Appendix 5

Benefit-Cost Model: Description and Methodology

This appendix contains links to the Benefit-Cost Analysis conducted for the grant application, provides an overview of the overall methodology used, and then described the analysis for each of the seven project components in greater detail.

Model

The full benefit-cost model is an Excel spreadsheet developed by TPB staff for the proposed project. The model is available at the TPB TIGER application website: www.mwcog.org/transportation/tiger2011 Select the link "BCA Model."

The model includes all calculations, assumptions and citations.

Description

The model spreadsheet is organized as follows:

File Tab	Description
Summary	This tab contains the summary of analysis of the seven component projects. Two tables (for 3% and 7% discount rates respectively) summarize the costs and benefits of each project. Followed by a summary table and a table that summarizes all the statistical data (e.g., users, trips, accidents, etc.) Below that are the tables used to summarize the data from each component project.
Project Components	For each component project, there are two tabs (listed below). ▪ The first tab has the costs of construction at the top and repeats the population numbers and travel impacts. The five project selection criteria follow; each is broken down into various sub-items, and the costs or benefits are calculated for the appropriate populations. At the bottom the costs and benefits are sub-totaled. The two discount rates are then applied to the sub-totals. ▪ The second tab contains the user (and non-user) data that provides the population numbers for the analysis. Metrorail mode of access and travel demand model data are shown. Travel impacts are also calculated (e.g., changes in VMT, transit trips, etc.).

Fort Totten
- *FT*
- *FT Users*

Forest Glen
- *Forest Glen*
- *FG Users*

New Carrollton
- *NC*
- *NC Users*

West Hyattsville
- *WH*
- *WH Users*

Army-Navy Drive
- *A-N Drive*
- *A-N Users*

Rosslyn Circle Crossing
- *Rosslyn*
- *Ro Users*

VRE
- *VRE*
- *VRE Users*

Assumptions	Reviews the elements used to construct the model. In other words, who are the users and non-users, and what are the costs and benefits that need to be evaluated.
Mode Operating Assumptions	Summarizes cost and model data used to calculate typical trips, their length, speed and travel time, travel cost, and other travel factors. Accident rates are also calculated from regional data.
Price Assumptions	Values of time and emissions are listed, along with citations
Emissions Assumptions	Emissions factors are listed, as used in MWCOG's Mobile 6 model.

Overall Methodology

The benefit-cost model for the *Multimodal Access Improvements for Rail Station Areas in the Washington Region* TIGER application is based on a relatively simple framework of the project construction and O& M costs and of the costs and benefits of the projects in each of the five primary project selection criteria.

- The major costs are: capital, operations & maintenance (O&M), construction congestion, and increased accidents.
- The major benefits are: user cost savings, travel time savings, increased access, congestion reduction, emissions reduction, improved public health, and accident reduction.
- Each cost and benefit is assessed against the number of users and any non-users to calculate each total impact.

Users and Non-Users

The primary sources for the number of pedestrian and bicycle users accessing transit, current and forecast (no-build), are WMATA Metrorail statistics and forecasts of rail ridership. The *2007 Metrorail Passenger Survey* is a comprehensive assessment of mode of access at every rail station, including walking and bicycling. WMATA has forecast models (based on planned land use and station typology changes) going through 2030 which were used to develop baseline annual growth numbers for this application. Other WMATA data included parking numbers, percent of parking users living within close proximity to each station, and bicycle locker occupancy rates.

From the current and forecast (new build) users, new users are then developed based on the potential population for mode switch and an assumption on how many users could be induced to switch, based on the *2010 WMATA Metrorail Pedestrian and Bicycle Access Improvements Study* and the ranges for mode use for different station typologies. A similar calculation is made for users making induced trips (trips not previously made).

