



National Capital Region
Transportation Planning Board

Metropolitan Washington Council of Governments (COG)
National Capital Region Transportation Planning Board (TPB)

Highway and Transit Networks for the Version 2.3.66 Travel Model, based on the 2016 CLRP and FY 2017-2022 TIP

Final Report
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Highway and Transit Networks for the Version 2.3.66 Travel Model, based on the 2016 CLRP and FY 2017-2022 TIP

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About the TPB

The National Capital Region Transportation Planning Board (TPB) is the federally designated metropolitan planning organization (MPO) for metropolitan Washington. It is responsible for developing and carrying out a continuing, cooperative, and comprehensive transportation planning process in the metropolitan area. Members of the TPB include representatives of the transportation agencies of the states of Maryland and Virginia and the District of Columbia, 23 local governments, the Washington Metropolitan Area Transit Authority, the Maryland and Virginia General Assemblies, and nonvoting members from the Metropolitan Washington Airports Authority and federal agencies. The TPB is staffed by the Department of Transportation Planning at the Metropolitan Washington Council of Governments (COG).

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1 Introduction

The National Capital Region Transportation Planning Board (TPB) is the federally designated Metropolitan Planning Organization (MPO) for the Washington, D.C. metropolitan area and is also one of several policy boards that operate at the Metropolitan Washington Council of Governments (COG). The COG/TPB staff develops and maintains, with consultant assistance, a series of regional travel demand forecasting models to support the regional transportation planning process in the Washington, D.C. area. One of the critical inputs to the regional travel demand forecasting model is a series of transportation networks, which represent both the highway (road) system and the transit system in the Washington, D.C. area. Transportation networks depict the highway and transit system for a series of discrete years, typically an existing “base” year and several forecast years. Transportation networks are used in the travel model to formulate impedances (travel times and costs) between origins and destinations. The travel model considers impedances as a basis for estimating the number of person trips that travel between zones and for allocating those person trips among specific modes of travel. Transportation networks also provide a basis upon which the performance of the existing and planned regional transportation system may be evaluated. The TPB Version 2.3.66 travel demand forecasting model is the latest in a series of adopted, regional, production-use travel demand forecasting models that belong to the Version 2.3 family of models.

Transportation networks are prepared with attention to several technical requirements:

- Networks are designed to represent the major transportation facilities and services that are relevant to the regional level of analysis. Thus, many of the smaller scale facilities, such as local roads, are purposefully excluded;
- Networks are designed to conform to a detailed area (or zone) system that is specifically designed for regional modeling. The existing fare system for the Washington, D.C. area consists of 3,722 transportation analysis zones (TAZs);
- Networks are designed to meet the specific technical requirements of the Version 2.3 family of travel demand models. The travel model currently requires network inputs that are used to develop travel highway and transit impedances between zones. The travel model requires modal travel impedances associated with both peak and off-peak operating conditions; and
- Networks are prepared in a format that is compliant with the specific requirements of the software platform that is currently used to apply the model. The Version 2.3 Travel Model is currently implemented with Citilabs Cube software.

Because of the technically specialized nature of the model’s transportation networks, substantial staff resources are required to develop and manage these travel model inputs each year. The network development activity is included in the TPB’s Unified Planning Work Program (UPWP) under the Travel Forecasting major work activity. Network development includes an annual update of the current-year highway and transit networks with the most up-to-date information, as well as the development of future-year networks that represent the continuously evolving Constrained Long-Range Transportation Plan (CLRP) and the Transportation Improvement Program (TIP), which is a six-year subset of the CLRP.

The network development activity also supports other elements of the work program, including Mobile Emissions Planning and Technical Assistance, which encompasses subarea and corridor studies conducted by both TPB staff and state/local planning agencies.

This technical report documents the travel demand model transportation networks that were used in the recent Air Quality Conformity Determination of the 2016 CLRP and FY 2017-2022 TIP, which was adopted by the TPB on November 16, 2016. As stated earlier, transportation network files are developed in compliance with the adopted travel demand model and its associated software. The currently adopted TPB travel demand model is known as Version 2.3.66. The travel model uses an area system with 3,722 TAZs and is currently applied using Citilabs Cube software (Version 6.4.1). Transit path-building is accomplished using a module of Cube Voyager called TRNBUILD. Cube Voyager also contains a newer transit path-building module called Public Transport (PT). Over the last few years, TPB staff is working to transition from the older transit path builder (TRNBUILD) to the newer transit path builder (PT). One of the features of PT is the ability to trace transit paths graphically, on-screen, over a transit map (TRNBUILD included only text-based reports of transit paths). TPB staff hopes to complete the transition from TRNBUILD to PT in FY 17.

This report described the process, technical conventions and specifications associated with the TPB's network-related inputs to the travel model. There are other supporting documents that are directly related to the 2016 CLRP network development process and specifications, including: 1) the air quality conformity report,¹ which includes an itemized listing of transportation improvements that are assumed in the 2016 CLRP and the TIP; and 2) the Version 2.3.66 User's guide,² which documents the overall model application process and describes the relationship between specific network files and program steps in the model chain.

The remainder of this chapter provides an overview of the TPB's network development process and its connection with the annual Air Quality Conformity process.

1.1 Annual Air Quality Conformity Process

One of the primary goals of TPB's network development program is to furnish modeling networks that used in the annual Air Quality Conformity Analysis of the CLRP and TIP. The analysis is generally undertaken each year to determine whether on-road mobile emissions resulting from motor vehicles using roads represented in the TIP and CLRP are compliant with approved emissions budgets or prevailing air quality standards set by federal law. The analysis includes the formulation of travel demand forecasts and associated mobile source emissions inventories for a set of milestone years. TPB

¹ "Air Quality Conformity Analysis of the 2016 Constrained Long-Range Plan Amendment and the FY 2017-2022 Transportation Improvement Program for the Washington Metropolitan Region" (Washington, D.C.: National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, November 16, 2016), http://old.mwcog.org/clrp/resources/KeyDocs_2016.asp.

² Ronald Milone, Mark Moran, and Meseret Seifu, "User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.66: Volume 1 of 2: Main Report and Appendix A (Flowcharts)" (Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, February 13, 2017), <https://www.mwcog.org/transportation/data-and-tools/modeling/model-documentation/>.

staff collects TIP and CLRP transportation network information from all TPB member jurisdictions, the three state departments of transportation (DDOT, MDOT and VDOT), WMATA, MTA, VRE, and other local transit service providers on an annual basis.³

The 2016 CLRP air quality conformity schedule, shown in Table 1-1, is typical of the procedure that is followed each cycle. The analysis schedule begins with a “Call for Projects” and disclosure of the Scope of Work and typically ends with the TPB’s review (and often approval) of the proposed TIP and CLRP and the Air Quality Determination findings. Federal regulations require extensive interagency consultation and public review throughout the duration of the analysis.

The 2016 CLRP air quality analysis involved six forecast year networks: 2016, 2017, 2020, 2025, 2030 and 2040. The networks reflect the TIP and CLRP project phasing obtained from the state and local agencies.

Table 1-1 Schedule for the 2016 CLRP and FY 2017-2022 TIP

| Year | Month | Event |
|---|--|--|
| 2015 | November | TPB briefed on draft call for projects |
| | December | TPB Released Final Call for Projects |
| 2016 | January | Draft project Inputs deadline for submission |
| | February | Technical Committee reviewed of draft CLRP / TIP Submissions and AQC Scope of Work |
| | | CLRP & TIP Project Submissions and Draft Scope of Work released for comment period |
| | | TPB Briefed on CLRP/TIP submissions and AQC Scope of Work |
| | March | MWAQC TAC briefed on project submissions and AQC Scope of Work |
| | | Comment Period Ended |
| | July | TPB reviewed comments and asked to approve CLRP / TIP Submissions and draft AQC Scope of Work |
| | | Public Forum on the development of the FY 2017-2022 TIP |
| | October | Technical Committee reviewed draft CLRP / TIP and AQC analysis |
| | | Draft CLRP / TIP and conformity analysis released for comment at Citizens Advisory Committee (CAC) |
| TPB Briefed on the draft CLRP/ TIP and conformity analysis | | |
| MWAQC TAC briefed on the draft CLRP / TIP and conformity analysis | | |
| November | Comment Period Ended | |
| | TPB reviewed comments and responses to comments | |
| | TPB adopted the draft CLRP / TIP and conformity analysis | |

Source: \\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables \ 2016CLRP_Schedule.xlsx

1.2 Network Development Program Overview

Network development activities are carried out in a way that accommodates the air quality conformity determination schedule. Federal law requires that the CLRP be updated every four years. However, realistically, in the Washington, D.C. area, the CLRP has been updated on an annual basis, which means

³ Although the modeled area, and thus the transportation networks, include one county in West Virginia (Jefferson Co.), the TPB model networks include only current-year roads in this county, not future-year roads.

that the air quality conformity process has been conducted annually. It has recently been suggested that TPB staff move to an every-other-year schedule, but a recent proposal to perform an “off-cycle” (i.e., outside of the ever-other-year schedule) conformity analysis for the state of Virginia means that the annual cycle may continue to be the norm. Under the annual cycle, one of the key objectives of the network development program is to prepare regional network inputs to the travel model in time for travel modeling work to proceed during the spring. The following procedure has typically been followed each year:

- 1) Pre-existing network inputs developed for the previous year’s air quality analysis, and the previous TIP and CLRP, are obtained as a starting point for highway network coding. For example, the 2016 CLRP inputs were built from the previously developed 2015 CLRP inputs. The TPB’s link and node network data are currently stored in a multi-year and multi-modal (highway and transit) Personal Geodatabase. TPB staff essentially develops a single multi-year database for each TIP and CLRP.
- 2) The pre-existing highway networks are subject to ongoing review and updates, such as when errors are detected by either TPB staff or external users of the regional travel model. These types of updates are incorporated into the current-year TIP and CLRP network database throughout the year.
- 3) The transit network “base-year” data is refreshed each year with the latest schedule information provided by the local operators, and provides the starting point for transit coding each year. Most of the transit schedule information is obtained from digital files that now exist in the public domain. The base-year data are generally consistent with the fall period of the air quality conformity cycle. For the air quality analysis of the 2016 CLRP, the transit network base year was 2015.
- 4) The current-year TIP and CLRP network elements (both highway and transit) are collected from the state and local implementing agencies and coded into the network. The coded projects are those considered to be “regionally significant,”⁴ as defined by the TPB.
- 5) Other miscellaneous and policy-related network inputs that are not currently stored in the geodatabase are prepared for each milestone year.

Network development activities also address the production of networks required for special project planning studies, as well as the development of specialized inputs supporting the TPB’s Models Development activities. This report focuses on the data and conventions used to construct the basic CLRP networks.

1.3 Report Structure

The remainder of this report addresses the structure and conventions of the TPB travel model transportation networks in greater detail. Chapter 2 presents the foundational elements of the TPB’s transportation networks, such as the zonal area system underpinning the network and the components

⁴ Memorandum from Jane Posey to TPB Technical Committee, Subject: Defining Regional Significance for Conformity, October 6, 2011

of the regional highway network. Chapter 3 describes the individual network files that are prepared for the transportation model and the attributes that are contained in each file. Chapter 4 describes the database that is currently used to maintain the regional network data. The database has been specially designed to consolidate network-related information within a multi-year and multi-modal framework and in a geographically referenced framework.

2 TPB Transportation Network Background

This chapter presents background on the travel model transportation networks that are developed each year by TPB staff, including a description of the study area (“modeled area”), a review of the zone system that underlies the networks, and the time-of-day period definitions that are represented. The basic elements associated with highway and transit networks are described, along with a review of network location (node) numbering. This chapter also presents an overview of the specific travel costs that are developed in the TPB networks and considered in the regional travel model.

2.1 Modeled Area

A map of the TPB modeled area (study area) is shown in Figure 2-1. The area covers 6,800 square miles and includes 22 of the region’s primary jurisdictions spanning the District of Columbia, Northern Virginia, suburban Maryland, and one county in West Virginia.⁵ The modeled area extends well beyond the current TPB member-area, which includes 10 of the 22 primary jurisdictions. The TPB-member portion of the modeled area, also shown in Figure 2-1, is about 3,500 square miles in size or about one half of the modeled area.

2.2 Time of Day Considerations

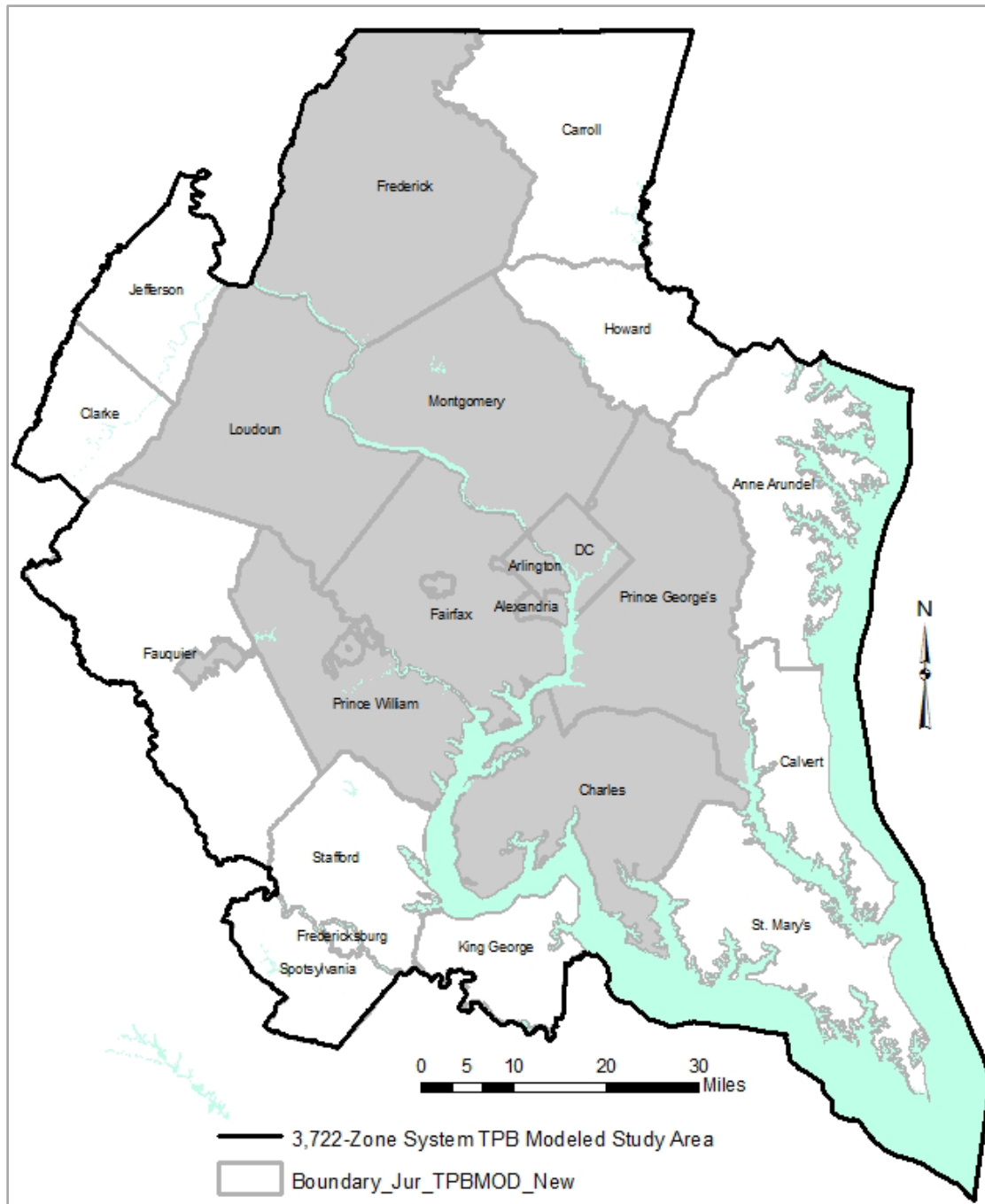
The travel model requires zonal travel times and costs for both peak and off-peak conditions because congestion levels experienced by different travel markets vary substantially over an average weekday. Thus, the travel model networks developed by TPB staff correspond to either peak or off-peak conditions.

Many of the primary highway facilities in the region operate with varying configurations during peak and off-peak hours of the day. Examples of operational changes include:

- HOV priority lanes/facilities: Freeways with diamond lanes or exclusive lanes that are dedicated to HOVs. Many HOV priority lanes operate in the peak-flow direction during peak periods and revert to general purpose lanes during the off-peak hours;
- Facilities with reverse-direction lanes: Several roads operate with varying directional lane configurations during the morning and evening time periods to better serve the peak-flow direction of traffic (e.g., The Theodore Roosevelt Bridge, which has a reversible lane). Some facilities operate entirely in one direction during rush periods and revert to two-way configurations during the off-peak; and
- Some facilities do not change in operation during the day, but are available only to special markets, such as autos only or airport-bound trips.

⁵ The term “jurisdiction” includes both counties (e.g., Arlington County) and major cities (e.g., the City of Alexandria and Washington, D.C.). One of the 22 jurisdictions, Spotsylvania County is only partially included in the modeled study area- the northern portion approximately north of VA 606. All other jurisdictions are fully included in the study area.

Figure 2-1 COG/TPB modeled area – 3,722-zone area system



Note: The TPB Member area also includes the urbanized portion of Fauquier County.

The following time-period definitions are used for the highway network:

- AM peak period (3 hours: 6:00 AM to 9:00 AM)
- Midday period (6 hours: 9:00 AM to 3:00 PM)
- PM peak period (4 hours: 3:00 PM to 7:00 PM)
- Night/early morning period (11 hours: 7:00 PM to 6:00 AM)

Although traffic assignment is conducted for four time-of-day periods (AM peak period, midday, PM peak period, and nighttime), the trip distribution and mode choice steps operate with travel times and costs developed from the AM peak period and midday period only.⁶

The highway network distinguishes these special operations by using facility-specific attributes that change by time-of-day period. These attributes include directional lanes and codes that enable or disable the use of a specific facility to specific travel markets (e.g., HOV traffic). Highway costs (tolls) on specific facilities are also coded differentially by time-of-day period.

The operational differences reflected in the regional highway networks pertain essentially to high-level facilities (freeways and principal arterials). **While numerous operational differences between time periods exist on minor arterials and collectors (for example turn prohibitions or parking restrictions), they are not reflected in the TPB networks.**

Like the highway network, the level of transit service in the Washington, D.C. region varies substantially during the average weekday. Consequently, transit networks prepared for the travel model provide a representation of peak and off-peak service. For each modeled transit route, an average headway (service frequency) and an average run time (time from start of the route to the end of the route) is calculated for the two time-of-day periods. For the calculation of average headways and run times, the peak period is represented by the AM peak hour (7:00-7:59 AM) and the off-peak period is represented by the five-hour midday period (10:00 AM to 2:59 PM).⁷ The AM period definition is reasonably representative of most peak/commuter service, but may not be adequate to represent peak-period service operating in the outer reaches of the region. Consequently, the peak frequencies and running times for express bus and local bus service in some “outer” jurisdictions are developed using an earlier peak hour definition which is decidedly more representative of peak conditions. The specific peak hour selected is based on the professional judgment of the network coder.

2.3 Zone Area System

Transportation Analysis Zones (TAZs) represent the basic geographic unit by which regional highway and transit travel flows are estimated by the travel demand model. The TAZ system is important to the overall network design because TAZs delineate the finest level of spatial resolution that can be supported by the land activity inputs, and hence the travel model. Consequently, the highway and transit facilities represented in the regional network are purposefully designed to conform around each TAZ as closely as possible.

The existing modeled area is subdivided into 3,722 TAZs. The zone system includes 3,675 internal TAZs and 47 external stations, which represent points of entry to, and exit from, the modeled area. The 3,722-TAZ system has been in existence since 2009 and has been designed to provide a greater level of resolution in concentrated areas of development known as “activity centers and clusters.” These

⁶ Milone, Moran, and Seifu, “User’s Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.66: Volume 1 of 2: Main Report and Appendix A (Flowcharts),” 117.

⁷ Ibid., 176.

concentrated areas were identified by COG’s Metropolitan Development Policy Committee in 2007 as a basis for encouraging mixed use development and as an aid for improving the coordination of land use and transportation planning.

The 3,722 TAZ system numbering has been developed on a jurisdictional basis as shown in Table 2-1. The table indicates that the internal TAZs are numbered from 1 to 3675. The external station locations are shown in Figure 2-2 and Figure 2-3. External station numbers are sequenced from 3676 to 3722 and are assigned to highway facilities in a clockwise direction, from Virginia Route 3 station in King George County to US 50/301 (the Chesapeake Bay Bridge) in Anne Arundel County. The table also indicates that 1,278 reserved TAZs are currently available for subzone work. However, changes to the existing TAZ system would require changes to dimensions that are currently specified in application scripts and programs.

The TAZs in Table 2-1 are referred to as “TPB TAZ” to distinguish them from “COG TAZ.” In 2008 and 2009, the COG GIS staff developed a new system of TAZs, which had more zones, but did not increase the size of the modeled area. In other words, the new zones were, on average, smaller than the previous zone system, which is useful for better modeling of transit and non-motorized trips. The old zone system had 2,191 TAZs and the new system has 3,722 TAZs. Reviews of the initial 3,722-TAZ system used in the COG Cooperative Forecasting process uncovered some instances where TAZ boundary refinements were needed. The result was that there are now two sets of zones for the 3,722-TAZ area system:

- COG TAZs: For land activity forecasts (COGTAZ3722_TPBMOD)
- TPB TAZs: For transportation modeling (TPBTAZ3722_TPBMOD)⁸

The specific differences between the two area systems are detailed in Table 2-2.

⁸ Meseret Seifu, “Review of New Zone System: 3722 Transportation Analysis Zones (TAZ)” (January 22, 2010 meeting of the Travel Forecasting Subcommittee of the Technical Committee of the National Capital Region Transportation Planning Board, held at the Metropolitan Washington Council of Governments, Washington, D.C., January 22, 2010), 23, <http://www.mwcog.org/uploads/committee-documents/ZI5aV1dd20100122152445.pdf>.

Table 2-1 Jurisdictional summary of 3,722 TPB TAZ ranges

| Jurisdiction | Jur. Code | Beginning TAZ No. | Ending TAZ No. | TAZ/Station Count |
|-----------------------------|-----------|-------------------|----------------|-------------------|
| District of Columbia | 0 | 1 | 393 | 393 |
| Montgomery Co., Md. | 1 | 394 | 769 | 376 |
| Prince George's Co., Md. | 2 | 770 | 1404 | 635 |
| Arlington Co., Va. | 3 | 1405 | 1545 | 141 |
| City of Alexandria, Va. | 4 | 1546 | 1610 | 65 |
| Fairfax Co., Va. | 5 | 1611 | 2159 | 549 |
| Loudoun Co., Va. | 6 | 2160 | 2441 | 282 |
| Prince William Co., Va. | 7 | 2442 | 2819 | 378 |
| Frederick Co., Md. | 9 | 2820 | 2949 | 130 |
| Howard Co., Md. | 10 | 2950 | 3017 | 68 |
| Anne Arundel Co., Md. | 11 | 3018 | 3116 | 99 |
| Charles Co., Md. | 12 | 3117 | 3229 | 113 |
| Carroll Co., Md. | 14 | 3230 | 3287 | 58 |
| Calvert Co., Md | 15 | 3288 | 3334 | 47 |
| St. Mary's Co., Md. | 16 | 3335 | 3409 | 75 |
| King George Co., Va. | 17 | 3410 | 3434 | 25 |
| City of Fredericksburg, Va. | 18 | 3435 | 3448 | 14 |
| Stafford Co., Va. | 19 | 3449 | 3541 | 93 |
| Spotsylvania Co., Va. | 20 | 3542 | 3603 | 62 |
| Fauquier Co., Va. | 21 | 3604 | 3653 | 50 |
| Clarke Co., Va. | 22 | 3654 | 3662 | 9 |
| Jefferson Co., WV | 23 | 3663 | 3675 | 13 |
| Total Internal TAZs | | | | 3,675 |
| External Stations: | | 3676 | 3722 | 47 |
| Reserved TAZ numbers | | 3723 | 5000 | 1,278 |

Ref: "i:\ateam\docum\fy14\2013CLRP_Network_Report\3722taz_master_node_table_aug_2013.xlsx"

Note: 13 of the 3675 internal TAZs are unused: 61, 382, 770, 777, 2555, 2629, 3103, 3266, 3267, 3478, 3482, 3495, 3544

Table 2-2 Differences between COG TAZ and TPB TAZ area systems

| COG TAZ | Jurisdiction | Issue | TPB TAZ |
|---------|-------------------------|--|-------------------------|
| 61 | District of Columbia | island/water body | unused TAZ |
| 382 | District of Columbia | water body | unused TAZ |
| 770 | Prince George's Co., MD | water body | unused TAZ |
| 777 | Prince George's Co., MD | water body | unused TAZ |
| 2555 | Prince William Co., VA | resolution too fine for regional model | dissolved into TAZ 2554 |
| 2629 | Prince William Co., VA | resolution too fine for regional model | dissolved into TAZ 2630 |
| 3103 | Anne Arundel Co., MD | resolution too fine for regional model | unused TAZ |
| 3266 | Carroll Co., MD | peninsula/water body | unused TAZ |
| 3267 | Carroll Co., MD | water body | unused TAZ |
| 3482 | Stafford Co., VA | resolution too fine for regional model | dissolved into TAZ 3489 |
| 3478 | Stafford Co., VA | resolution too fine for regional model | dissolved into TAZ 3489 |
| 3495 | Stafford Co., VA | resolution too fine for regional model | dissolved into TAZ 3494 |
| 3544 | Spotsylvania Co., VA | water body | unused TAZ |
| | | | |

Figure 2-2 Location of external stations in the modeled area

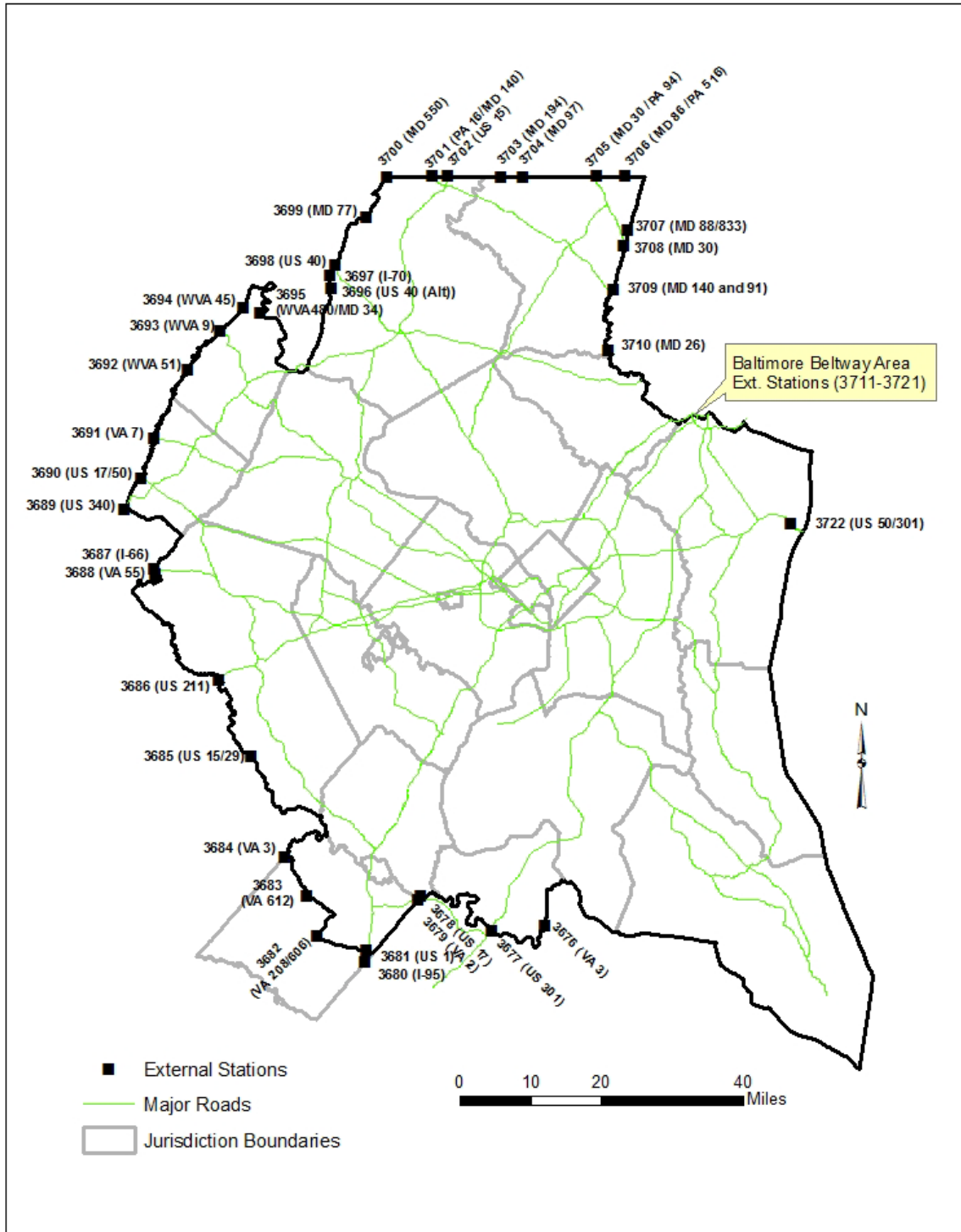
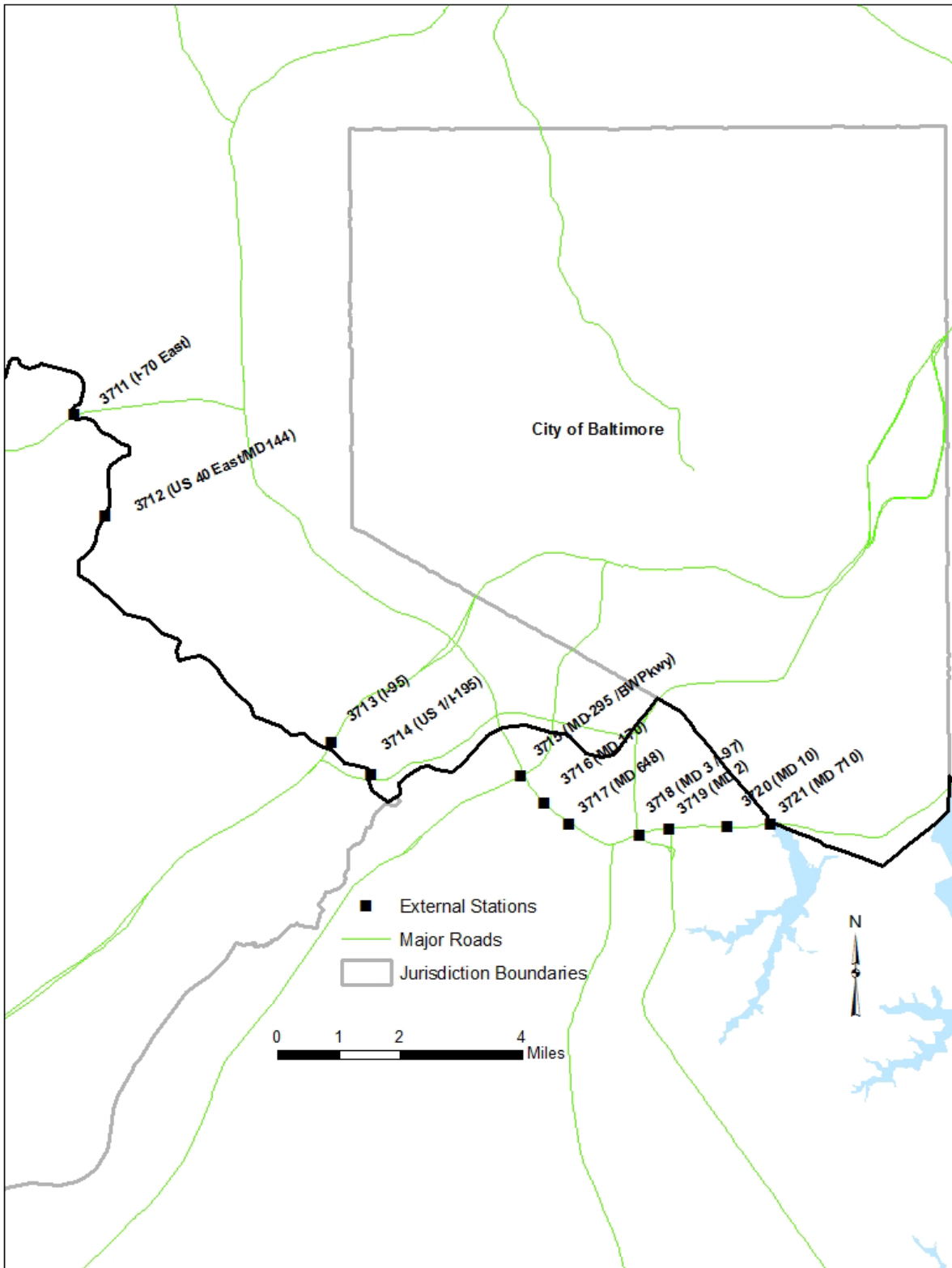


Figure 2-3 Location of external stations in Baltimore Beltway area



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2.4 Highway Network Elements

The transportation networks used by the travel model represent the region's transportation system as a collection of point locations (zone centroids and nodes) and transportation facility segments (links). This relatively simplistic depiction of the system provides the travel model with concise information about roadway connectivity and capacity that exists between zones. The model evaluates demand against the network capacity and subsequently produces level-of-service metrics (times and costs) between zones, which are important variables in the model.

There are several types of nodes and links that are used in the highway networks. These types are listed and described below:

- **Zone Centroids:** Point locations which represent the geographic center of activity of a TAZ. All trips begin and end at zone centroids. Although zones also have boundaries, zone boundaries are not explicitly represented in the transportation network, so all trips travel from one zone centroid to another zone centroid. The travel model represents zone-to-zone travel (inter-zonal travel), but not within-zone travel (intra-zonal travel), since this is below the grain of the model and its associated network.
- **PNR "Dummy" Centroids:** Point locations which represent park-and-ride (PNR) parking lots at Metrorail and commuter rail stations. These are components of the highway network that exist so that congested travel times from TAZs to rail PNR lots may be developed in the construction of auto-access links in the transit network.
- **Highway Nodes:** Point locations that represent highway intersections, zonal points-of-access to the highway system, or simply "break points" or "shape points" for links representing highway facilities.
- **Centroid Connector Links:** Segments (or links) between zone centroids and the highway network by which generated traffic may leave or enter the TAZ. These special links represent the physical connection between zonal activity and the highway system based on the underlying localized street system. Centroid connections usually number from one to four links for each TAZ. Traffic "loaded" on centroid connectors is exclusively limited to trips originating or destined to a specific TAZ.
- **PNR Connector Links:** Segments that represent access links between Metrorail/commuter rail PNR lots and the highway network. Traffic is not "loaded" on these types of links; they are used for the sole purpose of developing congested TAZ-to-PNR travel times.
- **Highway Links:** These represent the major highway segments in the regional network on which regional traffic is "loaded." The segments are comprised of freeway, expressway, arterial, and collector facilities and do not include local streets. Freeway links are usually coded by direction, as two "one-way" links. In contrast, most non-freeway segments are represented as a single "two-way" facility. Freeway ramps are included in the regional network, but are not represented as a "cloverleaf." Instead ramps are coarsely represented, and the regional model does not furnish accurate ramp volumes.
- **"Transit Only" Links:** This is a special group of highway links that exist below the zone level of analysis. These links exist in the network to improve the detail of bus route coding with respect

to zonal access to transit, particularly in areas where the zone size is large. These links are excluded from the traffic assignment process; regional traffic is not “loaded” onto this class of links.

2.5 Transit Network Elements

The transit system contains some components of the highway system described above, and consists of additional “point” and “segment” elements that are necessary for transit path building. The TPB transit network consists of a combination of the highway network along with transit-related elements. The transit elements are listed and described below:

- **Rail Stations:** Point locations where travelers may board or alight from fixed guideway transit service, including Metrorail, commuter rail, light rail, street car, and BRT.
- **Transit PNR Lots:** Park-and-Ride lot point locations. It is assumed that “auto-access” trips originating from TAZ centroids park at these locations, prior to boarding at rail stations or at bus stops (most typically express bus stops). The model also considers Kiss-and-Ride (KNR) access, but KNR access links do not connect to PNR lots; they connect directly to the rail stations.
- **Rail Links:** These represent fixed guideway (Metrorail, commuter rail, light rail, streetcar and BRT) segments that connect rail stations. These are not part of the background highway network. Once TPB staff makes the transition from the TRNBUILD transit path builder to the Public Transport (PT) transit path builder, there will no longer be a distinction between a highway network and a transit network – there will just be a transportation network, containing both highway and transit links in one network.
- **PNR Lot-to-Station Walking Links:** Links representing sidewalks between the PNR lot and the rail station.
- **Bus-to-Station Transfer Links:** Links representing sidewalks between bus stops and rail stations.
- **Walk Access Links:** Walk connections between zone centroids and transit stops accessible from the TAZ.
- **Auto Access Links:** Auto connections between the zone centroid and proximate PNR lots.
- **Sidewalk Links:** All highway links, other than freeways and expressways that are available for accessing transit from a zone centroid, or are available for transferring between transit modes.
- **Transit lines/routes:** These are the individual transit routes that are in service during specific time periods. Transit lines are categorized among “modes” which distinguish basic service types (including, for example, Metrorail lines). The “line” files contain general characteristics (mode, average headway, average end-to-end running time, and a one- or two-way indicator) as well as the route delineation, which is expressed as a node string. The route delineation of bus-related modes is defined as a series of highway nodes. Rail related route delineation is defined as a series of station nodes. In Cube, transit line files are text files. Since we currently use TRNBUILD, the files are in TRNBUILD format and have file extensions of “TB”. In the future, we will transition to Public Transport (PT) and, at that time, the files will be in PT format, which will be shown in the file name with the file extension “PT”.

