VDOT
Virginia Department of Transportation

Northern Virginia Regional Bikeway and Trail Network Study Update

Fall 2015

Northern Virginia (NOVA) Regional Bikeway and Trail Network Study *Update*

Fall 2015

Prepared by: Michael Baker International

ACKNOWLEDGEMENTS

Jurisdictions / Organizations participating in this study included:

- Arlington County
- City of Alexandria
- City of Fairfax
- City of Falls Church
- City of Manassas
- City of Manassas Park
- Fairfax County
- Loudoun County
- Prince William County
- Town of Clifton
- Town of Dumfries
- Town of Hamilton
- Town of Haymarket
- Town of Herndon
- Town of Leesburg
- Town of Lovettsville
- Town of Middleburg
- Town of Occoquan
- Town of Purcellville
- Town of Quantico
- Town of Round Hill
- Town of Vienna

- Alexandria Bicycle and Pedestrian Advisory Committee (BPAC)
- Fairfax Advocates for Better Bicycling (FABB)
- Federal Highway Administration (FHWA)
- Loudoun County's Advocate Representative
- Northern Virginia Regional Commission
- Virginia Department of Transportation, NOVA District, Transportation Planning

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INTRODUCTION

This report is an update to the Virginia Department of Transportation's (VDOT) 2003-2004 Northern Virginia Regional Bikeway and Trail Network Study, and, therefore should be used in conjunction with the original study rather than replacing it. All of the details in the original study (such as the policies and case studies) are not replicated. Instead, this report focuses on the progress since 2003 in implementing the original network.

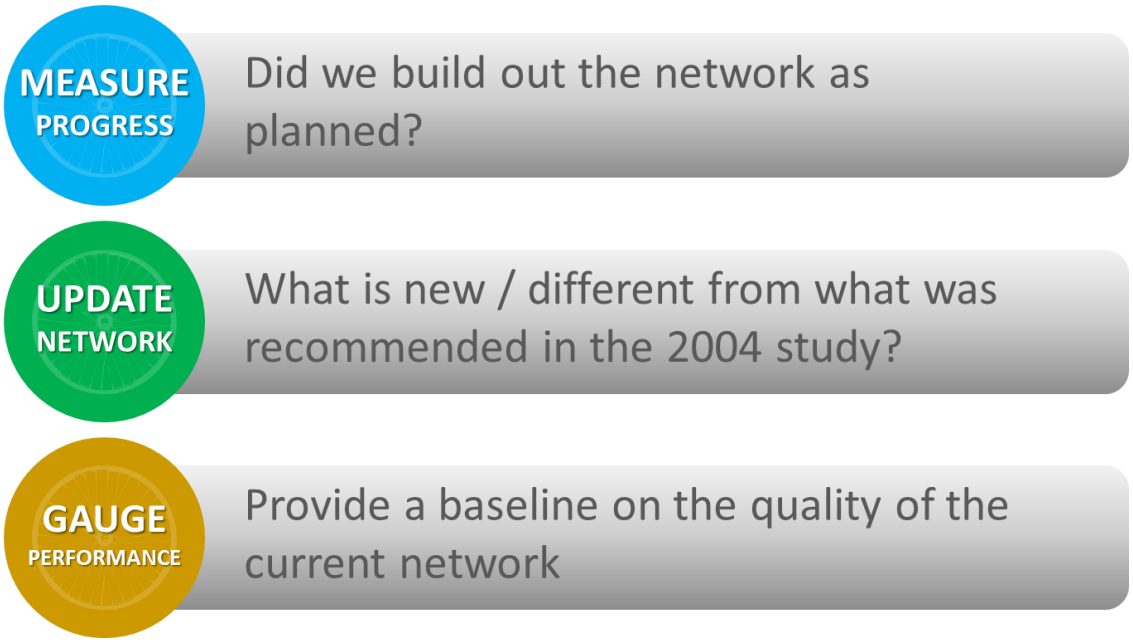
The goals of this update were (see **Figure 1**):

- Measure Progress: Determine the percentage of facilities proposed in 2003 that have been constructed.
- Update Network: Identify which new routes should be added to the network due to changes in population and land use.
- Gauge Performance: Create a performance measure for future use (Bicycle Level of Service).

As was the case in the original 2003-2004 Study, the updated Network does not attempt to reflect all bicycle facilities in Northern Virginia, but only the routes that rise to the level of being regionally significant. Regional significance was determined by quantifying the demand for each route using the Latent Demand Method, described in a later section. Public review and feedback were critical to the study since they provided field observations for the existing network, evidence of frequently used facilities, and real-world perspectives to validate (or modify) the bicycle comfort rating analysis.

This document is not intended to replace the plans of local jurisdictions.

FIGURE 1: PURPOSE OF THE STUDY

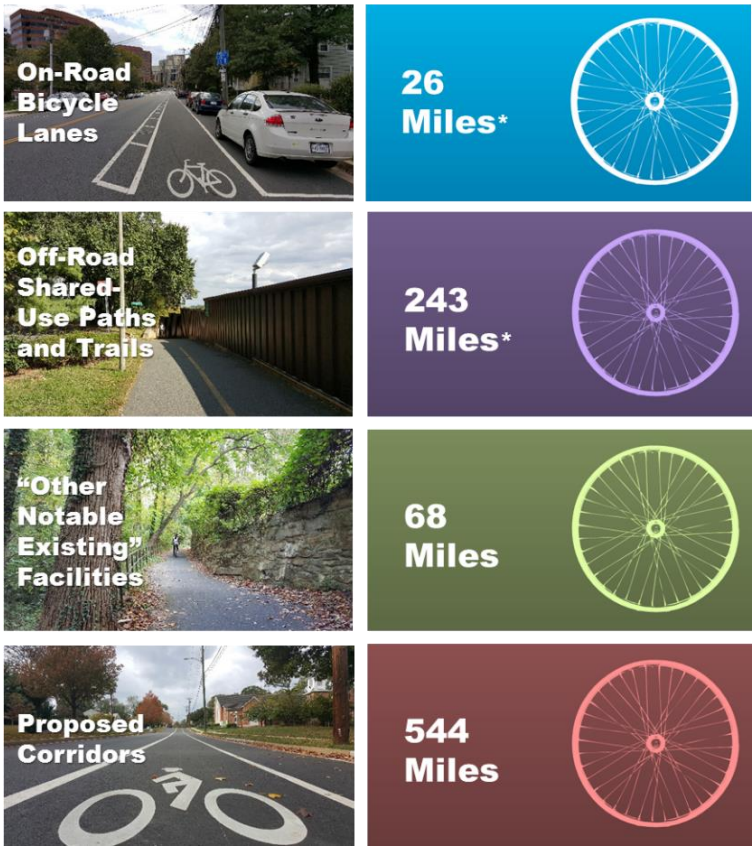


2003-2004 NETWORK EVALUATION

The 2003 Regional Bikeway and Trail Network included approximately 881 miles of existing and proposed bicycle facilities and corridors. While additional facilities certainly existed at the time, they were not considered "regionally significant" based on the latent demand results. The 2003 Network (**Figure 2**) was comprised of 243 miles of existing off-road, 26 miles of existing on-road, and 68 miles of "other notable existing" facilities, as identified by the local jurisdictions. In addition, the 2003-2004 network included 544 miles of "proposed regional corridors."

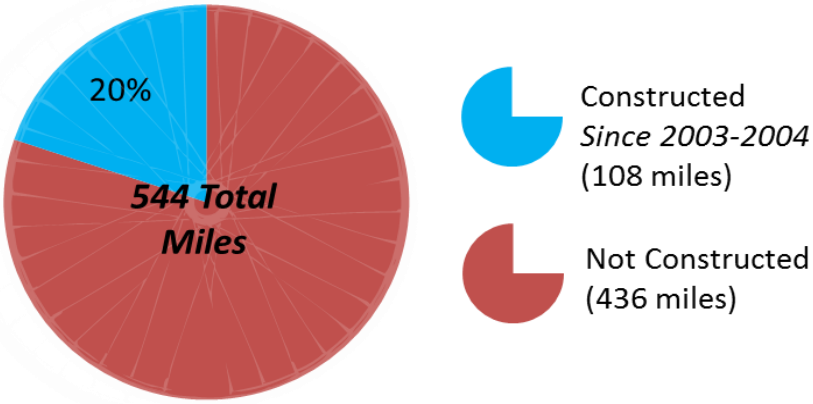
The region has made significant strides in bicycle planning, design, and construction since 2003. Many jurisdictions have recently completed their own bicycle studies and plans and are diligently working to enhance connectivity for cyclists and pedestrians. As such, today's existing regional network is much more extensive than what was seen in 2003. In fact, approximately 20% of the 2003 Proposed Network has been constructed, representing nearly 108 miles of bicycle facilities (**Figure 3**).

FIGURE 2: THE 2003-2004 EXISTING NETWORK



***2003 totals included approximately 65 miles of funded, but not yet constructed facilities.**

FIGURE 3: EVALUATING THE 2003 PROPOSED NETWORK



LATENT DEMAND ANALYSIS

Introduction

In 2003, a latent demand analysis was conducted as part of the Northern Virginia Regional Bicycle and Network Study to identify the relative potential bicycle trip activity in the region.[1] This 2015 study reintroduces the latent demand method as a way to compare potential bicycle demand over time and show the relationship between the existing land use, infrastructure and potential bicycle trip generation. The results were ultimately used to help redefine the study's regional bicycle network.

A Latent Demand model is used to identify the amount of bicycle travel (or "demand") likely to occur along existing street segments based on surrounding population, employment, and selected land uses. It is important to note that the demand is calculated based on network distances and without regard to existing traffic or the presence of bicycle facilities (trails, lanes, sidewalks). In other words, the model results are not constrained by existing bicycle facilities.

The latent demand model incorporates four general utilitarian trip purposes: work, school, shopping, and social/recreation. The trip purpose shares, expressed as percentages, were derived from the *National Household Travel Survey.*[2] The latent demand model relies heavily on geographic information systems (GIS) to quantify and analyze relative potential bicycle trip activity on the roadway network.

