Arlington County: Low-Stress Bicycle Network Mapping

MWCOG TPB Transportation/Land-Use Connections Program

Contract 16-018

Final Report

3/22/2017
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Description of Project

The goal of this project was to systematically investigate opportunities to improve Arlington County's bicycle network. This was done through combining two methods: 1) Level of Traffic Stress (LTS) method developed by Peter Furth (Northeastern University), a classification scheme that classifies streets into four levels of stress for cyclists using simple rules that rely on data either readily available or easy to acquire; and 2) BikeAble™, a tool recently developed by the Rails-to-Trails Conservancy in partnership with Dr. Michael Lowry (University of Idaho). BikeAble™ runs the level of traffic stress assignment through a GIS tool to determine the lowest-stress routes to connect residents to the places they want to go. When the analysis is complete, potential future bicycle and trail network projects are ranked by the increase in potential usage.

The project team consisted of the following members:

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Study Area Basics

Arlington County, located in Northern Virginia, across the Potomac River from the District of Columbia, is one of the nation’s most densely populated counties, home to 224,906 residents (as of the 2013 American Community Survey [ACS]) and covering only 26 square miles. The county’s bicycle facility network, shown in Figure 1, includes almost 50 miles of shared-use paths (SUPs)—paths shared by cyclists and pedestrians.

The county has four major employment centers: Ballston, Courthouse/Clarendon, Rosslyn, and Crystal City (Figure 2). The County experiences large daily in/out commuting flows, with slightly more employees traveling to jobs in Arlington than residents leaving for jobs elsewhere.\(^1\)

The ACS estimates that 1.3 percent of county residents regularly commute to work via bicycle; in some areas of Arlington this rate is over 10 percent.\(^2\) If this higher rate were shown to be the result of better access to lower-stress bicycling (e.g. lower speed limits for cars, protected bike lanes, trails etc.), it would strongly suggest significant potential to grow cycling as a healthy, sustainable, affordable mode of transportation in Arlington County.

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A: The Level of Traffic Stress (LTS) method, explained

**General Definition**

The chief deterrent to riding a bike in the U.S. is the high stress of riding without protection from the danger of fast and heavy motor traffic, or, more briefly, traffic stress. In an international survey, Pucher and Buehler found that for three nations in northern Europe with high levels of transportation cycling, “The key appears to be the provision of separate cycling facilities along heavily traveled roads and at intersections, combined with traffic calming of most residential neighborhoods.”\(^3\) Some streets have low traffic stress, while others have higher stress. Treatments such as bike lanes can sometimes mitigate

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\(^3\) [http://www.tandfonline.com/doi/abs/10.1080/01441640701806612](http://www.tandfonline.com/doi/abs/10.1080/01441640701806612)
most of the traffic stress; but at other times, even where there is a bike lane, riding in streets can be very stressful.

Over time, various methods have been developed for rating the suitability of streets for bicycling, attempting to capture how comfortable or stressful it is to ride there. However, none is widely known or used, for reasons including burdensome data requirements, black-box formulas, inconsistencies, failure to account for intersection effects, and the inability to gauge the positive effect of mitigating treatments such as protected bike lanes.

In 2012, Mekuria, Furth, and Nixon proposed a new scheme that classifies streets into four levels of traffic stress (LTS) using simple rules that rely on data either readily available or easy to acquire.4 The four levels of traffic stress are linked to Geller’s popular classification of people by their readiness to use a bike, shown below in Figure 3.5 Geller’s typology, and the distribution shown in Figure 3, were recently validated in a national survey.6

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4 Mekuria, Maaza C., Ph.D., Peter G. Furth, Ph.D., and Hillary Nixon, Ph.D. "LOW-STRESS BICYCLING AND NETWORK CONNECTIVITY." Mineta Transportation Institute, May 2012.
6 https://trid.trb.org/view.aspx?id=13941422
Four Levels of Traffic Stress

**LTS 1**: Suitable for young, old, and novice cyclists. Cyclists are either physically separated from traffic, or face a limited volume of low-speed traffic and rarely engage with more than one vehicle at a time.

![Examples of Level of Traffic Stress 1](image1.png)

**LTS 2**: Limits traffic stress to what the mainstream adult population, those who are “interested but concerned,” can tolerate. Cyclists may engage with multiple vehicles at once, but only at low speeds and infrequently. Or, they have a defensible place to ride where motor traffic, for the most part, stays away. They are physically separated from high speed and multilane traffic. The criteria for LTS 2 correspond to design criteria for Dutch bicycle route facilities.

![Examples of Level of Traffic Stress 2](image2.png)
Four Levels of Traffic Stress

**LTS 3**: A level of traffic stress acceptable to the “enthused and confident.” Involves interaction with moderate speed or multilane traffic, or close proximity to higher speed traffic.

![Examples of Level of Traffic Stress 3](image)

**LTS 4**: A level of stress acceptable only to the “strong and fearless.” Involves mixing with moderate speed traffic or riding in close proximity to high speed traffic.

![Examples of Level of Traffic Stress 4](image)
Factors influencing stress assignment

**Intersections**
Crossing busy streets without signal protection is one sure way to increase traffic stress and deter people from using bicycles. This was factored into the level of traffic stress model by assigning stress to links based on the presence or absence of intersection accommodations such as traffic signals and bike boxes. For example, a location where a person must cross four lanes of 35 mph traffic without a crossing island wide enough to protect a bicycle (seven feet) is assigned an LTS of 3. This is high enough to deter most of the adult population from using it.

**Barriers**
Another key concept in the LTS method is the idea of barriers. Barriers can come in a variety of forms. Arlington’s Lee Highway, for example, is a long barrier because it lacks low-stress crossings. At the intersection of Lee Highway and John Marshall Drive, for instance, the narrow median and absence of a signal create a barrier. Future network improvements propose mitigations to this high stress condition with a project including a signal and a short portion of cycle track along Lee Highway. Other types of barriers are discussed below (see pg. 11).

**Discontinuities**
Bicycle travel is subject to a “weak link” effect. Otherwise low-stress routes become unsuitable if even short stretches exceed riders’ stress tolerance. For example, a street's bike lanes may disappear approaching an intersection. Examples in Arlington include North Quincy approaching Washington Boulevard, Patrick Henry Drive approaching Washington Boulevard, and North Harrison approaching Williamsburg. In the LTS method, these segments are modeled as the absence of bike lane, and given higher scores. To create a future network, changes are proposed to complete these discontinuous bike lanes. Other links in the current network— for example the complicated area where Lee Highway, Lorcom Lane, Woodstock Street, and Old Dominion Drive intersect— are considered high stress because they lack bike lanes and clear directional cues. The future network assumes improvements in that area— protected bike lanes and common bike lanes—that will lower the stress.

