SUPPORTING DOCUMENTATION FOR ALTERNATIVES DEVELOPMENT

AUGUST 2013

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Introduction

The Purple Line is a proposed sixteen-mile light rail public transit system extending between Bethesda in Montgomery County to New Carrollton in Prince George's County, Maryland. In an effort to provide faster, more reliable rapid public transportation through this congested east-west corridor, the Maryland Transit Administration (MTA), in cooperation with the Federal Transit Administration (FTA) as the lead federal agency, is recommending the project to provide a direct connection to existing Maryland Rail Commuter Service (MARC), Amtrak, and local transportation services. The Purple Line is also intended to offer increased transportation options and improved connectivity to communities located between the existing Metrorail lines.

In accordance with the National Environmental Policy Act of 1969 (42 USC § 4332, as amended), the MTA is preparing a Final Environmental Impact Statement (FEIS) to evaluate potential options for addressing the goals and objectives of the Purple Line project. Regulations for the implementation of NEPA require that the project sponsor rigorously explore and objectively analyze a reasonable range of alternatives in the determination of a preferred project proposal (40 CFR § 1505.1). As a result, the Preferred Alternative presently under study in the FEIS/4(f) Evaluation is the product of extensive project planning and numerous refinement efforts that have occurred during the project's lengthy history. The project has evolved through numerous evaluative studies that have previously been conducted, in addition to the MTA's comprehensive coordination with elected officials, local communities, government and regulatory agencies, property owners, special interest groups, and non-profit organizations. Analyses of various alternatives and continued public and agency outreach have introduced a range of potential modes, alignments, station locations, and ancillary facilities for inclusion as part of the Purple Line FEIS study.

The purpose of this report is to provide a compendium of supporting documentation for the various alternatives that have been considered throughout the process of project development, in order to provide an understanding of the justification for the selection of the Preferred Alternative that has been carried forward for detailed analysis in the FEIS/4(f) Evaluation. This report consists of a compilation of memoranda, white papers, and additional studies on specific project elements that have been evaluated since the public release of the *Purple Line Alternatives Analysis and Draft Environmental Impact Statement* (AA/DEIS) (MTA, September 2008). This document is intended to support Chapter 2.0 of the FEIS/4(f) Evaluation and exemplifies the level of detailed consideration, coordination, and evaluation that has occurred as part of the extensive alternatives development for the Maryland Purple Line.

1. Review of Proposal by County Executive for Metrorail Purple Line Loop from Silver Spring to Medical Center Metrorail Stations

M-NCPPC

MONTGOMERY COUNTY DEPARTMENT OF PARK AND PLANNING

THE MARYLAND-NATIONAL CAPITAL
PARK AND PLANNING COMMISSION

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Silver Spring, Maryland 20910-3760

Revised 1-31-03

MEMORANDUM

TO: Montgomery County Planning Board

VIA: Charles R. Loehr, Director
Department of Park and Planning

FROM: County-wide Planning Division

SUBJECT: Review of Proposal by County Executive for Metrorail Purple Line Loop from Silver Spring to Medical Center Metrorail Stations

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RECOMMENDATION

Based on staff analysis of the information available concerning the Purple Line Loop (PLL) proposal, staff recommends that the proposal not be carried forward for further detailed study. This conclusion was arrived at based on the findings shown below, with considerable weight given toward the need to move an approvable project ahead in the project planning process. We find the Inner Purple Line (IPL) is the project that should be advanced.

These recommendations are based on technical data and staff research on the planning and implementation process for Federally-funded projects. The findings regarding a two-year or four-year delay for incorporation of the PLL into the current Purple Line study process are estimates but reflect known procedural time frames. Not having heard the community comments that will be presented at the Board hearing, staff has not attempted to evaluate the community acceptance of the PLL proposal.

In developing our recommendation not to study the Executive's Metrorail proposal further, staff is aware of the lack of Montgomery County political consensus on constructing the Inner Purple Line. Our recommendations are made on the basis of technical thought processes. We leave for others to determine what is necessary to overcome that lack of consensus.

The following sections are found in this memorandum:

I. Findings of Analysis
II. Purpose and Background
III. Description of Purple Line Loop
IV. Inner Purple Line
V. Purple Line Loop Performance
VI. Evaluation and Comparison of Purple Line Loop and Inner Purple Line

I. FINDINGS OF ANALYSIS

Staff finds three distinct advantages to the Purple Line Loop proposal:

- It addresses several known problems with the Inner Purple Line, such as adverse impacts to adjacent property owners, a degraded trail experience, and space constraints associated with adding tracks in the Silver Spring CBD.

- The PLL attracts more new riders than the IPL because it reduces transfers in the Metrorail system and is a faster ride between Silver Spring and Bethesda than the proposed Inner Purple Line light rail.

- The PLL would improve Metrorail operations flexibility and efficiency. Switches and tunnels would allow for several operating configurations between Shady Grove and Glenmont by connecting the Medical Center and Silver Spring Metrorail stations. It also provides redundancy in the Metrorail system that is not now available.

However, the Purple Line Loop raises several grave concerns as well:

- To continue study on the PLL, bringing it to the point where fully-informed decisions can be made about cost, environmental impacts, and all the other needed aspects that go into a Draft Environmental Impact Statement, is likely to take at least two years and possibly longer.

- The PLL costs approximately twice as much as the IPL. Costs of the PLL are very preliminary and would be subject to significant modification due to the very sketch-level nature of the planning to this point. WMATA staff's cost estimate is $616 million. Staff finds that this should be at least $746 million. This estimate is shown in detail in this memorandum. The IPL cost estimate is $371 million. The increase in project cost for the PLL is greater than the proportional increase in ridership.

- The cost effectiveness of the PLL, based on Park and Planning staff estimates of capital costs, is lower than that of the IPL.

