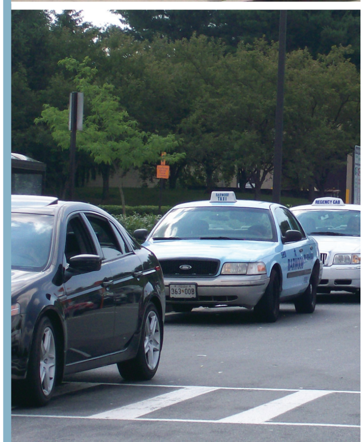
CCT Corridor Cities Transitway



CHAPTER III

Transportation System Performance and Effects

CORRIDOR CITIES TRANSITWAY
SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

Chapter III – Transportation System Performance and Effects

This chapter evaluates the transportation, mobility, and traffic impacts of the proposed modifications to the Original CCT Alignment and stations as described in **Chapter II** and below. Specifically, this chapter discusses the effects of the alignment and station modifications on transit service in the region and on traffic on local roadways. Additionally, this chapter tests the effects of various transit operations scenarios that include a selection of transit modal options – either Bus Rapid Transit (BRT) or Light Rail (LRT) – with the implementation of one or more of the proposed alignment modifications on the capital costs, operations and maintenance costs, and on transportation benefits (ridership, new transit riders, user benefits and cost-effectiveness) of the full CCT project (COMSAT to Shady Grove).

The effectiveness of transit service is dependent upon several factors including geographic coverage, hours of operation and frequency of service, door-to-door travel times, travel time reliability, number and convenience of transfers, ride comfort, and safety.

Chapter III of the **2009 AA/EA** provides detailed discussion of the proposed effects on the existing transit and transportation system of operating Alternative 6.2 (Transit-TSM) and build Alternatives 6A and 7A (LRT on the Original CCT Alignment with highway alternatives 6 or 7) and 6B and 7B (BRT on the Original CCT Alignment combined with highway alternatives 6 or 7). In general, the construction and operation of the CCT using either BRT or LRT – with or without implementation of one or more of the alignment modifications described in Chapter II of this document – in combination with associated proposed modifications to local feeder bus routes and the introduction of new express bus routes would provide the following transit system improvements:

- More frequent service
- Faster service
- Improved reliability and ride quality
- High quality station and stop amenities, including real-time transit information
- Access to key destinations and growth areas

Existing Transit Service Conditions

The north-south I-270/US 15 corridor is served by a variety of transit services, including local bus, commuter bus, and commuter rail. Washington Metropolitan Area Transit Authority (WMATA), Montgomery County Ride-On, Frederick TransIT, and the MTA provide transit service throughout much of Montgomery County, with commuter bus service extending into Frederick and Washington Counties and commuter rail service that extends into Frederick County, terminating in Martinsburg, West Virginia. There is not one single transit route or service that currently serves both the entire length of the corridor of the CCT or its proposed set of destinations.

The proposed transit service on the CCT would operate during the same time periods as other regional services, which presently operate as shown in **Table III-1**. Many bus routes operate on a variable schedule depending on destination and time of day, and some routes do not offer weekend service. Express buses usually operate only during weekday peak periods. It is expected that the CCT would operate seven days a week.

Table III-1: Existing Transit Service

TRANSIT SERVICE	WEEKDAY		WEEKEND
	STARTS	ENDS	
Metrorail	5:00 a.m.	1:00 a.m.	7:00 a.m.- 3:00 a.m.
MARC	4:30 a.m.	10:30 p.m.	No service
Local Bus	4:30 a.m.	12:30-2:00 a.m.	6:00 a.m.- 1:00 a.m.

Proposed CCT Transit Operations

Overall transit service for the CCT is described in **Chapter II** of the **2009 AA/EA** and summarized below. The proposed new transit service would feature the operation of either BRT or LRT on a fixed guideway from COMSAT to Shady Grove. Feeder bus services would provide access to CCT stations from local communities. Premium bus service would possibly operate on an improved/expanded I-270 facility from Frederick to Shady Grove, however the improvements required to enable that service are still under study. While this document generally addresses the effects of proposed modifications to the Original CCT Alignment in the Gaithersburg area, in this chapter it is often necessary to describe service within the context of the entire 14 to 16 mile corridor from COMSAT to Shady Grove in order to understand the broader implications of the possible changes.

For LRT service on the CCT, the assumption is that the light rail guideway would include double track operation following the alignment specified in **Chapter II** of the **2009 AA/EA** or using the modified alignments S1, S2, S2c, and/or S3 as described in this document. Light rail train sets would operate between the terminal stations at COMSAT and Shady Grove and provide service to the stations in between.

In the BRT service scenario, the buses would travel along the same guideway alignment identified for the LRT. Buses would use a two-lane guideway that would maintain complete separation from existing roadway traffic and provide direct service to all stations. The overall quality of transit service is an important factor influencing transit ridership. System users who perceive a transit service to be comfortable, convenient, and reliable are more likely to choose that service as their primary form of travel for a given trip.

Low-floor articulated buses at least 60 feet in length would be used for the trunkline service associated with BRT and newly defined premium bus services implemented as a component of the proposed transit services described on page II-4. These buses will provide a higher capacity than the standard 40-foot buses (90 passengers per bus versus 60 passengers per bus for standard buses) and should enhance the quality of the ride as well with more comfortable seating and a smoother ride. Hybrid or other alternatively fueled vehicles will be considered.

If LRT service is selected, the light rail vehicles would also provide more comfortable seating and a smoother ride than typical bus services.

Both BRT and LRT services would benefit from faster boardings and alightings than experienced on typical bus services due to the use of multiple doors and advance fare collection. Additionally, the CCT transit services would augment existing bus routes, nearly doubling transit service capacity in the corridor. The quality of a transit trip in the study area would also be enhanced by frequent service with reduced wait times than typical bus services in the region and by making station facilities more comfortable than currently available. Frequent transit service is proposed with all proposed transit

Table III-2: Transit Service Headways

ALTERNATIVE	PEAK PERIODS (minutes)	OFF-PEAK PERIODS (minutes)
Transit TSM with service to Crown Farm and Life Sciences Center*	6	10
LRT Modal Alternatives	7.5	10-12
BRT Modal Alternatives	5	8-12

Note that BRT service is more frequent than LRT service to compensate for the greater number of passengers that can be carried on an LRT vehicle. These headways define service frequencies that are designed to provide similar capacity of service (passengers per hour) between LRT and BRT services based on modeled ridership estimates. Headways will vary between different ridership model runs in order to balance need and capacity.

** The Transit TSM Alternative in this context operates on local roads using an alignment modified to provide direct service to Crown Farm and Life Sciences Center similar to the S1 and S2 alignment modifications described in this chapter. The LRT and BRT Alternatives assume implementation of none or any combination of the proposed alignment modifications S1, S2 or S2c, and S3 as part of the CCT alignment.*

alternatives, including the Transit Transportation Systems Management alternative or LRT or BRT with the alignment modifications S1, S2 or S2c, and S3 as shown in **Table III-2**. Modern stations with enhanced amenities such as shelters, seating, and real time transit information displays are proposed as well. The stations would also be designed with improvements in pedestrian, bicycle, park-and-ride, and car drop-off access where appropriate to make the trip to the transit station safer and more pleasant, as well as more accessible.

