Mason to Metro Bicycle Route Project

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Mason-Metro Bicycle Task Group

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Acknowledgements

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Table of Contents

Background

Background and Need Statement

As gasoline becomes more expensive, traffic congestion grows, and carbon emissions increase, bicycling in the DC area becomes a more obvious and responsible transportation option. Recently George Mason University, The Metropolitan Washington Area Transit Authority, The City of Fairfax, and Fairfax County have been making bicycle improvements a priority. Unfortunately the area still lacks a clear bicycle connection from George Mason University (Mason) and The City of Fairfax to the Vienna Metro station.

In 2011 a task force consisting of representatives from Mason and City of Fairfax Departments such as The Parks and Recreation Advisory Board, Transportation Division, Parks and Recreation, and Community Development and Planning Departments was formed to address the issue of bicycle transportation between Mason, The City of Fairfax, and the Metro. Members of the task force then bicycled to the Metro from Mason to define routes to be used in the study. In July of 2011 Tyler Orton was recruited to do research, analysis and provide recommendations on how to improve the routes provided.

Mason is located approximately 5 miles from the Vienna Metro, a distance easily traversed by bicycle. Currently there is no clear connection or route to connect the two points. A large number of students, faculty, and staff commute to and from the Vienna Metro to Mason. The 2010 Census reports that the City of Fairfax had a population of 22,565 [1]. Mason's Fairfax campus has a total student enrollment of 29,969 with 5,179 faculty and staff. Eighty Percent of the student population lives off campus. With such a large influx of students, faculty and staff commuting to the City of Fairfax area, all forms of transportation must be considered. With around 30,000 Mason affiliates being transported to and from the Metro, during peak months, by the Mason Shuttle busses, and another 15,000 being transported by the CUE bus, its obvious that transportation demand between Mason and the Metro is extensive. Mason and The Vienna Metro stop have both increased their bicycle parking due to high demand from bicycle commuters. The Vienna Metro now has a bicycle parking capacity of 126 (as of January 2012) and George Mason has a capacity of 847, showing that both areas have a strong bicycle population.

Improving bicycle transportation would help mitigate traffic congestion, ease parking demand at Vienna Metro and Mason and improve safety for cyclists. In addition it would aid bicycle transportation along the entire route for city residents to Vienna Metro, Mason, local Parks, and shopping centers. Bicycle facilities have even been shown to have positive impact on the local economy[2]. We hope that this study presents ample evidence to show that a bicycle route to the metro will not only provide a logical connection from Mason to the Metro but, serve as backbone for bicycle travel in the City of Fairfax and a launching point for Central Fairfax to become a great bicycling region.

Potential Impacts

As bicycle conditions are improved to the Metro, it's expected that the increase of bicycle traffic will have positive benefits, not only on the riders themselves, but also for the community. Many positive impacts occur as a direct result of improved bicycle facilities.

-Reduced auto traffic congestion
-Reduced emissions due to automobile traffic
-Increased acceptability of bicycling as a viable means of transportation for everyday short trips
-Benefits to local businesses and the local economy through increased patronage
-Increased use and enjoyment of local parks and trails
-Increased opportunity to exercise as an integral part of one's daily activities
-Reduced crowding in Mason to Metro Shuttles and CUE busses during peak hours

Process

When researching potential bicycle routes it's important to consider travel conditions for all levels of cyclists and all types of bicycles. The suggested routes, were examined with regard to the average speed of cyclists, accommodation of commuter cyclists, and amenities for low-confidence cyclists. The following is the process for the analysis.

1. Riding was done at a casual pace (10-12mph)
2. Traversed each route multiple times in each direction
3. Collected GPS data for each ride
4. Analyzed GPS data for route improvements
5. Each was traveled during 4-6pm rush hour period
6. Riding was done on a road bike with wide tires
7. Bike was under an additional 20-40 pound load

Qualities considered

Below are the qualities considered when recommending and providing suggested infrastructure changes for the Mason to Metro bicycle routes.

1. Directness
2. Safety (Traffic, Terrain)
3. Amount of riding on bike paths (more is better)
4. Amount of riding on busy roads (less is better)
5. Amount of riding on residential roads (more is better)
6. Amount of riding on Sidewalk (less is better)
7. Number of high traffic road crossings
8. Elevation change
9. Non paved riding surfaces
10. Non lit paths
11. Areas that are closed after dark
12. Width of shoulder
13. Bicycle parking

Stakeholder Interviews

Kristin Haldeman (WMATA) September 2011

1. Current bike parking at Vienna Metro is currently very over capacity
   -66 bicycle parking spaces (this has increased since the interview)
   -96 bikes parked at station in May of 2011
   -31 of those bikes were not attached to racks. (handrails etc.)
2. Vienna has one of the highest bicycle riderships of any station
3. The projected rack spaces for Vienna are 332 for 2020 and 580 for 2030
4. According to Justin Antos of WMATA in 2007 the number of bicycles per day at Vienna was 75. He states that that number is based on a 4 year old sample and more current counts already show that 75 bikes per day is low and has already increased
5. WMATA intends to increase mode share by 2% by 2020 and by 3.5% by 2030
6. The WMATA is particularly interested in the first and last mile trips that are effected by bicycling
7. WMATA intends to put bicycle "cages" (enclosed bike parking areas) in the parking garages at Vienna

Mike McCarty (Fairfax City Parks and Recreation) Septemeber 2011

1. Informed me that there are plans to create a crossing on Picket road to connect Thaiss and Gateway parks. This may lead to one less road crossing if the Fairfax Parks route is used (trails subcommittee)
2. There are 21 miles of trails in Fairfax, 10 miles of which are designated trails (not on sidewalks or roads)
3. Mike has concerns about investing and building trail systems only catered to bicycle commuters and not for recreation
4. Informed me of the Snyder Trail project connecting Eaton Place off of 123 toDraper Drive that could have a large effect on the University Dr. Route and showed me the signage that will be used for that project

Mike Jaskiewicz and Brooke Hardin (Department of Community Development and planning) September 2011

1. They both expressed concern in having three routes to make improvements on and that one route should be chosen
2. The chosen path should then have a formal plan made for it
3. When any construction is done along the route it could be planned so that they have to include bike improvements and infrastructure in the design (ex. Bike racks and paths)
4. Mike had an idea that in areas don't have bike lanes or areas with low visibility (underpasses) a system of signs and lights could be devised to bring attention to motorists that a bicycle is on that stretch of road or path
5. Brooke expressed concern for liability stating that once crosswalks or sharrows are placed the users consider the city liable instead of riding at their own risk

Alex Verzosa (Transportation Director, Department of Public Works) September 2011

1. Discussed Old Lee Highway in detail and the challenges that were faced in the 2005 Old Lee Highway Transportation study
2. Residents of Old Lee Highway do not want to lose on-street parking in front of their houses. This caused challenges for the initial plan in 2005 to add turn lanes, a 10ft. Multi Use path, a sidewalk, and curbs and gutters.
3. Alex suggested that there is potential to find which areas are narrowest on Old Lee and have them widened to provide ample area on the road for bike lanes in conjunction with the Parks and Recreation path on the west side of the road.
4. Alex also suggested a meeting with Curt McCullogh after more plans had been finalized to discuss MUTCD standards for the signage and traffic crossings

Route Information

The next section describes each of the routes in detail, providing information on the distance of each route, the elevation changes, travel time, advantages and disadvantages, and the suggested improvements for the route. A map of each route is located the page opposite of each description, with the route traveled (in red) and the elevation profile at the bottom of the page.

Saintsbury Dr. Route

Distance: 4.72 Miles

Elevation:
Start: 393ft.
Max: 476ft.
Gain: 200ft.