- Some assumptions of the design are critical and, if they must be changed, additional problems could arise. The center-to-center offset between the PLL trains and CSX trains is 18 feet in the designs, although recent designs for the IPL have had to use 25 feet based on CSX guidance. WMATA feels their agreement with CSX allows the lower number.

- The completion of the Capital Crescent Trail will be necessary as a separate project with the PLL, and will have some cost associated with it that has not been determined. Completing the trail is included in the costs for the IPL. Similarly, no new south entrance to the Bethesda Metrorail station would be created with the PLL, eliminating one of the benefits of the IPL design.

- Environmental issues can play a major role in the ability of this project to be approved for Federal funding. The PLL impacts substantially more wetlands, floodplains, and forest than the IPL.

- Community impacts such as visual effects, potential noise, vibration, and other aspects have not been well defined due to time constraints and the sketch-level nature of the planning. These impacts will be somewhat dependent upon the types of structure used to support the Metrorail tracks, their heights, and other variables.

- It does not seem that there are appropriate Metrorail station locations on the proposed alignment between Medical Center and Silver Spring, with the possible exception of the Seminary Road/Linden Lane area near the CSX tracks. However, a station there would require significant changes to the land use and adjacent roadway network to be cost-effective.

- The PLL will reduce the future available Metrorail service capacity for stations north of the Medical Center and Silver Spring stations, perpetuating the need for “turn back” service.

Finally, two findings do not affect the relative value of PLL and IPL:

- PLL is feasible to construct from an engineering perspective using the WMATA staff assumptions. The design uses some unusual structures, but there is public land or land from CSX that would allow for construction, and there are no physical constrains that could not be overcome. The DEIS has already resulted in the same finding for the IPL.

- A future rail extension from Silver Spring to Langley Park, College Park and New Carrollton could be constructed with connections to either a Metrorail loop or the Inner Purple Line light rail. There are costs and benefits associated with all combinations of light rail and Metrorail for the sections east and west of Silver Spring.

II. PURPOSE AND BACKGROUND

In mid-January 2003, County Executive Duncan sent to the Montgomery County Council a proposal to link the two sides of the Metrorail Red Line. This link would allow Metrorail trains to travel directly between the Medical Center and Silver Spring stations, creating a loop as well as extension possibilities. Council President Michael Subin sent this proposal to the Planning Board, asking for their review and recommendations to the Council by January 31.

In this paper, the County Executive's proposal is referred to as the Purple Line Loop (PLL) to differentiate it from the Inner Purple Line (IPL). The proposed Inner Purple Line is light rail that would run from the Bethesda Metrorail station via the Georgetown Branch right-of-way to Silver Spring. A continuation being studied from Silver Spring to Langley Park, College Park and to the New Carrollton Metrorail station is described in this memo as the Inner Purple Line East.

The basic question being asked of the staff and Board is:

- **Is this new Purple Line Loop feasible enough to recommend that Maryland DOT and Montgomery County spend time and money on further detailed study?**

- **How does this new proposal compare against the Inner Purple Line?**

For this analysis, most comparisons are done against the transit lines between Bethesda or Medical Center, and Silver Spring. This is the section where most detailed information is available about the two lines and where they are most comparable. Each could be linked to a line that would extend east of Silver Spring; ridership and other benefits, as well as costs, are shown in this paper. However, the planning for the eastern section is of a very sketch-level nature at this time.

The need to complete the decision-making about further study for this project is closely related to the time schedule of the Federal Surface Transportation bill reauthorization. U.S Congress House members must have their projects to the House Transportation and Infrastructure Committee by February 28, 2003. The Board was briefed on the Federal reauthorization process recently, and a summary of relevant information is included as an attachment to this memorandum.

Status of Related Projects

Several other projects related to the PLL proposal are in varying stages of study:

- The Inner Purple Line for its entire length from Bethesda to New Carrollton is in an initial Project Planning stage by the Maryland Transit Administration (MTA). The section from Silver Spring to New Carrollton is in a very early stage of analysis, with an alignment still to be determined. However, the western section, from Silver Spring to Bethesda, is well along in a

Supplemental Draft Environmental Impact Statement (SDEIS). A draft EIS was published in 1996 on this section. The SDEIS was initiated in 2001, identifying the impacts of double-tracking the section and updating other information. The SDEIS and Final EIS are expected to be completed in 2003.

- The Corridor Cities Transitway is a planned transitway from the Shady Grove Metrorail station, north to Clarksburg. This line is being evaluated as either a busway or light rail. A Draft Environmental Impact Statement was published in the spring of 2002, and is in the review process now. A decision on mode and other design alternatives is expected in fall of 2003, with a final EIS in 2004. That would allow for final design to begin.

- SHA is studying the addition of HOV lanes to the Capital Beltway from the American Legion Bridge to the Woodrow Wilson Bridge. This concept, developed in the same inter-modal corridor study that identified the “P6” rail alignment for IPL and IPL East, will be documented in a Draft Environmental Impact Statement likely to be completed during 2004. The concept is supported in the Planning Board’s Transportation Policy Report and a Public Hearing Draft of a Master Plan amendment was released in January 2003 that would add the portion west of I-270 to the Master Plan of Highways. Due to anticipated environmental and community impacts between I-270 and the Prince George’s County line, the County Council has decided to await further information from the SHA study before proposing an HOV lane addition to I-495 east of I-270 in the Master Plan of Highways.

III. DESCRIPTION OF PURPLE LINE LOOP

Operating Methods and Headways

The 4.7-mile[1] PLL would connect the Silver Spring and Medical Center stations on the Red Line using heavy rail cars like those found throughout the rest of the Metrorail system. The PLL would operate initially with a peak hour headway of 6 minutes (10 six-car trains per hour) and could operate with a peak hour headway of 5 minutes (12 eight-car trains per hour)[2] during the year 2025 without acquiring any additional rail cars beyond those WMATA is already planning to purchase in order to meet their year 2025 service goals. The PLL would operate as a true loop, such that Red Line trains that currently terminate at the Grosvenor and Silver Spring stations would instead continue clockwise along the loop from Medical Center and counterclockwise along the loop from Silver Spring.

