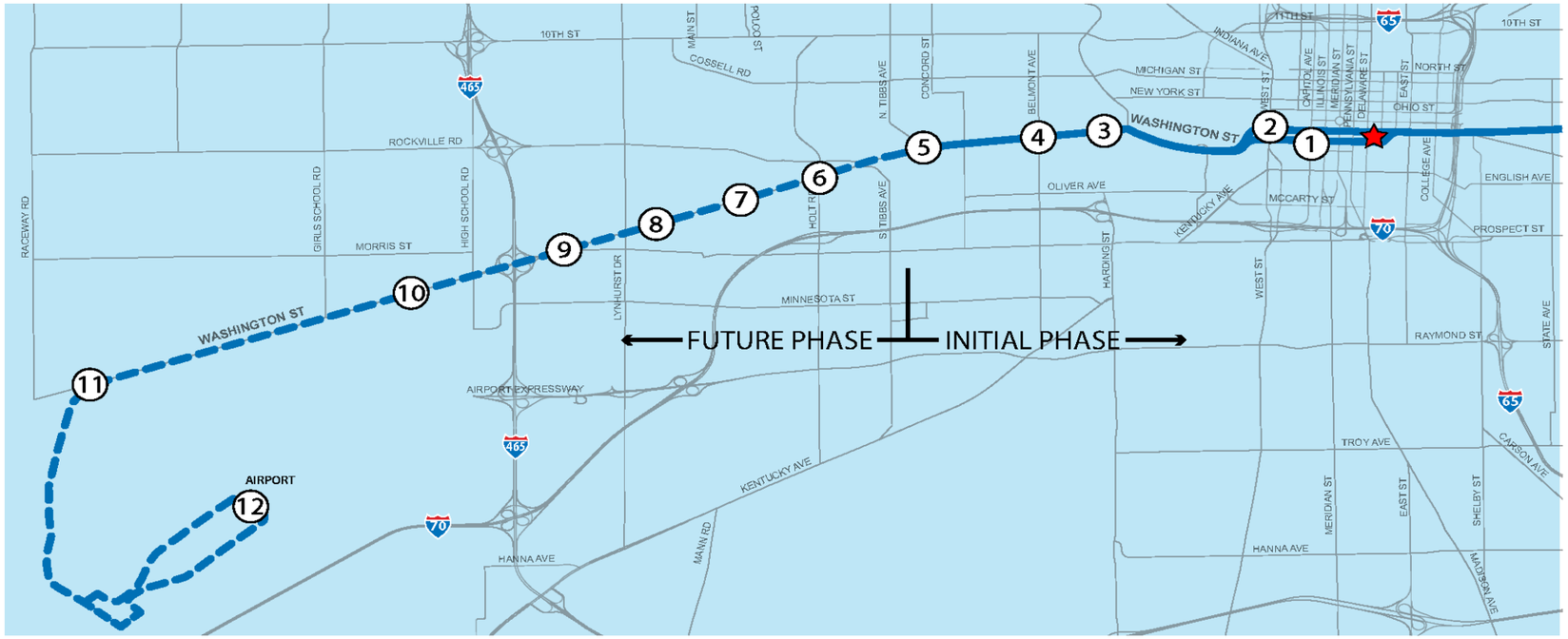


Figure 7.4 Recommended Blue Line BRT Stations

Minor widening of curbside lanes between Southeastern Avenue and I-465 should be provided by narrowing the inner lanes by a corresponding amount. Where feasible, the center two-way left turn lane could be replaced with a raised median, which would allow all four through lanes to be widened within the existing right-of-way. Opportunities for a median are limited by the large number of drives on Washington Street, but where feasible, they would provide the additional benefit of aesthetic streetscape improvements.

The only additional capital investment in the running way would be upgrades to pavement conditions at selected segments throughout the corridor. These pavement upgrades, could range from resurfacing to full reconstruction, as determined during project design.

7.2.5 Signal Technology

Transit signal priority and queue bypass lanes are recommended for the Blue Line to improve travel time and schedule reliability. Transit signal priority is recommended at all signalized intersections outside the downtown area. This can be accomplished at modest cost and would have minimal effect on general traffic operations in the corridor.