KEY TRIP ATTRACTORS

Methodology

After compiling the jurisdiction bicycle GIS data, a series of key trip attractors were established. These attractors (shown on the right) were identified based on their trip generation capacities and their respective locations.[3] Once mapped, spatial analysis was performed in GIS to record the number of attractors within varying proximities (0.5 miles, 1.0 miles, 1.5 miles, and 2.0 miles) of each identifiable roadway

[1] The 2003 Regional Bike and Trail Network Study can be found at: http://www.virginiadot.org/projects/northernvirginia/regional_bike_and_trail_network_study.asp

[2] National Household Travel Survey (NHTS), 2009. For the purposes of this analysis, the social/recreational trip purpose reflects three NHTS categories: social/recreational, visiting friends/relatives, and other family/personal business.

[3] This study's trip attractors (which also act as generators) were the focus of this analysis because of the double counting which can occur when incorporating population-based trip generation and attractor-based trip generation.

segment. The spatial buffers were dissolved in GIS to ensure that the features did not overlap. This process avoids double-counting trip attractors for a given roadway segment.

Next, trip generations were assigned to each type of attractor. The *Institute of Transportation Engineers (ITE) Trip Generation Handbook (8th Edition)* was used to identify typical trip generation potential for parks, schools, colleges, and universities. Adjustments were made for institutions with exceptionally high enrollment, such as George Mason University (32,562 students) and Northern Virginia Community College (49,000 students across several campuses). The *WMATA Metrorail Survey (May 2014) was* used to identify typical daily trip generation at Metrorail stations, while *American Public Transportation Association (APTA)* data were used to approximate trip generation for the Virginia Railway Express (VRE) stations.

The trip generations were subsequently multiplied by the respective trip purpose shares for a given trip purpose. The calculation yields the relative number of potential bicycle trips generated, which must also be adjusted by a distance probability factor.

Once the potential bicycling trips were estimated, probabilities for making trips at various lengths were applied. The trip probability adjustments help account for the diminishing trip potential across longer distances, especially since distance between origins and destinations affects bicycling more dramatically than it does for automobile travel. The trip probabilities also account for different trip purposes. For example, people are typically willing to bicycle a greater distance to work than they are to simply pick up items at a local store. The trip lengths and probabilities (**Table 1**) were derived from the *National Household Travel Survey* and are similar to what were used in other regional studies, such as the *Atlanta Region Bicycle Transportation & Pedestrian Walkways Plan.*

Table 1: Bicycle Trip Probabilities Based on Distance and Purpose

	Trip Purpose				
Average Trip Length	Work	School	Shopping	Social/Rec	Transit
0.5 miles	99.6%	99.0%	98.2%	99.5%	99.2%
1.0 mile	98.5%	86.4%	66.7%	96.2%	92.4%
1.5 miles	95.4%	45.1%	10.9%	84.2%	66.9%
2.0 miles	88.1%	0.0%	0.2%	59.1%	28.8%

The trip-making probabilities were multiplied by the relative number of generated bicycle trips for a particular bicycle segment, resulting in the number of bicycle trips for a particular purpose. These segment trips were aggregated for the four trip types.

Each segment was assigned a jurisdiction-specific quintile range based on its relative trip generation potential within its host jurisdiction. The quintiles, ranging from low demand to high demand, depict relative demand for bicycle facilities with little or no impedance.

Results

The summaries below, reflecting the results of the latent demand analysis for the region's largest jurisdictions, identify several high demand bicycle areas. These areas, also shown in **Figure 4**, serve as an initial screening for identifying regionally significant bicycle facilities.

Loudoun County: The latent demand analysis suggests that the highest potential bicycle demand is clustered in/around Leesburg, Ashburn, and Sterling and along notable bicycle facilities which connect these activity centers. Key roads, such as Ashburn Road (Route 641), provide access to jobs (Telos Corporation, Ashburn Farm Village Center), schools (Cedar Lane Elementary, Broad Run High), and offer connections to prominent regional bicycle facilities such as the Washington and Old Dominion (W&OD) trail.

Fairfax County: The County has significant pockets of potential bicycle demand in Herndon and Reston. Roads, such as Reston Parkway/Lawyers Road/Ox Road, provide a key north-south connection and offer access to parks; golf courses; schools; commercial centers, such as Reston Town Center; and significant regional employers such as the U.S. Geological Survey. The analysis also shows strong potential bicycle demand around George Mason University (Fairfax City), and at burgeoning mixed-use centers such as Mosaic District (Fairfax/Falls Church) and Tysons Corner.

Merrifield's Mosaic District. Source: Wikimedia.

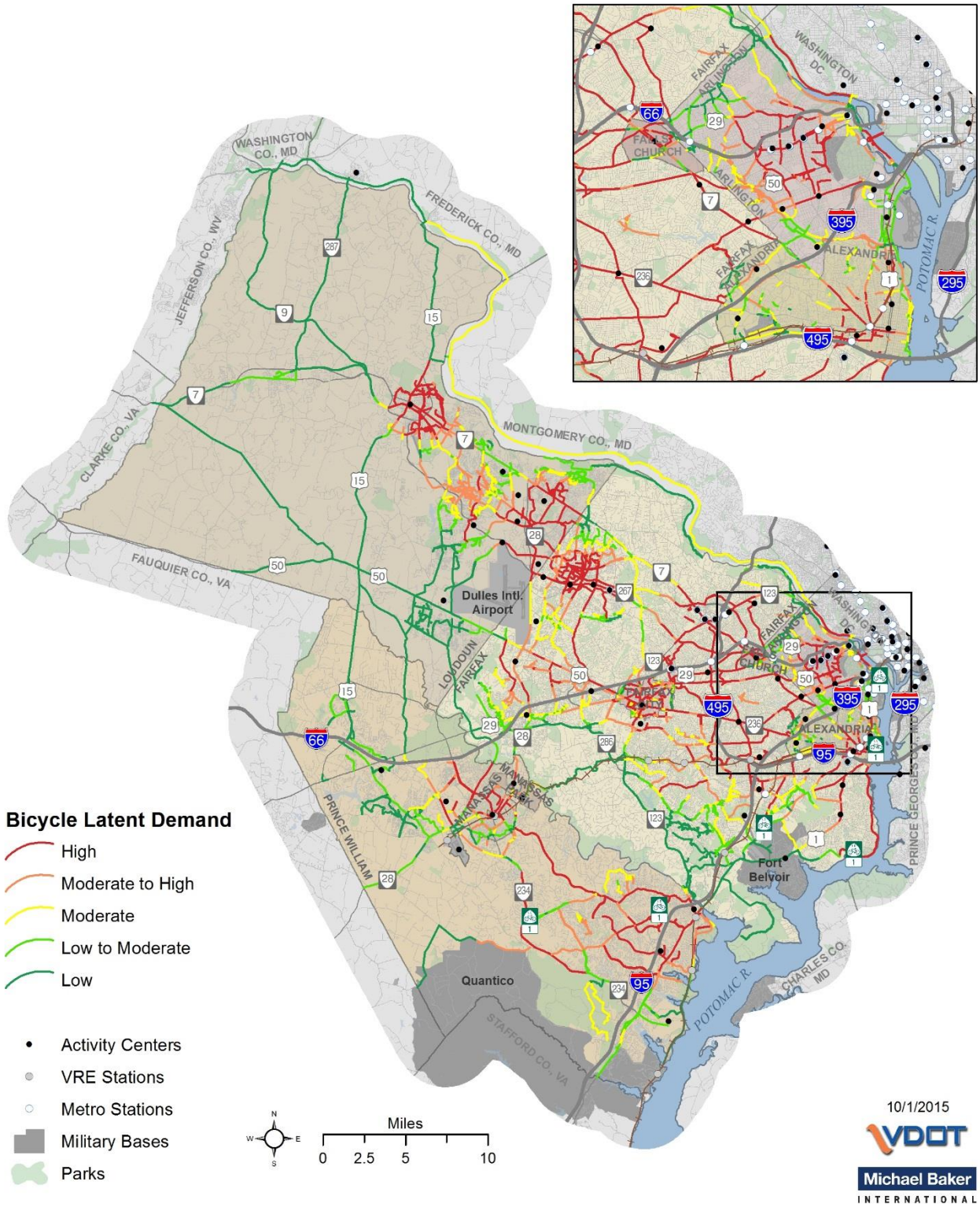
Prince William County: The results identify high bicycle demand in the vicinity of the county's VRE stations and around core activity centers, such as Potomac Mills and Woodbridge. Route 234 also shows strong demand, as the road offers access to regional recreational areas, such as George Hellwig Memorial Park and Prince William Forest. Sudley Road (City of Manassas) exhibits strong bicycle demand due to its proximity to Manassas Mall, Novant Health Medical Center, and Ellis Elementary.

Arlington County: The Ballston-Rosslyn corridor accounts for the county's highest bicycle latent demand. The latent demand results also identify strong bicycle demand on several north-south connections, such as the Arlington Boulevard Trail and on roads, such as N. Quincy Street and N. Irving Street.

City of Alexandria: Bicycle demand is potentially highest along the Metrorail corridor, particularly on those facilities which connect to the King Street Metro/Amtrak station. Demand also appears high along the recently constructed Potomac Yard Trail (below), from Cameron Avenue to Four Mile Run.

The Potomac Yard Trail in Alexandria. Source: Michael Baker International

FIGURE 4: LATENT DEMAND RESULTS



BICYCLE LEVEL OF SERVICE

Introduction

Bicycle Level of Service (BLOS) is a nationally used tool for quantifying the "bike friendliness" of a roadway. While BLOS was used to approximate the relative quality of service that a "typical" cyclist could expect along different stretches of the network, it should also be recognized that cyclists vary greatly in terms of competency and level of comfort when riding in traffic. A digital public outreach survey was used to validate the quantitative analysis and ultimately help capture the true level of comfort that cyclists experience on the region's roads.

Methodology

The study's BLOS analysis replicates the formula (Version 2.0) developed by Sprinkle Consulting, Inc. (See Appendix). This same formula has been used to calculate BLOS on local plans, such as the *Alexandria Pedestrian and Bicycle Mobility Plan* and the *U.S. Bicycle Route 1 Summary Recommendations Report*, as well as in extensive statewide planning efforts (e.g. Florida). The formula's calculations are based on various roadway characteristics and conditions (**Figure 5**).