Travel Time: 26.27

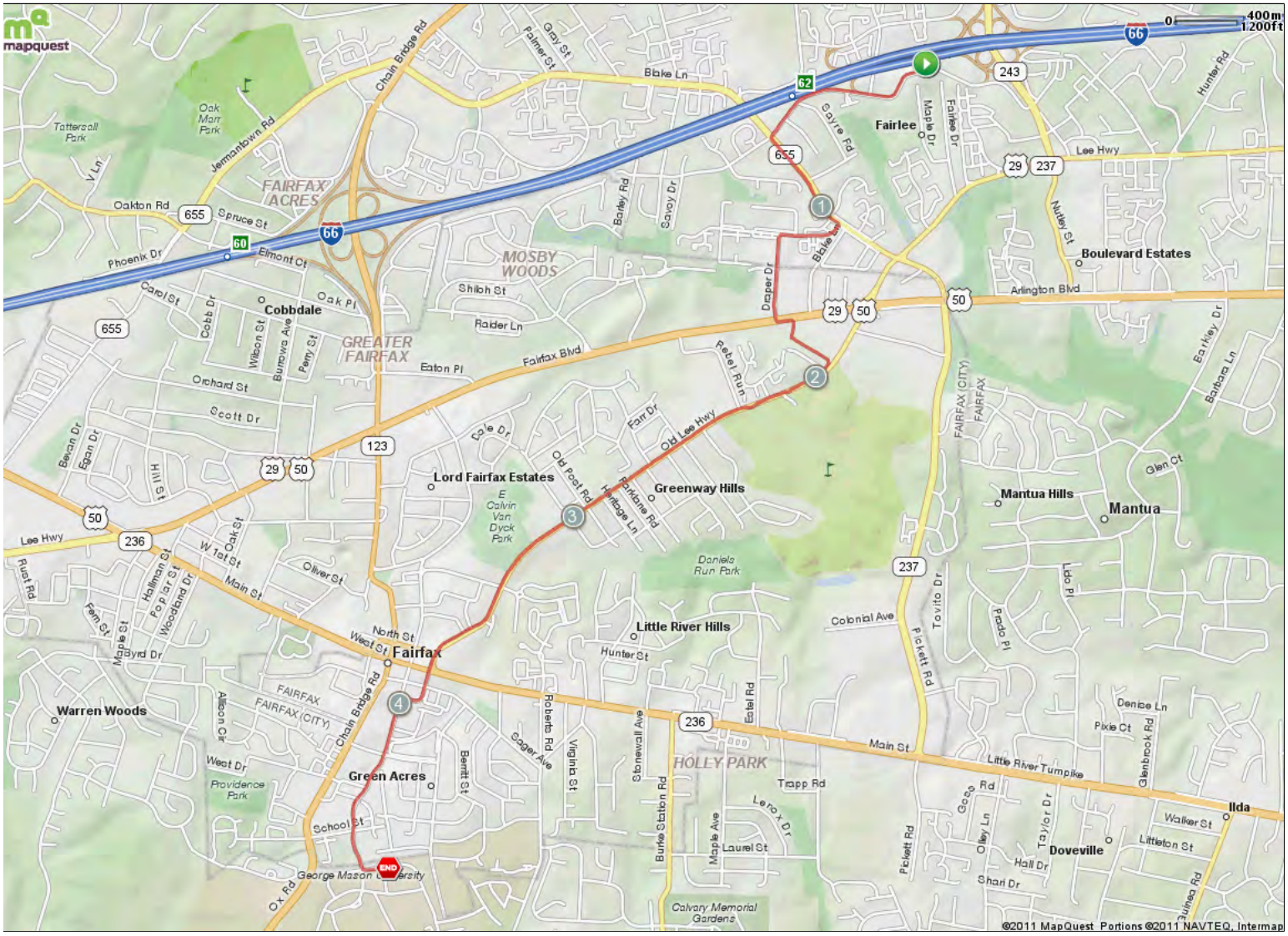
Advantages:
1. Very direct, fast
2. Easy to navigate
3. Route would be simple to sign
4. Fewer Infrastructure changes needed compared to other routes

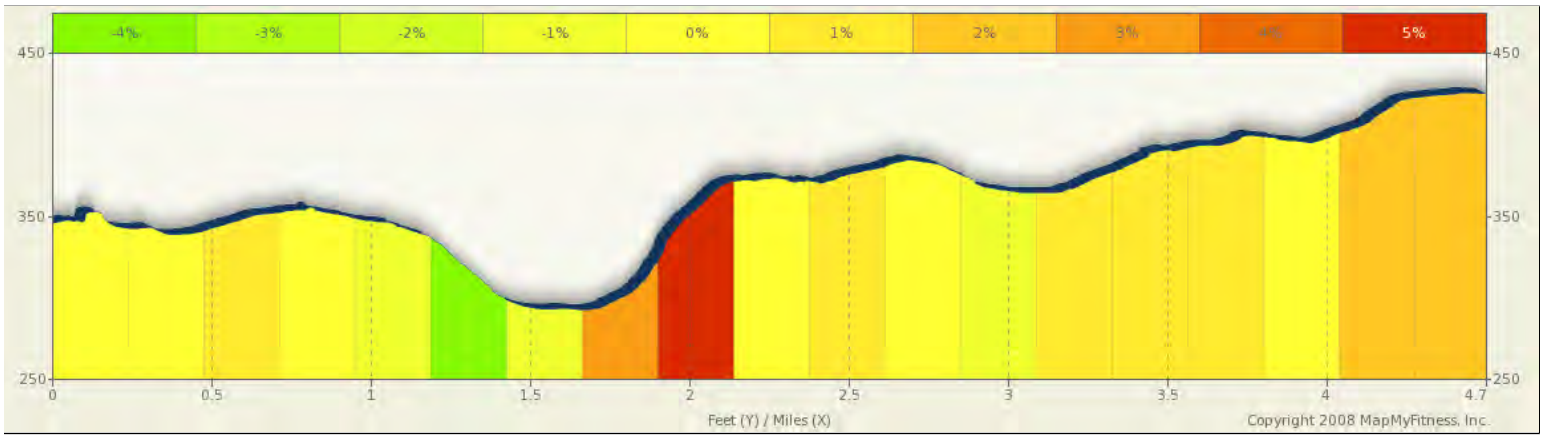
Disadvantages:
1. The most high traffic on road riding
2. Bike path is not paved
3. Bike path area is not lit or signed well
4. Infrastructure could be slightly more complicated compared to other routes

Suggested Improvements:
1. Put Sharrows or Bike Lanes on Old-Lee (see page 17)
2. Put Sharrows or Bike Lanes on Saintsbury Dr.
3. Install lighting and pave bike path on the Wilcoxson Trail connecting Route 50 and Old Lee Highway (page 17)
4. Post a bike/ped Crossing South of the Bridge on Old Lee Highway and/or pave a connection linking the Wilcoxon trail to the south side of Old Lee Highway
5. Put Bike Lanes on Blake Ln. or a Bike Path on one side of the road
6. Sign and time crossings at Blake Ln., and Route 50 for bicycles

Saintsbury Dr. Route

4.72 miles





University Dr. Route

Distance: 4.72 Miles

Elevation:
Start: 392ft.
Max: 479ft.
Gain: 167ft.