Physical Alignment

The section numbers indicated in the description of the physical alignment refer to the section illustrations located in the 11" x 17" color overview map. All section illustrations are looking to either the south or east. The sections were provided by WMATA staff.

***Silver Spring Station to 16th Street (MD 390): Section 1-1*:** In the area between the Silver Spring station and 16th Street, the outbound and inbound PLL tracks are separated to provide a more economical engineering solution. From the existing Silver Spring station, the area currently occupied by the pocket/turnaround tracks just north of the station would be converted into a 1000-foot-long retained cut[3] for single track. Beyond the existing station, the outbound (toward Medical Center) track would descend below the grade of the CSX tracks and main Red Line, into the retained cut and then into a 400-foot-long cut-and-cover tunnel to pass underneath the CSX tracks and Spring Street before entering a 1200-foot section of mined tunnel to pass back underneath the Red Line and an 800-foot-long cut-and-cover tunnel to pass underneath 16th Street. The track would emerge on the east side of the CSX tracks northwest of 16th Street, and would be on top of the stacked box configuration shown in Section 2-2.

Beginning northwest of 16th Street, the inbound tracks (toward Silver Spring) are shown at the bottom of the stacked box configuration in Section 2-2. The inbound tracks would remain below grade and break into the existing Red Line tunnel beneath 16th Street, where they would join up with the existing track and proceed along the remainder of the current Red Line route to Silver Spring.

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[1] Length of new construction

[2] The maximum headway for the PLL is 4.6 minutes (13 trains/hour), but has been rounded to the nearest whole number.

[3] A retained cut is basically a cut and cover tunnel without the cover. Sections of the Red Line between Grosvenor and Rockville are in a retained cut.

***16th Street to south of Talbot Street: Section 2-2*:** After emerging from the portals near 16th Street, the line proceeds in a retained cut on the east side of the CSX tracks in a stacked box configuration, outbound tracks on top, inbound tracks on the bottom.

***Transition From South of Talbot Street to North of Talbot Street: Section 3-3*:** The line transitions from the stacked box configuration to a more typical side-by-side double track alignment and passes under the Talbot Street bridge over CSX on the east side of the CSX tracks. Some work would have to be performed on the Talbot Street bridge to accommodate the additional train tracks.

North of Talbot Street to Tunnel Under CSX Tracks: Section 4-4: North of Talbot Street, the line continues in the standard double-track configuration on the east side of the CSX tracks. The total length of the at-grade and retained cut section from the 16th Street tunnel exit to north of Talbot Street is 1900 feet.

***Tunnel Under CSX Tracks: Section 4A-4A*:** The line then descends to a 1100-foot-long mined tunnel under the CSX tracks, emerging on the west side of the CSX tracks just south of Brookville Road. The line passes under the Brookville Road bridge over CSX on the west side of the existing tracks. Some work would have to be performed on the highway bridge to accommodate the additional train tracks.

***North of Brookville Road to Beltway Crossing: Section 5-5*:** After passing under the Brookville Road bridge, the line proceeds 1100 feet either at-grade or in a retained cut in a side-by-side double track configuration on the west side of the CSX tracks to the site of the proposed Walter Reed Annex station, southwest of Montgomery Street. Departing the station site, the line continues for 1500 feet either at-grade or in a retained cut on the west side of the CSX tracks before crossing the Capital Beltway (I-495) on a new bridge parallel to the existing bridges for the CSX tracks and Seminary Road. Immediately following the bridge, the line turns west and continues on an aerial structure, passing over Linden Lane before descending to roughly the same grade as the Beltway itself and continuing on the north side of the Beltway. The total length of the bridge over the Beltway and subsequent aerial structure is 2000 feet.

***North of Capital Beltway to Rock Creek Crossing: Section G-G* and Typical Cross Section** (on bottom left of map): While traveling for a distance of 1000 feet at roughly the same grade as the Beltway or slightly higher in this section, the line is shown on WMATA maps as at-grade.

Rock Creek Crossing to West of Connecticut Avenue (MD 185): Section F-F and Section E-E: The line would cross Rock Creek on a 600 foot-long single-column structure supporting double-track on top, northwest of and parallel to the Beltway crossing of Rock Creek. The line would then return to the at-grade alignment shown in section G-G for a distance of 2500 feet before ascending to an aerial structure and the proposed station in the northwest quadrant of the Beltway interchange with Connecticut Avenue (MD 185). This station would be an aerial station on a bridge long enough to pass over the interchange ramps as well as Connecticut Avenue itself. Section E-E shows the aerial structure on either side of the proposed Connecticut Avenue station. The total length of this aerial structure is 3300 feet.

Descent to Western Tunnel: Section D-D*:* After leaving the aerial section west of Connecticut Avenue, the line descends into a 1050-foot-long retained cut and enters a 1500-foot-long cut-and-cover tunnel parallel to the Beltway, on the north side just east of Cedar Lane.

Mined Tunnel Under Beltway to Medical Center Station: Section C-C: From the cut and cover on the north side of the Beltway, the line enters a mined tunnel that passes underneath the Beltway and turns to the southwest. The mined tunnel continues underneath the public right-of-way for Elmhirst Parkway and beneath parkland owned by the Commission before moving underneath the right-of-way for Cedar Lane. The line would then pass through an underground junction to join with the main branch of the Red Line north of the Medical Center station and continue into the station itself, which is approximately 85 feet underground. The total length of new mined tunnel is 3800 feet.

Potential Stations

Walter Reed Annex, located on the west side of the CSX tracks southwest of Montgomery Street. This station would be at-grade and adjacent to property owned by the U.S. Army. Currently, both walk and auto access to this site is only from the west, with the auto access via either Linden Lane or Brookville Road and then through the Walter Reed Annex.

