Improving Safety for All Users on Martin Luther King Drive

February 2012

DELAWARE VALLEY REGIONAL PLANNING COMMISSION

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The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

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Executive Summary

This project addresses safety concerns for pedestrians and bicyclists on Martin Luther King Drive (MLK Drive) from the Art Museum to Falls Bridge. The Philadelphia Streets Department developed a conceptual reconfiguration of the road and asked DVRPC to evaluate its feasibility in terms of traffic and safety. DVRPC performed field work collecting data, worked with Philadelphia stakeholders, developed a computer model, and researched best practices.

The challenges to safely accommodate more bicyclists and pedestrians on MLK Drive fit into three categories:

1. The bridge between MLK Drive and Eakins Oval does not function as a connector between MLK Drive and the Art Museum.

2. The Schuylkill River side path is difficult to access from intersecting roadways, such as Montgomery Drive and Sweet Briar Drive, and too narrow to accommodate multiple users at some points.

3. The road as currently configured is unwelcoming to cyclists.

DVRPC has developed a set of recommendations to address these challenges:

1. Improve the MLK Drive Bridge to increase access to the entire off-road system on the west side of the river. Reconfigure and upgrade this section of the road and path with traffic calming, path expansion, sidewalk repair, lane markings, and signage for wayfinding.

2. Create access points and link the side path to key intersections and park gateways, and improve the width and surface of the path to accommodate multiple users.

3. Reconfigure vehicle lanes for traffic calming and install protected bicycle facilities where possible for safe on-road cycling.

DVRPC developed a microsimulation model of MLK Drive in order to analyze the impact of various road configuration alternatives. Results indicate that a road diet would result in slower traffic speeds and some delay, though this may be both acceptable and desirable in some locations.

Any improvements to the path or on-road facilities will only be accessible if MLK Drive Bridge functions as a better connector between MLK Drive and the Art Museum. Once access to MLK Drive over MLK Drive Bridge is addressed, the city may choose to focus on either the path or on-road facilities, depending on a variety of constraints. Recommendations may be bundled strategically depending on different investment priorities, funding opportunities, and road capacity requirements.

Introduction

In June 2009 Mayor Michael Nutter requested that the Mayor's Office of Transportation and Utilities, Streets Department, Philadelphia Commission on Parks and Recreation (Fairmount Parks Commission), and City Planning Commission evaluate options to improve the safety of Martin Luther King Jr. Drive for all users. **This project was developed to address safety concerns for pedestrians and bicyclists on MLK Drive from the Art Museum to Falls Bridge.**

Why MLK Drive?

MLK Drive is an important destination for recreational cycling, walking, and jogging for Philadelphians of all ages and abilities. In addition, it connects Philadelphia's western neighborhoods and suburbs to Center City through Fairmount Park. However, as they are currently configured, MLK Drive's road and shared use path do not meet the needs of a broad range of cyclists.

Philadelphia's Streets Department has developed a conceptual reconfiguration of MLK Drive to accommodate on-road cycling. DVRPC explored the feasibility of this and several alternative plans through site visits, a road safety audit, vehicle counts, and the use of VISSIM microsimulation software to assess traffic impacts of redesign.

Figure 1: MLK Drive and path

Source: DVRPC 2011

Related Work

As DVRPC has scoped, refined, and moved forward with this analysis of MLK Drive bicycle and pedestrian safety, Trevor Booz, a Master of Engineering student at the University of Delaware, conducted his own research and analysis. Mr. Booz completed his thesis, *Modeling the Effects of Removing Motorized Vehicle Lanes to Create Space for Bicycle Facilities: A Case Study of MLK Drive Philadelphia, PA* (Booz, 2011).

Mr. Booz chose his thesis subject for many of the same reasons that DVRPC and planning partners at the City of Philadelphia developed the project. In discussions with the City of Philadelphia and the Bicycle Coalition of Greater Philadelphia, MLK Drive was identified as an important local route in need of improvement for bicycle safety. Mr. Booz also notes that while research about innovative bicycle facilities and road diets for traffic calming have received individual attention in recent years, there is very little information about implementing both road diets and bicycle facilities together. The literature review included in the thesis provides a comprehensive summary of bicycle facilities and safety strategies, which may be a useful resource for local and regional development of bicycle facilities.

Several important and common bicycle safety issues are addressed in this literature review. These provide guidance and best practices that are relevant to MLK Drive and the adjacent path. The following list summarizes several points that should be considered when choosing the most appropriate design for path and on-road facility improvements in Philadelphia:

- Advanced cyclists may not require special infrastructure for safety, but most cyclists are less confident adults or ride with children; a Federal Highway Administration (FHWA) report recommends that bicycle routes should be carefully selected and designed to accommodate these non-advanced riders.
- The main safety concern with shared use paths is conflict between the different user groups, especially in cases where the path does not provide room for passing. Two-way paths should be a minimum of 10 feet wide. High-volume locations should be between 12 to 14 feet wide.
- When a shared use path is located directly adjacent to the parallel road, with little physical separation from the on-road vehicle traffic, it is perceived as less safe by non-advanced cyclists.
- Sharing lanes with cars can discourage less confident cyclists.
- Shared travel lanes can be good for cyclists when vehicle speeds are less than 30 miles per hour, but are less suitable as speeds increase.
- Bicycles encounter conflict with motorists when cyclists on the right side of the road travel straight through the intersection and motorists to the left of the cyclists turn right.

Summary Points

This project was developed to address safety concerns for pedestrians and bicyclists on Martin Luther King Drive (MLK Drive) from the Art Museum to Falls Bridge. The Philadelphia Streets Department developed a conceptual reconfiguration of the road and asked DVRPC to evaluate the feasibility in terms of traffic and safety. DVRPC visited the site, worked with Philadelphia stakeholders, developed a computer model, and researched best practices.

At the same time, a graduate student at the University of Delaware conducted his own research and modeling and shared his findings and thesis with DVRPC. This thesis included a comprehensive literature review, with a focus on safety and perceived safety issues for on- and off-road bicycle facilities. Two points relate directly to MLK Drive and the shared use path: **the main safety concern with shared use paths is conflict between different user groups, especially when the path is not wide enough for passing; and bicycle routes should be carefully selected and designed to safely accommodate non-advanced riders.**

CHAPTER 2

Issues and Recommendations

Defining the Challenges

The challenges to safely accommodate more bicyclists and pedestrians on MLK Drive fit into three categories:

Challenge 1: MLK Drive Bridge does not function well as a connector between MLK Drive and the Art Museum.

Challenge 2: The shared use path is difficult to access from intersecting roadways such as Montgomery Drive and Sweetbriar Drive and too narrow to accommodate multiple users at some points.

Challenge 3: The road is unwelcoming to cyclists as currently configured.

Challenge 1: MLK Drive Bridge does not function well as a connector between MLK Drive and the Art Museum.

MLK Drive Bridge, which connects MLK Drive to the Schuylkill River Trail and the road leading to Eakins Oval, is an important link in the riverfront bicycle and pedestrian network. Unfortunately, this section of the network is perceived by many users as an obstacle to MLK Drive access. This comes down to two basic problems. **First, the design is focused on vehicle users and does not safely accommodate cyclists and pedestrians.** This is especially problematic on weekends, when MLK becomes a recreation destination and volumes of cyclists and pedestrians are often high. **Second, the link between MLK Drive and the Schuylkill River Trail paths is confusing, as it does not appear continuous across MLK Drive Bridge.**

Figure 2: Bridge sidewalk

Source: DVRPC 2011

The sidewalk on the bridge is narrow and in poor repair. There is barely enough room for one direction of bicycle travel, let alone two directions for shared use, and the crumbling pavement reduces the functional width. The edge of the road shoulder is visible in Figure 2. This on-road pavement is uneven and not wide enough to accommodate cyclists.

The transition between the 10-foot-wide MLK Drive shared use path on the inbound side and the narrow sidewalk on MLK Drive Bridge is very abrupt, which leads many cyclists to assume that they no longer belong on the path and should use the road instead. Some inbound cyclists ride with traffic on the right side of the road, and others ride against traffic on the left shoulder adjacent to this sidewalk. There is no clearly defined space for the two directions of bicycle traffic on the sidewalk, and the current road conditions are inhospitable to most cyclists.

MLK Drive Bridge presents a choke point in the bicycle and pedestrian network, and the road conditions here are inhospitable to cyclists. Therefore, it does not function well as a connector. This gap in the system reduces access to MLK Drive and the many park amenities and other local connectors on the west side of the Schuylkill River. **If bicyclists and pedestrians cannot cross MLK Drive Bridge comfortably, MLK Drive cannot be utilized to its potential.**

Recommendations

Improving MLK Drive Bridge will require additional sidewalk width in order for the off-road space to function as a shared use path. It is also important to clarify the connection between the MLK Drive and Schuylkill River paths, and implement traffic calming along this section where the path is directly adjacent to vehicle traffic.

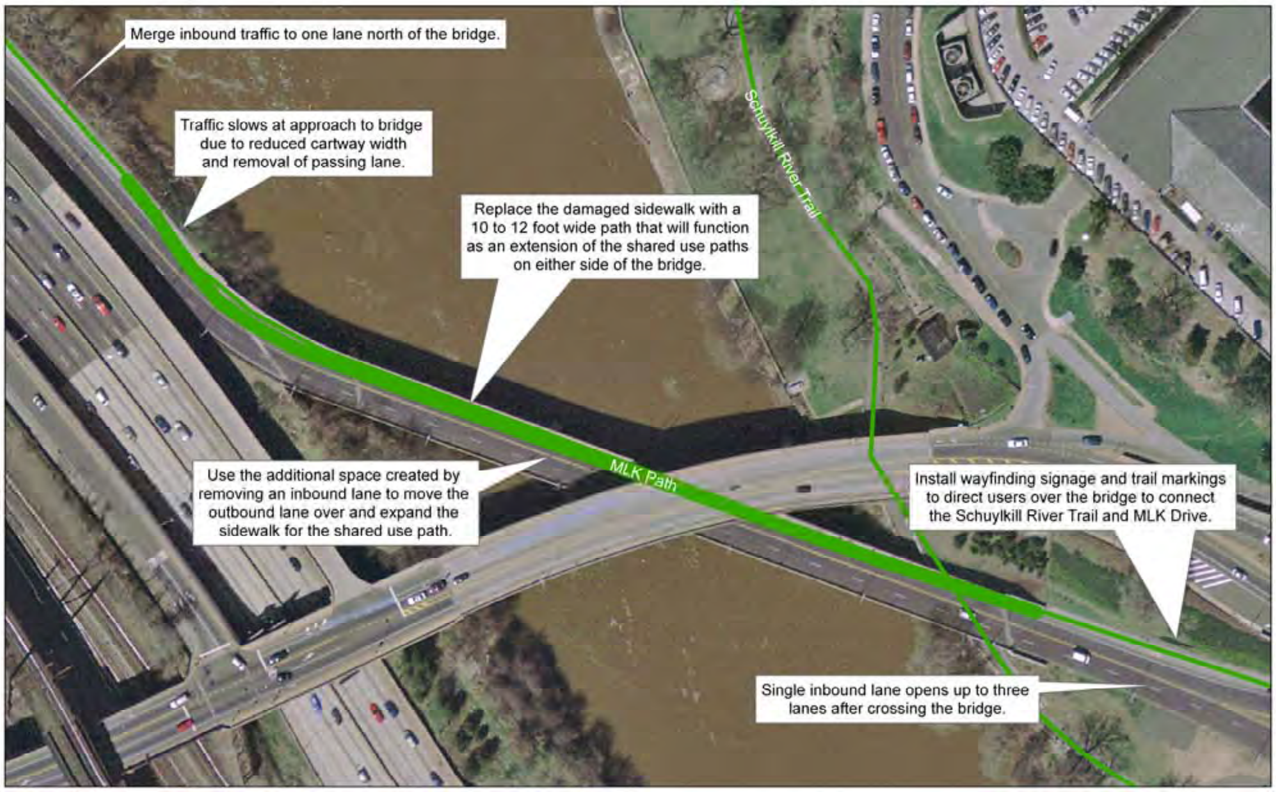
There are several approaches, which may be implemented individually as possible, or jointly for greater impact.

