Howard Research and Development Corporation

Downtown Columbia

Downtown Transit Center and Circulator Feasibility Study:

Part 2 - Downtown Columbia to Oakland Mills Multimodal Connection (Part of CEPPA #3)

Note:
This is an initial draft report presented to Howard County by the Howard Hughes Corporation. The County staff is in the process of reviewing this document and has not yet accepted it. Any questions or concerns regarding this draft report should be directed to the Howard Hughes Corporation.

October 2011

NELSON NYGAARD

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Introduction

The following studies were conducted on behalf of the Howard Research and Development Corporation as part of commitments to complete Community Enhancements, Programs, and Public Amenities (CEPPAs)as required by Howard County Council Bill No. 58-2009. Nelson\Nygaard Consulting Associates of San Francisco, California was commissioned to conduct the transit-related study of a connection over Route 29 as required by CEPPA 5.

Prior to submission of the first final development plan, a study must be completed to satisfy CEPPA number 3, which states:

> "GGP [General Growth Properties] will commission at GGP's expense in consultation with Howard County a study evaluating a new Downtown Columbia Route 29 interchange between Route 175 and Broken Land Parkway and options for a connection over Route 29 connecting Downtown Columbia to Oakland Mills, including potential bicycle, transit and multimodal improvements. The study will evaluate alternative alignments and geometry, capacity analysis, preliminary environmental assessments, right of way impacts, multimodal opportunities, interaction and options with regard to the Oakland Mills bridge connection, preliminary costs, design and implementation schedule."

Nelson\Nygaard met with GGP representatives and Howard County staff on July 21, 2010 to initiate discussions about the appropriate scope for the studies. Final scopes were submitted to the County in November 2010, and studies of transit center and circulator shuttle were commenced utilizing field observations and public data available from the County and other local, regional, and Federal agencies.

Chapter 1. Purpose for a Route 29 Connection Study

A transit, bicycle, and pedestrian connection across US Route 29 would enhance multi-modal connectivity between Downtown Columbia and Oakland Mills. This would be a replacement or enhancement of the existing pedestrian bridge and trail network that exists today. Prior to the initiating an evaluation of this connection, the consultant team was given a presentation by a special interest group called "Bridge Columbia." The presentation expressed the need and items for consideration associated with a proposed transit, bicycle, and pedestrian facility at the location of the existing pedestrian bridge. As part of the presentation, a suggested scope for a feasibility study was provided. In addition, several design criteria were identified for consideration as part of this evaluation. The information presented has been incorporated into this report as appropriate for this evaluation.

Methodology

After discussions with Howard County, Nelson\Nygaard, supported by Wallace-Montgomery & Associates, elected to conduct a total of four studies to evaluate the appropriateness of a new connection between Downtown Columbia and Oakland Mills:

1. An analysis of transit system impacts and potential transit diversions to determine the ridership impacts of a new bridge (Appendix A);
2. A non-motorized connections evaluation to determine the sufficiency of existing and proposed connections to the bridge (Appendix B);
3. A trip-making analysis to determine how the new facility might shift vehicle trips to transit, thereby reducing vehicle traffic (Appendix C); and
4. A preliminary engineering evaluation to assess the constructability and cost of a new bridge (Appendix D).

To aid in the analysis of the impact of the bridge, Nelson\Nygaard and Wallace, Montgomery & Associates created a list of assumptions and limitations for the evaluation of the transit, bicycle, and pedestrian bridge identified for study.

Preliminary Design Criteria

In order to evaluate the potential footprint (impact area and right-of-way) as well as a preliminary cost estimate for the proposed multi-modal connection, the following design criteria have been developed, meeting the minimum requirements for this type of facility.

- Transit vehicle design speed – 25 mph
- Transit design vehicle – 32-foot transit vehicle (to match the smaller vehicles being considered by Howard County Transit)
- Typical cross-section – 24-foot roadway (two 12-foot passable lanes) with a parallel 12-foot bicycle/pedestrian multi-use path. Minimum total clear width of 36 feet (not including parapet and fencing for structure over Little Patuxent River and US Route 29).

Environmental Inventory

In 2008, Biohabitats, Inc. completed an Environmental Enhancement Study for the Downtown Columbia area, which includes the stretch of the existing pathway and pedestrian bridge to the west of US Route 29. Based on that inventory, several environmental features were identified.

- Wetlands – Several wetland areas have been identified in the study area surrounding Lake Kittamaqundi and the Little Patuxent River. The largest area is located in the vicinity of the path and the existing GGP parking lot.
- Waters of the US – The existing pathway crosses the Little Patuxent River and the spillway/channel from Lake Kittamaqundi. The confluence of these two waterways is just south of the existing pathway. Little Patuxent River is a Class I Watershed with in-stream work restrictions from March 1st to June 15th.
- Forests – several forest stands are located throughout the study area. The location and quality of these forest stands were identified as part of the Environmental Enhancement Study.

Right-of-Way Information

The existing right-of-way for the pathway is owned primarily by the Columbia Association and Howard Research and Development Corporation. The minimum right-of-way width available is 50-feet, located primarily on the east side of US Route 29 for the connection to Oakland Mills.

Chapter 2. Findings

Transit System Impact Findings

Assuming a new connection is in place over Route 29, nine existing Howard Transit, MTA, and CMRT transit routes would be logical candidates for re-routing through Oakland Mills to and from Downtown Columbia – one of which already serves Oakland Mills. A tenth route is included in this evaluation: a new "Oakland Mills Connector" proposed by the "Bridge Columbia" group that would operate on 15-minute frequencies most of the day[1]. Each of these routes connects areas east of Route 29 today with Downtown Columbia (see Figure 1).

Transit Service Impacts

Based on the travel time evaluation of adding the new connection, two of the routes experience a reduction in travel time due to the bridge, while four routes have an increase, three have no change, and one is split: most trips on the Howard Brown route have an increase while some have a decrease.

More notable impacts occur to three routes:

- In the case of Howard Brown route trips serving the Columbia Medical Plan, the additional minute of travel time makes it difficult, but not impossible, for the route to meet its roundtrip cycle time of 120 minutes. This would pose a significant operational challenge on the route, and could degrade service quality overall if on-time reliability cannot be maintained.
- In the case of the Howard County Transit Silver route, the added travel distance and time due to operating over the transit bridge results in the route becoming unable to meet its required cycle time of 180 minutes due to insufficient recovery time. For this reason, the Silver Route is not a candidate for routing over the bridge.
- The Oakland Mills Connector service would experience a travel time savings from using Broken Land of slightly more than three minutes, which would reduce its one-way travel time from 11 minutes to 7 minutes. This would allow the route to attain 15 minute headways with the use of only one bus instead of two.

All told, a new connection over Route 29 could bring an average of 15 buses per hour throughout the day through Oakland Mills, or 169 daily buses and 64 daily shuttles. Peak load would be 28 buses per hour during commuting times.

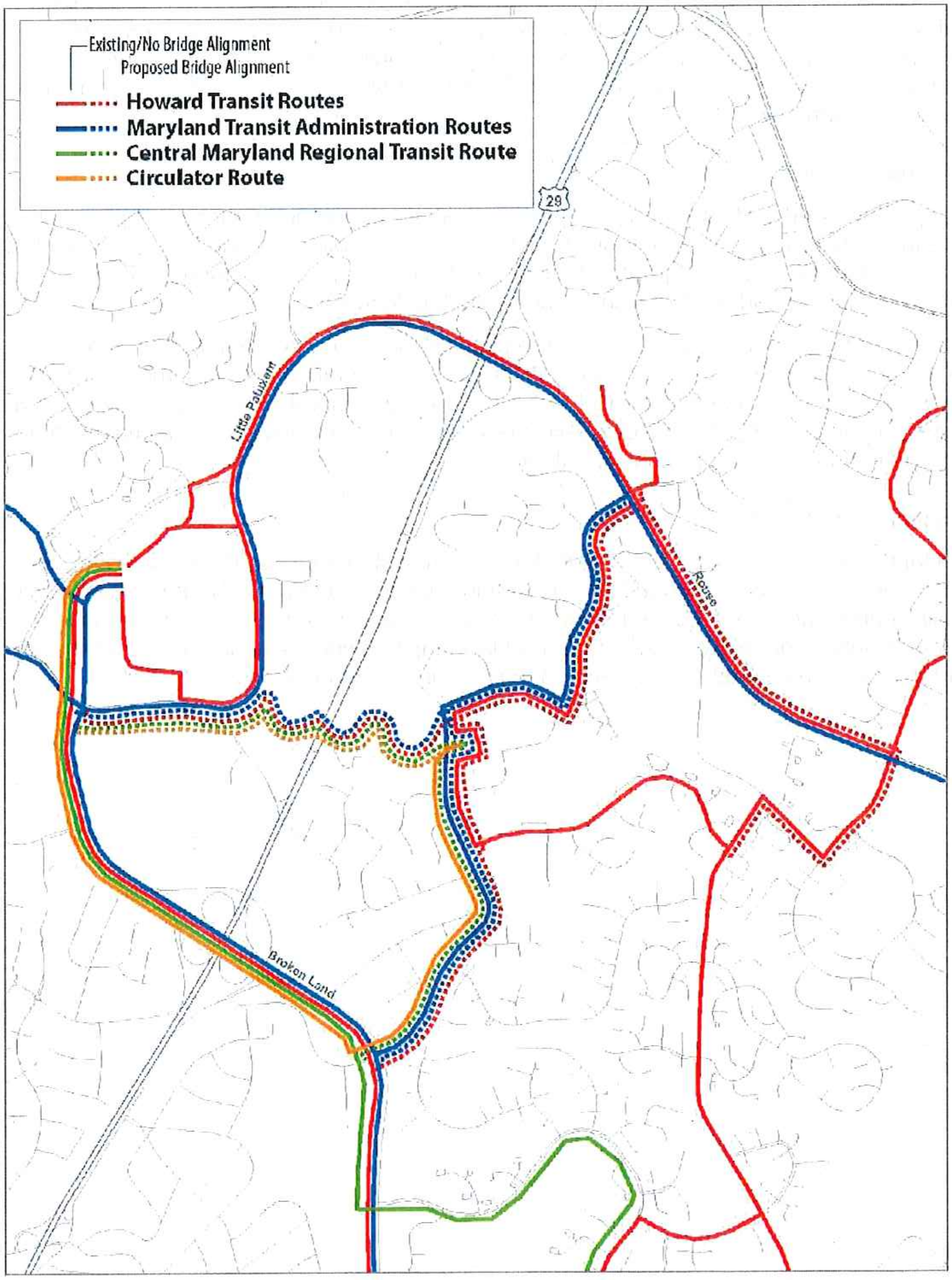
Ridership Impacts

In total, among all trips and services shifted to using the new connection – other than the Oakland Mills Connector – 100 new daily riders are gained, 130 are lost, and 328 riders continue to use the service, representing a net loss in ridership of 30 riders. If the new Oakland Mills Connector is included in the analysis, it would contribute to gaining 132 new

[1] For comparison purposes to current conditions when there is not a new connection over Route 29, the proposed bridge circulator is assumed to operate via Broken Land Parkway.

daily riders, losing 700 potential riders, and preserving 1,636 "existing" riders (assuming the Oakland Mills Connector had been operating on Broken Land Parkway originally).

Figure 1 Potential Re-Alignments of Howard Transit Service



Non-Motorized Access Findings

There are few non-auto connections between the Columbia Mall area and Oakland Mills Village Center, besides the existing path and pedestrian bridge across Route 29. Little Patuxent Parkway and Broken Land Parkway are intended mostly for motor vehicles with missing sidewalks and no bicycle facilities. There is only a single Howard County Transit through route that provides a circuitous (25 minute travel time) and infrequent (one hour headway) connection.

Existing Pathway

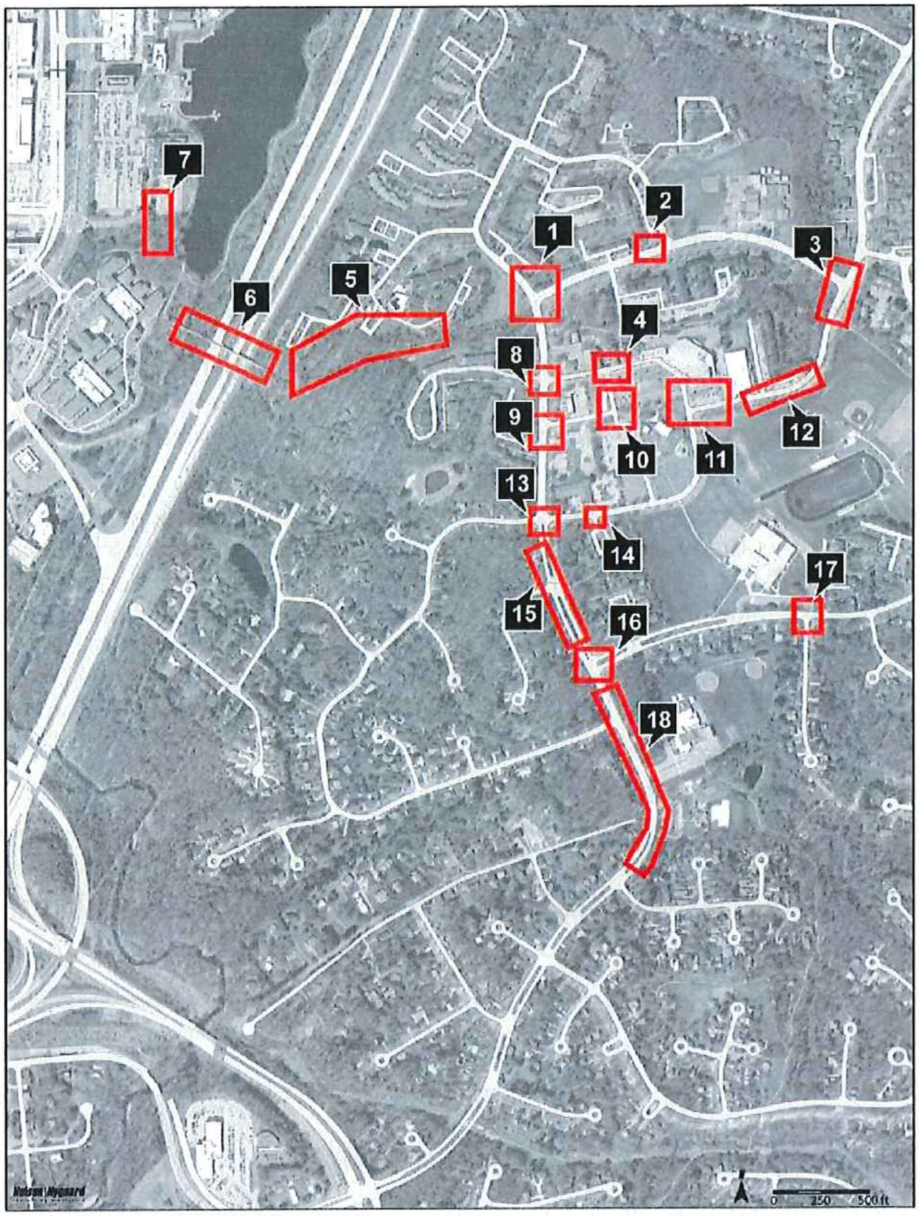
The pathway and bridge are reasonably maintained but present a number of physical design deficiencies, including poorly maintained lighting, a narrow width below minimum national standards, slopes greater than those allowed by the ADA, poorly delineated directional lanes, and a fully enclosed chain link enclosure.

While the Downtown Columbia end of the path splits to connect existing desire lines (and it will be noticeably improved as part of the Downtown Columbia redevelopment, including a significant extension of it westward to Howard County General Hospital), travelers arriving at the end of the path into Oakland Mills are greeted with an indirect connection with no indication of how to continue into Oakland Mills Village Center.

Walking Connections

Oakland Mills has an extensive sidewalk and path system that could connect with a new connection over Route 29, but it is indirect and curving – better suited for recreational trips rather than commuting trips. Some sidewalks do not always meet minimum standards for width or slope, and many crossings lack ADA-compliant curb ramps, crosswalk markings, and/or signing designed to warn drivers to look for pedestrians.

Figure 2 Needed Circulation Improvements in Oakland Mills and Downtown Columbia



Note: Numbers reference details in Appendix B.

Biking Connections

Cyclists arriving in Oakland Mills from a new connection over Route 29 will find an absence of bicycle facilities. Delineating space to dedicate bicycle lanes is needed throughout Oakland Mills, and many streets have the width to accommodate these markings, though only Stevens Forest Road has been marked with bike lane markings. However, these are periodically discontinuous. Almost no bike racks exist.

Transit Connections

In Oakland Mills, the central transit stop is convenient, comfortable, and has a shelter and stop amenities, including a route information panel and bench. However, the rest of the Oakland Mills stops could use many enhancements, including benches, shelters, trash receptacles, and route information. Most importantly, not all stops have sidewalks to wait on or crosswalks to connect to the stop.

Trip Generation Findings

When the standard ITE rates are applied to the existing uses in Oakland Mills plus the proposed land use program in Downtown Columbia, an estimated 235,000 average daily vehicle trips are produced. By developing a more accurate trip generation model that accounts for the local context factors of density, a mix of uses, transit service frequency, walking and biking facilities, and affordable housing, these two neighborhoods produce only 213,000 vehicle trips. Most of the characteristics of these two neighborhoods reduce the ITE trip generation rate, with the exception of residential density (which is considered by the model to be too sparse for the given land areas.)

Based on the evaluation of transit re-routing in Appendix A, the new connection over Route 29 could introduce as many as an additional 89 daily transit buses and 64 daily circulator shuttles in Oakland Mills, resulting in a greater reduction in vehicle trip generation rates and a total of 212,500 vehicle trips. Therefore, the new connection, introduction of a Oakland Mills Connector, and increase in fixed route bus service through Oakland Mills is predicted to remove 500 daily vehicle trips from the area's roadways, which represents an additional 0.2% reduction above the estimated 22,000 trips removed by Downtown Columbia's planned multi-modal transportation infrastructure.

