Appendix F - Transportation

FRIENDSHIP HEIGHTS
SECTOR PLAN

Appendix F: Transportation

This appendix includes the Friendship Heights Sector Plan Transportation Analysis.

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Friendship Heights Sector Plan Transportation Appendix

The purpose of this appendix is to document the transportation scenarios analyzed for the Friendship Heights Sector Plan, an overview of the analysis tools used, and report the findings of this analysis through the performance metrics required per the Montgomery County Council Planning, Housing and Economic Development (PEHD) Committee letter, dated 12/15/2020. This appendix also summarizes supplementary transportation analysis completed for the plan.

Travel Demand Forecasting Process and Assumptions

An enhanced version of Montgomery Planning's regional travel demand forecasting model, TRAVEL/4, was used to develop traffic forecast results for weekday travel during AM and PM peak periods. TRAVEL/4 is a Montgomery County-focused adaptation of the regional travel demand model developed by the Metropolitan Washington Council of Governments (MWCOG). The tool is a four-step model consisting of:

- **Trip generation**: forecasts the number of person trips by trip purpose that are produced by and attracted to each Traffic Analysis Zone (TAZ) based on given types of land uses and their associated densities.
- **Trip distribution**: forecasts the spatial pattern of person trip flows between origins and destinations.
- **Mode split**: estimates the share of travel modes that person trips use, including single occupant auto, multiple occupant auto (HOV2 and HOV 3+), and transit. This step is also known as mode choice. Nonmotorized trips such as walking and biking are estimated separately as part of the trip generation step and are not included in the trip distribution, mode split, or traffic assignments steps.
- **Traffic assignment**: allocates trips to a transportation network to estimate traffic flows and loads on each network segment.

The TRAVEL/4 model incorporates land use and transportation assumptions for the metropolitan Washington region, using the same algorithms as applied by the MWCOG's Gen2 travel demand model.

TRAVEL/4 Model Overview

The TRAVEL/4 regional travel demand model is used to reflect countywide and regional traffic effects. The tool is an adapted version of MWCOG's Gen2 Version 2.4.6 regional travel demand forecasting models, reflecting a more detailed transportation system network structure within Montgomery County relative to the standard MWCOG model.

In addition, relative to the standard MWCOG regional modeling tool, a more detailed traffic analysis zone (TAZ) structure is incorporated into TRAVEL/4, resulting in an increase in the number of TAZs in

Montgomery County. Additional model run scripting enhancements were made to the model code. In response to adjustments to the regional model transportation network and zone structure, other inputs, such as aggregate sociodemographic data, lookup tables, and model parameters, were revised accordingly for incorporation into TRAVEL/4.

TRAVEL/4 Forecast Assumptions

The Friendship Heights Sector Plan forecasts assumed the following parameters:

- A 2045 horizon year. This is currently the most distant horizon year for which forecast land use and transportation system development is available.
- Regional growth per the MWCOG Cooperative Forecast for all areas beyond the Plan Area.
- Transportation improvements in the region's Constrained Long-Range Plan (CLRP), a fiscally constrained transportation network.
- Other Montgomery County master-planned transportation projects including the MD 355 Flash BRT project. Consistent with the 2013 *Countywide Transit Corridors Functional Master Plan*, the MD 355 South corridor was not assumed to extend south of the Bethesda Metro Station.

Travel Demand Model Scenarios

In developing the Friendship Heights Sector Plan, four scenarios were evaluated using the department's TRAVEL/4 regional travel demand model.

- **Existing (2018) Scenario** represents the road network and land uses as they existed in 2018, which is the model base year. The roadways reflect the current number of lanes constructed, not the maximum build-out allowed by the adopted master plans.
- **2045 Adopted Master Plan (Baseline) Scenario** (i.e. the 1998 Friendship Heights Sector Plan) adds to the existing transportation network in the regional model all planned roadways in the current Master Plan of Highways and Transitways, which reflects the recommendations of all current, adopted plans applicable to the Sector Plan Area. Land use assumptions for this scenario incorporated population and employment projections for the regional model area, including a theoretical build-out of all property within the Sector Plan by the year 2045 under current zoning limits and expected land use categories.
- **2045 Proposed Master Plan Scenario** reflects the recommended transportation network and zoning in the Sector Plan's Working Draft.
- **2045 Extended 355 BRT Test Scenario** modifies the 2045 Proposed Master Plan Scenario by testing the effect of extending lane repurposing for dedicated bus lanes between Oliver Street and Bradley Boulevard. This scenario reflects the likely reality that dedicated bus lanes on MD 355 within the Friendship Heights Sector Plan area are likely to be implemented in conjunction with dedicated bus lanes between the Friendship Heights Sector Plan area and the Downtown Bethesda Plan area (i.e. between Oliver Street and Bradley Boulevard).