Most of the highway and transit network inputs are files that contain attributes of elements listed above. The attributes describe the physical location of nodes and the physical characteristics of links, such as the number of lanes, distance and the facility classification. These are specified in Chapter 3.

2.6 Overview of Network Travel Costs

The Version 2.3.66 Travel Model, like all the other models in the Version 2.3 family of models, requires several traveler out-of-pocket cost inputs. Most of the traveler costs are network-related or path-related elements. All of the cost inputs are either prepared in constant-year (year-2007) prices (dollars or cents) or are converted to constant-year prices as part of the model application process. The year 2007 is the model “base-year” because that was the year when model calibration data was collected. The travel model currently considers five travel cost components each affecting different varying steps of the travel model:

- Transit related
 - Transit fares
 - Parking costs associated with drive-access to transit (parking at a PNR lot)
- Highway related
 - Highway tolls
 - Parking costs associated with a non-transit trip
 - Other auto operating costs (distance based)

Transit fares are computed within the model stream in terms of current-year prices, and are ultimately converted to constant-year prices. PNR-related parking costs are provided for both the peak and off peak period. These PNR parking costs are stored in the station file (station.dbf). Current-year highway tolls are obtained from the appropriate websites. Future-year tolls are estimated in a semi-automated toll-setting process (see, for example, the current TPB model user’s guide). Both PNR parking costs and tolls are coded as input variables in current-year prices.

As suggested by the list above, parking costs for transit trips are handled separately from parking costs associated with auto trips. Parking costs associated with a non-transit trip are calculated using a parking cost model, which is applied with the Cube Voyager script *prefarv23.s*. These parking costs are a function of job density, specifically attraction TAZ employment density. This script also calculates “terminal time,” i.e., the time to park and un-park a car.⁹ Since these parking costs are calculated with a parking cost model, the network coder does not have to collect these. Lastly, auto operating costs are computed directly in year-2007 prices based on a single per-mile parameter.

PNR lot costs are coded as a station node attribute in the network input files in current-year cents. PNR lot costs, like tolls, are used exclusively in the development of rail-related transit paths. PNR lot costs may be altered with “shadow-price” variables that also exist in the station file for calibrating auto

⁹ Milone, Moran, and Seifu, “User’s Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.66: Volume 1 of 2: Main Report and Appendix A (Flowcharts),” 195.

access demand at specific rail stations. Also, unlike the other cost components, the PNR lot cost is not considered in the mode choice modeling process.

Highway tolls are coded on a highway network on a link-by-link basis and are specified as either a flat cost or as a per-mile rate. Highway tolls are rather unique cost components in that they affect the construction of highway paths. Most conventional travel models build minimum-impedance paths based on congested travel time. The TPB model builds highway paths based on a generalized cost function that equals the congested travel time plus the travel time equivalent of tolled costs. The monetary toll between zones therefore reflects any toll segments that exist along each minimum generalized cost path.

Zone-to-zone transit fares are computed in a way that mimics WMATA’s actual fare policy. The computation involves two steps: 1) the calculation of Metrorail fares between stations using WMATA policy parameters and 2) combining Metrorail fares between stations with bus/commuter rail fares between “Bus Fare Zones” which are entered as an input. Bus Fare Zones are currently 21 “macro areas” of the region that approximate WMATA policy areas and other transit market areas. The transit fares are dependent on minimum perceived time paths between TAZ that include Metrorail defined boarding and alighting stations, if Metrorail use is included within the path.

2.7 Node Numbering System

The various node groups are numbered in the network in a structured way. Structured node numbering is useful because it facilitates network integrity checks and network mapping. It is also important because model application programs reference predefined TAZs and node numbers and node ranges for the purposes of indexing or dimensioning.

An overview of the node numbering system that has been adopted for highway and transit networks on the 3,722-TAZ system is shown in Table 2-3. The numbering system allocates nodes from lowest to highest beginning with TAZs, station centroids, station nodes, PNR lot nodes, and finally highway nodes.

Table 2-3 TAZ/node numbering system overview

| Node Class | Node Type | Beginning TAZ / Node | Ending TAZ / Node | Node Count |
|------------------------------|------------------------|----------------------|-------------------|------------|
| TAZ/PNR Centroids | Internal TAZ Centroid | 1 | 3675 | 3,675 |
| | External Stations: | 3676 | 3722 | 47 |
| | Reserved TAZ numbers | 3723 | 5000 | 1,278 |
| | PNR Centroid | 5001 | 7999 | 2,999 |
| Transit Nodes | Transit Station Nodes | 8000 | 10999 | 3,000 |
| | Transit PNR Lot Nodes | 11000 | 13999 | 3,000 |
| | Transit Reserved Nodes | 14000 | 19999 | 6,000 |
| Highway Network Nodes | | 20000 | 54999 | 35,000 |

Ref: " I:\ateam\docum\FY15\2014CLRP_Network_Report\NW_Report_Tables\3722TAZ_Master_Node_Table_Jan_2015.xlsx"

The sub-allocation of transit nodes above is further detailed in Table 2-4.

Table 2-4 Node numbering system for transit nodes

| Node Type | Beginning | Ending | TAZ / Node |
|-------------------------------|------------|------------|------------|
| | TAZ / Node | TAZ / Node | Count |
| Metrorail PNR Centroids: | 5000 | 5999 | 1000 |
| Commuter Rail PNR Centroids: | 6000 | 6999 | 1000 |
| Light Rail/BRT PNR Centroids: | 7000 | 7999 | 1000 |
| Metrorail Station Node: | 8000 | 8999 | 1000 |
| Commuter Rail Station Node: | 9000 | 9999 | 1000 |
| Light Rail Station Node: | 10000 | 10499 | 500 |
| BRT Street car Station Node: | 10500 | 10999 | 500 |
| Metrorail PNR Lot Node: | 11000 | 11999 | 1000 |
| Commuter PNR Lot Node: | 12000 | 12999 | 1000 |
| Bus PNR Lot Node: | 13000 | 13999 | 1000 |
| Reserved Transit Nodes | 14000 | 19999 | 6000 |

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Note: 7000-7999 range is not currently used in the geodatabase.

Highway node numbers are allocated in discrete ranges by jurisdiction, as shown in Table 2-5.

Table 2-5 Allocated highway node ranges by jurisdiction

| Jurisdiction | Beginning TAZ / Node | Ending TAZ / Node | Allocated Nodes |
|-----------------------------|-------------------------|----------------------|--------------------|
| District of Columbia | 20000 | 21999 | 2000 |
| Montgomery Co., Md. | 22000 | 25999 | 4000 |
| Prince George's Co., Md. | 26000 | 29999 | 4000 |
| Arlington Co., Va. | 30000 | 31999 | 2000 |
| City of Alexandria, Va. | 32000 | 33999 | 2000 |
| Fairfax Co., Va. | 34000 | 37999 | 4000 |
| Loudoun Co., Va. | 38000 | 39999 | 2000 |
| Prince William Co., Va. | 40000 | 41999 | 2000 |
| Frederick Co., Md. | 42000 | 43999 | 2000 |
| Howard Co., Md. | 44000 | 45499 | 1500 |
| Anne Arundel Co., Md. | 45500 | 46999 | 1500 |
| Charles Co., Md. | 47000 | 47999 | 1000 |
| Carroll Co., Md. | 48000 | 48999 | 1000 |
| Calvert Co., Md. | 49000 | 49499 | 500 |
| St. Mary's Co., Md. | 49500 | 49999 | 500 |
| King George Co., Va. | 50000 | 50499 | 500 |
| City of Fredericksburg, Va. | 50500 | 50999 | 500 |
| Stafford Co., Va. | 51000 | 51999 | 1000 |
| Spotsylvania Co., Va. | 52000 | 52999 | 1000 |
| Fauquier Co., Va. | 53000 | 53999 | 1000 |
| Clarke Co., Va. | 54000 | 54499 | 500 |
| Jefferson Co., WV. | 54500 | 54999 | 500 |

3 Cube Voyager Network Inputs

Chapter 2 provided a broad overview of the TPB transportation networks in terms of the TAZ system, network elements, and node numbering conventions. This chapter presents more detail on the specific input files that are prepared, which include policy-related inputs as well as infrastructure-related inputs. The input files are presented in four sub-sections: cost deflation inputs, highway network inputs, transit network inputs, and transit fare inputs.

It is important to note that all input filenames used by the TPB travel demand model are assigned generic names, such as “link.dbf.” The Version 2.3 family of travel models identifies modeled scenarios using scenario-specific *subdirectories*, each containing generic input *filenames*. While this approach might appear confusing and error-prone, TPB staff has grown comfortable with the application approach for several years. More detail on the TPB’s model application may be found in the User’s Guide.¹⁰

3.1 Cost Deflation Inputs

The Version 2.3.66 model application includes a procedure that creates an inflation/deflation factor for converting current-year costs into constant-year (year-2007) costs. The factor is used in subsequent steps and applied to highway tolls and transit fares. The cost deflation factor information is stored in a user-prepared parameter file, shown in Figure 3-1. The file contains the historical year-to-year consumer price index (CPI) schedule published by the Bureau of Labor Statistics (BLS). The specific CPI index definition used for deflating modeled transportation costs is defined as “All Urban Consumers/U.S. city average for all items (1982-84=100).” The following link was used to obtain historical CPI data:

<http://www.bls.gov/cpi/cpid1601.pdf>

The CPI parameter file (Figure 3-1) is updated each year. The file contains a table showing the annual CPI starting from 2007 to the most recent historical year. The table also includes the computed average annual growth rate and the deflation factor implied from the base year to the current year. The deflation rate for converting current year costs is based on the historical rate of inflation defined as the base-year CPI divided by current-year CPI (the most recent year for which annual CPI data is furnished). As shown in the above parameter file, the existing deflation factor for the current year (2014) is 0.87584 (or 207.3 divided by 237.0). The ratio implies an average historical annual inflation rate between 2007 and 2014 is 1.92%. The historical and projected CPI growth at 2% is shown as a solid line in Figure 3-2. TPB travel forecasts generally assume that future cost escalation will follow the historical rate of inflation.

The InflationFTR variable (“inflation/deflation factor” variable) enables one to investigate varying future cost escalation scenarios. An InflationFTR value of “1.0” implies that future costs will escalate directly with the historical CPI growth rate. The parameter may be changed to, for example, “0.5” to reflect cost growth at one-half of the historical growth rate or to “2.0” to reflect cost growth at twice the historical

¹⁰ Ibid., chap. 4.

growth rate, etc. The dashed lines in Figure 3-2 indicate how project cost escalation for these types of scenarios compare with the TPB's default cost escalation assumption.

Figure 3-1 Cost deflation parameter file (CPI_File.txt)

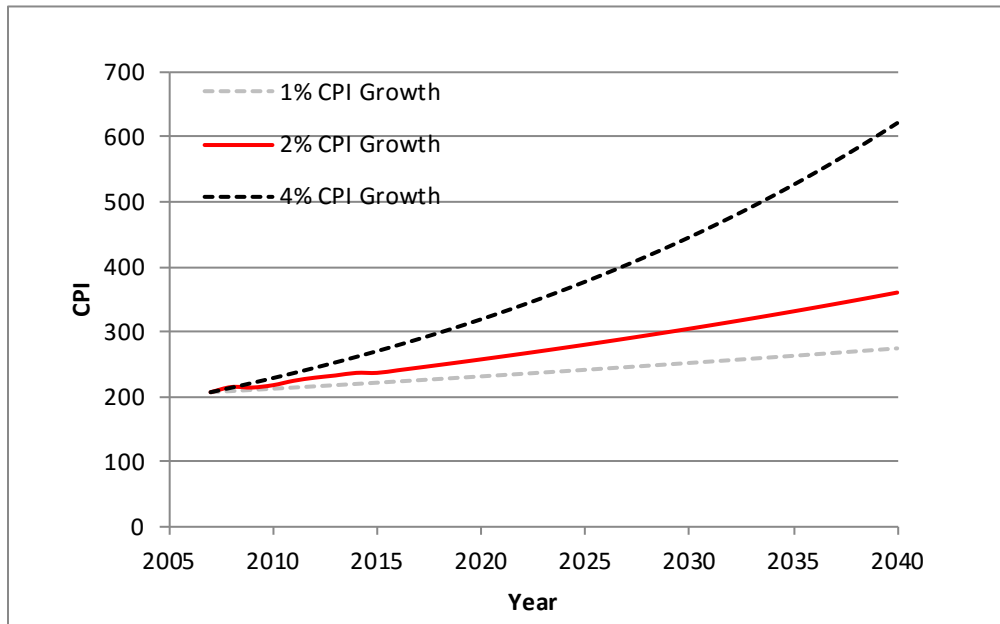
```

;; - MWCOG V2.3 Travel Model - Cost deflation Table
;; - 5/15/2016 - RJM
;; Data from BLS / All Urban Consumers (CPI-U) US City Avg.1982-84=100.0
;; http://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-
changes-from-1913-to-2008

InflationFTR      = 1.0      ; Inflation Assumption (DEFAULT IS 1.0)
Defl_Override     = 0.0      ; Deflation Override (DEFAULT IS 0.0) If Non-zero it is used as
deflator
                                ; Used as deflator IF NON-ZERO
BaseCPIYear       = 2007     ; Base year of the CPI Table
CurrCPIYear       = 2015     ; Current year on CPI table below (Year for which complete annual
CPI data is available)
;
;=====
; Establish historic CPI table and Deflation Factor           =
;=====
;
LOOKUP Name=CPI_Table,
LOOKUP[1] = 1,Result = 2,          ;; CPI index (from US BLS)
LOOKUP[2] = 1,Result = 3,          ;; Compounded Growth Rate From Base Year
LOOKUP[3] = 1,Result = 4,          ;; Deflation Factor
Interpolate = N, FAIL=0,0,0,list=Y,
;;
;;
;;          (((YrCPI/BsCPI)^(1/n))-1.0)*100   BsCPI/YrCPI
;;          Annual_Avg.                       Historic Deflation
;; YEAR      CPI                          Growth_Rate(%)      Factor
;; -----
R=' 2007,   207.342,          0.00,          1.0000 ', ; <--- BaseCPIYear
' 2008,   215.303,          3.84,          0.9630 ', ;
' 2009,   214.537,          1.72,          0.9665 ', ;
' 2010,   218.056,          1.69,          0.9509 ', ;
' 2011,   224.939,          2.06,          0.9218 ', ;
' 2012,   229.594,          2.06,          0.9031 ', ;
' 2013,   232.957,          1.96,          0.8900 ', ;
' 2014,   236.736,          1.91,          0.8758 ', ;
' 2015,   237.017,          1.69,          0.8748 ' ; <--- Curr(ent)CPI Year
; --- end of CPI File -----
; -----

```

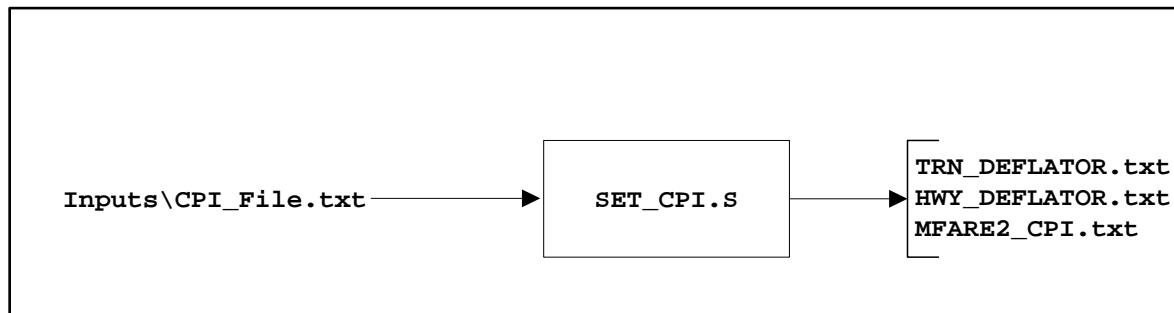
Figure 3-2 Projected CPI escalation at varying annual growth rates



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The CPI_File.txt file is called into the SET_CPI.S script as shown in Figure 3-3. The script writes out two one-line text files containing the deflation factors that are used to convert current year highway and transit costs to constant-year costs in subsequent modeling steps. The MFARE2_CPI.txt file contains summary CPI information.

Figure 3-3 Deflation process in the Version 2.3 Travel Model



3.2 Highway Network Files

A list of user-generated highway network inputs is provided in Table 3-1. The list includes a node file, a link file, a zonal land activity file, and a toll parameter file. The files are read into Cube Voyager scripts and are ultimately converted into a single binary or “built” network file (*.NET). Binary networks are used in the travel model application because they enable the software to process network-related operations more efficiently. The binary network ultimately created from the TPB “network building”

process is named *zonehwy.net*. This file is sometimes referred to as an “unloaded network” file because it does not include link volumes resulting from the traffic assignment step.

Table 3-1 also indicates the source of the files. The highway node and link file are developed from a multi-year and multi-modal geodatabase that is discussed in Chapter 4. Other inputs relating to zonal land activity and policy parameters are generated either manually or by off-line procedures.

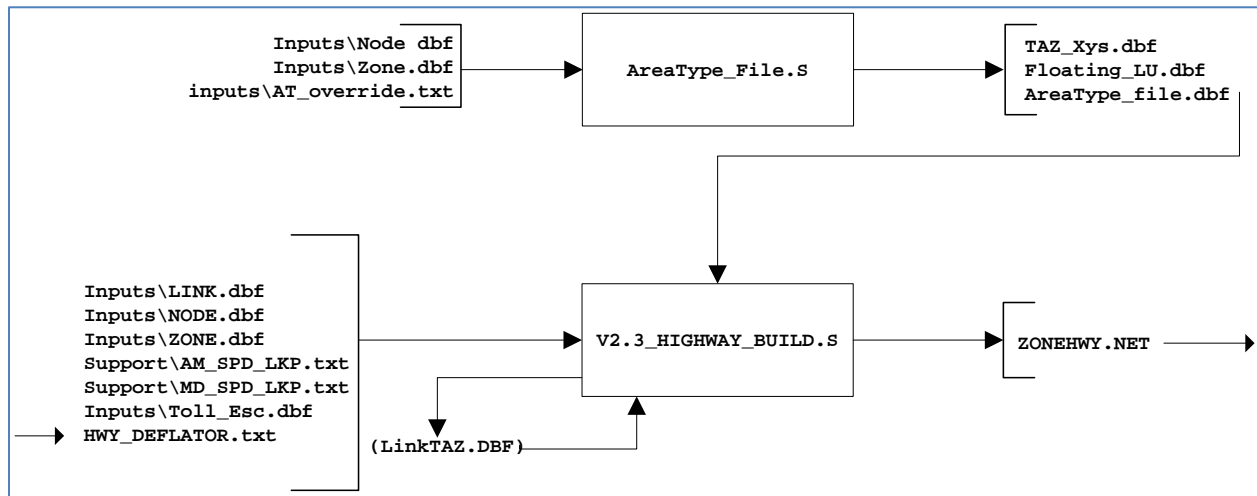
Table 3-1 Listing of highway network input files

| Filename | Description | Type | Source |
|--------------|--|------|-------------------|
| Node.dbf | XY coordinates of nodes in highway network | DBF | Geodatabase |
| Zone.dbf | Land use/land activity data at zonal level, 3722 TAZ | DBF | Analyst-generated |
| Link.dbf | Highway network links | DBF | Geodatabase |
| Toll_Esc.dbf | Toll policy parameters by link "Tollgrp" code | DBF | Analyst-generated |

Ref: "I:\ateam\docum\fy14\2013CLRP_Network_Report\v23_inputs_v10.xlsx"

The above files are used in a network building process that is shown in Figure 3-4. The process involves two steps, one that develops zonal area types (*AreaType_File.S*) and another that “builds” the highway network (*V2.3_Highway_Build.S*). The inputs files and the two steps are described in the next sections of the report.

Figure 3-4 Highway network building process



3.2.1 Zonal land use

The zone.dbf file contains zonal land activity and other items that are shown in Table 3-2. This file is created from a standard Cube Voyager process that reads a single, standardized, multi-year file from COG’s Cooperative Forecasts of land activity, and creates individual (year-by-year) files, that are used by the travel model. The Round 9.0 land activity was employed in the 2016 CLRP conformity. The Round 9.0 land activity totals for the modeled region are shown in Table 3-3. Cooperative Forecasts are prepared in five-year increments. If intermediate years are modeled, such as 2017 in the 2016 CLRP analysis, the land activity values are linearly interpolated.

Table 3-2 Format description of the land use file (zone.dbf)

| File Name | Variable Name | Description |
|-----------|---|--|
| Zone.dbf | TAZ | TAZ (1-3,722) |
| | HH | Households |
| | HHPOP | Household Population |
| | GQPOP | Group Quarters Population |
| | TOTPOP | Total Population |
| | TOTEMP | Total Employment |
| | INDEMP | Industrial Employment |
| | RETEMP | Retail Employment |
| | OFFEMP | Office Employment |
| | OTHEMP | Other Employment |
| | JURCODE | Jurisdiction Code (0-23) <i>0/dc, 1/mtg, 2/pg, 3/alr/, 4/alx,5, ffx, 6/ldn, 7/ pw, 8/(unused), 9/frd, 10/how, 11/aa, 12/chs, 13/(unused), 14/car, 15/cal, 16/stm, 17/ kg, 18/fbg, 19/stf, 20/spts, 21/fau, 22/clk, 23/jef</i> |
| | LANDAREA | Gross Land Area (in sq. miles) |
| | HHINCIDX | Ratio of zonal HH median income to regional median HH income in tenths (i.e. 10 = 1.0), per 2000 CTPP. |
| | ADISTTOX | Airline distance to the nearest external station in whole miles. |
| TAZXCRD | TAZ X-Coordinates (NAD83-based in whole feet) | |
| TAZYCRD | TAZ Y-Coordinates (NAD83-based in whole feet) | |

Before the zone-level land activity data can be used as an input to the travel model, it must undergo an adjustment process, known as the CTPP-based employment adjustment, which ensures that a consistent employment definition is used by all counties and jurisdictions in the modeled area. The reason for this adjustment is that different jurisdictions in the modeled area, which covers DC, Maryland, Virginia, and one county in West Virginia, use different definitions of employment.¹¹

¹¹ Ibid., 15.

Table 3-3 Round 9.0 Cooperative Forecasts regional totals by year

| Year | HH | HHPOP | GQPop | TotPop | TotEMP |
|------|-----------|-----------|---------|-----------|-----------|
| 2010 | 2,464,593 | 6,521,805 | 122,327 | 6,644,132 | 3,806,043 |
| 2015 | 2,625,332 | 6,932,754 | 135,814 | 7,068,568 | 4,015,845 |
| 2020 | 2,797,365 | 7,337,631 | 142,750 | 7,480,381 | 4,266,925 |
| 2025 | 2,959,187 | 7,710,017 | 145,813 | 7,855,830 | 4,539,957 |
| 2030 | 3,110,846 | 8,053,071 | 148,077 | 8,201,148 | 4,795,307 |
| 2035 | 3,240,616 | 8,360,530 | 150,350 | 8,510,880 | 5,025,580 |
| 2040 | 3,356,650 | 8,635,128 | 153,303 | 8,788,431 | 5,253,305 |

Note: CTPP employment adjustments have been made

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3.2.2 Highway Link and Node Coordinate Files

The link.dbf file contains the attributes of individual highway segments (links) that comprise the highway network. The link attributes are shown in Table 3-4. The highway network node file, node.dbf (Table 3-5), contains the XY coordinates for both TAZs and highway nodes. The link.dbf file describes basic characteristics of individual highway segments including distance, the number of directional lanes by time period (??LANE), directional user-market enable or disable codes (??LIMIT), and facility type (FTYPE). These highway network link key attributes are described in this section.

Table 3-4 Base highway link file description (link.dbf)

| File Name | Variable Name | Description |
|-----------|---------------|---|
| Link.dbf | A | A-Node |
| | B | B_Node |
| | DISTANCE | Link distance (in whole miles w/explicit decimal) |
| | JUR | Jurisdiction Code (0-23) <i>0/dc, 1/mtg, 2/pg, 3/alr/, 4/alx,5, ffx, 6/ldn, 7/ pw, 8/(unused), 9/ frd, 10/how, 11/aa, 12/chs, 13/(unused), 14/car, 15/cal, 16/stm, 17/ kg, 18/fbg, 19/stf, 20/spts, 21/fau, 22/clk, 23/jef</i> |
| | SCREEN | Screenline Code |
| | FTYPE | Link Facility Type Code (0-6) <i>0/centroids, 1/Freeways, 2/Major Art., 3/Minor Art, 4/ Collector, 5/ Expressway, 6/ Ramp</i> |
| | TOLL | Toll Value in current year dollars |
| | TOLLGRP | Toll Group Code |
| | AMLANE | AM Peak No. of Lanes |
| | AMLIMIT | AM Peak Limit Code (0-9) |
| | PMLANE | PM Peak No. of Lanes |
| | PMLIMIT | PM Peak Limit Code (0-9) |
| | OPLANE | Off-Peak No. of Lanes |
| | OPLIMIT | Off-Peak Limit Code (0-9) |
| | EDGEID | Geometry network link identifier |
| | LINKID | Logical network link identifier |
| | NETYEAR | Planning year of network link |
| | SHAPE_LENGT | Geometry length of network link (in feet) |
| | PROJECTID | Project identifier |

Table 3-5 : Highway node file description

| File Name | Variable Name | Description |
|-----------|---------------|---|
| Node.dbf | N | Highway Node Number |
| | X | X - Coordinates (NAD83-based in whole feet) |
| | Y | Y- Coordinates (NAD83-based in whole feet) |

Road attributes that may vary by time of day are represented by two sets of link attributes named <prd>lane and <prd>limit, where <prd> is “AM”, “PM”, and “OP.” The lane attribute describes the number of effective through lanes in operation during the period. The limit attribute assigns special market prohibitions that exist during a given time period. The limit prohibitions indicate 1) whether the directional link is available to traffic during the period or 2) whether link is available to certain markets during specific time periods or during the entire day. In many cases, lane coding is related to limit coding. The limit codes currently used by the model are presented in Table 3-6.

Table 3-6: Limit codes

| Limit Code | Vehicles Allowed | Vehicles Disallowed |
|------------|-------------------------------------|----------------------------|
| 0 | All Vehicles | No Vehicles |
| 2 | HOV 2+ Occ. Vehicles | 1-Occ. Vehicles, Trucks |
| 3 | HOV 3+ Occ. Vehicles | 1, 2 Occ. Vehicles, Trucks |
| 4 | All Vehicles, other than trucks | Trucks |
| 5 | Airport Passenger Auto Driver Trips | All other Vehicles |
| 9 | Transit Only | All other Vehicles |

Limit and lane codes are used to reflect changes in directional-lane configurations, a variety of HOV operations, and truck prohibitions (primarily on parkways). Limit coding is also used to identify “Transit Only” links (limit code = 9), which are used to more accurately depict transit route coding relative to zone centroids. These types of links are excluded from the highway assignment process because they are below the grain of both the zone system and the roadways included in the networks.

The third input file to AreaType_File.s (Figure 3-4) is a file that allows one to make an override of an area type value (AT_override.txt). For example, the area-type of the TAZ containing The Pentagon might be calculated as a 3 (“Medium employment density”), but one could override this value with a 1 (“High mixed employment and population density”). More details can be found in the travel model user’s guide.

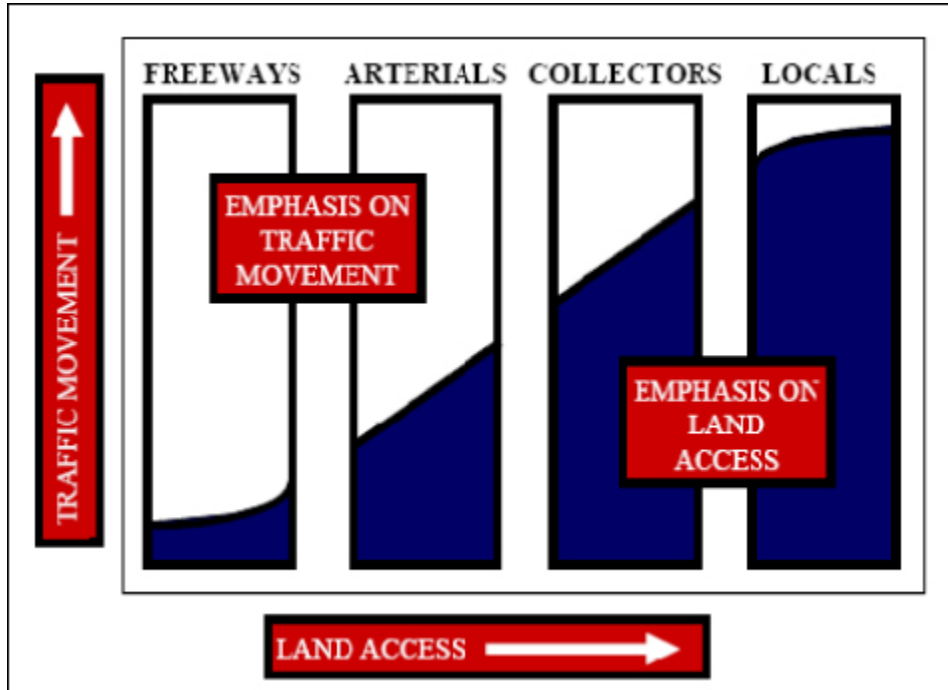
3.2.3 Roadway functional classification and the facility-type variable

Roads/highways are typically classified into a hierarchical system that indicates their design and the type of traffic they are designed to serve. The classic hierarchy is

- Freeways
- Arterials
- Collectors
- Local roads

Higher level roads, such as freeways, have an emphasis on mobility and traffic movement. Lower level roads, such as collectors and local roads, have an emphasis on land access. This continuum is shown graphically in Figure 3-5.

Figure 3-5 Classification of roads and their emphasis on mobility and access



Source: ¹²

Figure 3-6 shows examples of the different types of roads.

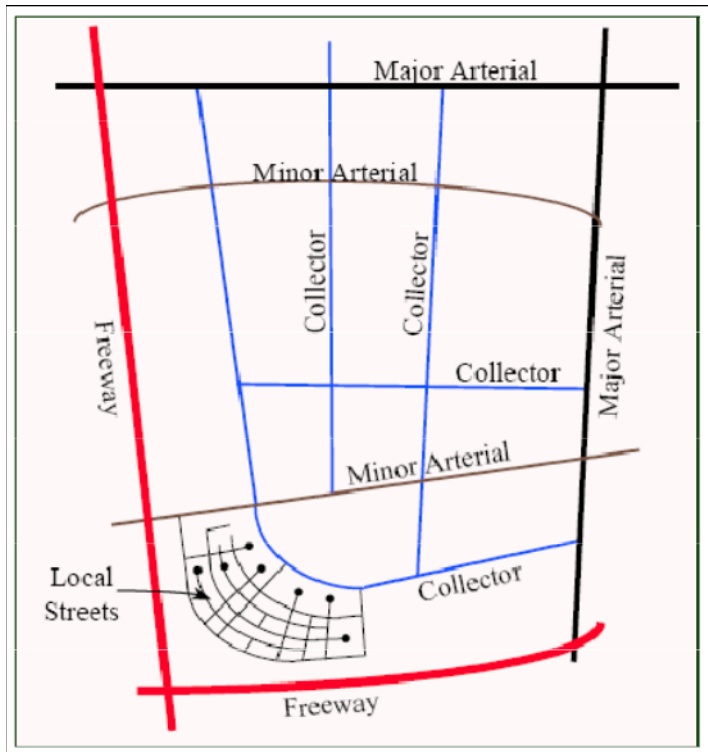
In COG/TPB highway networks, the facility-type (FTYPE) code is used to designate the hierarchy of road types. Facility-type codes are defined as:

- 0: centroid connectors;
- 1: freeways;
- 2: major arterials;
- 3: minor arterials;
- 4: collectors;
- 5: expressways; and
- 6: freeway and expressway ramps

The highest-class roads in TPB networks are freeways (FTYPE=1) and expressways (FTYPE=5). The lowest-class roads in TPB networks are collectors (FTYPE=4). Note that local roads are not typically part of TPB networks, but each centroid connector represents one or more local roads that are not explicitly represented.

¹² BLF Marketing, Wilbur Smith Associates, Inc., and RKG Associates, Inc., “Clarksville SMART GROWTH Plan – 2030: A Blueprint for Progress and Quality ... as We Grow to 250,000 Residents” (Clarksville, Tennessee, July 23, 2010), chap. 3, <http://www.clarksvillesmartgrowth.com/Sec3-TransportationAnalysis.htm>.

Figure 3-6 Example of different types of roads



Source: ¹³

The facility type (FTYPE) attribute is used in conjunction with an area-type indicator (ATYPE) which is used to establish modeled free-flow speeds and hourly capacity.

The federal government has its own classification scheme, called the federal functional classification system.¹⁴ While there is a correlation between TPB facility-type codes and the federal functional classification system, there are numerous exceptions. For example, facilities categorized as freeways in the federal system may be coded as expressways in the TPB network, or expressways in the federal system may be coded as freeways. These types of classification adjustments are ultimately made to ensure that the facility use and operation is accurately represented in the travel model. It should also be noted that the “ramp code” (FTYPE=6) was added to the facility code list in FY 2003 so that ramp-related VMT and emissions could be summarized from the travel model at the regional level. Ramp-type facilities in the TPB networks are associated with the same speed and capacity characteristics as freeway and expressway facilities.

¹³ Ibid.

¹⁴ “Highway Functional Classification Concepts, Criteria and Procedures” (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 2013), http://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/fcauab.pdf.

3.2.4 Other link attributes

Modeled link free-flow speeds and capacities are based on the facility type and an area type (ATYPE) variable. The area type identifies, in broad terms, the level of land development around each highway link. The area type variable is not included in the link.dbf file, but rather, is dynamically generated during the highway network building process:

- In the AreaType_File.s script, a “1-mile floating” land use density is computed for each TAZ. The floating density for a given TAZ equals the accumulated land activity of the TAZ, plus the land activity of all proximate TAZs within a one-mile radius, divided by the similarly accumulated land area. Floating population and floating employment figures are computed for each TAZ. The one mile radius is evaluated based strictly on centroid positioning;
- Each TAZ is assigned an area type (integer) value of 1 to 6 based on the joint population and employment density ranges defined in Table 3-7; The names of the six area types, as well as examples of each type, can be found in Table 3-8.
- The mid-point of each highway link is evaluated against all TAZ centroid positions. Each link is then assigned the area type value associated with the nearest TAZ.