Travel Time

Each transit alternative provides specific improvements to reduce north-south transit travel times along the CCT corridor, including use of a dedicated guideway, traffic signal priority, and improved boarding times. As would be expected, a dedicated right-of-way, which provides more direct connectivity to destinations, results in travel times that are reduced over similar travel between the same destinations in mixed traffic on local roadways. **Table III-3** provides expected travel times for each of the alternatives.

Feeder Bus Service

To extend the reach and benefit of the trunkline transit service into surrounding neighborhoods, each of the modeled CCT alternatives proposed modifications to existing area bus routes to bring passengers to stations of the proposed higher-speed trunkline service.

With LRT Alternatives, several existing bus routes (Ride-On routes 66, 67, 71, 74, 75, 78, and 90) would be re-routed to terminate at a LRT station allowing passengers to easily transfer from bus to LRT. With BRT Alternatives, the guideway would be used at various locations to provide access for local bus operation. Some local bus service would continue to operate along streets next to where the guideway is located to serve local bus stops, while others would use the CCT trunkline to provide more express service. **Figures II-4** and **II-5** of the **2009 AA/EA** illustrate proposed local bus service for the BRT and LRT modal alternatives.

Transit service on commuter bus, MARC, and Metrorail are generally assumed to operate the same as currently provided if the CCT is constructed using either BRT or LRT. Some changes to local bus routes may be made to take advantage of the higher speed and reliability of the LRT or BRT service on the CCT corridor. For example, transit schedules may be modified or local bus stops may be added to drop passengers off closer to the new CCT stations. Any proposed changes to existing routes will follow required procedures as specified by MTA, WMATA, or Ride-On, including public input and involvement.

Premium Bus Service

In addition to BRT or LRT on the CCT, all transit alternatives would include premium bus service between Frederick County and corridor park-and-ride lots, major activity centers, and transit stations operating on

Table III-3: CCT Travel Times

ALTERNATIVE	COMSAT TO SHADY GROVE	METROPOLITAN GROVE TO SHADY GROVE
TSM Alternative with S1 and S2 modifications	70 minutes	43 minutes
LRT on Original CCT Alignment	36 minutes	20 minutes
BRT on Original CCT Alignment	38 minutes	21 minutes
LRT on CCT alignment with S1 and S2	43 minutes	27 minutes
BRT on CCT alignment with S1 and S2	47 minutes	30 minutes
LRT on CCT alignment with S1, S2 and S3	44 minutes	27 minutes
BRT on CCT alignment with S1, S2 and S3	48 minutes	32 minutes

managed lanes of I-270. Managed lanes (such as the high occupancy vehicle lanes and Express Toll Lanes[SM] presented in the 2002 DEIS and 2009 AA/EA) are still under consideration by the Maryland State Highway Administration and it is uncertain at this time which of the considered alternatives will be selected for design and construction. These services were proposed to provide better service options for long distance commuters from Frederick City and County and are described in detail as part of Alternative 6.2: Transit TSM in **Chapter II** of the **2009 AA/EA** (pages II-12 to II-14). These include the FREDSG, FREDMGSG, and KPTNMGSG premium bus routes that are part of each of the CCT service alternatives.

As the CCT project proceeds in the project development process and a preferred alternative is selected for both highway and transit, the routes may be substantially modified. The routes were designed with the assumed implementation of Express Toll Lanes and direct connections to the major CCT stations as provided in highway alternatives 6 and 7, described in **Chapter II** of the **2009 AA/EA** and **Chapter II** of this document.

Transportation Performance

A travel demand model was used to estimate transit ridership and other performance criteria for each modal alternative using the proposed realignments of the Original CCT Alignment and based upon established operations assumptions. The results of this modeling were first reported in the *Corridor Cities Transitway Analysis of Alignment Alternatives Serving Crown Farm, Life Sciences Center and Kentlands,* completed in November 2009. This chapter summarizes much of this analysis.

Additionally, each of the proposed alignment modifications was analyzed for its potential effects on vehicular traffic in the area of the realignments. The traffic analysis was an important factor in decisions regarding whether to retain grade separated crossings of busy Montgomery County roadways, and resulted in several important recommendations regarding signalization required for operation of either BRT or LRT.

Travel Demand Methodology

The travel demand analysis of the possible alignment modifications used the same travel demand model used to analyze the performance of the CCT transit alternatives in the 2009 AA/EA, modified to include current land use forecasts for the build horizon year 2030. Specifically, the Metropolitan Washington Area Model Phase I Year 2030 Model (Version 3, dated 02/05/08) used for analysis of the CCT in the 2009 AA/EA was updated to include the Metropolitan Washington Council of Government's (MWCOG) new round of land use forecasts (Round 7.2a) and coded network changes to include the new alignment and station locations. Network coding was completed for each of the alignment modifications described in this document. In addition, the modeled alignments include a revised Transit TSM alternative that would operate bus services on local roads to generally serve the same transit stations included for the CCT, including those proposed for alignment modifications S1, S2 and S2c, and S3. The Transit TSM alternative is used to provide a baseline against which to analyze the costs and benefits of the BRT and LRT modal "build" alternatives in which BRT or LRT are operated on the dedicated CCT guideway.

Note that the alignment modifications are modeled in combinations, and are therefore discussed in a different manner than that used in much of the engineering and environmental analysis. Alignment modification S1 serving Crown Farm is included in all modeled scenarios, because it is so physically similar to the Original CCT Alignment that the model is not sensitive enough to capture the slight differences in operating distance, time, and station locations. Similarly, the model does not test the ridership attributed to S2c because it is so similar to S2 that the model cannot capture any differences between them. The scenarios modeled include the following:

- Transit TSM with modified service to Crown Farm and the Life Sciences Center (LSC)
- LRT on the CCT with modified service to Crown Farm and LSC
- BRT on the CCT with modified service to Crown Farm and LSC
- LRT on the CCT with modified service to Crown Farm, LSC and Kentlands
- BRT on the CCT with modified service to Crown Farm, LSC and Kentlands

In addition to a change in the coding, a change was made to the processing of results to account for perceived benefits between LRT and BRT related to the qualities and characteristics of the services. The "mode-specific attributes" account for such things as amenities, reliability, comfort, safety, and other characteristics associated with a given mode. These attributes were applied not only to the alignment modifications, but also to the original alternatives using the Original CCT Alignment and included in the 2009 AA/EA. This enables a more "apples-to-apples" comparison of the performance of all alternatives under consideration.

MTA is in the process of preparing an improved transit model (Phase II) to be used on later phases of the CCT project. This model would use the results of an MTA-administered travel survey conducted to fulfill FTA requirements and include improvements in travel origin-destination pairs and other refinements needed to model transit rider behavior to a level of specificity that would be able to provide for better micro-scale analysis. After the LPA decision is made for the CCT, this refined model would be used to develop the detailed forecasts needed for the New Starts application and technical analyses that address specific questions from the community.