Travel Time: 23.33

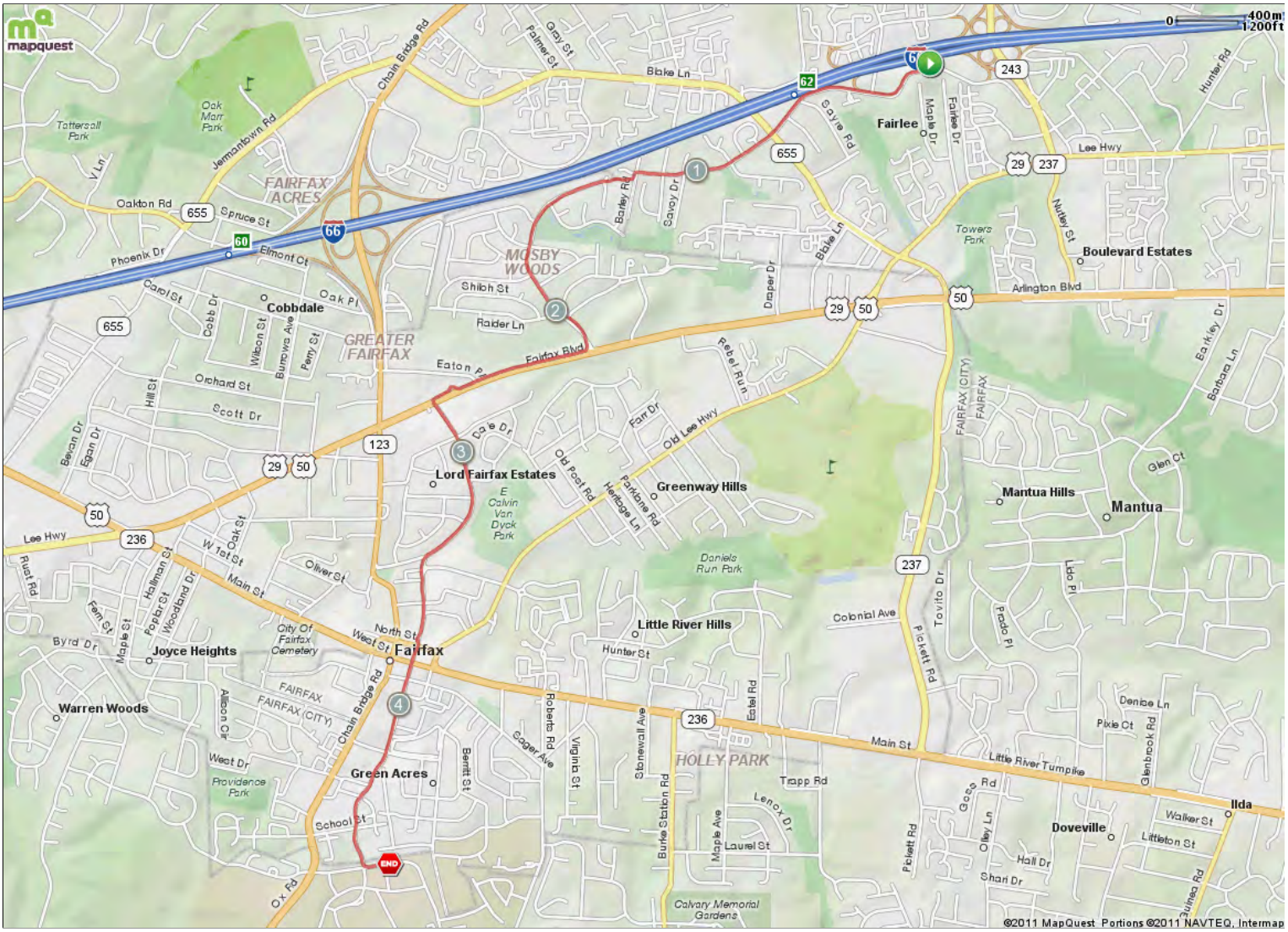
Advantages:
1. Easy to navigate
2. Very direct
3. One of the shortest routes
4. Most of the road riding is in residential areas

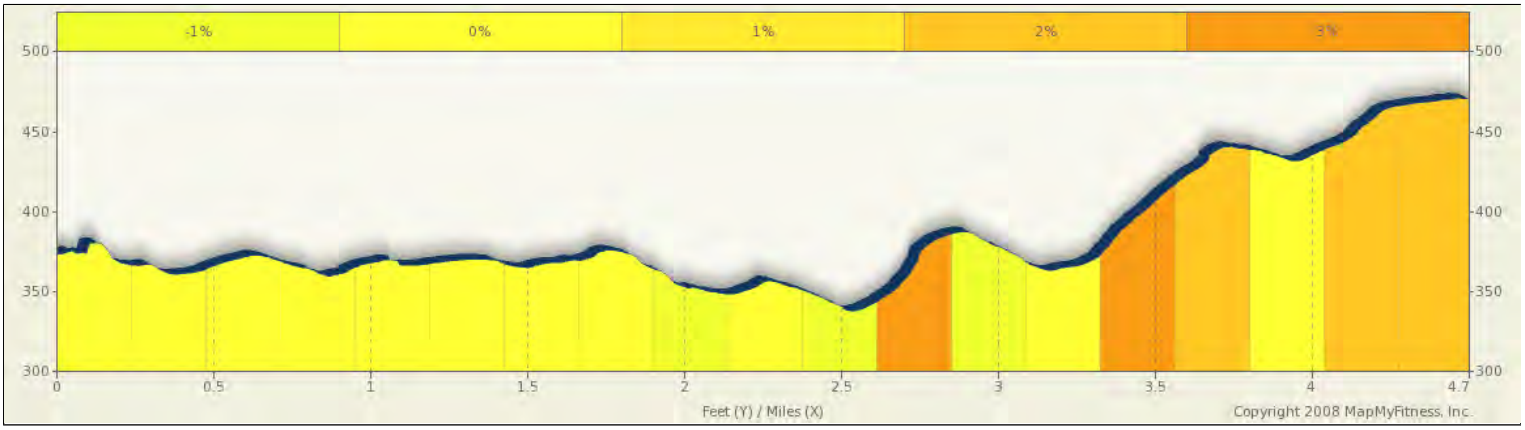
Disadvantages:
1. Crossing Rt. 50 Can be difficult
2. A lot of on sidewalk riding on Rt. 50
3. The bike path connecting Five Oaks to Plantation Pkwy. is hard to find, not well maintained and is prone to flooding,
4. There are a lot of small rolling hills
5. University drive in old town is very narrow

Suggested Improvements:
1. Sharrows or Bike Lane on Saintsbry Dr.
2. Clearly Sign Plantation Pkwy. and Five Oaks Connecting trail
3. Repave, clear connecting trail of debris, and fix drainage
4. Create a clear place for bicycles to cross Rt. 50, either at University Dr. or Plantation Pkwy. with crossing signs and lights
5. Make traffic signals crossing Rt. 50 sensitive to cyclists
6. Widen sidewalk on Rt. 50 to accommodate cyclists
7. Sharrows on University Dr. Connecting to George Mason Boulevard

University Dr. Route

4.72 miles





Fairfax Parks Route

Distance: 4.93 Miles

Elevation:
Start: 392ft.
Max: 476ft.
Gain: 230ft.