Transportation Network Inputs

Table 1 summarizes the key transportation infrastructure model inputs that differentiate each scenario. Land use assumptions for all four scenarios are summarized in a section following the scenario descriptions.

Table 1: Key Transportation Infrastructure by Scenario

Roadway	Existing (2018) Scenario	2045 Adopted Master Plan (Baseline)	2045 Proposed Master Plan Scenario	2045 Extended 355 BRT Test Scenario
Wisconsin Ave (MD 355) from Oliver St to Western Ave	6 GP* travel lanes No dedicated bus lanes	6 GP travel lanes No dedicated bus lanes	4 GP travel lanes 2 dedicated bus lanes	4 GP travel lanes 2 dedicated bus lanes
Wisconsin Ave (MD 355) from Bradley Ln to Oliver St	6 GP travel lanes No dedicated bus lanes	6 GP travel lanes No dedicated bus lanes	6 GP travel lanes No dedicated bus lanes	4 GP travel lanes 2 dedicated bus lanes
River Rd from Willard Ave Neighborhood Park to Western Ave	4 GP travel lanes	4 GP travel lanes	2 GP travel lanes	2 GP travel lanes

* GP lanes = general purpose travel lanes.

Land Use Inputs

Beyond the Plan Area, the TRAVEL/4 model scenarios described above included background regional land use demographics reflecting the MWCOG Round 10.0 Cooperative Forecast. The Cooperative Forecast documents existing year conditions and considers projected future growth in population and employment, allocated by Traffic Analysis Zone (TAZ), throughout the entire model region. Growth projections consider adopted plans and approved, unbuilt development projects.

Figures 1 through 3 illustrate the land use assumptions within the Plan Area for each model scenario. Table 2 provides this same information in a tabular format.