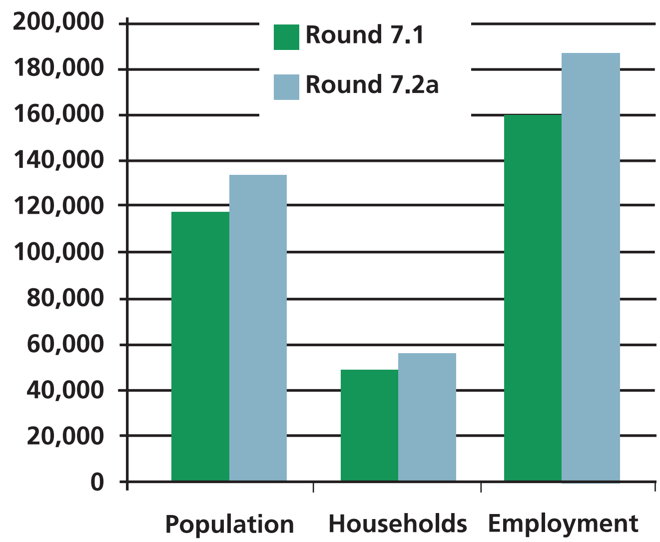
Round 7.1 to 7.2a Land Use

It is important to document the differences in land use assumptions in the CCT corridor between the analysis in this SEA and those in the 2009 AA/EA analysis. Land use is a critical input to the development of travel demand forecasts. Land use forecasts are generated regularly as part of the regional air quality conformity process and are based on the most recent assumptions for population and employment growth at various forecast years considering development activities and master planning efforts either approved or near the approval stage.

MWCOG Round 7.1 land use forecasts were used in the 2009 AA/EA to estimate travel demand and were linked with regional long-range transportation plan assumptions in the Phase I travel demand model. Round 7.2a forecasts updated the development assumptions for several areas in the CCT corridor, including the LSC area, the City of Gaithersburg, Metropolitan Grove, Germantown, and COMSAT. The forecast changes in land use, compared to Round 7.1, generated increased growth estimates for 2030 population, employment and households along the CCT corridor. As the Round 7.2a forecasts are currently approved by MWCOG, they were applied to this analysis to determine their effects on CCT ridership estimates.

A summary of changes in land use forecasts for the CCT corridor was prepared to highlight the changing assumptions between Round 7.1 and 7.2a forecasts. The population, household and employment projections for those areas within 2 miles of the corridor are shown on **Figure III-1** below:

Figure III-1: Differences Between MWCOG Round 7.1 and 7.2a Land Use Forecasts in CCT Study Area



Figures III-2 and **III-3** show the forecast household and employment differences between Round 7.1 and Round 7.2a. These changes represent updated planning assumptions based on master planning processes described in **Chapter I** and noted above. As master planning processes continue to modify future land use assumptions, so do the models that forecast land use for the future. It is expected that Round 7.2a will be replaced in the near future with another "round" of forecasts. Each of these changed land use forecasts will affect projected ridership on travel demand models used to estimate ridership and other performance factors for this project.

Figure III-2: MWCOG Round 7.1 vs 7.2a Change in Households (Year 2030)

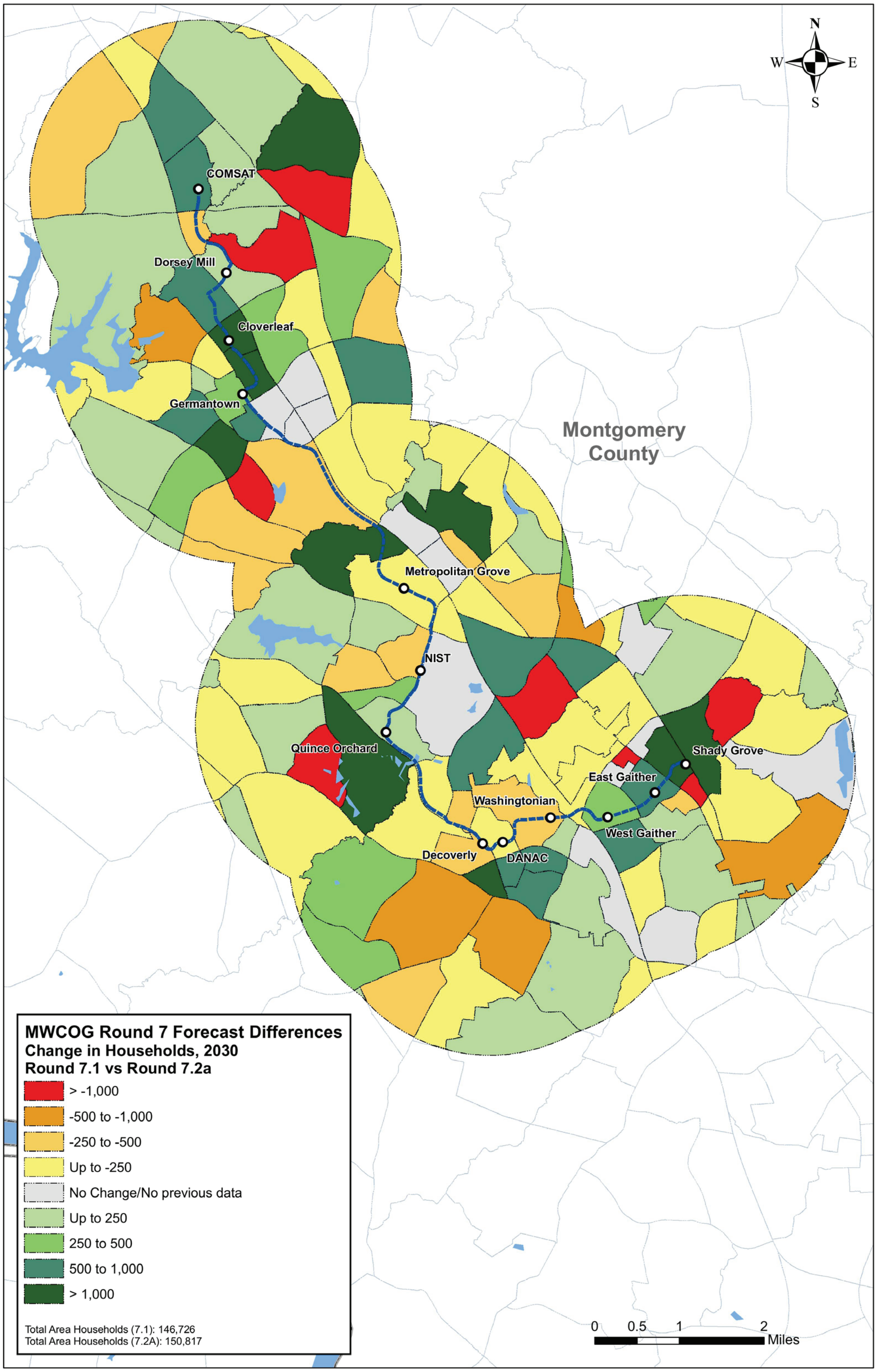
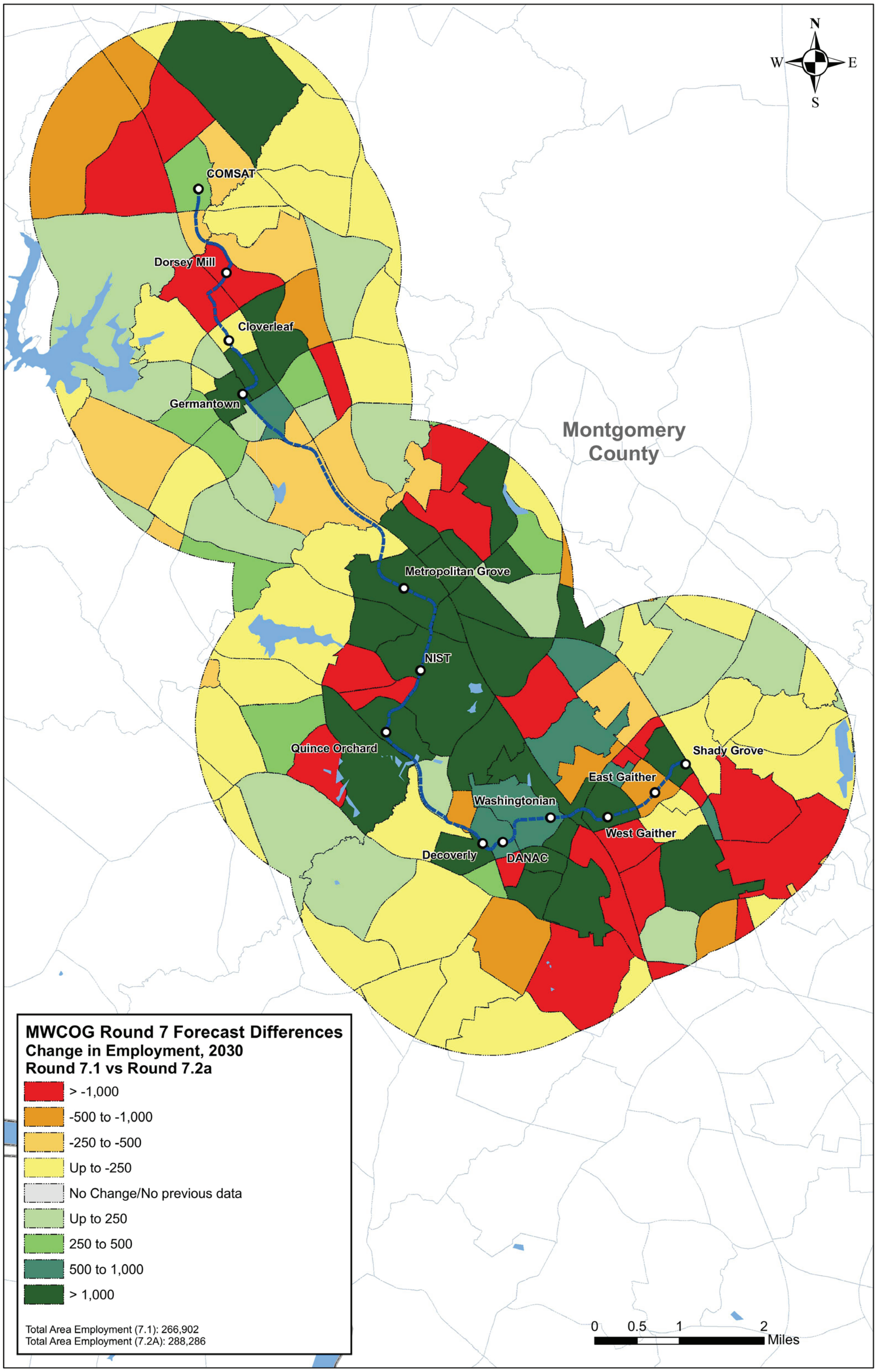