Figure 3 Summary of Trip Impacts

	Future with Transit Bridge	Future without Transit Bridge	Impact of Transit Bridge
ITE Trips	234,934	234,934	
Trips Change	-22,300	-21,800	-500
Resulting Trips	212,634	213,134	
Reduction from ITE	-9%	-9%	-0.21%

Preliminary Engineering Findings

A number of factors must be considered in order for the existing pathway trail and bridge to be expanded or replaced as a connection that accommodates walkers, bikers, and transit vehicles safely.

Alignment Considerations

The exiting trail's horizontal alignment is winding, which is difficult to convert for larger vehicular use, thereby requiring areas in which the horizontal alignment must be straightened out to accommodate transit vehicles. This may involve land takings and grade engineering.

The pathway trail on the east side of Route 29 has a 50-foot right-of-way for the majority of its length. For the replacement of this trail with a transitway, it is anticipated that the typical section for the roadway would require a minimum width of 42-feet plus areas for lighting, landscaping, and drainage. It is likely that a total right-of-way width of greater that 50-feet would be needed, requiring land acquisition.

Ultimately, the preferred location and function of a new connection is dependent on the determination of an alignment for a new interchange with Route 29, which is less than 1,000 feet away. Close coordination with State authorities will be necessary.

It should also be noted that there are several key natural environmental resources located in the study area that should be avoided. If impacts are not avoidable, a detailed mitigation design plan will need to be prepared based on Federal and State criteria.

Structural Considerations

The existing structure likely will not be able to be expanded as part of a new connection over Route 29. Given the age of the structure and the size of the piers, it will be more cost effective to replace the entire structure to meet the latest design criteria, rather than trying to retrofit the existing structure.

A variety of construction methods are possible, but for this evaluation, both a simple steel girder method as well as a cable-stayed method are evaluated (the Bridge Columbia group has advocated for a gateway cable-stayed design.) Both technologies can span the necessary distances. A total length of approximately 625-feet of new structure with an estimated minimum width of 38-feet is required to span US Route 29, the Little Patuxent River and Lake Kittamaqundi spill way.

In addition, approach roadways are needed: approximately 710-feet long in Downtown Columbia and approximately 1700-feet long in Oakland Mills. The total length of the facility exceeds 3,000 feet.

Cost Estimates

Absent land acquisition costs, the total preliminary cost estimate for the transitway and cable-stayed bridge structure as proposed by Bridge Columbia is approximately $21.35 million.

To provide a traditional bridge crossing in this location, the cost would be approximately $10.6 million. To add cable-stay appearance aesthetic treatments would cost approximately $1.25 million more.

Chapter 3. Recommendations

In order to evaluate the impact of a new connection over Route 29, four studies were conducted: 1) a transit-diversion analysis to determine ridership impacts; 2) a trip-making analysis to determine overall shifts to transit; 3) a non-motorized connections evaluation to determine the sufficiency of existing and proposed connections to the bridge; and 4) a preliminary engineering evaluation to assess the constructability and cost of a new bridge.

These studies have demonstrated that the benefit of a new transit bridge is not significant, based on the following conclusions:

- While incurring construction costs that exceed $21M, transit ridership would increase nominally due to diversions from areas now served by transit.
- Overall area-wide diversion to transit in full build-out would only be 500 daily trips against a total of 235,000 daily project trips.
- Adding a new circulator between Downtown Columbia and Oakland Mills would reach many more potential riders by using existing roadways rather than a new bridge.
- Finally, pedestrian and bicycle connections to the bridge in Oakland Mills are not robust – making new connections and eliminating gaps in the Oakland Mills network would likely improve the attractiveness of walking and biking far more than replacing the existing bridge.

Given these conclusions, the following recommendations are advanced:

1) **A new connection over Route 29 that is dedicated to transit, walking, and biking is not recommended.** The overall benefit to walking and biking is minimal given that a walking and biking connection already exists on this alignment. The benefit for transit is very nominal, adding only 500 net new daily riders at the expense of at least 130 existing riders. Furthermore, if a new Oakland Mills Connector service were added, it would capture more potential riders traveling via Broken Land Parkway as opposed to the new connection over Route 29, while adding only 3 minutes to the trip.

2) **If a new Route 29 interchange is constructed between Broken Land Parkway and Little Patuxent Parkway that connects Oakland Mills to Downtown Columbia, it should become the new primary pedestrian and bicycle connection between the communities.** Any structure and connecting roadways should be designed with accommodating pedestrian and bicycle facilities that connect these communities. The recreational, social, economic, and environmental value of promoting non-motorized modes of transportation will benefit both Downtown Columbia and Oakland Mills.

3) **A series of walking and biking improvements on the Oakland Mills side of Route 29 would provide benefits as important as upgrading the bridge itself.** The pattern of streets and paths to the east of the bridge involve many longer curved and unconnected blocks that produce indirect walking and biking paths, limiting the efficiency and desirability of walking or biking for time-sensitive trips. Improvements to crossings, sidewalks, and path connections will increase the use of the existing bridges over Route 29.

4) **Advancing a Transportation Demand Management Plan (TDMP) for Downtown Columbia will help promote increased use of transit, walking, bicycling and ride-sharing.** It will be important to support the plan with appropriate facilities and amenities,

such as bus shelters, bike racks, pathways, on-site showers, bike lanes, etc. in both Downtown Columbia and Oakland Mills.

Appendix A. Transit Service Impacts

This appendix evaluates the positive and negative impacts of a proposed new Route 29 crossing on transit operations in the vicinity of the Downtown Columbia and Oakland Mills areas. The goal of the analysis is to determine whether the addition of a bridge serving transit will result in a net benefit or net cost to transit operational times and ridership on existing routes operated by Central Maryland Regional Transit (CMRT), Howard County Transit, and the Maryland Transit Administration (MTA).

Additionally, a new circulator service has been proposed by "Bridge Columbia" that would form a direct connection between Oakland Mills Village and Downtown Columbia (which will be referred to as "the Oakland Mills Connector"). It will be assumed to operate on 15 minute headways for 16 hours per day. This Oakland Mills Connector is different from the circulator shuttle studied for CEPPA #5; the purpose of including this unique version of the circulator is to identify the maximum possible impact of a transit bridge. For this reason, the Oakland Mills Connector described here travels between Downtown Columbia and Oakland Mills Village, while the circulator shuttle described in Part B travels only around Downtown Columbia.

Methodology

To determine impacts, this analysis examines and compares transit travel time and ridership under two conditions: one in which bus routes continue to use existing public roadway facilities, and one in which transit vehicles are routed over the proposed transit bridge. The transit bridge would connect Downtown Columbia with Oakland Mills across Route 29, approximately midway between the two existing highway crossings at Little Patuxent Parkway and Broken Land Parkway, near the existing pedestrian bridge. The bridge would be open only to transit, pedestrian, and bicycle traffic. The addition of the bridge would require building approximately 0.75 miles of new roadway from Little Patuxent, through nearby parking lots, over Route 29, and connecting to Stevens Forest Road. The circulator is assumed to operate on Broken Land Parkway in the no-bridge scenario.

The following routes, which currently pass through or nearby to Oakland Mills (plus the Downtown Columbia to Oakland Mills Connector), are evaluated:

<u>CMRT</u>:

- Route E

<u>Howard County Transit</u>:

- Red Route
- Brown Route
- Gold Route
- Silver Route

<u>MTA</u>:

- Route 310
- Route 320
- Route 915
- Route 929

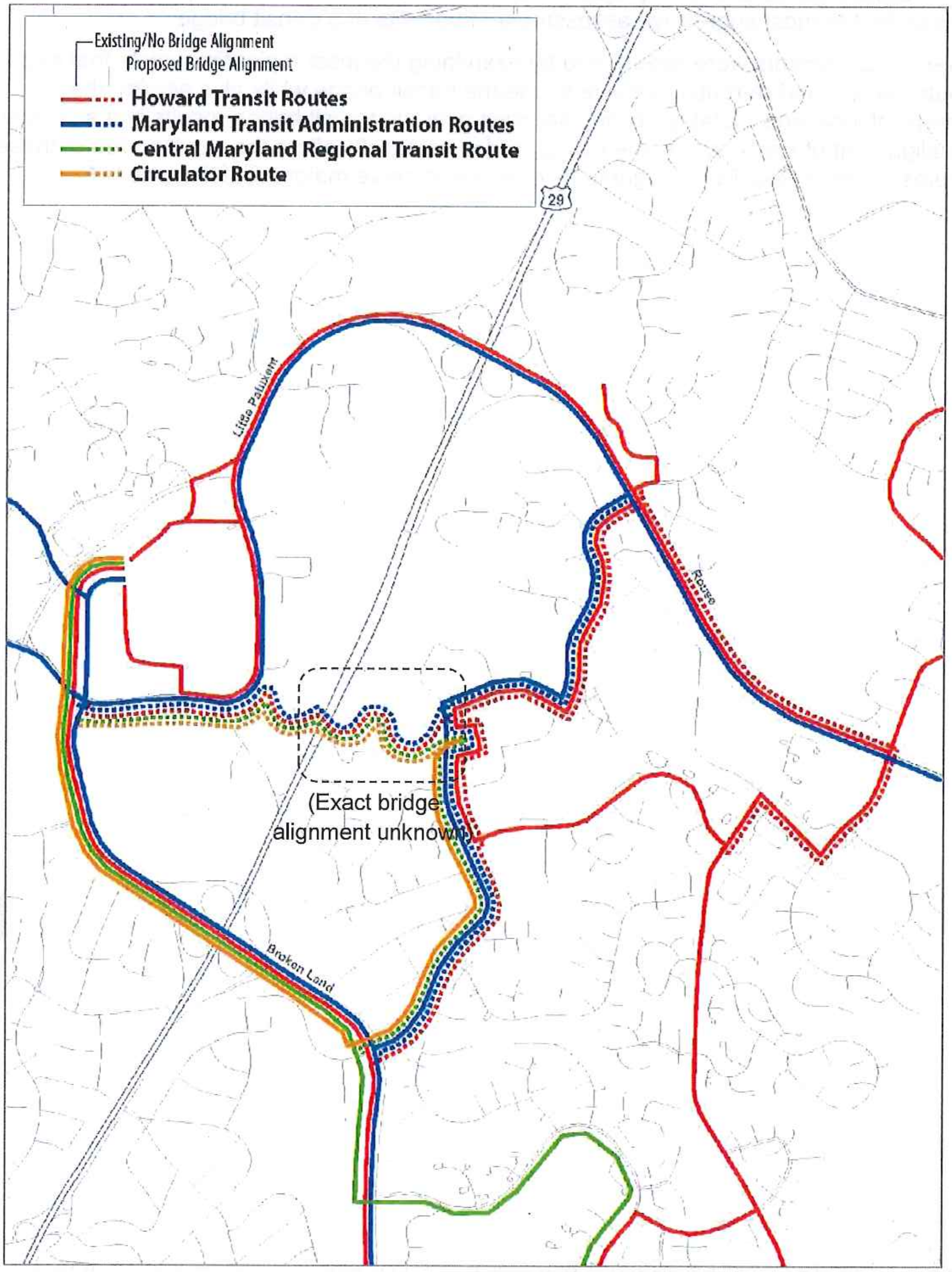
Figure 4 illustrates the two evaluation conditions (bridge and no bridge).Maps of each route individually are included in the Ridership Impacts section.

Impacts on existing transit routes are evaluated using existing population, land use, and circulatory pattern data. However, in the case of the proposed circulator, it was necessary to forecast impacts based on projected future build-out of Downtown Columbia. This allows for the most aggressive assessment of benefits of a transit bridge.

Revised alignments were determined by examining the most major timepoints that each route serves, and re-routing service to use the transit bridge while also serving the timepoint locations. Notably, routing services over the transit bridge results in a significant re-alignment of services in some cases, and substantially alters the service area of these routes. All re-routed transit alignments continue to serve major route timepoints.[2]

[2] In the case of the Howard County Transit Brown route, most trips serve Columbia Medical Plan while a minority of trips (those trips operating during peak periods) do not. All four MTA routes have express and non-express trips; all figures for MTA routes include only non-express trips that serve the Columbia Mall and (if applicable) the Oakland Mills area, in order to not significantly change the nature of the trips, as this would constitute a service reorganization.

Figure 4 Existing Transit Routing Near Oakland Mills and Proposed Routing over a Transit Bridge



A.1 Bus Travel Time Impacts

One potential benefit of a transit bridge is the opportunity to reduce transit route travel times on re-routed services. Travel time impacts on bus services are measured in two ways:

1. The total travel time of the route, end to end, under the bridge and no-bridge scenarios; and
2. The average change in travel time per resident served.

Total Route Travel Time

Total route travel time is measured to determine whether shifting the route to operate on the transit bridge will add or reduce the travel time for the route. Figure 5 describes the impact on route travel time based on the change in travel distance caused by diverting each route to operate over the transit bridge.[3]

[3] In cases where different trips may have different travel times during the day, the maximum travel time is used. One-way travel times on Howard Transit and CMRT routes are calculated as half of the roundtrip travel time for the route; in reality, one-way travel times may be slightly different.

Figure 5 Distance and Travel Time Change Due to Rerouting

	One-Way Trips per Day	Current One-Way Travel Time (mins)	One-Way Change in Travel Distance due to Bridge (miles)	One-Way Travel Time Difference (mins)	One-Way Travel Time with Bridge (mins)
CMRT Route E	27	48	1.1	3	51
Howard Red	36	55	0.0	0	55
Howard Gold	24	50	1.2	4	54
Howard Silver	34	81	1.1	4	84
Howard Brown (Columbia Medical Plan)	23	55	0.3	1	56
Howard Brown (Non-Columbia Medical Plan)	15	56	2.5	-9	47
MTA 310	5	55	0.0	0	55
MTA 320	2	72	0.0	0	72
MTA 915	19	120	1.1	3	123
MTA 929*	18	120	-2.3	-7	113
Circulator**	64	11	-0.9	-3	7

*Route 929 includes only the non-express trips that currently serve Oakland Mills

**"Current" figures for the Circulator route are based on a non-bridge case scenario wherein the circulator operates via Broken Land Parkway.

Two of the routes experience a reduction in travel time due to the bridge, while four routes have an increase, three have no change, and one is split: most trips on the Howard Brown route have an increase while some have a decrease:

- In the case of Howard Brown route trips serving the Columbia Medical Plan, the additional minute of travel time makes it difficult, but not impossible, for the route to meet its roundtrip cycle time of 120 minutes. This would pose a significant operational challenge on the route, and could degrade service quality overall if on-time reliability cannot be maintained.
- In the case of the Howard County Transit Silver route, the added travel distance and time due to operating over the transit bridge results in the route becoming unable to meet its required cycle time of 180 minutes due to insufficient recovery

time. For this reason, the Silver Route is not a candidate for routing over the bridge.

- The circulator service would experience a travel time savings from using Broken Land of slightly more than three minutes, which would reduce its one-way travel time from 11 minutes to 7 minutes. This would allow the route to attain 15 minute headways with the use of only one bus instead of two.

Aggregate Change in Travel Time per Resident per Day

The aggregate change in travel time per resident served indicates the aggregate savings or cost in travel time for existing riders (regardless of boarding location) that is caused by re-routing the service over the transit bridge. This is calculated by multiplying the change in travel time for each route by the number of daily riders on the route. This analysis applies only to existing riders, and not to future riders; impacts on anticipated future ridership, however, are described in a later section.

To determine this impact for the circulator service, the following steps were followed:

1.) Ridership first had to be calculated, since the circulator does not currently exist. To determine ridership, the number of transit trips produced from Oakland Mills to Downtown Columbia was estimated based on the two dominant types of trips: shopping trips and work trips (The number of trips made by Downtown Columbia residents to Oakland Mills is estimated to be negligible due to the absence of strong destinations or employment in the area.)

2.) To estimate shopping trips, data from the 2001 National Household Transportation Survey were used. These figures estimate the number of shopping trips per household per day. Average figures for the number of persons per household from the 2006-2008 American Community Survey were then applied to the Downtown Columbia unit count to determine the total population (7,943)[4]. Multiplying these two figures derives an estimate of the number of personal shopping one-way trips per person per day (0.743) and an aggregate total of daily shopping trips (5,665). To estimate which shopping trips go to Downtown Columbia versus other destinations, an ideal figure of 50% of these trips was used (2,832); and of these, ideally 50% would be taken on transit (1,416). Since these would be round-trips, the figure is halved, for a total of 708 round-trip shopping rides on transit per day.

3.) To estimate work trips, the number of existing work round-trips between Oakland Mills and Downtown Columbia (currently 250, based on Census Transportation Planning Package 2000 data) was multiplied by the ideal share of 50% to estimate the percentage of these that would be taken by transit in the future (125). Additionally, the number of new jobs created in Downtown Columbia as a result of build-out of the Downtown Columbia development plan is 5,361, based on development square footage figures by land use provided by GGP, combined with estimates of number of employees per square foot provided by the US Energy Information Administration. To estimate work trips based on job growth, it is optimistically estimated that 25% (1,005) of these will be held by new residents of

[4] Based on the five Transportation Analysis Zones (a geographic unit) within closest proximity of Oakland Mills Village. The land area in these zones totals 1,142 acres.

Oakland Mills. It is then estimated that 50% of the Oakland Mills jobs will be transit commute trips, resulting in 503 new round-trip work transit trips per day.

Therefore, the total estimated number of round-trip rides on the Downtown Columbia to Oakland Mills Village circulator is 1,336 (708 + 125 + 503).

Figure 6 describes the change in travel time per route, the number of riders on the route (2009 figures), and the total average change in travel time per resident served per day. In the case of the Howard County Transit Brown route, since no trip by trip ridership data exists, ridership for the whole route was divided proportionally between those trips that serve Columbia Medical Plan and those that do not.