Repair the sidewalk. The current sidewalk is badly in need of repair, as the crumbling edges are a visual indication of neglect and reduce the functional width of the sidewalk. Because this narrow sidewalk is an extension of the shared use paths on MLK Drive and the Schuylkill River Trail, any reduction in width diminishes its utility.

Narrow the vehicle cartway to create space for the sidewalk to expand and function as a shared use path. By merging the two in-bound vehicle lanes into one lane south of the

Sweetbriar intersection, vehicle traffic will have to slow at the merge and maintain more moderate speeds over MLK Drive Bridge. The elimination of one inbound lane across the bridge will allow for the outbound lane to shift left and create additional shared use space on the north side of the road here. The traffic-calming effects of such a road diet will also create safer conditions for users on the adjacent shared use path. Depending on vehicle cartway requirements, the additional space could provide enough width for the sidewalk to expand to 10 to 14 feet, matching the connecting shared use paths and accommodating high volumes of pedestrians and cyclists. See Figure 3 for an annotated reconfiguration recommendation map.

Figure 3: Reconfiguration Recommendations for the MLK Drive Bridge

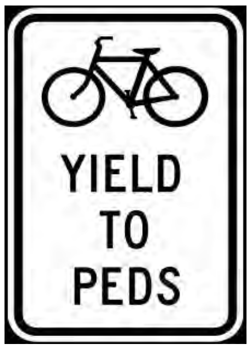


Source: DVRPC 2011

Because the inbound cartway opens up into three lanes immediately after the pedestrian signal on the east side of MLK Drive Bridge, this reduction in vehicle lanes poses little risk of congestion. DVRPC developed a microsimulation model to examine this alternative road configuration. See *Modeling Existing and Alternative Road Configurations* in Chapter 3 for more details.

Add signage to clarify that the sidewalk over MLK Drive Bridge connects the MLK Drive and Schuylkill River Trail paths, making the transition between shared use paths and the bridge sidewalk clear for all users. Inbound cyclists can use the sidewalk as an extension of the path to reach the Schuylkill River Trail. Outbound cyclists can be clearly directed from the Schuylkill River Trail to the MLK Drive path via the sidewalk. Signs along this path should direct cyclists to yield to pedestrians. The Manual on Uniform Traffic Control Devices (MUTCD) includes a wide variety of standard signs and pavement markings for bicycle facilities and wayfinding. Use standard lane markings and signage to reinforce pedestrian safety and clarify the bicycle route. “Yield to Peds” will remind cyclists on this narrow section of the path to share the facility. “Bike Route” will indicate to cyclists that the sidewalk is part of the shared use network, and that bicycles can use the sidewalk in this location.

Figure 4: Example MUTCD bicycle facility signs



Source: US Department of Transportation Federal Highway Administration, *MUTCD*

Summary

As currently configured, MLK Drive Bridge is a missing link in the riverfront network. This must be addressed in order to improve access to the entire off-road system on the west side of the river. Strategies include traffic calming, path expansion, sidewalk repair, lane markings, and signage for wayfinding.

Challenge 2: The shared use path is difficult to access from intersecting roadways such as Montgomery Drive and Sweetbriar Drive and is too narrow to accommodate multiple users at some points.

The shared use path adjacent to MLK Drive provides off-road access to the west side of the Schuylkill River, the MLK Drive counterpart to the Schuylkill River Trail north of the Art Museum. However, several factors make this amenity difficult to use: the path is disconnected from the road and difficult to access at intersections; the path is too narrow for easy passing and sharing among different users; the lack of a sufficient separation from the road places users uncomfortably close to high speed vehicle traffic; and the path pavement is uneven and unwelcoming to cyclists.

The shared use path is not well connected to important intersections. Easy access to the off-road path is essential unless the road configuration on MLK Drive is altered to create safer on-road riding conditions for cyclists. Transitions between the path and road can make this amenity accessible and relevant to a broad range of users. The Montgomery Drive intersection presents a problematic connection to the path because the path is below street grade at this intersection. Curb cuts here lead to grass rather than the path, and worn lines in the grass are visible where users have cut across to connect to the path.

Figure 5: Intersection of Montgomery Drive and MLK Drive, facing north from MLK Drive

The narrow curb cuts on the path-side of this intersection lead to grass. This section of the shared use path is at a lower grade than the street (to the right beyond edge of frame), so a direct connection is not possible. The crosswalks can only be accessed by taking a stairway up to street grade, and crossing over grass.

Source: DVRPC 2011

Figure 6: Worn grass between MLK Drive and the shared use path, facing south from the Montgomery Drive intersection

Because there is no convenient access from the crosswalk to the shared use path, cyclists and pedestrians have worn a trail in the grass to connect to the path where it is closer to street grade.

Source: DVRPC 2010

The Sweetbriar Drive intersection is also somewhat disconnected from the path, with only a few narrow curb cuts on the north side of the intersection connecting to the road at sharp angles. Because the road and path are at the same grade at this intersection, improvements are simpler than at Montgomery Drive.

Figure 7: Intersection of Sweetbriar Drive and MLK Drive, facing north from MLK Drive

Source: DVRPC 2011

This section of the path is adjacent to and at the same grade as the street and would require only minor improvements to connect at the intersection. However, as it is currently configured, cyclists have very little opportunity to transition between the street and the path.

Several sections of the path are directly adjacent to MLK Drive, which brings pedestrians and cyclists very close to the fast-moving traffic on the roadway. As noted in Chapter 1, **shared use paths with little separation from on-road vehicle traffic are perceived as less safe by non-advanced users.** This is most problematic south of Sweetbriar Drive, where vehicle volumes are highest.

Figure 8: Shared use path adjacent to MLK Drive, facing south, south of Girard

Source: DVRPC 2011

Vehicles travel at high speeds on MLK Drive, making the path's proximity to road traffic uninviting. A physical barrier at intervals along this path could formalize the separation between road and path, making this section of the path more user friendly to cyclists of all skill levels.

The path is the only appropriate bicycle facility for non-advanced cyclists between the Art Museum and Falls Bridge on the west side of the Schuylkill River. However, once users make it onto the path, several new challenges reduce overall accessibility. **The path is too narrow for**

easy passing between pedestrians and bicyclists, especially when users approach from opposite directions. The current dimensions and state of repair on the path do not accommodate multiple users. This leads to congestion when volumes are high, especially on weekend afternoons between Sweetbriar Drive and the Art Museum, when the path provides access to the car-free section of MLK Drive north of Sweetbriar Drive.

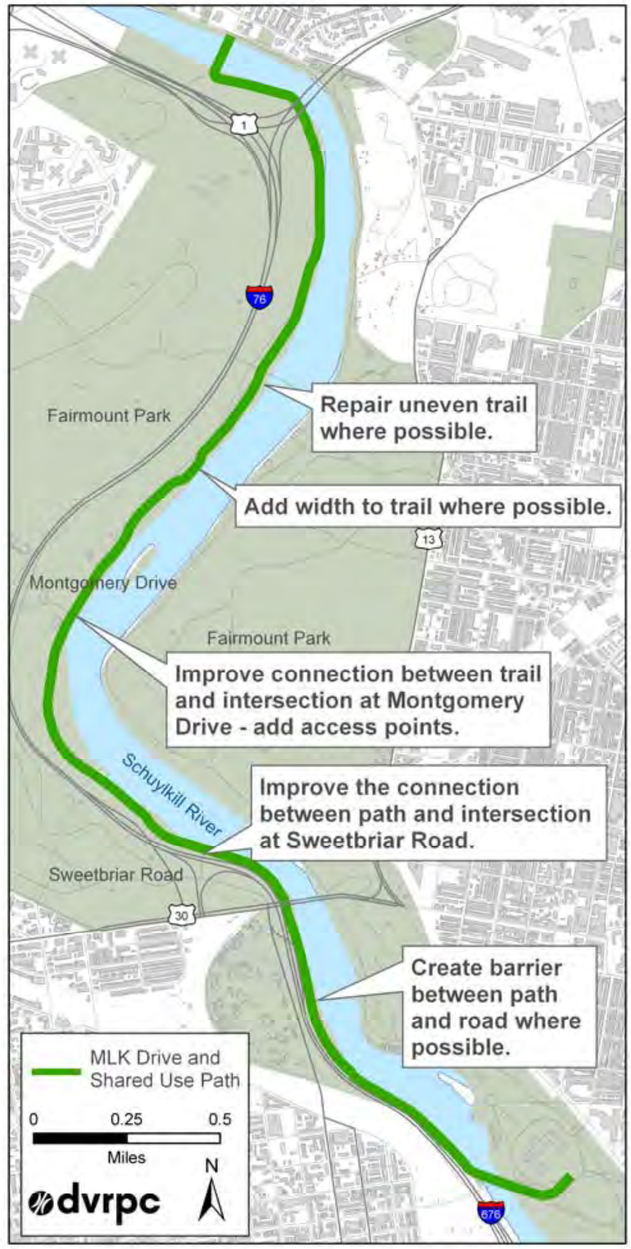
Much of the path is in very good condition. **However, at many locations along the path, the pavement is pushed up by tree roots, making the surface uneven and unwelcoming to bicyclists.** These conditions limit the overall utility for all cyclists.

Recommendations

There are several ways in which the path can be improved to function effectively for all users. The shared use path should be accessible at several points along the road, allowing for smooth transitions from intersections and the bridges at either end of the path, the pavement should be wide enough for different user groups to share the space safely, and the pavement should be smooth for comfortable riding. Any combination of these strategies, implemented according to scheduling and funding opportunities, will make the path more inviting and functional for all users.