Traveling Time: 31.49

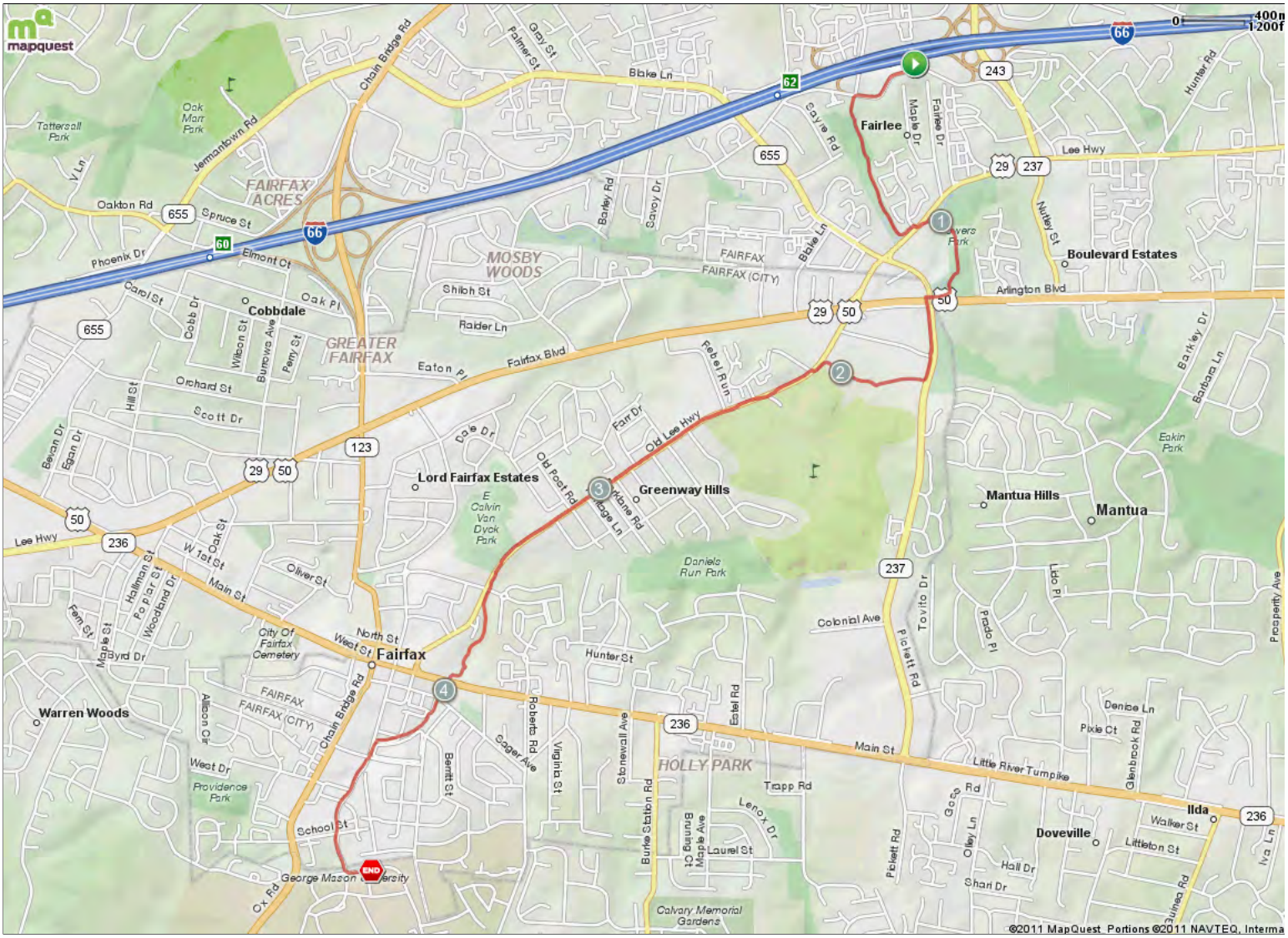
Advantages:
1. Route is very safe
2. There is much less on road riding than the other routes
3. It showcases the many parks in Fairfax
4. Most of the bike paths are in good shape
5. The route detours around some of the larger elevation changes

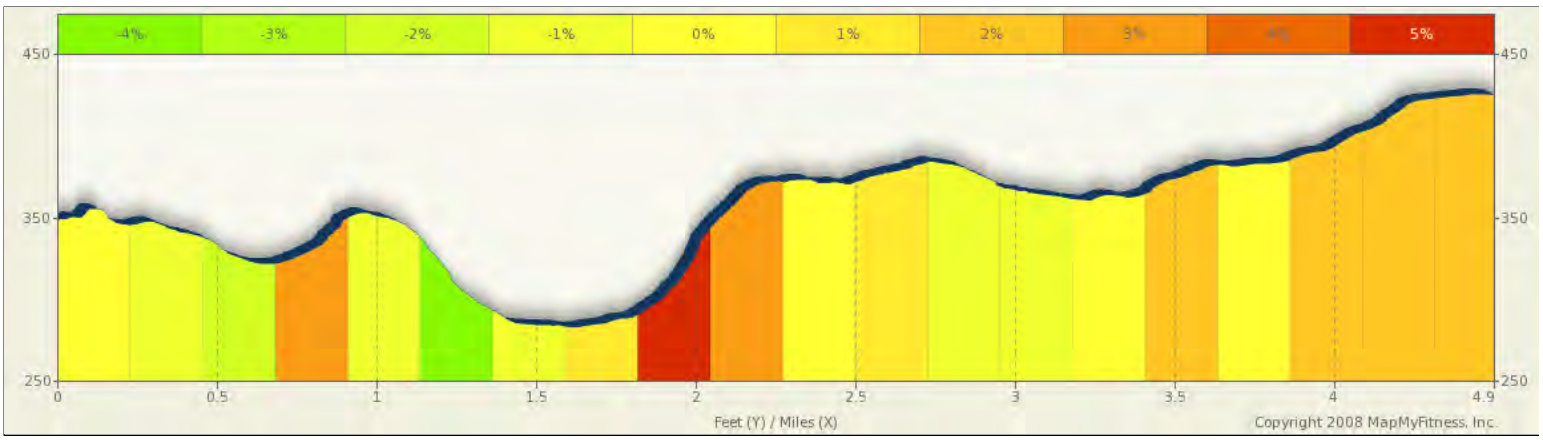
Disadvantages:
1.There are many decision points on this route
2. The route is slightly longer than the other two
3.There are 6 road major road crossings (Compared to 3 or 4)
4. There are a few bike path maintenance issues
5. It would require more signs
6. There are two broken pedestrian crossing buttons (crossing 29 and 236)

Suggested Improvements:
1. Maintenance on bike paths
   -Rough pavement, and low hanging branches on the path connecting Breckinridge and Sager Ave.
   -Rough pavement on Accotink Creek Park Trail
   -Large cracked pavement where East Blake Ln. Park meets Circle Dr.
2. Time, and sign bike crossing at Circle Woods Dr.
3. Where Towers Park Trail meets Rt. 29 connect trail to Merge lane and put bike lane in the Merge Lane (see photo on page 18)
4. Sharrows or bike lanes on Old Lee Highway
5. Change or connect path in TJ Maxx parking lot (page 16)
6. Time signals at Picket and Rt. 50 to allow for easier crossing

Fairfax Parks Route

4.93 miles





Supplementary Maps

These supplementary maps supply additional information not provided on the other maps or route descriptions. The bicycle level of service (BLOS) map shows the VDOT classifications, from 2009[3], for bicycle level of service of roads involved in the Mason to Metro route research. The Highway Capacity Manual defines levels of service (LOS) as "...qualitative measures that characterize operational conditions within a traffic stream and their perception by motorists and passengers."[4] Factors used to determine BLOS include, speed and travel time, freedom to maneuver, comfort/convenience, and traffic interruptions. Bicycle level of service is measured from A to F (including E); A being the most desirable and F being the least. The majority of the roads with available BLOS data that are included in the study are a level D, except for a small section of University Dr. which is a level C. Bicycle paths are not included in the BLOS data provided by VDOT.