For approaches with a bike lane “inside” a right turn lane—meaning the “through” bike lane transitions to a “pocket” bike lane between travel lanes—characteristics of the transition and the pocket bike lane determine whether the score is LTS 2, 3, or 4. That stress is then applied to the street segment. Arlington has few pocket bicycle lanes, so these do not factor strongly into network performance.
B: Assembling data and evaluating the existing network

Data Sources and Assumptions Used to Infer Missing Data

Arlington County has a wealth of data sufficient to verify conditions across the current bicycle network. This information includes detailed GIS files with geo-located streets and trails, and additional operational information such as speed limits, traffic counts, number of travel lanes, and the presence or absence of bike lanes. The location of all traffic signals is known. All of the County’s streets are functionally classified, with four types of non-arterial, non-primary streets, defined as:

- Private streets;
- Local streets;
- “Neighborhood principals,” which typically have centerlines, and may have traffic calming treatments (speed humps, speed cushions); and
- “Minor arterials,” which have centerlines but no traffic calming treatments (mainly because they carry bus traffic).

This project assumed that streets coded 35 (local) or 50 (private) had no centerline, a prevailing speed of 25 mph, and Average Daily Traffic (ADT) < 1500. With these assumptions, these streets were assigned LTS 1.

Two-lane roads coded 25 (minor arterial) or 31 (neighborhood principal) were assumed to have centerlines, a posted speed of 25 mph, and ADT in the range 750-1500. Although streets coded 31 often have speed humps, direct observation suggests that speed hump spacing is such that speed between slow points still reaches 25 mph. County staff identified streets in these categories having possibly moderately high traffic volume, and consulted the County’s database of recent traffic counts at representative locations. ADT was then set equal to ten times the peak hour volume, consistent with standard industry practice. For example, a recent count found that N. Lexington Street immediately south of Lee Highway has a peak hour two-way volume of 255. Therefore, its ADT is estimated to be 2550, resulting in an assigned LTS 3.

By default, bike lanes were assumed to be five feet wide, and where they occur alongside parking lanes, parking lanes are assumed to be eight feet wide, consistent with County design practice. This combined dimension of eight-foot parking plus five-foot bike lanes creates a dimension called “bike lane reach,” or the distance from face of curb to inside bike lane stripe, equal to 13 feet. County staff marked maps to locate protected bike lanes, buffered bike lanes, bike lanes that are six feet wide, and bike lanes not adjacent to parking lanes. These additional attributes were manually added to the GIS files. County staff located the small number of pocket bicycle lanes, and identified trail connections that had not previously been included in the roadway GIS data.

County maps were available to indicate where parking meters are in use, and these locations were coded as having high parking turnover. Bike lanes in the commercial strip between Clarendon and Rosslyn were coded as being frequently blocked.
Additionally, project staff directly:

- Double-checked all streets listed as having four or more lanes. In many cases, those streets had only two travel lanes, with others being used for parking or bike lanes. The number of lanes in the data was corrected as needed.
- Checked all locations with pocket bike lanes to verify whether they conformed with LTS 2, 3, or 4 criteria for pocket bike lanes.
- Checked intersection of streets exceeding LTS 2 in the absence of a median. If the median width (distance between the inside lane lines) was less than eight feet, or if the median ended so far in advance of the intersection that a crossing cyclist would not be protected, the crossing was treated as having no median. An example is Lee Highway at John Marshall Drive, where there is only a six-foot median. This could serve as a refuge for a pedestrian, but not for a person on a bicycle.
- Checked Google maps to carefully identify and add connections between streets and paths that were missing from the GIS base data. At least a dozen such connectors were added, mostly to the Four Mile Run Trail and the Bluemont Junction Trail.

To help spot and correct data errors, LTS classification maps were reviewed again by County staff. Examples of corrected problems included: blocks where bike lanes were missing; one-way streets not open to two-way bike travel; and roads with incorrect lane assignments.

C: Altering the existing network to create a future scenario

The bulk of the project consisted of “running” LTS and connectivity analysis software on the GIS representation of the bicycle network. A number of comparisons were made between the present real-world network and a future proposed network with improvements at high-stress locations, barriers, and discontinuities. This approach is discussed below and detailed in the Appendix as a list of proposed capital improvement projects.

Mesh Density and Barriers

In order for a bicycling network to work well, it needs to be relatively fine-grained and dense, with a degree of redundancy. This level of articulation is known as ‘mesh density’. Dutch practice aims for 500 m (5/16 mi) spacing of through bicycle routes. However, in actual Dutch urban bicycling networks, one can observe an average spacing of 700 m (7/16 mi) at major barriers, and those networks appear to be successful. For Arlington, the present study considered gaps wider than ½ mile (800 m) as presenting significant barriers to bicycling.

Figure 4 shows barriers in Arlington’s low-stress network (LTS 2 or less), indicating gaps greater than ½ mile. A set of long barriers isolates much of southeastern Arlington County. These are created by Arlington National Cemetery and the highways that surround it, the Army-Navy Country Club, I-395, and Columbia Pike. One section of Pentagon City is encircled by barriers, making it completely inaccessible by low-stress routes. Many sections of southern Arlington can only be reached through one or two
inconveniently located access points. The northern part of the county is less severely interrupted by barriers, but there are still many, including some more than 1.5 miles long that inhibit travel both north-south and east-west. On the other hand, there are also rather large barrier-free zones where Arlington’s grid of local streets, supplemented by trails and bike lanes on collector roads, allows low-stress bicycling over a large area without significant detour.

**Figure 4: Barriers**

Understanding the nature of barriers is important to developing solutions. Barriers are of four types:

- **Large institutions closed to bicycling.** The most prominent is Arlington National Cemetery and neighboring Joint Base Myer-Henderson Hall (JBM-HH) aka “Fort Myer.” The degree of isolation could be reduced by adding bicycle accommodations to the surrounding rights of way, as with the recently completed trail along Arlington Boulevard at the interchange with 10th Street and Courthouse Road.
• **Natural and man-made linear features, including rivers, freeways, and railroad tracks, impassable by bike except with bridges or underpasses.** Bridges and underpasses are expensive, long-lasting infrastructure features that tend to be spaced further apart than a typical street grid. If bridges and underpasses lack low-stress bicycling accommodations, the resultant gap in the bicycle network can be very wide. This kind of gap is found in Arlington along I-395, Jefferson Davis Highway, Arlington Boulevard, Four Mile Run Drive, and a section of I-66 in the western corner of the county.