Table 3-7 Area-type codes, from 1 to 7, based on population and employment density

| One-Mile “Floating” Population Density (Pop/Sq mi) | One- mile “Floating” Employment Density (Emp/Sq mi) | | | | | | |
|---|---|---------|-----------|-----------------|------------------|-------------------|---------|
| | 0-100 | 101-350 | 351-1,500 | 1,501- 3,550 | 3,551- 13,750 | 13,751- 15,000 | 15,001+ |
| 0-750 | 6 | 6 | 5 | 3 | 3 | 3 | 2 |
| 751-1,500 | 6 | 5 | 5 | 3 | 3 | 3 | 2 |
| 1,501-3,500 | 6 | 5 | 5 | 3 | 3 | 2 | 2 |
| 3,501-6,000 | 6 | 4 | 4 | 3 | 2 | 2 | 1 |
| 6,001-10,000 | 4 | 4 | 4 | 2 | 2 | 2 | 1 |
| 10,000-15,000 | 4 | 4 | 4 | 2 | 2 | 2 | 1 |
| 15,001+ | 2 | 2 | 2 | 2 | 2 | 1 | 1 |

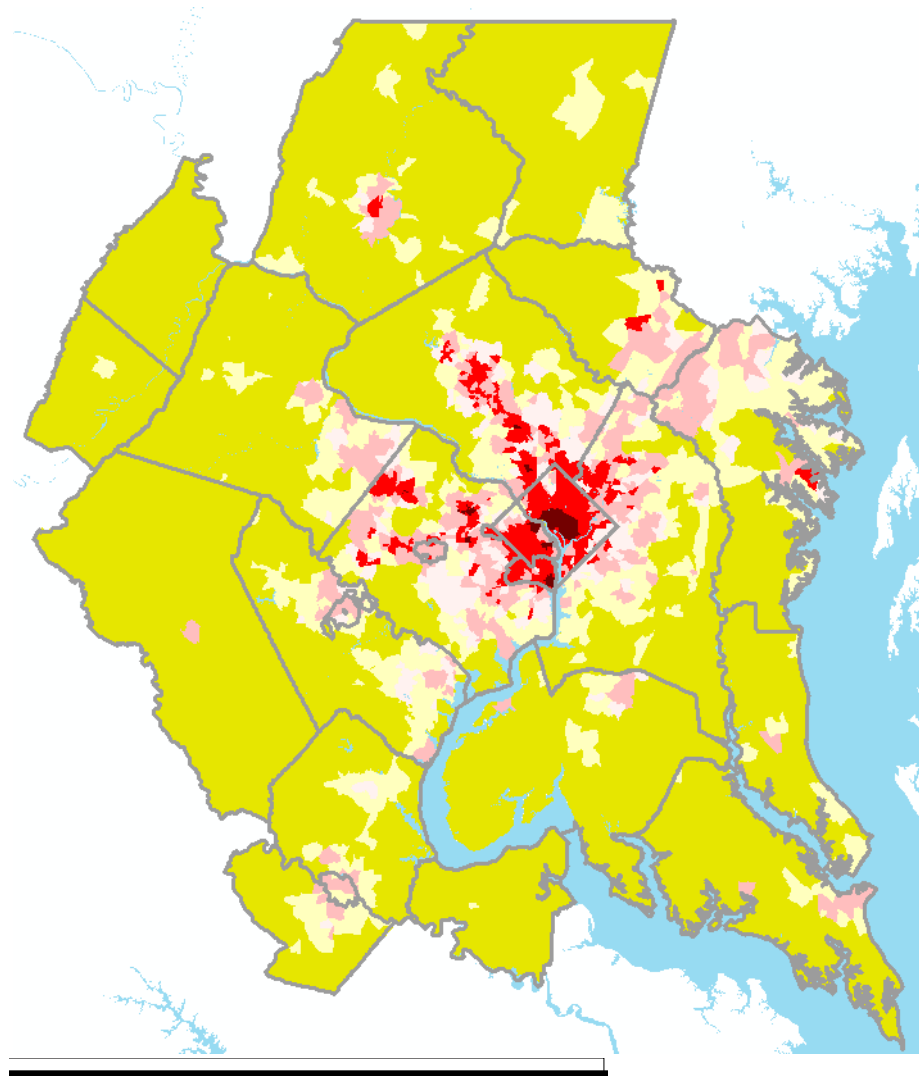
Table 3-8 The six area-type codes and examples of each area type

| Area Type | Name | Examples |
|-----------|--|---|
| 1 | High mixed employment and population density | <ol style="list-style-type: none"> 1. Downtown DC, between Georgetown, Florida Ave., and 11th St. NE & SE 2. Old Town Alexandria 3. The Rosslyn/Court House area of Arlington Co. 4. Pentagon City area of Arlington Co. 5. Downtown Bethesda, Maryland 6. Center of Tysons Corner, Virginia |
| 2 | Medium/high mixed density | <ol style="list-style-type: none"> 1. Most DC outside the downtown core 2. Most Arlington Co., south of Lee Highway 3. Most Alexandria 4. Areas of Tysons Corner just beyond the center 5. Annapolis, Maryland 6. Downtown Frederick, Maryland 7. Parts of Reston and Herndon, Virginia, along the Dulles Access/Toll Road |
| 3 | Medium employment density | <ol style="list-style-type: none"> 1. Parts of upper NW DC near Rock Creek Park 2. Parts of Arlington along Lee Highway 3. National Airport 4. The Pentagon 5. Arlington Cemetery 6. BWI Airport 7. Potomac Mills mall in Woodbridge, Virginia |
| 4 | Medium population density | <ol style="list-style-type: none"> 1. Parts of upper NW DC near Rock Creek Park 2. Parts of north Arlington 3. SE DC near the Capitol Heights Metrorail station 4. Chevy Chase, Maryland, near the DC border |
| 5 | Low density | <ol style="list-style-type: none"> 1. Area along McArthur Boulevard in DC 2. Upper north Arlington Co. 3. Fort Hunt section of Fairfax Co. 4. Dulles Airport 5. Andrews Air Force Base |
| 6 | Rural | <ol style="list-style-type: none"> 1. Great Falls, Virginia 2. Much of Loudoun Co., Virginia 3. Most of Fauquier Co., Virginia 4. Much of Charles, St. Mary's, and Calvert Counties, Maryland 5. Most of Frederick and Carroll Co., Maryland |

Note that the Pentagon and Arlington Cemetery are area type 3 (“medium employment density”). This is due to the use of the one-mile floating density. Arlington Cemetery should probably be categorized as “rural” (area type 6) and the Pentagon should probably be area type 2 (“medium/high mixed density”). These, and other similar cases, could be reset using the area-type override capability that currently exists in the travel model.

A map of the six area types can be found in Figure 3-7.

Figure 3-7 Map of the six area types



3.2.5 Toll Parameter File

The Washington, D.C. region includes several tolled highway facilities that vary substantially in tolling policy. On some facilities, such as the Dulles Toll Road or the Governor Nice Bridge, toll values are fixed and are not a function of the time of day or day of the week. On other facilities, toll rates can vary throughout the day, either set in advance, with “fixed” tolls that vary by specific times of the day, or set dynamically, as a function of real-time congestion levels. The Intercounty Connector (ICC), between Prince George’s County and Montgomery County, is an example of a facility where fixed toll rates vary by hour of the day, according to a schedule that has been set in advance. The high-occupancy/toll (HOT) lanes on I-495, known as the I-495 Express Lanes, are an example of a toll facility where the toll rates are

set dynamically, as a function of congestion levels. TPB staff reviews the tolling policy of private and publically operated facilities each year and strives to produce reasonably representative toll values for each time-of-day period.¹⁵

There are two cost-related variables in the link.dbf file that allow the user to flexibly specify tolls in the network: the *TOLL* and *TOLLGRP* variables. The **TOLL** variable is a monetary value of the fee charged to traverse the link. The network database contains tolls for each year, up to the current year. This allows the user to produce a year-2016 network, for instance, that would contain the tolls as they were in 2016. For forecast years, the network contains the current year’s tolls in current-year cents. **TOLLGRP** is a variable that is used to identify tolling locations in the network. A TOLLGRP code of 1 identifies existing facilities where fixed-rate tolls are collected at specific locations. The Dulles Toll Road (VA 267) is an example of this. A TOLLGRP code of 2 identifies links on the ICC. A TOLLGRP code of 3 or greater identifies links on a variably priced facility, such as the I-495 Express Lanes. The TOLLGRP rates are specified in the toll parameter/escalation file (*TOLL_ESC.dbf*). Table 3-8 lists the specific variables in the file.

Table 3-9 Toll parameter file (*Toll_esc.dbf*)

| Variable Name | Description |
|---------------|---|
| Tollgrp | Toll group code, 1=existing fixed-toll facility, 2=ICC, 3+= VA HOT lane |
| Escfac | Deflation factor override |
| Dstfac | Distance (per mile)-based toll factor in current-year cents/dollar (optional) |
| AM_Tftr | AM period Toll factor (no units) |
| PM_Tftr | PM period toll factor (no units) |
| OP_Tftr | Off-peak period toll factor (no units) |
| AT_Min | Area Type minimum override (optional) |
| AT_Max | Area Type maximum override (optional) |
| TollType | <i>Toll Type (1=operating in calibration year, 2= operating after calibration year)</i> |

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The file contains a base distance-based toll factor (*DSTFAC*), in cents/mile, and time-period-specific variables (e.g., *AM_TFTR* and *PM_TFTR*) that allow one to transform distance-based factors to time-period-specific toll rates. Except for the case where *TOLLGRP* = 1, the *TOLL* and *TOLLGRP* factors should not be invoked together. If the *TOLL* value of a given link is non-zero and the *TOLLGRP* value equals zero, the highway network building process automatically imposes a *TOLLGRP* override value of “1”. *TOLLGRP* codes that are used should therefore be greater than “1.”

The highway building process ultimately creates six period-specific toll attributes: *AMTOLL*, *PMTOLL*, *OPTOLL* (tolls by time-of-day on all toll facilities) and *AMTOLL_VP*, *PMTOLL_VP*, *OPTOLL_VP* (tolls by time-of-day on variable priced facilities only). Four toll facilities are modeled in base-year highway

¹⁵ See, for example, Jane Posey to Files, “2016 CLRP Toll Rates,” Memorandum, (January 11, 2017).

networks: the ICC, the Dulles Toll Road (VA 267), the Dulles Greenway, and the Harry W. Nice Memorial Bridge (between Charles County, Maryland and King George County, Virginia).

Figure 3-7 shows tolling locations on the Dulles Toll Road. Current and past year's toll value updates are reflected in the network database. In the 2016 CLRP network database, all forecast year networks reflect year 2016 toll values as shown in Table 3-9.

Note that in this table, the nominal toll rate is fixed at the year-2016 value through 2020, which implies that real tolls (prices) are dropping from 2016 to 2020.

Figure 3-8 Dulles Toll Road: Toll facilities locations

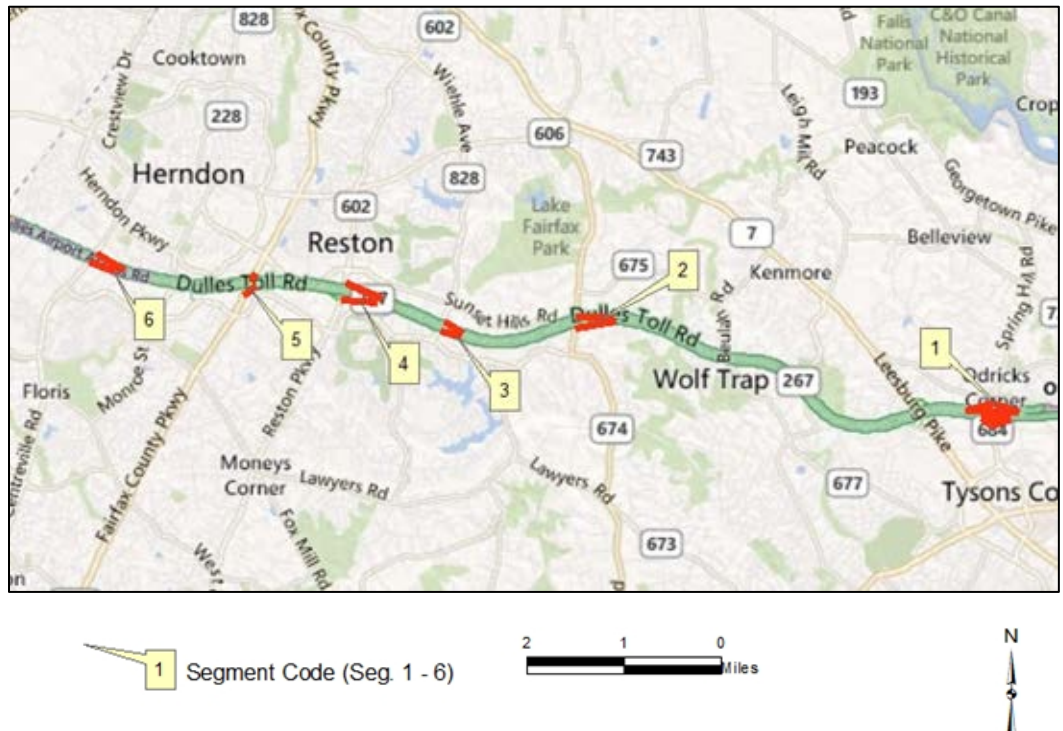


Table 3-10 Dulles Toll Road (VA 267): Toll inks

| Segment | A | B | Location | Direction | Toll Values (in 2016 cents) |
|---------|-------|-------|--|-------------------------------------|-----------------------------|
| | | | | | 2016 |
| 1 | 35130 | 35133 | Main Toll Plaza-Rt 684 Interchange (LOV) | Inbound | 250 |
| | 35136 | 35129 | Main Toll Plaza-Rt 684 Interchange (LOV) | Outbound | 250 |
| | 35430 | 36657 | Greensboro Dr at Tyco Rd | Inbound | 100 |
| | 36657 | 35129 | Greensboro Dr at Tyco Rd | Outbound | 100 |
| | 35130 | 35132 | Spring Hill Road- Off Ramp | Inbound | 100 |
| | 35132 | 35133 | Spring Hill Road- On Ramp | Inbound | 100 |
| | 35136 | 35131 | Spring Hill Road- Off Ramp | Outbound | 100 |
| | 35131 | 35129 | Spring Hill Road- On Ramp | Outbound | 100 |
| | 2 | 35097 | 35096 | Rt 674 (Hunter Mill Road) - On Ramp | Inbound |
| 35194 | | 35095 | Rt 674 (Hunter Mill Road) - Off Ramp | Outbound | 100 |
| 3 | 35101 | 35100 | Rt 828 (Wiehle Avenue)- On Ramp | Inbound | 100 |
| | 35196 | 35099 | Rt 828 (Wiehle Avenue)- Off Ramp | Outbound | 100 |
| 4 | 35105 | 35104 | Rt 602 (Reston Pkwy)-On Ramp | Inbound | 100 |
| | 35198 | 35103 | Rt 602 (Reston Pkwy)-Off Ramp | Outbound | 100 |
| 5 | 35287 | 35291 | Rt 7100 (Fairfax Co. Pkwy)- On Ramp | Inbound | 100 |
| | 35289 | 35286 | Rt 7100 (Fairfax Co. Pkwy)- Off Ramp | Outbound | 100 |
| 6 | 35109 | 35108 | Rt 228 (Centreville Road) -On Ramp | Inbound | 100 |
| | 35200 | 35107 | Rt 228 (Centreville Road) -Off Ramp | Outbound | 100 |

Note: Toll rates effective January 1, 2014. Year 2016 toll values are used for all forecast years.

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The 14-mile Dulles Greenway connects to the Dulles Toll Road at Route 28 (at Dulles International Airport), and extends west to Route 15 at Leesburg, as shown in Figure 3-8 and Figure 3-9. Dulles Greenway tolls (shown in Table 3-10, for segments 1-4, and Table 3-11, for segments 5-8) are coded in highway networks based on a weighted average of the cash rates, E-ZPass rates, and congestion-management tolling. Survey data indicate that the E-ZPass markets account for roughly three-fourths of users and that about half the travel occurs during the times when the congestion-management tolls are in effect. The main toll facility is represented west of the Route 28 (Sully Road) interchange with a weighted toll of \$5.88 in 2016 and beyond. A weighted toll of \$4.88 in 2016 and beyond is used for all westbound and eastbound on-ramps at Routes 28, 606, and 607. A weighted toll of \$4.08 in 2016 and beyond is coded for all westbound and eastbound on-ramps at Routes 772, Claiborne Parkway, and Belmont Ridge Road. A weighted toll of \$3.20 in 2016 and beyond is coded for all on-ramps at Route 653. No toll is charged at the future Battlefield Parkway interchange.

Figure 3-9 Dulles Greenway: Toll facilities locations (Map 1 of 2)

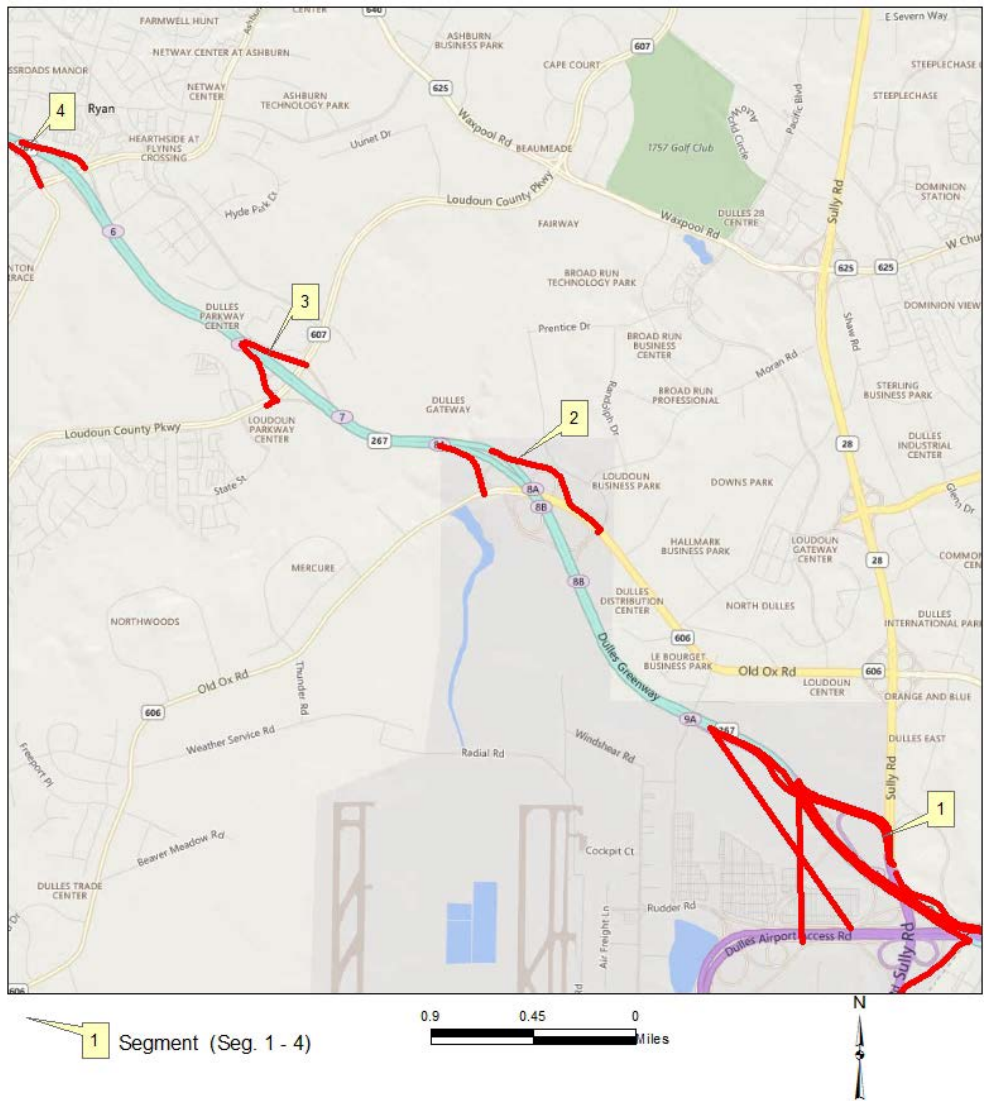


Table 3-11 Dulles Greenway Toll inks (Segments 1-4)

| Seg | Anode | Bnode | Location | Direction | Toll Values (in 2016 cents) | |
|-----|-------|-------|---|-----------|-----------------------------|-----|
| | | | | | 2016 | |
| 1 | 38046 | 38098 | Rt. 28 | Outbound | | 588 |
| | 38266 | 34810 | Rt. 28 | Inbound | | 588 |
| | 38025 | 34810 | Rt. 28 Toll Plaza on- Ramp | Inbound | | 100 |
| | 38046 | 38018 | Rt. 28 Toll Plaza off- Ramp | Outbound | | 100 |
| | 38064 | 38098 | Rt. 28 to Dulles Greenway on-Ramp | Outbound | | 488 |
| | 38266 | 38064 | Dulles Greenway to Rt. 28 off-Ramp | Inbound | | 488 |
| | 38043 | 38098 | Airport Access road to Dulles Greenway on- Ramp | Outbound | | 488 |
| | 38266 | 38047 | Dulles Greenway to Airport Access road off Ramp | Inbound | | 488 |
| 2 | 38029 | 38271 | Rt 606 (Old Ox Road) on-Ramp | Outbound | | 488 |
| | 38272 | 38273 | Rt 606 (Old Ox Road) off-Ramp | Inbound | | 488 |
| 3 | 38100 | 38276 | Rt 607 (Loudoun Co. Pkwy) on-Ramp | Outbound | | 488 |
| | 38277 | 38278 | Rt 607 (Loudoun Co. Pkwy) off-Ramp | Inbound | | 488 |
| 4 | 38065 | 38281 | Rt 772 (Old Ryan Rd) on-Ramp | Outbound | | 408 |
| | 38282 | 38283 | Rt 772 (Old Ryan Rd) off-Ramp | Inbound | | 408 |

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Figure 3-10 Dulles Greenway: Toll facilities locations (Map 2 of 2)

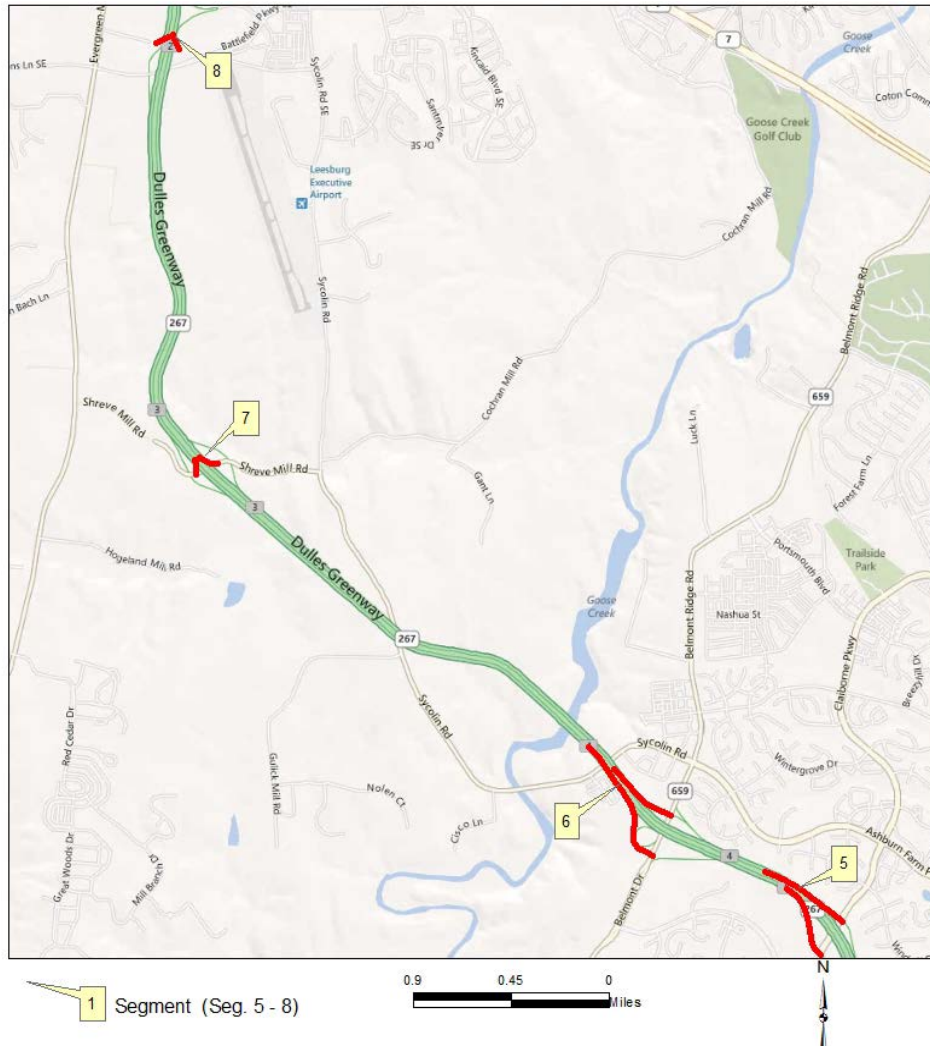


Table 3-12 Dulles Greenway Toll links (Segments 5-8)

| Seg | Anode | Bnode | Location | Direction | Toll Values (in 2016 cents) | |
|-----|-------|-------|-----------------------------|-----------|-----------------------------|--|
| | | | | | 2016 | |
| 5 | 38069 | 38289 | Claiborn Pkwy on-Ramp | Outbound | 408 | |
| | 38290 | 38291 | Claiborn Pkwy off-Ramp | Inbound | 408 | |
| 6 | 38070 | 38294 | Belmont Ridge Road on-Ramp | Outbound | 408 | |
| | 38295 | 38296 | Belmont Ridge Road off-Ramp | Inbound | 408 | |
| 7 | 38071 | 38299 | Shreve Mill Road on-Ramp | Outbound | 320 | |
| | 38300 | 38301 | Shreve Mill Road off-Ramp | Inbound | 320 | |
| 8 | 38072 | 38304 | Battlefield Pkwy on-Ramp | Outbound | na | |
| | 38305 | 38306 | Battlefield Pkwy off-Ramp | Inbound | na | |

Note: Toll rates effective June 2016. Year 2016 toll values are used for all forecast years.

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Table 3-12 shows that a weighted (E-ZPass vs. cash) toll of \$2.41 is coded on the Harry W. Nice Bridge, in both directions, on the forecast-year network links.

Table 3-13 Harry W. Nice Bridge toll links

| A | B | Location | Direction | Toll Values (in 2016 cents) |
|--|-------|---------------------|-----------|-----------------------------|
| | | | | 2016 |
| 50002 | 50001 | Virginia - Maryland | Inbound | 241 |
| 50001 | 50002 | Maryland - Virginia | Outbound | 241 |
| Note: Toll rates effective July 1, 2015. Year 2016 toll values are used for all forecast years. | | | | |

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Starting in 2012, the Intercounty Connector (ICC) in Maryland was included in all networks representing the year 2012 and beyond. HOT lane operations on I-95/I-395 between Turkeycock Run in Fairfax County and VA 610 (Garrisonville Road) in Stafford County are included in all networks representing 2015 and beyond. The I-395 HOV lanes from Turkeycock Run to Eads Street convert to HOT in 2019 and beyond. HOV/HOT lanes on I-95 between VA 610 and VA 17 in Spotsylvania County are in all networks representing 2025 and beyond. On I-495 (Capital Beltway) in Virginia HOT lane operations are included as follows:

- Beginning in 2013: From Hemming Avenue to south of Old Dominion Drive;
- Beginning in 2025: From south of Old Dominion Drive to the George Washington Parkway;
- Beginning in 2030: From the George Washington Parkway to the American Legion Bridge.

The HOV lanes on I-66 inside the Beltway convert to HOT lanes in 2017 and beyond. HOT lanes on I-66 outside the Beltway to University Boulevard are included in all networks starting 2012, and from University Boulevard to 1.2 miles west of US 15 in 2040.

As discussed earlier in this chapter, in the COG/TPB highway networks, the toll group variable (TOLLGRP) indicates the type of tolling on the facility. TOLLGRP code 1 is assigned for existing tolled facilities (Dulles Toll Road, Dulles Greenway and the Harry W. Nice Bridge). The ICC in Maryland is modeled as TOLLGRP code 2 with fixed toll values of 22 cents/mile during peak periods and 17cents/mile during off-peak periods (in 2016 cents). For all other tolled facilities, the TOLLGRP code varies and is used to develop variably priced tolls.

For the variably priced HOT lane facilities, I-95/I-395 and I-495 Capital Beltway, in Virginia, the network link toll value (TOLL) is left blank and the toll facility type variable (TOLLGRP) is used to access lookup tables of fixed fees and per-mile rates. The tolls vary based on the level of congestion. TOLLGRP codes 3-39 are used for I-495 as shown in Table 3-13. TOLLGRP codes 60-138 are used for I-95/I-395. The values for the HOT lanes on I-395 from Turkey Cock Run to Eads Street, which were added as a new project in the 2016 CLRP, are shaded in gray in Table 3-14. In the 2016 CLRP, the facility goes from VA 17 in Spotsylvania County (exit 126) to Eads St. Toll values (in 2016 cents), by time period and direction for I-495 (Capital Beltway) and I-95/I-395 HOT lanes, are displayed in Table 3-13 and Table 3-14 respectively.

Table 3-14 Toll values on I-495 Capital Beltway in Virginia (in 2016 cents) - 2016 CLRP

| North bound HOT Lane Segment | Toll Group | Distance (in mile) | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
|--|---------------|-----------------------|------|----|----|------|----|----|------|----|----|------|----|----|------|-----|----|------|-----|----|
| | | | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| Hemming Ave. --> VA 620 (Braddock Rd) | 7 | 0.17 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| At VA 620 | 9 | 0.84 | 17 | 17 | 13 | 17 | 17 | 13 | 17 | 17 | 13 | 17 | 17 | 13 | 17 | 17 | 13 | 17 | 17 | 13 |
| VA 620 --> VA 650 (Gallows Rd.) | 11 | 2.97 | 59 | 59 | 45 | 59 | 59 | 45 | 59 | 59 | 45 | 59 | 59 | 45 | 59 | 59 | 45 | 59 | 59 | 45 |
| VA 650 --> US 29 (Lee Highway) | 13 | 1.16 | 104 | 23 | 17 | 104 | 23 | 17 | 104 | 46 | 17 | 104 | 58 | 17 | 128 | 70 | 17 | 174 | 81 | 17 |
| US 29 --> I-66 | 15 | 0.35 | 7 | 7 | 5 | 7 | 7 | 5 | 7 | 7 | 5 | 7 | 7 | 5 | 7 | 7 | 5 | 7 | 7 | 5 |
| At I-66 | 17 | 0.59 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 |
| N. of I-66 --> VA 7 (Leesburg Pike) | 19 | 1.40 | 112 | 28 | 21 | 56 | 28 | 21 | 42 | 28 | 21 | 98 | 28 | 21 | 168 | 28 | 21 | 224 | 28 | 21 |
| VA 7 --> S. of VA 123 (Chain Bridge Rd) | 21 | 0.95 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 |
| At VA 123 | 23 | 0.11 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| VA 123 --> S. of VA 267 (Dulles Toll Rd) | 25 | 0.20 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 |
| S. of VA 267 | 27 | 0.15 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 |
| At VA 267 | 29 | 0.58 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 | 12 | 12 | 9 |
| N of VA 267 --> VA 738 (old Dominion Dr) | 31 | 0.81 | 16 | 16 | 12 | 16 | 16 | 12 | 16 | 16 | 12 | 16 | 16 | 12 | 16 | 16 | 12 | 16 | 16 | 12 |
| VA 738 --> VA 193 (George Town Pike) | 33 | 0.52 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 10 | 10 | 8 | 10 | 10 | 8 | 10 | 10 | 8 |
| At VA 193 | 35 | 0.68 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 14 | 14 | 10 | 14 | 14 | 10 | 14 | 14 | 10 |
| N of VA 193 --> GW Pkwy | 37 | 0.22 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 |
| GW Pkwy --> American Legion Brdg. | 39 | 0.79 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 111 | 103 | 12 | 142 | 142 | 12 |

| South bound HOT Lane Segment | Toll Group | Distance (in mile) | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
|---|---------------|-----------------------|------|-----|----|------|----|----|------|----|----|------|-----|-----|------|-----|-----|------|-----|----|
| | | | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| American Legion Brdg. --> GW Pkwy | 4 | 0.78 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 109 | 117 | 12 | 187 | 140 | 12 | |
| GW Pkwy --> N. of VA 193 (George Town Pike) | 6 | 0.40 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 8 | 6 | 8 | 8 | 6 | 8 | 8 | 6 |
| VA 193 --> VA 738 (old Dominion Dr) | 8 | 1.03 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 21 | 21 | 15 | 21 | 21 | 15 | 21 | 21 | 15 |
| VA 738 --> VA 694 (Lewinsville Rd) | 10 | 0.70 | 14 | 14 | 11 | 14 | 14 | 11 | 14 | 14 | 11 | 14 | 14 | 11 | 14 | 14 | 11 | 14 | 14 | 11 |
| VA 694 --> N of VA 267 (Dulles Toll Rd) | 12 | 0.18 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 |
| At VA 267 | 14 | 0.57 | 11 | 11 | 9 | 11 | 11 | 9 | 11 | 11 | 9 | 11 | 11 | 9 | 11 | 11 | 9 | 11 | 11 | 9 |
| S. of VA 267 | 16 | 0.12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| VA 267 --> VA 123 (Chain Bridge Rd) | 18 | 0.20 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3 |
| At VA 123 | 20 | 0.12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| VA 123 --> VA 7 (Leesburg Pike) | 22 | 0.96 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 | 19 | 19 | 14 |
| VA 7 --> N. of I-66 | 24 | 1.52 | 30 | 137 | 23 | 30 | 76 | 23 | 30 | 61 | 23 | 30 | 167 | 23 | 30 | 137 | 23 | 30 | 182 | 23 |
| At I-66 | 26 | 0.44 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 |
| I-66 --> US 29 (Lee Highway) | 28 | 0.43 | 9 | 9 | 6 | 9 | 9 | 6 | 9 | 9 | 6 | 9 | 9 | 6 | 9 | 9 | 6 | 9 | 9 | 6 |
| US 29 --> VA 650 (Gallows Rd.) | 30 | 1.17 | 23 | 59 | 18 | 23 | 59 | 18 | 23 | 59 | 18 | 23 | 59 | 18 | 23 | 94 | 18 | 23 | 129 | 18 |
| VA 650 --> N. of VA 620 (Braddock Rd) | 32 | 2.77 | 55 | 55 | 42 | 55 | 55 | 42 | 55 | 55 | 42 | 55 | 55 | 42 | 55 | 55 | 42 | 55 | 55 | 42 |
| At VA 620 | 34 | 1.00 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 |
| VA 620 --> Hemming Ave. | 36 | 0.04 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

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Starting year 2017, I-66 inside the Capital Beltway (from US Rt. 29 in Rosslyn to I-495) will be converted from an HOV facility to an HOT facility. Vehicles with two or more occupants will be free in the peak period, while others pay a toll. In 2021 the occupancy requirement will increase to three or more to avoid the toll. In 2040 the facility will be HOV3+ in both directions in the peak periods.

In all networks representing the year 2017 and beyond, on I-66 inside the Beltway, TOLLGRP codes of 200-210 (East/inbound) and TOLLGRP codes of 220-229,250 (West/outbound) are used. Table 3-15 displays toll values (in 2016 cents) summarized by segment, time period and direction for I-66 inside the Capital Beltway. Figure 3-10 shows I-66 inside the Capital Beltway.

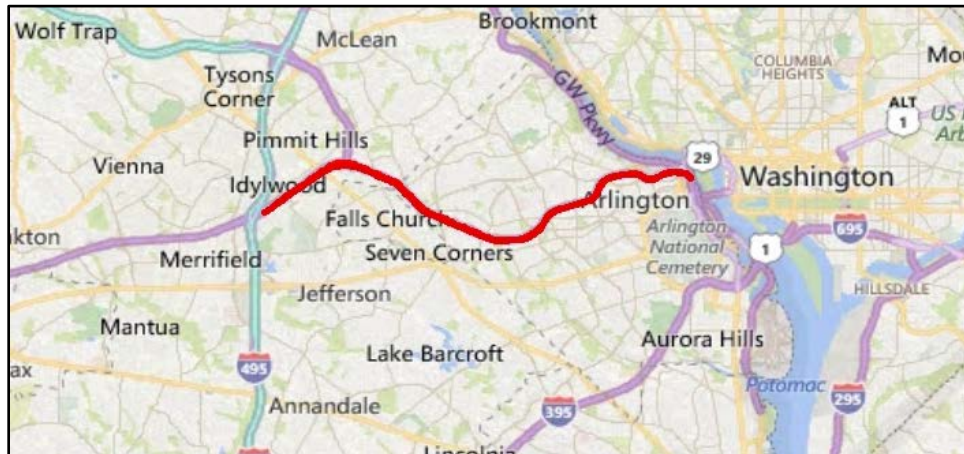
Table 3-16 Toll values on I-66 Inside the Capital Beltway (in 2016 cents) - 2016 CLRP

| I-66 Inside the Beltway: East bound | | | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
|--|------------|--------------------|------|----|----|------|----|----|------|----|----|------|----|----|------|----|----|------|----|----|
| HOT Lane Segment | Toll Group | Distance (in mile) | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| I-495 ~Leesburg Pike (VA 7) | 200 - 201 | 1.59 | NA | NA | NA | 32 | 32 | 24 | 32 | 32 | 24 | 32 | 32 | 24 | 36 | 32 | 24 | 51 | 32 | 24 |
| VA 7 ~ Dulles Toll Road (VA 267) | 202 | 0.30 | NA | NA | NA | 6 | 6 | 5 | 51 | 6 | 4 | 99 | 6 | 5 | 96 | 6 | 5 | 87 | 6 | 4 |
| VA 267 ~ North Sycamore | 203 - 205 | 2.01 | NA | NA | NA | 221 | 40 | 30 | 61 | 40 | 30 | 82 | 40 | 30 | 98 | 40 | 30 | 144 | 40 | 30 |
| North Sycamore ~ North Glebe Road (VA 120) | 206 - 207 | 2.60 | NA | NA | NA | 657 | 52 | 39 | 194 | 52 | 39 | 227 | 52 | 39 | 246 | 52 | 39 | 331 | 52 | 39 |
| VA 120 ~ Lee Highway (US 29) | 208 - 209 | 1.86 | NA | NA | NA | 74 | 37 | 28 | 223 | 37 | 28 | 212 | 37 | 28 | 242 | 37 | 28 | 260 | 37 | 28 |
| US 29 ~ Jefferson Davis Hwy | 210 | 0.97 | NA | NA | NA | 19 | 19 | 15 | 19 | 19 | 15 | 19 | 19 | 15 | 19 | 19 | 15 | 29 | 19 | 15 |

| I-66 Inside the Beltway: West bound | | | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
|--|------------|--------------------|------|----|----|------|-----|----|------|-----|----|------|-----|----|------|-----|----|------|-----|----|
| HOT Lane Segment | Toll Group | Distance (in mile) | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| Jefferson Davis Hwy ~ Lee Highway (US 29) | 220 | 0.99 | NA | NA | NA | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 20 | 15 | 20 | 30 | 15 |
| US 29 ~ North Glebe Rd (VA120) | 221 - 222 | 1.86 | NA | NA | NA | 37 | 990 | 28 | 37 | 219 | 28 | 37 | 148 | 28 | 37 | 158 | 28 | 37 | 209 | 28 |
| VA 120 ~ North Sycamore St. | 223 - 224 | 2.60 | NA | NA | NA | 52 | 52 | 39 | 52 | 68 | 39 | 52 | 91 | 39 | 52 | 101 | 39 | 52 | 260 | 39 |
| North Sycamore St. ~ Dulles Toll Rd (VA 267) | 225 - 226 | 1.90 | NA | NA | NA | 38 | 665 | 28 | 38 | 533 | 28 | 38 | 278 | 28 | 38 | 293 | 28 | 38 | 72 | 28 |
| VA 267 ~ Leesburg Pike (VA 7) | 227 | 0.46 | NA | NA | NA | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | 23 | 7 |
| VA 7 ~ Capital Beltwy (I-495) | 228 - 229 | 1.27 | NA | NA | NA | 26 | 150 | 19 | 26 | 119 | 19 | 26 | 182 | 19 | 26 | 166 | 19 | 26 | 174 | 19 |
| At I-495 | 250 | 0.70 | NA | NA | NA | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 11 | 14 | 14 | 11 | 14 | 14 | 11 |

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Figure 3-11 I-66 inside the Capital Beltway: Express Lane Facility



Starting year 2021, I-66 outside the Capital Beltway (from I-495 to west of US Rt. 15 in Prince William County, 25 miles) will be converted to 3 general purpose lanes and 2 managed HOT lanes in each direction, with tolling at all times.