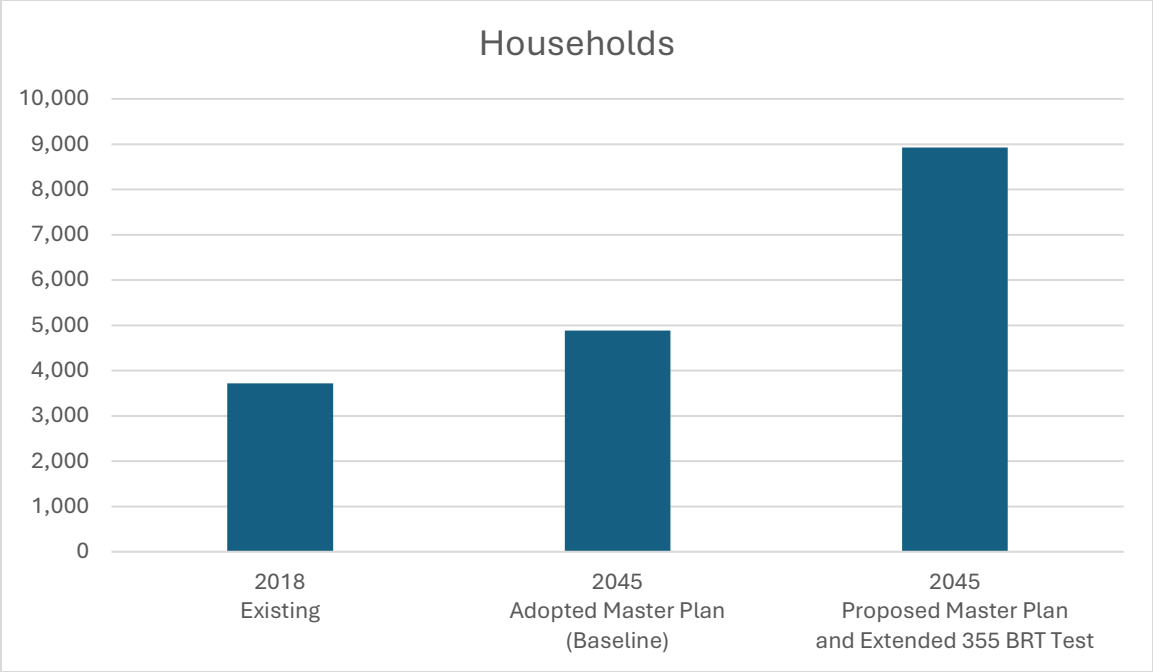

Figure 1: Plan Area Household Assumptions by Scenario

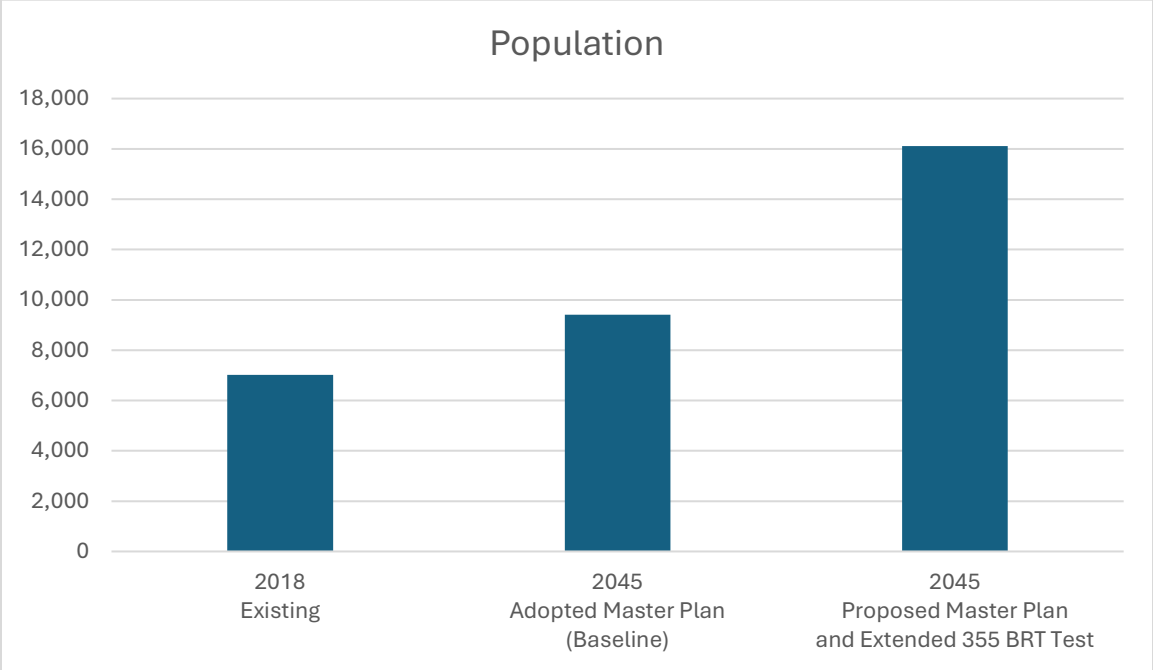

Figure 2: Plan Area Population Assumptions by Scenario

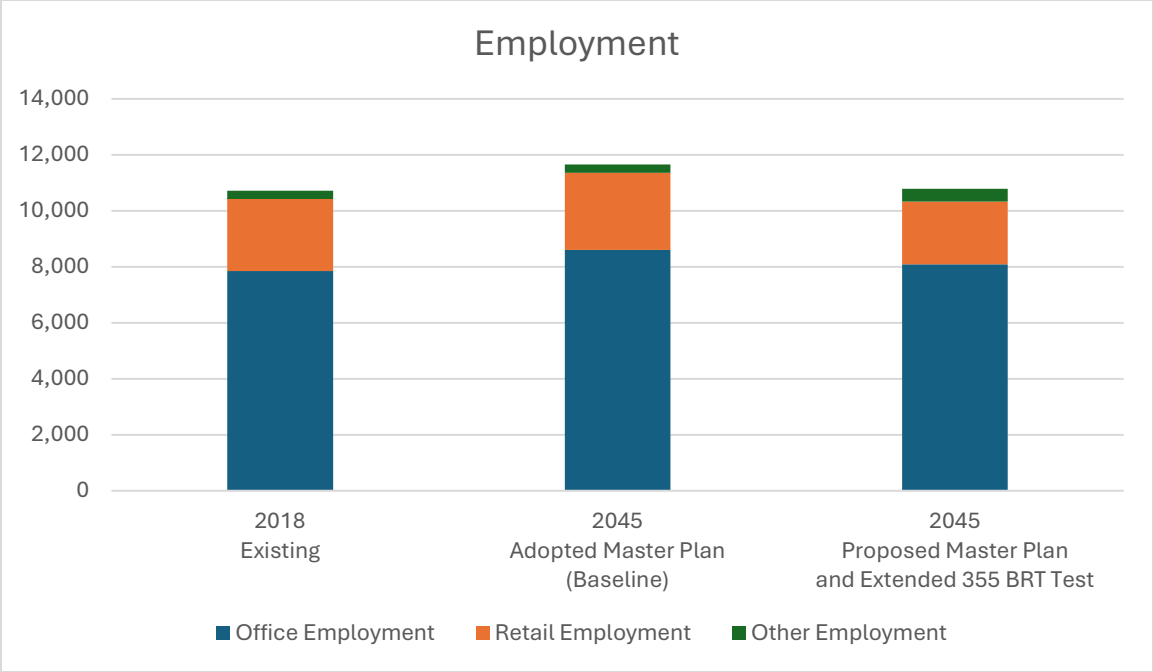

Figure 3: Plan Area Employment Assumptions by Scenario

Table 2: Plan Area Land Use Assumptions by Scenario

Model Scenarios	**Households**	**Population**	**Jobs**
Existing (2018)	3,721	7,016	10,717
2045 Adopted Master Plan (Baseline) – Existing Zoning	4,886	9,414	11,654
2045 Proposed Master Plan Scenario and Extended 355 BRT Test Scenario – Proposed Zoning	8,929	16,114	10,786
Change from 2045 Baseline to 2045 Test Scenarios	*+4,043*	*+6,700*	*-865*

Master Plan Adequacy Performance Metrics

The results of the TRAVEL/4 model runs are used to generate metrics to evaluate the transportation adequacy of master plans, which are composed of five transportation system performance metrics. These metrics and how they are derived and interpreted are briefly described below.

1. **Accessibility** is defined as the number of jobs that can be reached in the Washington, D.C. metropolitan region within 45 minutes by auto and by transit at the time of buildout. Adequacy is achieved if the master plan improves average accessibility for the "Parent" Policy Area[1] relative to the currently adopted master plan. The metric is calculated for each transportation analysis zone (TAZ), then averaged across all TAZs in the "Parent" Policy Area, weighting the accessibility value for each TAZ by the sum of its population and employment.
2. **Travel time** is defined as the average time by auto and by transit, considering all trip purposes during all times on a weekday at time of buildout. Adequacy is achieved if the master plan improves average travel time for the "Parent" Policy Area relative to the currently adopted master plan.