Figure 6 **Average Change in Travel Time per Resident Served per Day at Full Build-Out of Downtown Columbia in 2045**

	Route Ridership (2009)	Travel Time Difference (mins)	Aggregate Change in Travel Time per Resident per Day
CMRT Route E	357	3	1,129
Howard Red	494	0	0
Howard Gold	148	4	640
Howard Silver	582	4	2,147
Howard Brown (Columbia Medical Plan Trips)	300	1	323
Howard Brown (Non-Columbia Medical Plan Trips)	195	-9	-1,759
MTA 310	169	0	0
MTA 320	33	0	0
MTA 915	791	3	2,644
MTA 929	769	-7	-5,640
Subtotal	3,838	N/A	-515
Oakland Mills Connector	1,336	-3	-4,314
Total	5,174	N/A	-4,829

A.2 Ridership Impacts

Ridership impacts are measured by determining the number of area residents who would gain service and the number who would lose service for each route. To determine a catchment area, a half-mile radius is drawn around each route. Residential population is based on figures from the 2001 National Household Travel Survey (in turn based on the 2000 Census), using a geographic unit called the Transportation Analysis Zone. The number of residents within the half mile radius of transit is based on the population of the whole zone multiplied by the proportion of the zone's land area that is within the transit radius. Wetland, parkland, roads, and water are excluded from the radius area, since people do not live in these areas. Additionally, ridership gains are increased by an additional 15% of the resulting increase in ridership (if the result is indeed an increase rather than a decrease in ridership), which is a credit for the intensified frequency of services that would be provided by consolidating services through a single corridor.

Notes:

1.) The HCT Silver route is not examined because it is not a candidate for rerouting due to a resulting travel time that exceeds allowable cycle time if routed over the transit bridge, as described previously.

2.) For MTA routes, ridership in the study area is based on stop-by-stop ridership counts taken in September 2009.

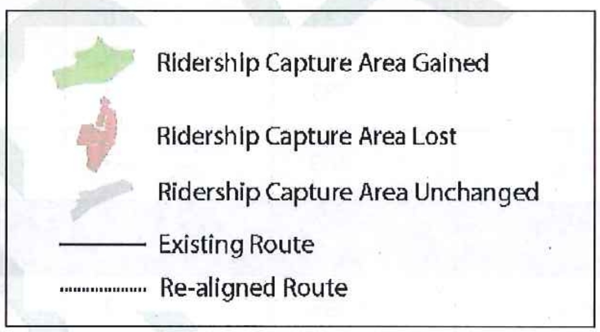
3.) For CMRT and HCT routes, no detailed ridership figures are available. Ridership in the study portion of these routes which would be affected by rerouting over the transit bridge is calculated by multiplying the geographic proportion of the route affected by re-routing against the total route ridership to derive an approximate segment ridership (This calculation necessarily assumes that ridership is constant along all areas of the route.)

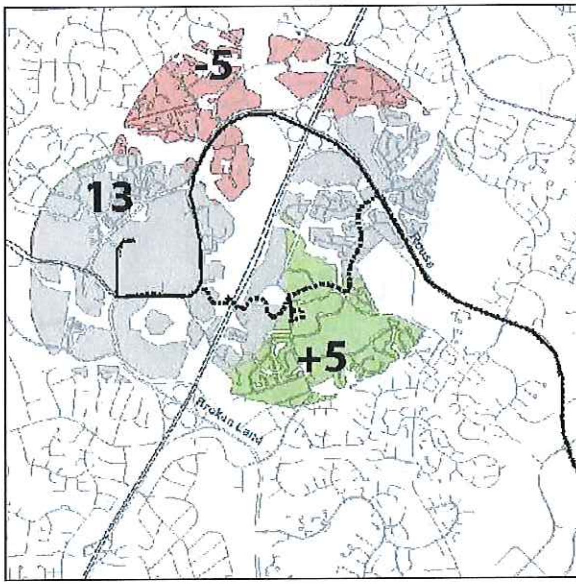
4.) For the circulator, ridership is calculated as described in the previous section.

The next pages (Figure 7) illustrate the impacts on average daily ridership levels on each route. Green areas show new areas served by diverting the route; red areas show areas no longer served; and grey areas show areas served in both the old and new routing. The number of average daily riders gained, lost or remaining constant, respectively, are indicated.

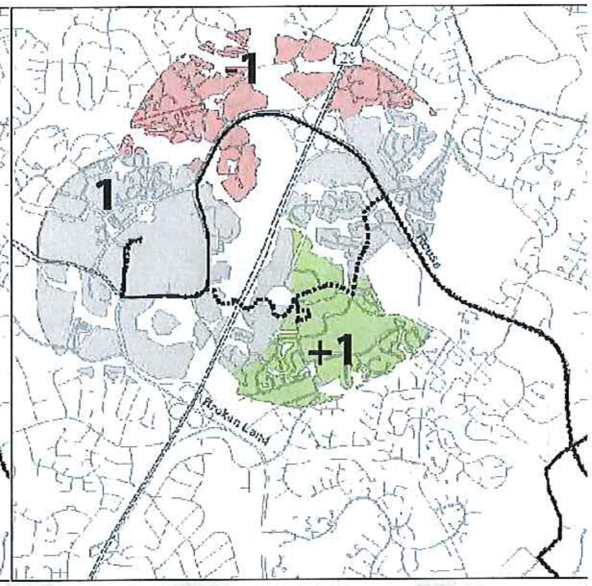
Figure 7 Impacts on Number of Transit Trips by Route

Legend:





MTA Route 310



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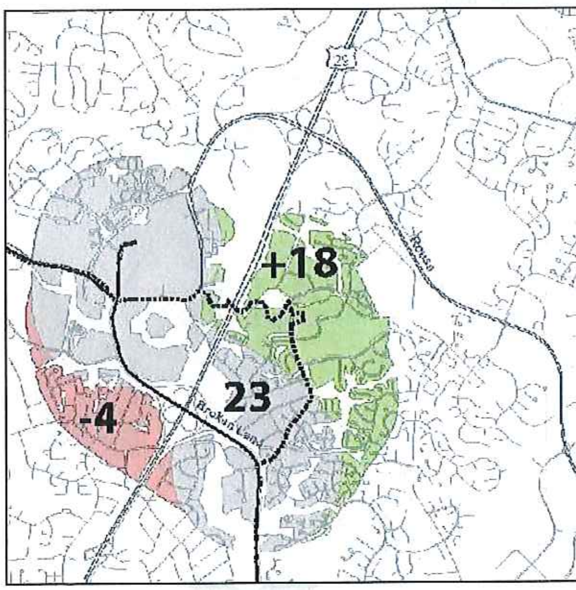

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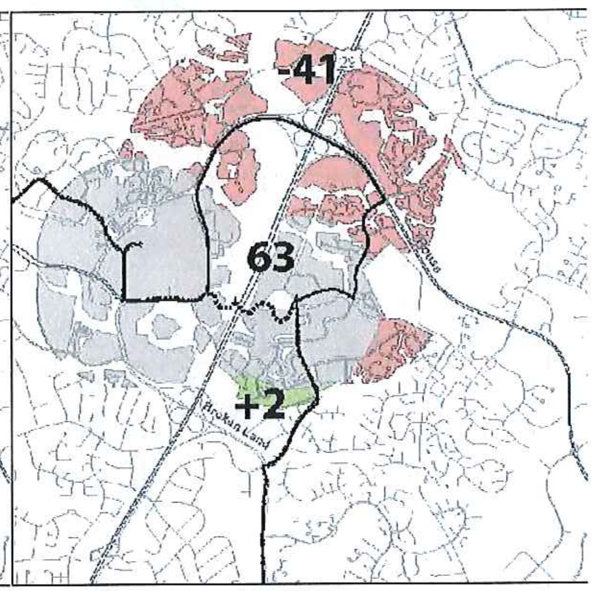
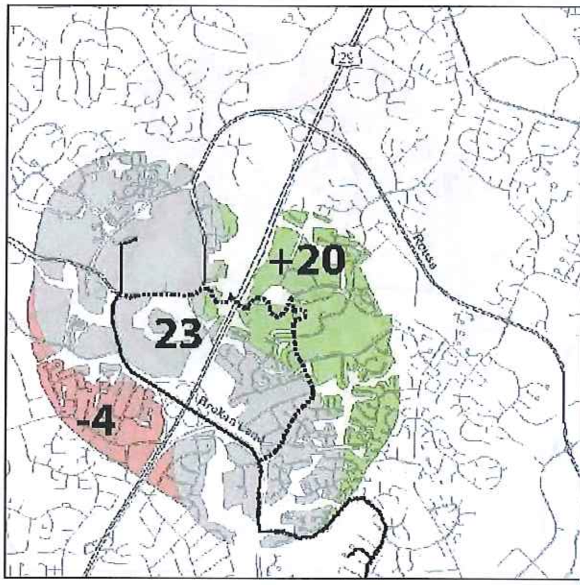
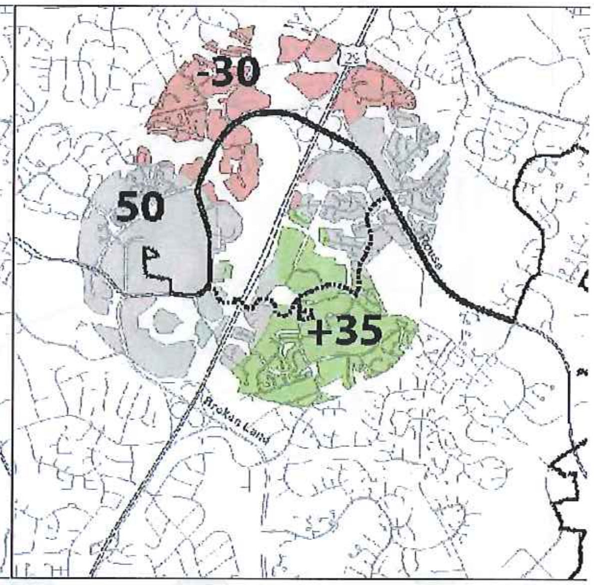


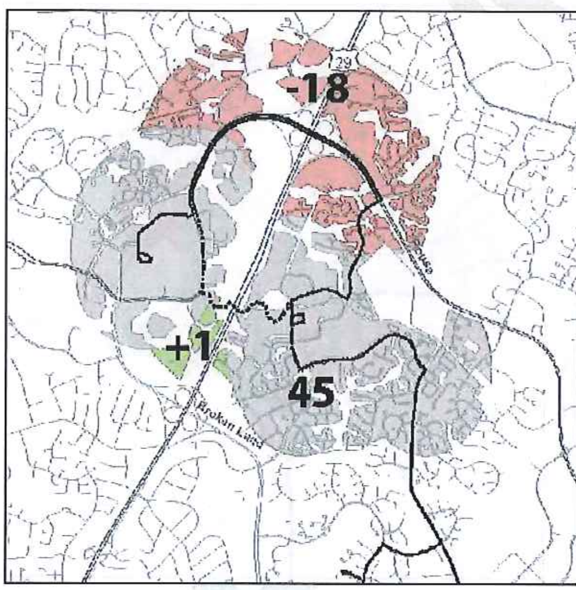
MTA Route 929



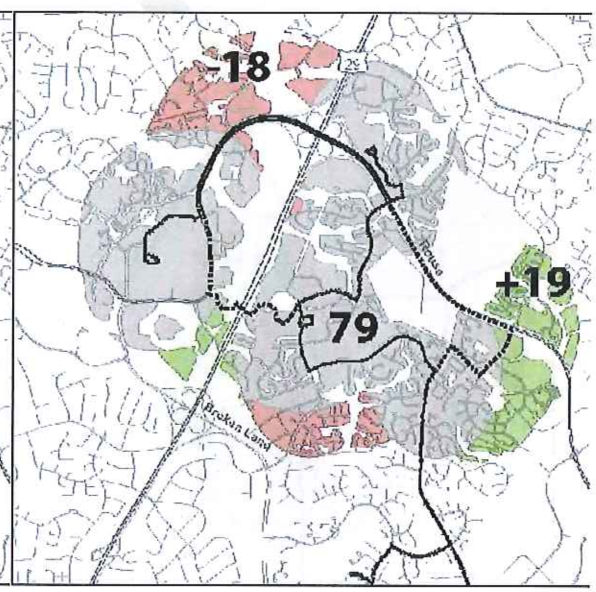
CMRT Route E



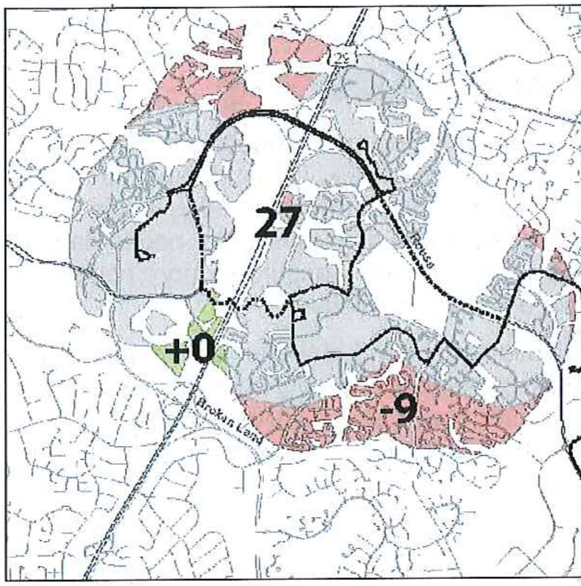
HCT Red Route



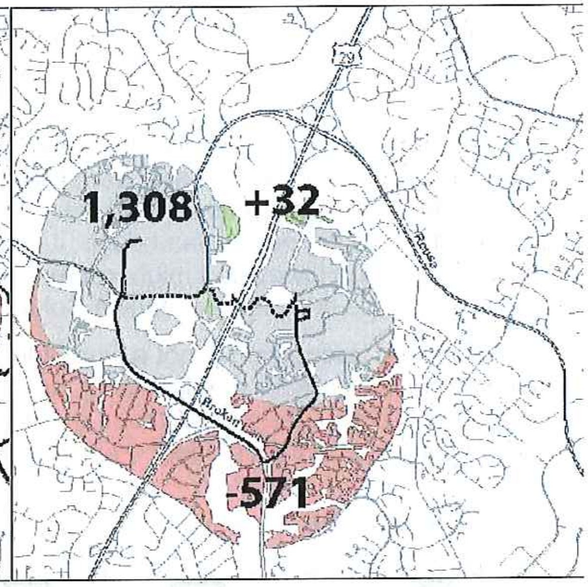
HCT Brown Route – Non-Columbia Medical Plan Trips



HCT Brown Route - Columbia Medical Plan Trips



HCT Gold Route



Circulator

Three routes gain riders overall (MTA Route 915, CMRT E Route, HCT Red Route); two routes gain and lose an equal number of riders (MTA Route 310 and 320); and three routes lose riders overall (MTA 929, HCT Gold Route, Circulator).

A.3 Key Findings

- A new connection over Route 29 could bring an average of 15 buses per hour throughout the day through Oakland Mills, up to a peak of 28 buses per hour at commute times.
- In the case of the Oakland Mills Connector service, the results could be interpreted as meaning that the ridership would be much higher if the route traveled via Broken Land Parkway due to the additional ridership capture area.
- The Howard County Transit Brown route loses riders on its trips that do not include Columbia Medical Plan and gains a single rider among trips that do serve Columbia Medical Plan.
- In total, among all trips and services shifted to using the transit bridge – other than the Oakland Mills Connector – 100 new daily riders are gained, 130 are lost, and 328 riders continue to use the service, representing a net loss in ridership.
- Including a new Oakland Mills Connector, the numbers rise to 132 new daily riders gained, 700 lost, and 1,636 riders continuing to use the services.

Appendix B. Evaluation of Non-Motorized Access

This appendix reviews the pedestrian and bicycle conditions and connections that are available for connection to a new transit bridge across Route 29. The bridge would accommodate two-way bus traffic, bikers, and walkers. Given that this bridge would replace the existing pedestrian bridge, it does not eliminate any gaps in the pedestrian and bicycle network. However, it might represent an opportunity to encourage more pedestrian and bicycle trips between Downtown Columbia and Oakland Mills.

The proposed connection is not a workable solution in a stand-alone environment. It will become part of broader transit, biking, and walking networks, and its success depends upon how well it connection to those existing or proposed networks. Absent good connections beyond each bridge approach, the bridge would be an unfulfilled investment.

Methodology

In order to encourage the use of a new bridge by pedestrians and bicyclists, a complete, convenient, and safe non-motorized transportation network is needed that enables people to get to their destinations with ease. Downtown Columbia is being designed with a fine grained network of development blocks to prioritize pedestrians and bicycles over vehicular movements. This network would be expected to connect directly to a new connection over US Route 29.

To the east in Oakland Mills, the existing walking and biking network is mature and not expected to change. Its ability to provide safe and easy connections between the bridge and destinations in Oakland Mills must be evaluated in order to ensure that the investment in a new bridge connection is appropriate for the level of walking and biking that is occurring or capable of occurring in Oakland Mills. In order to assess the quality of this network, detailed field evaluations were conducted in the fall of 2010. In addition to the extent and completeness of walking and biking facilities, the consultant team evaluated where gaps existed in the system, especially with regard to unmet desire lines where new connections might be needed.

B.1 Existing Conditions

There are few non-auto connections between Downtown Columbia and Oakland Mills Village Center today:

- Little Patuxent Parkway and Broken Land Parkway – these are primarily arterial roadways, intended mostly for motor vehicles. Each provides a circuitous (over 2 miles) walking/biking route, that is especially threatening to pedestrians and dangerous for cyclists on the portions that include these parkways.
- A single Howard County Transit through route – this provides only a circuitous (25 minute travel time), infrequent (one hour headway) connection.
- The existing path and bridge across Route 29.

In evaluating the connections between these two centers, the existing path is obviously the most likely multi-modal connection to serve non-automobile travelers because it is more direct. Therefore, the evaluation of existing conditions focuses on the path alignment and its connections.