Figure III-3: MWCOG Round 7.1 vs 7.2a Change in Employment (Year 2030)



Modeled CCT Alternatives Using the Modified Alignments

The following describes the alignment routing and operations assumptions for each of the modal alternatives modeled for this analysis. A variety of scenarios were tested in order to compare the implications of operating premium bus on local roads or operating LRT or BRT on one or more of the proposed realignments of CCT guideway.

Alternative Transit TSM with S1 and S2: Service to Crown Farm and Life Sciences Center

This TSM option is identical to Alternative 6.2-Transit TSM described in **Chapter II** of the **2009 AA/EA** (pages II-12 to II-14) except the routing of the trunkline (T1) bus service has been adjusted to serve the LSC and Crown Farm areas using roads assumed to be built as part of the development plans for those areas. The modified TSM trunkline bus service would follow Great Seneca Highway, turn south on Muddy Branch Road, and then make a turn to the east on a proposed Belward Campus Drive extension. The T1 bus route would traverse what is now the Belward Farm and would stop at a new station within the future development. The T1 bus route would then turn south on Johns Hopkins Drive and proceed across Key West Avenue onto a proposed arterial roadway traversing what is now the Montgomery County Public Safety Training Academy. A station stop would be made to serve the redevelopment planned for the site and continue forward. Upon reaching Medical Center Drive, the T1 buses would turn east, proceed across Great Seneca Highway, turn north onto Broschart Road and make a station stop near Blackwell Road. Continuing northward, the buses would cross Key West Avenue and proceed onto Diamondback Drive. At Decoverly Drive, T1 buses would turn to the right and proceed northeast onto a proposed extension of the road through the Crown Farm property. A station stop would be made just prior to Fields Road. After this, buses would turn east on Fields Road, south on Omega Drive, and east onto Research Boulevard. From here, T1 buses would follow the remainder of the TSM route to Shady Grove.

The T1 route would have limited stops operating on six-minute peak period headways from COMSAT to the Shady Grove Metrorail station, making stops at locations at or near where stations are proposed along the alignment modifications. During off-peak periods, the T1 route would operate at ten-minute headways, augmented by existing feeder bus routes.

The feeder bus plan for the TSM alternative would build upon the existing route structure, extend the service area into Frederick County, and improve service frequencies where appropriate. In addition to the trunkline bus route described above, new bus service would include the FREDSG and FREDMGSG routes between the Frederick Transit Center and Shady Grove and the KPTNMGSG route between Kemptown and Shady Grove. Route FREDSG would continue to Shady Grove via I-270 while Routes FREDMGSG and KPTNMGSG would follow the TSM trunkline route from Metropolitan Grove to Shady Grove, consistent with the Alternative 6.2-Transit TSM described in **Chapter II** of the **2009 AA/EA** (pages II-12 to II-13).

LRT with S1 and S2: Service to Crown Farm and Life Sciences Center

Under this modeled scenario, the LRT alignment is identical to Alternatives 6A and 7A in the 2009 AA/EA except in the vicinity of LSC and Crown Farm where the alignment would deviate from the Original CCT Alignment beginning at the Great Seneca Highway/ Muddy Branch Road intersection. The changes in alignments to service these new destinations are described in **Chapter II** of this report.

LRT service between COMSAT and Shady Grove would operate at six-minute headways during peak periods and ten-minute headways during off-peak periods. The premium bus and feeder bus services provide identical geographic coverage and frequencies as described for LRT (Alternatives 6A and 7A) in the 2009 AA/EA and supporting technical reports.

BRT with S1 and S2: Service to Crown Farm and Life Sciences Center

The BRT alignment is identical to the LRT alignment described above. The trunkline BRT service frequencies would be identical to that described in Alternatives 6B and 7B in the 2009 AA/EA with one trunkline BRT bus route (B1) on six-minute headways during peak periods and ten-minute headways during off peak-periods between COMSAT and the Shady Grove Metrorail station, making all stops. In addition, feeder buses would use the guideway augmenting the trunkline service.

The feeder bus service provides identical geographic coverage and frequencies as described for BRT alternatives in the 2009 AA/EA (Alternatives 6B and 7B), but with some minor re-routing to serve the LSC Belward, LSC West, LSC Central, and Crown Farm stations.

Two of the three new bus routes to Shady Grove, Routes FREDMGSG and KPTNMGSG, would follow the CCT alignment between Metropolitan Grove and Shady Grove, originating from the Frederick Transit Center and Kemptown respectively. Route FREDSG would operate between the Frederick Transit Center and Shady Grove via I-270.

LRT with S1, S2 and S3: Service to Crown Farm, Life Sciences Center and Kentlands

The LRT alignment is identical to the LRT alignment described above (LRT with S1 and S2) except that it adds the new routing to Kentlands. As noted above, LRT service between COMSAT and Shady Grove would operate at six-minute headways during peak periods and ten-minute headways during off-peak periods.