Bicycle Level of Service Map

Key:
Green = C
Yellow = D
Orange = E

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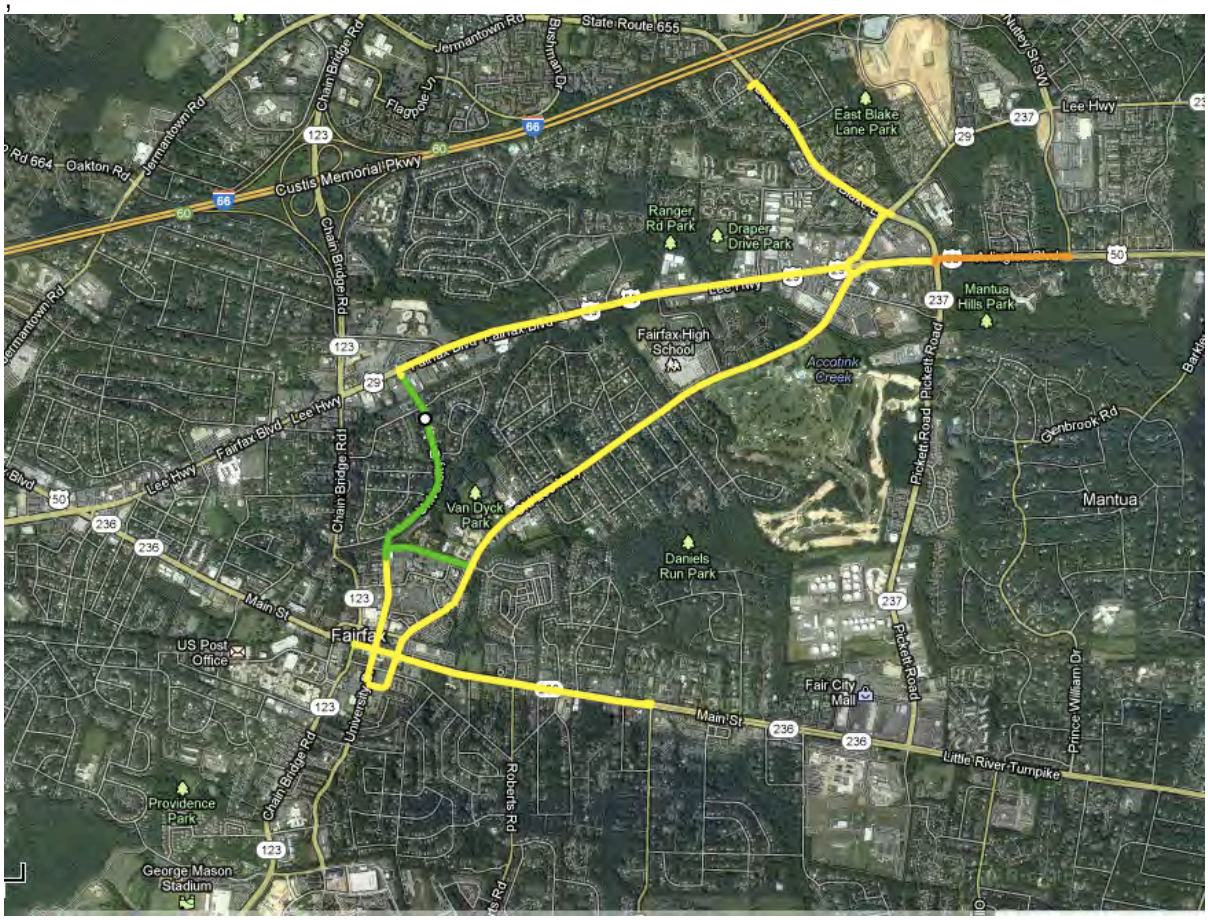


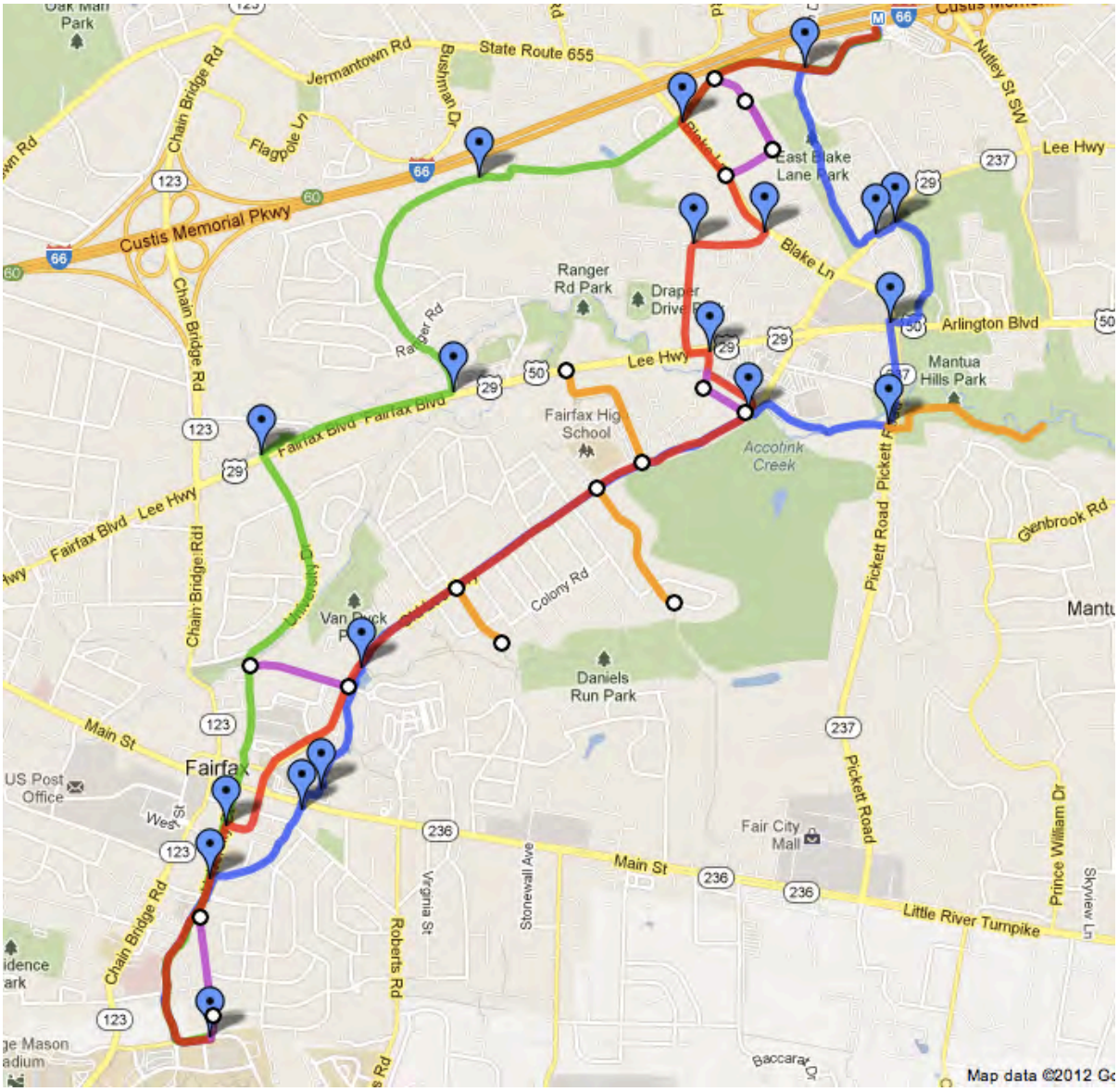
Mason to Metro Route Overlay Map

The Mason to Metro Overlay Map shows where all of the routes intersect and overlap, provides arterial routes from neighborhoods (in orange), and alternative routes (in purple).

Green Route = University Dr. Route
Red Route = Saintsbury Dr. Route
Blue Route = Fairfax Parks Route
Purple Routes = Alternative Routes
Orange Routes = Additional arterial roads to the routes

The blue markers all represent Major decision points on the routes.

The QR code above opens the Google map on your smart phone



Use http://g.co/maps/2f2kj to view the interactive map online.

Implementation

The implementation section of this project details the costs of the infrastructure changes detailed in the route information sections, provides a suggested implementation strategy, shows an example of a map handout for the route, and has photographs detailing some of the suggested changes.

One of the areas of the route already bicycle friendly, George Mason Boulevard.

Suggested Infrastructure Changes price list

The spreadsheet on the next page shows an itemized list of each infrastructure improvement sorted by route, and then builds on them by providing an estimated cost, where it lies in the county or city, the level of priority, critical dimensions, and total sums for each route. These estimated costs were provided by Erik Backus, of George Mason University, using MUTCD standards and the most recent costs available.