3. **Vehicle miles traveled (VMT)** per capita is defined as the sum of the weekday VMT from trips that both start and end within the "Parent" Policy Area and half the weekday VMT from trips that either start or end within the "Parent" Policy area. Adequacy is achieved if the plan improves (i.e., reduces) average VMT per capita for the "Parent" Policy Area relative to the currently adopted plan.
4. **Non-auto-driver mode share (NADMS)** is defined as the total share of all person trips by HOV2 passengers, HOV3+ passengers, transit passengers, and trips by nonmotorized modes for the journey to work in the Plan area.[2] Adequacy is achieved if the Plan confirms the relevant pre-established journey-to-work NADMS goal at buildout from the Growth and Infrastructure Policy. For the Friendship Heights Sector Plan, this is the Friendship Heights Policy Area.
5. **Low-stress bicycle accessibility** is defined as the percentage of potential bicycle trips that can be accommodated on a low-stress (LTS-2 or better)[3] bikeway network. Adequacy is achieved if the plan meets or improves the average percentage for the county at the time of buildout.

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[1] Per a December 15, 2020 memo from the County Council's Planning, Housing and Economic Development (PHED) Committee, for small-area sector plans analysis is conducted for the "parent" policy area as a whole, including all sector plans within it. For the Friendship Heights Sector Plan this includes the Bethesda-Chevy Chase Policy Area, as well Bethesda Central Business District, Chevy Chase Lake Master Plan Area, Friendship Heights Policy Area and Medical Center Policy Area.