Queue bypass lanes are recommended at selected locations along the Blue Line corridor where traffic simulations indicate that they would benefit travel time and reliability, and where roadway geometry allows for them. In the Blue Line corridor, queue bypass operations would use existing right-turn only lanes, typically proceeding through the intersection to a far side station before merging back into the curbside through traffic lane.

Queue bypass lanes are recommended at the following intersections:

- **Eastbound:**
  - Cherry Tree Plaza
  - Washington Square
  - Wal-Mart (Centre East)
  - Harding Street
- **Westbound:**
  - Washington Square

7.2.6 Vehicles

The Blue Line would be operated using 60-foot articulated bus transit vehicles designed for BRT use. The vehicles would have comfortable interiors, multiple doors for quick boarding and deboarding, provision for bicycle transport on board, and would provide a distinctive appearance to support brand identity.

Based on the preliminary operating plan, 12 vehicles would be required on the initial Blue Line segment between Cumberland and North Tibbs Avenue during the afternoon peak period. Service on the full Blue Line corridor would require 17 vehicles in maximum service. Applying a 20% spare ratio, the alternatives would require a total fleet of 15 and 21 BRT vehicles, respectively.

The appearance of Blue Line BRT vehicles will be important. Applying consistent brand elements to vehicles, stations, signage, and customer information materials would distinguish Blue Line BRT vehicles from existing local bus service vehicles. The brand should be well designed and easily recognizable to clarify that the service is more frequent, reliable, and comfortable than local IndyGo bus services.

7.2.7 Operating Plan

In order to comply with FTA standards for a Corridor-based BRT system (i.e. without a fixed guideway), the Blue Line should feature peak-period headways of 10 minutes, and headways of 15 minutes or better at least 14 hours per day. The Blue Line operating plan presented in Table 7.8 provides the requisite service levels, with additional periods of less frequent service on weekdays and Saturdays.

Table 7.8 also shows the proposed operating plan for the remaining local Route 8 service that would be offered upon implementation of the Blue Line. These service levels roughly correspond to the service levels that existed on the Blue Line prior to the 2013 service improvements implemented between Harding Street and Cumberland.

Table 7.8 Preliminary Blue Line Operating Plan

SERVICE PERIODS	SERVICE FREQUENCY	
	BRT	ROUTE 8
Weekday (19 Service Hours)		
5:00am – 6:00am	30	60
6:00am – 3:30pm	15	30
3:30pm – 6:30pm	10	30
6:30pm – 8:00pm	15	30
8:00pm – 12:00am	30	60
Saturday (18 Service Hours)		
6:00am – 7:00am	30	60
7:00am – 9:00pm	15	30
9:00pm – 12:00am	30	60
Sunday (14 Service Hours)		
7:00am – 9:00pm	15	30

7.3 *Blue Line Implementation*

The recommended alternative presented in this chapter is intended to form the basis for inclusion of the Blue Line in a future Environmental Impact Assessment as part of the Small Starts project development process. Prior to submitting a funding application to the FTA, the following elements remain to be completed:

- **Eastern Terminus**: Preliminary concepts and layouts for an eastern Blue Line terminal station in Cumberland should be further explored with town officials and local stakeholders. Since land acquisition may be necessary, this could be a significant element of the environmental impact study for the project.

- **Downtown Circulation Plan**: Currently, most transit routes through downtown circulate around the square formed by Ohio, Capitol, Maryland, and Delaware Streets. The construction of the Downtown Transit Center on the south side of Washington Street presents a challenge and an opportunity for IndyGo to reimagine how buses enter and pass through downtown Indianapolis. This single transit hub may allow for more direct routing of transit lines into and through downtown.

- **Pavement Improvements**: Pavement condition can have a significant impact on the riding experience for Blue Line users. Reconditioning needs should be evaluated as a part of project design and a determination made regarding whether or not to include them in project costs or to accomplish the work using other funding sources.

- **Proposed Stations:** The optional site for each station will depend on localized conditions as well as Blue Line system function. Recognizing that land use and development opportunities in the corridor are constantly changing, these conditions should be continuously reviewed, and final station decisions should be made near the time of implementation, such as during the design phase.