Multi-Use Trail and Bridge

The most important element in this access evaluation is the trail and bridge between Downtown Columbia and Oakland Mills. The existing pathway connects Downtown Columbia from the Little Patuxent Parkway in Downtown Columbia to Stevens Forest Road in the Village of Oakland Mills. It crosses the Little Patuxent River and US Route 29. This trail connects directly with the trail network partially surrounding Lake Kittamaqundi and serves both recreational as well as destination trips associated with the Columbia Mall, Merriweather Post Pavilion, restaurants, commercial properties, residences, the lake, and the Village of Oakland Mills.

The existing pathway and bridge are reasonably maintained but present a number of physical design deficiencies which handicap their potential. The lighting on the bridge is not well maintained, discouraging the path's use at night, especially by women. The trail falls short of the AASHTO recommended width of 10 feet, or even the minimum of 8 feet. Several points along the trail have a slope greater than allowed under the ADA maximum slope guidelines (see inset). Lanes are not delineated to separate pedestrians from bicyclists or safely separate higher speed users in opposite directions. In general, roadway crossings, signage, lighting, and amenities are deficient, and the bridge itself is fully enclosed in chain link fence with only the ends open.

ADA Maximum Slopes
8.3 percent for a maximum of 61.0 m (200 ft)
10 percent for a maximum of 9.14 m (30 ft)
12.5 percent for a maximum of 3.05 m (10 ft)

Figure 8 Examples of Trail Slope and Chain Link on Bridge

Certain improvements to the existing pathway are necessary to make it meet minimum safety and accommodation standards:

- Widen the paved surface of the path to at least 8 feet, preferably to 10-14 feet to encourage a wide range of users.
- Implement opposite direction travel-lane striping and stop and yield markings where applicable.
- Install new pedestrian-scale lights.
- Add wayfinding signage directing travelers to Oakland Mills Village Center, Downtown Columbia, and other key destinations.

- Add furniture, trashcans, and other amenities.
- Clear overgrown brush and landscaping to provide more sightlines along and into the path for security.

Access to Oakland Mills Village Center

As the existing pathway leading from Downtown Columbia to Oakland Mills Village Center emerges from the woods at Stevens Forest Road, it connects to a perpendicular north/south sidewalk, rather than continuing east across the road (an abandoned crosswalk landing exists, but the only marked crosswalk is 80-feet north). The visible dirt paths leading from the trailhead indicate the unmet need for a connection eastward. The traveler arriving here has no indication of where to cross or access an ultimate destination, including Oakland Mills Village Center.

Figure 9 Unmet Desire Lines

Circulation Within Oakland Mills

Walking

Figure 10 Mid-block crossing, White Acre Road

Mid-block crossing, White Acre Road. This crossing has highly visible pedestrian crossing indication signs, high visibility crosswalk markings, and curb extensions, but is lacking ADA compliant curb ramps due to the lack of detectable warning strips at the base of the ramp.

Oakland Mills has an extensive – though indirect – sidewalk and path system (Figure 12). Coupled with a recreational trail network, the walking system connects sites within the same block well, though connections to other blocks, the Village Center, and the path to Downtown Columbia are indirect.

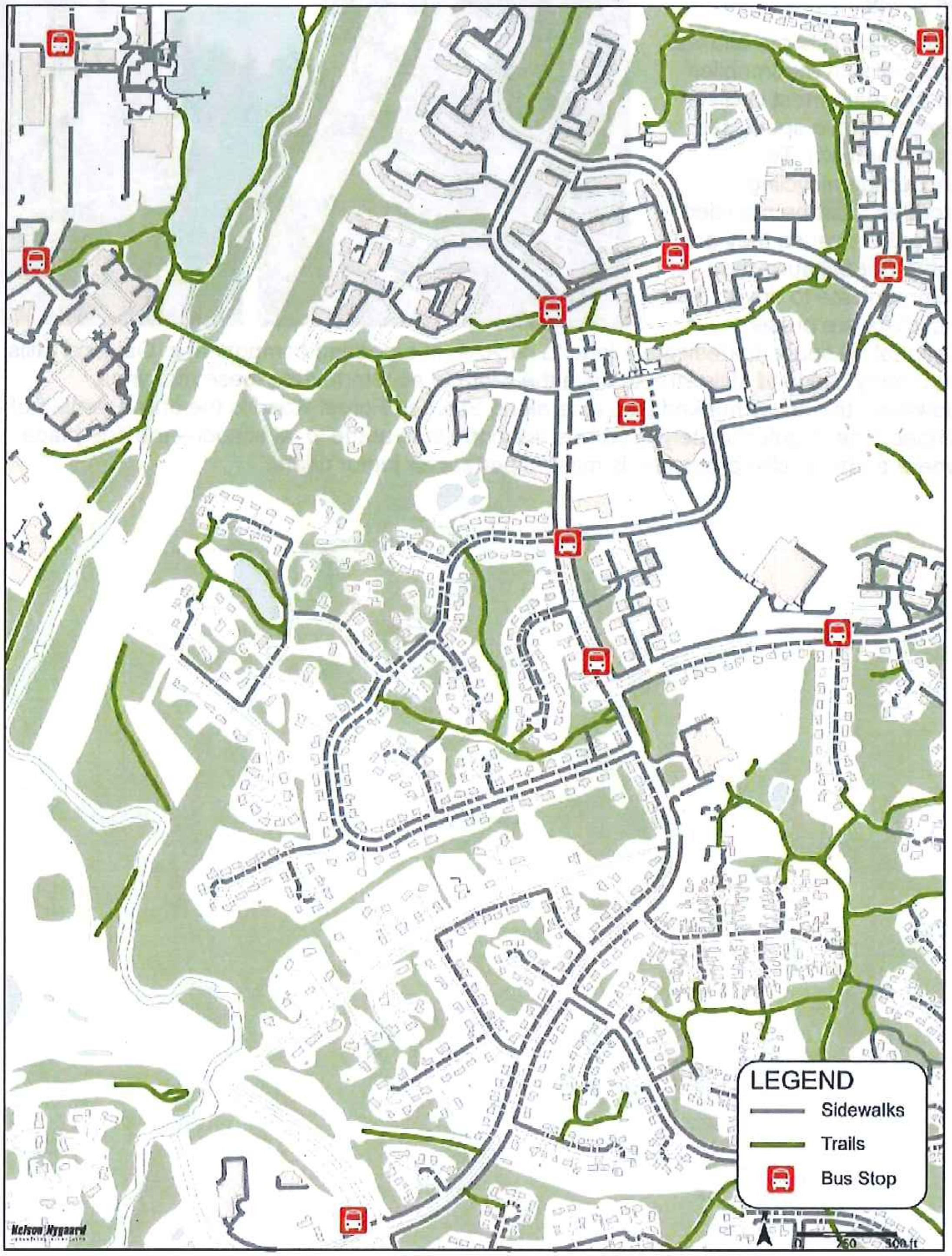
Some sidewalks do not always meet accessible minimum standards for width or slope. Every walkway that crosses a roadway requires ADA-compliant curb ramps and the crossings should be marked with crosswalks and – in most cases – signing designed to warn drivers to look for pedestrians. Many crossings in Oakland Mills are deficient in at least one of these measures.

Bicycling

Figure 11 Stevens Forest Road Bike Lane

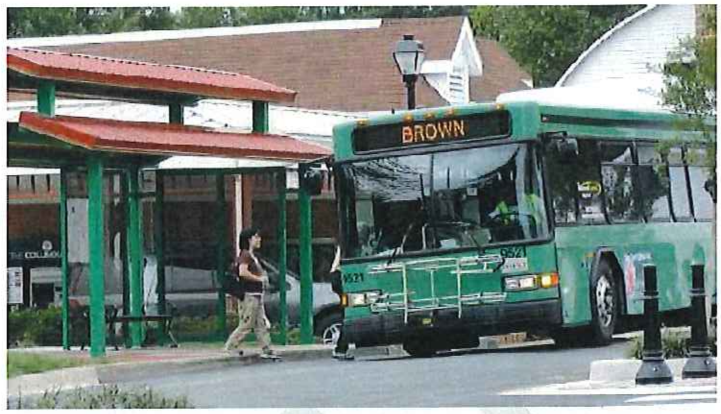
While bicyclists are allowed to travel with automobiles on the road, most cyclists prefer to have space set aside for them. To encourage bicycling, facilities must be provided, not only because they are safer, but because they communicate to drivers that bicyclists are present. Delineating space to dedicate a lane to bicycles is a needed component in Oakland Mills, and many Oakland Mills streets have the width to accommodate these markings. However, the newly marked bike lane along Stevens Forest Road is the only example of a striped lane. It unfortunately becomes discontinuous at the local school – the one place where added cyclist protection is most important for junior riders.

Figure 12 Oakland Mills Multi-Modal Network



Public Transportation

Figure 13 Public Transit Stop - Oakland Mills



Public transportation is a critical component for developing an attractive pedestrian and bicycling environment. All transit users are pedestrians at some point as they walk between bus stops and their destinations. The stops themselves also can be contributing factors to the overall environment providing both amenities (benches, lighting, trash barrels) and the kind of street level activity that makes sidewalks vibrant.

In Oakland Mills, the central transit stop is convenient, comfortable, and has a shelter and stop amenities, including a route information panel and bench. However, the rest of the Oakland Mills stops could use many enhancements, including benches, shelters, trash receptacles, and route information. Most importantly, not all stops have sidewalks to wait on or crosswalks to connect to the stop.

B.2 Needed Improvements

The Downtown Columbia Plan makes significant steps in developing a pedestrian and bicycle friendly street and circulation network. An improved pedestrian/bicycle connection across Route 29 would aid travelers to and from Oakland Mills. Yet in order for this investment to truly be successful in attracting non-auto users, the connections within Oakland Mills are much more critical as potential users will make their mode choice at the beginning of their trip. East of the existing bridge over Route 29, few strong connections into Oakland Mills exist that could be seen as viable for non-auto users. While a new or improved bridge helps a part of the journey, the majority of time spent walking and biking would be on Oakland Mills' existing network that lacks direct connections and includes many deficiencies.

This section identifies and locates a series of specific improvements to the Oakland Mills multi-modal network which would be necessary to attract new users to a new or improved bridge. These are identified in Figure 14 and described further below.

Figure 14 Circulation Improvements Reference Map

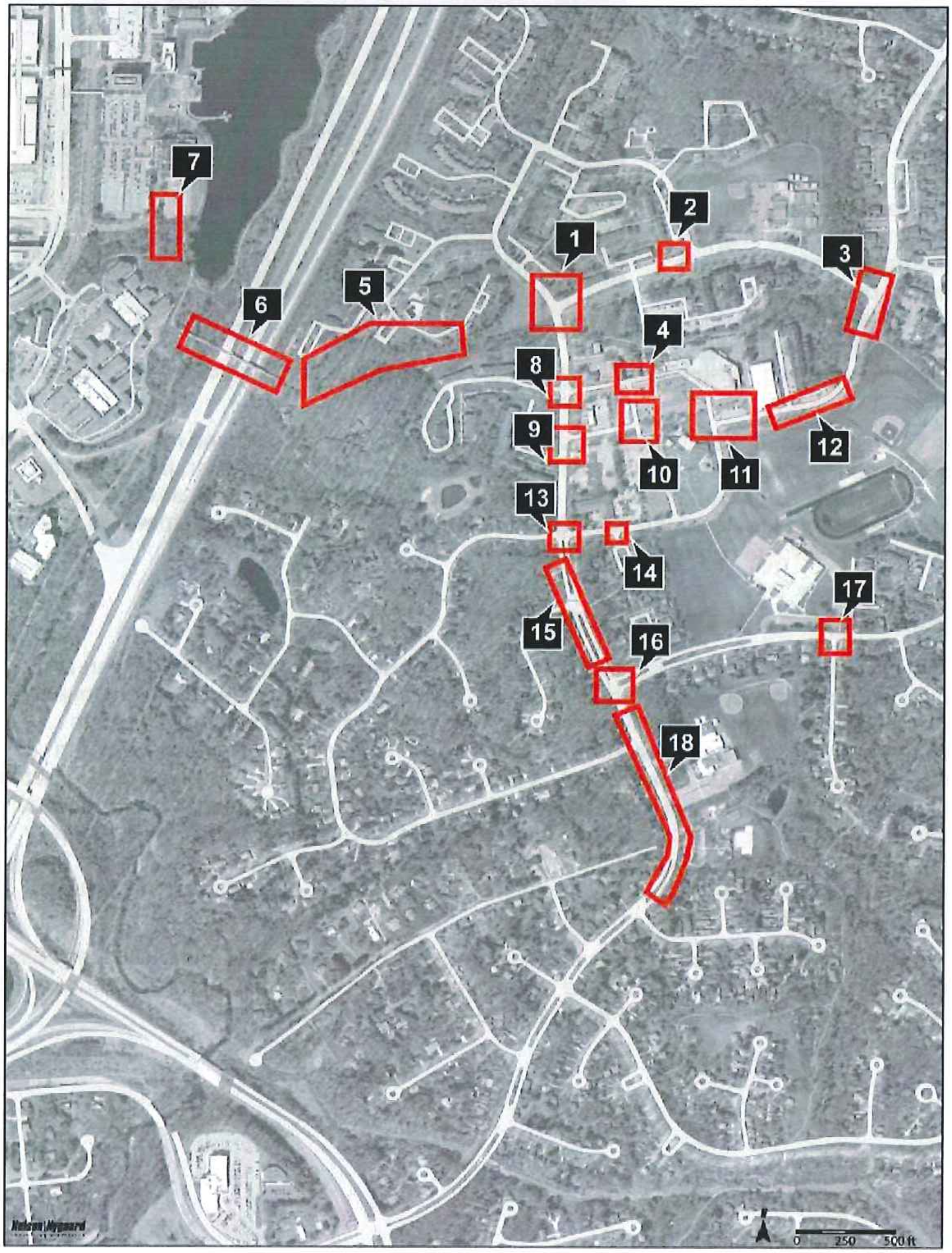


Figure 15 Location 1

- Add crosswalks and ADA compliant curb ramps on all three legs
- Formalize the informal paths by paving the dirt areas worn out by repeated walking
- Consider realigning the trailhead with the opposite sidewalk across Stevens Forest
- Consider traffic calming treatments on all approaches
- Consider bus stop amenities such as shelters, benches, route information, and a waiting surface

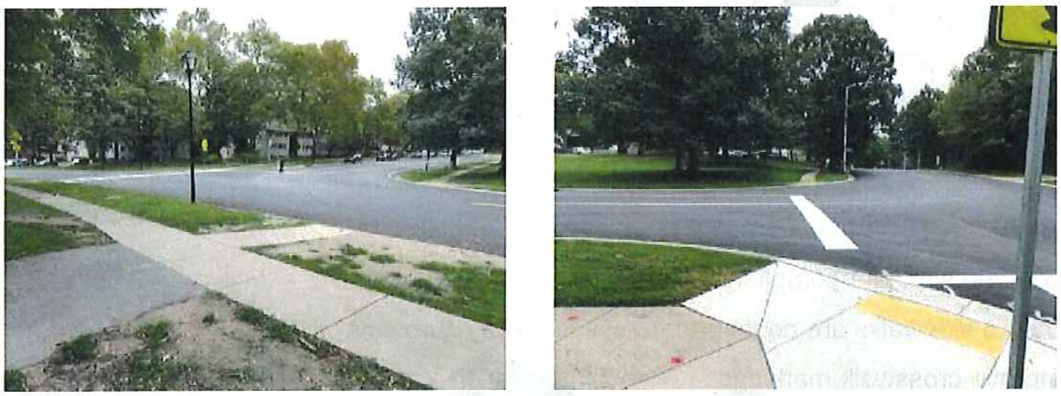


Figure 16 Location 2

- Consider bus stop amenities such as shelters, benches, route information, and a waiting surface

Figure 17 Location 3

- Add crosswalks and ADA compliant curb ramps on all three legs
- Consider bus stop amenities such as shelters, benches, route information, and a waiting surface

Figure 18 Location 4

- Examine slope for compliance with ADA
- Ensure sidewalks are continued across driveway curb cuts
- Improve crosswalk markings

Figure 19 Location 5

- Widen the walkway to the AASHTO recommended 10-feet for a multi-use trail, consider a larger width (12 to 14 feet)
- Place pavement markings delineating lanes for opposing directions
- Explore options for pedestrian lighting along the wooded section of the trail
- Ensure the slope is ADA compliant from end to end

Figure 20 AASHTO Multi-Use Path Guidelines

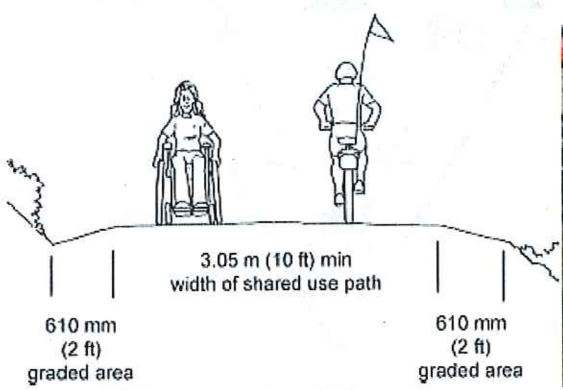
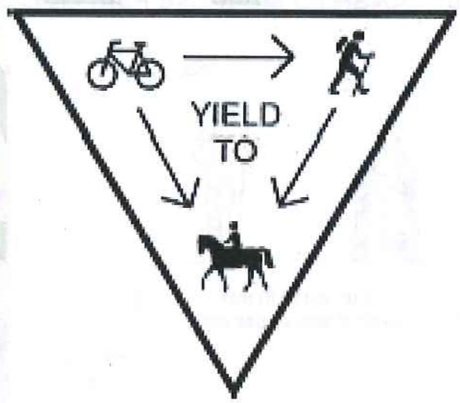