[2] To account for HOV trips, HOV2 trips count as one auto driver trip and one non-auto driver trip; HOV3+ trips count as one auto driver trip and 2.5 non-auto driver trips, based on an assumed vehicle occupancy of 3.5 for HOV3+trips. Expressed another way, NADMS includes 50% of HOV2 trips and 71.43% of HOV3+ trips.

[3] LTS-2 is defined as a bicycle travel network "appropriate for most adults" or "appropriate for most children" (Consistent with the approach for Objective 2.1 of the Bicycle Master Plan – "Countywide Connectivity.")

Figure 4 illustrates the Policy Areas that comprise the "Parent" Policy Area for the Friendship Heights Sector Plan analysis.[4]

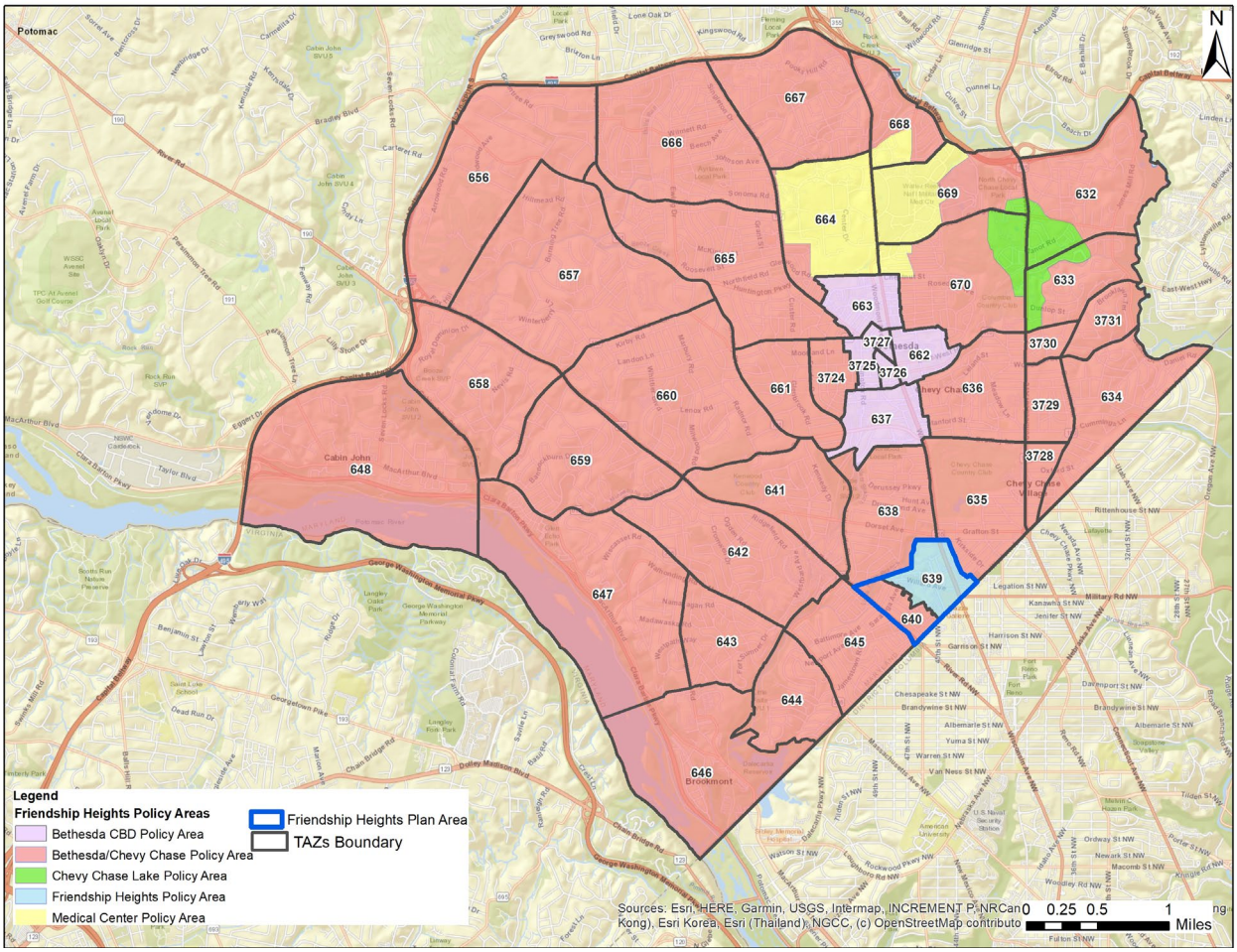

Figure 4: Friendship Heights "Parent" Policy Area, Policy Area, and TAZs

[4] TAZs 639 and 640 comprise represent the Plan Area. The TAZs comprising the "Parent" Policy Area are 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 3724, 3725, 3726, 3727, 3728, 3729, 3730, and 3731.