Access to the trail from points along MLK Drive is problematic. To remedy this, improve access from the road, especially at intersections and gateways to the west side of Farimount Park. Montgomery Drive and Sweetbriar Drive are particularly important. At Montgomery Drive, where the path is at a lower elevation than the street, link the crosswalk to the main path with a paved connector. "Desire lines" can be used as indicators of a best path (see example at Montgomery Drive intersection in Figure 6). These unofficial trails worn into the grass by repeated use may inform design of connections to the street.

Figure 9: Path improvement recommendations



Source: DVRPC 2011

At Sweetbriar Drive, where the path is adjacent to the street, the improvement is easier: widen curb cuts enough for turning bicycles to access the path from the intersection, and use wayfinding signage to formalize the connections at intersections; expand curb cuts to the full width of the intersection for increased flexibility and access.

Use bicycle and pedestrian signals at controlled intersections to enhance bicycle and pedestrian safety and rationalize traffic movements.

Figure 10: Crosswalk and path at Sweetbriar Drive intersection

Source: DVRPC 2010

The current configuration of the Sweetbriar Drive crosswalk includes only one formal crossing, with very narrow curb cuts. In order to function for higher volumes and multiple user groups, formalize bicycle and pedestrian crossings at this intersection with wide connections to the path.

Add additional traffic calming devices at key access points without signals, such as the Strawberry Mansion Bridge ramps and Black Road, in order to provide safe pedestrian and bicycle infrastructure beyond the edges of the path. These locations are recreation gateways and provide access to the west side of Fairmount Park. Vehicle users on MLK Drive must be aware of crossing cyclists and pedestrians at points other than Sweetbriar Drive and Montgomery Drive. Additional signage, activated lights to indicate the presence of pedestrians, wide speed bumps, or other pedestrian safety tools should be installed.

Conflict between bicyclists and pedestrians is the most important safety issue on shared use paths. The existing 10-foot-wide path meets minimum standards for a two-way facility, but does not accommodate high volumes or provide adequate space for passing during peak recreation hours. **Add width to the path where possible in areas free of utilities and trees.** While it is not necessary or practical to widen the entire path, expanding sections of the path will add enough space to create informal passing lanes and reduce congestion and conflict between approaching users. Such an improvement will make the path more functional for users of all speeds.

Figure 11: MLK Drive path, just north of Sweetbriar Drive, facing north

Expand the width of the path as much as possible, depending on grade changes and the location of trees and utilities. Additional width, even for sections of a few hundred feet in length, will create enough space for an informal passing lane to accommodate users of many speeds and will reduce congestion.

Source: DVRPC 2011

Finally, repair uneven pavement on the path where possible. Maintain the path surface in order to create a viable alternative to on-road riding. This will make the path more attractive to all cyclists, including those advanced and intermediate cyclists who prefer to travel at higher speeds.

Summary

The path is difficult to access from important intersections and recreation gateways and does not accommodate multiple users. Create access points to link the path with key intersections and park gateways and improve the width and surface of the path to accommodate multiple users.

Challenge 3: The road is unwelcoming to cyclists as currently configured.

With two south/east-bound lanes, and one to two north/west-bound lanes, this road provides ample space for high volumes and high speeds of vehicle traffic. The ease of passing allows the fastest vehicles on the road to set the pace of traffic. Fast-moving traffic running parallel on I-76 adds to the highway-like conditions where MLK Drive is adjacent to the interstate. **The posted speed limit for most of MLK Drive is 35 miles per hour, but the 85th percentile speed is 53 miles per hour, which is an indication of the designed speed of the road.** High retaining walls and the curving road combine to create poor visibility in several locations.

Signage currently in place prohibits cyclists from riding in the road during peak commute hours, and the shoulders are too narrow to accommodate cyclists in many locations. **High speeds, poor visibility, and narrow shoulders combine with fast driving to make this road unwelcoming for on-road cycling.**

Figure 12: MLK Drive at the Girard Avenue Bridge, facing south

This section of MLK Drive adjacent to I-76 is very unsafe for cyclists as currently configured. The highway-like design, ample space for passing, and long distance between traffic signals allow for high speed driving. The curving road and high retaining wall reduce visibility for both drivers and cyclists.

Source: DVRPC 2011

Figure 13: Road signs along MLK Drive explicitly prohibit on-road cycling during peak commute hours

Source: DVRPC 2010

The intersections along MLK Drive are very busy during peak commute hours and present a potential zone of bike-car conflict when cyclists on the right side of the road travel straight through the intersection and motorists to the left of the cyclists turn right. On MLK Drive this common safety concern is exacerbated by on-road conditions that allow aggressive driving. Therefore, adding standard bicycle lanes to the shoulders on MLK Drive does not address safety concerns or create an environment that is welcoming to non-advanced cyclists.

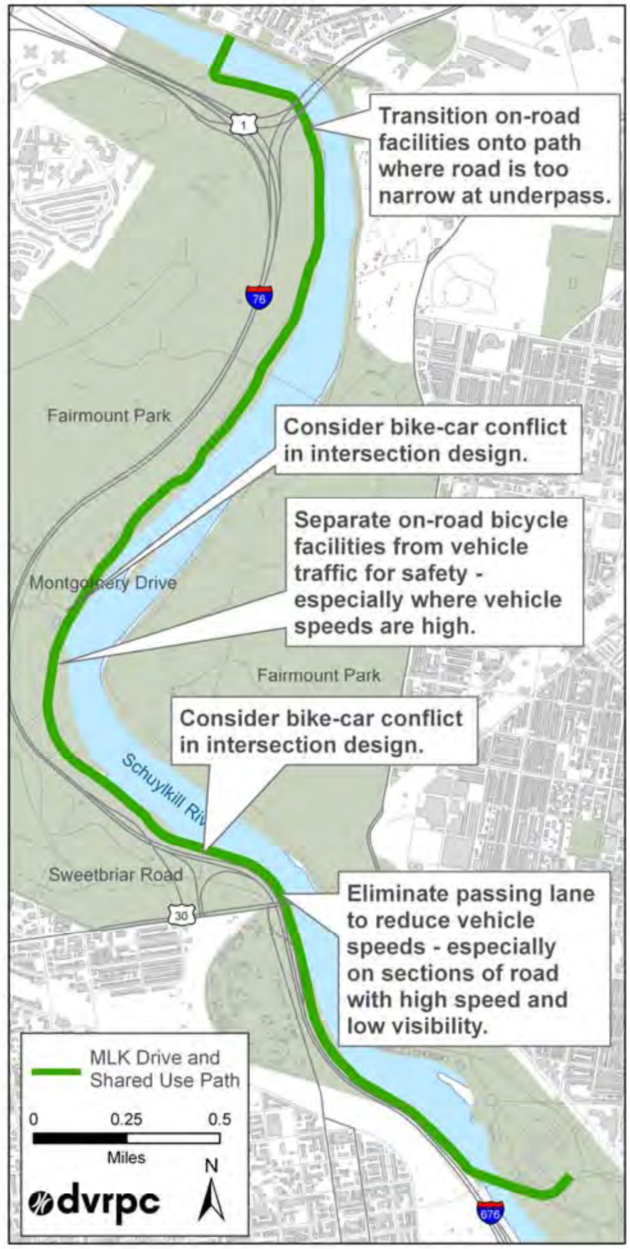
Recommendations

The current configuration of MLK Drive encourages high-speed driving, which is not safe for on-road cycling. With ample space for passing and long stretches of open road between traffic lights, MLK Drive provides highway-like conditions through the park. **Successful on-road bicycle facilities require a focus on traffic calming to create a safe environment for cycling.**

Implement a road diet to reduce opportunities for speeding. The current in-bound lane configuration allows the fastest car to set the speed. A reduction to one lane would allow the slowest car to set the speed and would prevent reckless and aggressive drivers from passing cars that travel at the posted 35 miles per hour speed limit. A partial road diet to slow traffic and create additional space on the road, should be considered, even if the entire length of MLK cannot be treated this way. For example, maintain current capacity at intersections with two lanes and merge to one lane between intersections to control speed and reduce weaving.

The design, location, and type of facility chosen must be carefully considered because marked bicycle facilities will direct cyclists of all skill levels to use the road. Safety is a primary factor in selecting an appropriate facility. Sharing lanes with cars can discourage less confident cyclists, and sharing travel lanes is not appropriate on roads with vehicle speeds above 30 miles per hour.

Figure 14: Road improvement recommendations



Source: DVRPC 2011

A separated two-way cycle track would protect on-road space for cyclists and eliminate both bike-car and bike-pedestrian conflict. The river-side of the road, with only occasional parking lots and no through cross traffic, presents an ideal location for a cycle track. Both directions of bicycle traffic would be located on the river side of the road to avoid conflicts with turning vehicles and at intersections and to more clearly define the separation between bicycle space and vehicle space. See the examples below in Figures 15 and 16.

Figure 15: Two-way cycle track in Montreal

This two-way cycle track in Montreal is separated from vehicle traffic with flexible bollards. The facility is wide enough for comfortable passing without conflict between approaching cyclists.

Source: West Windsor Bicycle and Pedestrian Alliance, http://wwbpa.org/tag/intercap/

Separate on-road facilities can provide a comfortable route for cyclists and eliminate conflict with motorists. **Cycle track designs are customizable depending on available space, budget, and aesthetic preference.** On roads with high speed vehicles, a buffer is recommended to formalize the separation from traffic, protect cyclists from aggressive vehicles, and prevent motorists from using the cycle track as a passing lane.

DVRPC recommends the international design standards summarized in Alta Planning's 2009 report, *Cycle Tracks: Lessons Learned* (www.altaplanning.com/cycle+tracks.aspx). Many of these design standards are based on international best practices outlined in the CROW Design Manual for Bicycle Traffic. CROW is a nonprofit organization in Europe whose mission is to distribute research and technology information about transport, infrastructure, and public space (www.crow.nl/english).

Specifications are based on international best practices, with an emphasis on safety and functionality. For best results, a two-way cycle track should be at least 12 feet wide to allow for comfortable passing. Minimum buffer width between the cycle track and road is based on the setting and speed of vehicle traffic, ranging from 3.6 feet with a physical barrier in a built up area, to five to eight feet on rural roads with 40 miles per hour traffic. If budget and road width allow, a raised and textured curbed median with a varied surface, such as cobblestones, may be appropriate. Alternatively, Jersey barriers may provide a comparable level of safety at a lower cost and within a narrower cartway.

Figure 16: Two-way cycle track in Brooklyn, NY, with enhanced Jersey barrier buffer

This two-way cycle track adjacent to the Brooklyn Navy Yard is a relevant example of protected on-road bicycle facilities. Both directions of bicycle traffic are effectively separated from the often high-volume, high-speed traffic with a standard-sized Jersey barrier that has been enhanced with context appropriate railing and decoration.