FIGURE 5: BICYCLE LEVEL OF SERVICE (BLOS) INPUTS

Image sources: Michael Baker International, creativecommons.org, pixbay.com

VDOT's Statewide Planning System (SPS) data was used to obtain the roadway characteristics and calculate BLOS throughout the study area. In some cases, field surveys and VDOT comments were used to update the SPS data for specific locations. Finally, the web-based public outreach (described in subsequent sections) served as a critical validation tool, providing over 3,000 comments on the BLOS results. This crowdsourced effort complemented the analysis, ultimately helping to illustrate a much more complete picture of regional bicycle comfort.

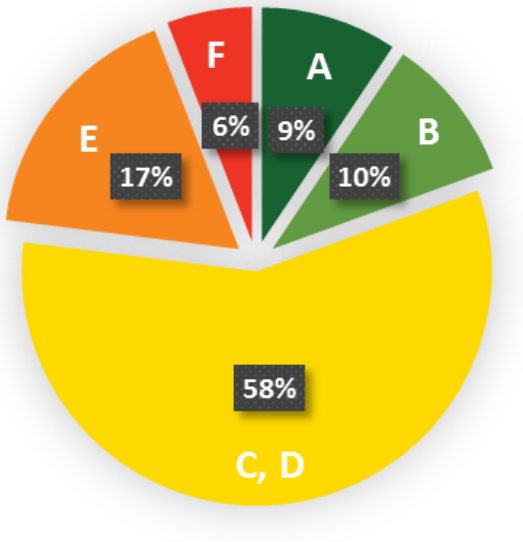
The BLOS scale (**Figure 6**) is based on six letter grades, A through F (from best to worst), to approximate the quality of a roadway segment for bicycle travel. The BLOS formula is shown in the Appendix.

FIGURE 6: BICYCLE LEVEL OF SERVICE SCALE

Results

The pie chart (**Figure 7**) shows the BLOS mileage distribution throughout the region. Bicycle level of service "A" and "B", generally considered comfortable bicycle facilities and representing about 19% (438 miles) of VDOT's regional roadway network, are distributed throughout the region. These comfortable cycling facilities are typically characterized by low-volume neighborhood streets or roadways with parallel shared use paths. Patrick Henry Drive (Arlington County), below, is a great example of a BLOS "A" facility, as it is predominately residential and equipped with bi-directional bicycle lanes. Dumfries Road (Route 234, Prince William County), from Independent Hill to Spriggs Road, also serves as a good example of a very comfortable bicycle facility due to its 10-foot shared use path and limited driveways (path borders Prince William Forest). Aden Road (also below) is an example of a BLOS "F" facility due to the roadway's lack of shoulders and high vehicle speeds.

FIGURE 7: REGIONAL BICYCLE LEVEL OF SERVICE BY RATING (A-F)

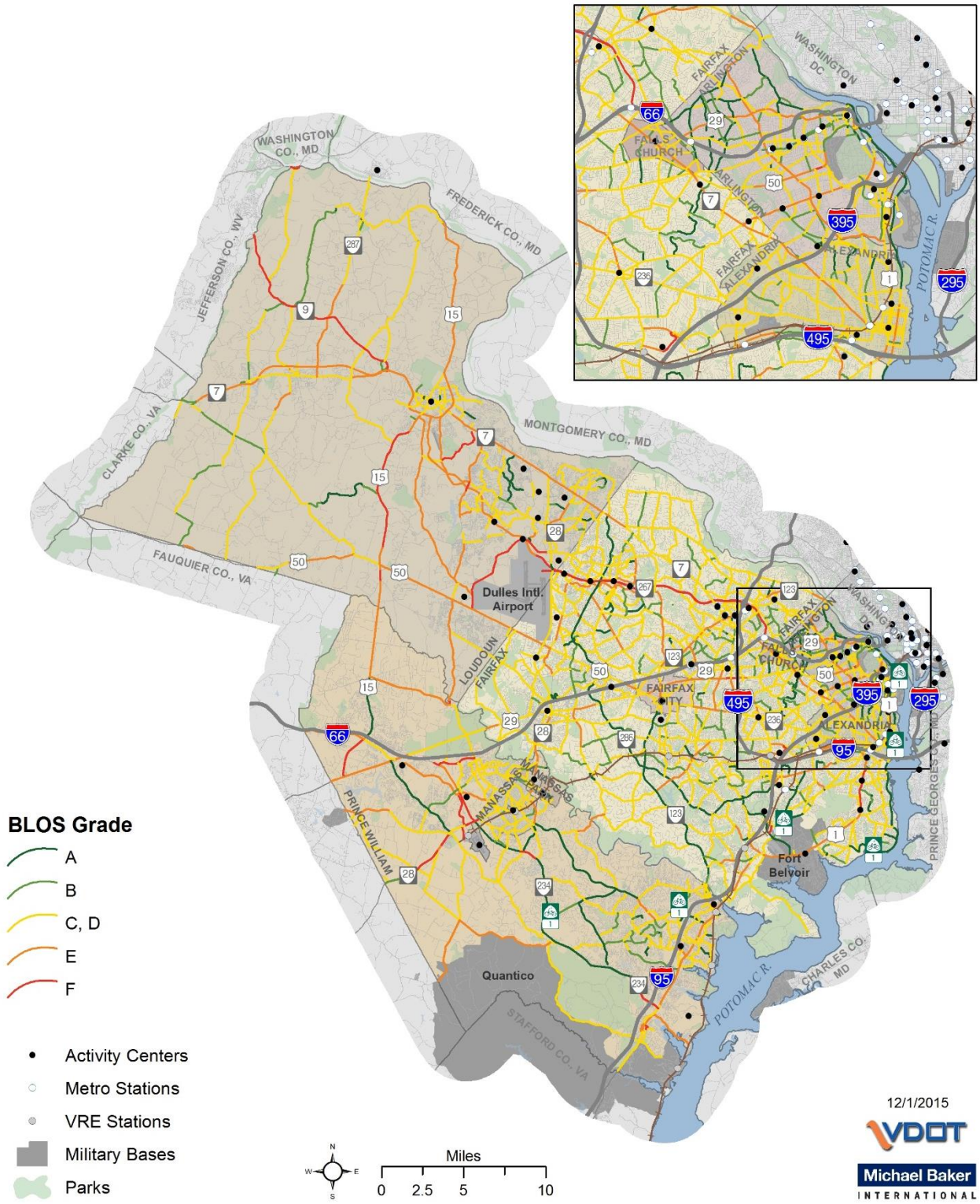


Patrick Henry Drive in Arlington County is a very comfortable bicycle facility. Source: Michael Baker International

Aden Road in Prince William County is an uncomfortable bicycle route due to its lack of shoulders and high vehicle speeds. Source: Michael Baker International

The regional BLOS results, shown in **Figure 8** below, were mapped using Geographic Information Systems (GIS) software and can be used as a benchmark for future studies. Locations where the BLOS was adjusted based on public comments are shown in the Appendix (**Table A-1** and **Table A-2**).

FIGURE 8: STUDY AREA BICYCLE LEVEL OF SERVICE (BLOS)



PUBLIC OUTREACH

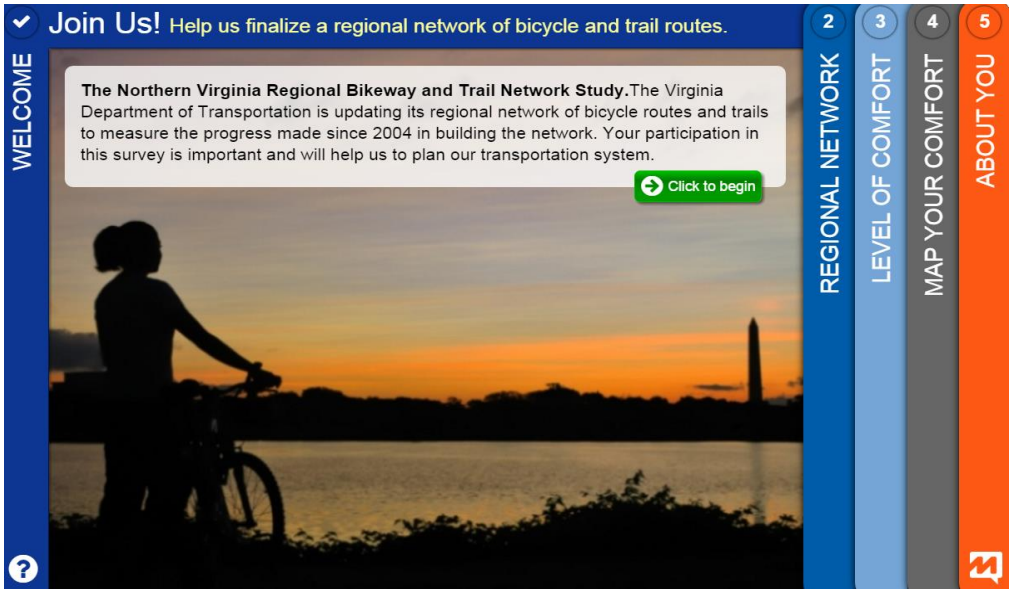
Taskforce

Similar to 2003, a working group comprised of representatives from the Northern Virginia jurisdictions was established at the beginning of the project. This Taskforce was instrumental in providing jurisdictional GIS data, reviewing progress at key milestones, advising the Department during the study, and providing input on the draft regional network through a web-based Wikimap. The taskforce also served as an outreach conduit, helping distribute the interactive public survey (MetroQuest).