The feeder bus service provides identical geographic coverage and frequencies as described for Alternatives 6A and 7A in the 2009 AA/EA, but with some minor re-routing to serve the Kentlands, LSC Belward, LSC West, LSC Central, and Crown Farm stations.

BRT with S1, S2 and S3: Service to Crown Farm, Life Sciences Center and Kentlands

The BRT alignment is identical to the LRT alignment described directly above (LRT with S1, S2 and S3). The trunkline BRT service would be identical to that described in Alternatives 6B and 7B in the 2009 AA/EA with the buses operating on six-minute headways during peak periods and ten-minute headways during off-peak periods. Some feeder bus routes would use a portion of the alignment to Shady Grove.

The feeder bus service provides identical geographic coverage and frequencies as described in the AA/EA, but with some minor re-routing to serve the Kentlands, LSC, and Crown Farm.

Two of the three new bus routes to Shady Grove, Routes FREDMGSG and KPTNMGSG, would follow the CCT alignment between Metropolitan Grove and Shady Grove, originating from the Frederick Transit Center and Kemptown respectively. Route FREDSG would operate between the Frederick Transit Center and Shady Grove via I-270.

Transit Service and Ridership Implications of the Modified Alignments in the Gaithersburg Area

The ridership estimates for the LRT and BRT scenarios described above were developed to compare the feasibility, attractiveness, and the ridership effects of operating on modified alignments in the Gaithersburg area to the transit alternatives studied in the 2009 AA/EA and 2002 DEIS.

The scenarios were set up to test:

- Ridership changes resulting from changing land use forecasts (Rounds 7.1 to 7.2a)
- Direct routing of LRT/BRT vehicles on a revised alignment through the destinations served by alignment modifications S1, S2, and S3

Table III-4 identifies some of the results of the modeling analysis performed for the representative scenarios relative to the alternatives tested in the 2009 AA/EA. Specifically, the table identifies the number of daily boardings, or riders, projected to take the CCT under a range of operating scenarios, including operation of a TSM, BRT, or LRT alternative on the Original CCT Alignment or as modified by adding S1, S2, and/or S3 to the alignment to serve growth areas. Additionally, the table identifies the number of new transit trips, i.e., trips that otherwise would have been taken by another travel mode (such as by automobile) that can be attributed to implementing one of these transit scenarios. A comparison of these numbers facilitates a decision on which of the scenarios is most effective at drawing riders to the CCT. In general, the FTA requires agencies to define a TSM alternative as a baseline of comparison against the so-called “build” alternatives that require the construction of a new transit facility in order to isolate the number of riders generated by the added capital investment.

Table III-4: Estimated Ridership and New Transit Trips

	ALTERNATIVE	BOARDINGS	NEW TRANSIT TRIPS
2009 AA/EA - Original CCT Alignment	6.2-Transit TSM	7,000	610-760
	6A–LRT	24,000-30,000	700-880
	6B–BRT	21,000-26,000	750-940
Original CCT Alignment Modified to Serve Crown Farm and LSC (S1 + S2)	TSM	9,000-12,000	780-980
	LRT	34,000-43,000	1,140-1,420
	BRT	30,000-37,000	1,200-1,510
Original CCT Alignment Modified to Serve Crown Farm, LSC and Kentlands (S1+ S2 + S3)	LRT	34,000-42,000	1,120-1,400
	BRT	29,000-37,000	1,190-1,490

Cost Analysis of CCT Alignment Modifications

Capital Cost Estimates

Capital cost estimates for the transit alternatives of the I-270/US 15 Multi-Modal Corridor Study, including those using one or more of the modified CCT alignments, have been developed in accordance with FTA guidelines. The guidelines call for cost estimates to be prepared and reported using the latest revision of FTA's Standard Cost Categories as described below. This forms the basis for the format and structure that is used for the capital cost detail and summary sheets developed for this project. The *Capital Cost Technical Memorandum* (March 2008) provides more detailed discussion on the methodology used to estimate capital costs.

The current FTA Standard Cost Categories consist of the following:

- Guideway and Track Elements
- Stations, Stops, Terminals, Intermodal
- Support Facilities: Yards, Shops, Administration Buildings
- Sitework & Special Conditions
- Systems (Power, Control, Communication)
- Right-of-Way, Land, Existing Improvements
- Vehicles
- Professional Services
- Contingency

Each of the alternatives under consideration for the CCT has a set of conceptual engineering drawings, typical sections, station locations, and/or written descriptions that provide definition for each of the major cost components. These documents form the basis for the infrastructure elements that were used to prepare the capital cost estimates. These facility elements can be classified into one of two broad groups, either typical or non-typical facilities. Typical facility costs are developed for elements that can be defined by a typical cross-section and applied over a given length of alignment, such as roadbed, track, and catenary power. The typical facility composite unit cost is developed by combining the costs for all of the individual construction elements for a typical section or facility and creating a representative composite unit cost. Typical sections or facilities are being developed for each of the alternatives.

Non-typical facilities include elements necessary for overall system operation but whose costs cannot be allocated to a specific geographic segment of the system (e.g., vehicles, O&M facility). After details are prepared for both typical and non-typical facilities and the cost data are developed, they are put into a format summarizing overall alternative cost and the cost of various alignment segments.

Contingency

Contingency is the estimated percentage by which a calculated value may differ from its true or final value. The contingency allowance is used to account for items of work (and their corresponding costs) that may not be readily apparent or cannot be quantified at the current level of design. These could include unknown project scope items, a potential project change resulting from public or political issues, or a change in environmental or technical requirements. For the purposes of this study, contingency is divided into two major categories: allocated and unallocated.

Allocated contingency is based on the level of design information available for individual items of work, as well as the relative difficulty in establishing unit prices for these items. The allocated contingency allowance, in the range of five percent to 30 percent, is allocated according to FTA construction or procurement cost categories. The exact percentage selected for each cost category is based on professional judgment and experience related to the cost variability typically seen for items of work within a particular cost category.

Unallocated contingency is similar to allocated contingency in that it is primarily applied as an allowance for unknowns and uncertainties due to the level of project development completed. The major difference is that allocated contingencies are intended to address uncertainties in the estimated construction, right-of-way, and vehicle costs that typically occur as the amount of engineering and design information advances, while unallocated contingencies are typically broader in nature and often address changes in the project scope and schedule. Unallocated contingency is calculated as two to five percent, depending on the cost category.

Professional Services

This cost category includes allowances for preliminary engineering, final design, project and construction management, agency program management, project insurance, surveys and testing, and start-up costs. These allowances are computed by applying a percentage to the total construction cost estimated for each cost category (excluding right-of-way and vehicle costs). Right-of-way and vehicle costs typically are calculated to include the management and administration costs associated with these activities and are therefore excluded from the calculation of professional services.

Capital Cost Assumptions

Key assumptions affecting the capital cost estimates included in the financial strategy are discussed in the following paragraphs.

The use of roadway rights-of-way controlled by the state is assumed to be granted to the project at no cost, except for construction of new facilities and replacement and/or repair of existing facilities. The costs for these property dedications will be shown when available, but will not be included in the final cost for the project.

There is a proposed hiker-biker trail project associated with the CCT. While the design of the CCT would accommodate this proposed trail, it is assumed that a separate funding program would be undertaken by local jurisdictions for implementation and maintenance of the trail.