Figure 21 Location 6

- Replace lighting system and provide routine maintenance
- Consider treatments other than chain link fencing over the bridge

Figure 22 Location 7

- Provide delineation and signs designating behavior within this large three-way intersection



Location 8 (no images)

- Add crosswalks and ADA compliant curb ramps on all four legs

Figure 23 Location 9

- Add crosswalks and ADA compliant curb ramps on all three legs

Figure 24 Location 10

- Consider real-time information display on next bus arrival
- Add additional bench(es)

Figure 25 Location 11

- Add crosswalks and ADA compliant curb ramps on all three legs

Figure 26 Location 12

- Ensure that the sidewalk is flat without root damage
- Consider permeable paving materials to maintain healthy roots for these mature trees
- Widen sidewalk to ADA required width

Figure 27 Location 13

- Add crosswalks and ADA compliant curb ramps on all four legs
- Consider bus stop amenities such as shelters, benches, route information, and a waiting surface

Location 14 (no images)

- Add a crosswalk and ADA compliant curbs from the housing to the Village Center

Figure 28 Location 15

- Add bicycle lane pavement markings
- Consider widening the bike lane
- Consider moving the bike lane to the curb. If parking is necessary, placing parking between the bike lane and travel lane
- Consider bus stop amenities such as shelters, route information, and a waiting surface

Location 16 (no images)

- Add crosswalks and ADA compliant curb ramps on all four legs

Location 17 (no images)

- Consider bus stop amenities such as shelters, benches, route information, or even a waiting surface
- Add crosswalks and ADA compliant curb ramps on all three legs

Figure 29 Location 18

- Add bicycle lane pavement markings
- Consider widening the bike lane
- Consider moving the bike lane to the curb. If parking is necessary, have parking between the bike lane and travel lane
- Continue the bike lane past the school and connect it to the northern portion of the bike lane

B.3 Key Findings

- There are few non-auto connections between the Columbia Mall area and Oakland Mills Village Center, besides the existing path and pedestrian bridge across Route 29. Little Patuxent Parkway and Broken Land Parkway are intended mostly for motor vehicles with missing sidewalks and no bicycle facilities. There is only a single Howard County Transit through route that provides a circuitous (25 minute travel time) and infrequent (one hour headway) connection.
- The existing pathway and bridge are reasonably maintained but present a number of physical design deficiencies, including poorly maintained lighting, a narrow width below minimum national standards, slopes greater than those allowed by the ADA, poorly delineated directional lanes, and a fully enclosed chain link enclosure.
- While the Downtown Columbia end of the path splits to connect existing desire lines (and it will be noticeably improved as part of the Downtown Columbia redevelopment), travelers arriving at the end of the path into Oakland Mills are greeted with an indirect connection with no indication of how to continue into Oakland Mills Village Center.
- Oakland Mills has an extensive sidewalk and path system, but it is indirect and curving – better suited for recreational trips rather than commuting trips. Some sidewalks do not always meet accessible minimum standards for width or slope, and many crossings lack ADA-compliant curb ramps, crosswalk markings, and/or signing designed to warn drivers to look for pedestrians.

- Delineating space to dedicate a lane to bicycles is a needed component in Oakland Mills, and many Oakland Mills streets have the width to accommodate these markings, though only Stevens Forest Road has been marked with non-standard bike lane markings that are periodically discontinuous.
- In Oakland Mills, the central transit stop is convenient, comfortable, and has a shelter and stop amenities, including a route information panel and bench. However, the rest of the Oakland Mills stops could use many enhancements, including benches, shelters, trash receptacles, and route information. Most importantly, not all stops have sidewalks to wait on or crosswalks to connect to the stop.

B.4 Summary

This evaluation of the non-motorized network reveals a number of missing or insufficient connections that impact the ability of the non-motorized network in Oakland Mills to supply adequate and safe means for non-automobile use of a new Route 29 connection. A number of other improvements would need to be made to support the investment in a new connection.

Appendix C. Trip-Making Impact

As Downtown Columbia develops, the level of activity in the center will grow considerably. More people will live in the increased housing stock; more guests will stay at hotels; employment will grow as office space expands; and more customers will go to new shops and restaurants. This liveliness will be accompanied by a significant increase in traffic. A properly designed parking and transportation demand management plan will limit the growth in traffic and its impacts on the regional transportation network.

The following assessment reports the results of a traffic study looking at the impact of a transit bridge on the volume of traffic in Columbia. It is to be expected that a transit bridge – and the potential resulting increase in transit service – will yield a decrease in the number of vehicle trips expected to be generated by future development. Given that the transit bridge would re-route transit through Oakland Mills, it would directly impact traffic generated by Downtown Columbia, but to a larger degree, Oakland Mills. As a result, this assessment considers the full build out of not only Downtown Columbia but Oakland Mills.

Methodology

To estimate the impacts of the proposed transit bridge, this Technical Memorandum uses results from URBEMIS, a trip generation modeling tool based on trip generation rates from the Institute for Traffic Engineers (ITE) *Trip Generation* guide. Unlike the traditional ITE methodology, URBEMIS adjusts trip rates based on local context and transportation demand management impacts. This tool is ideal for the assessment of a new connection across US Route 29 because it can predict how re-routing existing and future transit services across the proposed bridge will impact the number of vehicle trips generated by the proposed development.

In order to run the URBEMIS model, Howard County Department of Planning and Zoning provided detailed existing land use data for Downtown Columbia and Oakland Mills in September 2010. General Growth Properties provided detailed data for the proposed full build-out land use program for Downtown Columbia. To isolate the impact of the increase in transit service due to the transit bridge using URBEMIS, Downtown Columbia and Oakland Mills were evaluated separately and the results combined. The combined land use program assumed for this assessment is shown in Figure 30(separate detailed assumptions for Downtown Columbia and Oakland Mills can be found in the Appendix B).

Figure 30 Full Build-Out Land Use Program

Land Use	Measure	Unit
Residential		
Single family home	316	units
Low rise apartment	1,076	units
Mid rise apartment	6,022	units
Residential condos & townhouses	1,015	units
Congregate care (assisted living)	222	units
Non-Residential		
Hotel	830	rooms
Church	33,610	square feet
Elementary school	776	students
High school	1,205	students
Day care	8,340	square feet
City park	6,470	square feet
Government - civic center	20,720	square feet
Raquetball/heath	31,200	square feet
General office	6,329,800	square feet
Medical office	25,830	square feet
Shopping center	1,919,000	square feet
Quality restaurant	23,970	square feet
High turnover restaurant	8,350	square feet
Drive-in bank	4,630	square feet
Gasoline/service station	14	pumps
Convenience store (24 hour)	12,680	square feet
Supermarket	13,980	square feet

The URBEMIS mitigation component is a simple yet powerful tool; it employs standard traffic engineering methodologies, but provides the opportunity to adjust ITE average rates to quantify the impact of a development's location, physical characteristics, and any demand management programs. In this way, it can fairly evaluate developments that minimize their transportation impact by, for example, providing high densities and a mix of uses. Figure 31provides a summary of the specific trip reduction credits that can be granted by URBEMIS.

Figure 31   Potential Trip Reductions

	Residential[1]	Non-Residential
Physical Measures		
Net Residential Density	Up to 55%	N/A
Mix of Uses	Up to 9%	Up to 9%
Local-Serving Retail	2%	2%
Transit Service	Up to 15%	Up to 15%
Pedestrian/Bicycle Friendliness	Up to 9%	Up to 9%
Physical Measures subtotal	***Up to 90%***	***Up to 35%***
Demand Management and Similar Measures		
Affordable Housing	Up to 4%	N/A
Parking Supply[2]	N/A	No limit
Parking Pricing/Cash Out	N/A	Up to 25%
Free Transit Passes	25% * reduction for transit service	25% * reduction for transit service
Telecommuting[3]	N/A	No limit
Other TDM Programs	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness
Demand Management subtotal (4)	***Up to 7.75%***	***Up to 31.65%***

Notes:

(1) For residential uses, the percentage reductions shown apply to the ITE average trip generation rate for single-family detached housing. For other residential land use types, some level of these mitigation measures is implicit in ITE average trip generation rates, and the percentage reduction will be lower.

(2) Only if greater than sum of other trip reduction measures.

(3) Not additive with other trip reduction measures.

(4) Excluding credits for parking supply and telecommuting, which have no limit.

C.1 Standard Trip Generation Assessment

The Institute for Traffic Engineers' (ITE's) *Trip Generation* report and the companion *Trip Generation Handbook* are the most definitive available sources for estimating the automobile traffic that different land uses will generate. *Trip Generation* is an invaluable reference for traffic studies and environmental assessments, as it is by far the most comprehensive source of empirical data on the traffic impacts of different land uses. However, the information is most useful for auto-oriented, stand-alone suburban sites, from where the vast majority of data were collected. When the standard ITE rates are applied to the proposed land use program, the future development is estimated to produce nearly 235,000 average daily trips, as seen in Figure.

Figure 32 ITE Trip Generation Estimate

Land Use	Units	ITE Rate	Trips
Residential			
Single family home	316	9.57	3,024
Low rise apartment	1076	6.59	7,091
Mid rise apartment	6,022	5.76	34,687
Residential condos & townhouses	1015	5.81	5,897
Congregate care (assisted living)	222	2.02	448
Non-Residential			
Hotel	830	8.17	6,781
Church	33.61	9.11	306
Elementary school	776	1.29	1,001
High school	1205	1.71	2,061
Day care	8.34	79.26	661
City park	6.47	1.59	10
Government - civic center	20.72	27.92	579
Raquetball/heath	31.2	32.93	1,027
General office	6329.8	11.01	69,691
Medical office	25.83	36.13	933
Shopping center	1919	42.94	82,402
Quality restaurant	23.97	89.95	2,156
High turnover restaurant	8.35	127.15	1,062
Drive-in bank	4.63	148.15	686
Gasoline/service station	14	162.78	2,279
Convenience store (24 hour)	12.68	845.60	10,722
Supermarket	13.98	102.24	1,429
			234,934

For mixed-use areas, ITE advises that traffic engineers should collect local data, or adjust the ITE average trip generation rate to account for reduced auto use.

C.2 Adjusted Trip Generation

In order to gauge the trip generation impact of the transit bridge, two scenarios were evaluated to isolate the impact of building the bridge. The difference between each scenario centered on the addition of the transit bridge and the resulting increase in Oakland Mills transit service. One scenario evaluated the total number of trips generated by the full build-out of Downtown Columbia and Oakland Mills with a new transit bridge, the proposed Downtown Columbia street network, and increased transit service in Oakland Mills due to re-routings over the transit bridge. The second scenario evaluated the trips generated with no transit bridge and no resulting increase in transit service.

As mentioned above, URBEMIS adjusts the ITE estimated daily trips according to a series of mitigation measures, summarized in Figure 31above and described thoroughly in the Appendix B. Trip rates are altered depending on the presence and scale of the measure in the study area. Figure 33below compares the target for each measure required to receive the maximum reduction against the observed characteristics in the Downtown Columbia Plan and in Oakland Mills. Most of the characteristics of these two neighborhoods reduce the ITE trip generation rate, with the exception of residential density (which is considered by the model to be too sparse for the given land areas).

URBEMIS assumes a certain net residential density for each different type of housing. In the case of a project with a net residential density *higher* than the URBEMIS assumption, the ITE trip rate is *reduced;* in the case of a project with a net residential density *lower* than the URBEMIS assumption, the trip rate is *increased.* For instance, URBEMIS assumes that single family housing has an average density of 3 units per acre, if the single family housing in the development is only 2 units per acre, the average ITE trip rate of 9.57 for single family housing is increased to 10.10.

Figure 33 Adjustments to Trip Generation Estimates

	URBEMIS Assumptions			Downtown Columbia		Oakland Mills (without Transit Bridge)		Oakland Mills (with Transit Bridge)	
	Target for Max Impact	Max Impact on Residential(1)	Max Impact on Non-Residential	Observed	Trip Impact	Observed	Trip Impact	Observed	Trip Impact
Physical Measures									
Net Residential Density	380 units/acre	Up to 55%	N/A	10.75 units/acre	8%	2.59 units/acre	8%		8%
Mix of Uses	1.5 jobs/household	Up to 9%	Up to 9%	2.96 jobs/HH	-6%	1.17 jobs/HH	-8%		-8%
Local-Serving Retail	Local retail is present	2%	2%	Yes	-2%	Yes	-2%		-2%
Transit Service	900 trips	Up to 15%	Up to 15%	323 buses 64 shuttles	-6%	80 buses	-1%	169 buses 64 shuttles	-4%
Pedestrian & Bicycle Friendliness	1,300 intersection approaches/sq mile, 100% sidewalks, 100% bike network	Up to 9%	Up to 9%	528 intersection approaches/sq mile, 96.5% sidewalk, 20% bike/trail	-4%	296 intersection approaches/sq mile, 96.5% sidewalk, 25% bike/trail	-4%		-4%
Physical Measures subtotal		***Up to 90%***	***Up to 35%***		***-9%***		***-8%***		***-11%***
Demand Management and Similar Measures									
Affordable Housing	100% below market rate	Up to 4%	N/A	20%	-0.05%	n/a			
Parking Supply[2]		N/A	No limit	n/a	0%	n/a			
Parking Pricing/Cash Out	$6/day	N/A	Up to 25%	n/a	0%	n/a			
Free Transit Passes	Free transit passes offered	25% * reduction for transit service	25% * reduction for transit service	n/a	0%	n/a			
Telecommuting[3]		N/A	No limit	n/a	0%	n/a			
Other TDM Programs	At least 5 elements (2%, plus 10% credit); At least 3 elements (1%, plus 5% credit)	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness	n/a	0%	n/a			
Demand Management subtotal[4]		***Up to 7.75%***	***Up to 31.65%***		***-0.05%***				
Total Trip Impact					**-9%**		**-8%**		**-11%**

Notes:

(1) For residential uses, the percentage reductions shown apply to the ITE average trip generation rate for single-family detached housing. For other residential land use types, some level of these mitigation measures is implicit in ITE average trip generation rates, and the percentage reduction will be lower.

(2) Only if greater than sum of other trip reduction measures.

(3) Not additive with other trip reduction measures.

(4) Excluding credits for parking supply and telecommuting, which have no limit.

With the exception of the single-family housing in Oakland Mills, all of the residential densities were lower than the URBEMIS assumption for that housing type, thus increasing the residential trip rates above the ITE average. All of the other measures observed in Downtown Columbia and Oakland Mills result in reductions in trip rates.

Based on the evaluation of transit re-routing in Chapter 5, the transit bridge could introduce as many as an additional 169 daily buses and 64 daily shuttles in Oakland Mills, resulting in a greater reduction in vehicle trip generation rates, as Figure 33documents. Taken together, the observed measures would result in a reduction of 21,800 daily trips without the transit bridge and 22,300 if the bridge is built and transit services rerouted, as compared to the standard trip generation estimates.

Figure 34 Trip Change Summary

	No Transit Bridge	With a Transit Bridge
Net Residential Density	19,500	19,500
Mix of Uses	-14,000	-14,000
Local-Serving Retail	-5,300	-5,300
Transit Service	-12,900	-13,400
Pedestrian/Bicycle Friendliness	-9,000	-9,000
Affordable Housing	-100	-100
Total Impact on Trips	**-21,800**	**-22,300**

C.3 Key Findings

- When the standard ITE rates are applied to the proposed land use program, the future development is estimated to produce nearly 235,000 average daily trips.
- Most of the density, mixed use, local retail, and multi-modal characteristics of both Downtown Columbia and Oakland Mills reduce the ITE trip generation rate, with the exception of residential density (which is considered to be too sparse for the given land areas).
- Based on the evaluation of transit re-routing in Appendix B, the new connection could introduce as many as an additional 169 daily buses and 64 daily shuttles in Oakland Mills, up to a peak of 28 vehicles per hour, resulting in a greater reduction in vehicle trip generation rates.
- Taken together, local context factors would result in a reduction of 21,800 daily vehicle trips without the new connection. This reduction increases to 22,300 if the bridge is built and transit services are rerouted through Oakland Mills.

C.4 Summary

According to this assessment, constructing the proposed transit bridge and rerouting transit service through Oakland Mills would result in removing 500 daily trips from the area's roadways. All of these trips would divert to transit.

Appendix D. Preliminary Engineering Assessment

In order to evaluate the conversion of the existing pathway path to a facility capable of handling regional and local buses with a dedicated bridge across US Route 29, a preliminary engineering evaluation was conducted by Wallace-Montgomery in the fall of 2010.

D.1 Geometrics

Existing Conditions

The existing pathway varies from 6 to 8-feet in width. A graded clear distance of at least 2-feet per side is maintained for the trail length, with the exception of the structure over the Little Patuxent River and US Route 29. The width for the pedestrian structure is 10-feet with 1-foot parapet walls on each side. The existing trail follows the existing terrain slope as much as possible.

Vertical Alignment

Vertical curves vary in length and were developed primarily with the lay of the land. Some vertical curves are 20 to 50-feet in length and simply serve as rounding for the change in grades. The existing grade for the existing pathway ranges from 5% to over 12%. From Little Patuxent Parkway (LLP) down to the Lake Kittamaqundi, the grade is primarily 5% with the exception of two areas; 10-12% for 230-feet close to the connection with LPP; and approximately 220-feet prior to the lake. The west approach from the lake to the pedestrian structure has a grade of approximately 5%. For the east approach from the pedestrian bridge to Stevens Forest Road, the grade varies from 5-12%. At the connection to Stevens Forest Road, the grade approaches 20%.

Horizontal Alignment

The existing pathway from the GGP parking lot to the pedestrian structure over the Little Patuxent River and US Route 29 is approximately 695-feet long. The length of the pedestrian structure is 680-feet long, and the existing pathway on the east site of the pedestrian structure to Stevens Forest Road is approximately 1700-feet long.