Public Survey

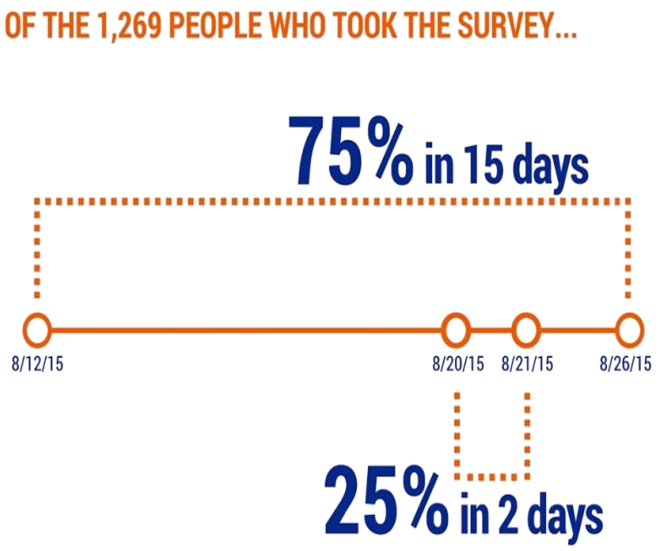
In August 2015, VDOT launched an interactive survey using MetroQuest, a web-based digital engagement platform. The survey was designed to obtain feedback on the draft regional bicycle network, learn more about comfort levels on different types of bicycle facilities, and validate (or modify) the bicycle level of service (BLOS) results. The survey was open for one month. Over 3,000 people visited the site and 40% (1,269) completed the survey, surpassing team goals. The excellent response rate can be partially attributed to several marketing strategies, including:

1. Targeted emails to a contact list with clear calls to action;
2. Conversations with select journalists and bloggers, such as:
    - WTOP
    - Bike Arlington Forum
    - Washington Area Bicyclist Association
    - Greater Greater Washington
    - Beyond DC
    - Fairfax Advocates for Better Bicycling
3. Creating shareable "digital cards" and strategic social media posts using Twitter and Facebook.

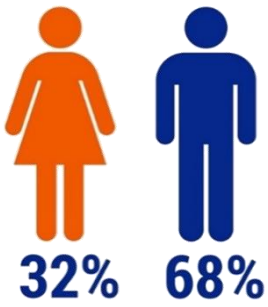


The MetroQuest "welcome page" provided an overview of the study and introduced the survey

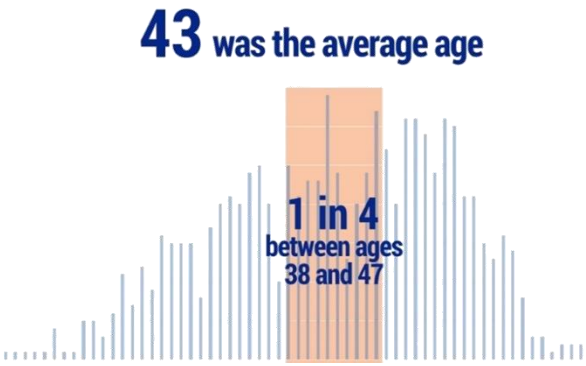
Some of the key survey findings are highlighted below and also illustrated through a series of graphics.



- Impressions (views) of the social media outreach were estimated near 50,000.
- Approximately 75% completed the survey within a 15-day period. 25% occurred within just two days.
- Almost 32% of the participants were female. This is higher than the most recent 2009 National Household Travel Survey's estimate (24%).
- The average participant was 43 years old. Nearly half of the total participants were between ages 30 and 45.
- Approximately 53% said their top reason for bicycling was recreation or exercise, while 37% said they commute to work or school by bike.
- People overwhelmingly rated shared-use paths as the most comfortable form of bicycle infrastructure from a choice of five alternatives (shared-use paths, bicycle lanes, shoulders, shared-lane markings, and mixed-traffic cycling).



The web survey also asked the public to locate their "home origins" (where they start most trips) and identify up to three destinations for their most frequent trips. The results are mapped below in **Figure 9 and Figure 10**. In addition to showing the density of origins and destinations, the maps identify Activity Centers as defined by the Metropolitan Washington Council of Governments (MWCOG). In general, there is a strong visual correlation between the activity center locations and the respondent origins and destinations.



Respondent origins are distributed throughout the region (**Figure 9**). Notable locations include: Montclair (Prince William County), Herndon/Reston and Dunn Lorring-Merrifield (Fairfax County), the cities of Manassas and Falls Church, along the Ballston-Rosslyn corridor (Arlington County), and in the Landmark, Taylor Run, Del Ray, and Potomac Yard neighborhoods (City of Alexandria).

Respondent destinations (**Figure 9**) are clustered along regionally significant trails, such as the W&OD, the Custis Trail, and the Mount Vernon Trail. As such, places like Purcellville and Leesburg (Loudoun County)

and Old Town Alexandria were identified as key attractors for cyclists. Notable respondent destinations also include mixed-use centers, such as Reston Town Center, Tysons Corner (Fairfax County), and parts of the Ballston-Rossyln corridor (Arlington County). **Figure 10** shows origin-destination connections, helping visualize cycling trip patterns (not specific routes) across the region.

FIGURE 9: RESPONDENT ORIGINS AND DESTINATIONS

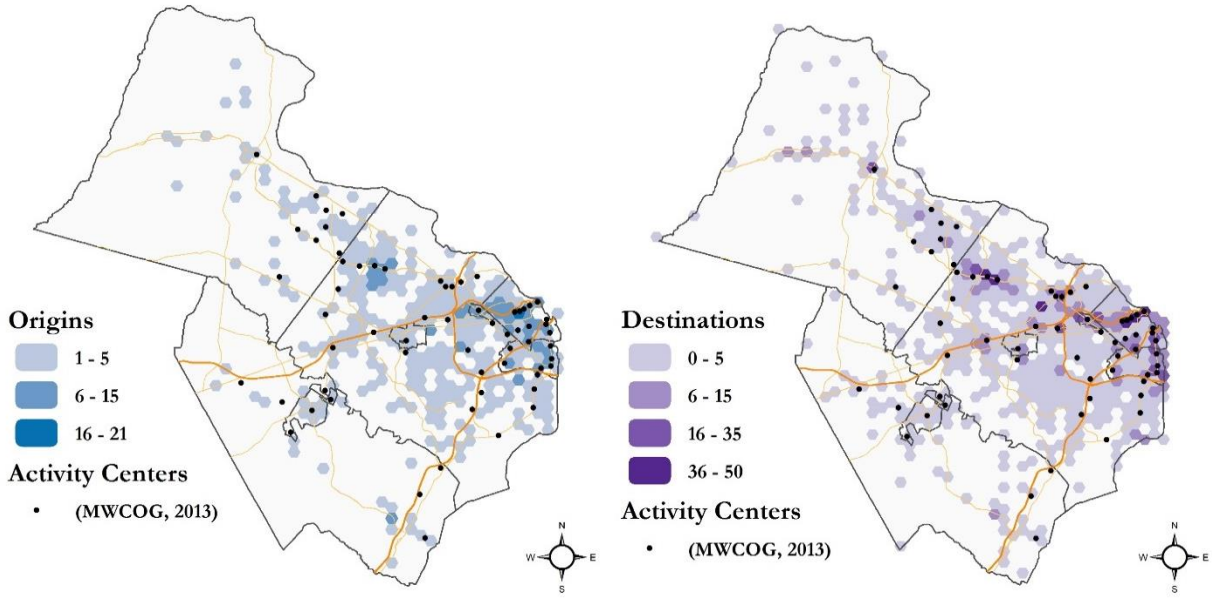
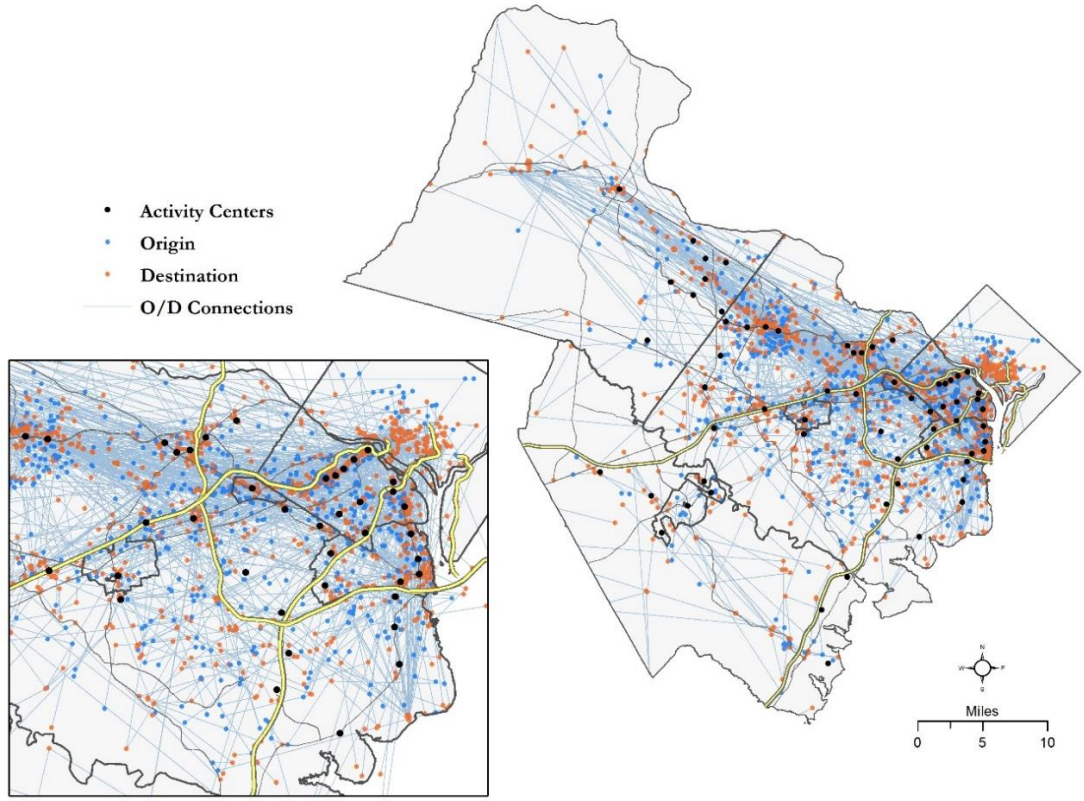
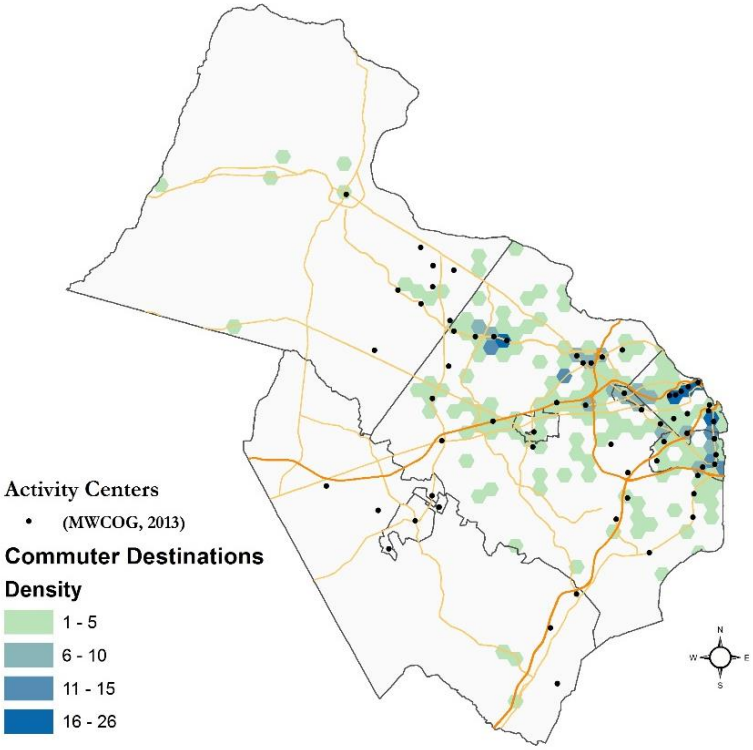