Adequacy Metric Results

The transportation performance metrics pertaining to accessibility, travel time, VMT per capita, and NADMS analyzed for the year 2045 adopted plan scenario (i.e. the 1998 Friendship Heights Sector Plan) and the year 2045 proposed plan scenario (this Sector Plan) indicate that the Plan achieves transportation adequacy for these metrics at buildout. The 2045 Extended 355 BRT Test Scenario, which tests extending BRT from the DC border to Bradley Boulevard, results in similar findings, with slightly less auto job accessibility than the proposed plan scenario. Results are summarized in Table 3.

The projected **auto job accessibility** for the year 2045 proposed Plan scenario shows a decrease of less than 1 percent from the 2045 adopted plan scenario, while **transit job accessibility** shows an 8 percent increase; the magnitude of the increase in the number of jobs accessible by transit exceeds the magnitude of the decrease in the number of jobs accessible by auto.

The projected **travel time** for the year 2045 proposed Plan scenario shows an approximate 1 percent decrease for auto travel time and 2 percent decrease for transit travel time compared to the 2045 adopted plan scenario.

The projected **VMT per capita** under the year 2045 proposed Plan scenario is approximately 2 percent lower than the projected VMT per capita under the year 2045 adopted plan scenario.

The projected **NADMS** results for the currently adopted and proposed plans are 58.4 percent and 59.9 percent, respectively. These projections exceed the pre-established 39.0 percent NADMS goal for both residents and commuters combined in the Friendship Heights Policy Area and indicates a 1.5 percentage point increase from the 2045 adopted Plan scenario to year 2045 proposed Plan scenario.

The **low-stress bicycle accessibility** metric is derived from the application of the Planning Department's Bicycle Travel Demand Model. The results for this metric will be added to the Plan's appendix when available.

Table 3: Transportation Adequacy Performance Metric Summary

Model Scenario	Auto Accessibility (Jobs)	Transit Accessibility (Jobs)	Auto Travel Time (minutes)	Transit Travel Time (minutes)	VMT Per Capita (miles)	NADMS (work trips)
2018 Existing	2,749,527	310,912	16.0	50.9	12.5	54.0%
2045 Baseline	2,726,847	395,168	17.3	50.4	12.1	58.4%
2045 Proposed Plan	2,713,726	428,196	17.2	49.6	11.9	59.9%
2045 Extended 355 BRT Test	2,702,959	428,155	17.2	49.6	11.9	60.0%

Table 4 summarizes the percent change in metric results between the 2045 scenarios and the 2045 Baseline scenario. As shown, the metric trends are similar under the two scenarios.

Table 4: Transportation Adequacy Performance Metric Percent Change from 2045 Baseline Results

Model Scenario	Auto Accessibility (Jobs)	Transit Accessibility (Jobs)	Auto Travel Time (minutes)	Transit Travel Time (minutes)	VMT Per Capita (miles)	NADMS (work trips)
2045 Proposed Plan	-0.5%	+8.4%	-0.6%	-1.6%	-1.5%	+1.5%
2045 Extended 355 BRT Test	-0.9%	+8.3%	-0.4%	-1.6%	-1.4%	+1.6%

Lane Repurposing Analysis

Staff completed a roadway segment capacity analysis to evaluate the vehicular traffic implications of repurposing one vehicle travel lane in each direction on both River Road (for separated bike lanes / sidepath) and Wisconsin Avenue (for dedicated bus lanes). The Wisconsin Avenue lane repurposing recommendation in the Friendship Heights Sector Plan update applies only to the portion of Wisconsin Avenue within the plan area; however, to be conservative from a vehicular traffic perspective, the analysis assumed lane repurposing on the full stretch of Wisconsin Avenue between Western Avenue and planned dedicated bus lanes in Bethesda. Analysis included two scenarios:

- **Lane Repurposing with Existing Volumes (2024)** is based on observed traffic volumes from the most recent available year 2024 with lane repurposing in the extents described above.
- **Lane Repurposing with Estimated Future Volumes (2045)** uses the 2024 observed traffic volumes as a starting point, then applies an adjustment factor based on the change in traffic volumes estimated by the TRAVEL/4 model between a year 2018 model run and the "2045 Extended 355 BRT Test Scenario" model run described above.