• **Breaks in the street grid.** Interruptions in the street grid created by features such as creeks or *cul-de-sacs* can be mitigated with public access easements to reconnect bicycle and pedestrian networks. These can enable cycling and walking without permitting through motor traffic.

• **High volume roads** can create barriers, in two different ways:

  One is from an absence of low-stress crossing opportunities. The example of Lee Highway (Rt 29) in the western part of the county was discussed above. Over a distance of 1.5 miles, the only signalized intersections are at high volume streets with high LTS scores. Median islands, when present, are frequently too small to afford protection. For cases like this, the arterial itself is the barrier. Other examples include sections of Glebe Road and Columbia Pike.

  The other way a high traffic road can create a barrier is when it generates high traffic stress, and it is the only connecting road in its neighborhood. In such cases the barrier is *along* the road, not across it. An example is N Quincy Street in the vicinity of Washington Boulevard. Both streets have high stress scores. When they are removed from the network of available route choices, the result is a large “block” with no low-stress passage. However, if there are alternative parallel, low-stress streets nearby, then the high stress character of a particular route might not create a barrier despite its high stress.

### Identified Weaknesses, and Proposed Improvements

An analysis of current conditions for Arlington revealed a number of weaknesses in the existing network, and led to suggested improvements. These are detailed as a package of more than 40 large and small capital projects. The strategies are enumerated below, and project details can be found in the Technical Appendices.

**Project Improvement Strategies**

A: Complete a ring around Arlington Cemetery and the Pentagon to minimize the barrier effect of these properties and the high-stress roadways surrounding them.

B: Add missing bike lane segments to discontinuous existing bike lane corridors.

C: Add sidepaths to fill gaps in low-stress routes along Arlington Boulevard.

D: Add cycle tracks (separated lanes or sidepaths) to arterials where space can be found without sacrificing travel lanes or parking.
E: Create cycle tracks where travel lanes can be eliminated without compromising traffic capacity.

F: Create new links to create new or extend existing quietways—routes following quieter streets, parks, or waterways—parallelizing Columbia Pike and Wilson Blvd.

G: Create quietways along existing low-traffic roads by eliminating high stress pinch points.

H: Physically separate bicycle operation in areas with high parking pressure or high turning volumes.

I: Improve access to Potomac River bridges and the Mt. Vernon Trail.

The effect of these proposed improvements is summarized in Table 1. The greatest share of the suggested improvements is a large increase in protected bike lanes. This would represent a shift in the County’s current bicycle planning practice. It would be consistent with the growing understanding, confirmed by research, that separated bicycle facilities serve not just the current cycling population, but provide an attractive and safe alternative for the general population that does not currently use bicycles. These changes create an aspirational network, relatively unconstrained by realities of budgets and contests over road design. Under this “what if” scenario, the total mileage of traditional bike lanes, sharrows, and “recommended” routes in Arlington County would actually decrease, as existing facilities are upgraded to provide LTS 1 connectivity.

As for Arlington County’s existing, significant, and popular trail system, as distinct from on-road facilities, it is enhanced in this scenario primarily with access improvements to further leverage LTS 1 connectivity already provided by these facilities. Taken together, the proposed improvements increase only modestly the current mileage of LTS 1 and 2 conditions in Arlington - about 10 percent. But because the proposed projects are intended to provide the greatest increase in connectivity, they have a great cumulative effect.

**Table 1: Bicycle Facility Types by Mileage**

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Base Case</th>
<th>Future Case</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bike Lane</td>
<td>45.6</td>
<td>37.4</td>
<td>-18%</td>
</tr>
<tr>
<td>Multi use Trail</td>
<td>48.4</td>
<td>53.3</td>
<td>10%</td>
</tr>
<tr>
<td>Neighborhood Greenway</td>
<td>0.0</td>
<td>2.1</td>
<td>-</td>
</tr>
<tr>
<td>Protected Bike Lane</td>
<td>1.1</td>
<td>30.4</td>
<td>2665%</td>
</tr>
<tr>
<td>Sharrow</td>
<td>6.3</td>
<td>3.3</td>
<td>-48%</td>
</tr>
<tr>
<td>Signed Bicycle Route</td>
<td>81.5</td>
<td>70.1</td>
<td>-14%</td>
</tr>
<tr>
<td>Wide Curb</td>
<td>0.0</td>
<td>0.2</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 5 illustrates the changes in LTS by segment from proposed improvements or new facilities. The proposed package of “future scenario” improvements is targeted, and most streets in the County will remain unchanged. However, the future scenario proposes high-value investments on key corridors and intersections, based on a rigorous assessment of right-of-way availability and demand. Examples of the most dramatic changes include conversions of existing LTS 4 segments such as George Mason Drive to LTS 1 conditions by adding a new protected bike lane.
D: Analyzing the Future Scenario for Improved Low-Stress Connectivity

Origins, Destinations, and “Baskets”

To evaluate and prioritize proposed future improvements to the bicycle network, a GIS tool called BikeAble™ was used. BikeAble™ was recently developed by the Rails-to-Trails Conservancy; a detailed description can be found in Lowry et al. (2016).\(^7\)

BikeAble™ requires five GIS data inputs: (1) bicycle trip origins; (2) selected destinations classified by type; (3) street network with number of lanes and LTS assignment; (4) intersections with traffic signals and other bicycle accommodations; and (5) digital elevation map.

The tool identifies the best low-stress route for bicycling between every origin and every destination by digitally iterating millions of virtual trips. Each “run” of the tool is done within parameters setting stress tolerance limits for connectivity between origins and destinations.

This project tested connectivity between several groups of origins and destinations, summarized in Table 2. One set of origins was all residential parcels, weighted by population density – i.e. how many persons per household. Several baskets of destinations were created, and search distances were specified to represent choices facing hypothetical cyclists considering a variety or trips. Origins were considered “connected” to destinations if feasible low-stress routes exist within the search distance parameter to enable the origin to reach 60 percent (“the majority”) of the destination types in the basket. (Note: search distances are different for different destination types.)