Mason to Metro Suggested Infrastructure Changes

#	Priority	Location/Route	Mason/ City/ County Area	Description	Critical Dimensions/Information	Est. Cost of Improvement
Overall Changes					*Sum*	*$ 57,920*
1	5	*Overall Changes*	City/County	Make parks along commuter routes open to commuter cyclists after dark	Take down/modify signage that indicates parks/trail closed at dark (or modify enforcement)	$ 170
2	5	*Overall Changes*	City	Create a clear signage package for all routes	Assume one sign every 250 ft, routes are 4.71, 4.72 and 4.92 mi long. Need approximately 105 signs per route (single route cost is $19,250)	$ 57,750
George Mason					*Sum*	*$ 1,100*
1	2	*George Mason*	Mason	Create a connection from George Mason Boulevard to the University Dr. bike lanes when making a left turn	60' of marking	$ 170
2	2	*George Mason*	Mason	Finish Bike Lane on the south side of University Drive at the George Mason Boulevard Intersection	150 yards of marking	$ 930
Saintsbury Dr. Route				*Route is 4.72 mi*	*Sum*	*$ 332,730*
1A	2	*Saintsbury Dr. Route*	City	Put Sharrows on Old-Lee	30 Sharrows, total length of 6500' spaced at approximately 250' apart and at intersections	$ 12,980
1B	2	*Saintsbury Dr. Route*	City	Put Bike Lanes on Old-Lee	Road Length of 6500'	$ 36,440
2A	2	*Saintsbury Dr. Route*	County	Put Sharrows on Saintsbury Dr	15 Sharrows, total length of 3000' spaced at approximately 250' apart and at intersections	$ 6,500
2B	2	*Saintsbury Dr. Route*	County	Put Bike Lanes on Saintsbury Dr	Road Length of 3000'	$ 18,620
3	1	*Saintsbury Dr. Route*	City	Install lighting and Pave bike path Connecting Route 50 and Old Lee Highway	Trail length 1000', lights every 100'	$ 42,000
4	6	*Saintsbury Dr. Route*	City	Post a bike/ped Crossing sign South of the Bridge on Old Lee Highway	2x signs	$ 440
5	2	*Saintsbury Dr. Route*	City	Time and Mark Crossing South of the Bridge on Old Lee Highway		$ 2,790
6A	2	*Saintsbury Dr. Route*	County	Put Bike Lanes on Blake Ln.	2000' length	$ 9,350
6B	2	*Saintsbury Dr. Route*	County	Put a Bike Path on one side of the road on Blake Ln.	2000' length	$ 202,290
7	2	*Saintsbury Dr. Route*	County	Sign and time Crossing's at Blake Ln. and Route 50 for Bicycles	2x signs and Programming	$ 1,320
Fairfax Parks Route				*Route is 4.92 mi*	*Sum*	*$ 438,860*
1	1	*Fairfax Parks Route*	County	Maintenance on bike paths: Rough Pavement, and low hanging branches on the path connecting Breckinridge and Sager Ave	20 yards long	$ 6,090
2	1	*Fairfax Parks Route*	County	Maintenance on bike paths: Rough Pavement on Accotink Creek Park Trail	10 yards long	$ 3,100
3	1	*Fairfax Parks Route*	County	Maintenance on bike paths: Large cracked Pavement where East Blake Ln. Park meets Circle drive	5 yards long	$ 1,600
4	2	*Fairfax Parks Route*	County	Time, and sign bike crossing at Circle Woods Dr	2x signs and Programming	$ 1,320
5	2	*Fairfax Parks Route*	County	Where Towers Park Trail meets Rt. 29 connect trail to Merge lane and put bike lane in the Merge Lane (see photo)		$ 27,330
6A	2	*Fairfax Parks Route*	City	Put Sharrows on Old-Lee	30 Sharrows, total length of 6500' spaced at approximately 250' apart and at intersections	$ 12,980
6B	2	*Fairfax Parks Route*	City	Put Bike Lanes on Old-Lee	Road Length of 6500'	$ 36,440
7	1	*Fairfax Parks Route*	City	Change or connect Path in TJ Maxx Parking lot	Add pathway, re-work crossing, see photos, Estimate is very rough.	$ 350,000
University Dr. Route				*Route is 4.71 mi*	*Sum*	*$ 344,320*
1A	2	*University Dr. Route*	County	Put Sharrows on Saintsbury Dr	15 Sharrows, total length of 3000' spaced at approximately 250' apart and at intersections	$ 6,500
1B	2	*University Dr. Route*	County	Put Bike Lanes on Saintsbury Dr	Road Length of 3000'	$ 18,620
2	3	*University Dr. Route*	City/County	Clearly Sign Plantation Pkwy. And Five Oaks Connecting Trail	2x signs	$ 440
3	4	*University Dr. Route*	City/County	Repave, clear bike path of debris, and fix drainage	700 feet	$ 131,510
4	2	*University Dr. Route*	City	Create a clear place for bicycles to cross 50, Either at University Dr. or Plantation Pkwy with crossing signs and lights		$ 2,790
5	2	*University Dr. Route*	City	Make traffic signals crossing 50 sensitive to cyclists		$ 930
6	2	*University Dr. Route*	City	Widen sidewalk on 50 to allow cyclists	2750' of widening	$ 182,070
7	2	*University Dr. Route*	City?	Sharrows on University Dr. Connecting to George Mason Boulevard	5 Sharrows	$ 1,460

Priorities: 1 = Safety, Wayfinding and Aesthetics, 2 = Safety and Wayfinding, 3 = Safety and Aesthetics, 4= Safety, 5 = Wayfinding and Aesthetics, 6 = Wayfinding, 7 = Aesthetics

The Existing bike route leading from Brekinridge Ln. To Sager Ave, which is part of the Fairfax Parks Route.

Suggested Implementation Strategy

The spreadsheet on the following page shows the baseline improvements for different levels of infrastructure changes to make the routes bicycle friendly. Because of its already bike friendly nature, the Fairfax Parks Route is suggested for improvements first. The University Dr. route is not recommended for improvements until the other routes have had infrastructures improvements, because of the difficulty and costs of making Rt. 50 bicycle friendly. The recommended base is the suggested level of improvement that is both cost effective and will provide a clear, safe connection to the Metro for cyclists. The Low Cost Base column is what would be necessary to make a clear connection from Mason to the Metro although it may be sacrificing a level of safety; the costs in this column only apply to the Fairfax Parks Route and the general improvements. In the follow up phase improvements on the Saintsbury Dr. Route are started, and then in the Wow Phase the Saintsbury Dr. Route is finished and the more expensive and elaborate changes are completed to make the routes as safe and bicycle friendly as possible.