Connecticut Avenue (MD 185) and the Capital Beltway (I-495), located in the northeast quadrant of the interchange (the area bounded by the on-ramp from northbound Connecticut Avenue to the westbound Beltway/Outer Loop). This station would be on an aerial structure. Auto and bus access to the station and an adjacent parking structure would be via the interchange ramps.

Cost Estimates

WMATA has estimated the capital cost of the PLL as described above at $616 million. Eliminating either of the two new stations would reduce the overall capital cost.

Operating costs depend primarily on the frequency of service along the PLL. Initial operation of the PLL at 6-minute headways (10 six-car trains per hour) would increase Metrorail annual operating costs by approximately $10 million for the increase in vehicle-hours of operation but would not require capital expenditure for new railcars. Year 2025 operation of the PLL at 5-minute headways (12 eight-car trains per hour) would increase annual operating costs by $10 million over base Red Line operations for the year 2025, again for the increase in vehicle-hours.

Future System Expansion

There are three potential system expansion points for the PLL. The first is from Silver Spring east to Takoma Park, Langley Park, College Park, and New Carrollton, generally following the route of the IPL. This extension could be done with either light rail or heavy rail. The second and third potential expansion points would branch off the PLL on the north side of the Beltway. On the west side, the line would branch off prior to the Cedar Lane portal and continue on the north side of the Beltway to Rock Spring Park (via Grosvenor or a new transfer station at Pooks Hill Road), Montgomery Mall, and ultimately Tysons Corner in Virginia. On the east side, the line would branch off prior to the Linden Lane bridge crossing the Beltway and continue on the north side to Four Corners (via Forest Glen), White Oak/FDA, and then turn down New Hampshire Avenue (MD 650) to Langley Park, where it would join the IPL alignment to College Park and New Carrollton. Both of these lines would almost certainly have to be operated as heavy rail. No detailed engineering has been performed on any of the three potential expansions.

Surrounding/Adjacent Land Uses at Proposed PLL Stations

An analysis of job and household data for a half-mile radius around each new station on the Purple Line Loop yielded the following results[4]:

In 2025, the Connecticut Avenue/I-495 station is projected to serve approximately 620 single-family households, no multi-family households, and about 795 jobs. The Walter Reed Annex station is projected to serve about 445 single-family households, 615 multi-family households, and 2,990 jobs. These are roughly the same as current conditions, as little new development is planned for these two areas under current plans.

Tunnel/Rock Conditions

Although detailed geotechnical and feasibility studies will be needed in siting and designing the tunnels of the PLL, an initial examination of the information available from published maps indicates no obvious problem with tunneling through the rocks along the proposed tunnel alignments. Indeed, these same formations have already been tunneled through for Metro in other locations in Montgomery County. However, specific locations of important features, such as depth to bedrock, formation contacts, and the Rock Creek Shear Zone, are subject to mapping resolution limitations and error, and if of geotechnical concern, would have to be assessed and/or verified in the field.

[4] Data rounded to the nearest 5 jobs and households.

IV. Inner Purple Line

The term Inner Purple Line (IPL) generally refers to a rail transit corridor connecting the Bethesda, Silver Spring, and New Carrollton Metrorail stations. The western portion of this corridor, primarily referred to as the Georgetown Branch, is a 4.4-mile master-planned transitway between Bethesda and Silver Spring along historic freight rail alignments. This section has a long and detailed planning history. It is summarized in Attachment 2 of this report. In the following text, the terminology will be:

- "IPL" refers to the Inner Purple Line between Bethesda and Silver Spring, the Georgetown Branch section.

- "IPL East" refers to the Inner Purple Line between Silver Spring and New Carrollton

Inner Purple Line Description

The current design being evaluated for the IPL between Silver Spring and Bethesda includes the following features:

- A double-track light-rail system, except for a portion of single-track adjacent to the Metro Plaza Building northwest of Colesville Road in Silver Spring

- A continuous trail adjacent to the light-rail line, except for a section approximately 1500 feet in length near the CSX Metropolitan Branch junction where the trail follows residential streets in the Rosemary Hills community

- Stations at Bethesda (Metrorail Station), Chevy Chase Lake (Connecticut Avenue), West Silver Spring (Lyttonsville Place), Woodside (16th Street), and Silver Spring (Transit Center).

Inner Purple Line Performance and Impacts from DEIS

The 1996 Draft Environmental Impact Statement for the IPL (Georgetown Branch Transit/Trail) concluded that the primarily single-track light-rail/trail alternative would:

- Carry approximately 19,500 daily riders

- Save travelers 427,400 hours annually

- Have a capital cost of approximately $205M and a cost-effectiveness per new rider of $23.29.

Park and Planning staff have conducted a separate analysis using their forecasting methodology to provide a comparison with the Purple Line Loop. The figures used are somewhat different than those from the DEIS due to different methodologies and future land use assumptions (this analysis uses a year 2025 jobs-and-household forecast, for example, while the DEIS used 2020).

The current capital cost estimate for the IPL is $371M, substantially higher than the 1996 DEIS estimate of $205M. The reasons for the increase are:

- $45M for escalation from 1995 dollars to 2003 dollars

- $100M associated with both the need to double-track the system to incorporate future operating plans for the IPL East extension and to increase the separation from CSX rails from the 18 feet acceptable to CSX in 1996 to the 25 feet now required by CSX

- $21M for locally preferred options described in the DEIS, including an overpass at Connecticut Avenue and underpass at the CSX Metropolitan Branch junction, and trail extensions through the Bethesda and Silver Spring stations

V. PURPLE LINE LOOP PERFORMANCE

Transportation and Mobility Impacts

This section presents the transportation and mobility impacts of the Purple Line Loop. Specifically, this analysis looked at network connectivity, travel demand for the new line including ridership by station, travel time savings, and access to stations. Section 6 compares the results of the PLL with the Inner Purple Line.