FIGURE 10: RESPONDENT ORIGIN-DESTINATION CONNECTIONS



Lastly, the analysis filtered responses to only those who primarily bike for commuting purposes (to work or school) (**Figure 11**). While these approximated commuter destinations are similar to the overall destinations (**Figure 9**), certain destinations become even more pronounced. The results indicate that Reston, Vienna, Tysons Corner, Falls Church, Arlington (Ballston to Rosslyn and Crystal City), and Alexandria (Potomac Yard to Old Town) exhibit some of the highest destination activity in the region (for those who primarily cycle for commuting purposes).

FIGURE 11: COMMUTER DESTINATIONS (*APPROXIMATED*)



Public Meeting and Comment Period

On November 18th, a public information meeting was held for the Northern Virginia Regional Bikeway and Trail Study Update. The materials were posted on the VDOT website prior to the meeting and notices were sent out using the same distribution list that was used for the MetroQuest survey.

The meeting included draft poster-size maps of the Regional Network and Bicycle Level of Service results. The study team also delivered a presentation, covering the study's key milestones and survey results. The discussion was productive and the attendees, representing several jurisdictions, asked engaging questions and recommended several additions/revisions to the regional network, itself.

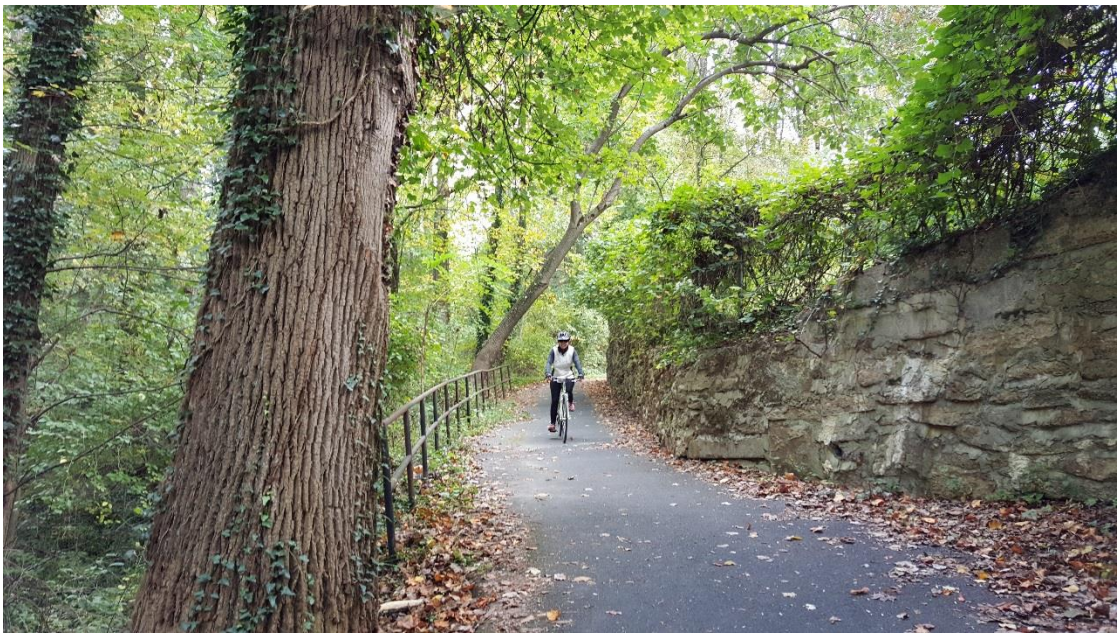
Attendance was relatively lower than desired, likely due to the successful web outreach (nearly 1,300 responses) in the months prior to the meeting and to the study's attentive Taskforce, whose members remained dedicated throughout the study, often providing input on behalf of their respective jurisdictions, committees, or interest groups.

In addition to the meeting, the draft study materials were posted on the VDOT website for review. All comments on the draft document were due on Wednesday, November 25th and several interested individuals or groups provided electronic comments via email. A summary of public input is provided in the **Appendix (Table A-3).**

THE 2015 REGIONAL NETWORK

The study's regional network is the culmination of plan review, data collection, demand analysis, and public input. The public provided approximately 1,000 comments on the Draft Regional Network. These comments were critical in identifying recently constructed facilities and providing suggestions for potential network additions. The 2015 Regional Network is comprised of existing and proposed bicycle facilities.

The 2015 Regional Network has an extensive network of existing bicycle facilities, accounting for 61 miles of on-road bicycle lanes, 365 miles of off-road shared-use paths and trails, and 73 miles of "other notable existing" facilities, which provide regional connections and are typically represented by stream valley trails and a few high-demand roads with shared-lane markings (sharrows), shoulders, or bicycle boulevard-features.

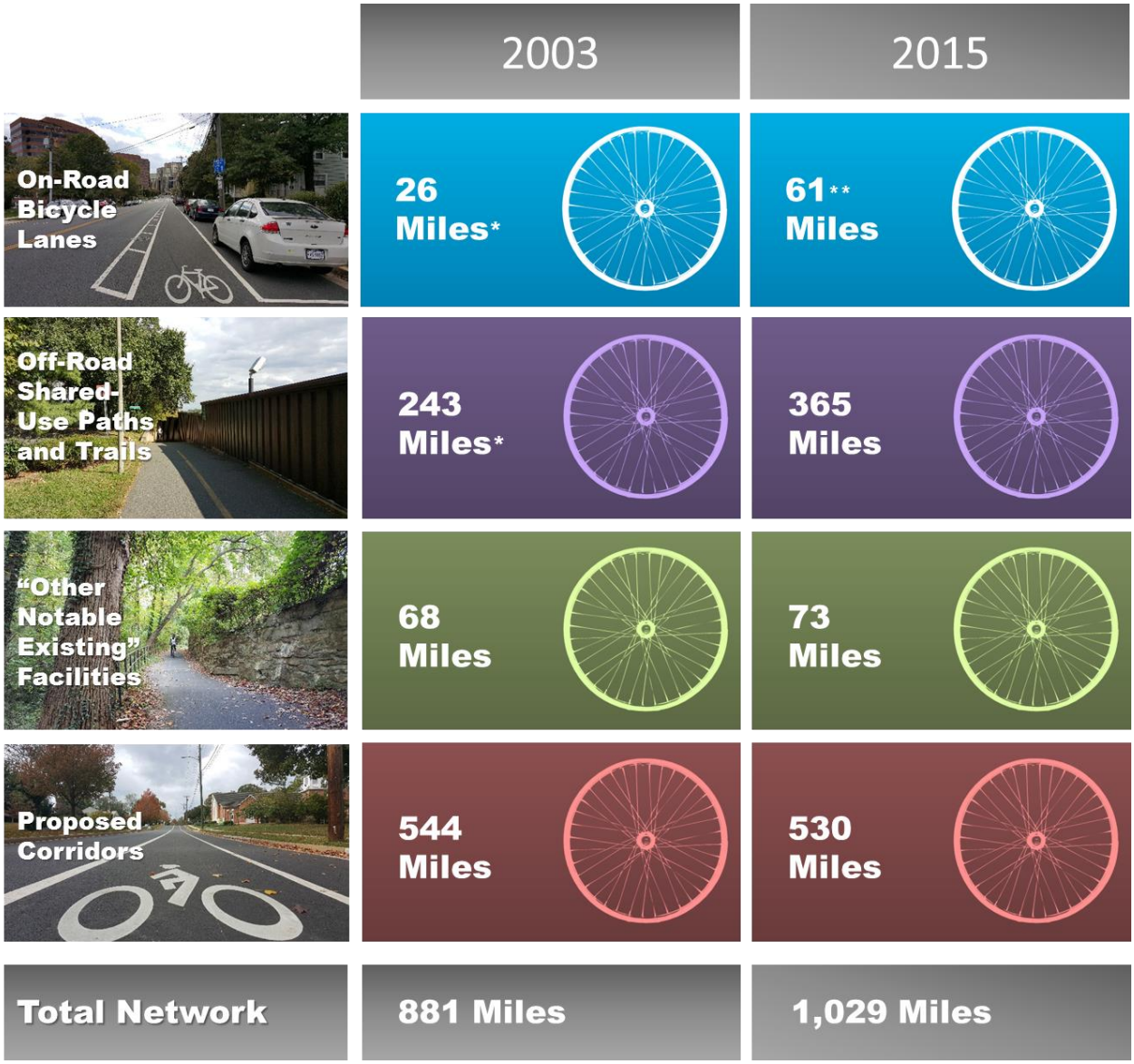


The Donaldson Run Trail in Arlington County is an "other notable existing" facility that connects the Yorktown Boulevard bicycle lanes to those on Military Road. Source: Michael Baker International

The 2015 "proposed" network includes the 2003 proposed facilities (436 miles that have *not* been constructed) and additional prominent bicycle corridors, as identified through the latent demand analysis and public engagement process. The 2015 network's proposed corridors, representing about 530 miles, may not necessarily refer to a specific roadway; rather, they are intended to identify potential high demand areas in the region. As such, the network's proposed corridors may also reflect parallel facilities, not just the specific highlighted roadways on the map**.**

Figure 12 compares the 2003 and 2015 regional networks and shows the network growth since 2003, particularly with on-road bicycle lanes (35 additional miles) and off-road shared-use paths and trails (122 additional miles). The 2015 Network has 5 additional miles of "other notable existing" facilities and a reduction in "proposed" facilities (14 fewer miles).