<table>
<thead>
<tr>
<th>Basket</th>
<th>Max #</th>
<th>Base</th>
<th>Future</th>
<th>Reach Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bikeshare to Bikeshare</td>
<td>3 miles</td>
<td>19%</td>
<td>28%</td>
<td>Avg. of all stations</td>
</tr>
<tr>
<td>Residential to Key Destinations</td>
<td>2 miles</td>
<td>87%</td>
<td>92%</td>
<td>60% of types</td>
</tr>
<tr>
<td>Residential to Public Facilities</td>
<td>1.5 miles</td>
<td>77%</td>
<td>84%</td>
<td>60% of types</td>
</tr>
<tr>
<td>Residential to Employment Centers</td>
<td>6 miles</td>
<td>0%</td>
<td>29%</td>
<td>4 (100%) centers</td>
</tr>
</tbody>
</table>

To elaborate on Table 2, the “Key Destinations” basket represented utilitarian non-work travel, and included:

- Metro stations
- Bus stops along Columbia Pike
- Post offices
- Pharmacies
- Banks
- Grocery and specialty food stores (e.g. bakeries, butcher shops, etc.)
- Hardware stores
- Convenience stores
- Dry cleaners
- Coffee shops
- Full service restaurants
- Liquor stores and bars.

The “Public Facilities” basket contained:

- Libraries
- Community centers
- Swimming pools
• Nature centers
• Parks
• Trailhead access to the Arlington Loop.

The source for “Employment Locations” was Hoovers industry location dataset. A total of 12,581 employment “origins” were found in Arlington County. For “Residential to Employment” connectivity, four employment center destinations were used: Ballston, Courthouse/Clarendon, Rosslyn, and Crystal City.

The results in Table 2 can be thought of as indicating how successfully the Arlington network provides low-stress connectivity between common origins and destinations. “Base” and “future” figures suggest that low-stress connectivity is a more meaningful measure of impact of proposed projects than simply the length of new or improved facilities. Although there is no guarantee that improved connectivity will lead to higher cycling volumes, preliminary research by Lowry and Loh indicates that observed cycling volumes are in fact strongly positively correlated with low-stress connectivity.

A Special Case: Bikeshare Connectivity Analysis

Much of the analysis that follows reports tests of connectivity between origins and destinations under current and proposed future conditions. Usually the origins and destinations are dissimilar (e.g. home to work), and the discussion will look at qualities of the origins, the destinations, and the LTS network itself. Concepts of “connectivity” and “flow” will be defined and explored.

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An introductory example of this kind of analysis is a test of connectivity between bike share stations. In this case, the origins and destinations are identical – all Arlington Capital Bikeshare stations. LTS connectivity was tested using a travel distance threshold of three miles or less. Under current conditions, 21 stations (out of 85 total stations) were found to be unconnected to any other Arlington stations via only low-stress routes. This finding raises a significant concern, as this lack of connectivity may prevent the County from fully realizing the benefits of investments already made in Capital Bikeshare infrastructure and marketing. In the future scenario, 13 existing stations remain out of reach of any other station using the three-mile or shorter low-stress route threshold. The results of this analysis would seem to call for reconsidering these station locations, as they remain isolated even under the improved conditions of the future scenario.

Currently, each station, on average, is within reach of 19 other stations via low-stress routes of three miles or less. With suggested future network improvements, the simulation shows the average station within reach of 28 other stations, an almost 50 percent improvement in low-stress connectivity. Figure 6 shows each station as a graduated symbol based on the number of other stations connected by a low-stress route up to three miles. These results suggest that even without adding additional stations, the utility of Bikeshare could be greatly increased, and serve a wider array of users, through infrastructure improvements to the bicycle network.
Analysis Results: Connectivity and Flow

Figures 7 through 12 present the results of the analysis. These figures show how low-stress connectivity between origins and destinations changes based on new or improved infrastructure, and how “potential trip flow” is distributed differently throughout the bicycle network as changes improve convenience and efficiency. The figures are presented in pairs: Figures 7, 9 and 11 illustrate connectivity, and Figures 8, 10 and 12 corresponding changes in flow.

It should be noted that the “baskets” considered in this analysis considered only destinations within Arlington County, and only civilian employment locations. Further analysis is needed to measure the impact of proposed improvements on connectivity between jurisdictions and for military personnel. Many of the proposed improvements, particularly around the Pentagon, Arlington Cemetery, and Fort Myer, are greatly improve low-stress access to military facilities and the District of Columbia.

Connectivity

Figure 7 shows the percentage of destination types within the “basket” reachable via a low stress route from each residential parcel in the County. It is important to note the distinction between reaching a diversity of destination types as opposed to a larger number of destinations. When tracking destinations by type, a parcel will not receive a high connectivity percentage simply by being able to reach additional locations of one destination type. The desired number of each destination type is a user-specified parameter, and in most cases it is set to one (e.g., you are “connected” once you can reach one dry-cleaner, or one Metro station). However, for some destination types the search looked for higher numbers. For example, because choice is important for some destination types the target for restaurants was 10 unique locations. The weights given to all types of “key destinations” are reported in Table 3.

This nuanced approach sets a high but realistic bar for what it means to be “connected.” It is noteworthy that under current conditions, 87 percent of Arlington residents can reach 60 percent of key destination types via low stress bicycle routes. This is a high baseline score, and reflects years of work in Arlington to improve everyday cycling. But ideally, even more residents would be able to reach even more important destinations by low stress routes.

The blue and dark green areas in Figure 7 indicate residential locations based on residential parcels 10 “connected” to 60 percent or a majority of destinations; this area expands significantly under the future

<table>
<thead>
<tr>
<th>Table 3: Target Number For Each “Key” Destination Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>3</td>
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<td>10</td>
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</tbody>
</table>

10 In this analysis, residential parcels represent residential locations as well as residents.
scenario. Some “key” destinations, such as full-service restaurants and Metro stations, are not evenly distributed spatially throughout the county, so it is therefore “easier” to improve access to some sub-categories within the Key Destinations basket.
Figure 7: Percentage of Key Destination Types Reached by Residential Locations

**Base Case Scenario**

87% of Residents Reaching the Majority of Destinations

**Future Case Scenario**

92% of Residents Reaching the Majority of Destinations

% Destinations Reached by Parcel

- 0% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%

0 1 2 Miles
**Potential Trip Flow**

The impact of the proposed improvements on low-stress connectivity should be evaluated not only in terms of the absolute percentages shown in Figure 7, but also by the “flow” of low-stress connectivity through the street network from origin to destination. Figure 8 visualizes connectivity “flow” focused on low-stress routes that connect origins and destinations—in this case residential parcels to key destinations. In other words, Figure 8 shows simulated “potential trips” occurring along low-stress routes between origins and destinations shown in Figure 7.