Source: DVRPC 2011

DVRPC's recommendations focus on creating the safest on-road facilities given the current traffic conditions on MLK Drive. The protected two-way cycle track addresses several safety concerns:

- High speeds and visibility concerns make placing bike facilities on the inbound side of MLK Drive difficult.
- Bringing both directions of bicycle traffic together on the river side of the road eliminates bike-car conflict caused by turning vehicles at intersections.
- The two-way cycle track design is flexible and can be customized according to constraints at each section of MLK Drive.

Other on-road facilities may be considered. Unprotected bicycle lanes may be an attractive option where road width and vehicle capacity requirements prohibit expanded bicycle facilities. However, if vehicle speeds and morning peak traffic volumes remain high, traditional unprotected bicycle lanes may not be appropriate on MLK Drive.

The following safety issues must be carefully evaluated before unprotected on-road bicycle facilities are installed on MLK Drive:

- Standard one-way bike lanes on the inbound side of the road do not reduce available passing and turning width as dramatically as a road diet, and therefore do not require motorists to modify their driving habits.
- Standard bike lanes do not protect cyclists from turning vehicles at intersections.
- Non-advanced cyclists will not be comfortable sharing the road with cars traveling at highway speeds.

- If bicycle lanes end abruptly at intersections in order to accommodate additional vehicle lanes, cyclists will be entirely unprotected in the zones of highest conflict.
- Inbound traffic follows a high and curving wall adjacent to I-76 south of Sweetbriar Drive where the reduced visibility leaves cyclists on this side of the road vulnerable and wedged between traffic and a wall.

Careful consideration must be given to the safety of all users if unprotected bicycle facilities are incorporated into a reconfiguration of MLK Drive. On-road facilities are less desirable than the current shared use path if cyclists will have to compete for road space with high speed vehicles. On-road and path volume counts conducted in December 2010 confirm this – nearly all cyclists choose to use the path over the road, even at a time of year when the majority of these users are advanced cyclists.

Summary

The current road conditions, including high speed traffic, create an environment that is unwelcoming and unsafe for roadway cycling. These issues may be addressed in a reconfiguration of MLK Drive in order to provide relevant and safe bicycle facilities. The best on-road facilities will provide cyclists with a protected right of way, free of conflicts with turning vehicles and aggressive drivers**. A two-way protected cycle track on at least a section of the river side of the road would create a positive cycling experience for users of all skill levels and contribute to traffic calming as a result of the accompanying road diet. Other options can be considered, but these may come with significant safety risks if vehicle speeds remain high. Alternative cycle track configurations are identified and analyzed in the next chapter.**

Modeling Existing and Alternative Road Configurations

This section briefly describes the software system, model elements, and computational procedures used to model traffic conditions along MLK Drive for this study. A step-by-step description of model development procedures can be found in Appendix A. This model simulates traffic conditions and signal operations on an average day during the AM peak hours, from 7:00 a.m. to 9:00 a.m. The simulated portion of MLK Drive extends from the Strawberry Mansion Bridge ramps to Eakins Oval. Descriptions and results of these alternative configurations are also discussed.

Software system

DVRPC employs a suite of modeling software developed by PTV Vision. This suite consists of two components: a macro-scale travel demand forecasting package (VISUM) and a micro-scale operations analysis simulator (VISSIM). PTV Vision originally developed this software for the dense transit systems found in many European cities, where it is the industry standard, and is equipped to accurately represent the complex travel decisions enabled by the Delaware Valley's multimodal transportation infrastructure. The DVRPC regional travel demand model (TIM 1.0) was recently converted to the VISUM platform and provided the basis for many of the inputs to this project's VISSIM microsimulation model, including intersection geometry, vehicle routes, and facility/turn volumes.

Model Elements

The general roadway characteristics and demand data from the TIM 1.0 model (including road network, facility/turn volume, and route choice data) were reviewed and given an initial calibration in the VISUM software. The study area was then "cut-out" of the larger model to create a smaller focused area model for enhancement with greater detail and exported to VISSIM for another round of calibration in the VISSIM software. The elements of geometry, traffic density, vehicle travel speeds, and signal control are discussed below.

Geometry

TIM 1.0 includes some of the roadway characteristics necessary for microsimulation modeling, such as the number of lanes, capacity, and a rough approximation of roadway geometry (nodes and links). After giving the geometry a thorough review, it was clipped from the regional model for more detailed attention. This smaller rudimentary model was enhanced using the VISUM software to include all intersections in the corridor, as well as detailed roadway geometry (lane movements, etc.). Finally, this focused network was exported to VISSIM, where roadway geometry was again enhanced at the intersection level, paying close attention to the number of lanes and length of turn pockets.

Traffic volume and routes

Estimating the volume of traffic was critical to accurately model AM peak commuting conditions in the corridor. DVRPC collected travel data along the corridor during the month of December 2010, and supplemented this data with historic counts from DVRPC's traffic count database, as well as those conducted by Trevor Booz. The data include a combination of automatic traffic recorder (ATR) counts and manual turning-movement counts. These counts are routinely processed by DVRPC's Office of Travel Monitoring, adjusted for consistency, and synthesized to accurately reflect travel conditions on an average day. Final hourly volumes were extracted from the daily counts to show the "peaking" nature of AM traffic density by selecting representative "control counts" and factoring the hourly vehicle inputs.

Vehicle travel speeds

Automobile travel speed on MLK Drive was measured using automated radar detector by the Philadelphia Streets Department between July 27 and August 3, 2009, between Black Road and Sweetbriar Drive. The results are shown in the following table:

Table 1: Travel Speed Data

		Speed (mph)	
		North	South
Percentile	15th	38	12
	50th	45	45
	85th	**51**	**53**
	95th	55	58

Source: Philadelphia Streets Dept, 2009

These data show that half of all vehicles (50th percentile) travel at 45 miles per hour or faster. The rule of thumb (from the Institute of Transportation Engineers) is that speed limits should be set at or near the 85^{th} percentile travel speed. The posted speed limit on MLK Drive is 35 miles per hour.

Signal control

Signal timing plans were provided by the Philadelphia Streets Department for signalized intersections in the study area. The signals are fixed-time controllers on a 60-second cycle.

Procedure

Each scenario was run a minimum of 10 times in VISSIM for five simulated hours during each run. The first two hours of simulation time are used for model development purposes. The third hour of simulation time “primes” the network with early morning traffic levels and lets vehicles enter the network before collecting data from the model. The model then runs for an additional two hours reflecting AM peak-period traffic volumes, during which time the model also collects output data and stores it in a Microsoft Access database. Each scenario was run in 10-iteration batches, and output data was averaged across all iterations.

Scenario Description

DVRPC simulated three alternative configurations to the current MLK Drive to test the impact of a road diet on traffic conditions. The alternatives describe a phased approach, rather than applying a single treatment to the entire corridor, to address the question “How much road diet is too much?”

A short description of the current roadway configuration and each alternative follows:

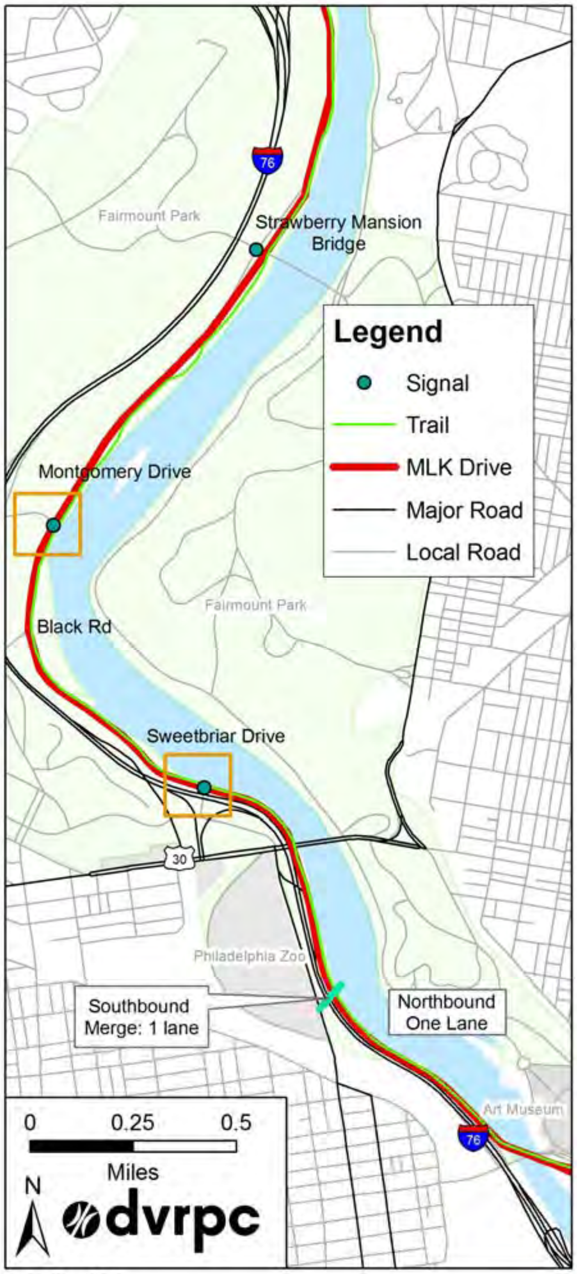
Current configuration

Northbound, MLK Drive consists of one (outbound) lane from the Art Museum toward Sweetbriar Drive, where it expands to two lanes approaching the intersection. Two lanes continue north from Sweetbriar Drive to Falls Bridge.

Southbound, MLK Drive consists of two inbound lanes from Falls Bridge to the Art Museum/Eakins Oval.

The Schuylkill River Trail follows the roadway from Falls Bridge to Eakins Oval, with varying degrees of separation and quality

Figure 17: Alternative 1



DVRPC, 2011

Alternative 1 – Bridge Safety

Alternative 1 maintains one northbound lane for the entire length of MLK Drive from Eakins Oval to Falls Bridge (instead of splitting into two lanes approaching Sweetbriar Drive).