Lane Repurposing Analysis Scope

National Cooperative Highway Research Program (NCHRP) Report 825, *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual,* provides guidance for "high level" analysis appropriate for feasibility studies of road diets and land development traffic impact studies.[5] The Federal Highway Administration's (FHWA) *Road Diet Informational Guide* also provides guidance on appropriate daily volumes for four-to-three lane conversion road diets.[6] Master-plan-level traffic analysis focuses on the capacity of roadway segments to accommodate anticipated levels of traffic demand, reflecting the scope of master plan recommendations for the number of vehicle travel lanes. Overall traffic capacity is also dependent on intersection operations (e.g., stop-controlled intersections or the configuration and timing of traffic signals), which are beyond the scope of master plan recommendations and are instead addressed by implementing partner agencies such as the

[5] https://www.nationalacademies.org/publications/23632, p. 81
[6] https://highways.dot.gov/safety/other/road-diets/road-diet-informational-guide

Montgomery County Department of Transportation (MCDOT) and the Maryland State Highway Administration (SHA); implementing partner agencies also conduct more detailed traffic analysis as they advance transportation infrastructure projects through further planning and design.

Lane Repurposing Analysis Method and Results

According to NCHRP Report 825:

> *Whether or not a more detailed urban street facility analysis is needed can be determined by comparing the counted or forecasted daily or peak hour traffic volumes for the urban street segments between each controlled intersection to the values given the service volume tables presented later in this subsection. If all of the segment volumes fall in the LOS E range or better, there will not be congestion spillover requiring a full facility analysis to better quantify the facility's performance.*
>
> *….*
>
> *If the counted or forecasted volumes for a segment fall within the agency's target LOS standard, then the segment and its associated downstream intersection can be excluded from a more detailed analysis.*

Observed Volumes (2024)

Observed annual average daily traffic (AADT) volumes were collected from the latest available data in SHA's Traffic Monitoring System, reflecting year 2024. AADT values were collected from two locations:

- River Road from Little Falls Parkway to the Washington DC Line: 16,601 AADT
- Wisconsin Avenue from the Washington DC Line to Cedar Lane: 30,180 AADT

Forecasted Volumes (2045)

Forecasted peak hour volumes for the year 2045 lane repurposing scenario were estimated by applying an annualized rate of change estimated from the TRAVEL/4 regional travel demand model to the year 2024 observed volumes.

For Wisconsin Avenue, average daily bi-directional volumes on four model segments between Western Avenue (node 22864) and Morgan Drive (node 23423) were compared for year 2018 (the latest available "existing" model year) and year 2045 to derive an annualized rate of change across the 27 years separating the two model runs. For River Road, average daily volumes on four segments between Little Falls Parkway (node 22026 and Western Avenue (node 20703) were compared in a similar way. The annualized rate of change was then applied to adjust the year 2024 observed volumes by 21 years to reach the year 2045. Table 5 summarizes the daily volume calculation.

Table 5 - Forecasted Daily Volume Calculation Summary

	River Road	Wisconsin Avenue
AADT (2024)	16,601	30,180
Percent Change in Daily Volume 2018 Model to 2045 Model	-9.01%	-2.49%
Years in Change Period (2018 to 2045)	27	27
Annualized Rate of Change	-0.35%	-0.09%
Years to Apply Change Factor (2024 to 2045)	21	21
Total Change Factor (2024 to 2045)	-7.08%	-1.94%
Forecasted Daily Volume (2045)	**15,426**	**29,593**

Source: TRAVEL/4 regional travel demand model

River Road – Road Diet Informational Guide

After lane repurposing, River Road would have one through vehicular traffic lane per direction with a shared center left turn lane. For four-to-three lane conversions like the one evaluated for River Road, FHWA's *Road Diet Informational Guide* (RDIG) states "the FHWA advises that roadways with [average daily traffic] of 20,000 [vehicles per day] or less may be good candidates for a Road Diet and should be evaluated for feasibility." With 16,601 existing AADT and 15,426 forecasted AADT, both existing and future volumes for the River Road location are well within the range of guidance for road diet implementation. As noted above, implementing partner agencies will conduct more detailed traffic analysis before implementing the road diet as they advance through further planning and design. Other research cited in the RDIG has documented road diets on roads with up to 24,000 vehicles per day, while Seattle, Washington set a maximum volume threshold for a road diet of 25,000 vehicles per day. **The research and existing and future forecasted volumes support a four-to-three lane road diet on River Road.**