Potential trip flow is best characterized as the magnitude of potential trips between origins and destinations along low-stress routes. The number of potential trips is a function of residents from a number of residential parcels attempting to reach a basket of destinations. In other words, potential trip flow is based on the number of potential trips that can take place along any low-stress route from any origin to a likely destination. The tool digitally simulates millions of virtual trips. The aggregate of these many potential trips are shown on the map, with the tool calibrated to favor the shortest possible distance on low-stress routes.

The potential trip flow visualizations show that for all types of trips, cyclists can expect the improved bicycle facility network to deliver not only low-stress routes that are more available and feel safer, but also routes that are more convenient and more efficient. “Efficiency” in this context means more direct low-stress routes between origins and destinations that provide opportunities to reach multiple destinations over shorter distances. Again, when the tool simulates trips it focuses on the shortest low-stress paths between origins and destinations. When proposed improvements shorten the low-stress paths between origins and destinations, the directness or efficiency of the potential trips is increased. It follows that the shorter low-stress paths enabled by proposed projects give access to more destinations along the routes with highest potential trip flow. Comparing Figures 7 and 8, the increase in percentage of destinations reached by residents from base case to future case corresponds with the future case potential trip flow.

As seen in Figure 8, the change in the pattern of flow from the baseline to the future scenario suggests that the proposed improvements will enable even cyclists who can tolerate only low levels of traffic stress to find much more direct routes between origins and destinations. Similar flow visualizations are shown in Figures 10 and 12 and correspond to the rows in Table 2.

In these figures, it might appear that flow is reduced or missing when base and future cases are compared. This is because proposed improvements that lower LTS may concentrate potential trips along more centralized low-stress routes, and reduce potential trips along less direct routes. These improvements can also help eliminate barriers created by high stress routes, which in turn accentuates the centralization of potential trips.

Figure 8 shows how improvements can centralize potential trips along low-stress routes. In the base case routes weave along several different routes, but in the future case potential trips are focused along fewer low-stress routes more centralized along Wilson/Clarendon Blvd. and Fairfax Dr. In other words, potential trips in the base case are dispersed along less direct routes, and in the future case with proposed improvements, the flow of potential trips is more centralized and “efficient”.

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Figure 8: Simulated Flow, Residential Locations to Key Destinations

Base Case Scenario

Future Case Scenario
Connectivity/Flow Results and Conclusions

Figure 9 shows the low-stress connectivity between residential locations and public facilities, such as libraries, parks, and trails. From the base case to the future case scenario, low-stress connectivity for Arlington County residents increases from 77 percent to 84 percent. The increase may result from proposed improvements on George Mason Drive and Walter Reed Drive, which are likely among the costliest improvements in the overall future scenario package of projects. In Figure 9, improved low-stress connection for south Arlington stands out. Low-stress, two-mile access to public facilities is notably improved.

Figure 10 visualizes the flow between residential locations and public facilities. The visualization depicts flow centralizing and increasing along routes with low-stress improvements or new facilities added to the base case. In other words, a resident would be able to take a more efficient low-stress route with proposed project improvements in the future case scenario.
Figure 9: Percentage of Public Facility Types Reached by Residential Locations

Base Case Scenario

Future Case Scenario

77% of Residents Reaching the Majority of Destinations

84% of Residents Reaching the Majority of Destinations

% Destinations Reached by Parcel

- 0% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%

25
Figure 10: Simulated Flow, Residential Locations to Public Facilities

Base Case Scenario

Future Case Scenario

Potential Trip Flow

- None
- Low
- Medium
- High
Figure 11 shows low-stress connectivity between Arlington County residences and employment centers. In the base case, no household in the entire county has a low-stress bicycle route of six miles or less to all four employment centers, and only 1 percent of residents can reach even three employment centers. Figure 9 shows that the targeted improvements of this study, representing only a 10 percent increase in LTS 1 and 2 facility mileage, could greatly improve low-stress bicycle access to employment within the county. Under the future scenario, 29 percent of residents would be able to reach all four employment centers via a low-stress bicycle route of six miles or less. These households are primarily in the southern part of Arlington County, where transportation access has long been a significant issue. Moreover, access to jobs is substantially improved county-wide. With the proposed improvements, 85 percent of residents can reach three employment centers on low-stress bicycle routes.

Figure 12 visualizes the flow between residential parcels and employment centers. The visualization depicts flow centralizing and increasing from base case to future case scenario along routes with stress improvements or new facilities. Again, a resident would be able to take a more efficient low-stress route with proposed project improvements in the future case scenario.
Figure 11: Percentage of Employment Centers Reached by Residential Locations

Base Case Scenario

0% of Residents Reaching All Four Employment Centers

Future Case Scenario

29% of Residents Reaching all Four Employment Centers

Number of Employment Centers Reached by Destination

- 0 Employment Centers
- 1 Employment Centers
- 2 Employment Centers
- 3 Employment Centers
- 4 Employment Centers

0 1 2 3 4

0 1 2 Miles

N
Figure 12: Simulated Flow, Residential Locations to Employment Centers

Base Case Scenario

Future Case Scenario

Residential Parcels Reaching Employment Center
- Low
- Moderate
- High
- Very High

Potential Trip Flow
- None
- Low
- Medium
- High
Project Rankings

Improved flow was chosen as the key determinant for proposing a set of capital projects. As mentioned previously, flow is based on the number of "potential trips" that can take place along a route from an origin to a likely destination. The project-ranking component of the analysis helps determine which proposed projects would have the greatest impact on the increase of low-stress connectivity. Comparing the metric for flow between base case and future (visualized in Figures 8, 10, and 12), results in a ranked list of proposed projects/improvements. The comparison between base case and future case calculates the change in flow rather than absolute flow volume.

Two key factors contribute to project rankings. First, if the project is centrally located at a point in the network that places it between many potential origins and destinations, it will “attract” more flow giving that proposed facility or improvement a higher ranking. Second, calculating the change in flow rather than absolute flow volume emphasizes the highest impact changes from base case to future case scenarios. Features either absent from the baseline, or with high LTS scores, have greater potential to show change from the baseline to the future. Therefore, this ranking alone should not be interpreted as an indication of which projects are the most “important.” Rather, it is one potential input to a prioritization process, illustrating the relative role of each project in connecting a web of flow. In practice, most jurisdictions use a number of criteria to prioritize projects.

The ranked list in the Technical Appendix is the result of comparing the base case and future case scenario of low-stress connectivity between residential parcels and key destinations. In this particular case, many of the projects located in and around Crystal City are ranked lower, because there are relatively fewer residential origins in that area. Since this list illustrates the effect of improving connections between residential parcels and key destinations, areas with fewer residential origins are less affected.