In addition, for some projects the jurisdictional agencies were able to supply additional pedestrian and bicycle survey or count data which were used to validate the WMATA numbers and or identify more accurate user numbers. For the Rosslyn Circle project, there was bicycle and pedestrian data available from studies done by MWCOG for VDOT. For the Fort Totten project, the planning materials also collected current user counts. For the Forest Glen project, mobility device users are calculated based on anecdotal estimates of device use at the station, as no survey has collected this data in a statistically significant way. For projects without additional data, there will be additional users benefitting beyond Metrorail customers, however these cannot be quantified.

Bikeshare use is calculated based on experience with bikeshare use rates for suburban areas, increasing over time as familiarity and acceptance of the system increase. Bike locker use is based on typical rail station bike locker occupancy rates, increasing over time as traveler knowledge and familiarity with the lockers increase.

Non-users are calculated for the projects that will have construction impacts on roadways (Forest Glen, Army-Navy Drive, and Rosslyn Circle Crossing) and are automobile trips. Regional travel demand model data for 2020, 2030, and 2040 provided raw Annual Average Daily Traffic (AADT) counts, which were used to calculate the affected non-users. These numbers were used in calculating construction impacts, and as a baseline from which VMT is reduced and fuel savings experienced as automobile users switch to other modes.

Construction and O&M Costs

The **capital cost** is the construction costs of the projects, including final engineering, utility re-location and other site preparation work, and infrastructure installation. Costs vary for each of the seven projects included in the application, and were provided by the respective project sponsors.

The **operations & maintenance cost** is presented for those projects that identified such costs. In most cases, there is no anticipated significant change in government or other source expenditures for the operations & maintenance of the improvements to be built under this application. Only the Forest Glen Metro Access and VRE Bicycle Locker projects have identifiable O & M costs. Maintenance of sidewalks and bake paths, upkeep and power supplies for crossings, and other improvements have no significant change in O & M costs.

Note: The Capital Bikeshare expansion proposed for the Arlington and the Forest Glen projects is considered operating cost-neutral. The first year of operation of this system in the Washington metropolitan region returned a slight operating profit. Whether this will change as the system expands, with both economies and dis-economies of scale stemming from that expansion, is unclear, as is whether any operating profit can fund capital replacement of bikes and stations as they reach the end of their useful operating life. Accordingly, there are no O&M costs or capital replacement costs included for the bikeshare components. Fees to make use of the bikeshare system are included in the user travel costs, but are not considered as revenue to be gained from the operation of the system.

Primary Selection Criteria Costs and Savings

The benefit-cost analysis model is organized in terms of the five primary selection criteria of the TIGER Discretionary Grant Program.

State of Good Repair

State of Good Repair impacts are not calculated in the model. Some improvements to be funded by the grant will lead to an improved State of Good Repair, including sidewalk and bikeway rehabilitation and replacement crossing signals for pedestrians. However, the physical infrastructure improvements have a relatively short life-time before maintenance requirements begin, while both physical and technological rehabilitation and replacement improvements have minimal costs for upkeep, leading to negligible savings. Accordingly, no analysis was found to be significant in determining any benefits or costs (due to construction impacts, again minimal) from the State of Good Repair improvements.

Economic Competitiveness

The primary factors considered in this criterion were User and Time Costs and Savings. Some improvements lead to travel time savings and reduced user costs. Other improvements lead to greater user time costs as users switch modes from faster autos to a combination of walk/bike and transit. In these latter cases, user cost savings outweigh the time costs, indicating the net benefit of the decision to switch modes.

User cost savings are a determination of the change in the direct per mile or trip user fees paid by travelers based on mode shifts among auto, transit (rail and/or bus), walk/mobility device, personal bike, and bikeshare. Assumptions behind this determination include average trip length (provided from the HHTS 2007/2008); vehicle operating cost, based on fuel costs, maintenance, repair, tire costs, and capital depreciation; average transit fares, based on average rail vs. bus trips, SmarTrip smart case usage, and fares; average taxi fares; and bikeshare user fees, based on likely percentage of members vs. day pass users. A parking fee assumption is also applied to all auto trips, which represents 50% (for a one-way trip) of the average daily parking cost at either a Metrorail station or in downtown DC.