In all networks representing the year 2021 and beyond, on I-66 outside the Beltway, TOLLGRP codes of 300-344 (West/outbound) and TOLLGRP codes of 345-390 (East/inbound) are coded on each link. Table 3-16 displays toll values (in 2016 cents) summarized by segments, time period and direction for I-66 outside the Capital Beltway. Figure 3-11 shows the express lane facility on I-66 outside the Beltway.

Table 3-17 Toll values on I-66 Outside the Capital Beltway (in 2016 cents) - 2016 CLRP

| I-66 Outside the Beltway: East bound | | Toll Group | Distance (in mile) | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
|---|--|------------|--------------------|------|----|----|------|----|----|------|----|-----|------|----|-----|------|----|-----|------|----|----|
| HOT Lane Segment | | | | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| Antioch Access ~ Avens Creek Dr. | | 393 - 394 | 0.36 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 7 | 6 | | |
| Avens Creek Dr. ~ US 15 | | 345 - 346 | 1.22 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 24 | 24 | 18 | | |
| US 15 ~ US 29 | | 347 - 351 | 2.82 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 56 | 56 | 43 | | |
| US 29 ~ PW County Pkwy (VA 234) | | 352 - 355 | 0.86 | NA | NA | NA | NA | NA | NA | NA | NA | 13 | 13 | 10 | 13 | 13 | 10 | 36 | 17 | 13 | |
| VA 234 ~Sudely Road | | 356 - 359 | 3.09 | NA | NA | NA | NA | NA | NA | NA | NA | 140 | 61 | 47 | 140 | 61 | 47 | 175 | 61 | 47 | |
| Sudely Road ~ Lee Highway (US29) | | 360 - 366 | 4.86 | NA | NA | NA | NA | NA | NA | NA | NA | 537 | 96 | 74 | 537 | 96 | 74 | 731 | 96 | 74 | |
| US29 ~ Sully Road (VA 28) | | 367 - 370 | 1.03 | NA | NA | NA | NA | NA | NA | NA | NA | 100 | 21 | 15 | 100 | 21 | 15 | 146 | 21 | 15 | |
| VA 28 ~ Fairfax County Pkwy (VA 286) | | 371 - 374 | 2.71 | NA | NA | NA | NA | NA | NA | NA | NA | 93 | 53 | 41 | 93 | 53 | 41 | 93 | 53 | 41 | |
| VA 286 ~ Lee Jackson Memorial Hwy (US 50) | | 375 - 378 | 2.53 | NA | NA | NA | NA | NA | NA | NA | NA | 103 | 50 | 38 | 129 | 50 | 38 | 141 | 50 | 38 | |
| US 50 ~ Chain Bridge Road (VA 123) | | 379 - 382 | 1.88 | NA | NA | NA | NA | NA | NA | NA | NA | 95 | 38 | 28 | 113 | 38 | 28 | 132 | 38 | 28 | |
| VA 123 ~ Nutely Street (VA 243) | | 383 - 386 | 2.54 | NA | NA | NA | NA | NA | NA | NA | NA | 300 | 51 | 38 | 336 | 51 | 38 | 358 | 51 | 38 | |
| VA 243 ~ Ceder Lane (VA 698) | | 387 - 388 | 0.86 | NA | NA | NA | NA | NA | NA | NA | NA | 68 | 17 | 13 | 88 | 17 | 13 | 80 | 17 | 13 | |
| VA 698 ~ Capital Beltway (I-495) | | 389 -390 | 1.22 | NA | NA | NA | NA | NA | NA | NA | NA | 77 | 24 | 18 | 100 | 24 | 18 | 93 | 24 | 18 | |
| I-66 Outside the Beltway: West bound | | | | | | | | | | | | | | | | | | | | | |
| HOT Lane Segment | | Toll Group | Distance (in mile) | 2016 | | | 2017 | | | 2020 | | | 2025 | | | 2030 | | | 2040 | | |
| | | | | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP | AM | PM | OP |
| I-495 ~ Cedar Lane (VA 698) | | 301 - 302 | 1.36 | NA | NA | NA | NA | NA | NA | NA | NA | 28 | 28 | 20 | 28 | 54 | 20 | 28 | 54 | 20 | |
| VA 698 ~ Nutely Street (VA 243) | | 303 - 304 | 1.70 | NA | NA | NA | NA | NA | NA | NA | NA | 34 | 47 | 25 | 34 | 82 | 25 | 34 | 95 | 25 | |
| VA 243 ~ Chain Bridge Road (VA 123) | | 305 - 308 | 2.02 | NA | NA | NA | NA | NA | NA | NA | NA | 40 | 255 | 31 | 40 | 264 | 31 | 40 | 339 | 31 | |
| VA 123 ~ Lee Jackson Memorial Hwy (US 50) | | 309 - 312 | 2.28 | NA | NA | NA | NA | NA | NA | NA | NA | 46 | 70 | 34 | 46 | 93 | 34 | 46 | 128 | 34 | |
| US 50 ~ Fairfax County Pkwy (VA 286) | | 313 - 316 | 2.06 | NA | NA | NA | NA | NA | NA | NA | NA | 41 | 89 | 30 | 41 | 121 | 30 | 41 | 105 | 30 | |
| VA 286 ~ Sully Road (VA 28) | | 317 - 320 | 2.39 | NA | NA | NA | NA | NA | NA | NA | NA | 48 | 48 | 36 | 48 | 48 | 36 | 48 | 48 | 36 | |
| VA 28 ~ Lee Highway (US 29) | | 321 - 324 | 1.07 | NA | NA | NA | NA | NA | NA | NA | NA | 22 | 22 | 15 | 22 | 33 | 15 | 22 | 85 | 15 | |
| US 29 ~ Sudely Road | | 325 - 331 | 4.78 | NA | NA | NA | NA | NA | NA | NA | NA | 95 | 95 | 72 | 95 | 143 | 72 | 95 | 383 | 72 | |
| Sudely Road ~ PW County Pkwy (VA 234) | | 332 - 335 | 2.92 | NA | NA | NA | NA | NA | NA | NA | NA | 59 | 59 | 43 | 59 | 63 | 43 | 59 | 82 | 43 | |
| VA 234 ~ Lee Highway (US 29) | | 336 - 339 | 1.43 | NA | NA | NA | NA | NA | NA | NA | NA | 6 | 6 | 5 | 6 | 6 | 5 | 28 | 28 | 21 | |
| US 29 ~ US 15 | | 340 -343 | 2.55 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 51 | 51 | 38 | |
| US 15 ~ Avens Creek Dr | | 344 | 0.60 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 12 | 12 | 9 | |
| Avens Creek Dr ~ Antioch Access | | 391 - 392 | 0.37 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 7 | 6 | |

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Figure 3-12 I-66 outside the Capital Beltway: Express Lane Facility

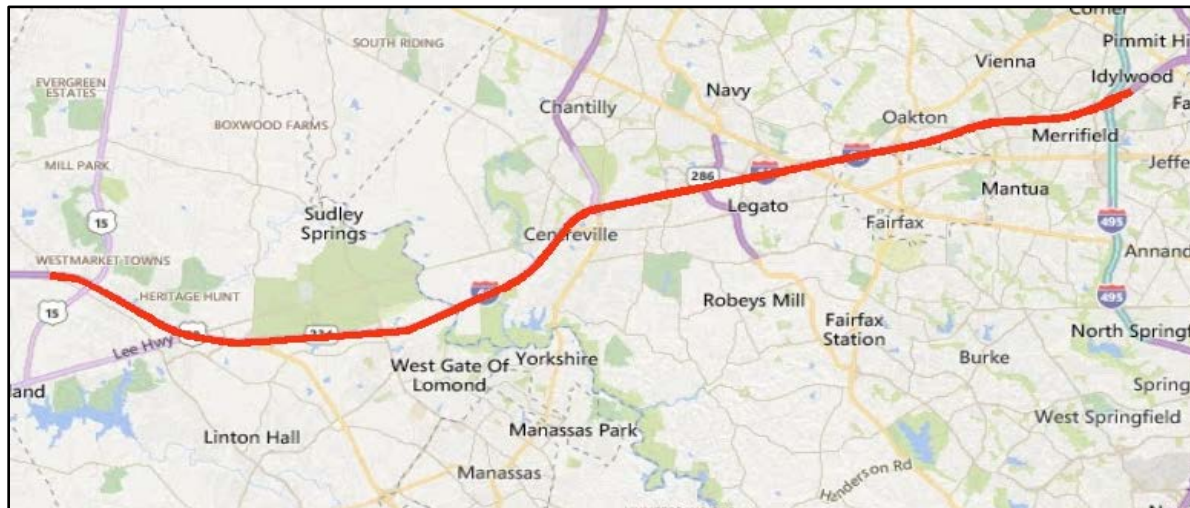
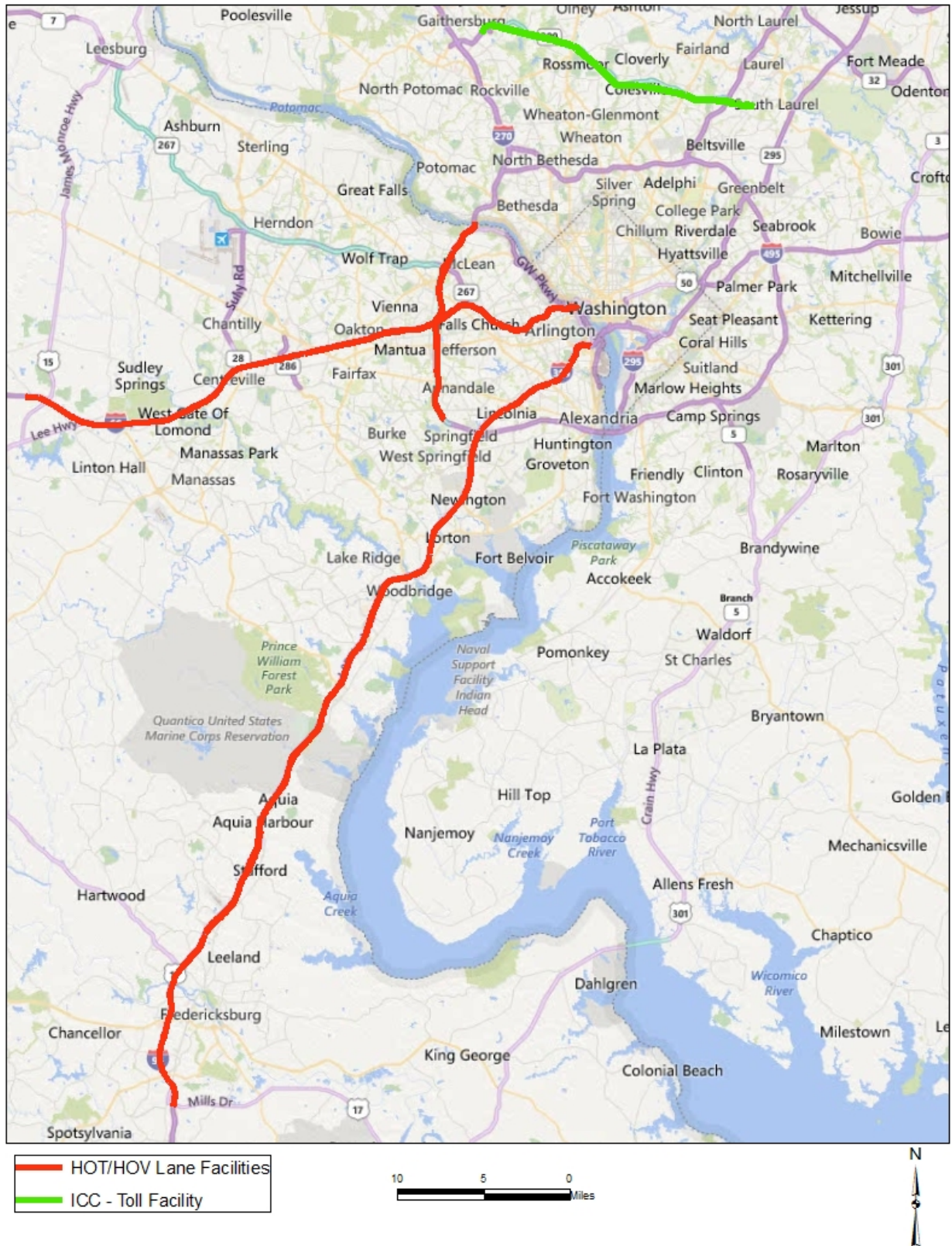


Figure 3-13 Existing and Future Managed-lane facilities whose toll varies by time of day

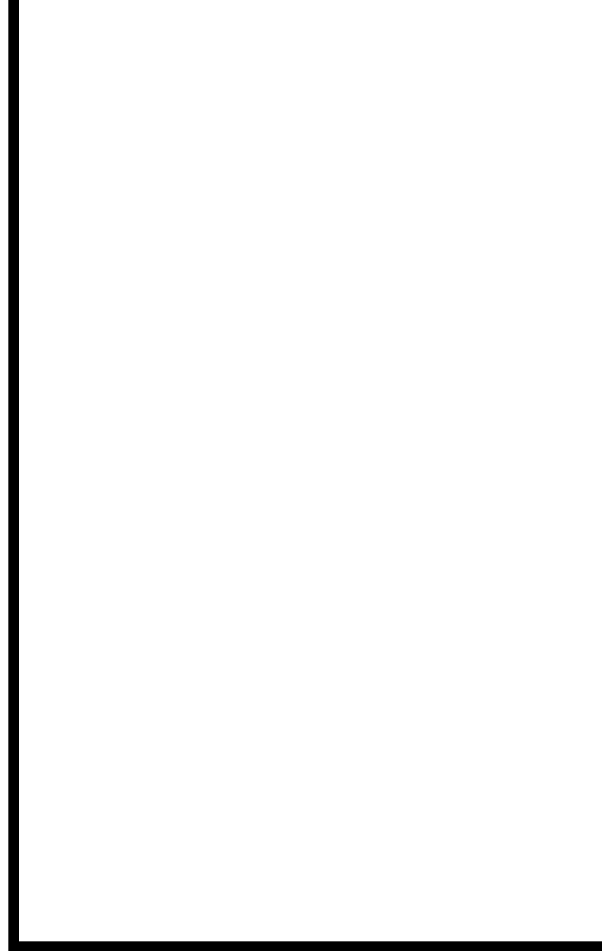


Source: C:\FY_12\Network_Docum_2011\TollGrp_12_29_15.mxd
I:\ateam\docum\fy17\2016CLRP_Network_Report\TollGrp_02_27_17.jpg

3.2.6 Highway Network Screenlines

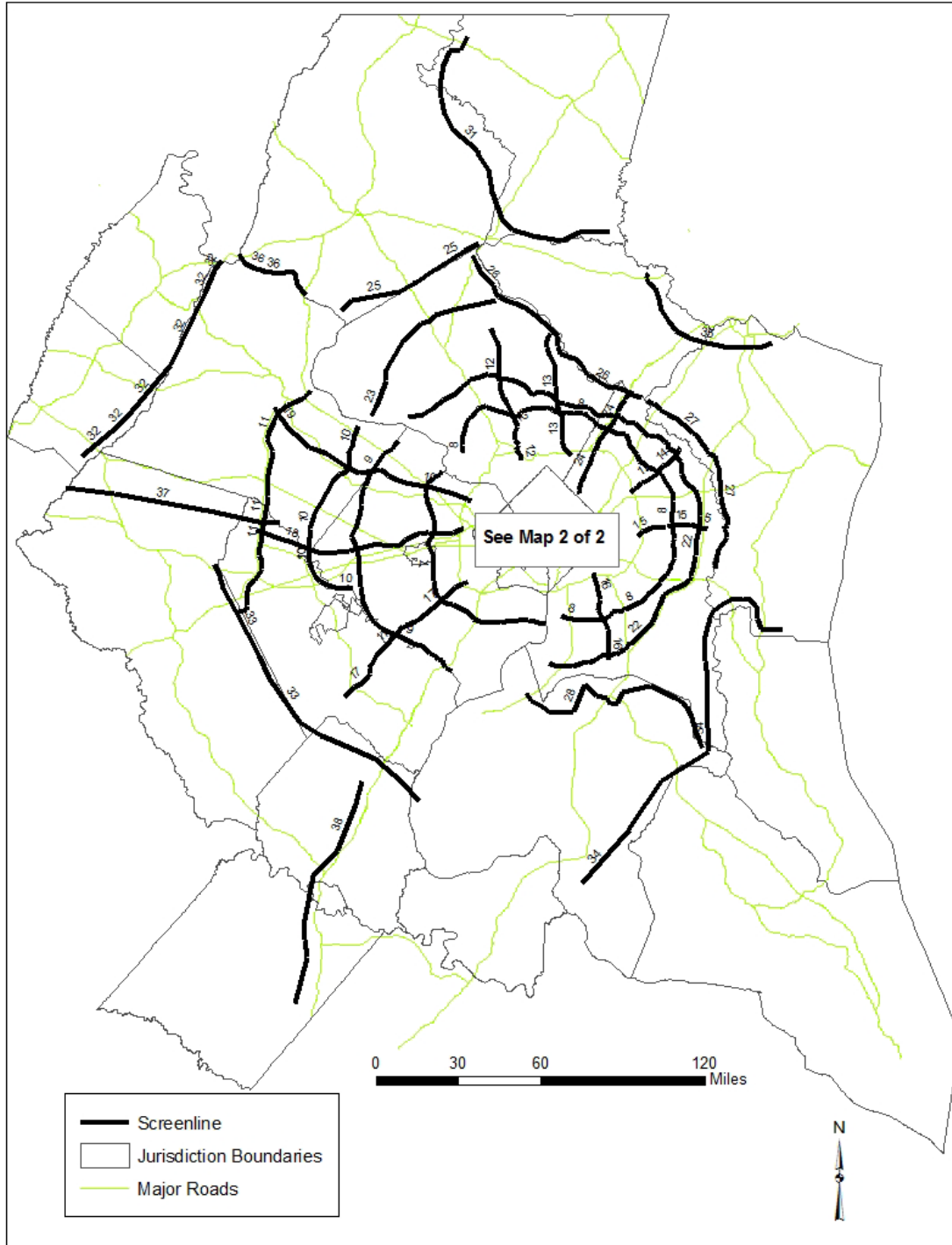
The network includes an attribute (SCREEN) which identifies 36 screenlines which are used for model summary or validation purposes.¹⁶ The screenline locations are shown in Figure 3-13 and Figure 3-14.

Figure 3-14 Highway Network screenlines: Inside the Beltway



¹⁶ The screen variable includes codes from 1 to 38, but the numbers 21 and 30 are unused

Figure 3-15 Highway network screenlines: Outside the Beltway



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3.2.7 2016 CLRP Highway Statistics

A summary of directional lane miles for the AM peak period is shown in Table 3-17.¹⁷ In the 2016 highway network, there were over 23,000 AM lane miles. By 2040, this number is predicted to increase by almost 1,500, which is 6%, regionally. Fairfax Co. and Prince George's Counties are predicted to have the largest increase in AM lane miles from 2016 to 2040 – 324 and 277 miles, respectively – though this is not surprising since these counties are the largest jurisdictions in the region. The District of Columbia is the only jurisdiction that is predicted to have decline in the AM lane miles from 2016 to 2040, but the decrease is very small (about 1 percent).

¹⁷ Computation of AM lane miles **excludes** TAZ connectors (FTYPE=0) and Transit only links (AMLIMIT=9).

Table 3-18 AM lane-miles for 2016 CLRP and FY2017-2022 TIP highway networks

| Jurisdiction Code | Jurisdiction | 2016 | 2017 | 2020 | 2025 | 2030 | 2040 | Diff 2040-2016 | Ratio 2040/2016 |
|-------------------|-----------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|
| 0 | District of Columbia | 1,411 | 1,408 | 1,409 | 1,403 | 1,403 | 1,403 | -8 | 0.99 |
| 1 | Montgomery Co., Md. | 2,653 | 2,653 | 2,709 | 2,735 | 2,767 | 2,767 | 114 | 1.04 |
| 2 | Prince Georges Co., Md. | 3,011 | 3,008 | 3,165 | 3,268 | 3,286 | 3,288 | 277 | 1.09 |
| 3 | Arlington Co., Va. | 514 | 514 | 522 | 522 | 522 | 522 | 8 | 1.02 |
| 4 | City of Alexandria, Va. | 325 | 325 | 329 | 330 | 330 | 330 | 5 | 1.01 |
| 5 | Fairfax Co., Va. | 3,308 | 3,344 | 3,360 | 3,549 | 3,562 | 3,632 | 324 | 1.10 |
| 6 | Loudoun Co., Va. | 1,605 | 1,661 | 1,721 | 1,765 | 1,778 | 1,801 | 195 | 1.12 |
| 7 | Prince William Co., Va. | 1,484 | 1,486 | 1,517 | 1,569 | 1,615 | 1,650 | 166 | 1.11 |
| 9 | Frederick Co., Md. | 1,663 | 1,669 | 1,680 | 1,685 | 1,713 | 1,713 | 50 | 1.03 |
| 10 | Howard Co., Md. | 963 | 963 | 967 | 1,010 | 1,016 | 1,034 | 71 | 1.07 |
| 11 | Anne Arundel Co., Md. | 1,375 | 1,375 | 1,386 | 1,422 | 1,433 | 1,447 | 72 | 1.05 |
| 12 | Charles Co., Md. | 851 | 851 | 851 | 851 | 859 | 859 | 8 | 1.01 |
| 14 | Carroll Co., Md. | 577 | 580 | 583 | 615 | 615 | 626 | 48 | 1.08 |
| 15 | Calvert Co., Md | 367 | 367 | 367 | 367 | 369 | 377 | 9 | 1.03 |
| 16 | St. Mary's Co., Md. | 455 | 455 | 455 | 461 | 461 | 461 | 6 | 1.01 |
| 17 | King George Co., Va. | 254 | 254 | 254 | 254 | 254 | 254 | 0 | 1.00 |
| 18 | City of Fredericksburg, Va. | 79 | 79 | 83 | 90 | 98 | 98 | 18 | 1.23 |
| 19 | Stafford Co., Va. | 580 | 580 | 596 | 621 | 625 | 636 | 56 | 1.10 |
| 20 | Spotsylvania Co., Va. | 441 | 441 | 441 | 458 | 465 | 493 | 52 | 1.12 |
| 21 | Fauquier Co., Va. | 795 | 795 | 795 | 795 | 795 | 795 | 0 | 1.00 |
| 22 | Clark Co., Va. | 161 | 161 | 161 | 161 | 161 | 161 | 0 | 1.00 |
| 23 | Jefferson Co., WVa. | 278 | 278 | 278 | 278 | 278 | 278 | 0 | 1.00 |
| | | 23,152 | 23,248 | 23,630 | 24,208 | 24,402 | 24,624 | 1,472 | 1.06 |

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Note: TAZ connectors (FTYPE=0) and Transit only links (AMLIMIT=9) are **excluded**.

3.3 Transit Network Files

The transit network consists of transportation infrastructure, represented via nodes and links, plus the transit service that runs over that infrastructure. The transportation infrastructure includes the highway network, which is used by buses, and transit-only infrastructure, such as transit stations and rail links. The input files used to construct the transit networks are listed in Table 3-18.

Table 3-19 Listing of transit network input files

| Filename | Description | Type | Source |
|------------------------|--|------|------------------------|
| Station.dbf | Station file: Metrorail, Comm.Rail, LRT stations/PNR lots & bus PNR lots | DBF | Geodatabase |
| AreaWalk.txt | Used to calculate zonal percent walk to transit values | Text | Travel Model-generated |
| met_node.tb | Metrorail stations | Text | Geodatabase |
| com_node.tb | Commuter rail stations | Text | Geodatabase |
| lrt_node.tb | LRT stations/stops | Text | Geodatabase |
| new_node.tb | BRT/streetcar stations/stops | Text | Geodatabase |
| met_pnr.tb | Metrorail PNR lots | Text | Geodatabase |
| com_pnr.tb | Commuter rail PNR lots | Text | Geodatabase |
| bus_pnr.tb | Bus PNR lots | Text | Geodatabase |
| lrt_pnr.tb | LRT PNR lots | Text | Geodatabase |
| new_pnr.tb | BRT/streetcar PNR lots | Text | Geodatabase |
| met_link.tb | Metrorail links | Text | Geodatabase |
| com_link.tb | Commuter rail links | Text | Geodatabase |
| lrt_link.tb | LRT links | Text | Geodatabase |
| new_link.tb | BRT/streetcar links | Text | Geodatabase |
| met_bus.tb | Transfer link (walk) between Metrorail station and bus stop | Text | Geodatabase |
| com_bus.tb | Transfer link (walk) between commuter rail station and bus & LRT stop | Text | Geodatabase |
| lrt_bus.tb | Transfer link (walk) between LRT station and bus stop | Text | Geodatabase |
| new_bus.tb | Transfer link (walk) between BRT/streetcar stop and bus stop | Text | Geodatabase |
| MODE1AM...,MODE10AM.tb | AM transit line files | Text | Geodatabase |
| MODE1OP...,MODE10OP.tb | Off-peak transit line files | Text | Geodatabase |

Ref: "I:\ateam\docum\FY15\2014CLRP_Network_Report\NW_Report_Tables\v23_inputs.xlsx"

The input files are intended to serve as extensions to the highway network, which provides the infrastructure for bus and rail service. The table indicates that all the transit link, node and line/route elements, and station file are produced directly from the geodatabase, with one exception: the AreaWalk.txt file which contains zonal walk-to-transit market areas. The Ver. 2.3.66 travel model includes an automated/integrated transit walkshed process. The process is run using a Python/ArcPy

script and does not require manual intervention from the user. Before discussing the individual input files, the next section discusses transit and non-transit mode codes used in the transit network.

3.3.1 Transit and Non-Transit Mode Codes

The transit network consists of various types of transit services and transit vehicles. For example, a bus typically operates on a road in mixed traffic (i.e., with private vehicles, such as cars and trucks). But a bus can also operate as bus rapid transit (BRT), meaning that it may use a combination of normal roads (mixed traffic) and bus-only links/segments (separate right of way). Similarly, there are many rail transit modes that operate now, or will operate in the future, in the Washington, D.C. area, such as Metrorail, commuter rail, light rail transit (LRT) and streetcar. In terms of network coding, we currently differentiate the following six transit modes:

- Local bus
- Express bus
- Metrorail
- Commuter rail
- Light rail transit (LRT)
- Bus rapid transit (BRT) and streetcar

The last mode, BRT and streetcar, is designated for transit service that travels on a *combination* of separate right of way (where the vehicles are not mixed with other traffic) and regular streets (where the vehicles are mixed with other traffic). By contrast, the LRT mode is designed to be used for transit service that travels *predominantly* on its own right of way (hence, it is not encumbered by other traffic). Historically, the coding practice by COG/TPB staff has been to distinguish three separate categories for both local and express bus service:

- Metrobus
- Non-Metrobus, inner jurisdictions (referred to as “other primary”)
- Non-Metrobus, outer jurisdictions (referred to as “other secondary”)

This results in the ten transit modes shown in Table 3-19.

Table 3-20 Transit mode codes

| Mode Code | Mode Description |
|-----------|--|
| 1 | Local bus: Metrobus (also includes DC Circulator bus) |
| 2 | Express bus: Metrobus |
| 3 | Metrorail |
| 4 | Commuter rail |
| 5 | Light rail |
| 6 | Local bus: Other primary service (inner jurisdictions) |
| 7 | Express bus: Other primary service (inner jurisdictions) |
| 8 | Local bus: Other secondary service (outer jurisdictions) |
| 9 | Express bus: Other secondary service (outer jurisdictions) |
| 10 | BRT/streetcar |

The transit path-builder, TRNBUILD, can combine average headways (frequencies) and run times (time from start to finish of the route), when two or more transit lines share the same link, via a technique known as “line combining.” The line combining can result in new, equivalent average headways and run time, but “TRNBUILD’s line-combining process combines only lines with the same mode.”¹⁸ For this reason, and especially as COG/TPB staff transitions from TRNBUILD to Public Transport (PT), staff may choose to consolidate some of the current 10 mode codes into fewer mode code designations.

Table 3-20 provides additional detail about the transit services/providers/operators that are included in each of the ten modes.

¹⁸ Citilabs, Inc., “Cube Voyager Reference Guide, Version 6.1.0” (Citilabs, Inc., April 24, 2013), 944.

Table 3-21 Detailed equivalency of transit mode codes and transit operators

| Mode No. | Mode Description | Abbreviation/Prefix | Transit Service |
|----------|-------------------------------|---------------------|---|
| 1 | Local Metrobus | "WM01 - 97, A - Z" | WMATA (DC, Alex., Falls Church, & MTG, PG, ARL, FFX Counties) |
| | | "DC" | District of Columbia Circulator |
| 2 | Express Metrobus | "WM05 - 29" | WMATA (ARL, ALEX, FFX) |
| | | "REX" | WMATA (FFX. Co.) |
| 3 | Metrorail | "WMRED" | RED Line |
| | | "WMBLU" | BLUE Line |
| | | "WMGRN" | GREEN Line |
| | | "WMORN" | ORANGE Line |
| | | "WMYEL" | YELLOW Line |
| 4 | Commuter Rail | "VFRED" | Frederick Line (VRE) |
| | | "VMAS" | Manassas Line (VRE) |
| | | "MBR" | Brunswick Line (MARC) |
| | | "MCAM" | Camden Line (MARC) |
| | | "MP" | Penn Line (MARC) |
| 5 | Light Rail | "MFRED" | Frederick City Line (MARC) |
| | | "AMTK" | AMTRAC Service |
| 6 | Other Primary - Local Bus | "PURPLE" | Purple Line -MTA (Bethesda -New Carrollton) |
| | | "ART" | Arlington County Bus |
| | | "DAT" | City of Alexandria Bus |
| | | "F" | Fairfax County Bus |
| | | "GO" | Prince Georges County Bus |
| | | "RO" | Montgomery Co. Ride On Bus |
| | | "SG" | Fairfax City Bus |
| 7 | Other Primary - Express Bus | "TYSL" | Tyson's Circulator |
| | | "DAT" | City of Alexandria Bus |
| 8 | Other Secondary - Local Bus | "F" | Fairfax County Bus |
| | | "ANN" | City Of Annapolis Bus |
| | | "CCATS" | Carroll County Bus |
| | | "CC" | Calvert County Bus |
| | | "FT" | Frederick County Bus |
| | | "HT" | Howard County Bus |
| | | "L" | City of Laurel Bus |
| | | "LT" | Loudoun County Local Bus |
| | | "OL" | OMNI-LINK (PrinceWilliam Co. Local) |
| | | "VF" | Fredericksburg, Va (VRE Bus) |
| 9 | Other Secondary - Express Bus | "VG" | Charles County Bus (VanGO) |
| | | "ST" | St Mary's County Bus |
| | | "LC" | Lee Coaches Commuter Bus |
| | | "LCS" | Loudoun Co. Commuter Bus |
| | | "LINK" | Washington Flyer- Dulles/WFC |
| | | "MT" | Maryland MTA Bus (Frederick, Howard, Anne Arundel, Calvert, St Mary's, &Charles Counties) |
| | | "OR" | OMNI-RIDE (Prince William Co. Commuter Bus) |
| 10 | BRT/ Streetcar | "PQ" | Quicks Commuter Bus (Fredericksburg, Spotsylvania & Stafford Counties) |
| | | "SDC" | Nat'l Coach Commuter Bus (Fredericksburg, Spotsylvania & Stafford Co's) |
| | | "MWAY" | US1 (Alexandria, Arlington) metroway BRT |
| 10 | BRT/ Streetcar | "DCST" | DC Streetcar |
| | | "US1BRT" | US1 (Fairfax) BRT |
| | | "CCTBRT" | Corridor Cities Transit Way |

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables \Transit_NetWrk_Mode_Codes.xlsx"

According to the rules of TRNBUILD, a transit path includes both transit and non-transit links. The transit links would include any movement on a transit vehicle, and these transit links would be categorized by the 10 transit modes previously mentioned. The non-transit links in a transit path are associated with accessing the transit service, transferring between transit services (especially those represented by different mode codes), and egressing from the transit service. In TRNBUILD vernacular, non-transit links are also called “support” links. Transit path-building and assignment are conducted in production/attraction format, so a transit path goes from a production zone to an attraction zone. At the production end of a transit trip, it is assumed that one will access the transit service via one of two modes: walking or driving. Walking includes biking. At the attraction end of a transit trip, it is assumed that there is only one egress mode: walking. This assumes that people do not egress from the transit system via car. Again, biking is considered part of walking. Also, transfers need to be made, such as from a rail station to a bus stop, and from a park-and-ride (PNR) lot to the associated transit stop. The five current mode codes use for these “non-transit” links are shown in Table 3-21.

Table 3-22 Non-transit mode codes

| Mode Code | Mode Description |
|-----------|---|
| 11 | Drive-access to transit |
| 12 | Transfer link between rail and bus (walk) |
| 13 | Sidewalk link (walk) |
| 14 | (Unused) |
| 15 | Transfer link between park-and-ride (PNR) lot and transit stop (walk) |
| 16 | Walk access to/egress from transit |

3.3.2 Rail Station File

The “station file” (station.dbf) contains information about Metrorail stations, commuter rail stations, light rail stations, bus rapid transit stations/stops, streetcar stations/stops, express-bus bus stops, and park-and-ride (PNR) lots that serve these stations/stops. The variables included in the station file are shown in Table 3-22.

As mentioned in the previous section, there are 10 transit mode codes and five non-transit mode codes. The station file uses its own “mode code,” which is a letter, instead of a number, as shown in Table 3-22. The station file also includes an access distance code (“NCT”), which controls the number, extent, and directionality of PNR/KNR access links generated for each parking lot. The acceptable values for the access distance code are shown in Table 3-23.

Table 3-23 Variables in the transit station file (Station.dbf)

| Name | Type | Field Description |
|-----------|------|--|
| SEQNO | N | Sequence Number |
| MM | C | Mode Code (M=Metrorail, C=Commuter rail, B=Bus, L=Light rail, N= BRT/streetcar) |
| NCT | N | Access distance code (1, 2, 3, 0, 9, 8) (See Table 3-23) |
| STAPARK | C | Does the station have a park-and-ride lot? (Y=yes; blank=no) |
| STAUSE | C | Is the station in use for the given year? (Y=yes; blank=no) |
| SNAME | C | Station Name/PNR lot name |
| STAC | N | Station centroid number (5001-7999), also known as a park-and-ride (PNR) lot centroid or a dummy PNR centroid" |
| STAZ | N | For the purposes of path building, the TAZ (1-3722) that represents the location of the station PNR lot. Usually the closest TAZ to the PNR lot. |
| STAT | N | Station Node (8000-8999, 9000-9999, 10000-10999) |
| STAP | N | Station park-and-ride (PNR) node number (11000-13999) |
| STAN1 | N | Station bus node #1 (used to generate a station-to-bus-node connector) |
| STAN2 | N | Station bus node #2 (used to generate a station-to-bus-node connector) |
| STAN3 | N | Station bus node #3 (used to generate a station-to-bus-node connector) |
| STAN4 | N | Station bus node #4 (used to generate a station-to-bus-node connector) |
| STAPCAP | N | Parking capacity (number of spaces at the PNR lot) |
| STAX | N | X coordinate of station/PNR lot (MD State Plane, NAD83, feet) |
| STAY | N | Y coordinate of station/PNR lot (MD State Plane, NAD83, feet) |
| STAPKCOST | N | Peak period parking cost (daily cost, cents) |
| STAOPCOST | N | Off-peak parking cost (hourly cost, cents) |
| STAPKSHAD | N | Peak-period shadow price (currently not used) |
| STAOPSHAD | N | Off-peak-period shadow price (currently not used) |
| FIRSTYR | N | Year of Station/PNR lot Opening (unused by scripts, but used as metadata) |
| STA_CEND | N | Project ID (Metadata) |
| | C | Scenario name, or left blank (Metadata) |
| | C | Comments, if any, regarding the file, since file cannot accept comment lines preceding the data lines |

Notes: The SEQNO variable does not correspond to the station node (STAT), and, unlike the STAT, cannot be assumed to stay the same over time.

Source: Jain, M. (2010, October). MWCOG network coding guide for Nested Logit Model (First draft: September 20, 2007; Updated February 2008 and October 2010). Memorandum.

Table 3-24 Transit access distance codes (NCT)

| Access Dist. Code | Interpretation |
|-------------------|---|
| 1 | End-of-the-line station (e.g., Shady Grove Metro) |
| 2 | Intermediate station (e.g., Rockville Metro) |
| 3 | PNR close to a CBD (e.g., Rhode Island Ave. Metro, Fort Totten) |
| 0 | Only KNR-access links generated (e.g., Braddock Road, National Airport, Clarendon) |
| 9 | Metrorail sta. in use, but no PNR/KNR access (e.g., Dupont Circle, Farragut North, Metro Ctr.) |
| 8 | Pentagon Metro Sta., allows for very long KNR links, to represent "slugging" (informal carpool) |

Table 3-24 shows the designated ranges for station centroids and station nodes associated with Metrorail, commuter rail, LRT, and BRT/streetcar.