1. Demand Forecasting Methodology

The analysis of transportation and mobility impacts performed for this study is based on travel forecasts performed using the M-NCPPC TRAVEL/2 demand model. This analysis used MWCOG Round 6.2 cooperative land-use forecasts for the year 2025 as the primary input to project travel demand. TRAVEL/2 is a regional travel model encompassing the greater Washington-Baltimore region, but with greater network detail within Montgomery County. Travel forecasts from the model are for the three-hour evening peak period.

It should be noted that the level of analysis performed for this study can best be described as sketch-level planning, given the limited time available for study. Travel forecasts developed to support Major Investment Studies in the corridor, such as the Georgetown Branch DEIS and the Capital Beltway Corridor Study, should be more reliable. However, TRAVEL/2 allows for a relative comparison of the Purple Line alternatives using the same methodology.

A summary of key project assumptions is shown in Table 1.

Table 1: Travel Model Assumptions

Input	Assumption
Land Use	MWCOG Round 6.2 Cooperative Forecasts (2025)
Base Highway and Transit Network	2025 Regional Constrained Long-Range Plan network (without Georgetown Branch)
Headways*	Metrorail (PLL): 5 minutes Light Rail (IPL): 6 minutes
Average Transit Speeds, including station stops	Metrorail: 37 mph Light Rail: 29 mph
Station Parking	Unconstrained (no parking charge)
Fare Structure	No Change from Base – assumes average Metro fare based on distance
Drive Access	Uses TRAVEL/2 coding convention, drive access allowed at all new stops
Bus Service in the Corridor	CLRP network assumes 10 minutes headways for bus routes serving the Silver Spring transit center. J2 Bus headway increased to 20 minutes for the PLL and IPL forecasts.

* The one-minute difference in headways between IPL and PLL has a negligible effect on travel demand forecasts.

2. Travel Patterns in the Corridor

Travel forecasts for the proposed Purple Line Loop provide an indication of the success of the line in terms of increasing transit ridership in the corridor, providing mobility benefits for new and existing transit riders, and supporting the economic viability of the communities connected by the transit line.

Future travel conditions are a function of both the underlying land use patterns and assumptions about the transportation network. According to the Round 6.2 forecasts, both population and employment are expected to increase for the area of Montgomery County inside of the Beltway. Between 2000 and 2025, employment is forecasted to increase by 17.5% and households are expected to increase by 15.3%. Information from the 1997 Census Update Survey reveals that 18.4% of Montgomery County residents work inside the Beltway, a total of about 85,000 workers.

The PLL would provide a critical link between the two legs of the Metrorail Red Line. As a result, it would serve both local and regional transit trips. Many of the riders would be expected to have at least one trip end within the portion of Montgomery County within the Beltway, but there would also be a number of potential through trips on the line – riders that begin and end their trips outside of the corridor.

3. Travel Time Savings

The PLL would average a speed of 37 miles per hour over 5.3 miles between Medical Center and Silver Spring for a total time of 8.6 minutes. Removing the Connecticut Avenue station would increase the average speed slightly to 39.3 miles per hour, decreasing the line time to 8.1 minutes. The current Metrorail time between Bethesda and Silver Spring is 35 minutes; the J2 bus travels between the two centers in 18 minutes.

Table 2 presents travel times for some typical origin-destination pairs for the Baseline and PLL scenarios. Travel times assume a walk connection to transit and include in-vehicle, walk, wait, and boarding times.

Table 2: Transit Times (in minutes) Between Selected Origin-Destination Pairs

Origin-Destination Pair	Base	With PLL
Bethesda to Silver Spring	34	17
Friendship Heights to Wheaton	41	33
Rockville to Takoma Park	50	40
Dupont Circle to Connecticut Ave (new station)	53	30

One measure of the benefits of the new line is the travel-time savings for transit riders. For transit trips that have a time savings with the PLL, the average time saved (as compared with the 2025 Baseline scenario) is 5.7 minutes. This amounts to a total time savings of 3,200 hours daily or 952,200 hours annually. For the PLL without the Connecticut Avenue station, time savings would be 3,030 hours daily or 900,200 hours annually.

4. Impact on Mode Shares

By improving transit service in the corridor, the PLL would attract some new work trips to transit causing a slight increase in the mode share for these trips. A number of factors affect mode share, including in-vehicle travel time, waiting time, walking time, auto availability, and characteristics of the station area such as density and walkability.

Table 3 shows transit mode shares for the Baseline and PLL scenarios. The PLL increases transit shares more in the Silver Spring policy area than for the county as a whole. This policy area includes the Lyttonsville/Walter Reed annex areas. Transit shares are projected to be greater for the home end of the trip, with the PLL increasing the share from 19.3% to 20.6% of work trips. Larger shifts in mode shares in this part of the county are difficult because there is already significant transit usage.

Table 3: Transit Mode Share for Work Trips

	Baseline		With PLL	
Area	**Work End**	**Home End**	**Work End**	**Home End**
Montgomery County	9.2%	14.1%	9.4%	14.4%
Policy Areas:				
Bethesda	18.0%	18.5%	18.8%	19.0%
Silver Spring	15.3%	19.3%	16.0%	20.6%

The mode shares shown above suggest that the PLL will primarily serve existing transit riders who are already using bus or rail service. The line may show a larger increase in boardings than in person-trips using transit. The person-trips are called “linked” trips because all of the segments of a transit trips are linked together. Boardings are referred to as “unlinked” trips. For example, a transit passenger who takes a bus to the PLL in Silver Spring, transfers to the Red Line in the direction of Shady Grove, and then walks to a job in Rockville would have three transit boardings (1 on bus, 2 on rail), but only one linked trip. On a regional basis, when compared with the Baseline scenario, the PLL alternative would increase linked transit trips by 1100 in the evening peak period, or 3850 daily trips. If the Connecticut Avenue station were not included in the PLL, there would be fewer new transit trips, about 1060 in the evening peak period, or 3725 daily trips.