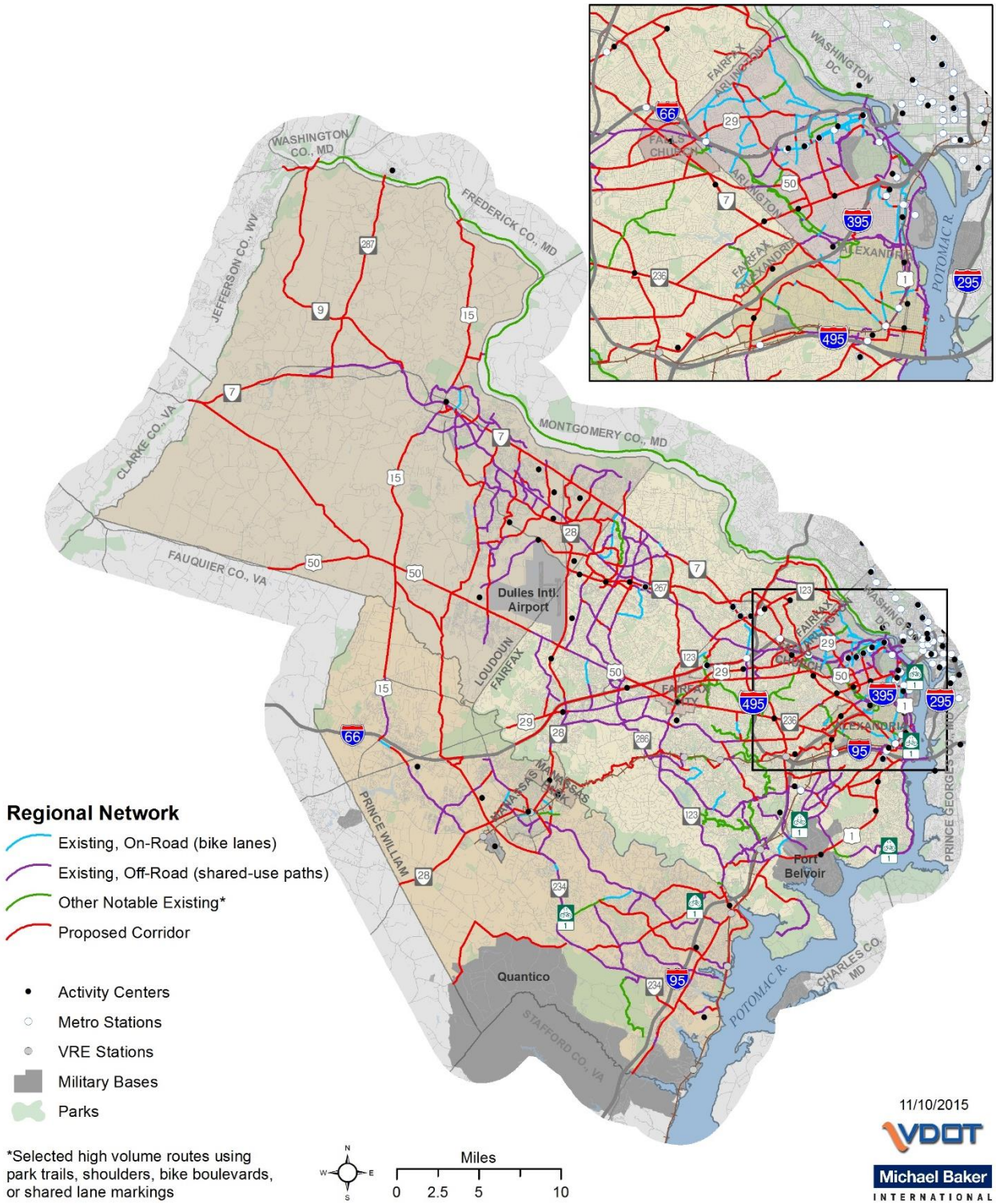
FIGURE 12: COMPARING THE 2003 AND 2015 NETWORKS



***The 2003 totals included approximately 65 miles of funded, but not yet constructed facilities.**
****The 2015 Regional Network includes approximately 1 mile of protected bicycle lanes (S. Eads Street and Hayes Street in Arlington)**

The 2015 Regional Network, reflecting existing and proposed facilities, is shown below (**Figure 13**). Notable additions to the network are shown in **Table 2.**

FIGURE 13: THE 2015 NORTHERN VIRGINIA REGIONAL BIKEWAY AND TRAIL NETWORK



Network Additions and Recommendations

The list below (**Table 2**) is comprised of segments which typically scored very high in the latent demand analysis and also garnered substantial public support on the MetroQuest survey. Key segments were also added to the network if they aligned with those found in the localities' plans. However, there are several segments in **Table 2** that are not represented on any jurisdiction plan or study; these candidates have been deferred to the jurisdictions for additional study.

Table 2: Recommended Additions to the Regional Bikeway and Trail Network

ID	Facility	Jurisdiction	Location	Recommendation
1	Army Navy Drive	Arlington County	Memorial Drive to S. Glebe Drive at the Four Mile Run Trail	Add as "proposed", connecting the existing Army Navy Drive bike lanes to S. Glebe Drive via S. Adams Street and 26th Road.
2	Boundary Channel Drive	Arlington County	S. Washington Boulevard to the Mount Vernon Trail via LBJ Park	Add connection in Lady Bird Johnson Memorial Park as "other notable existing" and add connection from LBJ Park to S. Washington Boulevard as "proposed."
3	Key Boulevard	Arlington County	N. Veitch Street to Kirkwood Road	Add as "other notable existing" since Key Boulevard operates as a bike boulevard, with various traffic calming measures (bulb outs, chokers, and traffic circles). Connect to Kirkwood Road on the west end via N. Jackson Street and 13th Street.
4	Arlington Boulevard	Arlington County	N. Pershing Drive to N. Meade Street	Add the existing Arlington Boulevard Trail along the southside of US 50 from N. Pershing Drive to N. Rolfe Street. Add "proposed" segment from N. Rolfe Street to the existing bicycle lanes on N. Meade Street per Arlington County plans.
5	S. Washington Boulevard	Arlington County	US 50 (Arlington Boulevard) to Columbia Pike (Towers Park)	Add as "on-road, existing" from US 50 to S. Courthouse Road and as "proposed" from S. Courthouse Road to S. Quinn Street / Columbia Pike.
6	Valley Drive/Preston Road/Martha Custis Drive	Arlington County and City of Alexandria	S. Glebe Road to N. Quaker Lane and the Four Mile Run Trail	Add as "other notable existing" along W. Glebe Road, Valley Drive, and Preston Road. Existing shared lane markings. Also add "other notable existing" along Martha Custis Drive/ Shirlington Bridge/ Quincy Street to the Four Mile Run Trail.
7	S. Abingdon Street/ 34th / S. Stafford / 33rd	Arlington County	31st Street to N. Quaker Lane	Add as "on-road, existing" from 31st Street to N. Quaker Lane (existing bike lanes). Recommend that S. Wakefield Street become a signed bicycle route.

ID	Facility	Jurisdiction	Location	Recommendation
8	Edsall Road	City of Alexandria	I-395 to South Pickett Street	Add as "proposed" per 2015 Eisenhower West Small Area Plan.
9	Eisenhower Avenue	City of Alexandria	S. Van Dorn Street to Holmes Run	Add as "proposed" per 2015 Eisenhower West Small Area Plan.
10	Braddock Road	City of Alexandria	W. Windsor Avenue (end of existing bike lanes) to King Street	Add as "other notable existing" (existing sharrows).
11	Janneys Lane / Seminary Road / N. Pickett Street / N. Pegram Road	City of Alexandria	King Street to Holmes Run Trail via N. Pickett Street and N. Pegram Road	Add existing bike lanes as "on-road" and add "proposed" from N. Quaker Road to N. Pickett Street and then continuing on N. Pickett and N. Pegram Road. Connect this "proposed segment" with the existing bike lanes on N. Pegram Road, which ultimately connect to the Holmes Run Trail.
12	Braddock Road	City of Alexandria	Commonwealth Avenue to Mount Vernon Avenue	Add as "other notable existing" from Mount Vernon Avenue to Commonwealth Avenue (existing sharrows).
13	Potomac Yard Trail	City of Alexandria	Cameron Street to the Four Mile Run Trail	Add as "off-road, existing" to reflect newly constructed trail along Main Line Boulevard and Potomac Avenue.
14	Hillwood Avenue / N. Cherry Street / E. Columbia Street	City of Falls Church	Seven Corners (Eden Center) to W&OD via Hillwood Avenue, N. Cherry Street and E. Columbia Street	Add as "other notable existing" (on existing sharrows) per public comments.
15	Annandale Road / Hummer Road / Cherry Street	City of Falls Church/Fairfax County	Route 236 to Hillwood Avenue via Annandale Road, Hummer Road, Arlington Boulevard (access road), and Cherry Street	Add as "other notable existing" from Route 236 to Route 50 (due to shoulders) and as "proposed" north of US 50 per public comments and recommendation from Taskforce member.
16	Signal Hill Road	City of Manassas	Fairmont Avenue to Signal View Drive	Add as "other notable existing" since Signal Hill Road is currently a "signed shared road" with high latent demand.
17	I-66 Proposed Trail	Fairfax County	Fairfax/Prince William County Line to Gallows Road	Add trail along I-66 as "proposed." Recommend that Prince William County evaluate the merits of extending the proposed trail.
18	Huntington Avenue	Fairfax County	Telegraph Road to US 1	Add as "proposed".
19	Lawyers Road	Fairfax County	Reston Parkway to Soapstone Drive	Add as "on-road, existing".
20	Soapstone Drive	Fairfax County	Lawyers Road to Sunrise Valley Drive	Add as "on-road, existing".