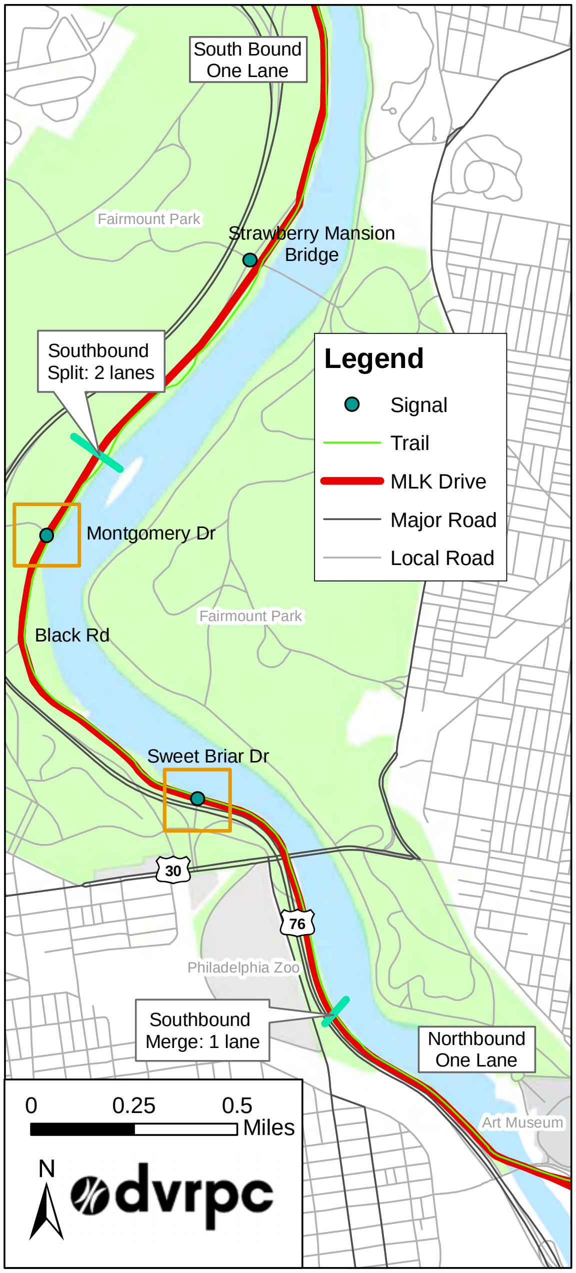
Alternative 1 retains the current two southbound lane configuration for the majority of the roadway until approximately 1,800 feet prior to the MLK Drive Bridge, where there is a merge into one lane crossing the river.

This results in a single travel lane in each direction crossing the MLK Drive Bridge and makes additional space available to enhance the shared bike/pedestrian path across the bridge. This path will replace the existing inadequate sidewalk, dramatically improving safety and access for all users.

Alternative 1a – High Volume

In response to comments from the Philadelphia Streets Department, DVRPC also developed an alternate demand scenario to simulate this configuration under heavy traffic conditions. This scenario is intended to test the bridge merge on the worst travel days of the year.

Figure 18: Alternative 2



DVRPC, 2011

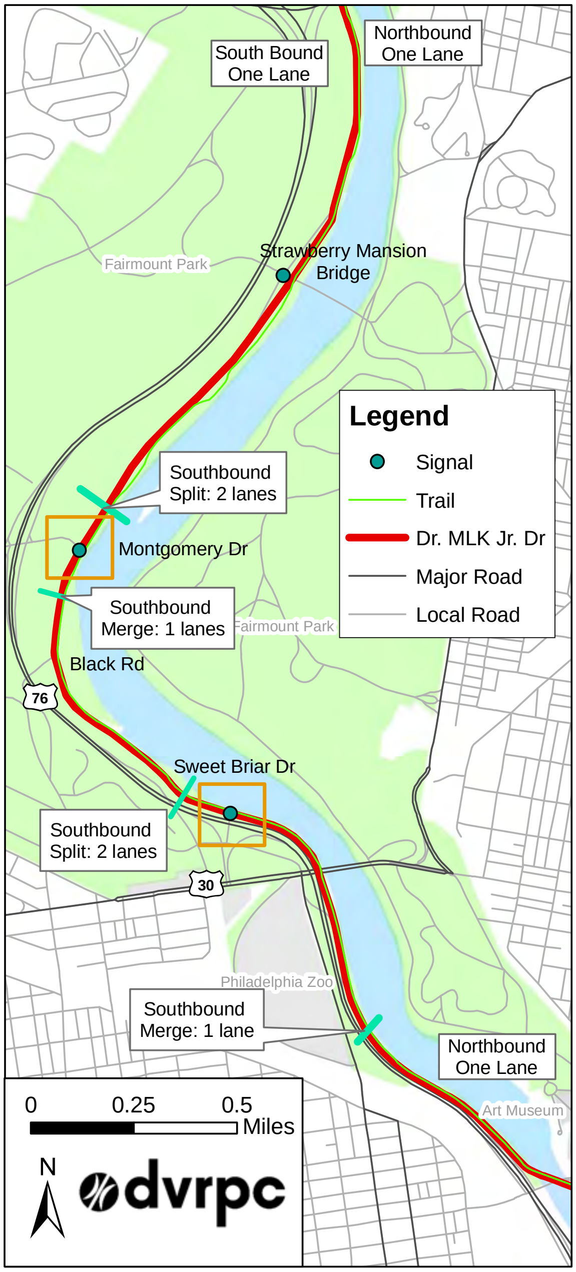
Alternative 2 – Bridge Safety and Partial Cycle Track

Alternative 2 maintains one northbound lane for the entire length of MLK Drive from Eakins Oval to Falls Bridge (same as Alternative 1).

Alternative 2 reduces the number of southbound travel lanes from two to one from Falls Bridge to the approach to Montgomery Drive, where the lane splits and returns to the existing configuration. Additionally, as in Alternative 1, the two lanes approaching the MLK Drive Bridge merge into one lane crossing the bridge.

This alternative makes room for a 14-foot cycle track from Falls Bridge to Montgomery Drive, with a six-foot buffer separating it from the automobile travel lanes. The cycle track merges with the shared use path just north of the narrow underpass at Montgomery Drive, where there is not enough room to accommodate two vehicle lanes, and the on-road cycle track. The cycle track and path remain merged south of Montgomery Drive to the MLK Drive Bridge. This alternative also includes the enhanced path across the river.

Figure 19: Alternative 3



DVRPC, 2011

Alternative 3 – Bridge Safety and Full Cycle Track

Alternative 3 maintains one northbound lane for the entire length of MLK Drive from Eakins Oval to Falls Bridge (same as Alternative 1).

Alternative 3 reduces the number of southbound travel lanes from two to one from Falls Bridge to the approach to Montgomery Drive (as in Alternative 2). The lane briefly splits to accommodate queuing at Montgomery Drive, but merges south of the intersection, leaving one travel lane between Montgomery Drive and Sweetbriar Drive. Again, the two lanes approaching the MLK Drive Bridge merge into one lane crossing the bridge.

This alternative makes room for a 14-foot cycle track from Falls Bridge to Sweetbriar Drive with a six-foot buffer separating it from the automobile travel lanes. The cycle track merges with the shared use path just north of Sweetbriar Drive, where there is not enough room to accommodate two vehicle lanes and the on-road cycle track. The cycle track and path remain merged south of Sweetbriar Drive to the MLK Drive Bridge. This alternative also includes the enhanced path across the river.

Model Results

Calibration

Calibration statistics are published in Appendix B. Alternative 1a required a separate calibration and Base Case simulation; this calibration and alternate demand scenario are summarized separately in Appendix B.

Validation

Before a computer model can be used to evaluate transportation alternatives, it must first demonstrate the capacity to reasonably reproduce current conditions. This process is known as model validation. Validation is achieved when a model reasonably reproduces measured data not used in the calibration of the model. For example, a microsimulation model should be able to successfully reproduce travel times, even though this data is not used to develop any of the model inputs. For this study, DVRPC chose intersection queue length and vehicle travel time to validate the model. Validation measures are shown in Tables 2, 3, and 4. It is important to note that both the observed data and the modeled data contain some level of error.

Automobile travel time data are presented below in Table 2. Travel time data was collected in May 2011 by DVRPC staff using the floating car method and a GPS tracking device.[1] The model reasonably represents the actual travel time within tolerances.

Table 2: Model Validation - Travel Time

	Travel Time (sec)			
Direction	**Data**	**Model**	**diff**	**%**
South	245	280	35	14%
North	220	252	32	15%

Source: DVRPC, 2011

Average intersection queue length data are shown below in Table 3; maximum intersection queue length data are shown in Table 4. Queues were counted manually by DVRPC staff in May 2011

[1] The floating car method is a means of collecting travel speed data. A driver uses a GPS device to track time and calculate average speed over the course of several runs of the designated route. The driver tries to pass as many cars as have passed them and in this way ensures their vehicle is traveling at a typical speed. By averaging speed and time over several runs a reasonable average travel time and speed can be calculated. By establishing data points along the route (in some cases every intersection is used), one can gain a find understanding of speeds, travel time, and delay to aid in the analysis.

(assume 21 feet per vehicle). In general, the model generates shorter average queues and longer maximum queues than are seen in the count data. However, the most important intersection legs (MLK Drive southbound and Montgomery Drive) produce acceptable results. The high maximum queues at Montgomery Drive are expected because the model does not include the up-stream signals, which would meter the flow of traffic somewhat and reduce the queue length.

Table 3: Model Validation - Average Queue Length

	Average Queue (vehicles)			
Montgomery Drive	**Count**	**Model**	**diff**	**%**
North Leg: MLK Drive (SB)	6	5	-1	-17%
West Leg: Montgomery Drive	5	6	1	20%
South Leg: MLK Drive (NB)	3	1	-2	-67%
Sweetbriar Drive				
North Leg: MLK Drive (SB)	4	2	-2	-50%
West Leg: Sweetbriar Drive	3	1	-2	-67%
South Leg: MLK Drive (NB)	3	3	0	0%

Note: 21 ft per vehicle

Source: DVRPC 2011

Table 4: Model Validation - Max Queue Length

	Maximum Queue (vehicles)			
Montgomery Drive	**Count**	**Model**	**diff**	**%**
North Leg: MLK Drive (SB)	14	25	11	79%
West Leg: Montgomery Drive	15	20	5	33%
South Leg: MLK Drive (NB)	7	7	0	0%
Sweetbriar Drive				
North Leg: MLK Drive (SB)	15	16	1	7%
West Leg: Sweetbriar Drive	5	8	3	60%
South Leg: MLK Drive (NB)	6	11	5	83%

Note: 21 ft per vehicle

Source: DVRPC 2011

Alternatives Analysis

Alternative 1 – MLK Drive Bridge Reconfiguration

One northbound lane; two southbound lanes merge to one lane north of approach to bridge at approximately 1,800 feet, so there is one lane in each direction over MLK Drive Bridge. After the southbound lane passes over MLK Drive Bridge and through the crosswalk, it quickly splits to three lanes before approaching Eakins Oval. Reducing the vehicle cartway to only one lane in each direction makes additional space available for the shared bicycle and pedestrian path across the bridge. This important link from the Schuylkill River Trail to MLK Drive and the adjacent path will dramatically improve access and safety.

Modeling Results: This configuration has minor impacts on the current roadway functionality.

Northbound MLK Drive, reducing the number of travel lanes increases the travel time by about 13 seconds and lowers both maximum and average speeds by two or three miles per hour each.

Average queuing and intersection delay are not significantly impacted. The maximum queue at Sweetbriar Drive more than doubles because the left lane no longer serves the through movement.

Southbound MLK Drive, introducing the merge on the approach to the MLK Drive Bridge, slows traffic as vehicles prepare to merge and match speed with the slowest driver ahead, creating about 13 seconds of additional delay. Average and maximum queuing are unaffected.