5. Projected Ridership on the Purple Line Loop

Table 4 shows the projected evening peak-period ridership for the PLL, with and without the Connecticut Avenue station. The PLL would carry 9,700 evening peak-period passengers with the Connecticut Avenue station and 8,470 passengers without the Connecticut Avenue station.

Because the PLL would be operated as a loop, the segment between the Medical Center and Silver Spring does not reflect the entire ridership of the loop. However, riders who exit and board on this segment are counted as ridership for the new segment of the loop. There may be some through trips that are also using the line but are not shown in this table. For example, a trip from Bethesda to Takoma would use the loop, but would not board or exit along the new segment.

Ridership on the entire Red Line including the PLL includes about 1,500 new boardings not accounted for by the 9,700 riders on the new PLL segment. However, there are roughly the same number, about 1,500 boardings, that are transfers from the PLL to the Red Line. These riders are counted as being on both the Red Line (outside of the PLL) and on the PLL.

Table 4: Evening Peak-Period Ridership for PLL Stations

	With Conn. Ave Station		**Without Conn. Ave Station**	
	Exits	**Boards**	**Exits**	**Boards**
Medical Center	1,240	2,700	1,630	2,610
Connecticut Ave	1,830	450	n/a	n/a
Walter Reed	1,480	470	1,720	520
Silver Spring	5,150	3,220	5,120	3,060
Evening Peak	**9,700**	**6,850**	**8,470**	**6,190**
Daily Riders	**34,000**		**29,700**	
Annual Riders	**10.10 million**		**8.82 million**	

The evening peak period ridership figures indicate the directionality of trips, with exits representing the home end of trips, and boardings representing the work end of trips in the evening peak period. The transit volumes by segment show a directional imbalance, with heavier flows from west to east. The maximum load point would be just east of Medical Center, with transit volumes of about 6900 eastbound and 2600 westbound.

Projections of daily and annual ridership have been developed by factoring evening peak-period totals. The peak-to-daily factor is a key assumption that affects the daily and annual evaluation measures. There is a range of values for existing Metro stations to convert evening peak period to daily trips, depending on the level of mid-day and non-work trips. The system average is about 3.0, but values can range from 2.6 for New Carrollton to 3.8 for Dupont Circle. To be consistent with the Georgetown Branch DEIS, a peak-to-daily factor of 3.5 was used in this study. A daily-to-annual factor of 297 was also used to generate annual trip estimates.

If the PLL were extended from Silver Spring to New Carrollton, ridership would significantly increase. Evening peak period riders on the entire line from Medical Center to New Carrollton are projected to be 20,500, or about 72,000 daily trips. The Medical

Center to Silver Spring segment would increase from 9,700 to 11,300 evening peak period riders with the line extended to New Carrollton.

6. Access and Egress Modes

The access and egress modes of passengers boarding and alighting at the new stations on the PLL were analyzed as a transportation impact. The travel forecasts conducted for this study assumed that there would be unconstrained parking for “park & ride” trips. Other riders would arrive at the stations as auto passengers, or “kiss & ride”. The forecasts indicate that if drive-access facilities were available, the Connecticut Avenue station would be primarily accessed by automobile, at 67% of the trips. Walk and bus access are expected to have about equal shares of the riders. Walk access to a Connecticut Avenue station would depend on proper facilities for pedestrians. Some existing Metrorail stations that are suburban and isolated in nature do attract walk-access trips. For example, Greenbelt (9.5%), Dunn Loring (12%), and Twinbrook (17%) do not have high residential densities near the station. Bus transfers at the Connecticut Avenue station would depend on routing existing L7 and L8 Connecticut Avenue buses with a direct connection to the new station.

The proposed Walter Reed station would have lower percentages of drive-access trips. The station would have a majority of trips accessing the station by walking. Bus access to the area would be minimal, currently served only by the Ride-On Route 4.

Table 5: 2025 Evening Peak Period Access/Egress Modes for New Stations

	Access/Egress Modes		
STATION	**Drive**	**Walk**	**Bus Transfer**
Connecticut Ave	67%	19%	14%
Walter Reed	43%	54%	4%

7. Highway Traffic Impact

The PLL would have a minimal impact on vehicle miles traveled (VMT). Countywide, the PLL does not change VMT compared with the Baseline scenario. For the section of the county inside the beltway, the PLL reduces VMT by less than 0.1%. There is a very slight 0.2% increase in VMT in the Kensington/Wheaton area, probably as a result of the new park-and-ride trips. Traffic volumes on the Capital Beltway do not show any reduction due to the new transit line. There would likely be local traffic impacts around new stations due to transit riders arriving by automobile.

Purple Line Loop Natural Environmental Impacts

Any transportation facility requiring Federal funds must go through an environmental impact statement. M-NCPPC has a Geographic Information System (GIS) that has information for a number of elements considered as sensitive areas. This is not intended to replace the millions of dollars that will ultimately have to go into detailed studies, but it does provide a preview of areas that may require avoidance, minimization, or mitigation. For the purposes of consistency, the data to create the chart below come from GIS. The chart did not use data from the draft EIS for the Georgetown Branch Trolley. **A map showing critical environmental features is attached to this memorandum.**

The best thinking on the proposed Purple Line Loop is that after following the CSX right-of-way to I-495, it will generally be on the north side of the existing edge of paving but still within SHA's easement for I-495. Staff looked at an area 50 feet from the edge of paving. **Actual impacts would be substantially reduced if the line were supported on piers above the grade of I-495.**

Overall, the PLL will have much greater impacts on the natural environment than the IPL. Its alignment adjacent to Rock Creek Park means it will, by its nature, produce negative effects that will be difficult to avoid.

There are several cautions about the following information. This is a planning level analysis and is based on many simplifying assumptions and should be used as a preliminary screening method. The results are less precise than would be determined from individual project engineering studies and extensive environmental fieldwork. Limitations include the following:

- The locations and extent impact were determined by a 50-foot right-of-way. Areas of disturbance could change significantly as the design process reduces impacts through relocation and design and construction methods.