ID	Facility	Jurisdiction	Location	Recommendation
21	Sugarland Trail	Fairfax County	Dranesville Road to Herndon Parkway	Add as "other notable existing" from Dranesville Road (at Sugarland Road) to Herndon Parkway near Tamarack Way.
22	Reston Parkway	Fairfax County	Lawyers Road to the W&OD Trail	Add as "proposed" given role as important north/south connection.
23	Wiehle Avenue	Fairfax County	W&OD Trail to Baron Cameron Avenue	Add as "proposed" per latent demand analysis and Fairfax County Bicycle Master Plan.
24	Gunston Road	Fairfax County	US 1 (Jefferson Davis Highway) to terminus of Mason Neck Trail	Add as "proposed" from US 1 to the beginning of the trail and as "off-road, existing" along the trail to show the trail as a regional recreational destination.
25	Hillsboro Road	Loudoun County	W. Main Street (and W&OD) to Route 9	Recommend that County evaluate the merits of this connection per public comments.
26	Battlefield Parkway	Loudoun County	Fieldstone Drive (end of existing shared- use path) to Ball's Bluff Road (where path resumes)	Recommend that County evaluate the merits of this connection.
27	Battlefield Parkway	Loudoun County	Potomac Station Drive (end of path) to location where path resumes, just NE of Tuscarora Creek	Add as "proposed" per Taskforce Wikimap Exercise.
28	Plaza Street NE	Loudoun County	Principal Drummond Way SE to off-road path near Lynchburg Terrace NE	Add as "on-road, existing" per Taskforce Wikimap Exercise.
29	Tuscarora Creek Trail	Loudoun County	S. King Street to W&OD Trail in the Town of Leesburg	Add as "proposed".
30	Russell Branch Parkway Trail	Loudoun County	Existing path to the W&OD Trail via Trailview Boulevard	Add as "proposed".
31	Lomond Drive/Manassas Drive/Signal View Drive	Prince William County	Route 234 Business to Signal Hill Road	Recommend that County evaluate the merits of this connection.
32	Parkgate Drive / Old Church Road / Bristow Road / Lucasville Road	Prince William County	Aden Road (USBR 1) to Hastings Drive (City of Manassas) via Parkgate Drive, Old Church Road, Bristow Road, and Lucasville Road	Recommend that County and City evaluate the merits of this connection per public comments.
33	Neabsco Road	Prince William County	US 1 (Jefferson Davis Highway) to Daniel K. Ludwig Drive	Add as "off-road, existing" to reflect shared- use path to Potomac Heritage Trail destination.

ID	Facility	Jurisdiction	Location	Recommendation
34	Daniel K. Ludwig Drive	Prince William County	Neabsco Road to the "proposed regional corridor" (2003 network), which follows the Potomac Heritage Trail	Recommend that County evaluate the merits of this connection.
35	Rippon Boulevard	Prince William County	US 1 (Jefferson Davis Highway) to Farm Creek Drive	Add as "off-road, existing" to reflect shared use path per Comprehensive Plan.
36	River Heritage Boulevard	Prince William County	US 1 (Jefferson Davis Highway) to Harbor Station Parkway	Add as "proposed".
37	Harbor Station Parkway	Prince William County	River Heritage Boulevard to Dunnington Place	Add as "off-road, existing".

Key Boulevard was added to the 2015 Regional Network as an "other notable existing" facility since it operates as a bike boulevard, with various traffic calming measures (speed humps, bulb outs, and traffic circles). Source: Michael Baker International.

SUMMARY OF STUDY

This study measured the progress since 2003-2004 in constructing the Regional Bikeway and Trail Network and used the Bicycle Level of Service (BLOS) as a benchmark for evaluating bicycle comfort. The study's Taskforce advised the Department throughout the study and the public was invaluable in reviewing the draft network and validating the analysis results. The key study components are summarized below.

- The Latent Demand Method, a GIS-based analysis that evaluates proximities and potential trip generation to key attractors, was used to map bicycle demand in the region. Latent demand scores were assigned based on five tiers and were ultimately used to identify regionally significant network additions. **Figure 4** shows the latent demand results.

- A Bicycle Level of Service analysis was used to quantify the "bike friendliness" of the region's roadway network. The results indicate that 19% (438 miles) of the region's roadways operate at BLOS "A" or "B". Future bicycle studies can employ this method to measure regional progress in improving bicycle comfort.

- A web-based public survey, open for approximately one month, was used to obtain feedback on the draft regional bicycle network and on cyclists' origins, destinations, and comfort levels. Nearly 1,300 citizens provided input, helping to finalize the 2015 Regional Network and modify the BLOS results (**Table A-1** and **Table A-2** in the Appendix.)

- A public meeting was held on November 18th to review the draft materials and included a presentation and several large-format maps. The meeting's discussion was productive and led to several Regional Network additions/revisions. Furthermore, interested parties submitted electronic comments on the Draft Study. A summary of public input is provided in **Table A-3** in the Appendix.

- The Final 2015 Regional Bikeway and Trail Network is more extensive than that of 2003 and reflects the region's progress in improving bicycle connectivity through on-road and off-road bicycle infrastructure. The region has made progress in implementing the 2003-2004 Network, having constructed nearly 20% of the 2003 proposed facilities (108 miles).

  The 2015 Network includes 365 miles of off-road shared-use paths and trails, 61 miles of on-road bicycle lanes, 73 miles of "other notable existing" facilities, and 530 miles of proposed regional corridors.

APPENDIX

Bicycle Level of Service Formula

The study's bicycle comfort analysis used the Bicycle LOS Model (Version 2.0), developed by Sprinkle Consulting, Inc., to evaluate bicycle comfort on the region's roadways. The formula's equation is shown below.

$$\text{Bicycle LOS} = a_1 \ln (Vol_{15}/L_n) + a_2 SP_t(1+10.38HV)^2 + a_3(1/PR_5)^2 + a_4 (W_e)^2 + C$$

Where:

Vol_{15} = Volume of directional traffic in 15 minute time period

$Vol_{15} = (ADT \times D \times K_d) / (4 \times PHF)$

where:
ADT = Average Daily Traffic on the segment or link
D = Directional Factor
K_d = Peak to Daily Factor
PHF = Peak Hour Factor

L_n = Total number of directional *through* lanes
SP_t = Effective speed limit

$SP_t = 1.1199 \ln(SP_p - 20) + 0.8103$

where:
SP_p = Posted speed limit (a surrogate for average running speed)

HV = percentage of heavy vehicles (as defined in the 1994 Highway Capacity Manual)
PR_5 = FHWA's five point pavement surface condition rating
W_e = Average effective width of outside through lane:

where:
$W_e = W_v - (10 \text{ ft} \times \% \text{ OSPA})$ and $W_l = 0$
$W_e = W_v + W_l (1 - 2 \times \% \text{ OSPA})$ and $W_l > 0$ & $W_{ps} = 0$
$W_e = W_v + W_l - 2 (10 \times \% \text{ OSPA})$ and $W_l > 0$ & $W_{ps} > 0$ and a bikelane exists

where:
W_t = total width of outside lane (and shoulder) pavement
OSPA = percentage of segment with occupied on-street parking
W_l = width of paving between the outside lane stripe and the edge of pavement
W_{ps} = width of pavement striped for on-street parking
W_v = Effective width as a function of traffic volume

and:
$W_v = W_t$ if ADT > 4,000veh/day
$W_v = W_t(2-0.00025 \times ADT)$ if ADT ≤ 4,000veh/day, and if the street/road is undivided and unstriped

a_1: 0.507 a_2: 0.199 a_3: 7.066 a_4: - 0.005 C: 0.760

(a_1 - a_4) are coefficients established by multi-variate regression analysis.

The BLOS scores were stratified into service categories "A, B, C, D, E, and F" (ranges shown on right) to reflect users' perception of the road segment's level of service for bicycle travel.

LEVEL-OF-SERVICE	BLOS SCORE
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

Bicycle Level of Service Modifications

Locations where the bicycle level of service scores were adjusted based on public comments are shown in the tables below. **Table A-1** lists the "upgrades" (facilities whose BLOS scores were upgraded based on public input); **Table A-2** lists the "downgrades" (facilities whose BLOS scores were downgraded based on public input).

TABLE A-1: BLOS UPGRADES (BASED ON PUBLIC INPUT)

ID	Facility Name	Jurisdiction	Location	BLOS Comments
1	Eisenhower Avenue	City of Alexandria	Eisenhower Ave. Underpass to Telegraph Road	Upgrade from D to B
2	Arlington Boulevard	Arlington County	N. Pershing to N. Rhodes Street	Upgrade from D to B
3	16th Street	Arlington County	Patrick Henry Drive to N. Glebe Road	Upgrade from D to B
4	Fairfax Drive	Arlington County	N. Glebe Road to N. Kirkwood Road	Upgrade from C to B
5	N. Veitch Street	Arlington County	Wilson Boulevard to 21st Street	Upgrade from C to B
6	21st Street / N. Scott Street / Key Boulevard	Arlington County	To Rossyln (19th Street)	Upgrade from D to B
7	South Eads Street	Arlington County	18th Street to 31st Street	Upgrade from D to B
8	S. Arlington Mill Drive	Arlington County	S Walter Reed Drive to S Shirlington Road	Upgrade from D to B
9	S. Kenmore Street	Arlington County	S Walter Weed Drive to S Shirlington Road	Upgrade from C to B
10	26th Street N	Arlington County	Old Dominion Drive to Military Road	Upgrade from C to B
11	Four Mile Run Drive	Arlington County	Columbia Pike to S. Shirlington Road	Upgrade from D to B
12	N. Westmoreland Street	Fairfax County / Arlington County	Chain Bridge Road (Mclean) to Fairfax Drive	Upgrade from D to B
13	Lawyers Road	Fairfax County	Reston Parkway to Twin Branches Road	Upgrade from D to C