Table 3-25 Station centroid and station node range by mode

| Mode | Mode Code | Station Centroid Range | Station Node Range |
|---------------------------------------|-----------|------------------------|--------------------|
| Metrorail (Mode 3) | M | 5000-5999 | 8000-8999 |
| Commuter rail (Mode 4) | C | 6000-6999 | 9000-9999 |
| Light rail transit (Mode 5) | L | Not used | 10000-10499 |
| Bus rapid transit/streetcar (Mode 10) | N | Not used | 10500-10999 |
| Bus (Modes 1, 2, 6-9) | B | Not used | Not used |

3.3.3 Walk- and Drive-Access to Transit

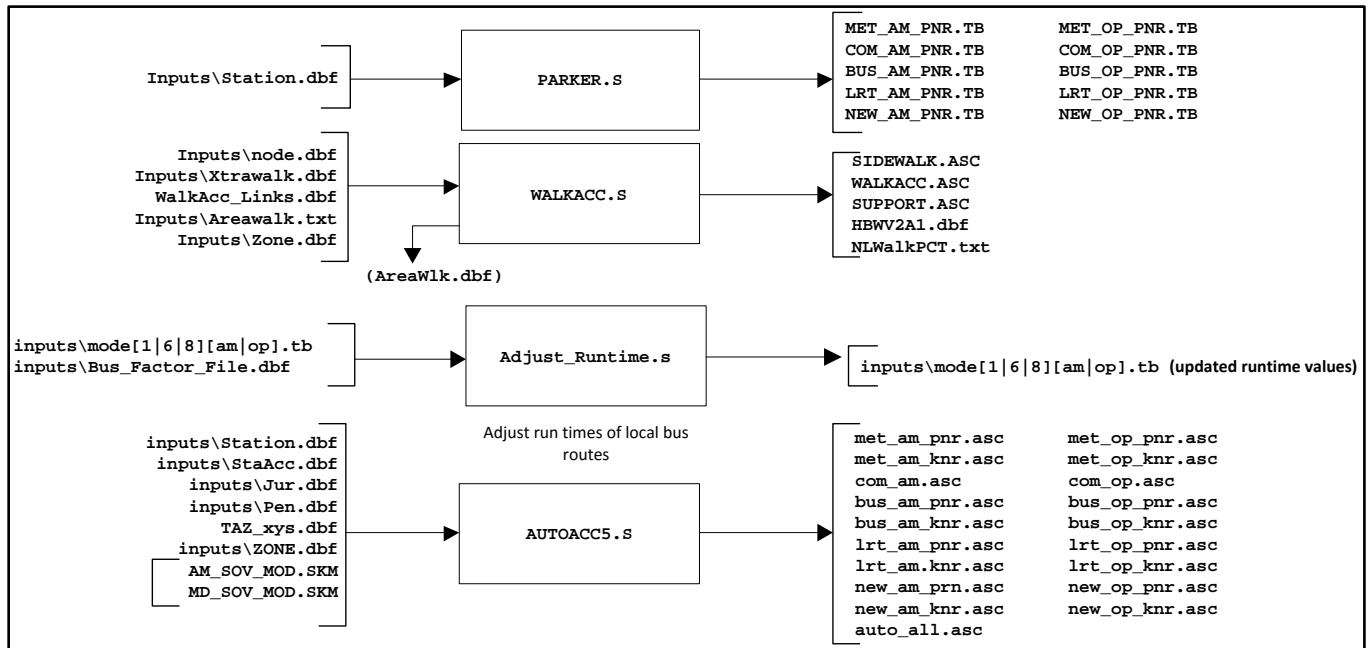
As stated earlier, transit path-building and assignment are conducted in production/attraction format, so a transit path is constructed from a production zone to an attraction zone. At the production end of a transit trip, it is assumed that one will access the transit service via one of two modes: walking or driving. Walking includes biking. At the attraction end of a transit trip, it is assumed that there is only one egress mode: walking. This assumes that people do not egress from the transit system via car.

A series of Cube Voyager scripts are used as part of the transit network building process to enable automatic generation of transit access and transfer links, including zonal walk access links, PNR lot-to-rail station links, and auto access links (TAZ-to-station links). These are non-transit modes that are used to access transit and transfer between transit services and have transit mode codes of 11-16 as shown in Table 3-21. Further details can be found in Chapter 21 of the Version 2.3.66 model User’s Guide, which discusses the automatic generation of transit access, auto-access links, and walk-access links.

As shown in Figure 3-15, there are three Cube Voyager scripts that are used for developing access links:

- WALKACC.S: Used to develop zonal walk-access links
- AUTOACC5.S: Used to generate zonal drive-access links
- PARKER.S: Used to generate walk connections between PNR lots and rail stations

Figure 3-16 Process for developing walk-access and drive-access links



As noted in the Version 2.3.66 Travel Model user’s guide, the automated approach for generating these links has greatly streamlined the transit network coding process. All three of these programs were originally developed as stand-alone Fortran programs developed by AECOM Consult. TPB staff converted these three Fortran programs to Cube Voyager scripts.

WALKACC.S requires the following input files:

- Node.dbf: A file with the X and Y coordinates of all the transit stop nodes
- Xtrawalk.dbf: A file with extra/user-specified walk links, which can be used in cases where the background highway network lacks sufficient detail to provide adequate walk access (it is assumed that one can walk on all highway links, except freeways, expressways, and ramps).
- WalkAcc_Links.dbf: A list of highway links that can be used for generating walk-access links (developed by MODNET.S)
- Areawalk.txt: A file containing information needed to calculate the zonal percent-walk-to-transit (PWT) values. An excerpt from this file can be found in Figure 3-16. This file contains the following variables:
 - **TAZID**: TAZ number.
 - **TAZAREA**: Area of the TAZ in square miles.
 - **MTLRTSHR**: Area of the TAZ (sq. mi.) within a short (0.5 mile) walk of Metrorail or LRT service
 - **MTLRTLNG**: Area of the TAZ (sq. mi.) within a long (1.0 mile) walk of Metrorail or LRT service
 - **ALLPKSHR**: Area of the TAZ (sq. mi.) within a short (0.5 mile) walk of any transit service (including Metrorail and LRT) in the AM peak period

- **ALLPKLNG**: Area of the TAZ (sq. mi.) within a long (1 mile) walk of any transit service (including Metrorail and LRT) in the AM peak period
- **ALLOPSHR**: Area of the TAZ (sq. mi.) within a short (0.5 mile) walk of any transit service (including Metrorail and LRT) in the **off-peak** period
- **ALLOPLNG**: Area of the TAZ (sq. mi.) within a long (1 mile) walk of any transit service (including Metrorail and LRT) in the **off-peak** period
- Zone.dbf: Standard zonal attribute input file.
- HBWV2A1.dbf: A file with zonal information that is both created by WALKACC.S and then later read into WALKACC.S.

This file need not be sorted by TAZ (as can be seen in Figure 3-16).

Figure 3-17 An excerpt from the AreaWalk.txt file

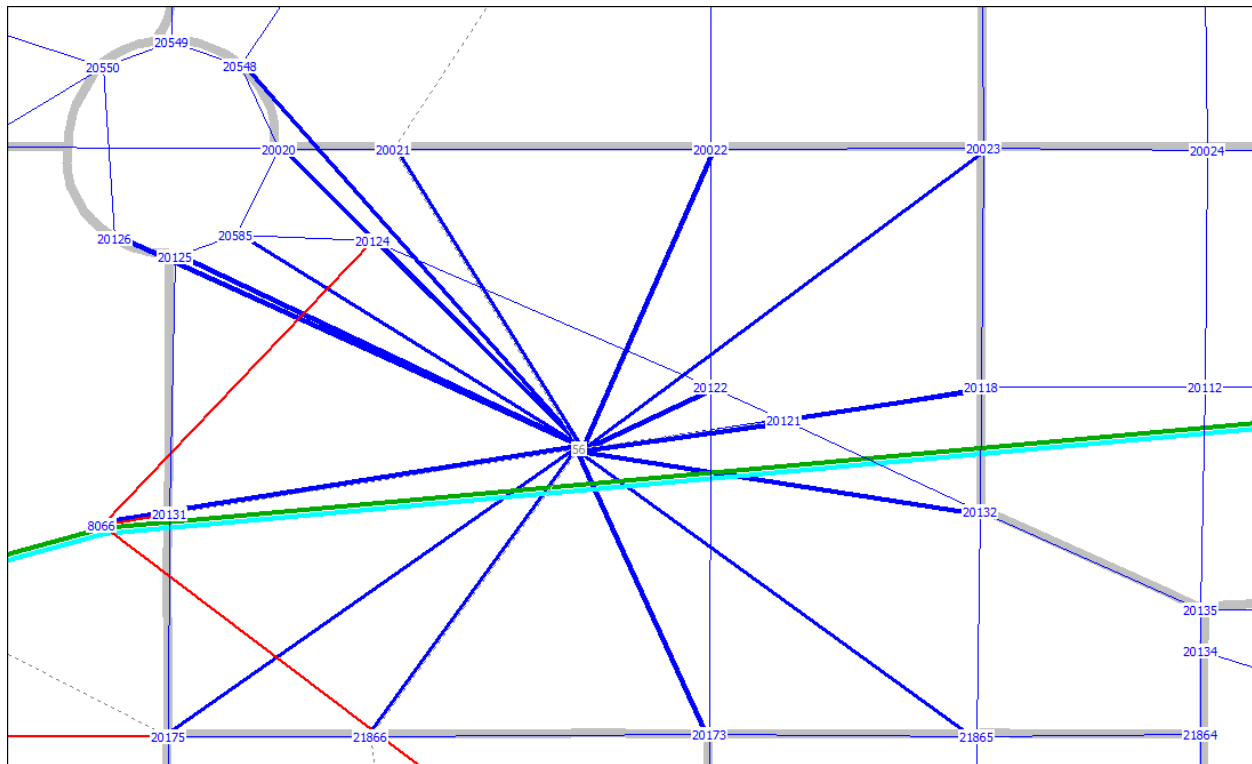
| TAZID | TAZ_AREA | MTLRTSHR | MTLRTLNG | ALLPKSHR | ALLPKLNG | ALLOPSHR | ALLOPLNG |
|-------|----------|----------|----------|----------|----------|----------|----------|
| 2633 | 0.0540 | 0.0000 | 0.0000 | 0.0540 | 0.0540 | 0.0540 | 0.0540 |
| 2634 | 0.1897 | 0.0000 | 0.0000 | 0.1897 | 0.1897 | 0.1897 | 0.1897 |
| 2635 | 0.6364 | 0.0000 | 0.0000 | 0.4804 | 0.6364 | 0.4804 | 0.6364 |
| 2636 | 0.4917 | 0.0000 | 0.0000 | 0.4917 | 0.4917 | 0.4917 | 0.4917 |
| 2637 | 1.2188 | 0.0000 | 0.0000 | 1.2188 | 1.2188 | 1.1620 | 1.2188 |
| 2638 | 0.6354 | 0.0000 | 0.0000 | 0.4923 | 0.6354 | 0.5544 | 0.6354 |
| 2639 | 0.6991 | 0.0000 | 0.0000 | 0.4743 | 0.6991 | 0.4743 | 0.6991 |
| 2640 | 0.0593 | 0.0000 | 0.0000 | 0.0593 | 0.0593 | 0.0593 | 0.0593 |
| 259 | 0.6207 | 0.3757 | 0.6183 | 0.4934 | 0.6207 | 0.4891 | 0.6207 |
| 260 | 0.4965 | 0.0000 | 0.0303 | 0.4232 | 0.4965 | 0.4232 | 0.4965 |
| 1788 | 1.4192 | 0.0000 | 0.0000 | 0.5475 | 1.1463 | 0.5475 | 1.1463 |
| 1789 | 0.2863 | 0.0000 | 0.0412 | 0.2863 | 0.2863 | 0.2863 | 0.2863 |
| 1790 | 0.3237 | 0.0000 | 0.0537 | 0.3237 | 0.3237 | 0.3237 | 0.3237 |
| 1791 | 0.2910 | 0.0000 | 0.0000 | 0.2661 | 0.2910 | 0.2661 | 0.2910 |
| 1792 | 0.1824 | 0.0000 | 0.0029 | 0.1824 | 0.1824 | 0.1824 | 0.1824 |
| 1793 | 0.1622 | 0.0000 | 0.0000 | 0.1622 | 0.1622 | 0.1622 | 0.1622 |
| 1794 | 0.1026 | 0.0000 | 0.0000 | 0.1026 | 0.1026 | 0.1026 | 0.1026 |
| 1795 | 0.1574 | 0.0000 | 0.0000 | 0.1574 | 0.1574 | 0.1574 | 0.1574 |
| 1796 | 0.9296 | 0.0000 | 0.0000 | 0.9296 | 0.9296 | 0.9296 | 0.9296 |
| 1797 | 0.3545 | 0.0000 | 0.0000 | 0.3545 | 0.3545 | 0.3545 | 0.3545 |
| 1798 | 0.9034 | 0.0000 | 0.0083 | 0.8868 | 0.9034 | 0.8868 | 0.9034 |
| 1799 | 0.3016 | 0.0000 | 0.0000 | 0.3012 | 0.3016 | 0.3012 | 0.3016 |

The principal output files from WalkAcc.S are

- sidewalk.asc: Sidewalk links.
- walkacc.asc: Walk-access/walk-eggress links.
- support.asc: Non-transit/support links.

Figure 3-17 shows walk access/egress links (mode 16) in TAZ 56, which is east of Foggy Bottom Metrorail Station. The thick, dark blue links, in the starburst shape, are the walk access/egress links for one zone (TAZ 56). The thin, dark blue segments are road links. The red links are transit-only links, and the thick, light blue and green links are the Metrorail links (Metrorail's Orange/Blue Line).

Figure 3-18 Walk access/egress links in TAZ 56, east of Foggy Bottom Metrorail Station



Ref: "L:\modelRuns\fy14\Ver2.3.52_Conformity2013CLRP_Xmittal\2010_Final\zonehwy.net"; "support_mode16_taz56.asc" "MODE3AM.TB"

AutoAcc5.s requires the eight input files shown in Figure 3-15. Figure 3-18 shows an example of the drive-access links (mode 11) associated with the Ballston Metrorail Station park-and-ride (PNR) lot. The lot is located just to the south of the station, which appears as a black dot on the orange line representing Metrorail's Orange Line. Notice that the star-burst shape of the auto access links is not a simple circle, but rather has a directional orientation, reflecting the fact the people have less tendency to back-track when looking for parking at the production end of their trip.

Figure 3-19 Drive-access links associated with the Ballston Metrorail Station PNR lot



Ref: "L:\modelRuns\fy14\Ver2.3.52_Conformity2013CLRP_Xmittal\2010_Final\zonehwy.net"; "MODE3AM.TB" "auto_all_ballston_knr.asc"
"auto_all_ballston_pnr.asc" "support.asc"

3.3.4 Station Coordinate Files

The files in Table 3-18 that end with “_node.tb” are the station coordinate files:

- Met_node.tb: Metrorail stations
- Com_node.tb: Commuter rail stations
- LRT_node.tb: LRT stations/stops
- New_node.tb: BRT and/or streetcar stations/stops

These files come directly from the geodatabase. The file extension of “TB” indicates “TRNBUILD” and was introduced by COG/TPB staff a number of years ago to differentiate the files from those formatted for the previous transit path builder, TRNPTH (“TP”). An excerpt from the Metrorail station coordinate file (met_node.tb) can be seen in Figure 3-19. Coordinates are Maryland State Plane, NAD 1983, in feet.

Figure 3-20 Excerpt from the Metrorail station coordinate file (met_node.tb)

| | | | | | | |
|----------|------|----|---------|----|--------|----------------------|
| XY NODE= | 8001 | X= | 1265599 | Y= | 529193 | ;;Shady Grove |
| XY NODE= | 8002 | X= | 1270639 | Y= | 516540 | ;;Rockville |
| XY NODE= | 8003 | X= | 1278225 | Y= | 508218 | ;;Twinbrook |
| XY NODE= | 8004 | X= | 1280517 | Y= | 503088 | ;;White Flint |
| XY NODE= | 8005 | X= | 1282829 | Y= | 496367 | ;;Grosvenor |
| XY NODE= | 8006 | X= | 1284767 | Y= | 485106 | ;;Medical Center |
| XY NODE= | 8007 | X= | 1285560 | Y= | 479782 | ;;Bethesda |
| XY NODE= | 8008 | X= | 1288003 | Y= | 471196 | ;;Friendship Heights |
| XY NODE= | 8009 | X= | 1289640 | Y= | 466682 | ;;Tenleytown |
| XY NODE= | 8010 | X= | 1294409 | Y= | 464951 | ;;Van Ness-UDC |
| XY NODE= | 8011 | X= | 1295608 | Y= | 462324 | ;;Cleveland Park |
| XY NODE= | 8012 | X= | 1297352 | Y= | 458473 | ;;Woodley Park-Zoo |
| XY NODE= | 8013 | X= | 1299822 | Y= | 453020 | ;;Dupont Circle |
| XY NODE= | 8014 | X= | 1301030 | Y= | 450307 | ;;Farragut North |
| XY NODE= | 8015 | X= | 1304332 | Y= | 448558 | ;;Metro Center |
| XY NODE= | 8016 | X= | 1306089 | Y= | 448606 | ;;Gallery Place |
| XY NODE= | 8017 | X= | 1307581 | Y= | 447814 | ;;Judiciary Square |
| XY NODE= | 8018 | X= | 1310220 | Y= | 448408 | ;;Union Station |
| XY NODE= | 8019 | X= | 1313230 | Y= | 456638 | ;;Rhode Island Ave |
| XY NODE= | 8020 | X= | 1313751 | Y= | 461393 | ;;Brookland-CUA |
| XY NODE= | 8021 | X= | 1311788 | Y= | 467989 | ;;Fort Totten |
| XY NODE= | 8022 | X= | 1307186 | Y= | 476758 | ;;Takoma |

3.3.5 Transit Parking Lot Coordinate Files

The files in Table 3-18 that end with “_pnrn.tb” are the transit parking lot coordinate files:

- met_pnrn.tb: Metrorail PNR lot coordinates
- com_pnrn.tb: Commuter rail PNR lot coordinates
- bus_pnrn.tb: Bus PNR lot coordinates
- lrt_pnrn.tb: LRT PNR lot coordinates

- new_pnrn.tb: BRT and/or streetcar PNR lot coordinates

An excerpt from the Metrorail PNR lot coordinate file (met_pnrn.tb) can be seen in Figure 3-20. Coordinates are Maryland State Plane, NAD 1983, in feet.

Figure 3-21 An excerpt of the Metrorail PNR lot coordinate file (met_pnrn.tb)

| | | | | | | | |
|----|-------|-------|----|---------|----|--------|--------------------|
| XY | NODE= | 11001 | X= | 1265315 | Y= | 529089 | ;;Shady Grove |
| XY | NODE= | 11002 | X= | 1270959 | Y= | 516684 | ;;Rockville |
| XY | NODE= | 11003 | X= | 1278613 | Y= | 508435 | ;;Twinbrook |
| XY | NODE= | 11004 | X= | 1281327 | Y= | 503024 | ;;White Flint |
| XY | NODE= | 11005 | X= | 1283249 | Y= | 496139 | ;;Grosvenor |
| XY | NODE= | 11007 | X= | 1285562 | Y= | 479783 | ;;Bethesda |
| XY | NODE= | 11019 | X= | 1313784 | Y= | 456689 | ;;Rhode Island Ave |
| XY | NODE= | 11021 | X= | 1311284 | Y= | 468649 | ;;Fort Totten |
| XY | NODE= | 11023 | X= | 1303903 | Y= | 483450 | ;;Silver Spring |
| XY | NODE= | 11024 | X= | 1299517 | Y= | 491425 | ;;Forest Glen |
| XY | NODE= | 11025 | X= | 1297560 | Y= | 499796 | ;;Wheaton |
| XY | NODE= | 11026 | X= | 1297615 | Y= | 508431 | ;;Glenmont |
| XY | NODE= | 11027 | X= | 1338527 | Y= | 489633 | ;;Greenbelt |
| XY | NODE= | 11028 | X= | 1332678 | Y= | 476884 | ;;College Park |
| XY | NODE= | 11029 | X= | 1324845 | Y= | 472917 | ;;PG Plaza |
| XY | NODE= | 11030 | X= | 1321380 | Y= | 469383 | ;;West Hyattsville |
| XY | NODE= | 11040 | X= | 1313758 | Y= | 436270 | ;;Anacostia |
| XY | NODE= | 11042 | X= | 1319454 | Y= | 427220 | ;;Southern Avenue |

3.3.6 Rail Links

The files in Table 3-18 that end with “_link.tb” are the rail link files:

- met_link.tb
- com_link.tb
- lrt_link.tb
- new_link.tb

An excerpt of the Metrorail rail link file (met_link.tb) is shown in Figure 3-21. The first record of the file is for the rail link (tracks) between Shady Grove Metrorail Station (8001) and Rockville Metrorail Station (8002). Metrorail is mode code 3 and this segment of track has a distance of 2.61 miles. The speed coded for each rail link is a function of the rail link distance.

Figure 3-22 An excerpt of the Metrorail rail link file (met_link.tb)

| | | | | | | | | | | | |
|------|--------|-------|------|--------|----|-------|-----|---------|---|--------|-------|
| LINK | NODES= | 8001- | 8002 | MODES= | 03 | DIST= | 261 | ONEWAY= | N | SPEED= | 40.05 |
| LINK | NODES= | 8002- | 8003 | MODES= | 03 | DIST= | 213 | ONEWAY= | N | SPEED= | 40.20 |
| LINK | NODES= | 8003- | 8004 | MODES= | 03 | DIST= | 109 | ONEWAY= | N | SPEED= | 22.00 |
| LINK | NODES= | 8004- | 8005 | MODES= | 03 | DIST= | 135 | ONEWAY= | N | SPEED= | 41.40 |
| LINK | NODES= | 8005- | 8006 | MODES= | 03 | DIST= | 219 | ONEWAY= | N | SPEED= | 44.60 |
| LINK | NODES= | 8006- | 8007 | MODES= | 03 | DIST= | 102 | ONEWAY= | N | SPEED= | 31.50 |
| LINK | NODES= | 8007- | 8008 | MODES= | 03 | DIST= | 170 | ONEWAY= | N | SPEED= | 34.40 |
| LINK | NODES= | 8008- | 8009 | MODES= | 03 | DIST= | 91 | ONEWAY= | N | SPEED= | 23.40 |
| LINK | NODES= | 8009- | 8010 | MODES= | 03 | DIST= | 109 | ONEWAY= | N | SPEED= | 33.30 |
| LINK | NODES= | 8010- | 8011 | MODES= | 03 | DIST= | 55 | ONEWAY= | N | SPEED= | 18.90 |
| LINK | NODES= | 8011- | 8012 | MODES= | 03 | DIST= | 80 | ONEWAY= | N | SPEED= | 21.30 |
| LINK | NODES= | 8012- | 8013 | MODES= | 03 | DIST= | 115 | ONEWAY= | N | SPEED= | 35.70 |
| LINK | NODES= | 8013- | 8014 | MODES= | 03 | DIST= | 56 | ONEWAY= | N | SPEED= | 15.30 |
| LINK | NODES= | 8014- | 8015 | MODES= | 03 | DIST= | 79 | ONEWAY= | N | SPEED= | 22.20 |
| LINK | NODES= | 8015- | 8016 | MODES= | 03 | DIST= | 33 | ONEWAY= | N | SPEED= | 17.40 |
| LINK | NODES= | 8015- | 8068 | MODES= | 03 | DIST= | 46 | ONEWAY= | N | SPEED= | 24.60 |

3.3.7 Transfer Links

Non-transit links, or support links, include links to access the transit system, to egress from the transit system, and to transfer between transit routes. Transfer links are used to transfer between a rail mode (mode codes 3, 4, 5, and 10) and a non-rail mode (mode codes 1, 2, 6, 7, 8, and 9), such as from Metrorail to bus. Under current coding conventions, these rail-to-non-rail transit transfer links are designated mode code 12. There are four transfer link files:

- met_bus.tb
- com_bus.tb
- lrt_bus.tb
- new_bus.tb

An excerpt from the file containing transfer links between Metrorail stations and bus stops is shown in Figure 3-22.

Figure 3-23 An excerpt from the file (met_bus.tb) containing transfer links (mode 12) between Metrorail stations and bus stops

| | | | | | | | | | | |
|------------|-------|-------|---------|---|--------|----|--------|---|---------|---|
| SUPPORT N= | 8001- | 22395 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8001- | 22397 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8002- | 9005 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8002- | 22351 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8002- | 22370 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8003- | 22344 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8003- | 22672 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8004- | 22332 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8004- | 22670 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8005- | 22327 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8006- | 22054 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8007- | 22048 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8008- | 22864 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8009- | 20718 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8010- | 20753 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8011- | 20756 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8012- | 20763 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |
| SUPPORT N= | 8013- | 20503 | ONEWAY= | N | MODES= | 12 | DIST = | 1 | SPEED = | 3 |

The station file, mentioned earlier, contains up to four “bus” nodes for each rail station. “Bus node” means any transit node near the rail station that should be connected with the rail station. So, for example, for the Rockville Metrorail Station (8002), the first “bus” node (STAN1) is 9005, which is not a bus stop, but rather a commuter rail station (the Rockville MARC station). The pairing of each rail station and its associated “bus” nodes forms the transfer links that are found in the transfer link files.

3.3.8 Transit Line/Route Files

The AM Peak and Off-Peak transit line files are text files that contain operational information about individual transit lines/routes, including the average headway (frequency) for the time-of-day period, the average scheduled running time for the time-of-day period, and the route itinerary, which are the nodes through which the transit passes. Transit routes can be designated one-way or two-way. Figure 3-23 shows an example of a transit line file in TRNBUILD format for Mode 1 (local bus: Metrobus and DC Connector). The TPB transit networks currently designate ten mode codes as listed in Table 3-19 and Table 3-20.

Figure 3-24 Example of a transit line/route file in TRNBUILD (TB) format

```

;$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
;$   Scenario-----> base           *
;$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
;* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
;*               DC Circulator       *
;* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
LINE NAME="DC98",
OWNER="DC Circulator;NW 14TH ST & NW K ST;CALVERT ST NW & LANIER PL NW;2015;base",
ONEWAY= Y,MODE= 01,FREQ[1]= 10,RUNTIME= 30,
    N= 20072 -20426 -20425 -20424 -20423 21831 -20448 -20446 -20445,
        21746 -20413 21745 21822 21819 21744 -20371 21826 -20919,
        -20826 -20827 -20833 20829 -20605 20653 20652 21523 -20651,
        20650

;$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
;$   Scenario-----> base           *
;$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
;* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
;*               DC Circulator       *
;* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
LINE NAME="DC98S",
OWNER="DC Circulator;CONNECTICUT AVE & 24TH ST;NW 14TH ST & NW I ST ;2015;base",
ONEWAY= Y,MODE= 01,FREQ[1]= 10,RUNTIME= 35,
    N= 20650 -20651 21523 20652 20653 -20605 20829 -20833 -20827,
        -20826 -20919 21826 -20371 21744 21819 21822 21745 -20413,
        21746 -20445 -20407 -21766 21814 20406 20405 -20403 -20435,
        -20434 -20433 21631 20400 -20399 -20398 -20105 20104 20072
    
```

Ref: M:\fy17\CGV2_3_66_Conformity2016CLRP_Xmittal\2016_Base\Inputs\MODE1AM.TB

The average headways reflect the frequency of service, defined by the number of buses or rail cars that operate per hour per period (AM or off peak). The coded headways are subject to a maximum of 60 minutes during both AM peak and off-peak periods. Running time is defined as the average scheduled end-to-end route time in minutes during the given time-of-day period.

As was mentioned on page 48, in the path building process, transit routes that share the same mode code and share the same links can be combined, using TRNBUILD’s line combination procedures, such that the traveler experiences a new combined headway and runtime for the set of common routes.

A transit line file is divided into a series of transit lines/routes. For example, Figure 3-23 shows two bus routes for the DC Circulator: the 98 and the 98 South. Each route in the file begins with “header” information. The header section of any transit route in a transit line file is described in Table 3-25.

Table 3-26 Header section for each transit route in a transit line file

| File Name | Variable Name | Description |
|---------------------------------------|---------------|--|
| Mode<No. ><per>.tb | LINE NAME | Abbreviation of transit service provider name |
| | OWNER | The OWNER variable is currently being used to store five fields, which are separated by semicolons: <ol style="list-style-type: none"> 1. Transit operator 2. Origin 3. Destination 4. Year represented 5. Scenario |
| | ONEWAY | Y/N (Y= Yes and N=No) |
| | MODE | Transit mode codes (1 - 10) |
| | FREQ[1] | Average time between successive arrivals (or departures) of transit vehicles on a given route for the period (AM or OP). Also known as average headway. |
| | RUNTIME | Average time (in min) for the transit vehicle to go from the start to the finish of its route, for the given period (AM or OP) |

Key: <No.> 1-10
 <per> = AM (AM peak period) or OP (off-peak period), see pp. 2-3 to 2-4.

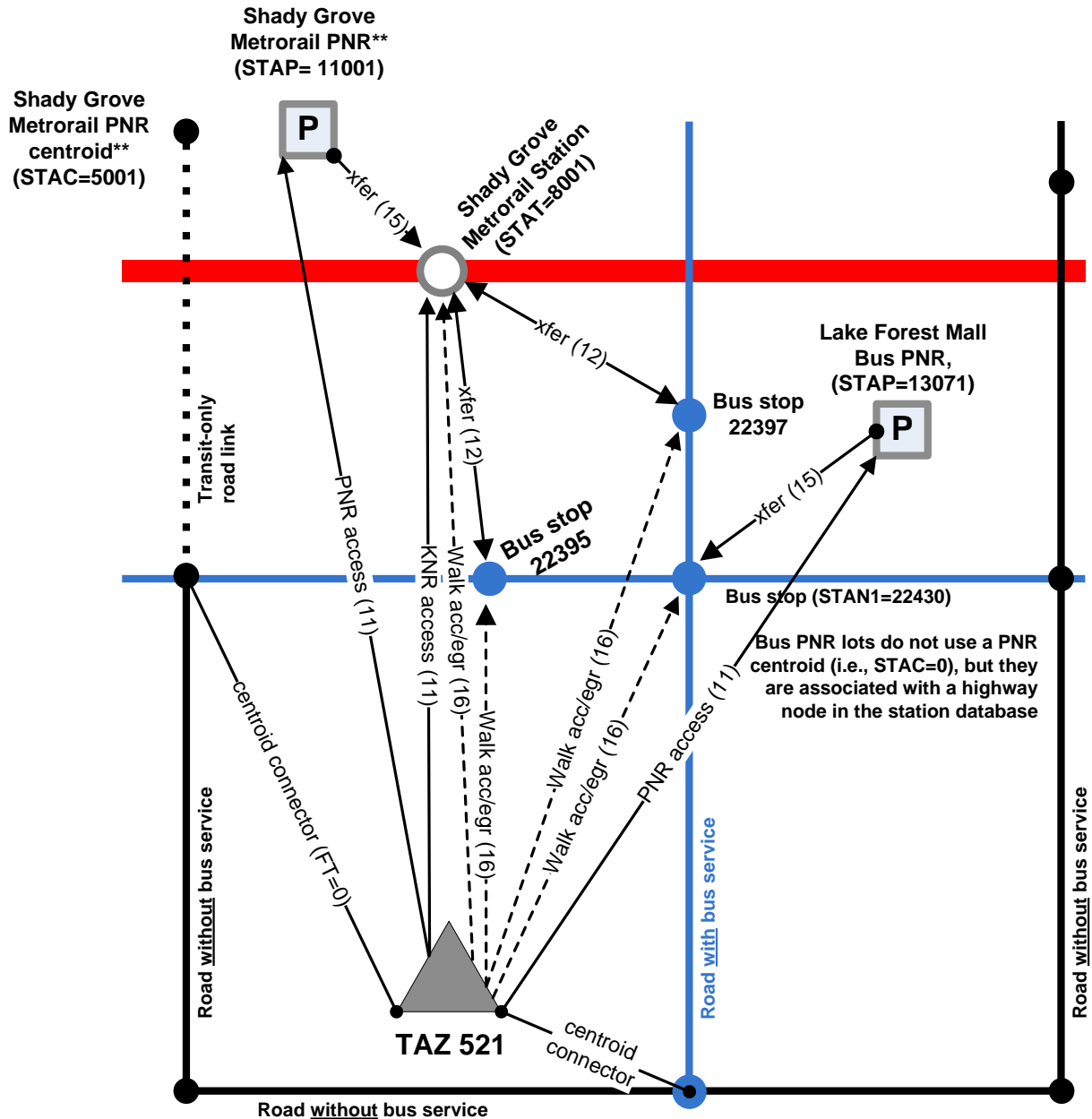
After the route header information, there is a node itinerary, which is a list through which the route passes.

The file extension of “TB” in the names of the line files (also sometimes called “mode files”) indicates “TRNBUILD” and was introduced by COG/TPB staff several years ago to differentiate the files from those formatted for the previous transit path builder, TRNPTH (“TP”). A more standard file extension for these types of files is “LIN,” which stands for transit line/route.

3.3.9 Example of network coding

Figure 3-24 shows a diagram that illustrates the existing MWCOC/TRNBUILD convention for network coding around rail stations (Metro or commuter rail), park-and-ride lots, and bus service.

Figure 3-25 Existing MWCOC/TRNBUILD convention for network coding around rail stations, park-and-ride lots, and bus service



Ref: "I:\ateam\docum\fy14\2013CLRP_Network_Report\network_coding_station_diagr_mwcog_trnbuild.vsd"

In Figure 3-24, numbers in parentheses are mode codes. For example, mode code 11 is drive access to transit, which can be either drive and park (PNR) or drive and drop off ("kiss and ride," KNR). Mode code 16 is for walk access or egress links. Two types of transfer links are shown in the diagram:

- Mode 12: Transfer between a rail mode and an non-rail transit mode (walk)
- Mode 15: Transfer between a PNR lot and the rail station (walk)

Also, the PNR node and the dummy PNR node are stored in the background highway network.

3.3.10 Transit route summaries

This section of the report presents transit route summaries. The highway and transit networks discussed in this report are based on the 2016 CLRP and FY 2017-2022 TIP. The 2016 CLRP and FY 2017-2022 TIP were also the basis for the networks used in the most recent air quality conformity analysis,¹⁹ which was approved by the TPB on November 16, 2016. The analysis years for the air quality conformity work were 2016, 2017, 2020, 2025, 2030 and 2040. Additionally, the base year for updating the transit information in the transit networks was 2015. Specifically, transit service was based on schedule information obtained in the fall/winter of 2015, and transit projects in the 2016 CLRP were added to the transit network for each appropriate forecast year. Thus, the years included in this report are: 2016, 2017, 2020, 2025, 2030 and 2040.

Summaries of the AM peak period Metrorail routes are shown in Table 3-26. Note that Table 3-26 does not show data for 2030 and 2040, since the Metrorail data for these two years was the same as that for 2025 (so only 2025 is shown in the Metrorail tables). The table lists COG/TPB's transit route name, origin and destination stations, average headways, average run-times, line distances, and average line speed for service during the AM peak hour and Off-peak period. Table 3-27 presents the same information, but for the off-peak period. Note that the Red Line has two different routes:

- Red Line A: From Shady Grove (end of the line) to Glenmont (end of the line)
- Red Line B: From Grosvenor to Silver Spring

This is reflected in the route names, e.g., Red-A and Red-B. Note: Some routes are denoted "A" even though there is only one of them, such as Green Line A ("Grn-A").

¹⁹ "Air Quality Conformity Analysis of the 2016 Constrained Long-Range Plan Amendment and the FY 2017-2022 Transportation Improvement Program for the Washington Metropolitan Region."