Travel time savings are a similar determination that measures the time difference for bike trip shifted from another source. Assumptions behind this calculation include mode shifts, average trip length, average speed by mode (including an average transit wait time of 5 minutes), and value of time, which was taken from the NHTSA guidance.

Livability

Increased access is a determination of the benefit from trips taken that previously were not possible or worth the time or cost (i.e., new user induced trips). This benefit was calculated using a consumer surplus model, based on the difference between the user/time cost of the mode used and the automobile use alternative.

Congestion reduction is based on an assumption of the congestion relief benefit for each VMT reduced. This is therefore based on VMT reduction calculations and a congestion reduction value, taken from NHTSA guidance. VMT reduction calculations are based on the average trip length and trips shifted to the combination of walk/bike plus transit for a commute from auto, and auto and taxi to bike. For the bikesharing components, users were shifted from walk, personal bike, auto, and bus transit modes.

Environmental

Emissions reductions is a straightforward determination of reductions in VOCs, NO_x, $PM_{2.5}$, SO_x, and CO_2 based on average light duty fleet emissions rates from COG's Mobile 6 model used for air quality conformity and the VMT reductions described above, using the figures specified in the Notice of Funding Availability Appendix and/or the TIGER Benefit Cost Analysis Resource Guide (updated 2/1/12).

Improved public health is determined using assumptions taken from reports on active transportation, including the health care cost savings for people completing 30 minutes of daily exercise vs. those that currently do not ($20 per year), the percent of those bicycling or walking who do not meet activity recommendations (conservatively assumed to be 20%), and the average extra exercise time needed to meet the requirement (15 minutes).

Safety

Accident costs/savings are based on the current accident rate, projected changes in the number of users and their choice of modes, assigned values for different types of accidents, and the anticipated changes in safety from the capital improvements to be funded by this grant application. Accident rates were determined for automobile users based on accident and VMT data from the Virginia Department of Motor Vehicles, Maryland Office of Highway Safety, and the District Department of Transportation, based on an average across the past 10 years.

Accident rates were determined on a trip basis for pedestrians and bicyclists based on regional accident data for these modes (same sources and timeframe as for automobiles) and the number of trips for each mode obtained from the Household Travel Survey (HHTS) for 2007/2008, projected to 2011 use. As there is no regional calculation of pedestrian miles traveled or bicycle miles travelled, and as no change in miles per capita is anticipated for current, currently forecast, or new users of these modes, it was determined that accident rates per trip would be a reasonable assumption in calculating an accident rate for use in the analysis.

Reductions in pedestrian and bicycle accident rates were based on local experience, specifically the Montgomery County Pedestrian Safety Initiative: (http://www.montgomerycountymd.gov/dirtmpl.asp?url=/Content/dot/dir/pedsafety/index.asp).

Focused safety engineering efforts of projects similar to those of this application have witnessed accident reductions from 18% to 56%, depending upon the level of improvement, and as summarized in the CountyStat system. The Rosslyn Circle Crossing project also made use of the FHWA Highway Safety Improvement Program (HSIP) analysis to develop Crash Reduction Factors following implementation of the proposed improvements.
http://www.arlingtonva.us/departments/environmentalservices/cpe/capprojects/page63515.aspx

Based on the types of improvements assigned, reduced accident rates were assigned at a gross level to the improvements proposed in this application calculate the anticipated benefits to be realized. Accident rates also take into account new users and users switching modes, so that automobile accident numbers decline for the overall project. The increase in bicycle and pedestrian activity, on the other hand, generates some increase in accident numbers and costs for these modes.