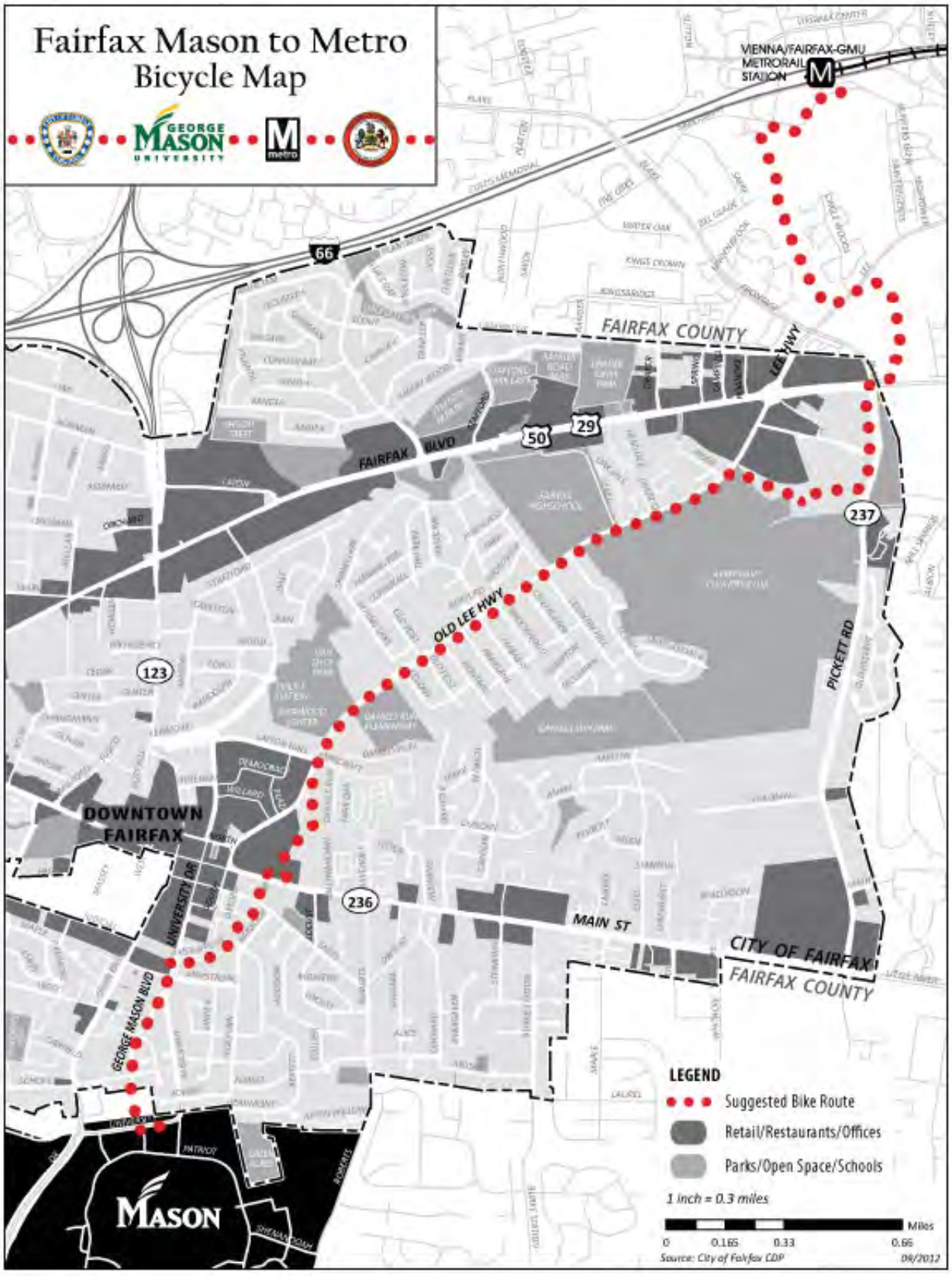
Mason to Metro Suggested Infrastructure Changes

#	Mason/ City/ County Area	Description	Low Cost Base	Recommended Base	Follow-up Phase	WOW Phase
Overall Changes						
1	City/County	Make parks along commuter routes open to commuter cyclists after dark	$ 170.00 x	$ 170.00 x		
2	City	Create a clear signage package for all routes	$ 9,625.00 x	$ 19,250.00 x	$ 19,250.00 x	
George Mason						
1	Mason	Create a connection from George Mason Boulevard to the University Dr. bike lanes when making a left turn	$ 170.00 x	$ 170.00 x		
2	Mason	Finish Bike Lane on the south side of University Drive at the George Mason Boulevard Intersection	$ 930.00 x	$ 930.00 x		
Saintsbury Dr. Route	*Route is 4.72 mi*					
1A	City	Put Sharrows on Old-Lee				
1B	City	Put Bike Lanes on Old-Lee			$ 36,440.00 x	
2A	County	Put Sharrows on Saintsbury Dr			$ 6,500.00 x	
2B	County	Put Bike Lanes on Saintsbury Dr				$ 18,620.00 x
3	City	Install lighting and Pave bike path Connecting Route 50 and Old Lee Highway				$ 42,000.00 x
4	City	Post a bike/ped Crossing sign South of the Bridge on Old Lee Highway				$ 440.00 x
5	City	Time and Mark Crossing South of the Bridge on Old Lee Highway				$ 2,790.00 x
6A	County	Put Bike Lanes on Blake Ln.			$ 9,350.00 x	
6B	County	Put a Bike Path on one side of the road on Blake Ln.				$ 202,290.00 x
7	County	Sign and time Crossing's at Blake Ln. and Route 50 for Bicycles				$ 1,320.00 x
Fairfax Parks Route	*Route is 4.92 mi*					
1	County	Maintenance on bike paths: Rough Pavement, and low hanging branches on the path connecting Breckinridge and Sager Ave	$ 6,090.00 x	$ 6,090.00 x		
2	County	Maintenance on bike paths: Rough Pavement on Accotink Creek Park Trail	$ 3,100.00 x	$ 3,100.00 x		
3	County	Maintenance on bike paths: Large cracked Pavement where East Blake Ln. Park meets Circle drive	$ 1,600.00 x	$ 1,600.00 x		
4	County	Time, and sign bike crossing at Circle Woods Dr	$ 1,320.00 x	$ 1,320.00 x		
5	County	Where Towers Park Trail meets Rt. 29 connect trail to Merge lane and put bike lane in the Merge Lane (see photo)	$ 27,330.00 x	$ 27,330.00 x		
6A	City	Put Sharrows on Old-Lee	$ 12,980.00 x			
6B	City	Put Bike Lanes on Old-Lee		$ 36,440.00 x		
7	City	Change or connect Path in TJ Maxx Parking lot				$ 350,000.00 x
University Dr. Route	*Route is 4.71 mi*					
1A	County	Put Sharrows on Saintsbury Dr				
1B	County	Put Bike Lanes on Saintsbury Dr				
2	City/County	Clearly Sign Plantation Pkwy. And Five Oaks Connecting Trail				
3	City/County	Repave, clear bike path of debris, and fix drainage				
4	City	Create a clear place for bicycles to cross 50, Either at University Dr. or Plantation Pkwy with crossing signs and lights				
5	City	Make traffic signals crossing 50 sensitive to cyclists				
6	City	Widen sidewalk on 50 to allow cyclists				
7	City?	Sharrows on University Dr. Connecting to George Mason Boulevard				
			$ 63,315.00	$ 96,400.00	$ 71,540.00	$ 617,460.00

Information provided by Eric Backus and Kevin Sitzman

Draft Map Handout

To promote the bicycle route, maps of the route will be made with locations of parks and local businesses. This map will be distributed at areas along the route, at local businesses, at government buildings, and online. Below is an example of this map. The red areas are businesses and the green are parks.