Alternative 2 – MLK Drive Bridge and Partial Cycle Track

Bridge lane reduction, outlined above; two-way cycle track north of Montgomery Drive on the river side of the road (east side); reduction of the vehicle cartway north of Montgomery Drive to accommodate one lane in each direction and a 14-foot-wide cycle track with 6-foot divider separating the cycle track and vehicle traffic. Note that the cycle track will merge with the path just south of the narrow underpass, where there is not enough space to accommodate two vehicle lanes and a bicycle lane. Between this point and Falls Bridge, the cycle track will follow the shared use path rather than remaining on-road.

Modeling Results: This configuration has significant impacts on the functioning of MLK Drive. Notable locations include MLK Drive southbound north of Montgomery Drive and northbound at Sweetbriar Drive.

Northbound MLK Drive, reducing the number of travel lanes increases the travel time by about 15 seconds and lowers both maximum and average speeds by about two or three miles per hour each. Additionally, vehicles making the northbound left turn onto Sweetbriar Drive experience an increased delay of 22 seconds because gaps in the southbound traffic become less frequent.

Southbound MLK Drive, introducing the lane drop on the approach to the MLK Drive Bridge slows traffic as vehicles prepare to merge and match speed with the slowest driver ahead; creating about 13 seconds of additional delay. Additionally, reducing the number of lanes north of Montgomery Drive decreases the maximum queue at that intersection by half and average speed is lowered by about two miles per hour reflecting the reduced upstream capacity (fewer vehicles reach the intersection to enter the queue). This further increases travel time for users who travel the length of MLK Drive from Falls Bridge to Eakins Oval (though the section from Falls Bridge to Montgomery Drive is not modeled).

Alternative 3 – Bridge and Full Cycle Track

Bridge lane reduction and partial cycle track configuration, outlined above; two-way cycle track continues south of Montgomery Drive to Sweetbriar Drive, and one vehicle lane in each direction continues through this section of MLK Drive in order to maintain adequate space for the on-road cycle track; the cycle track merges with the path just north of Sweetbriar Drive.

Modeling Results: This configuration has major impacts on the current functioning of MLK Drive and frequently fails to serve the volume of southbound traffic modeled for this study.

Northbound MLK Drive, travel time increases by about two minutes (133 seconds). Both maximum and average speeds are reduced by about two or three miles per hour each. The northbound left turn onto Sweetbriar Drive experiences heavy delay, almost three minutes (167 seconds), and queuing builds to a maximum of 44 vehicles. Similar queuing occurs at the Montgomery Drive intersection. These effects occur because gaps in the southbound traffic become very infrequent, preventing left turns in a timely fashion.

Southbound MLK Drive, travel time increases by two minutes (121 seconds) and average speed is reduced by two miles per hour. Maximum queues at the Montgomery Drive intersection build to 30 vehicles (longer than when two lanes were available) and users experience about 20 seconds of additional intersection delay. Queuing at Sweetbriar Drive is lower due to the lower upstream capacity.

Eastbound Montgomery Drive, users experience longer queues by as much as 80 percent (maximum queues reach 30 vehicles in length).

Alternative 1a - Bridge Safety (High Volume)

The same as 1, but with ‘worst case’ traffic volumes exceeding current levels.

Modeling Results: Under the existing configuration, these heavy volumes produce very long queues on MLK Drive at the signalized intersections, particularly at Montgomery Drive southbound. Overall, southbound travel time increases by three minutes compared to the standard volume base case.

This configuration has major impacts on the current roadway functionality at high volumes and fails to serve the southbound volume of traffic modeled for this alternative.

Northbound MLK Drive, reducing the number of travel lanes increases the travel time by about 13 seconds and reduces both maximum and average speeds by about two or three miles per hour each. Queuing and intersection delay at the left turn onto Sweetbriar Drive become much worse; delay increases by over one minute (94 seconds), while the maximum queue grows to more than 50 vehicles.

Southbound MLK Drive, introducing the lane merge on the approach to the bridge creates queuing that eventually spills back into the signalized intersections and increases overall travel time by nine minutes. Travel time from Sweetbriar Drive to the MLK Drive Bridge is worse by almost five minutes (290 seconds); travel speed across the bridge is reduced by about 15 miles per hour.

Summary

Any changes in the road configuration must take into consideration the impact on motor vehicle traffic. Table 5 compares the different road configuration alternatives in terms of qualitative impacts on traffic flow along MLK Drive.

Table 5: Qualitative Impacts - Alternatives Compared

	Alt 1	Alt 2	Alt 3	Alt 1a
Overall Impact	Minor	Significant	Major	Fail
MLK Northbound	Slower	Slower	Slower	Very Slow
@Montgomery Dr			Longer Queue	Longest Queue
@Sweetbriar Dr		Left turn delay	Longer Queue, Left turn delay	Longest Queue
MLK Southbound		Slower (north of Montgomery)	Slow (insufficient capacity)	Very Slow (insufficient capacity)
@Montgomery Dr		Shorter Queue	Longer Queue	Longest Queue
@Sweetbriar Dr			Longer Queue	Longest Queue
Montgomery Dr			Longer Queue	Longest Queue
Sweetbriar Dr				Longest Queue
MLK Drive Bridge	Slower	Slower	Slower	Slower

Source: DVRPC 2011

Alternative 1, which reduced the number of traffic lanes on the MLK Drive Bridge to one lane in each direction, had a negligible impact on traffic, slowing traffic over the bridge, as well as northbound traffic along MLK Drive.

Alternative 2 reduced vehicular travel lanes and provided a two-way cycle track between Montgomery Drive and Falls Bridge. This alternative slowed both directions of traffic along MLK Drive as well as on the bridge, and created a delay in left-turning traffic at Sweetbriar Drive.

Alternative 3 extended the lane reduction and cycle track to Sweetbriar Drive and had significant impacts on traffic, particularly southbound, and extended queues at all intersections.

Alternative 1a, which used the same configuration as Alterative 1 but 'worst case' traffic volumes, resulted in delays throughout the corridor and major queuing at all intersections.

As evident in Table 5, each modeled configuration has some impact on traffic along MLK Drive, each has the side benefit, however, of slowing traffic and potentially improving safety for all road users.

CHAPTER 4

Conclusions

The recommendations outlined in this report would all individually contribute to a safer, more accessible MLK Drive and path for all users. They may also be bundled strategically depending on road capacity, different investment priorities, and funding opportunities.

Any improvements to the path or on-road facilities will only be accessible if MLK Drive Bridge functions as a connector between MLK Drive and the Art Museum. Once access to MLK Drive over MLK Drive Bridge is addressed, the city may choose to focus on either the path or on-road facilities, depending on a variety of constraints.

DVRPC has identified two broad strategic approaches to improve safety for all users on MLK Drive:

1: Focus on increasing function and access to the shared use path.

2: Focus on increasing road safety with on-road bicycle facilities and traffic calming measures.

There are pros and cons inherent in either of these strategies, and the city's preferred approach will depend on a combination of priorities, funding opportunities, timing, and political support. If funding resources and local support for both path improvements and on-road bicycle facilities are available, MLK Drive and the stunning riverside path could set the standard for multi-modal recreation and transportation facilities. However, even if investments are directed toward only one of these two approaches, the upgrade in function and attractiveness will change the way the road and path are used and will draw new bicycle and pedestrian users.

Improve MLK Drive Bridge

The MLK Drive Bridge is an essential link to the Schuylkill River Trail and the Art Museum. MLK Drive and the shared use path must be accessible via this bridge in order to function as a relevant and continuous bicycle and pedestrian facility. All improvements to the road and path require improvements to MLK Drive Bridge in order to be successful.

Issues

The narrow sidewalk over MLK Drive Bridge does not meet the needs of current bicycle and pedestrian use, and traffic conditions are unsafe for standard bicycle lanes on either side of the road.

Recommendations

A traffic calming road diet is recommended. This will reduce vehicle speeds, curb aggressive driving and create additional space to accommodate bicycle and pedestrian users over MLK Drive Bridge.

If increasing sidewalk width proves infeasible because of the additional weight brought on by the increased concrete, there may be alternative materials that can be used to rebuild the sidewalks. More dramatically, the ability to construct a cantilevered walkway adjacent to the current bridge may be investigated, but these alternatives will be significantly more expensive than simply expanding the sidewalk.

Option 1: Path Focus

Path improvements paired with bridge safety strategies as outlined in Chapter 2 can make the MLK Drive shared use path an attractive destination for cyclists of all levels.

Issues

The path is currently difficult to access from many important intersections and park gateways; at high-volume areas, it is not wide enough to accommodate multiple users, and the surface is not consistently comfortable for cyclists.

Recommendations

Adding curb cuts, especially at Montgomery Drive and Sweetbriar Drive intersections and gateways to the west side of Farimount Park, such as Black Road and the Strawberry Mansion Bridge ramps would improve access to the shared use path.

The shared use path should be widened in locations where trees and utilities do not interfere in order to create informal passing lanes and reduce conflict among pedestrians and cyclists of varying skill levels.

In locations where tree roots have caused uneven pavement, the shared use path should be repaired so that the surface is more inviting to cyclists of all skill levels and it can function as a primary bicycle route on the west side of the Schuylkill River.

These recommendations for path improvements are intentionally broad and flexible. Any combination of these strategies, implemented according to scheduling and funding opportunities, will make the path more inviting and functional for all users.

Option 2: Road Safety Focus

Road improvements paired with bridge safety strategies as outlined above in Chapter 2 can turn MLK Drive into an attractive destination for cyclists of all levels and a showcase for Philadelphia's world class cycling facilities and many waterfront recreation amenities.

Issues

The current configuration of MLK Drive allows high-speed drivers to use this road as an informal highway. Excess lane capacity between intersections leaves plenty of room for passing and fast turns. These conditions make on-road cycling dangerous and very unappealing to non-advanced cyclists.

Recommendations

Safety is of primary importance in designing facilities to improve MLK Drive for all users. Standard bike lanes on each side of the road do not adequately protect cyclists from aggressive and high-speed vehicles. Therefore, a separated two-way cycle track is recommended. Such a facility would allow bicyclists to access the road without competing for space with motorists. A protected two-way cycle track accommodates users of all skill levels, reduces opportunities for bike-car conflict, and can be designed as part of a traffic calming road diet.

Other facility types may be considered, though the safety implications of directing cyclists to share the road with high-speed, high-volume traffic must be carefully considered.

Conclusions

As the road and path are currently configured, MLK Drive is only accessible to most bicycle and pedestrian users on weekends from April through October when the road is closed to through traffic. On weekends in November through March and weekdays year round, this road is the domain of motor vehicles.

Improvements to MLK Drive Bridge will create a link between the two paths on either side of the Schuylkill River, making a continuous loop from the Art Museum to Falls Bridge and back safe and easy to access.

Improvements to the path would allow the city to make investments without disrupting vehicle traffic. The recommendations outlined as part of this option may require the city to undertake a long permitting process due to the environmentally sensitive riverside location of the path. However, if this is an option, each improvement could be made as funding and timing allow, and piece by piece this path could become an incredible resource for recreation and waterfront access in Philadelphia.