Additional Information on the Benefit-Cost Analysis for Specific Project Components

1. Fort Totten / 1st Place-Galloway Road Access Improvement Project

Input Data and Assumptions

Information was used from the extensive report completed for this location, the District Department of Transportation (DDOT) "*1st Place and Galloway St, NE Transportation Access Study and Improvement Plan, Final Report & Conceptual Design*", completed August 4, 2011. Detailed pedestrian counts and the projected costs and benefits of improvements are provided in the report and were used for the modeling of this project. The report is available here: http://www.tooledesign.com/forttotten

Data Limitations

There is extensive development underway and planned for this area. While previous forecasts were used for future user projections, it is likely that this area will experience considerable additional growth that has not yet been captured in local planning.

2. Forest Glen Metrorail Access Project

Input Data and Assumptions

Extensive pedestrian counts and safety data have been recorded for the location of this project, at the intersection of Forest Glen Road and Georgia Avenue, which has been a subject of study since 2001. Montgomery County Department of Transportation provided pedestrian movement, vehicle flow/volume, traffic signal impact, pedestrian travel times, and much other information. This leads to precise calculations for the benefit-cost analysis. As a tunnel project, providing a new entrance and pedestrian connection under this very busy and dangerous intersection, the project construction costs are considerable. Accordingly, the benefit-cost analysis was extended to fifty years (including a million-dollar refurbishment at year 40) to provide a project benefit-to-cost ratio and internal rate-of-return (IRR) that more accurately capture the long-term benefits of this investment.

Ninety-five percent of the pedestrians crossing at this road intersection are travelers accessing Metrorail. The primary benefit will be in safety. The location has an accident rate of 0.75 pedestrian accidents a year over the past five years. These accidents are anticipated to be eliminated by the construction of the separate grade crossing, leading to considerable savings in accident costs. In addition, separation of the pedestrian (and bicycle) mode from the road will also lead to considerable benefits in travel time for road non-users, as the signal cycle time taken up by pedestrian crossing will be significantly reduced, reducing automobile wait times and congestion as this highway.

In addition, a calculation was made for the potential benefits offered to mobility device users by this project. Currently such users have an excessively long detour enroute to the dominant trip generator, the Holy Cross Hospital to the east of the Metrorail station. Mobility device users coming from Metrorail have to travel the length of the parking lot heading west, before reaching street-level and being able to turn 180 degrees and head for the hospital. Beyond the considerable travel savings, the qualitative impact of having a direct path is likely to be considerable for this segment of users.

Data Limitations

This project connects two other pedestrian and bicycle improvements completed in recent years, heading east to the hospital and south under the I-495 Capital Beltway. The provision of this “missing link” is anticipated to lead to greater than currently projected use, but is not included in the analysis.

In addition, while assumptions were made for mobility device users, the little data available on such use leads to a modest estimate of the benefits of this project for such users. Given planned expansion at the hospital, the growing number of mobility device users nationwide, and the increasing cost of travel alternatives, the potential for considerably greater mobility device use, and consequent benefits, exists.

3. Pedestrian Safety Measures for the New Carrollton Metrorail Station

Input Data and Assumptions

The primary data source is WMATA Metrorail data, and the improvements funded are anticipated to have important benefits for the currently small percentage of users accessing the station by bicycle and foot. Future development is planned in this area, as well as the construction of the Purple Line light rail system, which could considerably increase activity.

Data Limitations

The primary limitation is the estimate of potential users, based on current data and forecasts, given the significant development planned for this area.

4. Rosslyn Circle Crossing Multimodal Access Improvments

Input Data and Assumptions

The data source for the Rosslyn Circle project is based on Arlington County's developed plans for this project, available at:
http://www.arlingtonva.us/departments/environmentalservices/cpe/capprojects/page63515.aspx

Proposed improvements will provide significant safety benefits for pedestrian and bicycle users, reducing accident rates (30%) and costs, based on an FHWA Highway Safety Improvement Program (HSIP) analysis to develop Crash Reduction Factors for the proposed improvements. Current bicycle and pedestrian user counts were taken from data collected for the Virginia Department of Transportation, and forecast based on WMATA's Metrorail Access Study projected ridership growth. Additional users are also anticipated to use the improvements, both new trips and switching from other modes.