ID	Facility Name	Jurisdiction	Location	BLOS Comments
14	Twin Branches Road	Fairfax County	Lawyers Road to S. Lakes Drive	Upgrade from C to B
15	Tapawingo Road	Fairfax County	Nutley Street to Ninovan Road	Upgrade from C to B
16	Soapstone Drive	Fairfax County	Glade Drive to Sunrise Valley Drive	Upgrade from D to B
17	Cottage Street	Fairfax County	Locust Street to Gallows Road	Upgrade from C to B
18	Electric Avenue	Fairfax County	Chain Bridge Road to Gallows Road	Upgrade from D to B
19	Gallows Road	Fairfax County	Gallows Branch Road to Idylwood Road	Upgrade from C to B
20	Courthouse Road	Fairfax County	Chain Bridge Road (Vienna) to Chain Bridge Road (Oakton)	Upgrade from C to B
21	Stringfellow Road	Fairfax County	Fairfax County Parkway to I-66	Upgrade from D to B
22	Furnace Road	Fairfax County	Ox Road (Route 123) to Lorton Road	Upgrade from F to B
23	Heming Avenue	Fairfax County	Braddock Road to Queensbury Avenue	Upgrade from C to B
24	Queensbury Avenue	Fairfax County	Heming Avenue to Braddock Road	Upgrade from C to B
25	Silverbrook Road	Fairfax County	Ox Road (Route 123) to Lorton Road	Upgrade from F to C
26	Mountain Road	Loudoun County	Charles Town Pike to Long Lane	Upgrade from C to B
27	Darbydale Avenue	Prince William County	Minnieville Road to Dale Boulevard	Upgrade from C to B
28	Fitzwater Drive	Prince William County	Aden Road and Burwell Road	Upgrade from E to D

Table A-2: BLOS Downgrades (Based on Public Input)

ID	Facility Name	Jurisdiction	Location	BLOS Comments
1	Mount Vernon Trail	City of Alexandria	Slaters Lane to First Street	Downgrade from A to C
2	Duke Street (Route 236)	City of Alexandria	Van Dorn Street to US 1	Downgrade from D to E
3	S. Washington Street	City of Alexandria	First Street to I-95	Downgrade from D to E
4	Lee Highway (US 29)	Arlington County	I-66 to Fort Myer Drive	Downgrade from D to E
5	N. Lynn Street	Arlington County	Wilson Boulevard to Mount Vernon Trail	Downgrade from B to D
6	N. Quincy Street	Arlington County	N. Glebe Road to US 29 (Lee Highway)	Downgrade from A to B and B to C
7	S. Washington Boulevard	Arlington County	10th Street to Columbia Pike	Downgrade from A to C
8	Glebe Road	Arlington County	Williamsburg Pike to Jefferson Davis Highway	Downgrade from D to E
9	US 1	Arlington County / City of Alexandria	Fairfax County Parkway to I-95 (Alexandria)	Downgrade from D to F
10	Chain Bridge Road / Maple Avenue / Dolley Madison Boulevard	Fairfax County / Arlington County	Route 236 to Potomac River via Tysons Corner (very long segment)	Downgrade from B to C, C to D, and D to E depending on individual segments
11	Sully Road (Route 28)	Fairfax County	US 29 (Centreville) to Route 7	Downgrade from A to D
12	Route 235 (USBR 1)	Fairfax County	US 1 to Old Mount Vernon Road	Downgrade from A to D
13	US 50	Fairfax County	Route 236 (Main Street) in Fairfax to Washington Blvd in Arlington, near Fort Myer (very long segment)	Downgrade from D to E and E to F
14	Sunset Hills Road	Fairfax County	Reston Parkway to Wiehle Avenue	Downgrade from D to E
15	Franconia Road	Fairfax County	I-95 to Rose Hill Drive	Downgrade from C to E
16	Fox Mill Road	Fairfax County	Fairfax County Parkway to Vale Road	Downgrade from D to E
17	Hunter Mill Road	Fairfax County	Clovermeadow Drive to Chain Bridge Road	Downgrade from D to E
18	Nutley Street	Fairfax County	US 50 (Arlington Blvd.) to Maple Avenue	Downgrade from C, D to E

ID	Facility Name	Jurisdiction	Location	BLOS Comments
19	Prosperity Avenue	Fairfax County	US 29 (Lee Highway) to Route 236 (Little River Turnpike)	Downgrade from D to E
20	Gallows Road	Fairfax County	US 50 to Columbia Pike	Downgrade from D to E
21	Wiehle Avenue	Fairfax County	VA-267 to Baron Cameron Avenue	Downgrade from D to E
22	Sunrise Valley Drive	Fairfax County	Centreville Road to Hunter Mill Road	Downgrade from D to E
23	Burke Lake Road	Fairfax County	Ox Road to Braddock Road	Downgrade from D to E
24	Columbia Pike	Fairfax/Arlington	Route 7 (Leesburg Pike) to Washington Boulevard	Downgrade from D to E
25	Leesburg Pike (Route 7)	Falls Church, Fairfax, Alexandria	I-66 to Russell Road (Alexandria) - long segment	Downgrade from D to E
26	Leesburg Pike (Route 7)	Loudoun County	Dranesville to Seneca Road	Downgrade from C to E
27	Charles Town Pike (Route 9)	Loudoun County	West of Leesburg	Downgrade from E to F
28	Nokesville Road	Prince William County	Fauquier Drive to Route 234 (in Manassas)	Downgrade from D to E, C to D, B to C depending on individual segments
29	Dumfries Road	Prince William County	County Club Drive to US 1	Downgrade from E to F
30	Joplin Road	Prince William County	Breckenridge Road to US 1	Downgrade from C to D and D to E depending on individual segments

Comments on the Draft Study

Table A-3 below highlights the public comments received during the Draft Study's public comment period. The study team responses are shown in the second column.

Table A-3: Comments on the Draft Study

Comments	Responses
Extend Battlefield Parkway west to fill in the gap shown on the existing map	Included in Locality's plan, high latent demand, Add existing segment as "off road" and add the other segment, just east of US 15, as "proposed".
The graphic in the report, however, was difficult to read showing the bicycle trail status on Virginia Route 50 between Fairfax Circle and the Potomac River. Including the comments in your report about the bicycle riding comfort levels along Rt 50 will inform future improvement decisions and trail opportunities.	The regional network and bicycle level of service maps will be provided electronically on the VDOT study website where the public can zoom in to see details.
An appendix should be added to the final report that lists--in detail and by facility type, locality, and (if feasible) year completed--every bikeway and trail project completed in NoVa since the original (2004) network study report, including the facility type and typical width, length, and limits of each added segment.	This level of detail is beyond the scope of this study.
An additional section should be added to the final report that associates, as appropriate, the completed and proposed bikeway and trail network segments identified in the study with the eight regional travel corridors in the TransAction 2040 plan. Moreover, an explicit goal of this bikeway network update should be to identify, designate and prioritize segments for development in the coming decade, and ultimately sign at least one continuous high-quality bicycling route in each of these eight regional travel corridors through Northern Virginia.	While the study has existing facilities and/or proposed regional corridors on all eight corridors shown in the TransAction 2040 plan, prioritizing projects are beyond the scope of this study.
Old Centreville Rd/Ordway Rd, between Rte 28/Centreville Rd in Manassas Park and Compton Rd/Rte 658 in southern Fairfax County. This two-lane, open-section road across the Bull Run barrier is a lower-traffic alternative to Centreville Rd and could be upgraded for bicycling at relatively little expense by retrofitting 4-foot paved shoulders. VDOT is renovating or replacing the Old Centreville Rd bridge over Bull Run in the near future.	Since this route straddles two jurisdictions with differing latent demands, each location would have to evaluate their portion.

Comments	Responses
Clover Hill Rd/Godwin Dr/Lucasville Rd/Bristow Rd/Old Church Rd/Parkgate Dr, between Wellington Road in the City of Manassas and Aden Rd (USBR1, just east of Fleetwood Dr in Aden. This low-traffic route, which crosses the Rte 234 Bypass/PW Pkwy barrier on an overpass, connects the City of Manassas to the Nokesville area and USBR1 towards Fredericksburg.	Table 2 in the document (#32) provides a very similar recommendation.
Lomond Dr and Lomond S Dr, from Ashton Ave in Prince William County to Liberia Ave in the City of Manassas, is a vital throughstreet with relatively low traffic volumes that could be retrofitted with bike lanes and/or sharrows.	High latent demand, but is not reflected in the City's plans. Recommend that the Locality evaluate the merits of this connection per public comments.
Fairmont Ave, from Sudley Rd/Bus 234 near Godwin Dr to Lomond Dr, is a vital low-traffic link between the City of Manassas and the considerable residential street network in Sudley plus Splashdown Water Park, on the east side of Sudley Rd.	High latent demand, but is not reflected in the County's plans. Recommend that the Locality evaluate the merits of this connection per public comments.
Lomond Dr/Manassas Dr/Signal View Dr, from Lomond S Dr to Signal Hill Dr, is a vital continuous route through the City of Manassas Park.	High latent demand and a suitable east-west alternative that connects to other existing and proposed facilities. Recommend that the county evaluate the merits of this connection per public comments.
Signal Hill Rd, from Fairview Ave in Old Town Manassas to Signal View Dr to the east of Liberia Ave, is an important eastward extension of the east-west bike route through Old Town on Prince William St.	Signal Hill Road is currently a "signed shared road" with high latent demand and therefore could be considered an "other notable existing" facility in the study. Add to the Regional Network.
S Grant Ave/Old Dominion Dr/Dumfries Rd (Bus 234), between Wellington Rd and Rte 234/PW Pkwy, is a useful route south from Old Town Manassas and past the Prince William County Fairgrounds that minimizes exposure to the traffic on Bus 234/Dumfries Rd. With future residential development south of Old Dominion Dr, new low-traffic streets that avoid more of Bus 234 may be created.	Low latent demand and is not reflected on the City's bike map. Therefore, this is not included in the Regional Network at this time.
Amhert Dr/Yorkshire Ln, from Manassas Dr to Centreville Rd, is a useful east-west route through the Yorkshire community directly north of Manassas Park.	High latent demand, but is not reflected in the County's plans. Recommend that the Locality evaluate the merits of this connection per public comments.
At least one trail crossing of the Flat Branch stream valley, somewhere between Lomond Dr/Lomond Dr S and Bull Run, is very much needed to link the Sudley community with Manassas Park and Yorkshire. Such a crossing (or multiple crossings) should be included in the upcoming VDOT study of extending Godwin Dr to the east of Sudley Rd as a bypass of Rte 28 through Manassas and Manassas Park.	Recommend evaluation by Locality.