The exiting trail horizontal alignment is formed by series of short tangent and broken back or reversing cure combinations. This type of configuration is a winding alignment which is difficult to convert for larger vehicular use, thereby requiring areas in which the horizontal alignment must be straightened out to accommodate transit vehicles.

The horizontal radii for the trail range from 40-feet to 250-feet. The radius as the trail approaches the pedestrian structure on the west side is 40-feet.

Preferred Conditions

Vertical Alignment

In accordance with the Howard County Development Manual, the maximum roadway grade allowed is 10%. In addition, for vehicular movements, vertical curves must be a least 75-feet (3 times the design speed) or longer to provide the required stopping sight distance.

It is recommended that the trail connection and pedestrian structure over US Route 29 from Downtown Columbia to Oakland Mill be renovated to include new decorative guard rails allowing clear sightlines to vehicular traffic, resurfacing, enhanced and decorative lighting, potential video security and other enhancements to assure greater aesthetics and security of path users. It is recommended that pathways be intended for two-way use by commuters and recreationists and designed to a standard that accommodates the various users with minimal conflicts. Per AASHTO, the standard width of these paths should be 10-feet with 2-foot clear distance on both sides for safe operation.

Horizontal Alignment

It is preferred that the existing pathway be rehabilitated in-place or reconstructed as part of the overall proposed transportation improvements. If the pathway is reconstructed and included as part of a new connection over Route 29 without a broader interchange construction project, the distance from the GGP parking lot to the pedestrian structure over the Little Patuxent River and US Route 29 would be approximately 710-feet long. The distance from the east site of the pedestrian structure to Stevens Forest Road would be approximately 1700-feet long.

The length of the pedestrian structure would be approximately 625-feet long. The reduced length of the pedestrian structure is a direct result for the need to increase the radii along the trail near the bridge to accommodate transit vehicles. The minimum radius for the transitway as it approaches the structure is 100-feet with a design speed of 15 mph. A design speed of 25 mph would be preferred for the preliminary transitway alignment. The minimum horizontal radius for the transitway with a design speed of 25 mph is approximately 250-feet.

Relationship to Proposed Interchange

As part of the adopted Downtown Columbia General Plan, a third, full-movement, grade-separated interchange at US Route 29 is proposed. This interchange is proposed to be located approximately mid-way between the two existing interchanges with Broken Land Parkway and MD 175/Little Patuxent Parkway. The interchange may take one of several forms, depending upon the outcome of subsequent, detailed engineering studies. The interchange could link US Route 29 to Downtown Columbia only or could directly link Oakland Mill, US Route 29 and Downtown Columbia. This interchange could be designed to serve as the potential gateway to Downtown Columbia and included several aesthetic elements.

The network will be built over time as the Plan is implemented. The phasing of these improvements is related to the development density levels recommended by the Plan. The final extent of the road improvements will be determined by the Adequate Public Facilities Act.

Relationship to Existing Pathway

The location and design of the proposed third interchange over US Route 29 has yet to be identified. Conceptual alternatives will be developed as part of a feasibility study to be conducted by GGP and Howard County, with representation included by the Maryland State Highway Administration.

As part of the feasibility study, the relationship to the existing pathway will be taken into consideration. Based on the conceptual alternatives developed for the interchange and the location of the interchange, consideration will be given to maintaining and improving the existing trail and pedestrian structure over US Route 29, relocating the pathway to a new location, or incorporating the pathway as part of the overall US Route 29 interchange transportation improvement.

Transitway and Multi-Use Path Option – "Bridge Columbia"

As part of the "Bridge Columbia" presentation, it was recommended that at "transit only" connection be provided following the alignment of the existing pathway. The typical section for this proposed connection includes a minimum width 24-foot transitway (two 12-foot travel lanes) and a 12-foot multi-use path.

As part of the design, this proposed transit bridge should be developed as a signature structure to symbolize Columbia and be seen as a landmark over the US Route 29 corridor. A conceptual drawing was provided by the "Bridge Columbia" group showing the transitway over US Route 29.

D.2Design Considerations

Existing Pedestrian Structure

The existing pedestrian bridge is a steel box girder structure consisting of 6 spans with a total span width of 680-feet. The pedestrian bridge crosses both US Route 29 and the Little Patuxent River. The bridge has a 10-foot wide concrete deck with 1-foot parapets for a total out-to-out width of 12-feet. A chain link fence is provided as a safety and anti-climb measure on top of the parapets. In addition, for the spans over US Route 29, a full (enclosed) cage is provided to restrict the ability for objects to be thrown onto the roadway.

Structural Criteria

Since the existing pathway bridge spans US Route 29, any changes to the existing structure or the construction of a new structure will need to be reviewed and approved by the State Highway Administration Office of Structures. If Federal funding is involved, the structure will also have to be reviewed and approved by the Federal Highway Administration.

The rehabilitation or redesign of the pathway and/or transit bridge is subject to the SHA design criteria presented in the 2003 SHA Office of Structures Policy and Procedures Manual. Based on the SHA criteria, a minimum vertical clearance of 16-feet 9-inches (roadway to bottom of girder) is required over US Route 29. The bridge design must be load path redundant so that there are no fracture critical members. In addition, the structure must be designed to require low maintenance and to facilitate future deck replacement. All barriers must meet vehicular crash tested approved designs. In addition, SHA highly recommends that a steel superstructure be used for any structure over a SHA roadway.

The existing structure likely will not be able to be expanded as part of a transit bridge option. Given the age of the structure and the size of the piers, it will be more cost effective to replace the entire structure to meet the latest design criteria, rather than trying to retrofit the existing structure.

Aesthetic Opportunities

One of the recommendations for either the proposed third US Route 29 Interchange or a multi-use transitway would be to have a structure that could serve as a signature bridge for the "Gateway to Columbia." Coordination and approval by SHA would be required for the structural design and aesthetic treatments proposed. The 2005 SHA Aesthetic Bridges Users Guide would serve as the key reference for the proposed structure.

The criterion identified in the user's guide provides information concerning:

- Shape of piers
- Girder type
- Parapet / end post shape
- Color
- Patterns and texture
- Non-structural facing material (brick, stone, etc.)
- Ornamentation
- Fencing options
- Lighting
- Landscaping

Constructability

Constructability for the rehabilitation or reconstruction of the existing pathway or transitway is another consideration affecting the feasibility and cost for the structure and path. As part of a constructability review, consideration should be given to construction staging areas, erosion and sediment control and SWM measures, maintenance of traffic on US Route 29 and the location of construction equipment and other resources. In addition, work over waterways and other environmentally sensitive areas add additional difficulty and cost to the project. Additional right-of-way and/or temporary easements will likely be required for construction and access to the project area.

Consideration should be given to construction a new structure next to the existing pedestrian structure in order to keep the connection between the communities. However this may not be possible due to the availability of right-of-way or environmental constraints in the study area.

"Bridge Columbia" Conceptual Structure Review

As part of the "Bridge Columbia" presentation, it was recommended that a feasibility study be conducted looking at a two lane Bus-only roadway plus Pedestrian/Bike Trail connecting Downtown Columbia and the Village of Oakland Mills. This connection would replace the existing pedestrian bridge over US Route 29. From an operational standpoint, all existing Howard County Bus Routes between East Columbia and Town Center would be routed over the new bridge. Frequent shuttle service with low-floor buses would operate between Wilde Lake, Downtown Columbia and the Village of Oakland Mills using the new bridge. In addition, a dramatic new structure over US Route 29 will be constructed as a "signature" to symbolize Columbia.

As part of the presentation, a rendering was presented showing a new bridge for transit vehicles and pedestrians/bicycles. The concept was for a cable-stayed bridge with two, 2-column piers, rectangular parapets and two-strand railing. Advantages of this concept include the completion of a unique signature bridge which can serve as a landmark for Columbia. In addition, a cable-stay type structure traditionally is for longer structure, thereby reducing the number of pier locations. The concept presented only discussed the crossing of US 29. However, the structure would also need to cross the Little Patuxent River as well as the associated floodplain and wetland areas.

There are several disadvantages associated with the conceptual structure presented by "Bridge Columbia" that must be taken into consideration. First, signature bridges are often more costly than standard bridges. Any structure that does not meet the criteria identified in the 2005 SHA Aesthetics Bridge Users Guide will be difficult to obtain approval from SHA.

For a cable-stay style design, the overall bridge design is not redundant (fracture critical member), meaning the bridge contains components that if one of these crucial components fails, the bridge is in danger of collapse. Also, the required size for the piers would likely be much greater that that shown in the aesthetic rendering.

The cost of a specialty structure is higher than tradition structural design, including structures with aesthetic treatments. Part of the reason for the higher cost is the specialty construction methods and equipment required which limits the number of potential bidders for the project. Finally, long term maintenance and inspection efforts are more involved given the uniqueness of the structure.

While these factors are disadvantages, it does not mean that a reasonable structure design with aesthetic features could not be designed to serve as a signature structure for the "Gateway to Columbia." The main cost benefit analysis should be completed based on the transit demand for the facility and the overall operational benefits to the Columbia Transportation network.

Environmental Impacts

For any of the transportation projects completed as part of the Downtown Columbia Master Plan, the impact to the environmental resources, including historic and archeological resources, will need to be identified. As identified earlier in this memorandum, there are several key natural environmental resources located in the study area. Impacts to the existing environmental features should be avoided where possible. If impacts are not avoidable, all effort should be given to minimize impacts. For the impacted environmental resources, a detailed mitigation design plan will need to be prepared based on Federal and State criteria dependent upon the funding for the proposed improvement and the resources impacted.

Storm Water Management

Stormwater management (SWM) for State and Federal projects is reviewed and approved by the Maryland Department of the Environment. SWM for non-Capital improvement projects in Howard County is reviewed by the Howard County Department of Planning and Zoning, Development Division. County projects that impact State Highways also must receive an Access Permit from the State Highway Administration, who reviews drainage and stormwater facilities as they relate to their facilities and their maintenance programs.

Stormwater Management for this project is governed by new SWM regulations effective May 4, 2010, adopted to comply with the SWM Act of 2007. The SWM Act of 2007 set forth new guidelines for SWM for development, in particular, redefining redevelopment and requiring Environmental Site Design (ESD) to the Maximum Extent Practicable (MEP) before structural SWM facilities may be considered. In summary, quality SWM is required for 100% of new pavement and 50% of redevelopment (or reconstructed pavement.) Quantity SWM must be provided that returns the runoff condition for all new pavement back to the runoff condition for woods in good condition. In addition, all quality SWM must be provided by ESD practices and all quantity SWM must be provided by ESD practices to the MEP before structural SWM facilities may be considered. Management of the 10-year storm peak discharge for proposed conditions back to existing conditions is required by the

County in areas of known flooding. Runoff directed to the Little Patuxent River in the project vicinity is most likely subject to the 10-year control requirements.

The need for SWM facilities will be required as part of the rehabilitation or reconstruction of the multi-use structure or transitway. This will require additional right-of-way for the expansion or construction of SWM facilities or the need to identify off-site mitigation (i.e. banking areas, fee in-lieu) to address the quality and quantity requirements.

Right-of-Way Needs

The existing pathway includes property owned by both the Columbia Association and Howard Research and Development Corporation. The west side of the pathway is located on property owned by the Howard Research and Development Corporation and has sufficient right-of-way available to expand the trail. The property on the east side of US Route 29 is owned by the Columbia Association and has a 50-foot right-of-way for the majority of the length of the trail.

It is assumed that any improvements to the existing trail to meet ADAAG standards can be completed within the existing right-of-way. Some temporary construction easements may be required for areas in which grading and drainage improvements are necessary.

For the replacement of the existing pathway with a transitway, it is anticipated that the typical section for the roadway would require a minimum width of 42-feet. This does not include any additional area for lighting, landscaping, or grading for drainage. It is likely that a total right-of-way width of greater that 50-feet would be required, including additional areas for construction easement for grading, drainage and SWM areas. This impact will be even greater if pedestrian movements must be maintained during construction.

Safety

For any concept considered, certain amenities and safety features should be considered to help improve the safety while improving the utilization of the pathway. Some key features include, but are not limited to:

- Improve pedestrian lighting over the existing structure
- Add pedestrian lighting along the entire trail length
- Replace the full cage and fence on the existing structure over US Route 29 and the Little Patuxent River with anti-climb fencing or other suitable alternative
- Regularly maintain vegetation/landscaping
- Widen the pathway to 10-feet with min. 2-feet of clear area on each side
- Add pavement markings to delineate the direction of travel
- Improve grades to meet ADAAG DOT Standards
- Add security camera through the trail corridor
- Add security call boxes for emergencies placed strategically along the trail

D.3Cost Estimate

In an effort to estimate the cost for a new transit, bicycle, and pedestrian connection between Downtown Columbia and Oakland Mills, the following cost figures were used. These cost values have been developed on a cost per square foot basis.

- Structure–$250-$600/square foot (steel beam - cable stay)
- Roadway– $25/square foot

For this cost estimate, a $600/square foot structure cost for a cable stay design (presented by "Bridge Columbia") and $25/square foot roadway/transitway cost has been developed. In addition a 30% contingency has been added to the overall cost to account for additional items that are not included as part of a feasibility analysis. Detailed engineering or quantity calculations have not been completed as part of this analysis. The numbers presented are for evaluation purposes only and should not be used for establishing funding.

In order to accommodate the width of the roadway and turning radius for the transit vehicles, the overall length of the transitway structure will need be approximately 55-feet shorter than the existing structure. A total length of approximately 625-feet of new structure with an estimated minimum width of 38-feet is required to span US Route 29, the Little Patuxent River and Lake Kittamaqundi spill way. Therefore, the estimated structure cost, for a cable stay structure is 625-feet x 38-feet x $600/square foot for or approximately $14.25 million.

The Westside approach roadway from the GGP parking lot to the pedestrian bridge is approximately 710-feet. The Eastside approach from the proposed structure is approximately 1700-feet. The total combine length for a new roadway/transitway, not including the structure is approximately 2410-feet. The estimated width of the proposed roadway/transitway is 36-feet (24-foot transitway and 12-foot multi-use path. Therefore the estimated roadway/transitway cost is 2410-feet x 36-feet x $25/square foot for a total of approximately $2.17 million.

The total combined cost for the structure and roadway without the additional 30% contingency is $16.42 million. With the 30% contingency, the total preliminary cost estimate for the transitway and structure is $16.42 million x 30% for a total of approximately $21.35 million. This information has been summarized Figure 35.

Figure 35 Preliminary Cost Estimate for Transitway

	Length (feet)	Width (feet)	Total Size (square feet)	Cost ($ per sf)	Cost (rounded)
Structure	625 ft	38 ft	23,750 sf	$600 / sf	$14.25 million
Roadway/Transitway	2410 ft	36 ft	86,760 sf	$25 / sf	$2.17 million
				Total Cost	$16.42 million
				Total Cost w/ 30% contingency	***$21.35 million***

*Therefore the estimated cost range for a new transitway and structure is estimated to be between **$20-25 million.***

This estimate is greater than the $10-15 million estimate presented by "Bridge Columbia." For a Cable-Stay Bridge Design as proposed by "Bridge Columbia," the estimated cost for square foot would be approximately $500-$650 per square foot, which is more than double the structure cost for a traditional bridge crossing in this location.

Cable stay bridges are more cost effective for longer span structures where a span length of 400 feet or greater is required. However, a false cable-stay designed could be included as part of the aesthetic treatment for a traditional structure.

As indicated earlier in this memorandum, the reason for the higher cost is the specialty construction methods and equipment required which limits the number of potential bidders for the project. In addition, long term maintenance and inspection efforts are more involved given the uniqueness of the structure.

To provide a traditional bridge crossing in this location, it is estimated that the cost for the structure would be approximately $250/square foot. Therefore, the cost for the structure would be approximately $6 million, resulting in a total cost of approximately $8.2 million. With the 30% contingency, the cost would be approximately $10.6 million, within the range of $10-15 million presented by "Bridge Columbia".

For a traditional bridge design with cable stay aesthetic features, the cost per square foot is estimated to be approximately 15% higher at approximately $290 per square foot. Therefore an additional cost of approximately $950,000 just for the structure would be required. With the 30% contingency, the cost is approximately $1.25 million higher for cable-stay appearance aesthetic treatments.

D.4 Key Findings

- The exiting trail horizontal alignment is winding, which is difficult to convert for larger vehicular use, thereby requiring areas in which the horizontal alignment must be straightened out to accommodate transit vehicles.
- The location and function of a new connection is dependent on the determination of alignment for a new interchange with Route 29, less than 1,000 feet away.
- The existing structure likely will not be able to be expanded as part of a new connection over Route 29. Given the age of the structure and the size of the piers, it will be more cost effective to replace the entire structure to meet the latest design criteria, rather than trying to retrofit the existing structure.
- There are several key natural environmental resources located in the study area that should be avoided. If impacts are not avoidable, a detailed mitigation design plan will need to be prepared based on Federal and State criteria.
- The pathway on the east side of Route 29 has a 50-foot right-of-way for the majority of its length. For the replacement of this trail with a transitway, it is anticipated that the typical section for the roadway would require a minimum width of 42-feet plus areas for lighting, landscaping, and drainage. It is likely that a total right-of-way width of greater that 50-feet would be needed, requiring land acquisition.
- Absent land acquisition costs, the total preliminary cost estimate for the transitway and cable-stayed bridge structure as proposed by Bridge Columbia is approximately $21.35 million.
- To provide a traditional bridge crossing in this location, the cost would be approximately $10.6 million. To add cable-stay appearance aesthetic treatments would cost approximately $1.25 million more.

Appendix E. URBEMIS Details

Standard Trip Generation Estimates

The Institute for Traffic Engineers' (ITE's) *Trip Generation* report and the companion *Trip Generation Handbook* are the most definitive available sources for estimating the automobile traffic that different land uses will generate. *Trip Generation* is an invaluable reference for traffic studies and environmental assessments, as it is by far the most comprehensive source of empirical data on the traffic impacts of different land uses. However, the information is most useful for auto-oriented, stand-alone suburban sites, from where the vast majority of data were collected. For mixed-use areas ITE advises that traffic engineers should collect local data, or adjust the ITE average trip generation rate to account for reduced auto use.