Wisconsin Avenue – NCHRP Report 825

After lane repurposing, Wisconsin Avenue would have two through vehicular traffic lanes per direction. Table 6 reproduces a portion of NCHRP Report 825 Exhibit 45, which provides guidance on daily capacities for urban streets; capacities resulting in LOS E or better are considered acceptable. Although the values provided in Exhibit 45 are sensitive to a number of operational details that are not established during a master plan, it captures key observed data (the K-Factor and D-Factor) and aspects that reflect master planned recommendations (number of lanes and posted speed limit, reflecting target speed), making it a useful tool for master-plan-level evaluation of recommendations. A K-Factor represents the proportion of AADT occurring in the peak hour, and a D-Factor represents the proportion of AADT occurring in the peak direction during the peak hour. Applying both factors to the AADT provides an estimate of the one-way traffic volume in the highest-volume direction during the highest-volume hour. For a given level of AADT, a higher K-factor will place more demand on peak hour roadway capacity because more of the daily traffic will occur during the peak hour, and a higher D-factor will place more demand on peak direction roadway capacity because more of the daily traffic will occur in the peak direction.

Table 6: Excerpt from NCHRP Report 825 Exhibit 45: HCM daily service volume and capacity table for urban streets (for Four-Lane Streets with Posted Speed Limit = 30 mph)

K-Factor	D-Factor	LOS C	LOS D	LOS E
0.09	0.55	2,200	24,700	35,800
0.09	0.60	2,000	22,700	32,800
0.10	0.55	2,000	22,300	32,200
0.10	0.60	1,800	20,400	29,500
0.11	0.55	1,800	20,300	29,300
0.11	0.60	1,700	18,600	26,900

The TRAVEL/4 regional travel demand model forecasts that volumes on the analyzed segment of Wisconsin Avenue will decrease slightly (approximately 2% total) between 2024 and 2045; however, to maintain a conservative estimate of roadway capacity, the higher year 2024 AADT is used in the analysis.

Table 7 compares the characteristics of the analyzed segment of Wisconsin Avenue to the relevant values in the NCHRP daily capacity table ("Exhibit 45").

- D-Factor: Wisconsin Avenue's observed D-factor falls between two values on Exhibit 45, so a lower bound and upper bound capacity are shown, reflecting capacity ranging between 32,800 and 35,800 daily vehicle trips, which exceeds the existing demand of 30,180.
- Posted Speed Limit: The posted speed limit on Wisconsin Avenue is 25 mph, which is lower than the lowest posted speed limit provided on Exhibit 45. LOS E capacities on Exhibit 45 for streets with a 30-mph speed limit are approximately 3% lower than those for streets with a 45-mph speed limit; conservatively assuming capacities decrease a further 3% when the posted speed limit is reduced from 30 mph to 25 mph, the 2024 AADT of 30,180 is still below both the lower and upper bound capacities of 31,816 and 34,726 daily vehicle trips.
- K-Factor: The analysis is further conservative because Wisconsin Avenue's observed K-factor is 16% less than the lowest K-factor provided in Exhibit 45, leaving substantially more capacity during the peak hour. Furthermore, considering the TRAVEL/4 forecasts decrease between traffic by 2045, there is even more capacity relative to estimated demand.

The analysis indicates that the capacity of the roadway at LOS E exceeds both the existing and future forecasted volumes. **The guidance and existing and future forecasted volumes support repurposing one through vehicle travel lane per direction on Wisconsin Avenue.**

Table 7 - Wisconsin Avenue Characteristics vs. Exhibit 45 Daily Capacity Table, Selected Values

Element	Wisconsin Avenue (2024)	Exhibit 45 Capacity Lower Bound	Exhibit 45 Capacity Upper Bound
AADT	30,180	32,800	35,800
Capacity, less 3%		31,816	34,726
K-Factor	0.0753	0.09	0.09
D-Factor	0.5803	0.60	0.55
Lanes	Four	Four	Four
Posted Speed Limit	25 mph	30 mph	30 mph