- Steep slopes are generally not accounted for.

- The right-of-way does not capture project components such as storm water management facilities and staging areas, which create additional areas of disturbance.

- The extent of the environmental features is often more extensive than the indicators available in the GIS. Therefore this tool should be used to compare alignments rather to evaluate a single alignment.

These limitations are acceptable for a planning level review, because the measurements are primarily to be used in relative terms rather than as absolutes. They are a useful composite indicator of relative resource disturbance among these alternatives.

A definition of the terms used in the Environmental Features is in Attachment 3. Note that the PLL assumes 50 feet of disturbance outside the current Beltway pavement. This could be reduced with structures.

Table 6: Environmental Features

Environmental Features (Shown in acres, except as noted)	IPL	PLL
Total Acres of Surface Right-of-Way (not tunnel areas)	27.4	21.5
Wetlands	0.1	2.8
Floodplain	0.9	6.1
Number of Stream Crossings	2	5
Stream Buffers	4.4	7.6
Park Property	0	7.0
Forest	0.9	9.5
Significant Forest (100 acres or more)	0.1	6.3
Interior Forest Habitat (300 feet from edge of forest)	0	5.5
Number of Buildings	2	0
Number of Private Home Lots	0	1
Number of Archeology Sites	6	2
Number of Historic Districts	0	0
Linear Feet of ROW Adjacent to Park Property	1199	6945

Community Impacts of the PLL

A number of area master plans contain references to the Georgetown Branch Trolley/ Trail (now Inner Purple Line western portion), providing guidance to the access, land use, and other features, all supporting this project. Some considered other options. The North and West Silver Spring Master Plan (August 2000) recommends the implementation of the Georgetown Branch Transitway between Silver Spring and Bethesda to reduce demand along East-West Highway. However the Plan also says that “This Master Plan’s proposed land uses and transportation network do not preclude any of the transit modes or alignments which are currently proposed in the CBMIS (The Capital Beltway Major Investment Study).” Transit access to the two major Central Business Districts is not negatively affected by the PLL, so it generally carries out the master plan goals of improving transit use.

Probably the largest change from current plans is in the station locations. The Georgetown Branch Master Plan Amendment specifically recommends a transitway and trail along the Georgetown Branch alignment between Bethesda and Silver Spring. The plan recommends a light-rail line with up to eight stations total, six of them being neighborhood stations in between the terminal stations in the Bethesda and Silver Spring CBDs. It recommends that there be a minimum of five stations built initially: Bethesda CBD, Connecticut Avenue/Chevy Chase Lake, Lyttonsville, Spring Street and Silver Spring CBD. The Plan also recommends three additional stations for future consideration: East-West Highway, Jones Mill Road and Woodside/16th Street. The current Inner Purple Line proposal is consistent with these recommendations and includes five stations. Additional stations could be added in the future.

By comparison, the PLL includes only two new middle stations to serve neighborhoods. However, they are in new locations: the Connecticut Avenue/Chevy Chase Lake station is moved north to Beach Drive where it is no longer near the Chevy Chase Lake commercial neighborhood and is no longer a “walk-to” station. It would become a park and ride station with a parking garage.

The Lyttonsville Road station is moved northeast to the campus of the Walter Reed Army Institute for Research where there are security issues for the campus. There are also access issues for the surrounding neighborhoods due to distance and the fact that access may be limited by Army security. This station would be better located on Linden Lane where the community has access and where it could benefit the reuse of the historic National Park Seminary property. However, the latter site also poses acquisition issues since it is the site of an Army warehouse and salt dome. To date, the Army has not been willing to include the property in the National Park Seminary sale even though it would add significantly to the economic feasibility of restoring and reusing the National Park Seminary site. Without a new site and new warehouse, the Army will likely not be interested in selling or leasing the site.

On the positive side, a station at Linden Lane could increase the land use options and economic feasibility of reuse of the National Park Seminary historic resource.

With the PLL, the 16th Street Station is eliminated. In recent Inner Purple Line studies, the 16th Street station took the place of the one at Spring Street. The PLL would include neither station.

Several master plans may need to be amended to reflect a substitution of the PLL for the IPL alignment.

The alignment that better provides transit to the local neighborhoods also has the greater potential impact on those neighborhoods in terms of views and noise. The necessary community impact mitigation would therefore be greater for the Inner Purple Line which best serves the local neighborhoods than it would be for the PLL alignment.

The PLL would remove the need for a maintenance yard in the Lyttonsville area. The privately-owned land could be used for other industrial uses consistent with the master plan recommendations for that area. The property owned by M-NCPPC at Lyttonsville Road/Lyttonsville Place could be retained for public use such as trailhead parking for the Capital Crescent Trail.

Noise, Vibration and Visual Impacts

It is likely that the PLL will have some negative effects on homes near the alignment. The use of the CSX and Capital Beltway right-of-way means that no homes are directly adjacent to the alignment. However, depending on the height of the structures and location within the right-of-way, homes in some communities may have negative noise, vibration or visual impacts. Only further detailed study could quantify this topic, and the necessary information is not available at this time.

Many of the communities that could be directly affected already have noise walls designed to mitigate traffic noise generated from vehicles on the road surface and not from a higher level. Therefore, the visibility and proximity of an elevated heavy-rail line would be an issue. The neighborhoods that should be evaluated are:

- Forest Glen Park on the south side of the Beltway, particularly Newcastle Avenue

- Jones Mill Road on the south side of the Beltway, particularly Parkview Road

- Kensington Parkway, particularly Glenmoor Drive on both the north and south sides of the Beltway

- Stoneybrook Road near the Mormon Temple on the north side, particularly Hill Street and Campbell Drive

VI. EVALUATION AND COMPARISON OF PURPLE LINE LOOP AND INNER PURPLE LINE

This section compares the PLL and IPL and describes the pertinent findings summarized in Section I of this memorandum.