The capital cost estimates assume traditional design-bid-build procurement, construction, and equipping for implementing the CCT project.

For reasons of construction management, corridor readiness, and/or funding availability, the project could be implemented in stages or phases. At this point, no definitive decision has been made regarding any phasing or staging. Possible initial phases, referred to as minimal operable segments (MOSs), could be Shady Grove to Metropolitan Grove and/or Metropolitan Grove to COMSAT. Any initial MOS phase would require a maintenance and storage facility.

Capital Cost Estimates

The cost estimates for the LRT and BRT alternatives are presented in **Table III-5** and are in 2007 dollars. **Table III-5** enables a comparison of the operation of LRT and BRT modes on the proposed modified alignment alternatives with the operation of LRT and BRT on the Original CCT Alignment. In general, LRT alternatives have higher capital costs than BRT alternatives due to LRT's need for continuous track, power, and signal systems.

Operating and Maintenance Cost Estimates

Operating and maintenance (O&M) cost estimates were developed using a model created for the 2009 AA/EA

Table III-5: Capital Cost Estimates

	ALTERNATIVE	COSTS (millions of 2007 dollars)
2009 AA/EA - Original CCT Alignment	TSM	$118.63
	LRT	$875.65
	BRT	$461.24
Original CCT Alignment with Crown Farm and LSC* (S1 + S2)	TSM	$124.88
	LRT	$972.63
	BRT	$505.15
Original CCT Alignment with Crown Farm, LSC and Kentlands* (S1+S2+S3)	LRT	$999.01
	BRT	$532.63

** These costs were originally calculated without a relocated DANAC station corresponding with alignment modifications S2 and S2c. The relocated DANAC is assumed under alignment modifications S2 and S2c to accommodate anticipated redevelopment of the DANAC property. A capital cost estimate conducted by MTA indicates the relocated station would cost an additional $12.1 million, reflecting the need for more tunneling to cross Key West Avenue and the addition of a new station. Only the costs associated with alignment modification S2 were calculated. S2c was not estimated*

and have been updated using the latest agency data. The transit O&M model conforms to FTA's most recently issued technical guidelines for transit alternatives analysis (*Procedures and Technical Methods for Transit Project Planning: Review Draft, September 1986 and updates).*

Estimating O&M costs involves two primary steps: 1) development of operating plans and estimation of operating statistics for each transit mode included in each service alternative and 2) development of O&M cost models and their application to the operating statistics obtained in step 1 to estimate the O&M costs for the new service. The operating statistics (vehicle hours, vehicle miles, etc.) are derived from the final operating plan for each service alternative.

Unit costs developed from Montgomery County Transit Ride-On operating statistics were used to represent all local bus service within the model. In this model, revenue miles, revenue hours, the number of peak vehicles, and other operating statistics for a particular transit alternative are converted to the resources that are required to operate and maintain the alternative (such as employees, materials, and services) using productivity factors that express the resources required as a function of the level of service. For local bus, the following supply variables were assigned:

- Vehicle Revenue Hours—costs driven by labor costs for vehicle operations
- Vehicle Revenue Miles—costs driven by materials and supplies for both vehicle operations and vehicle maintenance
- Peak Vehicles— costs for vehicles that operate during peak hours, the maximum number of service vehicles in operation

For local bus, the 2005-2007 data were escalated to 2009 dollars and then allocated to the service characteristics with which they were most closely associated (e.g., operator wage and fringe benefit costs were attributed to vehicle hours of service provided, fuel costs were allocated to vehicle miles, etc.). These allocated costs were summed to form a cost model based on three service characteristics: service hours, vehicle miles, and peak vehicles (the number of vehicles that operate during peak hours). The costs were then divided by the number of units of each operating statistic to develop unit total cost factors for each category.

The resulting unit cost factors are as follows:

$49,155 x number of buses operated during peak

$2.80 x number of annual vehicle miles

$51.26 x number of annual vehicle service hours

The LRT unit costs were derived using data from MTA. The individual costs were summed to form a cost model based on four service characteristics: vehicles in maximum service (peak number of vehicles), track miles, passenger car (one car of a potentially multi-car train) revenue hours and revenue miles. The rail model distinguishes between labor costs and non-labor costs for operating characteristics.

The unit cost factors for light rail include:

$91,572	x	number of vehicles in maximum service
$174,651	x	number of directional route miles (track miles)
$3.51	x	number of annual passenger car revenue miles
$118.26	x	number of annual passenger car revenue hours

Operating Statistics

Operating statistics were developed using the same service assumptions used in the 2009 AA/EA and described in the *Detailed Definition of Alternatives* technical report. Generally, span of service extends from 5:00 AM until 12:00 midnight with the peak period spanning three hours in both the AM and PM. The majority of bus routes within the corridor that operate only in the peak period today are also assumed to operate only in the peak period in the future, but overall bus frequencies are improved for all alternatives, including the No-Build alternative, compared to existing frequencies. This increase in bus frequencies reflects Ride-On policies as well as factors that would typically increase bus service such as expected growth in population and employment within the corridor.

Service frequencies for both the trunkline service (BRT or LRT) as well as the feeder bus routes were adjusted to reflect changes in passenger loads. Passenger loads were obtained from the travel demand estimates, which provide peak period maximum load point volumes for each route. Off-peak frequencies were assumed in the *Definition of Alternatives* technical report.

The O&M cost estimates were developed by applying the operating statistics of each alternative to the unit costs described above. These costs are determined separately for LRT, BRT, and feeder bus and then summed together to derive total annual operating costs in the corridor by mode. Subtracting the O&M cost of the No-Build from the O&M cost of each proposed Build alternative provides the net O&M cost for each Build alternative.

Table III-6 shows the net annual O&M costs for each alternative. Differences in maximum load volumes, guideway length, and travel time account for the differences in Vehicle Revenue Hours, Vehicle Revenue Miles, and Daily Peak Vehicles. Not surprisingly, the longer guideway of the alignments serving the LSC result in higher operating costs.

The lower capacity of the BRT vehicles, compared to LRT vehicles, results in higher annual operating costs for the BRT alternatives. Note that many of the feeder bus routes in the BRT alternatives also operate on the guideway, resulting in quicker travel times and higher boardings on those routes than would be the case if they operated on local roads.

Cost-Effectiveness

FTA requires an analysis of cost-effectiveness as a measure of the long-term benefits of the proposed project compared to the capital and operating costs of the project. In its evaluation of the cost-effectiveness of a proposed project, FTA considers the incremental cost per hour of transportation system user benefits in the forecast year. Transportation system user benefits reflect the improvements in regional mobility—as measured by the changes in travel time to users of the regional transit system—caused by the implementation of the proposed project. The cost-effectiveness measure is calculated by (a) estimating the incremental "base-year" annualized capital and operating costs of the project (over a lower cost "baseline" of transit service) and then (b) dividing these costs by the projected user benefits. The result of this calculation is a measure of project cost per hour of projected user benefits (i.e., travel-time) expected to be achieved if the project is added to the regional transit system. Proposed projects with a lower cost per hour of projected travel-time benefits are evaluated as more cost effective than those with a higher cost per hour of projected travel-time benefits.