Improvements to the road would allow the city to create safe on-road facilities and implement traffic calming measures that will make MLK Drive safer for bicyclists, pedestrians, and vehicle drivers alike. The recommendations outlined as part of this option would require the city to repurpose a portion of the cartway for non-motorized use, and may reduce traffic capacity at some locations. However, such an on-road facility would provide cyclists of all skill levels with an attractive recreation and transportation corridor, and would call attention to Philadelphia's incredible park and riverfront amenities, and to the city's commitment to safe and accessible roads designed for all users.

MLK Drive and the Schuylkill River are truly among Philadelphia's most invaluable recreation and outdoor resources. Recommendations outlined in this report are inherently flexible. There are numerous best practices from other similar U.S. cities and international examples that provide design guidance. Literature reviews describe strengths and weaknesses of various facilities so Philadelphia may invest in only the most appropriate and beneficial improvements to accommodate bicyclists, pedestrian, and vehicles. Improvements to accessibility on the path and road through this part of Fairmount Park will create a world class destination.

APPENDIX A

Model Construction

The PTV Vision software package, consisting of VISUM (macro-level demand modeling) and VISSIM (micro-level operations simulator), was used to model the scenarios in this study. Initial network editing and demand calibration was done using the VISUM software to develop a focused model. The remaining work was completed in the VISSIM software. This project utilizes the VISUM-to-VISSIM connected functionality. This method allows the user to export a skeleton network from VISUM, complete with vehicle inputs and routing decisions. The two models retain a connection, such that the user can export different demand assumptions without losing the network enhancements that have been made to a VISSIM network. This appendix details the specific software procedures that were used in the conduct of simulations for this project.

Modeling procedure

Network preparation in VISUM

1. The 2010 DVRPC AM Peak period model (full VISUM implementation) was used as the base model for this study. The network geometry and attributes were reviewed for coding errors and the assigned volumes vetted against the surveyed count data for general network assignment reasonability.

Develop focused subarea model

2. The study area was “clipped” out of the regional model to create a smaller, more manageable version file that will serve as the basis for the VISSIM network and demand inputs. The subarea model includes the portion of MLK Drive from just south of the Strawberry Mansion Bridge ramps to Eakins Oval.

3. The raw subarea network was enhanced using aerial photography to rectify the roadway geometry.

Calibrate focused demand model

4. Five-hour (AM peak) traffic volume and turn counts were input into the model at all available locations. The smaller trip matrix (generated during step 2) was calibrated using the TFlowFuzzy algorithm.

5. Vehicle routes and turns were reviewed for soundness. Re-run TFlowFuzzy as needed.

Export to VISSIM

6. The calibrated and focused subarea model was exported to VISSIM. The network was exported in the .ANM file, while the vehicle routes were exported in the .ANMROUTES file. Two additional files were created with the “P” prefix (.PANM and .PANMROUTES) to connect the VISSIM model back the VISUM version file. This allows the modeler to return to the VISUM network and export a new demand scheme without losing any enhancements made to the VISSIM network.

7. The .ANM and .ANMROUTES files were read into VISSIM and reviewed for errors or export/import process issues.

Clean and enhance VISSIM network

8. The raw network imported from VISUM required a good deal of editing before a simulation could be successfully run. The network geometry was again rectified against the aerial photography. Several passes were made over the entire network, working east to west (in the direction of major flow) and paying special attention to a different feature with each pass:

    a. **Roadway geometry:** clean the network between intersections and focus on shape and number of lanes.

    b. **Intersection geometry:** review lane turns (the path a vehicle takes through the intersection) and correct spline (the arc of the turn).

    c. **Intersection control:** add signal heads and program signal controller (fixed-time) using signal timing plans, add right-on-red where allowed, and review and edit conflict zones (right-of-way between conflicting movements within each intersection).

Refine VISSIM network and calibrate automobile traffic

9. Edited desired speed distributions based on Philadelphia Streets Department data. Defaults were used for vehicle mix (no classification counts were taken) and vehicle acceleration/deceleration profiles.

    a. Ran test simulation and reviewed traffic flow for bottlenecks, signal control errors, weaving problems, and failing left turns.

10. Added the data collection elements, defined travel time segments, and established the output connection with a Microsoft Access database to store simulation performance data.

Validate base case scenario

11. Ran full simulation to validate the existing case against travel time and queue length data.

12. Established a Base Case folder and duplicated VISSIM files from the validated existing case; Ran Base Case scenario; recorded data and summarized.

Develop Alternative 1

13. The Base Case alternative folder was copied and renamed to use as a template for the Alternative 1 scenario. Originally, this alternative was a more aggressive intervention; however, in response to comments, the project team developed the less intense alternative found in this report. Removed one northbound lane. Reduced by one the number of southbound lanes approaching the MLK Drive Bridge. Lane change behavior was edited to emulate the very aggressive lane change behaviors common during AM commute hours (safety distance reduction factor = 0.25; minimum headway = 1 ft) as recommended by PTV Vision.

14. Ran Alternative 1; recorded data and summarized.

Develop Alternative 2

15. The Alternative 1 folder was copied and renamed to use as a template for Alternative 2.

16. Reduced the number of southbound lanes on MLK Drive north of Montgomery Drive. Originally, this alternative was conceived as the first alternative.

17. Ran Alternative 2; recorded data and summarized.

Develop Alternative 3

18. The Alternative 2 folder was copied and renamed to use as a template for Alternative 3.

19. Reduced the number of lanes southbound on MLK Drive south of Montgomery Drive, through the Black Road intersection and splitting again just north of Sweetbriar Drive.

20. Ran Alternative 3; recorded data and summarized.

APPENDIX B

Data Tables

Model Calibration Tables

Model calibration statistics are presented below:

Table 6: Model Calibration - Facility Volume

Facility Volume (Peak Hour)								
year	dir	road	from	to	Count	Model	diff	%
2011	South	MLK Drive	Strawberry Mansion Br EB ramp	Montgomery Dr	1,310	1,332	22	2%
2011	North	MLK Drive	Montgomery Dr	Strawberry Mansion Br EB ramp	538	523	(15)	-3%
2010	South	MLK Drive	Montgomery Dr	Black Rd	1,596	1,638	42	3%
2010	North	MLK Drive	Black Rd	Montgomery Dr	637	576	(61)	-10%
2011	South	MLK Drive	Black Rd	Sweetbriar Dr	1,494	1,512	18	1%
2011	North	MLK Drive	Sweetbriar Dr	Black Rd	555	559	4	1%
2008	South	MLK Drive	Spring Garden St (overpass)	Girard Ave (overpass)	1,568	1,514	(54)	-3%
2008	North	MLK Drive	Girard Ave (overpass)	Spring Garden St (overpass)	613	598	(15)	-2%
2010	East	Montgomery Dr	Belmont Ave	Dr. Matrin Luther King Jr Dr	686	654	(32)	-5%
2010	West	Montgomery Dr	Dr. Matrin Luther King Jr Dr	Belmont Ave	325	383	58	18%
2010	South	Sweetbriar Drive	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	511	519	8	2%
2010	North	Sweetbriar Drive	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	442	538	96	22%
2010	East	Black Rd	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	30	28	(2)	-7%
2010	West	Black Rd	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	146	134	(12)	-8%

Source: DVRPC 2011

Table 7: Model Calibration - Turn Volume

Turn Volume (Peak Hour)								
year	dir	road	turn	to	Count	Model	diff	%
2010	South	MLK Drive South	right	Montgomery WB	153	149	(4)	-3%
2010	East	Montgomery	right	MLK EB	457	459	2	0%
2010	East	Montgomery	left	MLK WB	189	185	(4)	-2%
2010	North	MLK Drive North	left	Montgomery WB	220	234	14	6%
2010	South	MLK Drive South	right	Sweetbriar Dr WB	299	431	132	44%
2010	North	Sweetbriar Drive	right	MLK EB	462	446	(16)	-3%
2010	North	Sweetbriar Drive	left	MLK WB	49	73	24	49%
2010	North	MLK Drive North	left	Sweetbriar Dr WB	119	107	(12)	-10%

Source: DVRPC 2011

Table 8: Model Calibration - Average and Maximum Speed

		Average Speed			
dir	road	Data	Model	diff	%
South	MLK Drive	45	42	-3	-7%
North	MLK Drive	45	44	-1	-2%
		Max Speed			
dir	road	Data	Model	diff	%
South	MLK Drive	58	57	-1	-2%
North	MLK Drive	55	60	5	9%

Source: DVRPC 2011

Model Results

Table 9: Alternatives Analysis - Facility Volume

Facility Volume (Peak Hour)					Alternative1			Alternative2			Alternative3		
dir	road	from	to	Calibration	Alt1	diff	%	Alt2	diff	%	Alt3	diff	%
South	MLK Drive	Strawberry Mansion Br EB ramp	Montgomery Dr	1,332	1,285	(47)	-4%	1,285	(47)	-3%	1,221	(111)	-9%
North	MLK Drive	Montgomery Dr	Strawberry Mansion Br EB ramp	523	503	(20)	-4%	504	(19)	-4%	484	(39)	-8%
South	MLK Drive	Montgomery Dr	Black Rd	1,638	1,583	(55)	-3%	1,589	(49)	-3%	1,520	(119)	-7%
North	MLK Drive	Black Rd	Montgomery Dr	576	555	(21)	-4%	555	(21)	-4%	517	(59)	-11%
South	MLK Drive	Black Rd	Sweetbriar Dr	1,512	1,449	(63)	-4%	1,465	(47)	-3%	1,399	(113)	-8%
North	MLK Drive	Sweetbriar Dr	Black Rd	559	533	(26)	-5%	533	(26)	-5%	515	(44)	-8%
South	MLK Drive	Spring Garden St (overpass)	Girard Ave (overpass)	1,514	1,463	(51)	-3%	1,478	(36)	-2%	1,437	(78)	-5%
North	MLK Drive	Girard Ave (overpass)	Spring Garden St (overpass)	598	578	(20)	-3%	578	(20)	-4%	571	(27)	-5%
East	Montgomery Dr	Belmont Ave	Dr. Matrin Luther King Jr Dr	654	630	(24)	-4%	630	(24)	-4%	629	(25)	-4%
West	Montgomery Dr	Dr. Matrin Luther King Jr Dr	Belmont Ave	383	368	(15)	-4%	361	(22)	-6%	335	(48)	-13%
South	Sweetbriar Dr Dr	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	519	500	(19)	-4%	500	(19)	-4%	498	(21)	-4%
North	Sweetbriar Dr Dr	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	538	519	(19)	-3%	520	(18)	-3%	485	(53)	-10%
East	Black Rd	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	28	32	4	14%	32	4	16%	32	4	13%
West	Black Rd	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	134	140	6	4%	132	(2)	-2%	124	(10)	-8%