Table 3-27 AM peak-period Metrorail line summary by year: 2016, 2017, 2020, and 2025

| Transit Route Name | Transit Yr. | Origin | Destination | Hdwy | RT (mins.) | Dist. (mi) | Spd (mph) |
|--------------------|-------------|--------------------------------|---------------------|------|------------|------------|-----------|
| WMBLUA | 2016 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMYELB | 2016 | FRANCONIA/SPRINGFIELD | GREENBELT | 12 | 58 | 29 | 30 |
| WMGRNA | 2016 | GREENBELT | BRANCH AVE | 6 | 47 | 23 | 29 |
| WMSILV | 2016 | WIEHLE | LARGO TOWN CENTER | 6 | 75 | 32 | 26 |
| WMORNA | 2016 | VIENNA | NEW CARROLLTON | 6 | 57 | 26 | 27 |
| WMREDA | 2016 | SHADY GROVE METRO | GLENMONT METRO | 6 | 65 | 32 | 30 |
| WMREDB | 2016 | SILVER SPRING METRO | GROSVENOR METRO | 6 | 44 | 19 | 26 |
| WMYELA | 2016 | MT VERNON SQ/7TH ST-CONVENTION | HUNTINGTON AV METRO | 6 | 25 | 10 | 24 |
| WMBLUA | 2017 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMYELB | 2017 | FRANCONIA/SPRINGFIELD | GREENBELT | 12 | 58 | 29 | 30 |
| WMGRNA | 2017 | GREENBELT | BRANCH AVE | 6 | 47 | 23 | 29 |
| WMORNA | 2017 | VIENNA | NEW CARROLLTON | 6 | 57 | 26 | 27 |
| WMREDA | 2017 | SHADY GROVE METRO | GLENMONT METRO | 6 | 65 | 32 | 30 |
| WMREDB | 2017 | SILVER SPRING METRO | GROSVENOR METRO | 6 | 44 | 19 | 26 |
| WMYELA | 2017 | MT VERNON SQ/7TH ST-CONVENTION | HUNTINGTON AV METRO | 6 | 25 | 10 | 24 |
| WMSILV | 2017 | VA 772 | LARGO | 6 | 90 | 43 | 29 |
| WMBLUA | 2020 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMYELB | 2020 | FRANCONIA/SPRINGFIELD | GREENBELT | 12 | 58 | 29 | 30 |
| WMGRNA | 2020 | GREENBELT | BRANCH AVE | 6 | 47 | 23 | 29 |
| WMORNA | 2020 | VIENNA | NEW CARROLLTON | 6 | 57 | 26 | 27 |
| WMREDA | 2020 | SHADY GROVE METRO | GLENMONT METRO | 6 | 65 | 32 | 30 |
| WMREDB | 2020 | SILVER SPRING METRO | GROSVENOR METRO | 6 | 44 | 19 | 26 |
| WMYELA | 2020 | MT VERNON SQ/7TH ST-CONVENTION | HUNTINGTON AV METRO | 6 | 25 | 10 | 24 |
| WMSILV | 2020 | VA 772 | LARGO | 6 | 90 | 43 | 29 |
| WMBLUA | 2025 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 66 | 30 | 27 |
| WMYELB | 2025 | FRANCONIA/SPRINGFIELD | GREENBELT | 12 | 60 | 29 | 29 |
| WMGRNA | 2025 | GREENBELT | BRANCH AVE | 6 | 47 | 23 | 29 |
| WMORNA | 2025 | VIENNA | NEW CARROLLTON | 6 | 57 | 26 | 27 |
| WMREDA | 2025 | SHADY GROVE METRO | GLENMONT METRO | 6 | 65 | 32 | 30 |
| WMREDB | 2025 | SILVER SPRING METRO | GROSVENOR METRO | 6 | 44 | 19 | 26 |
| WMYELA | 2025 | MT VERNON SQ/7TH ST-CONVENTION | HUNTINGTON AV METRO | 6 | 27 | 11 | 24 |
| WMSILV | 2025 | VA 772 | LARGO | 6 | 90 | 43 | 29 |

Note: AM peak period is from 7:00 – 7:59 AM. Years 2030 and 2040 Metrorail data is the same as 2025.

Ref: "I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx"

Source: 2016 CLRP and FY2017-2022 TIP

Table 3-28 Off-peak period Metrorail line summary by year: 2016, 2017, 2020, and 2025

| Transit Route Name | Transit Yr. | Origin | Destination | Hdwy | RT (mins.) | Dist. (mi) | Spd (mph) |
|--------------------|-------------|-----------------------|-------------------|------|------------|------------|-----------|
| WMBLUA | 2016 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMGRNA | 2016 | GREENBELT | BRANCH AVE | 12 | 47 | 23 | 29 |
| WMSILV | 2016 | WIEHLE | LARGO TOWN CENTER | 12 | 75 | 32 | 26 |
| WMORNA | 2016 | VIENNA | NEW CARROLLTON | 12 | 57 | 26 | 27 |
| WMREDB | 2016 | SILVER SPRING METRO | GROSVENOR METRO | 12 | 43 | 19 | 27 |
| WMYELA | 2016 | FT TOTTEN | HUNTINGTON | 12 | 36 | 15 | 25 |
| WMREDA | 2016 | SHADY GROVE METRO | GLENMONT METRO | 12 | 63 | 32 | 30 |
| WMBLUA | 2017 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMGRNA | 2017 | GREENBELT | BRANCH AVE | 12 | 47 | 23 | 29 |
| WMORNA | 2017 | VIENNA | NEW CARROLLTON | 12 | 57 | 26 | 27 |
| WMREDB | 2017 | SILVER SPRING METRO | GROSVENOR METRO | 12 | 43 | 19 | 27 |
| WMYELA | 2017 | FT TOTTEN | HUNTINGTON | 12 | 36 | 15 | 25 |
| WMSILV | 2017 | VA 772 | LARGO | 12 | 75 | 32 | 26 |
| WMREDA | 2017 | SHADY GROVE METRO | GLENMONT METRO | 12 | 63 | 32 | 30 |
| WMBLUA | 2020 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 64 | 30 | 28 |
| WMGRNA | 2020 | GREENBELT | BRANCH AVE | 12 | 47 | 23 | 29 |
| WMORNA | 2020 | VIENNA | NEW CARROLLTON | 12 | 57 | 26 | 27 |
| WMREDB | 2020 | SILVER SPRING METRO | GROSVENOR METRO | 12 | 43 | 19 | 27 |
| WMYELA | 2020 | FT TOTTEN | HUNTINGTON | 12 | 36 | 15 | 25 |
| WMSILV | 2020 | VA 772 | LARGO | 12 | 90 | 43 | 29 |
| WMREDA | 2020 | SHADY GROVE METRO | GLENMONT METRO | 12 | 63 | 32 | 30 |
| WMBLUA | 2025 | FRANCONIA/SPRINGFIELD | LARGO TWN CTR | 12 | 66 | 30 | 27 |
| WMGRNA | 2025 | GREENBELT | BRANCH AVE | 12 | 47 | 23 | 29 |
| WMORNA | 2025 | VIENNA | NEW CARROLLTON | 12 | 57 | 26 | 27 |
| WMREDB | 2025 | SILVER SPRING METRO | GROSVENOR METRO | 12 | 43 | 19 | 27 |
| WMYELA | 2025 | FT TOTTEN | HUNTINGTON | 12 | 38 | 15 | 24 |
| WMSILV | 2025 | VA 772 | LARGO | 12 | 90 | 43 | 29 |
| WMREDA | 2025 | SHADY GROVE METRO | GLENMONT METRO | 12 | 63 | 32 | 30 |

Note: Off-peak period is from 10:00 AM- 2:59 PM

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx "

Source: 2016 CLRP and FY2017-2022 TIP

Line summaries for commuter rail are shown in Table 3-28 and Table 3-29. Table 3-28 covers the AM peak period and Table 3-29 covers the off-peak period for years 2016, 2017, 2020, and 2025 (and implicitly 2030 and 2040, since these years are the same as 2025). Starting year 2025 VRE will provide service between Union Station and Haymarket during both peak and off-peak periods (shown in a shade of gray in Table 3-30). Line summaries for light rail and BRT/ Streetcar are shown in Table 3-30 and Table 3-31. Table 3-31 covers the off-peak period summaries for the years 2016, 2017, 2020, 2025, and 2030 (and implicitly 2040, since this year is the same as 2030).

Table 3-29 AM peak-period commuter rail summary by year: 2016, 2017, 2020, and 20205 (Shaded cells new in 2016 CLRP)

| Transit Route Name | Transit Year | Origin | Destination | Hdwy | RT(mins.) | Dis.(mi) | Spd(mph) |
|--------------------|--------------|--------------------------|--------------------------|------|-----------|----------|----------|
| AMTK86I | 2016 | Fredericksburg | UNION STATION VRE | 60 | 79 | 60 | 46 |
| MBR876 | 2016 | BRUNSWICK STATION | UNION STATION | 60 | 95 | 50 | 32 |
| MBR878 | 2016 | Duffields WVA | Union Station | 60 | 111 | 62 | 34 |
| MCAM847 | 2016 | DORSEY | UNION STATION | 60 | 54 | 25 | 28 |
| MCAM840 | 2016 | UNION STATION | DORSEY | 60 | 47 | 25 | 32 |
| MP409 | 2016 | BWI | UNION STATION | 60 | 36 | 30 | 50 |
| MP407511 | 2016 | BWI | UNION STATION | 30 | 42 | 30 | 43 |
| MBR892 | 2016 | FREDERICK | UNION | 60 | 111 | 56 | 30 |
| MCAM845 | 2016 | DORSEY | Washington-Union | 60 | 50 | 25 | 30 |
| MP404 | 2016 | Washington-Union | BWI | 60 | 32 | 30 | 56 |
| MP502 | 2016 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| VFRED1I | 2016 | Spotsylvania | Washington-Union Station | 30 | 101 | 60 | 36 |
| VMAS321 | 2016 | Washington-Union Station | Broad Run | 60 | 75 | 36 | 29 |
| VMAS51I | 2016 | BROAD RUN AIRPORT VRE | UNION STATION | 30 | 79 | 36 | 27 |
| AMTK86I | 2017 | Fredericksburg | UNION STATION VRE | 60 | 81 | 60 | 44 |
| MBR876 | 2017 | BRUNSWICK STATION | UNION STATION | 60 | 95 | 50 | 32 |
| MBR878 | 2017 | Duffields WVA | Union Station | 60 | 111 | 62 | 34 |
| MCAM847 | 2017 | DORSEY | UNION STATION | 60 | 54 | 25 | 28 |
| MCAM840 | 2017 | UNION STATION | DORSEY | 60 | 47 | 25 | 32 |
| MP407511 | 2017 | BWI | UNION STATION | 30 | 42 | 30 | 43 |
| MBR892 | 2017 | FREDERICK | UNION | 60 | 111 | 56 | 30 |
| MCAM845 | 2017 | DORSEY | Washington-Union | 60 | 50 | 25 | 30 |
| MP404 | 2017 | Washington-Union | BWI | 60 | 32 | 30 | 56 |
| MP502 | 2017 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| MP409 | 2017 | BWI | UNION STATION | 60 | 36 | 30 | 50 |
| VMAS321 | 2017 | Washington-Union Station | Broad Run | 60 | 75 | 36 | 29 |
| VMAS51I | 2017 | BROAD RUN AIRPORT VRE | UNION STATION | 30 | 79 | 36 | 27 |
| VFRED1I | 2017 | Spotsylvania | Washington-Union Station | 30 | 103 | 60 | 35 |
| AMTK86I | 2020 | Fredericksburg | UNION STATION VRE | 60 | 81 | 60 | 44 |
| MCAM840 | 2020 | UNION STATION | DORSEY | 60 | 47 | 25 | 32 |
| MBR876 | 2020 | BRUNSWICK STATION | UNION STATION | 60 | 95 | 50 | 32 |
| MBR878 | 2020 | Duffields WVA | Union Station | 60 | 111 | 62 | 34 |
| MCAM847 | 2020 | DORSEY | UNION STATION | 60 | 54 | 25 | 28 |
| MP407511 | 2020 | BWI | UNION STATION | 30 | 42 | 30 | 43 |
| MBR892 | 2020 | FREDERICK | UNION | 60 | 111 | 56 | 30 |
| MCAM845 | 2020 | DORSEY | Washington-Union | 60 | 50 | 25 | 30 |
| MP404 | 2020 | Washington-Union | BWI | 60 | 32 | 30 | 56 |
| MP502 | 2020 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| MP409 | 2020 | BWI | UNION STATION | 60 | 36 | 30 | 50 |
| VMAS321 | 2020 | Washington-Union Station | Broad Run | 60 | 75 | 36 | 29 |
| VMAS51I | 2020 | BROAD RUN AIRPORT VRE | UNION STATION | 60 | 79 | 36 | 27 |
| VFRED1I | 2020 | Spotsylvania | Washington-Union Station | 20 | 103 | 60 | 35 |
| AMTK86I | 2025 | Fredericksburg | UNION STATION VRE | 60 | 81 | 60 | 44 |
| MCAM840 | 2025 | UNION STATION | DORSEY | 60 | 47 | 25 | 32 |
| MBR876 | 2025 | BRUNSWICK STATION | UNION STATION | 60 | 95 | 50 | 32 |
| MBR878 | 2025 | Duffields WVA | Union Station | 60 | 111 | 62 | 34 |
| MCAM847 | 2025 | DORSEY | UNION STATION | 60 | 54 | 25 | 28 |
| MP407511 | 2025 | BWI | UNION STATION | 30 | 42 | 30 | 43 |
| MBR892 | 2025 | FREDERICK | UNION | 60 | 111 | 56 | 30 |
| MCAM845 | 2025 | DORSEY | Washington-Union | 60 | 50 | 25 | 30 |
| MP404 | 2025 | Washington-Union | BWI | 60 | 32 | 30 | 56 |
| MP502 | 2025 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| MP409 | 2025 | BWI | UNION STATION | 60 | 36 | 30 | 50 |
| VMAS321 | 2025 | Washington-Union Station | Broad Run | 60 | 75 | 36 | 29 |
| VMAS51I | 2025 | BROAD RUN AIRPORT VRE | UNION STATION | 60 | 79 | 36 | 27 |
| VMAS51H | 2025 | Haymarket | Union Station | 30 | 94 | 43 | 27 |
| VMAS321H | 2025 | UNION STATION | Haymarket | 60 | 90 | 43 | 29 |
| VFRED1I | 2025 | Spotsylvania | Washington-Union Station | 20 | 103 | 60 | 35 |

Note: AM peak period is from 6:00 – 6:59 AM. Years 2030 and 2040 commuter rail data is the same as 2025.

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx "

Source: 2016 CLRP and FY2017-2022 TIP

Table 3-30 Off-peak-period commuter rail summary by year: 2016, 2017, 2020, and 2025 (Shaded cells new in 2016 CLRP)

| Transit Route Name | Transit Year | Origin | Destination | Hdwy | RT(mins.) | Dis.(mi) | Spd(mph) |
|--------------------|--------------|--------------------------|--------------------------|------|-----------|----------|----------|
| AMTK94I | 2016 | Fredericksburg | Washington-Union Station | 60 | 87 | 60 | 41 |
| AMTK95O | 2016 | UNION STATION VRE | Fredericksburg | 60 | 70 | 60 | 51 |
| AMTK176 | 2016 | MANASSAS | UNION STATION | 60 | 61 | 33 | 32 |
| MBR871 | 2016 | UNION STATION | BRUNSWICK STATION | 60 | 94 | 50 | 32 |
| MPEN1O | 2016 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| MPEN1I | 2016 | BWI | UNION STATION | 60 | 39 | 30 | 46 |
| VFR301 | 2016 | Washington-Union Station | Spotsylvania | 60 | 104 | 60 | 35 |
| VMAS336 | 2016 | Broad Run | Washington-Union Station | 60 | 70 | 36 | 31 |
| VMAS325 | 2016 | UNION STATION | BROAD RUN | 60 | 79 | 36 | 27 |
| AMTK94I | 2017 | Fredericksburg | Washington-Union Station | 60 | 89 | 60 | 40 |
| AMTK95O | 2017 | UNION STATION VRE | Fredericksburg | 60 | 72 | 60 | 50 |
| AMTK176 | 2017 | MANASSAS | UNION STATION | 60 | 61 | 33 | 32 |
| MBR871 | 2017 | UNION STATION | BRUNSWICK STATION | 60 | 94 | 50 | 32 |
| MPEN1I | 2017 | BWI | UNION STATION | 60 | 39 | 30 | 46 |
| MPEN1O | 2017 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| VFR301 | 2017 | Washington-Union Station | Spotsylvania | 60 | 106 | 60 | 34 |
| VMAS336 | 2017 | Broad Run | Washington-Union Station | 60 | 70 | 36 | 31 |
| VMAS325 | 2017 | UNION STATION | BROAD RUN | 60 | 79 | 36 | 27 |
| AMTK94I | 2020 | Fredericksburg | Washington-Union Station | 60 | 89 | 60 | 40 |
| AMTK95O | 2020 | UNION STATION VRE | Fredericksburg | 60 | 72 | 60 | 50 |
| AMTK176 | 2020 | MANASSAS | UNION STATION | 60 | 61 | 33 | 32 |
| MBR871 | 2020 | UNION STATION | BRUNSWICK STATION | 60 | 94 | 50 | 32 |
| MPEN1I | 2020 | BWI | UNION STATION | 60 | 39 | 30 | 46 |
| MPEN1O | 2020 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| VFR301 | 2020 | Washington-Union Station | Spotsylvania | 60 | 106 | 60 | 34 |
| VMAS336 | 2020 | Broad Run | Washington-Union Station | 60 | 70 | 36 | 31 |
| VMAS325 | 2020 | UNION STATION | BROAD RUN | 60 | 79 | 36 | 27 |
| AMTK94I | 2025 | Fredericksburg | Washington-Union Station | 60 | 89 | 60 | 40 |
| AMTK95O | 2025 | UNION STATION VRE | Fredericksburg | 60 | 72 | 60 | 50 |
| AMTK176 | 2025 | MANASSAS | UNION STATION | 60 | 61 | 33 | 32 |
| MBR871 | 2025 | UNION STATION | BRUNSWICK STATION | 60 | 94 | 50 | 32 |
| MPEN1I | 2025 | BWI | UNION STATION | 60 | 39 | 30 | 46 |
| MPEN1O | 2025 | UNION STATION | BWI | 60 | 35 | 30 | 51 |
| VMAS325H | 2025 | Union Station | Haymarket | 60 | 94 | 43 | 27 |
| VMAS336H | 2025 | Haymarket | UNION STATION | 60 | 85 | 43 | 30 |
| VFR301 | 2025 | Washington-Union Station | Spotsylvania | 60 | 106 | 60 | 34 |
| VMAS336 | 2025 | Broad Run | Washington-Union Station | 60 | 70 | 36 | 31 |
| VMAS325 | 2025 | UNION STATION | BROAD RUN | 60 | 79 | 36 | 27 |

Note: Off-peak period is from 10:00 AM- 2:59 PM. Years 2030 and 2040 commuter rail data is the same as 2025.

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx "

Source: 2016 CLRP and FY2017-2022 TIP

Table 3-31 AM peak-period Light Rail / BRT Streetcar summary by year: 2016, 2017, 2020, 2025, and 2030

| Transit Route Name | Transit Year | Origin | Destination | Hdwy | RT(mins.) | Dis.(mi) | Spd(mph) |
|--------------------|--------------|--------------------------|--------------------------|------|-----------|----------|----------|
| DCSTHST1 | 2016 | UNION STATION | OKLAHOMA AVE | 15 | 12 | 1 | 5 |
| MWAYN | 2016 | Braddock Rd Metro | Pentagon City Metro | 12 | 25 | 4 | 10 |
| MWAYN/ | 2016 | Reed-Potomac Yards Metro | Crystal City Metro | 12 | 12 | 2 | 10 |
| MWAYS | 2016 | Pentagon City | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| MWAYS/ | 2016 | Crystal City Metro | Reed-Potomac Yards Metro | 12 | 8 | 2 | 15 |
| DCSTHST1 | 2017 | UNION STATION | OKLAHOMA AVE | 15 | 12 | 1 | 5 |
| MWAYN | 2017 | Braddock Rd Metro | Pentagon City Metro | 12 | 25 | 4 | 10 |
| MWAYN/ | 2017 | Reed-Potomac Yards Metro | Crystal City Metro | 12 | 12 | 2 | 10 |
| MWAYS | 2017 | Pentagon City | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| MWAYS/ | 2017 | Crystal City Metro | Reed-Potomac Yards Metro | 12 | 8 | 2 | 15 |
| DCSTCARA | 2017 | BOLLING AFB | GOOD HOPE RD & MLK | 15 | 12 | 1 | 5 |
| DCSTHST1 | 2020 | UNION STATION | OKLAHOMA AVE | 15 | 12 | 1 | 5 |
| MWAYN | 2020 | Braddock Rd Metro | Pentagon City Metro | 12 | 25 | 4 | 10 |
| MWAYN/ | 2020 | Reed-Potomac Yards Metro | Crystal City Metro | 12 | 12 | 2 | 10 |
| MWAYS | 2020 | Pentagon City Metro | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| MWAYS/ | 2017 | Crystal City Metro | Reed-Potomac Yards Metro | 12 | 8 | 2 | 15 |
| DCSTCARA | 2020 | BOLLING AFB | GOOD HOPE RD & MLK | 15 | 12 | 1 | 5 |
| DCSTHST2 | 2020 | UNION STATION | BENNING RD METRO | 10 | 24 | 4 | 10 |
| DCSTMST | 2020 | Good Hope Rd SE | Maine Ave. SW | 15 | 20 | 2 | 6 |
| CCTBRT | 2020 | METRO GROVE | SHADY GROVE | 4 | 25 | 10 | 24 |
| PURPLE | 2020 | Bethesda | New Carrollton | 6 | 59 | 16 | 16 |
| PURPLE | 2025 | Bethesda | New Carrollton | 6 | 59 | 16 | 16 |
| DCSTHST1 | 2025 | UNION STATION | OKLAHOMA AVE | 15 | 12 | 1 | 5 |
| MWAYN | 2025 | Braddock Rd Metro | Pentagon City Metro | 12 | 22 | 1 | 3 |
| MWAYN/ | 2025 | Reed-Potomac Yards Metro | Crystal City Metro | 12 | 11 | 2 | 11 |
| MWAYS | 2025 | Pentagon City Metro | Braddock Rd Metro | 12 | 22 | 4 | 11 |
| MWAYS/ | 2025 | Crystal City Metro | Reed-Potomac Yards Metro | 12 | 7 | 2 | 17 |
| DCSTCARA | 2025 | BOLLING AFB | GOOD HOPE RD & MLK | 15 | 12 | 4 | 20 |
| DCSTHST2 | 2025 | UNION STATION | BENNING RD METRO | 10 | 24 | 1 | 3 |
| DCSTMST | 2025 | Good Hope Rd SE | Maine Ave. SW | 15 | 20 | 4 | 12 |
| DCSTGTWN | 2025 | Union Station/ H St. | Georgetown | 10 | 25 | 2 | 5 |
| CCTBRT | 2025 | COMSAT | SHADY GROVE | 4 | 25 | 3 | 7 |
| US1BRT | 2030 | HUNTINGTON METRO STATION | WOODBIDGE VRE | 6 | 38 | 15 | 24 |
| DCSTHST1 | 2030 | UNION STATION | OKLAHOMA AVE | 15 | 12 | 1 | 5 |
| MWAYN | 2030 | Braddock Rd Metro | Crystal City Metro | 12 | 22 | 4 | 11 |
| MWAYN/ | 2030 | Reed-Potomac Yards Metro | Crystal City Metro | 12 | 11 | 2 | 11 |
| MWAYS | 2030 | Crystal City Metro | Braddock Rd Metro | 12 | 22 | 4 | 11 |
| MWAYS/ | 2030 | Crystal City Metro | Reed-Potomac Yards Metro | 12 | 7 | 2 | 17 |
| DCSTCARA | 2030 | BOLLING AFB | GOOD HOPE RD & MLK | 15 | 12 | 1 | 5 |
| DCSTHST2 | 2030 | UNION STATION | BENNING RD METRO | 10 | 24 | 4 | 10 |
| DCSTMST | 2030 | Good Hope Rd SE | Maine Ave. SW | 15 | 20 | 2 | 6 |
| DCSTGTWN | 2030 | Union Station/ H St. | Georgetown | 10 | 25 | 3 | 7 |
| CCTBRT | 2030 | COMSAT | SHADY GROVE | 4 | 25 | 10 | 24 |
| PURLRT | 2030 | Bethesda | New Carrollton | 6 | 59 | 16 | 16 |

Note: AM peak period is from 7:00 – 7:59 AM. Year 2040 Light Rail / BRT Street car data is the same as 2030

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx "

Source: 2016 CLRP and FY2017-2022 TIP

Table 3-32 Off-peak-period Light Rail / BRT Streetcar summary by year: 2016, 2017, 2020, 2025, 2030

| Transit Route Name | Transit Year | Origin | Destination | Hdwy | RT(mins.) | Dis.(mi) | Spd(mph) |
|--------------------|--------------|----------------------|---------------------|------|-----------|----------|----------|
| DCSTHST1 | 2016 | UNION STATION | OKLAHOMA AVE | 30 | 12 | 1 | 5 |
| MWAYN | 2016 | Braddock Rd Metro | Pentagon City Metro | 12 | 22 | 4 | 11 |
| MWAYS | 2016 | Pentagon City Metro | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| DCSTHST1 | 2017 | UNION STATION | OKLAHOMA AVE | 30 | 12 | 1 | 5 |
| MWAYN | 2017 | Braddock Rd Metro | Pentagon City Metro | 12 | 22 | 4 | 11 |
| MWAYS | 2017 | Pentagon City Metro | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| DCSTCARA | 2017 | BOLLING AFB | GOOD HOPE RD & MLK | 30 | 12 | 1 | 5 |
| MWAYN | 2020 | Braddock Rd Metro | Pentagon City Metro | 12 | 22 | 4 | 11 |
| MWAYS | 2020 | Pentagon City Metro | Braddock Rd Metro | 12 | 24 | 4 | 10 |
| DCSTCARA | 2020 | BOLLING AFB | GOOD HOPE RD & MLK | 30 | 12 | 1 | 5 |
| DCSTHST2 | 2020 | UNION STATION | BENNING ROAD METRO | 10 | 24 | 4 | 10 |
| DCSTMST | 2020 | Good Hope Rd SE | Maine Ave. SW | 30 | 20 | 2 | 6 |
| PURLRT | 2020 | Bethesda | New Carrollton | 12 | 59 | 16 | 16 |
| CCTBRT | 2020 | METRO GROVE | SHADY GROVE | 8 | 25 | 10 | 24 |
| DCSTHST1 | 2025 | UNION STATION | OKLAHOMA AVE | 30 | 12 | 1 | 5 |
| MWAYN | 2025 | Braddock Rd Metro | Pentagon City Metro | 12 | 20 | 4 | 12 |
| MWAYS | 2025 | Pentagon City Metro | Braddock Rd Metro | 12 | 22 | 4 | 11 |
| DCSTCARA | 2025 | BOLLING AFB | GOOD HOPE RD & MLK | 30 | 12 | 1 | 5 |
| DCSTHST2 | 2025 | UNION STATION | BENNING ROAD METRO | 10 | 24 | 4 | 10 |
| DCSTMST | 2025 | Good Hope Rd SE | Maine Ave. SW | 30 | 20 | 2 | 6 |
| DCSTGTWN | 2025 | Union Station/ H St. | Georgetown | 10 | 25 | 3 | 7 |
| CCTBRT | 2025 | METRO GROVE | SHADY GROVE | 8 | 25 | 10 | 24 |
| PURPLE | 2025 | Bethesda | New Carrollton | 12 | 59 | 16 | 16 |
| US1BRT | 2030 | HUNTINGTON METRO S | WOODBIDGE VRE | 12 | 38 | 1 | 2 |
| DCSTHST1 | 2030 | UNION STATION | OKLAHOMA AVE | 30 | 12 | 4 | 20 |
| MWAYN | 2030 | Braddock Rd Metro | Pentagon City Metro | 12 | 20 | 4 | 12 |
| MWAYS | 2030 | Pentagon City Metro | Braddock Rd Metro | 12 | 22 | 1 | 3 |
| DCSTCARA | 2030 | BOLLING AFB | GOOD HOPE RD & MLK | 30 | 12 | 4 | 20 |
| DCSTHST2 | 2030 | UNION STATION | BENNING ROAD METRO | 10 | 24 | 2 | 5 |
| DCSTMST | 2030 | Good Hope Rd SE | Maine Ave. SW | 30 | 20 | 3 | 9 |
| DCSTGTWN | 2030 | Union Station/ H St. | Georgetown | 10 | 25 | 10 | 24 |
| CCTBRT | 2030 | METRO GROVE | SHADY GROVE | 8 | 25 | 15 | 36 |
| PURLRT | 2030 | Bethesda | New Carrollton | 12 | 59 | 16 | 16 |

Note: Off-peak period is from 10:00 AM- 2:59 PM. Year 2040 Light Rail / BRT Street car data is the same as 2030.

Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\CLRP_2016_Met_Com_BRT_Files_Updated.xlsx "

Source: 2016 CLRP and FY2017-2022 TIP

Summaries of transit service in the TPB modeled region by mode and time period are shown in Table 3-32. The year 2040 transit service is the same as that shown for the year-2030 network except for mode 7, Primary Express Bus. Where number of transit lines increase from 47 to 57 and transit line miles increase from 1,283 to 1,473. The transit lines shown are directional, i.e., transit lines coded as two-way are counted twice and one-way routes are counted once. From 2016 to 2040, it is expected that the AM lane-miles of transit will increase by 1,380 miles and the off-peak lane-miles of transit will increase by 535 miles.

Table 3-33 Number of transit lines and line miles coded in networks: 2016, 2017, 2020, 2025, 2030 and 2040

| AM Period | | 2016 | | 2017 | | 2020 | | 2025 | | 2030 | | 2040 | | Diff 2040 - 2016 | |
|-----------------|-----------------------|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|------------------|--------------------|
| Mode | Mode Description | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles |
| 1 | Local Metrobus | 397 | 3,389 | 397 | 3,399 | 397 | 3,401 | 397 | 3,401 | 397 | 3,401 | 397 | 3,401 | 0 | 12 |
| 2 | Express Metrobus | 44 | 555 | 44 | 555 | 54 | 730 | 54 | 730 | 54 | 730 | 54 | 730 | 10 | 175 |
| 3 | Metrorail | 16 | 401 | 16 | 401 | 16 | 424 | 16 | 425 | 16 | 425 | 16 | 425 | 0 | 24 |
| 4 | Commuter Rail | 14 | 554 | 14 | 554 | 14 | 554 | 16 | 640 | 20 | 794 | 20 | 794 | 6 | 241 |
| 5 | Light Rail | 0 | 0 | 0 | 0 | 2 | 31 | 2 | 31 | 2 | 31 | 2 | 31 | 2 | 31 |
| 6 | Primary Local Bus | 358 | 3,143 | 358 | 3,143 | 376 | 3,344 | 376 | 3,347 | 376 | 3,348 | 376 | 3,348 | 18 | 205 |
| 7 | Primary Express Bus | 29 | 857 | 29 | 857 | 29 | 857 | 46 | 1,263 | 47 | 1,283 | 57 | 1,473 | 28 | 616 |
| 8 | Secondary Local Bus | 151 | 1,862 | 151 | 1,862 | 151 | 1,862 | 151 | 1,862 | 151 | 1,862 | 151 | 1,862 | 0 | 0 |
| 9 | Secondary Express Bus | 72 | 2,622 | 72 | 2,622 | 72 | 2,622 | 72 | 2,630 | 72 | 2,630 | 72 | 2,630 | 0 | 8 |
| 10 | BRT/Streetcar | 6 | 14 | 8 | 16 | 12 | 46 | 14 | 53 | 16 | 83 | 16 | 83 | 10 | 68 |
| Sum | | 1,087 | 13,397 | 1,089 | 13,409 | 1,123 | 13,870 | 1,144 | 14,383 | 1,151 | 14,587 | 1,161 | 14,777 | 74 | 1,380 |
| Off Peak Period | | 2016 | | 2017 | | 2020 | | 2025 | | 2030 | | 2040 | | Diff 2040 - 2016 | |
| Mode | Mode Description | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles | # Transit Lines | Transit Line miles |
| 1 | Local Metrobus | 312 | 2,742 | 312 | 2,752 | 312 | 2,754 | 312 | 2,754 | 312 | 2,754 | 312 | 2,754 | 0 | 11 |
| 2 | Express Metrobus | 15 | 239 | 15 | 239 | 23 | 379 | 23 | 379 | 23 | 379 | 23 | 379 | 8 | 140 |
| 3 | Metrorail | 14 | 353 | 14 | 353 | 14 | 376 | 14 | 377 | 14 | 377 | 14 | 377 | 0 | 24 |
| 4 | Commuter Rail | 9 | 393 | 9 | 393 | 9 | 393 | 11 | 479 | 11 | 479 | 11 | 479 | 2 | 87 |
| 5 | Light Rail | 0 | 0 | 0 | 0 | 2 | 31 | 2 | 31 | 2 | 31 | 2 | 31 | 2 | 31 |
| 6 | Primary Local Bus | 279 | 2,480 | 279 | 2,480 | 287 | 2,564 | 287 | 2,565 | 287 | 2,566 | 287 | 2,566 | 8 | 86 |
| 7 | Primary Express Bus | 14 | 422 | 14 | 421 | 14 | 421 | 18 | 509 | 18 | 509 | 18 | 509 | 4 | 87 |
| 8 | Secondary Local Bus | 177 | 2,113 | 177 | 2,113 | 177 | 2,113 | 177 | 2,113 | 177 | 2,113 | 177 | 2,113 | 0 | 0 |
| 9 | Secondary Express Bus | 32 | 1,160 | 32 | 1,160 | 32 | 1,160 | 32 | 1,160 | 32 | 1,160 | 32 | 1,160 | 0 | 0 |
| 10 | BRT/Streetcar | 4 | 11 | 6 | 13 | 10 | 43 | 12 | 50 | 14 | 80 | 14 | 80 | 10 | 68 |
| Sum | | 856 | 9,913 | 858 | 9,924 | 880 | 10,234 | 888 | 10,417 | 890 | 10,448 | 890 | 10,448 | 34 | 535 |

Source: 2016 CLRP and FY2017-2022 TIP

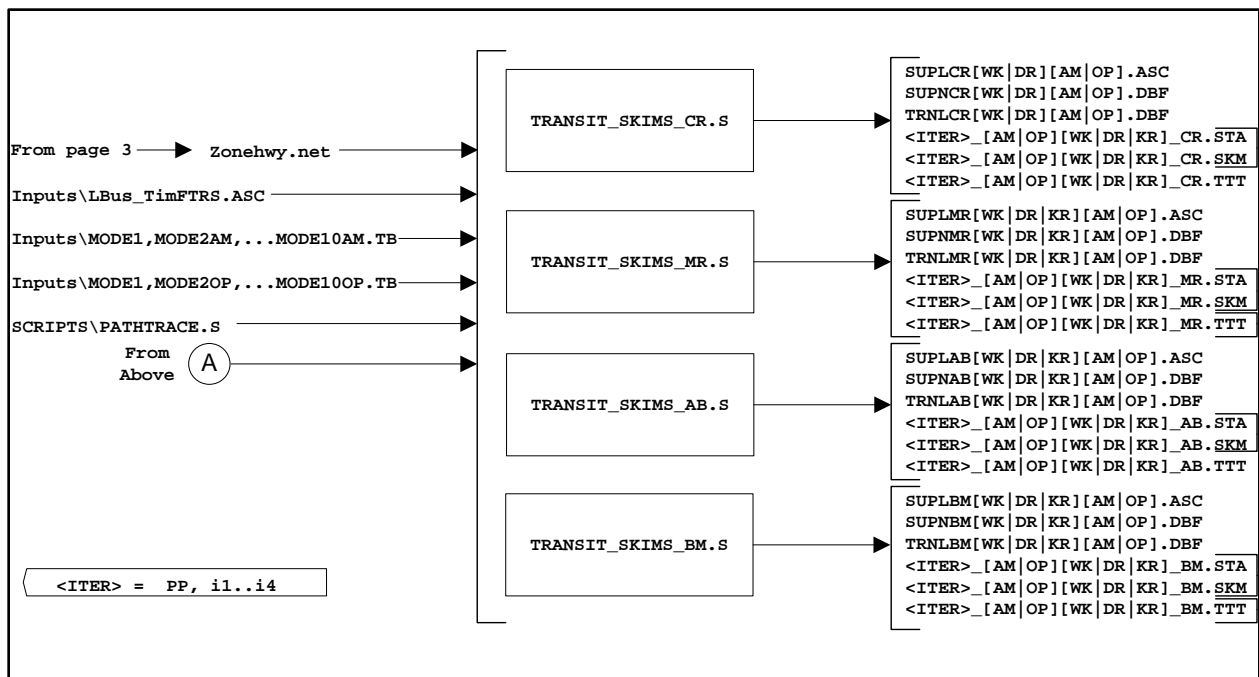
Notes: Lane miles are directional, not centerline.

Ref: I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\Trn_Lines_Miles.xlsx

3.4 Transit path building

The transit path building and path skimming process involves the development of 22 sets of level-of-service (LOS) skims (matrices) corresponding to two time-of-day period (peak and off-peak), by four transit sub-modes (bus only, Metrorail only, bus-Metrorail combination, and commuter rail), by three access modes (walk, PNR, KNR). For the calculation of average headways and run times, the peak period is represented by the AM peak hour, and the off-peak period is represented by the five-hour midday period. Although one might expect 24 sets of skims (2x3x4), there are only 22 since KNR access to commuter rail mode is not considered by the mode choice model, and so the total number of required path sets equals 22. This process is shown schematically in Figure 3-25 and is covered in more detail in Chapter 21 Section 21.6 of the Version 2.3.66 User’s Guide dated February 13, 2017.

Figure 3-26 Process for conducting transit path building



3.5 Transit Fare Files

3.5.1 Gathering fare data from the transit providers

WMATA is the dominant transit operator in the Washington, D.C. area, operating both the Metrorail and Metrobus systems. WMATA was created in 1967 as an interstate compact agency.²⁰ The formal name for its area of coverage is the “Washington Metropolitan Area Transit Zone” (WMATZ), but it is more commonly referred to as the WMATA Compact area. As of 2009, the area includes the following jurisdictions:

- District of Columbia
- The following cities in Virginia
 - Alexandria
 - Falls Church
 - Fairfax
- The following counties in Virginia
 - Arlington
 - Fairfax
 - Loudoun
- The following counties in Maryland
 - Montgomery
 - Prince George’s

The tariff used for this analysis was Tariff #33v2, effective July 1, 2014.

In addition to the WMATA tariff, transit fare data is collected for the other transit operators in the modeled area, such as Ride On, ART, Fairfax Connector, MARC, VRE, and PRTC/Omni. A recent memo discusses the collection of transit fare data for the region.²¹ A 2016 version of this memo is expected soon.

3.5.2 Calculating zone-to-zone fares used by the model

The COG transit fare programs are known as MFARE1 and MFARE2. These were originally written as UMODEL programs, known as RPFARE1 and RPFARE2,²² within the UTPS mainframe software system. In the early 1990s, they were then converted to FORTRAN programs called MFARE1 and MFARE2 for the Maryland Department of Transportation, and then, a year later, they were converted to Microsoft FORTRAN 5.0 for use with MINUTP.²³ The FORTRAN version was used in the Version 2.1D #50 Travel Model, in 2004. In 2007 or 2008, MFARE1 and MFARE2 were converted to TP+ scripts (which is now

²⁰ “WMATA Compact, as Amended through August 2009” (Washington Metropolitan Area Transit Authority, August 2009), http://www.wmata.com/about_metro/docs/Compact_Annotated_2009_final.pdf.