Table III-7 presents the cost-effectiveness thresholds FTA is using in FY 2010 for assigning a High, Medium-High, Medium, Medium-Low or Low cost effectiveness

Table III-6: Net Annual Operating and Maintenance Costs

	ALTERNATIVE DESCRIPTION	DAILY VEHICLE REVENUE MILES	DAILY VEHICLE REVENUE HOURS	DAILY PEAK VEHICLES	ANNUAL VEHICLE REVENUE MILES	ANNUAL VEHICLE REVENUE HOURS	TRACK MILES	TOTAL OPERATING COST LRT
LIGHT RAIL TRANSIT								
Original CCT Alignment	6A	5,587	252	36	1,675,956	75,550	26.6	$22,759,000
CCT with Crown Farm and LSC (S1+S2)	LRT	5,528	273	39	1,658,377	82,022	29	$24,157,000
CCT with Crown Farm, LSC and Kentlands (S1+S2+S3)	LRT	5,696	278	39	1,708,781	83,429	30	$24,675,000
BUS RAPID TRANSIT								
Original CCT Alignment	6.2-Transit TSM	4,291	229	19	1,287,369	68,733	0	$9,864,000
	6B	6,792	323	32	2,037,508	96,951	26.6	$17,130,000
CCT with Crown Farm and LSC (S1+S2)	TSM	4,293	238	16	1,287,777	71,306	0	$9,850,000
	BRT	6,676	361	38	2,002,706	108,267	29	$18,042,000
CCT with Crown Farm, LSC and Kentlands (S1+S2+S3)	BRT	6,782	361	38	2,034,594	108,367	30	$18,258,000

rating for each proposed project. FTA publishes updates to these breakpoints annually to reflect the impact of inflation. FTA prefers a project to achieve at least a "Medium" rating in order to proceed in the FTA New Starts process. Additionally, a project's cost-effectiveness counts for 20 percent of a project's overall rating for New Starts. These ratings are used for the purposes of making funding recommendations to Congress for the discretionary New Starts transit project program.

Table III-8 summarizes the cost-effectiveness calculations for the alternatives. As shown, each of the alignment alternatives is compared to the TSM alternative. With this comparison the FTA is

Table III-7: Cost-Effectiveness Thresholds

COST EFFECTIVENESS RATING	COST EFFECTIVENESS VALUE
High	less than or equal to $11.99
Medium-High	between $12.00 and $15.99
Medium	between $16.00 and $24.49
Medium-Low	between $24.50 and $30.49
Low	greater than or equal to $30.51

determining whether the cost of a fixed guideway system is worth the investment. The table shows that the BRT alternatives are more cost-effective than the LRT alternatives and that there are higher user benefits from serving the LSC and Crown Farm areas for both BRT and LRT alternatives than with the Original CCT Alignment. Implementation of alignment modification S3 to more directly serve the Kentlands is not as cost-effective as the original location on the Original CCT Alignment because the additional travel time appears to inconvenience passengers from north of Quince Orchard and the capital cost is higher.

Roadway Network Effects of a Realigned CCT

This section describes the effect of alignment modifications S1, S2, and S3 on other local surface transportation facilities both in terms of impacts resulting from transit vehicles in operation and from induced traffic associated with site development of the two maintenance facility locations under study.

Analysis Methodology

Existing traffic counts were obtained from a variety of sources including the Maryland State Highway Administration (SHA), the Maryland National Capital Park and Planning Commission (M-NCPPC), and peak hour traffic counts obtained by the study team on May 18-20, 2010. Estimates of 2030 turning movement volumes at key intersections were developed by applying growth factors (obtained from comparison of link volumes in the 2005 and 2030 Travel Demand Models) to available count data. These projected 2030 turning movement volumes represent the "No Build" condition. The assessment of "Build" conditions varied depending on the type of impact (signalized and unsignalized transit crossing or induced traffic from site development) and are described in the following sections. Traffic operations were evaluated using Critical Lane Analysis, which is a tool that can determine the utilization of intersection capacity. Critical Lane Analysis is the preferred method by SHA and M-NCPPC for planning-level evaluation of intersection performance.

Signalized Crossings

The various CCT alignment modifications have the potential to impact roadway traffic patterns at several locations where at-grade portions of the proposed transit alignment coincide with existing at-grade intersections of high-volume roadways, typically the case for all intersections where the CCT alignment crosses intersections along a numbered state route. Most of these locations are already signalized, though existing signals will require modification to accommodate a transit phase. Due to the high traffic volumes at these locations as well as the anticipated high frequency of transit service, it would be infeasible to stop traffic

Table III-8: Cost-Effectiveness

	ALTERNATIVE DESCRIPTION	CAPITAL COSTS	ANNUAL OPERATING COSTS*	ANNUAL USER BENEFIT HOURS	COST EFFECTIVENESS
2009 AA/EA – Original CCT Alignment	6.2-Transit TSM	$118,636,000	$19,791,000	1,500,000–1,890,000	
	6A – LRT	$875,650,000	$25,523,000	3,660,000–4,590,000	$24.00–$30.00
	6B – BRT	$461,240,000	$25,224,000	3,720,000–4,650,000	$11.21–$13.93
Original CCT Alignment with Crown Farm and LSC (S1+S2)	LRT	$972,630,000	$26,416,000	5,430,000–6,780,000	$16.04–$20.05
	BRT	$505,150,000	$25,984,000	5,490,000–6,840,000	$7.43–$9.26
Original CCT Alignment with Crown Farm, LSC and Kentlands (S1+S2+S3)	LRT	$999,010,000	$26,945,000	5,370,000–6,720,000	$16.86–$21.14
	BRT	$532,630,000	$26,346,000	5,430,000–6,780,000	$8.11–$10.13

** Includes costs of operating feeder and premium bus services* through preemption in order to serve the transit movement. At such locations it is proposed that the CCT be served at signalized intersections using Transit Signal Priority (TSP), which requires that the CCT vehicle be held temporarily if it arrives in the middle of a conflicting signal phase. Signal control would then serve both the CCT and compatible traffic movements (those not in conflict with the CCT) at the earliest opportunity. Proposed locations for a signalized CCT crossing in the Gaithersburg area are as follows:

Signalized Crossings of CCT Alignment Modifications

- Intersection of Decoverly Drive and Diamondback Drive (Alignments S1, and S2)
- Crossing of Diamondback Drive north of Key West Avenue (Alignment S1)
- Transit crossing of Great Seneca Highway north of Medical Center Drive (Alignment S2c)
- Crossing of Muddy Branch Road south of Great Seneca Highway (Alignments S2 and S2c)
- Crossing of Lakelands Drive south of Great Seneca Highway (Alignment S3)
- Crossing of Orchard Ridge Drive south of Quince Orchard Road (Alignment S3)
- Crossing of Twin Lakes Drive south of Quince Orchard Road (Alignment S3)

With TSP, the transit movement can have a minimal impact to traffic congestion because the transit movement is timed to coincide with compatible (non-conflicting) traffic movements. In cases where the CCT alignment parallels a high-volume roadway such as Great Seneca Highway, the majority of the signal cycle is already dedicated to serve the high-volume "through" movement and does not conflict with the transit vehicle's passage. Therefore, the transit vehicle can often proceed across the minor street with no delay