Project rankings would look different for other combinations of origins and destinations considered in this analysis, such as Capital Bikeshare stations or employment centers. When the configuration or distribution of origins and destinations changes the flow changes, and therefore other proposed facilities or improvements might be favored and would produce a different ranked list.

E: Conclusions

Under current conditions, low-stress connectivity in Arlington is relatively good, but proposed capital projects aimed at overcoming barriers, as shown in Figure 4, would improve it significantly. Proposed improvements that expand low-stress connectivity and improve LTS scores have greater impact than simple linear extensions of the existing network.

For this analysis, a number of projects were proposed that reduced stress at intersections, and focused on overcoming barriers and discontinuities. The study derived a number of high-level strategic recommendations, which led to a detailed list of specific projects that was noted previously (pg. 13) and appears in the Appendix.
The study has shown that a few specific additions and improvements have the greatest impact on reduced stress and increased connectivity. Proposed improvements along Fairfax Dr. and Clarendon Blvd. have the greatest effect on expanding residential low-stress connectivity in all scenarios. Improvements on Fairfax Dr. and Clarendon Blvd. also greatly centralize and create efficiency for low-stress bicycle trips in Arlington County as gauged by calculations showing improved flow. Improvements along George Mason Dr. create a pronounced expansion of low-stress connectivity in northwest and south Arlington.
Technical Appendices

LTS Criteria Used for Arlington County

LTS criteria version 2.1 (May, 2016) were used for Arlington County, and are given in Tables 1-3. Because the most important shift is between LTS 2 and 3, changes affecting this transition were made after consultation with County staff, and differ from the original LTS criteria.

The LTS method employs a number of criteria. Some can be modified for local conditions. In the Arlington study, the following characteristics were adjusted.

Changes to criteria for bikes in mixed traffic:

LTS is sensitive to ADT on two-lane, two-way roads with marked centerline and mixed traffic.

- Therefore, traffic volume data must be available or inferable on such streets.
- The region for LTS 2 was expanded to include 35 mph roads with less than 750 ADT (whether laned or not) and 30 mph roads with up to 3000 ADT (unlaned) or 1500 (1+1 lanes). This recognizes that roads with low traffic volumes are attractive for bicycling even if traffic is going at moderately high speeds because cyclists rarely encounter multiple cars at the same time.
- On 1+1 lane roads with ADT > 1500, LTS increased (relative to the original criteria) to 3 even when speed = 25 mph, recognizing that on moderate to high volume, narrow roads like this, encounters with passing cars are frequent and stressful because the cyclist is perceived as blocking the car’s lane.

Changes to criteria for bikes in bike lanes or shoulders that are not alongside a parking lane:

- Maximum speeds for LTS 2 and LTS 3 were increased to better reflect the protection that cyclists feel when riding in their own defensible space.
- For consistency with mixed traffic criteria, 4-lane roads with bike lanes, very low volumes, and a prevailing speed of 25 mph or less have LTS 2.

There are no changes to criteria for bikes in bike lanes alongside a parking lane.

There are no changes to the criteria for crossings or intersection approaches.
### Table 1: Criteria for Cycling in Mixed Traffic

<table>
<thead>
<tr>
<th>Number of lanes</th>
<th>2-way ADT</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 25 mph</td>
<td>30 mph</td>
</tr>
<tr>
<td>Unlaned 2-way street (no centerline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-750</td>
<td>LTS1</td>
<td>LTS 2</td>
</tr>
<tr>
<td>751-1500</td>
<td>LTS1</td>
<td>LTS 2</td>
</tr>
<tr>
<td>1501-3000</td>
<td>LTS 2</td>
<td>LTS 2</td>
</tr>
<tr>
<td>3000+</td>
<td>LTS 2</td>
<td>LTS 3</td>
</tr>
<tr>
<td>1 thru lane per direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1-way street or 2-way street with centerline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-750</td>
<td>LTS1</td>
<td>LTS 2</td>
</tr>
<tr>
<td>751-1500</td>
<td>LTS 2</td>
<td>LTS 3</td>
</tr>
<tr>
<td>1501-6000</td>
<td>LTS 3</td>
<td>LTS 3</td>
</tr>
<tr>
<td>6001+</td>
<td>LTS 3</td>
<td>LTS 3</td>
</tr>
<tr>
<td>2 thru lanes per direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LTS 3</td>
<td>LTS 3</td>
</tr>
<tr>
<td>6001+</td>
<td>LTS 3</td>
<td>LTS 4</td>
</tr>
<tr>
<td>3+ thru lanes per direction</td>
<td>any ADT</td>
<td>LTS 3</td>
</tr>
</tbody>
</table>

Note: If combined width of parking lane and bike lane < 12 ft or bike lane is blocked frequently, use mixed traffic criteria.

### Table 2: Criteria for Cycling in Bike Lanes and Shoulders not Alongside a Parking Lane

<table>
<thead>
<tr>
<th>Number of lanes</th>
<th>Bike lane width</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 25 mph</td>
</tr>
<tr>
<td>1 thru lane per direction, or unlaned</td>
<td>6+ ft</td>
<td>LTS 1</td>
</tr>
<tr>
<td></td>
<td>4 or 5 ft</td>
<td>LTS 2</td>
</tr>
<tr>
<td>2 thru lanes per direction and divided</td>
<td>6+ ft</td>
<td>LTS 2</td>
</tr>
<tr>
<td></td>
<td>4 or 5 ft</td>
<td>LTS 2</td>
</tr>
<tr>
<td>3+ lanes or 2 lanes undivided per direction</td>
<td>6+ ft</td>
<td>LTS 3</td>
</tr>
<tr>
<td></td>
<td>4 or 5 ft</td>
<td>LTS 3</td>
</tr>
</tbody>
</table>

Note: If bike lane width < 4 ft or bike lane is blocked frequently, use Mixed Traffic criteria.

### Table 3: Criteria for Cycling in Bike Lanes and Shoulders Adjacent to a Parking Lane

<table>
<thead>
<tr>
<th>Number of lanes</th>
<th>Bike lane reach = Bike + Pkg lane</th>
<th>Parking turnover</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 20 mph</td>
<td>25 mph</td>
</tr>
<tr>
<td>1 lane per direction</td>
<td>15+ ft</td>
<td>any</td>
<td>LTS 1</td>
</tr>
<tr>
<td></td>
<td>14 ft</td>
<td>any</td>
<td>LTS 2</td>
</tr>
<tr>
<td></td>
<td>12 or 13 ft</td>
<td>low*</td>
<td>LTS 2</td>
</tr>
<tr>
<td></td>
<td>12 or 13 ft</td>
<td>high*</td>
<td>LTS 2</td>
</tr>
<tr>
<td>2+ lanes per direction</td>
<td>15+ ft</td>
<td>any</td>
<td>LTS 3</td>
</tr>
<tr>
<td></td>
<td>12-14 ft</td>
<td>any</td>
<td>LTS 3</td>
</tr>
</tbody>
</table>

Notes: If bike lane reach < 12 ft or bike lane is blocked frequently, use Mixed Traffic criteria.