²¹ Jane Posey to Files, “Transit Fares for the 2014 CLRP and FY 2015-2020 TIP Air Quality Conformity Analysis,” Memorandum, (December 31, 2014).

²² “RP” stands for the name of the original developer: Richard Pratt.

²³ William G. Allen Jr., “User’s Guide for the MWCOG Fare Programs, Microcomputer Version,” Final (Metropolitan Washington Council of Governments, June 1992), 2.

Cube Voyager), though the conversion was not documented, and the MFARE1 and MFARE2 scripts were first used in the Version 2.2 Travel Model in the spring of 2008.

MFARE1 estimates station-to-station Metrorail fares, which are distance based. Per WMATA policy, the distance used is the “composite distance,” which is the average of the straight-line (airline) distance between Metrorail stations and the actual over-the-rail distance between stations.²⁴ **MFARE2 first calculates non-Metrorail transit fares (commonly referred to as “bus” fares**, even though non-Metrorail transit also includes commuter rail, LRT, and BRT). **Next, MFARE2 outputs the following zone-to-zone matrices:**

1. Total transit fares. For paths that include Metrorail, this would include both the Metrorail fare and any other non-Metrorail transit fare that is involved.
2. Metrorail-only fares
3. “Bus”-only fares (i.e., non-Metrorail-transit-only fares)
4. “Bus” access to Metrorail fares (i.e., non-Metrorail-transit access to Metrorail fares)
5. “Bus” egress from Metrorail fares (i.e., non-Metrorail-transit egress from Metrorail fares)²⁵

MFARE1 estimates station-to-station Metrorail fares using the composite distance, according to the following procedure, which is based on rules in the WMATA tariff:

- A fixed boarding fare charged for the first few miles.
- A secondary fare charged for the next few miles.
- A "tertiary" fare per mile charged for the remaining miles of the trips.
- The sum of above three fare elements should be less or equal to a maximum fare.
- Calculate discounted fare which applies to certain stations.
- Output final fares to a station-to-station matrix.²⁶

One of the key inputs to the MFARE1 process is the section of the WMATA Tariff dealing with Metrorail fares (see, for example, Table 3-33). From this table, we can see that there is a peak and an off-peak fare and there is a maximum peak and off peak fare (\$5.90 and \$3.60). However, as noted at the bottom of the table, there is a \$1.00 surcharge for all non-SmarTrip single-ride fares. Since the travel model cannot differentiate SmarTrip card users from non-SmarTrip card users, an adjustment is made to fare data input to the model. According to WMATA, 10% of Metrorail riders use cash farecards, which means their base fare is \$3.15, not \$2.15. Assuming that the remaining 90% are paying with a SmarTrip (or a similar fare from a monthly), we can calculate a new, slightly higher, average base fare of \$2.25:

$$(\$2.15) * (90\% \text{ of riders}) + (\$2.15 + \$1.00) * (10\% \text{ of riders}) = \$2.25.$$

²⁴ Washington Metropolitan Area Transit Authority, “Tariff of The Washington Metropolitan Area Transit Authority on Metro Operations within the Washington Metropolitan Area, Tariff Number 33v2, Effective July 1, 2014” (Washington Metropolitan Area Transit Authority, July 1, 2014), 4.

²⁵ Allen, “User’s Guide for the MWCOG Fare Programs, Microcomputer Version,” 2.

²⁶ Ibid., 3.

This concept is shown in Figure 3-26. Further details will be described in an upcoming memo. The actual WMATA fare tariff data is input to the model using the file tariff.txt (see Figure 3-27).

Table 3-34 Metrorail fare structure, WMATA Tariff #33v2

| Metrorail Fare Structure (Effective July 1, 2014) | Regular Fares | | Senior & Disabled Fares ⁽³⁾⁽⁴⁾ |
|--|---------------------|----------------------------|--|
| | Peak ⁽¹⁾ | Off-Peak ⁽²⁾⁽⁶⁾ | |
| First 3 composite miles ⁽⁵⁾ | \$ 2.15 | | One-half peak fare |
| Each additional composite mile more than 3 and less than or equal to 6 | \$ 0.326 | | |
| Each composite mile greater than 6 | \$ 0.288 | | |
| Maximum peak fare (Exclusive of Surcharge and Differentials) | \$ 5.90 | | |
| First 3 composite miles ⁽⁵⁾ | | \$ 1.75 | One-half peak fare |
| Each additional composite mile more than 3 and less than or equal to 6 | | \$ 0.244 | |
| Each composite mile greater than 6 | | \$ 0.216 | |
| Maximum off-peak fare | | \$ 3.60 | |
| A \$1.00 surcharge applies to all non-SmarTrip® single-ride fares (\$0.50 for senior & disabled) | | | |

Notes:

- A. Peak and off-peak fares will be determined by the time riders enter through the rail faregates.
- B. Only a Metrorail Farecard, valid pass, SmarTrip® Card, or an emergency trip ticket are accepted as rail payment.
- C. All Metrorail fares round to the nearest \$0.05
- D. A \$0.05 surcharge on entry and exist at up to two stations in each jurisdiction in the Compact Transit Zone for the purpose of funding station-specific capital improvements to Metro facilities located at the station(s) where the surcharge is levied may be imposed with further Board approval. No such stations are currently authorized
- E. Patrons must have a minimum of \$1.25 in value on their SmarTrip® card (\$2.25 on a paper farecard) to enter the Metrorail system. Senior or disabled patrons must have a minimum of \$0.55 in value on their SmarTrip® card (\$1.05 on a reduced fare paper farecard) to enter the Metrorail system.
- F. Patrons may not exit the Metrorail system with a negative balance in excess of \$1.50 on their SmarTrip® card. Patrons attempting to exit the Metrorail system with a negative SmarTrip® balance in excess of \$1.50 must use the Exitfare machines to add value before exiting.

Footnotes:

- (1) Peak fares are in effect from opening through 9:30a.m. and from 3:00p.m. to 7:00p.m. weekdays, except for national holidays. Peak fares are also in effect from 12:00a.m. to 3:00a.m. Saturday and Sunday to accommodate late night Friday and Saturday service.
- (2) Off-Peak fares shall be in effect during all other hours on weekdays, Saturday and Sunday, and all national holidays.
- (3) Fares for seniors and patrons with disabilities are one-half the peak fare rounded down to the nearest \$0.05, including any applicable surcharge and differential, when using applicable fare media.
- (4) Effective June 27, 2010, new and recertifying MetroAccess customers shall be eligible for the "Free Ride Program" only if they are determined to be conditionally eligible for paratransit service; provided that existing MetroAccess customers (and one personal care assistant per customer) may continue participating in the Free Ride Program until their current period of paratransit eligibility expires.
- (5) A composite mile is the average of the straight-line (airline) distance between stations and the actual over-the-rail distance
- (6) Martin Luther King, Jr. Day, President's Day, Columbus Day, and Veteran's Day the Metrobus system will operate under a modified holiday schedule and will charge base fare on all routes; the Metrorail system will operate on a holiday schedule with off-peak fares in place and that parking at Metro parking facilities will be free.

Source: WMATA. "Tariff of the Washington Metropolitan Area Transit Authority on Metro Operations within the Washington Metropolitan Area, Tariff Number 33V2, Effective July 1, 2014," July 1, 2014.

Figure 3-27 Metrorail fare structure, WMATA Tariff #33v2: Adjustments made for input to model

| Metrorail Fare Structure (Effective July 1, 2014) | Regular Fares | | Senior & Disabled Fares ⁽³⁾⁽⁴⁾ |
|--|---------------------|----------------------------|--|
| | Peak ⁽¹⁾ | Off-Peak ⁽²⁾⁽⁶⁾ | |
| First 3 composite miles ⁽⁵⁾ | \$ 2.15 | | One-half peak fare |
| Each additional composite mile more than 3 and less than or equal to 6 | \$ 0.326 | | |
| Each composite mile greater than 6 | \$ 0.288 | | |
| Maximum peak fare (Exclusive of Surcharge and Differentials) | \$ 5.90 | | |
| First 3 composite miles ⁽⁵⁾ | | \$ 1.75 | One-half peak fare |
| Each additional composite mile more than 3 and less than or equal to 6 | | \$ 0.244 | |
| Each composite mile greater than 6 | | \$ 0.216 | |
| Maximum off-peak fare | | \$ 3.60 | |
| A \$1.00 surcharge applies to all non-SmarTrip® single-ride fares (\$0.50 for senior & disabled) | | | |

Weighted for non-smarttrip card users: \$2.25; \$6.00; \$1.85; \$3.70

Ref: I:\ateam\docum\FY16\2015CLRP_Network_Report\NW_Report_Tables\Bus Fare Matrix 2015.xls

Figure 3-28 Metrorail fares (peak and off-peak) and the rail-to-bus discounts (Tariff.txt)

```

-----
;;
;; WMATA Tariff 33v2 effective July 1 2014 fare structure input to MFARE2.S
;; Note: assumed a composit of SmarTrip and non SmarTrip rates for metrorail
;; using percents from Wendy Jia 11/26/2013 email
;;
;; WMATA has changed the off-peak fare structure to charge by composite
;; mile after the first 3 composite miles (a similar structure
;; to that used for peak service fares)
;;
;; (Prepared April 1, 2015/jp)
-----
;; Peak and OffPeak Metrorail Policy
;;
; Fare Increment      Fare Rate in Cents      Trip Distance Increment(in Composite Miles)
; in Cents           per Composite mile:    Associated with Fare Increment/Rate
;-----
Pk_Fare_Incr1 = 225.0  Pk_Fare_Rate1 = 0.0   Pk_Fare_Dist1 = 3.0 ;
Op_Fare_Incr1 = 185.0  Op_Fare_Rate1 = 0.0   Op_Fare_Dist1 = 3.0 ;

Pk_Fare_Incr2 = 0.0   Pk_Fare_Rate2 = 33.0  Pk_Fare_Dist2 = 3.0 ;
Op_Fare_Incr2 = 0.0   Op_Fare_Rate2 = 24.0  Op_Fare_Dist2 = 3.0 ;

Pk_Fare_Incr3 = 0.0   Pk_Fare_Rate3 = 29.0          ;
Op_Fare_Incr3 = 0.0   Op_Fare_Rate3 = 22.0          ;

Pk_Fare_Max    = 600.0          ;
Op_Fare_Max    = 370.0          ;

-----
;; Rail-to-Bus discounts in current year cents based on selected tariff ;;
;;
DC_RailBus_Disc = 125.0 ; Area defined by Jur='0' in the zone file input ;; Discount available to SmartTrip
card holders only
MD_RailBus_Disc = 125.0 ; Area defined by Jur='1' in the zone file input ;;
VA1_RailBusDisc = 125.0 ; Area defined by Jur='2' in the zone file input ;;
VA2_RailBusDisc = 125.0 ; Area defined by Jur='3' in the zone file input ;;

```

MFARE2 calculates “bus” (non-Metrorail transit) fares using a set of “bus” fare zones. The current program allows for up to 21 bus fare zones in the modeled area. Each TAZ must be associated with either one or two bus fare zones. This is done in the TAZ fare zone file (TAZFRZN.ASC), which is discussed later. The geography of the bus fare zones can be changed from year to year, to reflect areas that have similar transit fares, such as the area around a commuter rail line. Maps of the current bus fare zones can be seen in Figure 3-28 and Figure 3-30. The first figure shows the primary bus fare zones. The second shows the secondary bus fare zones. And the third figure shows the combined effect of overlaying the two bus fare zone systems. Bus fare zone 1 (Figure 3-28) corresponds roughly to the original WMATA Compact area, before Loudoun County was added. In some cases, the bus fare zones are in two discontinuous pieces, such as bus fare zone 2 (Figure 3-28). In some cases, the bus fare zone may be made up of three discontinuous pieces, such as bus fare zone 9, which has two sections in Figure 3-28 and one section in Figure 3-29. In Figure 3-30, we can see the combined effect: there are some parts of Frederick Co. where the TAZs are associated with only one bus fare zone (such as 8, 9 or 10), but there are some parts of Frederick Co. where the TAZs are associated with two bus fare zones (such as 8 and 9, or 9 and 10). At any rate, no TAZ can be associated with more than two bus fare zones. Names for the 21 bus fare zones can be found in Table 3-35.

Figure 3-29 Regional Primary Bus Fare Zone Map

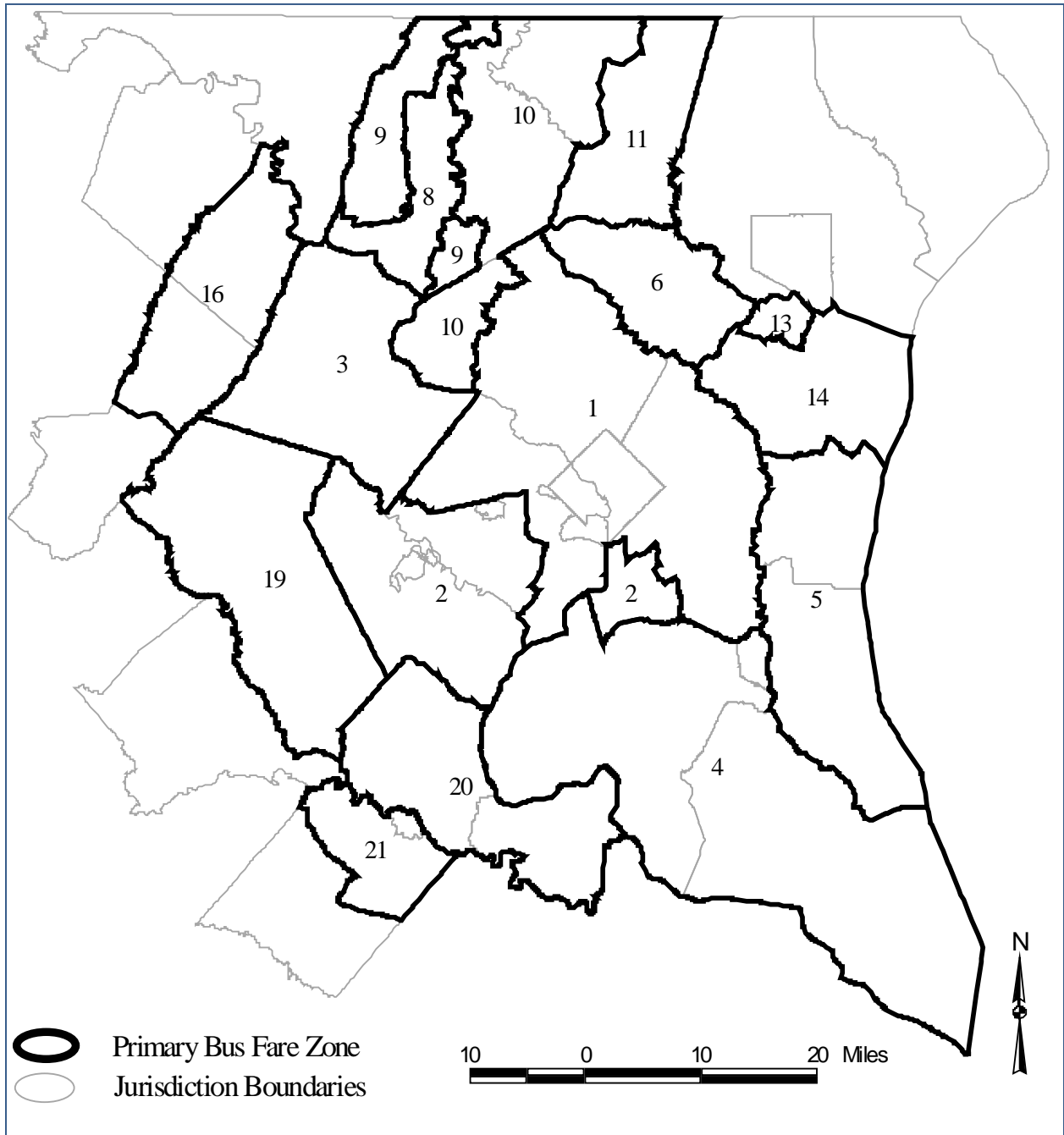


Figure 3-30 Regional Secondary Bus Fare Zone Map

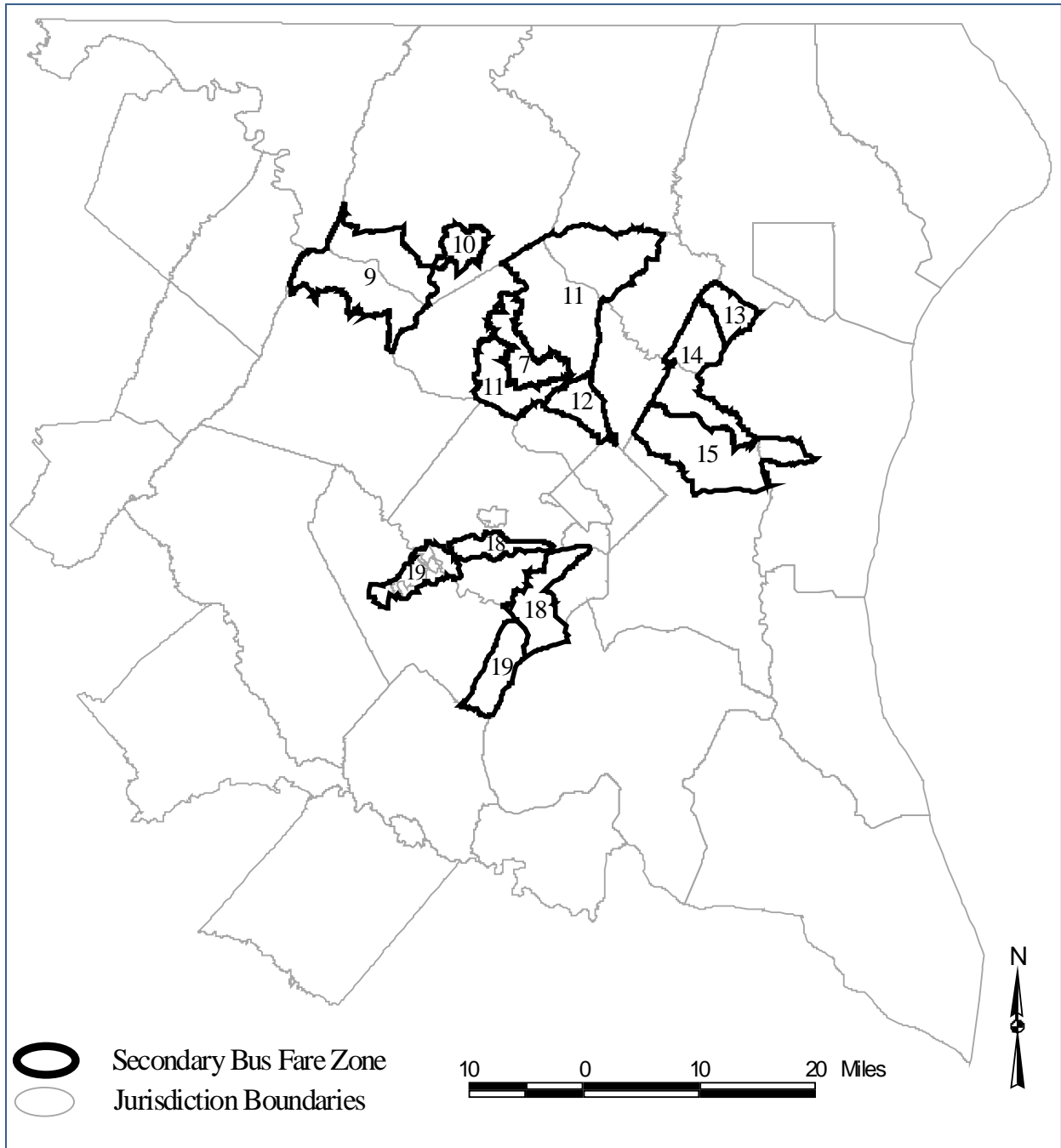
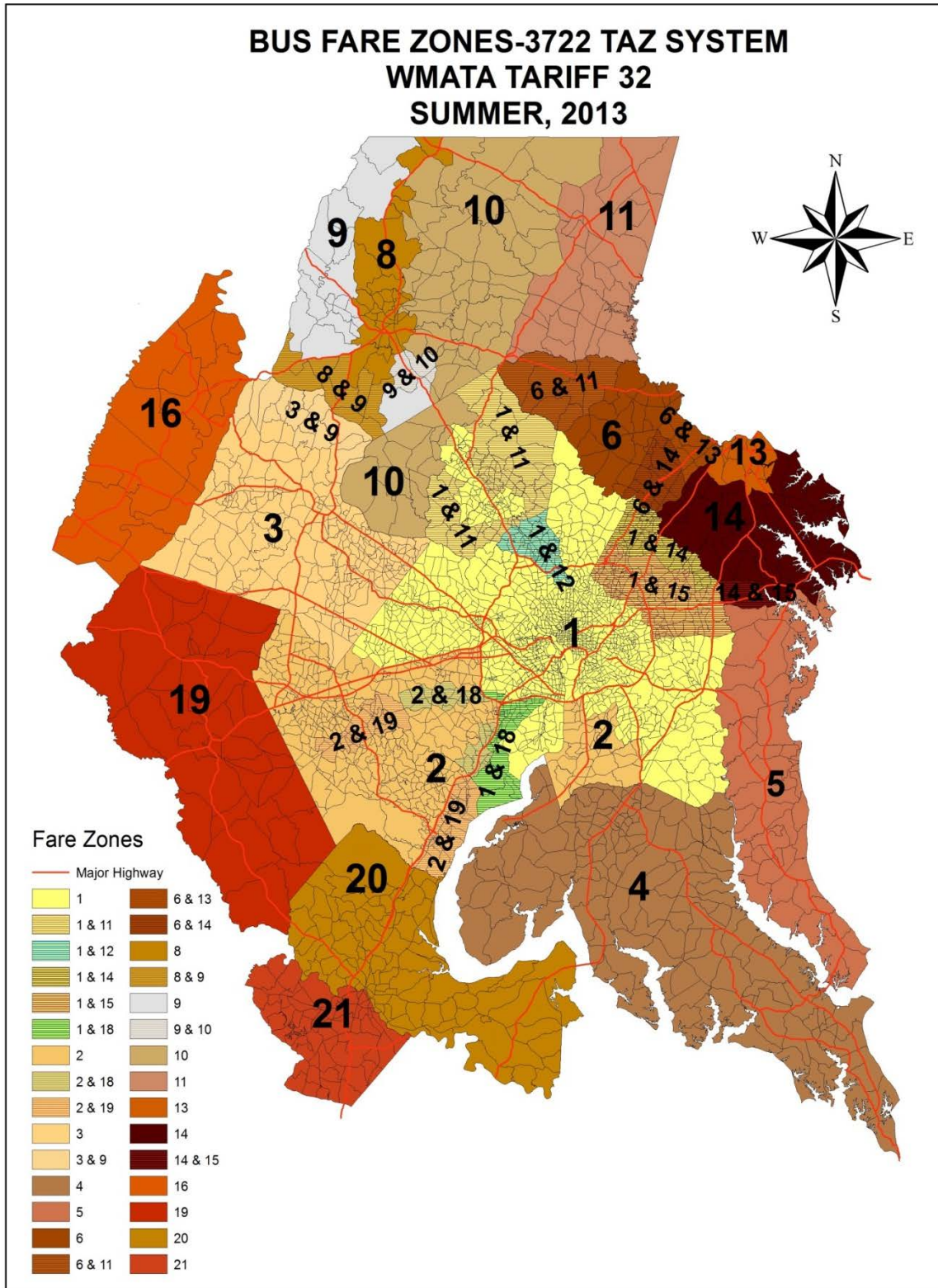


Figure 3-31 Combine bus fare zones (primary overlaid with secondary)



When a TAZ is identified as being in more than one bus fare zone, the fare is calculated using the average fare for both zones. Additionally, each Metrorail station must be associated with a bus fare zone. These associations between bus fare zones and TAZs, and between bus fare zones and Metrorail stations, are stored in the TAZ bus fare zone file (TAZFRZN.ASC), whose file format can be seen in Table 3-34.

Table 3-35 File format: File relating bus fare zones to TAZs and Metrorail stations (TAZFRZN.ASC)

| Columns | Format | Field Description |
|--|--------|--|
| <i>Zonal data (All lines in the file)</i> | | |
| 1-8 | I4 | TAZ Number (1-3,675) and Metrorail Station No. (1-150) |
| 9-16 | I4 | 1 st Bus fare zone 1 (currently numbered 1 to 21) |
| 17-24 | I4 | 2 nd Bus fare zone 2 (currently numbered 1 to 21) |
| <i>Metrorail station data (first 150 lines of the file only)</i> | | |
| 41-48 | I4 | 1 st Bus Fare Zone (currently numbered 1 to 21) |
| 49-56 | I4 | 2 nd Bus Fare Zone (currently numbered 1 to 21) |
| 57-64 | I8 | Jurisdiction code |
| 65-72 | I8 | P discount |
| 73-80 | I8 | A discount |

The “bus” fare matrix is a 21-by-21 matrix that represents the average non-Metrorail-transit fares from one “bus” fare zone to another. In theory, there can be a separate bus fare zone for peak and off peak travel. In practice, COG/TPB staff has adopted the practice of using only one bus fare matrix, since there is typically little time-of-day variation in the non-Metrorail transit fares. The current bus fare matrix is shown in Table 3-35. This table also provides names for the bus fare zones.

Table 3-36 AM Peak and Off-Peak Bus Fare Matrix between MWCOG Fare Zones (Expressed in 2016 cents)

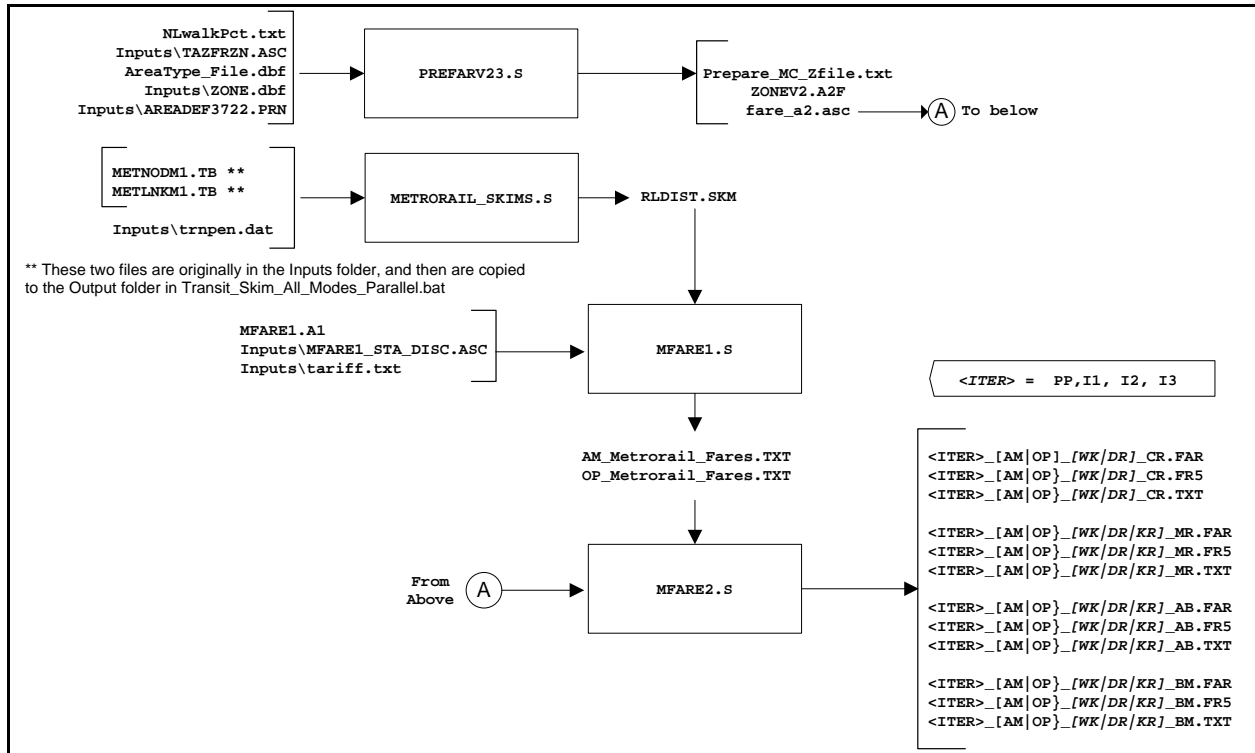
| | WMATA Regular Service | WMATA Express Ser. & Internal Metrobus Special Fare Service | Loudoun Comm. Bus | Charles & St. Mary's Comm. Bus (MTA) | Calvert and Southern AA Comm Bus (MTA) | Howard Comm. Bus (MTA) | Not Used Corridor Cities Transitway (Mont. Co) | Frederick Internal Bus | MARC Rail Brunswick (Frederick) | MARC Rail Brunswick (Mont. R8) | MARC Rail Brunswick (Mid. Mont) | MARC Rail Brunswick (Inner) | MARC Rail Penn/ Camden (Outer) | MARC Rail Penn/ Camden (Mid) | MARC Rail Penn/ Camden (Inner) | MARC Rail Brunswick (W.VA and Clark auto Connect) | VRE Zones 1 & 2 (Inside Beltway) | VRE Zones 3 & 4 (FFX and PW) | VRE Zones 5 & 6 (PW & FAUQ Auto Connect) | VRE Zones 7 & 8 (Staff. & KG Auto Connect) | VRE Zone 9 (Spots. & Fred'brg) |
|-----------|-----------------------|---|-------------------|--------------------------------------|--|------------------------|--|------------------------|---------------------------------|--------------------------------|---------------------------------|-----------------------------|--------------------------------|------------------------------|--------------------------------|---|----------------------------------|------------------------------|--|--|--------------------------------|
| Fare Zone | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 1 | 175 | 510 | 800 | 412 | 386 | 348 | 498 | 482 | 522 | 430 | 368 | 307 | 430 | 368 | 307 | 795 | 397 | 485 | 571 | 658 | 723 |
| 2 | 510 | 158 | 1310 | 922 | 896 | 858 | 1008 | 992 | 1032 | 940 | 878 | 817 | 940 | 878 | 817 | 1305 | 689 | 225 | 140 | 428 | 494 |
| 3 | 800 | 1310 | 100 | 1212 | 1186 | 1148 | 1298 | 1282 | 1322 | 1230 | 1168 | 1107 | 1230 | 1168 | 1107 | 1595 | 1197 | 1285 | 1371 | 1458 | 1523 |
| 4 | 412 | 922 | 1212 | 100 | 798 | 760 | 910 | 894 | 934 | 842 | 780 | 719 | 842 | 780 | 719 | 1207 | 809 | 897 | 983 | 1070 | 1135 |
| 5 | 386 | 896 | 1186 | 798 | 425 | 734 | 884 | 868 | 908 | 816 | 754 | 693 | 816 | 754 | 693 | 1181 | 783 | 871 | 957 | 1044 | 1109 |
| 6 | 348 | 858 | 1148 | 760 | 734 | 348 | 846 | 830 | 870 | 778 | 716 | 655 | 778 | 716 | 655 | 1143 | 745 | 833 | 919 | 1006 | 1071 |
| 7 | 498 | 1008 | 1298 | 910 | 884 | 846 | 130 | 747 | 633 | 516 | 130 | 439 | 928 | 866 | 805 | 1293 | 895 | 983 | 1069 | 1156 | 1221 |
| 8 | 482 | 992 | 1282 | 894 | 868 | 830 | 747 | 114 | 114 | 617 | 617 | 617 | 912 | 850 | 789 | 696 | 879 | 967 | 1053 | 1140 | 1205 |
| 9 | 522 | 1032 | 1322 | 934 | 908 | 870 | 633 | 114 | 500 | 503 | 503 | 503 | 952 | 890 | 829 | 582 | 919 | 1007 | 1093 | 1180 | 1245 |
| 10 | 430 | 940 | 1230 | 842 | 816 | 778 | 516 | 617 | 503 | 386 | 386 | 386 | 860 | 798 | 737 | 386 | 827 | 915 | 1001 | 1088 | 1153 |
| 11 | 368 | 878 | 1168 | 780 | 754 | 716 | 130 | 617 | 503 | 386 | 309 | 309 | 798 | 736 | 675 | 795 | 765 | 853 | 939 | 1026 | 1091 |
| 12 | 307 | 817 | 1107 | 719 | 693 | 655 | 439 | 617 | 503 | 386 | 309 | 307 | 737 | 675 | 614 | 795 | 704 | 792 | 878 | 965 | 1030 |
| 13 | 430 | 940 | 1230 | 842 | 816 | 778 | 928 | 912 | 952 | 860 | 798 | 737 | 386 | 386 | 386 | 1225 | 827 | 915 | 1001 | 1088 | 1153 |
| 14 | 368 | 878 | 1168 | 780 | 754 | 716 | 866 | 850 | 890 | 798 | 736 | 675 | 386 | 309 | 309 | 1163 | 765 | 853 | 939 | 1026 | 1091 |
| 15 | 307 | 817 | 1107 | 719 | 693 | 655 | 805 | 789 | 829 | 737 | 675 | 614 | 386 | 309 | 232 | 1102 | 704 | 792 | 878 | 965 | 1030 |
| 16 | 795 | 1305 | 1595 | 1207 | 1181 | 1143 | 1293 | 696 | 582 | 386 | 795 | 795 | 1225 | 1163 | 1102 | 700 | 1192 | 1280 | 1366 | 1453 | 1518 |
| 17 | 397 | 689 | 1197 | 809 | 783 | 745 | 895 | 879 | 919 | 827 | 765 | 704 | 827 | 765 | 704 | 1192 | 397 | 463 | 549 | 636 | 701 |
| 18 | 485 | 225 | 1285 | 897 | 871 | 833 | 983 | 967 | 1007 | 915 | 853 | 792 | 915 | 853 | 792 | 1280 | 463 | 230 | 288 | 375 | 441 |
| 19 | 571 | 140 | 1371 | 983 | 957 | 919 | 1069 | 1053 | 1093 | 1001 | 939 | 878 | 1001 | 939 | 878 | 1366 | 549 | 288 | 223 | 288 | 354 |
| 20 | 658 | 428 | 1458 | 1070 | 1044 | 1006 | 1156 | 1140 | 1180 | 1088 | 1026 | 965 | 1088 | 1026 | 965 | 1453 | 636 | 375 | 288 | 230 | 267 |
| 21 | 723 | 494 | 1523 | 1135 | 1109 | 1071 | 1221 | 1205 | 1245 | 1153 | 1091 | 1030 | 1153 | 1091 | 1030 | 1518 | 701 | 441 | 354 | 267 | 223 |

I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\Bus Fare Matrix 2016.xls

Source: WMATA Tariff #33v2, effective July 1, 2014.

In addition to MFARE1 and MFARE2, there are two other Cube Voyager scripts that are used in fare development: Prefarv23.s, Metrorail_Skims.s. The entire automated fare development process, consisting of all four programs is shown in Figure 3-31).

Figure 3-32 Process for developing zone-to-zone transit fares



Source: Page A-12 of the User's Guide for the MWCOG/NC RTPB Travel Forecasting Model, Version 2.3, Build 66. February 13, 2017

Ref: "I:\ateam\docum\fy14\2013CLRP_Network_Report\Ver2.3.52_flowchart_v2_transit_fares.vsd"

Ultimately, 22 fare matrices are developed by sub-mode, time-of-day period, and access type:

- Four sub-modes (Bus Only Metrorail only, Metrorail/ Bus, and Commuter Rail) by;
- Two time periods (AM, off-peak), by;
- Three access types (Walk, PNR, and KNR).

Since commuter rail access is distinguished by walk and auto access only (i.e., no differentiation between KNR and PNR), 22 matrices are developed (instead of the 24 implied above).

Table 3-36 lists the main transit fare input files. Chapter 17 of the Version 2.3.66 Travel Model User's Guide, dated February 13, 2017, also discusses the fare development process.

Table 3-37 Listing of Transit Fare Input Files

| Filename | Description | Type | Source |
|---------------------|---|-------------|-------------------|
| tazfrzn.asc | Fare Zone File | Text | Analyst-generated |
| areadef3722.prn | Input TAZ-Mode choice district equivalence | Text | Analyst-generated |
| trnpen.dat | Metrorail network turn penalty file | Text | Analyst-generated |
| metlnkm1.tb | Metrorail links | Text | Geodatabase |
| metnodm1.tb | Metrorail nodes | Text | Geodatabase |
| mfare1_Sta_Disc.ASC | Metrorail Station fare discount array in cents | Text | Analyst-generated |
| tariff.txt | WMATA Transit fare (tariff) policy Metrorail station XYs scaled to 1/100ths of miles | Text | Analyst-generated |
| mfare1.a1 | | Text | Geodatabase |
| BUSFARAM.ASC | AM bus fare matrix | Text | Analyst-generated |
| BUSFAROP.ASC | Off-peak bus fare matrix (same as AM) | Text | Analyst-generated |

Ref: "i:\ateam\docum\fy14\2013CLRP_Network_Report\v23_inputs_v10.xlsx"

4 COG/TPB Multi-Year, Multi-Modal Geodatabase

The network link and node inputs to the TPB travel model are maintained and managed in a multi-year, multi-modal spatial database, implemented as an ArcGIS geodatabase. The geodatabase interacts with a customized editing program, known as COGTools,²⁷ that runs within ArcGIS (Version 10.2). The program enables highway and network elements in the database to be viewed and edited interactively. This chapter provides some background on the geodatabase (GDB) design, structure and operation. The chapter also addresses how TPB staff utilizes digital, machine-readable transit information that is now publicly available to update and refresh the regional transit networks each year.