All too often, however, ITE's warnings are ignored and standard trip generation rates are applied in inappropriate locations – with serious impacts on the character and financial feasibility of mixed-use development. Part of the reason is that, until now, there has been no standardized tool to allow these adjustments to trip generation rates to be made. In order to address this problem, the air quality management districts of California, along with the California State Department of Transportation, worked together in 2004 to examine all of the key variables that influence automobile trip generation. They were able to quantify the trip generation impact of key locational and programmatic factors, and inserted these formulas into URBEMIS, a national model for calculating air quality impacts of projects.

The URBEMIS mitigation component is a simple yet powerful tool; it employs standard traffic engineering methodologies, but provides the opportunity to adjust ITE average rates to quantify the impact of a development's location, physical characteristics and any demand management programs. In this way, it provides an opportunity to fairly evaluate developments that minimize their transportation impact, for example, providing high densities and a mix of uses. Figure 36 provides a summary of the specific trip reduction credits that are granted by URBEMIS.

Figure 36 Summary of Trip Reduction Credits

	Residential(1)	Non-Residential
Physical Measures		
Net Residential Density	Up to 55%	N/A
Mix of Uses	Up to 9%	Up to 9%
Local-Serving Retail	2%	2%
Transit Service	Up to 15%	Up to 15%
Pedestrian/Bicycle Friendliness	Up to 9%	Up to 9%
Physical Measures subtotal	***Up to 90%***	***Up to 35%***

Demand Management and Similar Measures		
Affordable Housing	Up to 4%	N/A
Parking Supply(2)	N/A	No limit
Parking Pricing/Cash Out	N/A	Up to 25%
Free Transit Passes	25% * reduction for transit service	25% * reduction for transit service
Telecommuting(3)	N/A	No limit
Other TDM Programs	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness
Demand Management subtotal (4)	***Up to 7.75%***	***Up to 31.65%***

Notes:

(1) For residential uses, the percentage reductions shown apply to the ITE average trip generation rate for single-family detached housing. For other residential land use types, some level of these mitigation measures is implicit in ITE average trip generation rates, and the percentage reduction will be lower.

(2) Only if greater than sum of other trip reduction measures.

(3) Not additive with other trip reduction measures.

(4) Excluding credits for parking supply and telecommuting, which have no limit.

Assessing Trip Generation

The methodology for conducting traffic studies is well established in the traffic engineering profession. The first step – which is the only element considered in this assessment – is to calculate the number of vehicle trips that will be generated by each land use. Subsequently, these trips are assigned to the roadway network and the impact on vehicle level of service is calculated.

Typically, the analyst uses the following procedure to calculate trip generation:

- Determine the land-use type(s) (e.g. "High-Rise Residential Condominium/Townhouse") in the development (shown in Figure 37~~Figure 37~~ and Figure 38~~Figure 38~~)
- Determine the trip generation rate for each land-use type using *Trip Generation* or similar references. These publications provide average trip generation rates per unit of land use (e.g., per residential unit, per employee, per 1,000 square feet of gross floor area, or per theatre seat)
- Multiply the average trip generation rate by the number of units of development for each type of land use included in the project, and sum the different land-use components
- The total number of trips can be reduced to account for (i) "internal capture" (i.e., trips between different components of a mixed-use project such as a restaurant and cinema); and (ii) "pass-by trips" (such as a commuter stopping to buy groceries on the way home from work)

Figure 37 **Downtown Columbia Land Use Program**

Land Use	Measure	Unit
Residential		
Low rise apartment	525	units
Mid rise apartment	6,022	units
Residential condos & townhouses	872	units
Congregate care (assisted living)	222	units
Non-Residential		
Quality restaurant	23,970	square feet
Hotel	830	rooms
Raquetball/heath	31,200	square feet
Gasoline/service station	14	pumps
Convenience store (24 hour)	9,890	square feet
Government - civic center	20,720	square feet
General office	6,329,800	square feet
Shopping center	1,919,000	square feet

Figure 38 **Oakland Mills Land Use Program**

Land Use	Measure	Unit
Residential		
Single family home	316	units
Low rise apartment	551	units
Residential condos & townhouses	143	units
Non-Residential		
Church	33,610	square feet
Elementary school	776	students
High school	1,205	students
High turnover restaurant	8,350	square feet
Day care	8,340	square feet
Supermarket	13,980	square feet
Convenience store (24 hour)	2,790	square feet
City park	6,470	square feet
Drive-in bank	4,630	square feet
Medical office	25,830	square feet

Figure 39 Standard Trip Generation Estimates

Land Use	Units	ITE Rate	Trips
Residential			
Single family home	316	9.57	3,024
Low rise apartment	1076	6.59	7,091
Mid rise apartment	6,022	5.76	34,687
Residential condos & townhouses	1015	5.81	5,897
Congregate care (assisted living)	222	2.02	448
Non-Residential			
Hotel	830	8.17	6,781
Church	33.61	9.11	306
Elementary school	776	1.29	1,001
High school	1205	1.71	2,061
Day care	8.34	79.26	661
City park	6.47	1.59	10
Government - civic center	20.72	27.92	579
Raquetball/heath	31.2	32.93	1,027
General office	6329.8	11.01	69,691
Medical office	25.83	36.13	933
Shopping center	1919	42.94	82,402
Quality restaurant	23.97	89.95	2,156
High turnover restaurant	8.35	127.15	1,062
Drive-in bank	4.63	148.15	686
Gasoline/service station	14	162.78	2,279
Convenience store (24 hour)	12.68	845.60	10,722
Supermarket	13.98	102.24	1,429
			234,934

An important advantage of this simple approach is that very little information about a project is needed to predict trip generation, and trip generation calculations are simple. There are, however, several limitations of such two-variable formulas. Most importantly, they do not take into account the multitude of other variables, such as parking price, transit service, and the quality of the pedestrian environment, that transportation research has shown to strongly affect trip generation.

This means that the variation in trip rates *within* each land use category is frequently very high, indicating that quantity of development (e.g. number of units or gross floor area) is not sufficient to predict trip generation with any accuracy. For example, the highest-density residential developments in the San Francisco Bay Area generate 82% fewer trips than the lowest-density developments. For some land uses, such as office supply superstores and fast-food restaurants, *Trip Generation* finds no statistically significant correlation between the quantity of development and trip generation rates, or finds that the correlation is in the "wrong" direction (i.e., there is an inverse correlation).[5] Indeed, ITE frequently advises caution and the use of engineering judgment when determining the appropriate trip generation rates.

Even where there is a strong correlation between the amount of development and trip generation rates, there is still considerable variation in the rates observed in different surveys. For the land use type "Single Family Detached Housing", for example, ITE reported rates ranged from a low of 4.31 daily trips per dwelling unit, to a high of 21.85 daily trips. The *Trip Generation* manual reports that, "This land use included data from a wide variety of units with different sizes, price ranges, locations and ages. Consequently, there was a wide variation in trips generated within this category."

Recognizing these points, the *Trip Generation Handbook* includes a detailed appendix on the effects of TDM and transit. *Trip Generation* advises the reader:

> "The average trip generation rates in this report represent weighted averages from studies conducted throughout the United States and Canada since the 1960s. Data were primarily collected at suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs. At specific sites, the user may wish to modify trip generation rates presented in this document to reflect the presence of public transportation service, ridesharing or other TDM measures, enhanced pedestrian and bicycle trip-making opportunities, or other special characteristics of the site or surrounding area."

Modifying the trip generation rates in this way is essential for a mixed-use project such as Downtown Columbia that can expect lower rates of auto use. Otherwise, they will be disadvantaged by the traffic study, which in effect assumes a "worst case scenario" in terms of car use. The development may be asked to pay higher fees or fund infrastructure widenings that may not be necessary – measures which often damage the quality of the pedestrian environment, not to mention affecting development feasibility.

These limitations have been well documented by ITE and other analysts. What has been missing until now, however, is an alternative, established tool to modify the average trip generation rates. This is the purpose of the URBEMIS mitigation component described in this paper. **At its heart, therefore, the URBEMIS mitigation component is a tool for adjusting the average trip generation rates reported in the Institute for Transportation Engineers' *Trip Generation* manual to more fairly reflect the particular characteristics of a proposed development.** It can be seen as a "plug in" to the standard traffic study methodology.

The URBEMIS Approach to Trip Generation

The URBEMIS mitigation component (referred to simply as "URBEMIS" in the remainder of this paper) provides a simple method of estimating the percentage reduction in vehicle trips generated by a proposed development, compared to the baseline that would be obtained through the use of ITE average trip generation rates. It quantifies the trip reduction "credits" that can be gained through implementation of a range of mitigation measures.

In some cases, credits are obtained through simply locating a development in the right place – for example, close to transit, or in a place where it will optimize the jobs-housing balance. In some cases, the credits are assessed based on the physical characteristics of

[5] For an in-depth review of the development of trip generation rates, see Shoup (2003).

the development, such as density and provision of sidewalks. Other credits are granted based on commitments from the developer to implement demand management programs such as parking pricing, or provide deed-restricted affordable housing. The potential reduction credits assumed by URBEMIS are outlined in Figure 36 above. The sections below discuss each credit in turn and the rationale for the level of trip reduction reductions.

It must be stressed that the trip reductions recommended here are subject to considerable uncertainty. They should be interpreted as the mid-point of a range, rather than as a single, precise value. Travel behavior is complex and difficult to predict, and the approach described here will need to be refined in future years, as more data become available.

However, although the methodological dangers are obvious, there is generally no question about the *direction* of the relationship between trip generation and a given mitigation measure, only the size of the relationship and the appropriate variable to use as a model input. Some adjustment is better than none at all – which is what most conventional trip generation methodologies provide (Ewing & Cervero, 2001). In addition, existing project-level trip generation methodologies, even though well-accepted within the transportation planning and engineering profession, are themselves subject to considerable uncertainty, and results are reported with unwarranted precision (Shoup, 2003).

Recently, in *California Building Industry Assoc. v. San Joaquin Valley Unified Air Pollution Control District* issued in February 2008, URBEMIS was upheld as a sophisticated computer model capable of determining the impact of a development and the application of mitigating factors when applying a mitigation fee to a developer.

Data Requirements

Figure 40 shows the broad category of inputs that are required to complete the URBEMIS mitigation component in full, along with suggested data sources. Note, however, that the mitigation component can still be run, even if some of these inputs are missing.

The number of trips generated by a development depends not only on the characteristics of the project itself, but also on the surrounding area. High-density housing in an urban area, for example, will generate fewer trips than the same housing located close to a freeway interchange and surrounded by low-density subdivisions. For this reason, URBEMIS requires data for the area within approximately a half-mile radius from the center of the project, or for the entire project area, whichever is larger. In the case of this analysis, data were collected for the entire Downtown Columbia plan area as well as for a portion of Oakland Mills. Both study areas were large enough to not require data to be collected outside of the study limits. Specific inputs used in this analysis are outlined in

Figure 40 Data Requirements and Suggested Sources

Required Input	Suggested Source	
	Project	Surrounding Development
Net residential density[1]	Project plans	Block-level census data
Number of housing units	Project plans	Block-level census data
Number of jobs	Project plans[2]	Census Transportation Planning Package. Local jurisdiction may provide more current or fine-grained data
Local serving retail	Project plans	Site observations
Below-market-rate units	Project plans	N/A
Parking supply	Project plans	N/A
Transit service	Transit agency maps/schedules	
Intersection density[3]	Project plans	Street plans
Sidewalk completeness[3]	Project plans	Site observations
Bike lane completeness[3]	Project plans	Site observations
Parking pricing	Development agreement or similar	Site observations (if applicable)
Free transit pass provision	Development agreement or similar	N/A
Telecommuting/flexible work schedules	Development agreement or similar	N/A
Other TDM programs	Development agreement or similar	N/A

Notes:

(1) Net residential data excludes land not devoted to residential uses, prorating mixed-use sites by the percentage square footage of each use.

(2) US Department of Energy figures can be used to calculate the number of employees when only development square footage is known. See, for example, http://www.eia.doe.gov/emeu/consumptionbriefs/cbecs/pbawebsite/summarytable.htm.

(3) These inputs can be calculated manually, or automatically if the plans and data are available in a GIS system

Figure 41 Project Specific Data Inputs

Land Uses	Existing Columbia Town Center	Existing Oakland Mills	Future Columbia Town Center	Future Oakland Mills
All Planned Non-Residential (Sq. Ft.) and Residential Uses	(See Figures 3 & 4)		(See Figures 3 &4)	
Area Characteristics				
Number of housing units within 1/2 mile radius	2,488	2,931	7,990	3,050
Employment within 1/2 mile radius	1,876	3,159	7,237	3,580
Presence of local serving retail within 1/4 mile (Y/N)	Y	Y	Y	Y
Transportation Services and Facilities				
Number of daily fixed-route buses stopping w/in 1/4 mile of	323	80	323	169
Number of daily rail or rapid transit buses stopping w/in 1/2 mile of site	0	0	0	0
Number of dedicated daily shuttle trips	0	0	64	64
Number of intersections per square mile	287	296	528	296
Percent of streets w/in 1/2 mile with sidewalks on one side	5%	3%	3%	3%
Percent of streets w/in 1/2 mile with sidewalks on both sides	90%	95%	95%	95%
Percent of arterials/collectors with bike lanes (or where suitable, direct parallel routes exist)	10%	25%	20%	25%
(Parking spaces provided on-site for non-residential uses)	Not included		Not included	
Transportation Demand Management				
Secure bike parking (at least one space per 20 vehicle	N	N	N	N
Showers/changing facilities provided (Y/N)	N	N	N	N
Building Management and/or Tenant Programs				
Daily Parking Charge	$0	$0	$0	$0
Free transit passes (Y/N)	N	N	N	N
Car-sharing services provided (Y/N)	N	N	N	N
Information provided on transportation alternatives (bus	N	N	N	N
Carpool matching programs (Y/N)	N	N	N	N
Preferential carpool/vanpool parking (Y/N)	N	N	N	N
Dedicated employee transportation coordinator (Y/N)	N	N	N	N
Guaranteed ride home program provided (Y/N)	N	N	N	N
Employee Telecommuting Program (Y/N)	N	N	N	N
Compressed Work Schedule 3/36 (Y/N)	$0	$0	$0	$0

Relationship to ITE Residential Trip Generation Rates

It should be noted that, to some extent, ITE average trip generation rates for residential uses implicitly account for the level of transit service, density and other factors that influence trip generation. This is because ITE publishes average trip generation rates for several types of residential development, which vary considerably. This is largely due to the different types of environments in which the housing types are found; high-rise apartments, for example, are often located in dense neighborhoods with good transit.[6]

[6] ITE's *Trip Generation* manual states that data are collected primarily from suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs. While little information is available about the precise characteristics of individual study sites, it appears from the sources referenced that this is not the case for some land uses, particularly higher density residential land uses. For the "High-Rise Residential Condominium/Townhouse", for example, the manual's text shows that sites were surveyed in such cities as Vancouver, Canada: a city where it is difficult to find high-density condominiums that lack sidewalks, transit service, and a mix of uses nearby.

In order to avoid double counting, URBEMIS therefore assumes various default values for mitigation measures such as residential density, mix of uses and transit service. These defaults are set so that results from URBEMIS are consistent with ITE average trip generation rates.[7]

Mitigation Measures Included in URBEMIS

This section discusses each of the mitigation measures included in URBEMIS in turn. It provides a brief discussion of the rationale for the inclusion of that measure, and the method of calculation. Most mitigation measures apply to both residential and non-residential uses. The exceptions are density and affordable housing (which apply to residential uses only), and parking supply, parking pricing, telecommuting and other TDM programs (which apply to non-residential uses only). Figure 42 describes each of the reduction measures' impacts on trips and the specific target required to achieve the maximum reduction. This is compared with the actual inputs used in the URBEMIS analysis described in this report.

Figure 42 Trip Reduction Measures

	URBEMIS Assumptions			Columbia Town Center		Oakland Mills (without Transit Bridge)		Oakland Mills (with Transit Bridge)	
	Target for Max Impact	Max Impact on Residential(1)	Max Impact on Non-Residential	Observed	Trip Impact	Observed	Trip Impact	Observed	Trip Impact
Physical Measures									
Net Residential Density	380 units/acre	Up to 55%	N/A	10.75 units/acre	5%	2.59 units/acre	8%		8%
Mix of Uses	1.5 jobs/household	Up to 9%	Up to 9%	0.91 jobs/HH	-7%	1.17 jobs/HH	-8%		-8%
Local-Serving Retail	Local retail is present	2%	2%	Yes	-2%	Yes	-2%		-2%
Transit Service	900 trips	Up to 15%	Up to 15%	323 buses 64 shuttles	-6%	80 buses	-1%	169 buses 64 shuttles	-4%
Pedestrian/Bicycle Friendliness	1,300 intersection approaches/sq mile, 100% sidewalks, 100% bike network	Up to 9%	Up to 9%	528 intersection approaches/sq mile, 96.5% sidewalk, 20% bike/trail	-4%	296 intersection approaches/sq mile, 96.5% sidewalk, 25% bike/trail	-4%		-4%
Physical Measures subtotal		***Up to 90%***	***Up to 35%***		-13%		-8%		-11%
Demand Management									
Affordable Housing	100% below market rate	Up to 4%	N/A	20%	-0.05%	n/a			
Parking Supply(2)		N/A	No limit	n/a	0%	n/a			
Parking Pricing/Cash Out	$6/day	N/A	Up to 25%	n/a	0%	n/a			
Free Transit Passes	Free transit passes offered	25% * reduction for transit service	25% * reduction for transit service	n/a	0%	n/a			
Telecommuting(3)		N/A	No limit	n/a	0%	n/a			
Other TDM Programs	At least 5 elements (2%, plus 10% credit); At least 3 elements (1%, plus 5% credit)	N/A	Up to 2%, plus 10% of the credit for transit and ped/bike friendliness	n/a	0%	n/a			
Demand Management subtotal (4)		***Up to 7.75%***	***Up to 31.65%***		-0.05%				
Total Trip Impact					-14%		-8%		-11%

[7] These default values were estimated using two methods. First, Nelson\Nygaard reviewed the literature and held discussions with professionals in the fields of architecture and town planning, to ascertain typical ranges for density and other characteristics of each land use type (for useful summaries, see Calthorpe, 1993, and Local Government Commission, 2002). Second, these ranges of values were plugged into the formulas for the mitigation measures, and adjusted until the baseline values for each characteristic equaled the average ITE trip generation rates for each land use.