Source: DVRPC 2011

Table 10: Alternatives Analysis - Turn Volume

Turn Volume (Peak Hour)					Alternative1			Alternative2			Alternative3		
dir	road	turn	to	Calibration	Alt1	diff	%	Alt2	diff	%	Alt3	diff	%
South	MLK Drive South	right	Montgomery WB	149	148	(1)	0%	142	(7)	-4%	132	(17)	-12%
East	Montgomery	right	MLK EB	459	450	(9)	-2%	449	(10)	-2%	448	(11)	-2%
East	Montgomery	left	MLK WB	185	172	(13)	-7%	172	(13)	-5%	169	(16)	-9%
North	MLK Drive North	left	Montgomery WB	234	219	(15)	-6%	219	(15)	-7%	203	(31)	-14%
South	MLK Drive South	right	Sweetbriar Dr WB	431	410	(21)	-5%	410	(21)	-7%	386	(45)	-10%
North	Sweetbriar Dr	right	MLK EB	446	426	(20)	-4%	426	(20)	-4%	424	(22)	-5%
North	Sweetbriar Dr	left	MLK WB	73	73	0	0%	73	0	1%	73	(1)	-1%
North	MLK Drive North	left	Sweetbriar Dr WB	107	110	3	3%	110	3	2%	99	(8)	-7%

Source: DVRPC 2011

Table 11: Alternatives Analysis - Travel Time

Travel Time (sec)		Alternative1			Alternative2			Alternative3		
Direction	Model	Alt1	diff	%	Alt2	diff	%	Alt3	diff	%
South	294	307	13	4%	309	15	5%	415	121	41%
North	262	275	13	5%	275	13	5%	395	133	51%

Source: DVRPC 2011

Table 12: Alternatives Analysis - Average and Maximum Speed

		Average Speed (mph)									
dir	road	Calib	Alt1	diff	%	Alt2	diff	%	Alt3	diff	%
South	MLK Drive	41	42	1	2%	40	-1	-2%	40	-1	-2%
North	MLK Drive	44	41	-3	-7%	41	-3	-7%	41	-3	-7%
		Max Speed (mph)									
dir	road	Calib	Alt1	diff	%	Alt2	diff	%	Alt3	diff	%
South	MLK Drive	57	60	3	5%	59	2	4%	59	2	4%
North	MLK Drive	60	58	-2	-3%	58	-2	-3%	58	-2	-3%

Source: DVRPC 2011

Table 13: Alternatives Analysis – Average Queue

Average Queue (vehicles)		Alternative 1			Alternative 2			Alternative 3		
Montgomery Drive	Calib	Avg	diff	Percent	Avg	diff	%	Avg	diff	%
North Leg: MLK Drive (SB)	5	4	-1	-20%	3	-2	-40%	9	4	80%
West Leg: Montgomery Drive	6	6	0	0%	7	1	17%	11	5	83%
South Leg: MLK Drive (NB)	1	1	0	0%	1	0	0%	3	2	200%
Sweetbriar Drive										
North Leg: MLK Drive (SB)	2	3	1	50%	2	0	0%	1	-1	-50%
West Leg: Sweetbriar Drive	1	1	0	0%	1	0	0%	1	0	0%
South Leg: MLK Drive (NB)	3	4	1	33%	4	1	33%	17	14	467%

Source: DVRPC 2011

Table 14: Alternatives Analysis – Maximum Queue

Maximum Queue (vehicles)		Alternative 1			Alternative 2			Alternative 3		
Montgomery Drive	Calib	Max	diff	Percent	Max	diff	%	Max	diff	%
North Leg: MLK Drive (SB)	25	23	-2	-8%	12	-13	-52%	30	5	20%
West Leg: Montgomery Drive	20	22	2	10%	24	4	20%	30	10	50%
South Leg: MLK Drive (NB)	7	8	1	14%	9	2	29%	35	28	400%
Sweetbriar Drive										
North Leg: MLK Drive (SB)	16	15	-1	-6%	15	-1	-6%	12	-4	-25%
West Leg: Sweetbriar Drive	8	8	0	0%	8	0	0%	9	1	13%
South Leg: MLK Drive (NB)	11	13	2	18%	14	3	27%	44	33	300%

Source: DVRPC 2011

Table 15: Alternatives Analysis – Intersection Delay

Delay (seconds)			Alternative1			Alternative2			Alternative3		
Intersection	Movem.	Base	Delay	diff	%	Delay	diff	%	Delay	diff	%
MLK/Mont	EB thru	25	28	3	12%	21	-4	-16%	39	14	56%
MLK/Mont	EB right	26	29	3	12%	20	-6	-23%	49	23	88%
Mont/MLK	left	21	30	9	43%	31	10	48%	30	9	43%
Mont/MLK	right	62	54	-8	-13%	57	-5	-8%	53	-9	-15%
MLK/Mont	WB thru	6	9	3	50%	9	3	50%	12	6	100%
MLK/Mont	WB left	24	22	-2	-8%	21	-3	-13%	30	6	25%
MLK/Sweet	EB thru	13	12	-1	-8%	12	-1	-8%	10	-3	-23%
MLK/Sweet	EB right	15	14	-1	-7%	14	-1	-7%	7	-8	-53%
Sweet/MLK	left	23	22	-1	-4%	22	-1	-4%	26	3	13%
Sweet/MLK	right	11	10	-1	-9%	10	-1	-9%	11	0	0%
MLK/Sweet	WB thru	9	9	0	0%	9	0	0%	14	5	56%
MLK/Sweet	WB left	131	134	3	2%	153	22	17%	298	167	127%

Source: DVRPC 2011

Alternative 1a

Table 16: Alternative 1a Facility Volume – Calibration

Facility Volume (Peak Hour)					Alternative1a		
dir	road	from	to	Calibration	Alt1	diff	%
South	MLK Drive	Strawberry Mansion Br EB ramp	Montgomery Dr	1,558	1,407	(151)	-10%
North	MLK Drive	Montgomery Dr	Strawberry Mansion Br EB ramp	518	520	2	0%
South	MLK Drive	Montgomery Dr	Black Rd	1,858	1,725	(133)	-7%
North	MLK Drive	Black Rd	Montgomery Dr	568	565	(3)	-1%
South	MLK Drive	Black Rd	Sweetbriar Dr	1,741	1,584	(157)	-9%
North	MLK Drive	Sweetbriar Dr	Black Rd	552	549	(3)	-1%
South	MLK Drive	Spring Garden St (overpass)	Girard Ave (overpass)	1,914	1,666	(248)	-13%
North	MLK Drive	Girard Ave (overpass)	Spring Garden St (overpass)	598	598	-	0%
East	Montgomery Dr	Belmont Ave	Dr. Matrin Luther King Jr Dr	682	670	(12)	-2%
West	Montgomery Dr	Dr. Matrin Luther King Jr Dr	Belmont Ave	377	366	(11)	-3%
South	Sweetbriar Dr	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	545	529	(16)	-3%
North	Sweetbriar Dr	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	396	370	(26)	-7%
East	Black Rd	Lansdowne Dr	Dr. Matrin Luther King Jr Dr	28	28	-	0%
West	Black Rd	Dr. Matrin Luther King Jr Dr	Lansdowne Dr	141	129	(12)	-9%

Source: DVRPC 2011

Table 17: Alternative 1a Turn Volume – Calibration

Turn Volume (Peak Hour)					Alternative1		
dir	road	turn	to	Calibration	Alt1	diff	%
South	MLK Drive South	right	Montgomery WB	146	136	(10)	-7%
East	Montgomery	right	MLK EB	473	457	(16)	-3%
East	Montgomery	left	MLK WB	181	184	3	2%
North	MLK Drive North	left	Montgomery WB	231	230	(1)	0%
South	MLK Drive South	right	Sweetbriar Dr WB	304	284	(20)	-7%
North	Sweetbriar Dr	right	MLK EB	478	462	(16)	-3%
North	Sweetbriar Dr	left	MLK WB	65	61	(4)	-6%
North	MLK Drive North	left	Sweetbriar Dr WB	92	85	(7)	-8%

Source: DVRPC 2011

Table 18: Alternative 1a – Average and Maximum Speed

		Average Speed			
dir	road	Calibration	Alt1a	diff	%
South	MLK Drive	41	41	0	0.5%
North	MLK Drive	44	41	-3	-7.4%
		Max Speed			
dir	road	Calibration	Alt1a	diff	%
South	MLK Drive	57	58	1	1.9%
North	MLK Drive	60	59	-2	-2.6%

Source: DVRPC 2011

Table 19: Alternative 1a – Travel Time

Travel Time (sec)		Alternative1a		
Direction	Calib	Alt1a	diff	%
South	476	1,027	551	116%
North	263	358	95	36%

Source: DVRPC 2011

Table 20: Alternate 1a – Average Queue

Average Queue (vehicles)		Alternative 1a		
Montgomery Drive	Calib	Alt1a	diff	%
North Leg: MLK Drive (SB)	59	76	17	29%
West Leg: Montgomery Drive	16	24	8	50%
South Leg: MLK Drive (NB)	1	2	1	100%
Sweetbriar Drive				
North Leg: MLK Drive (SB)	3	43	40	1333%
West Leg: Sweetbriar Drive	1	8	7	700%
South Leg: MLK Drive (NB)	7	24	17	243%

Source: DVRPC 2011

Table 21: Alternate 1a – Maximum Queue

Maximum Queue (vehicles)		Alternative 1a		
Montgomery Drive	Calib	Alt1a	diff	%
North Leg: MLK Drive (SB)	79	79	0	0%
West Leg: Montgomery Drive	38	53	15	39%
South Leg: MLK Drive (NB)	9	13	4	44%
Sweetbriar Drive				
North Leg: MLK Drive (SB)	20	76	56	280%
West Leg: Sweetbriar Drive	12	15	3	25%
South Leg: MLK Drive (NB)	24	52	28	117%

Source: DVRPC 2011

Table 22: Alternatives 1a – Intersection Delay

Delay (seconds)			Alternative1a		
Intersection	Movem.	Calib	Alt1a	diff	%
MLK/Mont	EB thru	50	51	1	2%
MLK/Mont	EB right	46	49	3	7%
Mont/MLK	left	98	108	10	10%
Mont/MLK	right	110	113	3	3%
MLK/Mont	WB thru	5	9	4	80%
MLK/Mont	WB left	29	29	0	0%
MLK/Sweet	EB thru	14	21	7	50%
MLK/Sweet	EB right	13	21	8	62%
Sweet/MLK	left	21	38	17	81%
Sweet/MLK	right	13	31	18	138%
MLK/Sweet	WB thru	10	10	0	0%
MLK/Sweet	WB left	265	332	67	25%

Source: DVRPC 2011

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Geographic Area Covered: Philadelphia

Key Words: Bicycle, pedestrian, bike, facility, on-road, safety, Martin Luther King Drive, Fairmount Park, shared use path, cycle track,

Abstract: This project addresses safety concerns for pedestrians and bicyclists on MLK Drive in Philadelphia. Included in this analysis is best practice research, the results of a computer model, and the results of fieldwork.

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