4.1 Geodatabase Overview and Editor

The TPB's transportation network geodatabase (GDB) serves as a central repository for highway and transit node and link data. It is currently prepared in Microsoft Access format as a personal geodatabase and stores network data in a multi-modal (highway and transit) and a multi-year framework. The geodatabase includes spatial/geographic information that allows network elements to be viewed and edited in the ArcGIS environment. The GDB also includes link attribute data that is required by the travel model. The use of a structured, time-series network database offers several key advantages that did not exist previously:

- Consistency in node and link geometry is enforced over time-series networks. Consistency in link attribute coding over time is also enforced.
- Transit network elements are integrated with highway elements in a relational database. Before the GDB existed, transit features were developed as independent text files that referenced the highway node system. The GDB combines transit and highway features so that they may be viewed (or mapped) as a complete system. The use of related tables has also enabled the dynamic linking of transit edits to occur as a result of highway editing.
- Consistency and accuracy of link screenline and jurisdiction codes are enforced over time. Before the GDB existed, screenline codes and jurisdiction codes were manually coded on highway links and subject to error and inconsistent coding from year to year. Using the GDB, screenlines and jurisdictional boundaries are represented as physical entities. The GDB then uses these physical entities and spatial operations to dynamically assign the appropriate jurisdiction and screenline code to each relevant link, thus reducing the likelihood of manual coding errors.
- The use of a geo-referenced database has greatly facilitated the incorporation of external data from partner agencies into the network development process. Most of the traffic counts, highway inventory data, observed speed data and transit routing information exists in some type of geo-referenced format.

²⁷ Qiang Li and Jim Yin, "COGTOOLS User Guide, Revision 3.0" (Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, October 17, 2013).

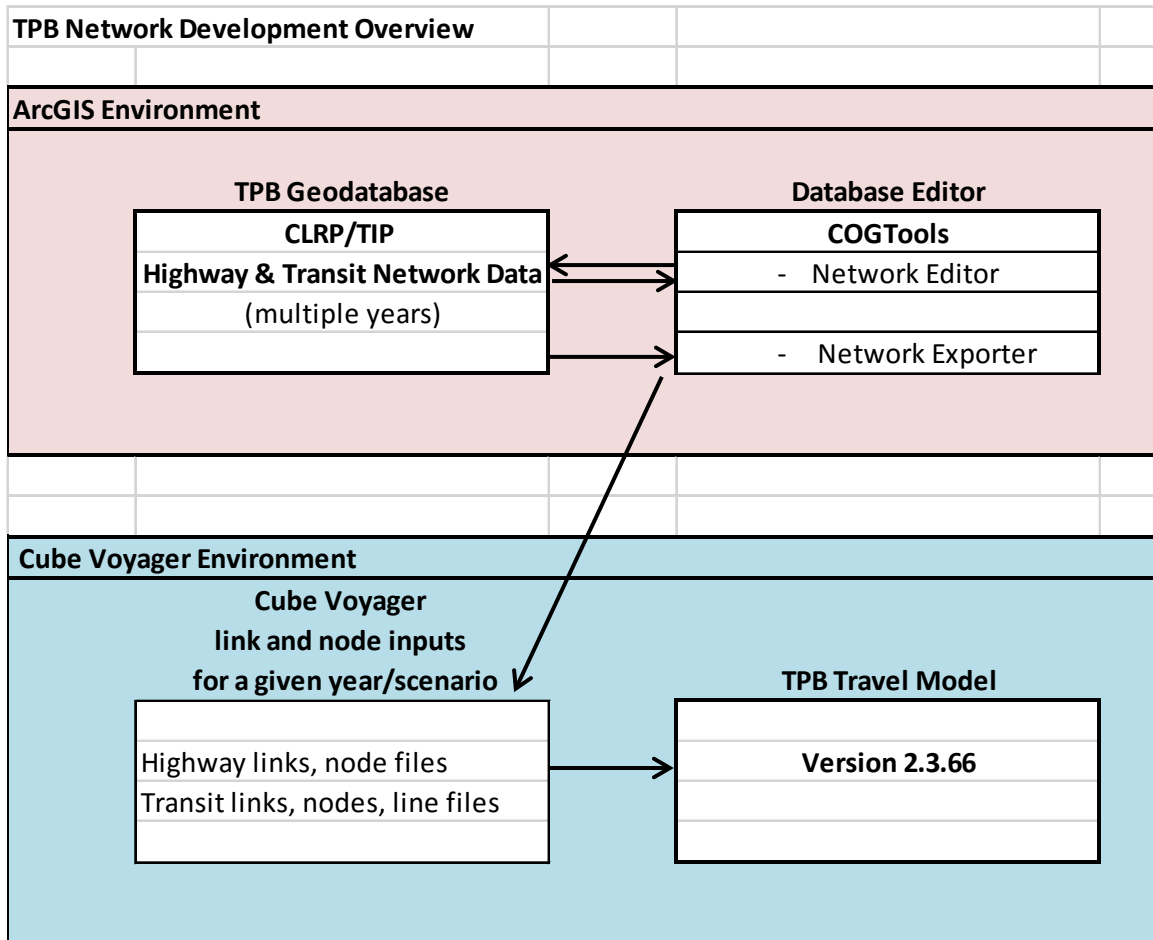
Some of the shortcomings of the current GDB approach include the following:

- Each network scenario is represented by a network year. This is generally not a problem, since the network year and network scenario are the same thing, but it means that one cannot easily represent two network scenarios that would occur in the same year.
- Edits to the highway network are reflected in the transit network, but only in a limited capacity.
- Although highway networks can be generated for any year between the base and horizon year, transit networks can be generated for only the designated milestone years.

The last two of these shortcomings are discussed in more detail later in the chapter.

TPB staff produces a new version of the multi-year GDB each year, such that it reflects latest version of the CLRP and TIP. The GDB is not developed from “scratch,” but rather, is typically developed using the GDB produced from the prior fiscal year (and the prior CLRP) as a starting point. A macro-scale view of the relationship between the GDB and the TPB travel model is shown in Figure 4-1. The figure indicates that the GDB development occurs in the ArcGIS environment.

Figure 4-1 Relationship Between the GDB and the Cube Voyager Modeling Process



Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\chapter4_overview_process.xlsx"

As shown in Figure 4-1, the GDB is maintained in ArcGIS and is not an integrated component of the travel modeling environment, which makes use of Citilabs Cube software and is normally launched from a Windows command prompt. The GDB interacts with a customized and interactive program editor named COGTools. The editor is applied as an added “tool bar” within the standard ArcGIS graphical user interface. The COGTools application includes two primary functions: 1) the ability to edit (add, delete or modify) network elements within the GDB and 2) the ability to export year-specific files from the GDB into to Cube Voyager-format files that are read directly into the travel model. The COGTools application also enables customized viewing and mapping of the highway and transit features in the GDB.

Before the current Esri geodatabase/COGTools approach, TPB staff used a “master” network stored in ArcInfo to manage the highway networks. In 2004, TPB staff invented a way to perform batch updates on link attributes such as facility type and number of lanes. This process was known as “TIPUP,” i.e., TIP update process. In 2009, this process was revised and re-named “PrepTIP,” i.e., prepare TIP batch update program.²⁸ Later, this TIPUP/PrepTIP process was updated to work with the geodatabase. TPB staff developed a suite of custom-designed, web-based forms that are tied to a back-end database, constructed by COG’s website contractor. TPB staff extracts the data using SQL Server Management Studio (personal correspondence, A. Austin, 1/27/16). Next the data is imported it into Microsoft Access to create our TIP and other reports. A few years ago, TPB staff reviewed some commercially available options, but they were mostly geared towards ranking and prioritizing projects, which was not what was needed for COG’s multi-jurisdiction/three-state situation. Note that the current process is not documented.

Following the batch update, manual edits are typically implemented to fine-tune network updates using the COGTools toolbar. Highway editing functions include the ability to:

- Add new facilities: Two approaches
 - Copy the link from a HERE/NAVTEQ street centerline file and add it to the geodatabase
 - Manually draw the link on the screen via a mouse or other similar pointing device
- Split highway links (insert a node within an existing highway link)
- Delete highway links
- Edit highway link attributes

The toolbar also includes the following transit editing capabilities:

- Add a transit route
- Copy a transit route
- Delete a transit route
- Modify an existing transit route alignment (represented as a series of nodes)
- Edit transit route attributes

²⁸ Robert Snead, Charlene Howard, and Jane Posey, “Highway Network Database Batch Updates: PrepTIP Program,” Memorandum, (March 11, 2009).

The COGTools design dynamically implements transit network changes in response to highway edits, albeit in a limited capacity. For example, when a highway network link is split, the affected transit route(s) are dynamically modified to include the added node within the existing route string.²⁹ However, if a highway network link is deleted, the affected transit route(s) are not modified, but the user is prompted to manually reconfigure the transit route. Also, only existing transit years in the geodatabase at the time of the highway edit are affected by transit edits. The transit editing tool is designed to identify transit routing errors, including discontinuities in the node string and cases where the transit route is coded in a manner that is inconsistent with the highway link directionality.

The current COGTools application treats highway network editing in a multi-year context. Highway and transit network edits are implemented with attention to a specific “year” attribute that exists on each link. The 2016 CLRP highway networks were prepared, for milestone years: 2016, 2017, 2020, 2025, 2030, and 2040. The COGTools editor allows for the generation of highway networks for *any year* between the base year and horizon year, respecting the edits implemented for each milestone year. Highway edits implemented for a given year, say 2020, will carry forth among networks for all years hence, including both milestone years and intermediate years. Transit networks, unlike highway networks, are developed individually for specific milestone years, so the database lacks the ability to propagate changes from one transit network to the next. However, all the transit years that are developed are stored together in the GDB.

The COGTools toolbar also allows for exporting year-specific files from the GDB to input files that are directly used by the travel model. The exporting process is performed separately for highway files and transit files. The highway export may be performed for any year and two formats may be selected:

- 1) *Cube Voyager input file* (link.dbf and node.dbf), or
- 2) *Personal geodatabase* (link and node feature classes).

The first format is designed to export network link and node files, in DBF file format, for any year specified by the user (i.e., any milestone or non-milestone year). The files exported comply with the input file format required by the Version 2.3.66 Travel Model. The second format may be used to export highway network line and point feature classes from the geodatabase and build a highway network (*.net) in Cube Base, using the GIS tools module in Cube Base (“Build highway network from a feature class / shapefile”).

The highway exporting function includes the following features:

- It assigns link distances that reflect HERE/NAVTEQ centerline “true shape” lengths. Link distances are converted from feet to whole miles with an explicit decimal.
- It assigns jurisdiction codes to the highway network links based on the jurisdictional boundary shapes. Jurisdictional boundaries are included as a feature class in the

²⁹ This capability is also available in the Citilabs Cube Base graphical network editor, provided the user has both the highway and transit networks open at the same time.

network geodatabase. Highway links are associated with jurisdictions based on the midpoint of the link relative to jurisdictional boundaries.

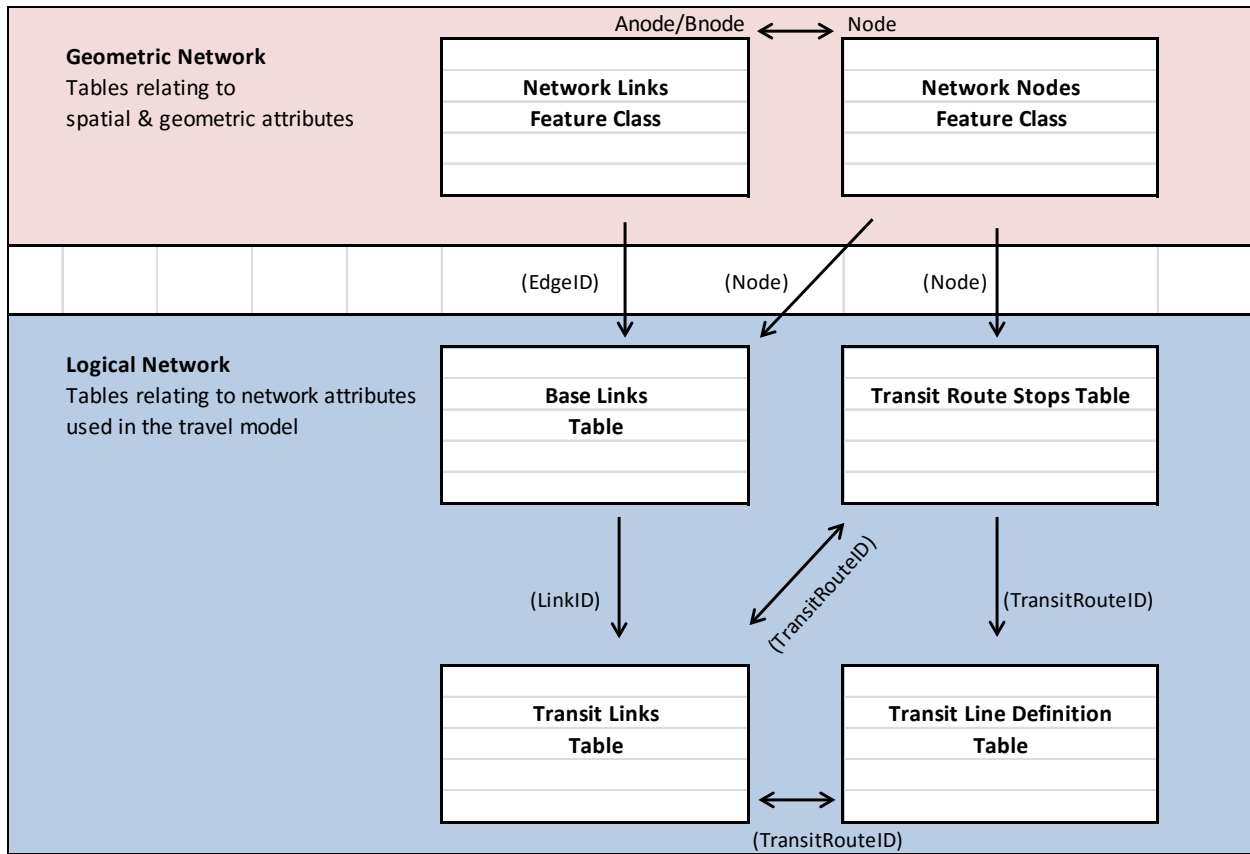
- It assigns screenline codes to all highway network links that intersect the screenline feature class/layer that is contained in the network geodatabase.

The transit exporting function generates the full complement of year-specific transit link, node and route/line files for each transit year specifically included in the database. These are compliant with TPB's Version 2.3.66 travel model specifications.

4.2 Geodatabase Tables Overview

A more detailed view of the tables that exist within the GDB structure is shown in Figure 4-2. The GDB is a collection of related MS Access tables that are of two general types: geometric network tables and logical network tables. The geometric network consists of two "feature class" tables: a network links table and a network nodes table. The two tables contain basic attributes of links and nodes in the transportation network, and geographic information that is necessary for displaying network features on a map. The network links attributes are shown in Table 4-1. The network node table attributes are shown in Table 4-2.

Figure 4-2 TPB Geodatabase Structure



Ref: " I:\ateam\docum\fy17\2016CLRP_Network_Report\Rpt_Tables\chapter4_overview_process.xlsx"

In contrast, the logical network is a group of tables that contain travel model-related attributes associated with the links and nodes. The logical network consists of four tables:

1. Base Links: Highway and transit network link attributes (see Table 4-3).
2. Transit Links: Transit network-related links (see Table 4-4).
3. Transit Route Stops: Transit route alignments, expressed as a network node sequence (see Table 4-5).
4. Transit Line Definition: The transit line attributes (see Table 4-6).

The highway network is composed of geometric elements from the network links and network node tables and logical network elements from the Baselinks table. The EdgeID variable in the network links table is a unique number that uniquely identifies each physical (geometric) link. It does not vary by direction or network year. As shown in Figure 4-2, the EdgeID is a primary key field that relates the geometric and logical highway networks. The relationship between the geometric network and the logical network is one to many (1:N). That is, each record/link in the geometric network (Network Link feature class table) may correspond to zero, one, or many records/links in the logical network (Base Links table). Records/links in the logical network represent different network years.

In the logical network, LinkID is a unique number assigned to identify links by direction. It is a primary key variable that relates the logical network base links table and transit links table. The relationship between logical links and transit links is also one to many (1:N). That is, each logical network link may correspond to zero, one, or many transit links.

In the geometric network, the Network Nodes feature class mainly provides the geographic location of transportation facilities, such as transit stations, bus stops, park-and-ride lots, intersections, and zone centroids. Node is the unique numerical ID that relates the geometric network and the logical network, i.e., the nodes feature class table and the base links table.

Table 4-1 Network Links Feature Class table with "Link Type" codes (1-16) description

| Field Name | Data Type | Description |
|-----------------------|--------------|--|
| OBJECTID | Long Integer | Geodatabase record identifier |
| Shape | N/A | Geodatabase geometry field |
| EdgeID | Long Integer | Geometry network link identifier |
| LinkType | Long Integer | Link type code: |
| | | 1. Highway Link |
| | | 2. Bus Link |
| | | 3. TAZ Connector |
| | | 4. Metrorail Link |
| | | 5. Commuter Rail Link |
| | | 6. Light Rail Link |
| | | 7. Light Rail to Bus |
| | | 8. Metro Station to Bus Stop |
| | | 9. Commuter Station to Bus Stop |
| | | 10. Metro PNR to Station |
| | | 11. Commuter PNR to Station |
| | | 12. Bus PNR to Bus Stop |
| | | 13. Light PNR to Station |
| | | 14. BRT/Street Link |
| | | 15. BRT/Street PNR to Station |
| 16. BRT/Street to Bus | | |
| ANode | Long Integer | A Node |
| BNode | Long Integer | B Node |
| FunctionClass | Long Integer | Link facility type code (0 - 6) <i>0/centroids, 1/Freeways, 2/Major Art., 3/Minor Art, 4/ Collector, 5/ Expressway, 6/ Ramp</i> |
| Oneway | Integer | One-way or two-way link code: 1= two-way and 2= one-way |
| RampFlag | Text | (Not Used) |
| RoutelD | Long Integer | (Not Used) |
| RouteName | Text | Facility name |
| UpdateBy | Text | Person's name updating the geodatabase |
| Screen | Long Integer | Screenline Code (1-38) |
| JUR | Integer | Jurisdiction code (0-23): |
| | | <i>0/dc, 1/mtg, 2/pg, 3/alr/, 4/alx,5, ffx, 6/ldn, 7/ pw, 8/(unused), 9/frd, 10/how, 11/aa, 12/chs, 13/(unused), 14/car, 15/cal, 16/stm, 17/ kg, 18/fbg, 19/stf, 20/spts, 21/fau, 22/clk, 23/jef</i> |
| | | |
| Length | Double | Link Length in feet |
| Shape_Length | Double | ArcGIS auto-generated geometry length "true shape" in feet |

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Table 4-2 Network Nodes Feature Class table with "Node Type" codes (1-13) description

| Field Name | Data Type | Description |
|---------------------------------|--------------|---|
| OBJECTID | Long Integer | Geodatabase record identifier |
| Shape | N/A | Geodatabase geometry field |
| Node | Long Integer | Node numbers |
| NodeType | Long Integer | Node type code: |
| | | 1= Highway Node |
| | | 2= Bus Node |
| | | 3= TAZ Centroid |
| | | 4= Metrorail Node |
| | | 5= Commuter Rail Node |
| | | 6= Light Rail Node |
| | | 7= Light Rail Parking Lot Node |
| | | 8= Metro Parking Lot Node |
| | | 9= Commuter Parking Lot Node |
| | | 10= Bus PNR Node |
| | | 11=BRT Street Node |
| | | 12= BRT Street PNR |
| 13= Station Dummy Centroid Node | | |
| Jur | Text | Jurisdiction code (0 - 23) <i>0/dc, 1/mtg, 2/pg, 3/alr/, 4/alx,5, ffx, 6/ldn, 7/ pw, 8/(unused), 9/ frd, 10/how, 11/aa, 12/chs, 13/(unused), 14/car, 15/cal, 16/stm, 17/ kg, 18/fbg, 19/stf, 20/spts, 21/fau, 22/clk, 23/jef</i> |
| UpdatedBy | Text | (Not Used) |
| X_COORD | Double | X coordinate of a node (MD State Plane, NAD83, feet) |
| Y_COORD | Double | Y coordinate of a node (MD State Plane, NAD83, feet) |
| Name | Text | TransitStop/Station Name |
| NetYear | Long Integer | The year the network node becomes active in the database |

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Table 4-3 Base Links Table with "Mode" codes (1-16) description

| Field Name | Data Type | Description |
|-----------------|--------------|--|
| OBJECTID | Long Integer | Geodatabase record identifier |
| LinkID | Long Integer | Logical network link Identifier |
| EdgeID | Long Integer | Geometry network link identifier |
| ANode | Long Integer | A Node |
| BNode | Long Integer | B Node |
| NDPR2 | Text | Combination of Anode and Bnode (Not Used) |
| BaseYear* | Long Integer | Year 2000 or Year 2001 |
| TravelDirection | Text | (Not Used) |
| Distance | Double | Link distance in miles (X.XX) |
| LinkType | Long Integer | Link type code (1-16) |
| Mode | Long Integer | Mode Code (1-16): 1= Local Metrobus 2= Express Metrobus 3= Metrorail 4= Commuter Rail 5= Light Rail 6= Other primary - Local bus 7= Other primary - Express bus 8= Other secondary - Local bus 9= Other secondary – Express bus 10= Bus Rapid Transit or Streetcar 11= Drive Access link 12= Bus-to-rail Transfer link 13= Walking link 14= (Not Used) 15= PNR-to-Rail station/Bus stop 16= Zonal Access or Egress |
| TOLL | Integer | Toll value in current year dollars |
| TollGrp | Long Integer | Toll Group code (1- 9999) |
| FType | Long Integer | Link facility type code (0 - 6) <i>0/centroids, 1/Freeways, 2/Major Art., 3/Minor Art, 4/ Collector, 5/ Expressway, 6/ Ramp</i> |
| LType | Text | Link type: <i>H=Highway links, T=Transit only links, and Z=TAZ</i> |
| AType | Long Integer | Area type code (1 -6) |
| <Period> Lane | Long Integer | <Period> number of lanes |
| <Period> Limit | Long Integer | <Period> limit code (0 - 9) |
| Screen | Long Integer | Screenline code |
| NetYear | Long Integer | The year the network link becomes active in the database |
| ProjectID | Text | Project identifier |
| ZoneID | Long Integer | TAZ centroid identifier (1-3,722) |
| Status | Long Integer | Link status code: <i>1= Active and 2= Retired</i> |
| COGStatus | Text | (Not Used) |
| UpdateDate | Text | The date and time of link attributes update |
| Jur | Long Integer | Jurisdiction code (0 - 23) <i>0/dc, 1/mtg, 2/pg, 3/alr/, 4/alx,5, ffx, 6/ldn, 7/ pw, 8/(unused), 9/ frd, 10/how, 11/aa, 12/chs, 13/(unused), 14/car, 15/cal, 16/stm, 17/ kg, 18/fbg, 19/stf, 20/spts, 21/fau, 22/clk, 23/jef</i> |
| Count | Long Integer | (Not Used) |
| Speed | Double | (Not Used) |
| Key | | |
| <Period> = | AM | AM peak period (6:00 9:59 AM) |
| | PM | PM peak period (3:00 - 7:00 PM) |
| | OP | Off-peak period (10:00 Am - 2:59 PM) |
| BaseYear* | 2000 | Links entered into the databasae by DCI when first developed |
| | 2001 | Links subsequently entered into the databasae by DTP staff |

4.3 Transit Network Tables

In the logical network, the transit network is represented by the following three tables:

1. Transit Links: Maintains the attributes of the transit network links.
2. Transit Route Stops: Consists of all transit connection points including bus stops, transit stations, and park-and-ride lots.
3. Transit Lines Definition: Contains year-specific transit data for each transit route.

The TransitRouteID variable is a primary key in the “Transit Line Definition” table and a foreign key in the “Transit Links” table and “Transit Route Stops” table. Thus, as shown in Figure 4-2, it links these three tables together. Attributes maintained in the Transit Links, Transit Route Stops, and Transit Lines Definition tables are shown in Table 4-4, Table 4-6, and Table 4-5, respectively.

Table 4-4 Transit Links Table

| Field Name | Data Type | Description |
|----------------|--------------|--|
| ObjectID | Long Integer | Geodatabase record identifier |
| LinkID | Double | Logical network link identifier |
| TransitRouteID | Long Integer | Transit Route identifier |
| ANode | Double | A Node |
| BNode | Double | B Node |
| LinkSequence | Double | Sequence number of links that form a transit route |
| Scenario | Text | Project identifier |
| TransitYear | Double | Specific year of the transit route |
| SYear | Double | Year project is open for use |
| Operation | Double | Operation time code: <i>1= AM peak and 2= off-peak</i> |

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Table 4-5 Transit Route Stops Table

| Field Name | Data Type | Description |
|----------------|--------------|--|
| ObjectID | Long Integer | Geodatabase record identifier |
| TransitRouteID | Long Integer | Transit Route identifier |
| Node | Long Integer | List of nodes used by a transit route |
| NodeSequence | Long Integer | Sequence number of nodes on a specific transit route |
| Operation | Long Integer | Transit operation period code: <i>1= AM peak (7:00AM - 7:59 AM) and 2= off-peak (10:00AM-2:59PM)</i> |
| StopFlag | Integer | Transit stop or non-stop code: <i>0= Stop and 1= Non-Stop</i> |
| SourceYear | Long Integer | Base year from which transit route is derived |
| SYear | Long Integer | Year project is open for use |
| Scenario | Text | Project identifier |
| TransitYear | Long Integer | Specific year of the transit route |

Table 4-6 Transit Lines Definition Table

| Field Name | Data Type | Description |
|------------------|--------------|--|
| ObjectID | Long Integer | Geodatabase record identifier |
| TransitRouteID | Long Integer | Transit Route identifier |
| TransitRouteName | Text | Transit Route name |
| OriginNode | Long Integer | Origin-of-transit-route stop node identifier |
| DestinationNode | Long Integer | End-of-transit-route stop node identifier |
| OriginNodeName | Text | Origin transit line station name e.g. Shady Grove Station |
| DestiNodeName | Text | End-of-the line station name e.g. Glenmont Station |
| Oneway | Long Integer | One-way or two-way route code: 1= two-way and 2= one-way |
| Mode | Long Integer | Mode Code: 1= Local Metrobus 2= Express Metrobus 3= Metro Rail 4= Commuter Rail 5= Light Rail 6= Other primary - Local bus 7= Other primary - Express bus 8= Other secondary - Local bus 9= Other secondary – Express bus 10= Bus Rapid Transit or Streetcar 11= Drive Access link 12= Bus-to-rail Transfer link 13= Walking link 14= (Not Used) 15= PNR-to-Rail station/Bus stop 16= Zonal Access or Egress |
| Headway | Double | Transit vehicle headway (in mins.) |
| Runtime | Long Integer | Transit route running time (in mins.) |
| Operation | Long Integer | Transit operation period code: 1= AM peak (7:00 AM -7:59 AM) and 2= off-peak (10 AM-2:59 PM) |
| SourceYear | Long Integer | Base year from which transit route is derived |
| Scenario | Text | Project identifier |
| TransitYear | Long Integer | Specific year of the transit route |
| SYear | Long Integer | Year project is open for use |
| RunSpeed | Long Integer | (Not Used) |
| LineDistance | Long Integer | (Not Used) |
| Operator | Text | Transit operator / owner name, e.g. WMATA |

Ref: "I:\ateam\docum\FY16\2015CLRP_Network_Report\NW_Report_Tables\gdb_tables.xlsx"

4.4 General Transit Feed Specification (GTFS) Data

One of the standard procedures in the annual network development process is an update of the base-year transit network line files. The base-year transit network is the starting point for developing all the future-year transit networks. The update generally involves:

- 1) Ensuring that the transit lines reflect the most up-to-date run times and service frequencies.
- 2) Checking on whether individual transit lines have been added or removed.

In the past, the update was done using the paper route schedules published by the transit operators. In the late 1990s, the larger transit operators, such as WMATA and Ride-On, provided some digital, machine-readable schedule data that could be used to calculate average run times and frequencies (headways) for each of the two time-of-day periods (peak and off peak).^{30 31} In 2005, Google and Portland's TriMet transit agency developed an electronic data format for incorporating transit data into online maps. The format was initially known as "Google Transit Feed Specification" (GTFS). Over the next few years, this standard became the default format for sharing public transit scheduling information, and later, the name was changed to "General Transit Feed Specification" (also GTFS). A GTFS feed is a collection of comma-separated (CSV) files that represents a public transit system's schedules and transit route itineraries. Each file contains an aspect of transit service, including stops, routes, trips, and other schedule data. The GTFS specification is defined by the series of files shown in Table 4-7.

Currently, COG staff makes use of both the machine-readable, digital data from GTFS and paper schedules (or PDF files from transit operator websites), when the GTFS data is not available. Given the manual effort involved, the transit line updating process has generally been one of the more onerous tasks in the network development area.

³⁰ Mark S. Moran, "Using Electronic Files from WMATA to Calculate Average Headways and Run Times for 1998 WMATA Bus Service," Internal Report (Washington, D.C.: Metropolitan Washington Council of Governments, February 18, 1999).

³¹ Mark S. Moran, "Fall 1999 Ride On Bus Schedule Data: Using SAS to 1) Calculate Average Headways and Run Times and 2) Determine Which Routes Are Eligible for Coding as Two-Way Routes," Internal Report (Washington, D.C.: Metropolitan Washington Council of Governments, October 20, 1999).

Table 4-7 GTFS files

| Filename | | |
|----------------------------|----------|---|
| <u>agency.txt</u> | Required | One or more transit agencies that provide the data in this feed. |
| <u>stops.txt</u> | Required | Individual locations where vehicles pick up or drop off passengers. |
| <u>routes.txt</u> | Required | Transit routes. A route is a group of trips that are displayed to riders as a single service. |
| <u>trips.txt</u> | Required | Trips for each route. A trip is a sequence of two or more stops that occurs at specific time. |
| <u>stop_times.txt</u> | Required | Times that a vehicle arrives at and departs from individual stops for each trip. |
| <u>calendar.txt</u> | Required | Dates for service IDs using a weekly schedule. Specify when service starts and ends, as well as days of the week where service is available. |
| <u>calendar_dates.txt</u> | Optional | Exceptions for the service IDs defined in the calendar.txt file. If calendar_dates.txt includes ALL dates of service, this file may be specified instead of calendar.txt. |
| <u>fare_attributes.txt</u> | Optional | Fare information for a transit organization's routes. |
| <u>fare_rules.txt</u> | Optional | Rules for applying fare information for a transit organization's routes. |
| <u>shapes.txt</u> | Optional | Rules for drawing lines on a map to represent a transit organization's routes. |
| <u>frequencies.txt</u> | Optional | Headway (time between trips) for routes with variable frequency of service. |
| <u>transfers.txt</u> | Optional | Rules for making connections at transfer points between routes. |
| <u>feed_info.txt</u> | Optional | Additional information about the feed itself, including publisher, version, and expiration information. |

GTFS information in the Washington, D.C. region is available for about 87% of the existing transit routes. As shown in Table 4-8, 15 of the 27 transit service providers included in the regional transit network currently post GTFS information.

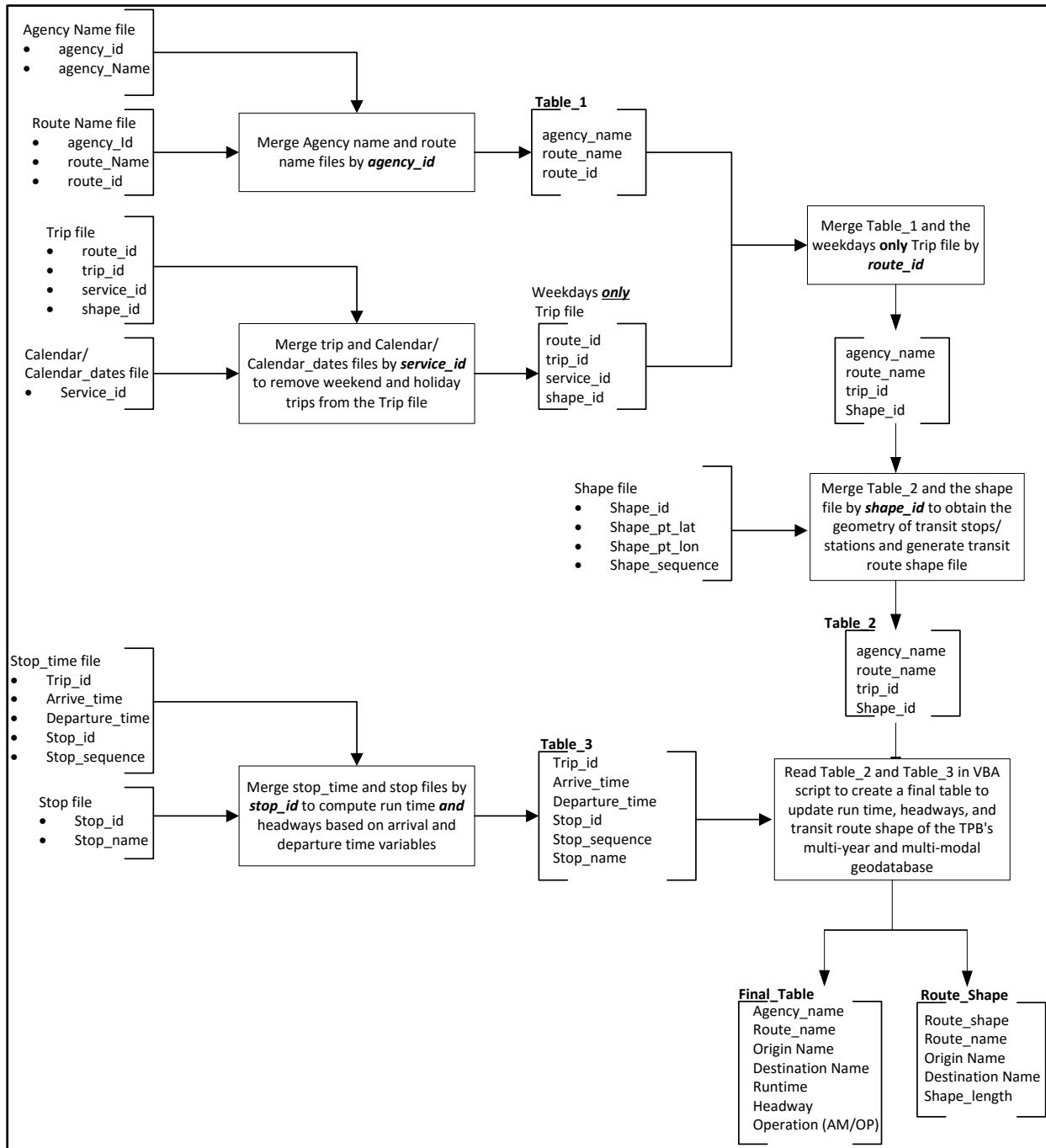
Table 4-8 Availability of GTFS data for transit operators in the Washington, D.C. area

| Seq. No. | Transit Providers | GTFS Data | Paper Schedule |
|----------|----------------------------------|-----------|----------------|
| 1 | WMATA | x | |
| 2 | Arlington County | x | |
| 3 | Bethesda Circulator | | X |
| 4 | City of Alexandria | x | |
| 5 | Calvert County | | X |
| 6 | Charles County | | X |
| 7 | Fairfax City | X | |
| 8 | Fairfax County | x | |
| 9 | Falls Church | x | |
| 10 | Frederick County | x | |
| 11 | Fredericksburg Feeder Bus to VRE | | X |

| Seq. No. | Transit Providers | GTFS Data | Paper Schedule |
|----------|--|-----------|----------------|
| 12 | Greater Springfield Transit | | X |
| 13 | Howard County | x | |
| 14 | City of Laurel | x | |
| 15 | Lee Coaches Commuter Bus | | X |
| 16 | Loudoun County | x | |
| 17 | Maryland MTA | x | |
| 18 | Montgomery County | x | |
| 19 | National Coach Commuter Bus (Fredericksburg, Spotsylvania & Stafford Counties) | | X |
| 20 | OMNI-LINK (Prince William County) | x | |
| 21 | OMNI-RIDE (Prince William County Commuter Bus) | x | |
| 22 | Prince George's County | x | |
| 23 | Quicks Commuter Bus (Fredericksburg, Spotsylvania & Stafford Counties) | | X |
| 24 | Rex Bus | | X |
| 25 | St. Mary's County | | X |
| 26 | Tyson's Circulator | | X |
| 27 | Washington Flyer- Dulles/WFC | | X |
| | Total | 15 | 12 |

TPB staff downloads GTFS data directly from the primary transit providers or from the GTFS Data Exchange website (<http://transit.land/> or <http://transitfeeds.com/>) each fall. Once GTFS data are ready, TPB staff has developed an automated database procedure to convert these text files into Microsoft Access database tables and compute average transit route run times and average route headways by time-of-day period. The automated database procedure also extracts geometric (route itinerary) information. The procedure for processing GTFS data is shown in Figure 4-3.

Figure 4-3 Process for combining GTFS data into the COG Geodatabase



Ref: "I:\ateam\docum\FY16\2015CLRP_Network_Report\GTFS_Data_Process_Flowchart.docx"

After the GTFS data are added to the GDB, transit service from providers which do not use GTFS is coded into the GDB using schedule information from each provider's website. This completes the base-year transit network files upon which all forecast-year transit network files are built.