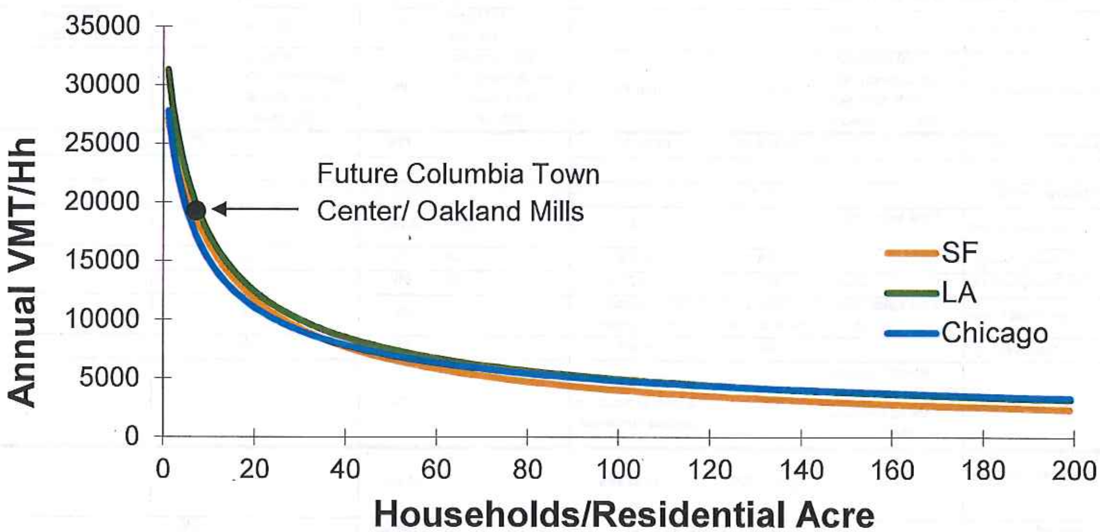
Figure 43 Summary of URBEMIS Results

	Future with Transit Bridge	Future without Transit Bridge	Impact of Transit Bridge
ITE Trips	234,934	234,934	
Trips Change	-31,200	-30,700	-500
Resulting Trips	203,734	204,234	
Reduction from ITE	-13%	-13%	-0.21%

Density

Residential density provides one of the strongest correlations of any variable with automobile use. However, care needs to be taken when calculating the impact of density on trip generation, since only some of this effect is due to the inherent effects of density, as opposed to factors for which density serves as a proxy, such as parking price, local retail, transit service frequency and pedestrian friendliness.[8] URBEMIS therefore uses the nonlinear equation developed by Holtzclaw *et. al.* (shown in Figure 44), but reduces the credit by 40% to avoid double counting with transit service, mix of uses and bicycle and pedestrian facilities, all of which correlate with density.

Figure 44 Residential Density Vs. Vehicle Travel



Source: Holtzclaw et. al. (2002).

The input required is *net residential density*, which excludes the area devoted to arterials, open space and other land uses, but includes local streets. The baseline net residential density is three units per acre: URBEMIS provides trip rate reductions for higher density, and trip rate increases for lower densities. This factor is evaluated in URBEMIS by inputting the quantity of different housing unit types and the related residential acreage for

[8] For summaries, see Kuzmyak et. al. (2003); Boarnet & Crane (2001); Criterion and Fehr & Peers (2001); Cervero & Ewing (2001).

each housing type, as described above. The comprehensive evaluation of this project estimated 7,652 units on 712 acres in Downtown Columbia and 1,010 units on 390 acres in Oakland Mills. In Downtown Columbia, the 2,150 units include 525 low-rise apartments on 105 acres, 6,033 mid-rise apartments on 410 acres, 872 condos/townhomes on 180 acres, and 222 assisted living units on 17 acres. In Oakland Mills, the 1,010 units include 316 single family homes on 145 acres, 551 low-rise apartments on 180 acres, and 143 condos/townhomes on 143 acres. Overall, Downtown Columbia's average residential density is 10.75 units per acre and Oakland Mills has 2.59 units per acre. In this case, the residential density for each housing type is generally lower than assumed when using the standard ITE rates. As a result, the net residential density increases the estimated number of trips as demonstrated in the trip generation rates adjusted based upon density shown in **Error! Reference source not found.**. The residential density results in an increase in roughly 13,000 daily trips over the ITE estimated trips or 6-percent increase of the ITE estimated trips.

Trip generation at the non-residential end is also influenced by density, but to a much lesser degree (Cervero, 1989, cited in Kuzmyak et. al, 2003). There are also far fewer studies investigating this relationship, and there is no comparable dataset to that for residential density. No credit is provided by URBEMIS for higher non-residential densities though it is included in the analysis.

Figure 45 Residential Density Impact on Trip Rates

		Units	Acres	Units/Acre	Assumed Units/Acre for ITE Rates	ITE Rates	URBEMIS Residential Density Adjusted Rates
Columbia Town Center	Apartments Low Rise	525	105	5	16	6.59	8.79
	Apartments Mid Rise	6,033	410	15	38	5.76	7.03
	Condo/Townhouse General	872	180	5	16	5.81	8.84
	Congregate Care Facility	222	17	13	n/a	2.02	2.11
Oakland Mills	Single Family Housing	316	78	4	3	9.57	9.13
	Apartments Low Rise	551	101	5	16	6.59	8.65
	Condo/Townhouse General	143	41	3	16	5.81	9.35

Mix of Uses

Many references point to the impact of "diversity" or mix of uses on travel behavior. This is true both at the macro-scale, e.g. jobs-housing balance, and the micro-scale, e.g. the availability of services within walking distance.[9] The analysis is complicated by the fact that some of the most beneficial developments from this perspective may be single-use, in an area where another use is predominant (e.g. residential in an employment area). For this reason, the mix of uses in the wider neighborhood (within one-half mile of the project center) is considered, where this area is larger than the project area itself. According to the US Census estimates and Baltimore Regional Council's Round 7C estimates, Downtown Columbia has 2,488 housing units and 1,876 jobs, and Oakland Mills has 2,931 housing units and an estimated employment of 3,159. In the future, after Downtown Columbia

[9] See, for example, Criterion and Fehr & Peers (2001); Ewing & Cervero (2001); Kuzmyak et. al. (2003).

build-out, it is estimated that there will be 7,990 housing units and 7,237 jobs, and Oakland Mills will have 3,050 housing units and 3,580 jobs.

To adjust trip generation rates as a function of the mix of land uses for a particular project is:

$$\text{Trip Reduction} = \frac{\left(1-\left(\frac{ABS(1.5 \times h\, e)}{1.5 \times h + e}\right).25\right.}{.25 \times 0.03}$$

Where h = study area households (or housing units)

e = study area employment

The formula assumes an "ideal" housing balance of 1.5 jobs per household and a baseline diversity of 0.25. The maximum possible reduction using this formula is 9%. With an overall jobs-housing balance of roughly 0.98 jobs/households, there is an estimated 16,400 fewer trips or 7-percent.

This reduction takes into account overall jobs-population balance. The presence of local serving *retail* can be expected to bring further trip reduction benefits, and URBEMIS provides an additional credit of 2%. This is towards the lower end of the range given in published research,[10] in order to avoid double counting with the jobs-housing balance mitigation measure. Local serving retail was assumed during the analysis and resulted in 5,300 fewer trips.

Transit

Any index of transit service needs to consider two fundamental issues: the amount of service (i.e., frequency and service span), and quality (particularly speed), which have a strong relationship with ridership.[11] The index used by URBEMIS therefore places the emphasis on frequency, but gives greater weight to rail service (in view of greater speed and comfort) and dedicated shuttles (which will be targeted to the needs of the specific development). It considers the quantity of bus service within one-quarter mile, and rail service within one-half mile.[12] The transit service index is determined as follows:

- Number of average daily weekday buses stopping within 1/4 mile of the site
- *Twice* the number of daily rail or bus rapid transit trips stopping within 1/2 mile of the site
- *Twice* the number of dedicated daily shuttle trips
- Divided by 900, the point at which maximum benefits are assumed

In order to account for non-motorized access to transit, half the reduction is dependent on the pedestrian/bicycle friendliness credit (described in the following section). As well as existing service, planned and funded transit service should be included in the calculation although purely demand responsive service may not be.

$$\text{Trip Reduction} = t * 0.075 + t * ped/bike\, score * 0.075$$

Where t = transit service index

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[10] E.g. Parsons Brinkerhoff (1996); and NTI (2000), both cited in Kuzmyak et. al. (2003).

[11] See, for example Kittselson & Associates et. al, (2003); Holtzclaw et. al. (2002) Pratt et. al. (2003); Nelson\Nygaard (2002).

[12] See Lund et. al. (2004) for a discussion of walking distances to transit.

In Downtown Columbia, there are currently 323 average daily weekday buses stopping within ¼ mile of the site. Those routes are Howard County Transit's Red (36), Gold (24), Silver (34), Brown (38), Green (52), Yellow (29), and Orange (29); Central Maryland Regional Transit's (CMRT) Route E (27); and Maryland Transit Administration's (MTA) commuter service, including Route 150 (10), Route 310 (5), Route 320 (2), Route 915 (19), and Route 929 (18). The proposed circulator would add 64 daily trips for a total of 387 trips.

In Oakland Mills, there are currently 80 trips per day, including Howard County Transit's Gold (24) and Brown (38), and MTA's Route 929 (18). If a transit bridge exists, additional routes would be able to be rerouted over the bridge and thus Oakland Mills would have more frequent service. With the transit bridge, Oakland Mills would be served by 169 trips per day, plus 64 circulator trips. The 169 trips are comprised of Howard County Transit's Red (36), Gold (24), and Brown (38); CMRT's Route E (27); and MTA's Route 310 (5), Route 320 (2), Route 915 (19), and Route 929 (18). Without the construction of the transit bridge and subsequent rerouting of transit service, an estimated 12,900 trips (5-percent) will be avoided due to future transit service. Were the transit bridge to be built, an estimated 13,400 trips (6-percent) would be avoided, or an additional reduction of 500 trips.

Figure 46 Transit Impact on Trip Generation

	No Transit Bridge			With a Transit Bridge		
	Observed	Trip Change	Trip Impact	Observed	Trip Change	Trip Impact
Transit Service	Columbia: 323 local buses & 64 shuttles Oakland Mills: 80 local buses	-12,900	-5%	Columbia: 323 local buses & 64 shuttles Oakland Mills: 169 local buses & 64 shuttles	-13,400	-6%

Bicycle and Pedestrian

Research for the Florida Department of Transportation, FHWA and other organizations has shown that there are numerous statistically significant factors that can assess the quality of the bicycle and pedestrian environment. These include motor vehicle volumes and speeds, truck volumes, roadway widths, urban design, and lateral separation between pedestrians and motor vehicles.[13] However, many of the data inputs required for these indices are highly complex to gather, particularly prior to occupancy. For this reason, URBEMIS uses three of the most important variables that are identified in the literature[14] to calculate the quality of the bicycle and pedestrian environment, as follows:

- Intersection density, which measures street connectivity. A well-connected grid (high intersection density) provides better opportunities for pedestrian travel than cul-de-sacs and "loops and lollipops" (low intersection density)
- Sidewalk completeness
- Bike network completeness

No reduction is allowed if the entire area within a half-mile walk of the project center consists of a single use. However, the pedestrian/bicycle factor can still be used to calculate pedestrian access to transit, as part of the transit mitigation measure.

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[13] For example, FHWA (1998); Landis et. al. (2001).

[14] See, for example, Dill (2003); Parsons Brinkerhoff (1993); Kuzmyak et. al, (2003); Ewing & Cervero (2001); and Ewing (1999). Note that network density is inversely related to block size, which is sometimes considered in the research.

$$\text{Ped/Bike Factor} = \frac{(\text{network density} + \text{sidewalk completeness} + \text{bike lane completeness})}{3}$$

Where: *Network density = intersections [sum of valences] per square mile/1300 (or 1.0, whichever is less)*

*Sidewalk completeness = % streets with sidewalks on both sides + 0.5 * % streets with sidewalk on one side*

Bike lane completeness = % arterials and collectors with bicycle lanes, or where suitable, direct parallel routes exist

A maximum reduction of 9% is assumed. The trip reduction is calculated as:

$$\text{Trip Reduction} = 9\% * ped/bike\ factor$$

Downtown Columbia was estimated to currently have 287 intersection legs, 5-percent of the streets with sidewalks on one-side, 90-percent of the streets with sidewalks on both sides, and with 10-percent of the arterials/collectors having bike lanes or direct parallel routes. After project build-out, there is estimated to be 528 intersection legs, 3-percent of the streets with sidewalks on one-side, 95-percent of the streets with sidewalks on both sides, and with 20-percent of the arterials/collectors having bike lanes or direct parallel routes. In Oakland Mills, it is estimated that there are currently 210 intersection legs, 3-percent of the streets with sidewalks on one-side, 95-percent of the streets with sidewalks on both sides, and with 25-percent of the arterials/collectors having bike lanes or direct parallel routes. URBEMIS estimates a reduction of nearly 9,000 trips or 4-percent reduction from the ITE estimate attributable to the bicycle and pedestrian infrastructure.

Affordable Housing

A significant amount of evidence points to the fact that lower-income households own fewer vehicles and drive less.[15] Obviously, it is difficult if not impossible to account for the exact incomes of residents in URBEMIS, because the occupants are not known at the pre-development stage. However, the percentage of deed-restricted below-market-rate (BMR) housing does offer a way to incorporate this effect. URBEMIS assumes a 4% reduction in vehicle trips for each deed-restricted BMR unit.

$$\text{Trip reduction} = \%\ units\ that\ are\ BMR * 0.04$$

No information was available to determine BMR housing for the current housing stock, but it was assumed based on development plans that the Downtown Columbia proposed build-out would have 20% BMR, and according to the formula above, gains a 0.8% reduction. A development with 100% BMR would gain a 4% reduction.

Transportation Demand Management

Transportation Demand Management (TDM) programs have been shown to reduce employee vehicle trips by up to 38%, with the largest reductions achieved through parking pricing.[16] URBEMIS provides credits for a range of TDM program elements, provided that they form part of a legally enforceable agreement (for example, a development agreement with a city) that guarantees that the mitigation measures will be implemented. URBEMIS provides the most credit for the three TDM elements that have the greatest impact on travel behavior:

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[15] See, for example, Russo (2001); Holtzclaw et. al., 2002.

[16] Shoup & Willson (1980); Comsis (1993); Valk & Wasch (1998); Pratt (2000).

- Parking pricing – up to 25% trip reduction, which is attained with a $6 daily charge.[17] Parking cash-out programs are granted 50% of the reduction for direct parking charges, in recognition of the fact that their impacts tend to be significantly lower (Pratt, 2000).

  $$\textit{Trip reduction} = \frac{\textit{daily parking charge}}{6 * 0.25}$$

- Free transit passes – up to 25% of the trip reduction granted for transit service availability.[18] Thus, the credit is more valuable in places that have good transit service. The 25% credit is based on Santa Clara County's EcoPass program which reduced vehicle trips by 19%.
- Telecommuting and compressed work schedules – employee vehicle trips are reduced by the percentage of employees that telecommute, or have a 'free' day gained through a compressed schedule, on an average day.

Lacking any significant evidence to the contrary, Nelson\Nygaard estimated that there is no daily parking charge for the non-residential parking, and that no free transit passes are included. We estimated that there is an insignificant participation rate in a telecommuting program and in a 3-day 36-hour work week.

Other TDM program elements, that do not include financial incentives, tend to have a smaller impact on travel behavior. Reductions are based on the number of the following elements incorporated into the program; none of which are included in our assumptions:

- Secure bicycle parking (at least one space per 20 vehicle parking spaces)
- Showers/changing facilities
- Guaranteed Ride Home
- Car-sharing services
- Information on transportation alternatives, such as bus schedules and bike maps
- Dedicated employee transportation coordinator
- Carpool matching programs
- Preferential carpool/vanpool parking

The impact of a TDM program will also depend on the travel alternatives available. A program will have more impact if the site is served by frequent transit, for example (although note that a TDM program can do much to promote carpooling even in other locations). For this reason, URBEMIS uses part of the TDM credit to adjust the credits granted for transit service and pedestrian/bicycle friendliness.

Credits for all TDM program elements are applied only to the types of trips that the TDM program seeks to influence. For example, if only employees, and not visitors, are subject to parking charges, the credit is applied only to employee vehicle trips.

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[17] The 25% reduction is based on the approximate midpoint of observed reductions, which range from 15% to 38% (Shoup & Willson, 1990; Comsis, 1993; Pratt, 2000).

[18] Free transit pass programs have been shown to increase transit ridership by 50-79% (City of Boulder, undated; Caltrans, 2002), and reduce vehicle trips by 19% (Shoup, 1999).

Figure 47 TDM Program Reductions

Level	Number of Elements	Recommended Reduction
Major	At least 5 elements	2%, plus 10% of the credit for transit and pedestrian/bike friendliness
Minor	At least 3 elements	1%, plus 5% of the credit of transit and pedestrian/bike friendliness
No program	None	None