* Absent local evidence, parking turnover can be assumed to be high in commercial areas and low otherwise.
Project Details

A: Complete a ring around Arlington Cemetery and the Pentagon to minimize the barrier effect of these properties and the high-stress roadways surrounding them.

- Rt. 27, Walter Reed to S Rolfe: a sidepath along the west side, with connector at 6th St S
- Columbia Pike, S. Rolfe to S. Quinn: a one-block extension of the shared use path along the north side of Columbia Pike that was recently completed at the Rt. 27 interchange
- Columbia Pike, with sidepath, realigned so that there is no hook to meet Joyce; interchange with Pentagon access redone, too
- S. Joyce near Columbia Pike: Completing the sidepath between Columbia Pike and the underpass under I-395
- Army-Navy Drive: protected bike lane on south side from S 12th to 1 block west of Joyce
- Boundary Channel Drive interchange with I-395: to be rebuilt with roundabouts north and south of I-395, a sidepath crossing I-395, and a short path extension from the north roundabout to the existing path at the southern edge of the Pentagon Lagoon Yacht Basin (This project will create a more direct route from the 14th Street Bridge and Mt Vernon Path to Crystal City)
- Route 110, Memorial Ave. to Rt. 27: create a separated bike path along the eastern side (i.e. the cemetery side), replacing an existing desire path on the other side of 110

B: Add missing bike lane segments to discontinuous existing bike lane corridors.

- Williamsburg Drive
- Yorktown / Little Falls
- Washington Blvd (N McKinley to Westmoreland)
- Pershing Drive (the gap is on the block immediately east of Glebe Rd)
- S 2nd Street (the gap is on the block immediately east of Glebe Rd)
- Patrick Henry Drive (missing bike lanes are on either side of Washington Blvd)
- Military / N Henderson
- N Harrison
- S Eads

C: Add sidepaths to fill gaps in low-stress routes along Arlington Boulevard.

- Route 50, north side, east and west of George Mason Drive
- Route 50, south side, west of Carlin Springs Road
- In addition, a pedestrian underpass under US 50 at Trenton St already exists, but has stairs on the north side. Adding a bike ramp to the north side will make it bikeable.
D: Add cycle tracks (separated lanes or sidepaths) to arterials where space can be found without sacrificing travel lanes or parking.

- Fairfax Blvd (I-66 to Clarendon Circle), Clarendon Blvd, Wilson Blvd east of Clarendon Circle (where cycle tracks are key to this corridor’s commercial success)
- George Mason Drive
  - S Columbus to S 6th – upgrade E side sidewalk to SUP. It fronts few homes or businesses, mostly fronts parkland
  - N Henderson to Carlin Springs (creates a good E-W route) - upgrade W sidewalk to SUP. Fronts only an elementary school and parkland
  - Wilson Blvd to Custis Trail – upgrade E sidewalk to SUP. On the bridge over 66, combine sidewalk and bike lane to make SUP
  - Patrick Henry to N Florida (crossing Lee Hwy) – bike lanes. Northbound, sacrifice the (short) parking lane and the RT lane at Lee (almost certainly unnecessary). Southbound, it will cost more – shift curb to widen roadway from 24 to 27 ft. to add a bike lane for about 320 ft. from Lee Hwy going south; after that, convert parking lane (has only a few legal spaces) into bike lane
- Sycamore Street
- Crystal Drive (a sidepath can be created a long its eastern side)
- Walter Reed Drive south of Columbia Rd
- Old Dominion Road northwest of Rt 29. While the right-of-way is narrow, a sidepath will fit, and this is a critical link to McLean and Tyson’s Corner, following an old rail line with a bicycle-friendly grades
- Expand north-side sidewalk of Lee Highway to a shared-use sidepath where it connects Lorcom to Woodward
- Expand Lorcom’s northwest-side sidewalk to a shared-use sidepath from Lee to Trenton (1 block north of Rt. 29), and potentially further from Trenton to Vacation
- N Quincy – upgrade existing bike lanes to protected bike lanes to reduce traffic stress from high parking turnover in the Ballston area

E: Create cycle tracks where travel lanes can be eliminated without compromising traffic capacity.

- Carlin Springs Road, George Mason Drive to Arlington Blvd (road diet from 2+2 lanes to 1+1)
- S Joyce / S 15th, Army-Navy Drive to Crystal Drive (road diet from 2+2 lanes to 1+1)
- Fort Myer Drive and Lynn Street through Roslyn (road diet from 4 lanes to 3)
- The Washington Blvd eastbound bridge over I-66 in East Falls Church (road diet from 2 lanes to

F: Create new links to create new or extend existing quietways paralleling Columbia Pike and Wilson Blvd.

- A new path around the edge of the Army-Navy Country Club connecting S Queen to the underpass carrying Country Club Drive under I-395 (quietway south of Columbia Pike)
- New street or path segments filling in gaps in S 12th Street between S. Rolfe and S. Cleveland (quietway south of Columbia Pike)
• A footbridge extending S 9th Av over Four Mile Run, connecting the neighborhoods east and west of Four Mile Run (quietway north of Columbia Pike)
• Several short sections of path extending S 8th west from Four Mile Run to Patrick Henry Drive (quietway south of Wilson Blvd)
• A new “17.5 St” path, one block between N Stafford and N Taylor to overcome a N-S barrier (without it, the only E-W route between the Custis Trail and Lorcom requires deviating north a block then back south a block)