Table III-9: Critical Lane Analysis

INTERSECTION	2030 NO-BUILD				2030 BUILD				CCT IMPACT
	AM PEAK		PM PEAK		AM PEAK		PM PEAK		
	V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS	
Diamondback Drive & Decoverly Drive	0.25	A	0.28	A	0.39	A	0.38	A	LOW
Key West Avenue & Diamondback Drive / Broschart Road	1.03	F	1.15	F	1.03	F	1.15	F	none
Great Seneca Highway & Medical Center Drive	0.64	B	0.92	E	0.84	D	0.99	E	MODERATE
Key West Avenue & Johns Hopkins Drive	1.06	F	0.93	E	1.15	F	1.10	F	MODERATE
Muddy Branch Road & Mission Drive / Midsummer Drive	0.62	A	0.51	A	0.62	A	0.51	A	none
Great Seneca Highway & Muddy Branch Road	1.53	F	1.07	F	1.53	F	1.07	F	none
Great Seneca Highway & Lakelands Boulevard	0.97	E	0.74	C	0.97	E	0.74	C	none
Quince Orchard Road & Sioux Lane / Orchard Ridge Road	0.36	A	0.36	A	0.36	A	0.36	A	none
Quince Orchard Road & Twin Lakes Lane	0.42	A	0.44	A	0.42	A	0.44	A	none

a. v/c = volume to capacity, the ratio of the anticipated traffic volume to the road's capacity

b. LOS – level of service, a measure of traffic congestion, where "A" represents free-flow conditions, and "F" represents highly congested condition.

and negligible impact on roadway traffic. **Table III-9** shows the results of Critical Lane Analysis evaluation of key intersections under the 2030 "No-Build" and 2030 "Build" scenarios.

Minor Crossings of CCT Alignment Modifications

The CCT will also interface with the road network at the intersections of numerous local streets and private entrances at the following locations:

- Anticipated crossings of private entrances and local intersections associated with Crown Farm development (Alignment S1)
- Crossing of private entrances along Decoverly Drive (Alignment S1)
- Crossing of private entrances and local intersections on the east side of Broschart Road (Alignment S2)
- Crossing of Mission Drive east of Muddy Branch Road (Alignments S2, S2c)

The locations noted above would operate under minor-approach stop control.The traffic movement parallel to the CCT is allowed to proceed in free flow and all turning vehicles (to or from the entrance) are obligated to yield right-of-way.

Efficient operation of the CCT requires that these crossings operate under transit preemption. Operationally, this would result in interruption of access to entrances with each passage of a transit vehicle.

For the BRT option there will be little change from the perspective of drivers at these entrances since they already yield to traffic along the major street. However, the bi-directional operation of the BRT warrants gating or other safety measures since half of the BRT vehicles will be operating in a direction opposite to oncoming traffic.

In the case of LRT these crossings must be protected by gates for safety and site-specific evaluation should determine if the interruption to site traffic warrants signalization to provide a protected movement for turning vehicles when the CCT is not present. Currently, 2030 traffic projections do not indicate a need for signal control at these locations.

CCT O&M Site Impact Analysis

O&M Site at Metropolitan Grove (LRT or BRT)

Evaluation of traffic operations for the 2030 Build scenarios considered the O&M Site proposed at Metropolitan Grove. Alternative site designs for the BRT and LRT options differ in layout but are functionally similar in that all site generated traffic will access the public road network via Metropolitan Grove Road.

Site Trip Generation

Evaluation of traffic impacts from the O&M site considered site-generated traffic including O&M staff, drivers, and transit vehicles for the BRT option. Site trip generation for both LRT and BRT during the AM and PM peaks is affected by the shift changes that are expected to occur at 7AM and 3PM. Additionally, bus pull-outs from the site will affect traffic during the AM and PM peak hour for the BRT option. Site trip generation for the O&M site is summarized as follows:

AM peak hour:

- 67 cars entering for 7:00 AM-3:00 PM shift
- 48 cars exiting for 11:00 PM-7:00 AM shift
- 8 bus pull-outs (BRT option only)

PM peak hour:

- 65 cars entering for 3:00 PM-11:00 PM shift
- 67 cars exiting for 7:00 AM-3:00 PM shift
- 2 bus pull-outs (BRT option only)

Distribution of Site-Generated Traffic

The influence area of generated traffic for the O&M site included signalized intersections along Clopper Road from Watkins Mill Road (one signal to the west of Metropolitan Grove) to Quince Orchard Road (two signals to the east). The evaluation was carried out to Quince Orchard Road due to the routing of buses from the site to serve the CCT in which all buses would exit the O&M site to travel eastbound on Clopper Road and would split at Quince Orchard Road where buses serving the northbound routes (originating at Shady Grove) are anticipated to go straight across Quince Orchard Road en route to I-270. Buses serving the southbound routes (originating at COMSAT) would turn left on Quince Orchard Road to go north. Passenger car traffic relating to shift changes is distributed throughout the Clopper Road corridor consistent with prevailing traffic patterns.

Table III-10: Metropolitan Grove O&M Site – Results of Critical Lane Analysis

INTERSECTION	ANALYSIS SCENARIO	AM PEAK		PM PEAK	
		v/c	LOS	v/c	LOS
Clopper Road & Watkins Mill Road	2030 No-Build	0.52	A	0.45	A
Clopper Road & Metropolitan Grove Road		0.54	A	0.56	A
Clopper Road & Firstfield Road		0.73	C	0.72	C
Clopper Road & Quince Orchard Road		0.76	C	0.85	D
Clopper Road & Watkins Mill Road	2030 Build LRT	0.53	A	0.46	A
Clopper Road & Metropolitan Grove Road		0.56	A	0.61	A
Clopper Road & Firstfield Road		0.74	C	0.74	C
Clopper Road & Quince Orchard Road		0.77	C	0.86	D
Clopper Road & Watkins Mill Road	2030 Build BRT	0.53	A	0.46	A
Clopper Road & Metropolitan Grove Road		0.57	A	0.63	B
Clopper Road & Firstfield Road		0.75	C	0.74	C
Clopper Road & Quince Orchard Road		0.77	C	0.86	D

Impacts of Site-Generated Traffic

Evaluation of traffic impacts from the O&M site compared traffic under "Build" conditions for both the BRT and LRT options to 2030 "No Build" traffic based on forecasts. Signalized intersections within the influence area were analyzed for AM and PM traffic under each condition using Critical Lane Analysis, consistent with M-NCPPC Local Area Transportation Review parameters. As **Table III-10** indicates, the analysis shows that all intersections are projected to function at an acceptable Level of Service (D or better) during both AM and PM peak hours under the 2030 No-Build scenario, and that site traffic results in negligible increases to congestion for the BRT and LRT Build scenarios.

O&M Site at Observation Drive (BRT Only)

An alternative O&M site under consideration for the BRT option is located near the intersection of West Old Baltimore Road and the future extension of Observation Drive just east of the I-270 overpass over Old Baltimore Road and approximately 1.3 miles west of MD 355. A detailed traffic analysis of the Observation Drive site was not conducted, given the very different current and future conditions of land uses and available roadway capacity at the location of the Observation Drive O&M site compared to those of the Metropolitan Grove O&M site.

At his location, the CCT is anticipated to run down the median of Observation Drive intersecting the local road network at an at-grade intersection with West Old Baltimore Road. Preliminary layouts of the O&M site show access to the site being provided via entrances on Old Baltimore Road.

Traffic impacts resulting from this site include staff traffic related to shift changes at the O&M site and the ingress/egress of BRT vehicles to the CCT alignment. The impact of bus traffic is limited to the immediate vicinity of the site between the site entrance and Observation Drive. Staff traffic will distribute through the local roadway network and is anticipated to have a similarly negligible impact on congestion as is apparent with the O&M site location at Metropolitan Grove. Minor improvements at local intersections, such as the intersection of West Old Baltimore Road and MD 355, will be considered in the course of selecting the preferred site for the O&M facility.