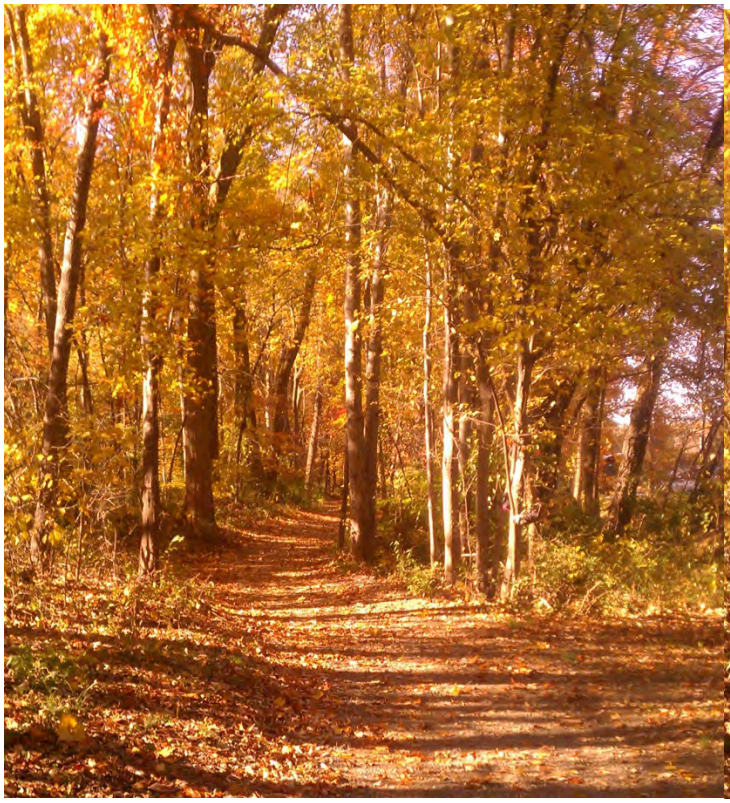
Map by: Kelly O'Brien

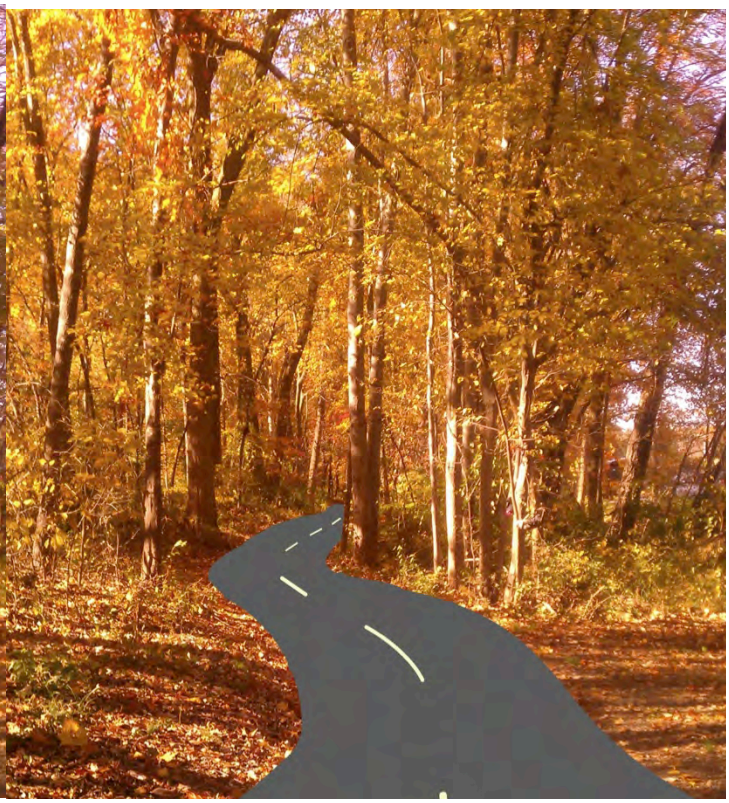
Infrastructure Detail Photographs

The following photographs show some of the infrastructure changes in detail, to further explain how they will look when completed.

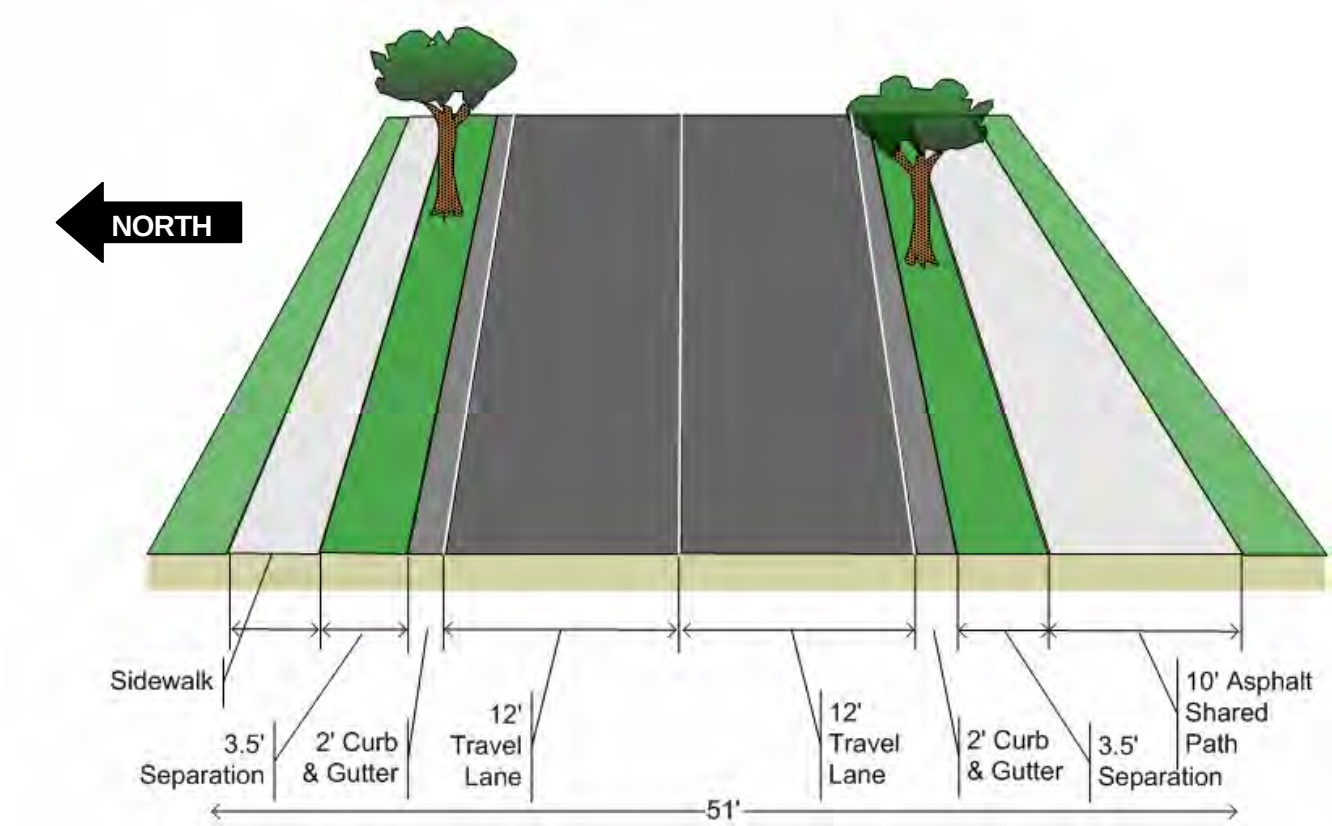
Above: The current lay out of The Main St. Marketplace. The blue line is the route tracked for the project.

Below: An Idea to help with pedestrian and bicycle traffic through The Main St. Marketplace. A crosswalk would be added to the east that would coincide with the pedestrian walk ways already in the parking lot. The Current traffic signal would also be moved to the east. Cyclists would then have the option to use the bike path or pedestrian paths to navigate the parking lot.





Above: The Wilcoxson Trail, connecting Old Lee Highway to Route 50 on the Saintsbury Dr. route, would be greatly improved by paving the current shared use path.
Below: A cross-section of Old lee highway (taken from the Old Lee Highway Transportation Study[5]) demonstrating an improved shared use path expanded to 10 feet wide.



Above: Where the Cross County Trail meets Route 29 Facing west. The example above would ease travel from East Blake Ln. Park to the Cross County Trail where the current sidewalk is very narrow.

Endnotes (sources)

[1] http://quickfacts.census.gov/qfd/states/51/51600.html

[2] http://www.bikeleague.org/resources/reports/pdfs/economic_benefits_bicycle_infrastructure_report.pdf

[3] http://www.virginiadot.org/programs/resources/NoVa2009.pdf

[4] http://ntl.bts.gov/DOCS/98072/ch01/ch01_03.html

[5] http://www.fairfaxva.gov/publicworks/old_lee_highway_study_092505part3.pdf