G: Create quietways along existing low-traffic roads by eliminating high stress pinch points.
• John Marshall quietway @ Lee Highway: A “HAWK” crossing signal along with a short section of sidepath along the south side of Lee Highway connecting the southern leg of John Marshall Drive to the crossing
• N Quantico quietway @ Lee Highway: A “HAWK” crossing signal
• S Monroe quietway @ Columbia Pike: A short section of bike lane on the approaches to Columbia Pike. (Traffic calming elsewhere along S Monroe may be appropriate as well.)
• N Fillmore quietway @ Washington Blvd / N 10th: a sidepath along Washington Blvd from Fillmore to N 10th, and legal contraflow on N Fillmore just north of N 10th
• N Fillmore quietway @ Clarendon: cycle tracks on N Fillmore for the block between Clarendon Blvd and Wilson Blvd
• N Irving quietway @ Clarendon Circle: sidepath along Washington Blvd to allow the two legs of N Irving to meet, along with legal contraflow on N Irving just north of Washington Blvd
• Little Falls - Old Glebe quietway @ Glebe Rd & Little Falls: expanded crossing island, along with removal of centerline on N Dittmar Rd
• Little Falls - Old Glebe quietway @ Glebe Rd & Old Glebe: sidepath on Glebe Rd between Old Glebe and Upland, together with a signal-protected crossing at either Old Glebe or Upland
• N 5th St quietway @ N Quincy: simple path needed to connect N 5th (dead end) to N Quincy
• S 6th St quietway @ S Courthouse Rd: minor treatment needed (TBD) to ensure that cyclists can cross Courthouse and navigate the short dog leg connecting the two legs of S 6th St.
• N 26th St quietway @ Old Dominion: bike lanes for a few blocks of N 26th at Marymount U.

H: Physically separate bicycle operation in areas with high parking pressure or high turning volumes.

• S 12th, S 15th, S 18th, S 23rd: cycle tracks for the block crossing under Rt. 1
• N Fillmore and N Rhodes: cycle tracks for the block between Clarendon and Wilson Blvds.
I: Improve access to Potomac River bridges and the Mt. Vernon Trail.

- In connection with reconstruction of the RR bridge over the GW Parkway: a path continuing Long Bridge Park to the Mount Vernon Trail
- A path from the Marine Corps Memorial over Rt. 110 (alongside the Arlington Blvd eastbound bridge), then looping under Arlington Blvd EB, then using a widened underpass to follow Rt 50 EB underneath Arlington Blvd WB, and then connecting to the existing sidepath on the south side of the Roosevelt Bridge

Project Rankings Scored by Change in Flow, Connectivity of Residential Locations to Key Destinations

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clarendon Blvd</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>2</td>
<td>Fairfax Dr</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>3</td>
<td>Wilson Blvd</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>4</td>
<td>N Irving Quietway @ Clarendon Circle</td>
<td>Quietway</td>
</tr>
<tr>
<td>5</td>
<td>Key Blvd (One Block)</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>6</td>
<td>Nash St</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>7</td>
<td>N Harrison St (south of Lee Highway)</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>8</td>
<td>N Lynn St</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>9</td>
<td>N Barton St (Wilson to Clarendon link)</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>10</td>
<td>23rd St S</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>11</td>
<td>Henderson Rd</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>12</td>
<td>N Fillmore St (Wilson to Clarendon link)</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>13</td>
<td>18th St S</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>14</td>
<td>S Monroe St</td>
<td>Quietway</td>
</tr>
<tr>
<td>15</td>
<td>9th Ave Footbridge @ Four Mile Run</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>16</td>
<td>Lee Highway</td>
<td>Protected Bike Lane/Bike Lane</td>
</tr>
<tr>
<td>17</td>
<td>N Barton St (10th St N to N Pershing)</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>18</td>
<td>N Fillmore St @ 10th St N</td>
<td>Quietway</td>
</tr>
<tr>
<td>19</td>
<td>George Mason Dr</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>20</td>
<td>S Walter Reed Dr</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>21</td>
<td>Arlington Blvd (north side @ George Mason Dr)</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>22</td>
<td>Crystal Drive</td>
<td>Protected Bike Lane/Sidepath</td>
</tr>
<tr>
<td>23</td>
<td>Patrick Henry Drive</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>24</td>
<td>S 12th St</td>
<td>Quietway/Multiuse Trail</td>
</tr>
<tr>
<td>25</td>
<td>Pentagon Memorial</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>26</td>
<td>S Joyce St/15th St S</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>27</td>
<td>Military Rd</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>28</td>
<td>2nd St S</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>29</td>
<td>10th St S</td>
<td>Quietway/Multiuse Trail</td>
</tr>
<tr>
<td>30</td>
<td>Fort Myer Dr</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>31</td>
<td>S Eads St (north gap)</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>32</td>
<td>Army-Navy Drive</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>33</td>
<td>Washington Blvd (McKinley to Westmoreland)</td>
<td>Protected Bike Lane</td>
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<td>34</td>
<td>Carlin Springs Rd</td>
<td>Protected Bike Lane</td>
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<tr>
<td>35</td>
<td>Queen St Quietway Connection</td>
<td>Multiuse Trail</td>
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<td>36</td>
<td>6th St S Quietway @ S Courthouse Rd</td>
<td>Quietway</td>
</tr>
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<td>37</td>
<td>N Pershing Dr</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>38</td>
<td>N Sycamore St/N Roosevelt St</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>39</td>
<td>Washington Blvd (@ Fort Myer)</td>
<td>Sidepath/Multiuse Trail</td>
</tr>
<tr>
<td>40</td>
<td>N Harrison St (north of Yorktown High)</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>41</td>
<td>Little Falls Rd</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>42</td>
<td>Old Dominion Dr</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>43</td>
<td>N Quantico St</td>
<td>Protected Bike Lane</td>
</tr>
<tr>
<td>44</td>
<td>Dittmar Rd</td>
<td>Quietway</td>
</tr>
<tr>
<td>45</td>
<td>Wilson Blvd Sidepath</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>46</td>
<td>Marine Corps Memorial to Roosevelt Bridge</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>47</td>
<td>East-side ramp to Washington Boulevard @ Pentagon North</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>48</td>
<td>S Eads St (south gap)</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>49</td>
<td>Glebe Road (@ Old Glebe)</td>
<td>Sidepath/Quietway</td>
</tr>
<tr>
<td>50</td>
<td>Long Bridge Park to MVT</td>
<td>Multiuse Trail</td>
</tr>
<tr>
<td>51</td>
<td>S Rolfe - S Cleveland Quietway @ Columbia Pike</td>
<td>Wide Curb Lane</td>
</tr>
<tr>
<td>52</td>
<td>Yorktown Dr/Old Dominion Dr/28th St N</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>53</td>
<td>Arlington Blvd (south side at Carlin Springs Rd)</td>
<td>Wide Curb Lane</td>
</tr>
<tr>
<td>54</td>
<td>N Quincy St</td>
<td>Bike Lane</td>
</tr>
<tr>
<td>55</td>
<td>N Rhodes St (Clarendon to 16th St N)</td>
<td>Protected Bike Lane</td>
</tr>
</tbody>
</table>