One of the most significant impacts of this project is the forecast cost of congestion from proposed traffic signal modifications and roadway narrowing and lane removal. These changes will benefit non-motorized users but negatively impact auto users. This impact will vary by location, time of day, and the final modifications made to signal cycles, which will likely go through several adjustments. Based on the various LOS analyses (available via the link) an average 4.2 second delay for each automobile was used as a base assumption.

Data Limitations

Users are forecast based on current mode share and likely increases. This component project is only one part of the changes planned for this area, which could lead to more additional users than modeled.

5. West Hyattsville Metrorail Station Access Improvements

Input Data and Assumptions

The improvements at West Hyattsville include 500 feet of new sidewalk construction between the station and a large residential community to the south-east, and construction of a large bicycle storage center at the rail station. Users of both modes will benefit from the new sidewalk, saving travel time and reducing accidents (forecast at a 15% reduction for both modes). Increasing pedestrian and bicycle use is forecast.

Data Limitations

Users are forecast based on current mode share and likely increases, however there may well be a considerable latent market and additional users not captured that could lead to considerably greater use than modeled.

6. Army Navy Drive Multimodal Access Improvement Project

Input Data and Assumptions

Arlington County and the Federal Highway Administration (FHWA) conducted detailed counts of pedestrian activity in the project area in support of the 14th Street Bridge (I-395) Environmental Impact Study. The component project extends from the current improvements being undertaken by FHWA where Army-Navy Drive crosses under I-395 (Shirley Highway). These pedestrian counts, along with the mode of access information for Pentagon City, the most centrally located of the three Metrorail stations in proximity to the project, are used to calculate pedestrian and bicycle user numbers. Current bicycle use is already high in the area, but the construction of the bicycle track and the expansion of the

bikeshare system should lead to even higher numbers. Some improvements in bicycle user travel time are anticipated from the cycle track. While pedestrian and bicycle mode share is anticipated to increased, safety will also be improved, reducing accident numbers and costs. The improvements funded are anticipated to provide a 20% improvement in pedestrian safety and a 50% improvement in bicyclist safety.

Data Limitations

The area is currently in significant transition as the Department of Defense and the many ancillary businesses relocate across the region. WMATA Metrorail predictions currently forecast a decrease over time in users, which is used in the analysis. However, the potential for this area, with close proximity to the District of Columbia, well-served by three Metrorail stations and a VRE commuter rail station, and the planned regional growth could lead to greater use than predicted in future years.

7. Bicycle Lockers at Virginia Railway Express (VRE) Stations

Input Data and Assumptions

The benefit-cost analysis for this project component forecasts the benefits of having bicycle storage lockers available at eight commuter rail stations. User numbers are generated from the total number of lockers available and typical bicycle locker occupancy rates at other rail station in the region. The rate is presumed to grow over time as information on the lockers becomes more publicized and as growing development around these rail stations leads to greater bicycle use. The benefits of travelers using bicycle to access the commuter rail stations and make transit trips rather than drive include: reduced user costs, health benefits, automobile VMT reduction and environmental benefits. The most significant cost is the higher number of accidents and consequent accident costs associated with increased bicycle activity. There are no changes in travel time or costs due to the funded improvements themselves; these are only due to mode shift.

Data Limitations

User data is developed on a set of assumptions of use of the bicycle lockers, based on regional experience. An important factor affecting locker use rate is the price charged for the lockers. No price has been set, and accordingly there are no user costs for the lockers in the analysis, nor any revenues. If the lockers are offered at no-fee to customers, use rate would likely be higher. If a fee is charged, occupancy rates would be closer to those used in the model, but no such costs or revenues were included. Given the lack of data on locker costs, and the relatively small impact, it was determined to leave consideration of these factors out of the analysis.