- **Local Funding Plan**: As a part of long range planning under Indy Connect, the Indianapolis MPO has conducted extensive financial planning for system implementation, in terms of capital cost and ongoing costs for operation and maintenance. At the time of application for funding from the FTA, additional detail will be available regarding dedicated local funding sources and project timing. At that time, the Indianapolis MPO and IndyGo will be in position to prepare a strong financial plan for funding the Blue Line, including a definition of relationships with other Indy Connect transit projects, particularly the Red and Green lines.

- **Continued Development of MAP-21 Regulations and Tools:** Some aspects of the new Small Starts project evaluation process under MAP-21 have yet to be fully developed. These include congestion relief and quantitative analysis of economic development impacts. Additionally, the new STOPS model for ridership estimation, released in September 2013, has yet to achieve widespread adoption in the industry and may require additional training or the collection of additional data before it is suitable for use in Indianapolis.

7.4 *Other Indy Connect Corridors*

For the purposes of project financing and requesting FTA capital funding, it will be crucial that Blue Line planning be conducted in coordination with other Indy Connect corridors, particularly the Red and Green lines. Assuming that Cumberland to North Tibbs Avenue is implemented as the initial segment of the Blue Line, consideration should also be given to the remainder of IndyGo Route 8, as well as the future Airport Express Line from downtown Indianapolis and the Plainfield Connector.

7.4.1 Near Term Plan for IndyGo Route 8

Indianapolis International Airport is a major destination on the west side, and Route 8 should continue to provide service along Washington Street from downtown to the Airport. This will ensure that airport workers in the surrounding neighborhoods continue to have transit access to their place of employment.

Currently, Route 8 provides 15-minute headway service as far west as Harding Street throughout most of the day on weekdays, with 30-minutes headways on weekends. In order to enhance service on the west side, it is advisable to extend these service frequencies westward as the initial Blue Line segment is implemented. This would encourage continued ridership growth and would ensure that the thriving Latino business district benefits from enhanced service.

In addition, a standard IndyGo shelter and concrete pad should be provided at each major stop along West Washington Street, if not already in place. Additional right-of-way may be required at some locations. This would allow Route 8 passengers to wait for a bus without exposure to the elements. It is recommended that these shelters be provided at locations identified for future West Blue Line stations using a design suitable for future upgrade to full BRT services.

7.4.2 Airport Express Line

The Indy Connect plan includes an express service from downtown to the Airport. This plan element should be retained in order to provide a direct connection between two key destinations. The service is independent and complimentary to Blue Line BRT service and could be implemented any time too serve the unique market for which it is intended.

The conceptual plan is to have the Airport Express commence service at the Downtown Transit Center. This would allow transferring passengers from throughout the metro area to have rapid service to the Airport. A service frequency of 20 minutes would be desirable with service from 5:00 am to 11:00 pm.

As envisioned, the Airport Express would make a few limited stops downtown west of the transit center to serve the convention center area, then proceed directly to the airport. A preliminary recommendation is to route the Airport Express westward on Washington Street to West Street, where it would then head southward to Interstate 70 and onward to the Airport. Marketing and information displays would need to be coordinated among the Indianapolis Airport Authority, IndyGo, and Indianapolis Downtown Inc. (IDI) to inform potential passengers of the service.

7.4.3 Plainfield Connector

Plainfield Connector service should continue by means of the same Route 8 transfer point used today, at Washington Street and Bridgeport Road. This will ensure that access to the major warehouse facilities in Plainfield is maintained. Evening service from 6:30 PM to 11:00 PM and weekend service should also be considered as demand grows, particularly during the busy holiday season. Ultimately, the service schedule should be commensurate with the IndyGo daily service span on Route 8. This will provide riders with a consistent expectation of service.

In terms of capital upgrades to this route, it is recommended that a shelter with benches be provided at the Bridgeport Road connection point to IndyGo. Concrete pads would be desirable at each of the current Plainfield Connector stops, although some locations might require additional right of way. Benches should be provided at stops with the highest number of riders. Additionally, there should be seamless fare compatibility with IndyGo. In lieu of the paper multi-trip passes currently used, the same fare collection method should be used on both systems.