Benefits of PLL

Staff finds three distinct advantages to the PLL proposal that would make it appealing for further study if they were not outweighed by other factors.

1. <u>PLL Addresses Known Concerns with IPL</u>

Current project planning efforts for the IPL have identified a number of concerns that will be addressed and resolved in the SDEIS and FEIS documentation for the IPL, but would be eliminated if the IPL were functionally replaced by the PLL:

- Issues associated with introduction of the light-rail mode:
  - The yard and shop required along the alignment
  - The short segment of single-track operation at the Metro Plaza Building
  - Need for additional cross-sectional width through the Silver Spring Transit Center
  - Location of tail-tracks at Silver Spring
- Issues associated with the introduction of transit vehicles in the Georgetown Branch right-of-way
  - Mitigation of indirect adverse impacts to adjacent property owners, primarily related to noise/vibration and visual effects
  - Concerns regarding a degraded experience for trail users, particularly in the tunnel under the Apex and Air Rights Buildings in Bethesda
  - Opposition by adjacent property owners, notably the Columbia Country Club

2. <u>PLL Attracts More New Transit Riders</u>

The PLL is projected to attract more new transit riders than the IPL. There are two primary factors that make the PLL more attractive to transit users:

- Slightly higher speeds than the IPL and average of 37 miles per hour compared with 29 miles per hour.
- A reduced need for transfers compared with the IPL. There are more “one-seat rides” with the PLL because it connects directly with the Red Line. The IPL would have a greater number of trips that would transfer at least once between the Purple Line and the Red Line.

The cost-effectiveness calculations included in this section use both new riders (linked) and total riders (unlinked) trips. Total riders gives an indication of the number of users of the new line but this number includes some riders who could take bus or rail under the Baseline scenario. New riders only included those person trips that shifted from an auto mode to a transit mode.

3. <u>PLL Enhances Metrorail Operations Efficiency and Flexibility</u>

There are operating efficiencies in having a Purple Line Loop.

- It would use WMATA's current rolling stock.
- It could start with no additional cars.
- It would not require a new maintenance yard.
- It would provide more options for Metrorail operators to switch trains to different locations in the event of an emergency.
- It would even be possible to bypass downtown and still serve many stations should an emergency require it.
- It would be a "one seat" ride from Silver Spring to Bethesda and all Redline stations to the south.
- In contrast, the **Inner Purple Line** would: add a new technology to the region with all new cars, would require a new maintenance yard, a unique labor force and the development of operating rules for the trolley.

Disadvantages Of PLL

Despite three substantial benefits of PLL described above, staff finds many more concerns with the PLL that form the basis for the recommendation not to introduce the PLL into the current state study process.

1. <u>Federal Study Process Delays</u>

Staff understands from our experience and discussions with MTA that if the PLL is incorporated into the current Purple Line EIS process, it will take approximately two years of data collection, alternatives development, and engineering to bring the PLL to a common level of detail with the IPL. If these efforts result in identifying major environmental issues, the outcome will take much more time and it may be that the Inner Purple Line is the preferred alternative from the perspective of the Federal approval agencies.

FTA Criteria

The Federal Transit Administration (FTA) evaluates new transit projects making its decisions on those projects, with the selected ones obtaining Full Funding Grant Agreements and thereafter appropriations. Specifically they look at mobility improvements, environmental benefits, operating efficiencies, cost effectiveness and supporting land use. The level of local support, as reflected in funds available, and readiness to implement are also considered.

Perhaps the most heavily-weighted factor is **cost effectiveness**. In general terms, cost effectiveness is the cost of the proposed new start (annualized incremental capital plus annualized operating cost) per unit of benefit. The FTA is changing its definition of "benefit". In the last authorization process, FTA used new transit trips as its measure of benefit. They are changing that to total "user benefits" which is calculating the time saving by all users of the new project as well as time saved by roadway users from reduced congestion. As this new measure is still somewhat under development, no one can yet perform these calculations. M-NCPPC staff has provided the old measure of cost per new rider, while recognizing that it does not capture the complexity of the pending FTA criteria.

Staff is using our in-house transportation forecasting computer model to make estimates of ridership and user benefit. It has not been specifically calibrated for this area as would be done for an analysis with more time. Staff is confident, however, in the model's ability to calculate the relative differences of alternate routes. Readers must recognize that the calculation of user benefits will change when the new FTA methodology is available for use. In the absence of the actual user benefit calculation that FTA will use (and not knowing what percentage of the costs will be paid by non-Federal sources for either alignment), staff cannot be certain of each alternative's relative competitiveness for FTA approval. Staff can only make a quick-response assessment on the basis of the information available.

Certainly, the project with the most benefits per dollar of cost has the higher probability of being recommended by FTA. On the comparison made by M-NCPPC, the IPL is more cost effective. The Purple Line Loop's increased ridership, due to increased speed, and time saved by travelers over light rail is not enough to overcome the increase in cost as compared to the IPL.

One proxy for **environmental benefits** is new transit riders; the other is changes to total vehicle miles of travel. Both these measure are related to reduced air pollution. The PLL has more new transit riders and reduces vehicle miles of travel more than the IPL.

On the basis of **land use**, the IPL would rate better. There are certainly no differences in land use in either the Silver Spring CBD or Bethesda CBD, which have stations in the same locations under all routes. The difference is between those major centers. The master plans for the areas covering Connecticut Avenue and Lyttonsville anticipate light rail. There would be one less station on the PLL and the relocation of two intermediate stops would be required. The Connecticut Avenue stop would move to an elevated spot above I-495. Transit-oriented development at this location would be highly unlikely. The Purple Line Loop would replace the Lyttonsville stop to a location along the CSX tracks south of Linden Lane. There would have to be significant zoning changes in the area to take advantage to the accessibility that Metrorail would bring. How much acceptance or resistance there would be for such changes is unknown. The light rail alignment also had a stop at 16th Street to support the existing residential high rises nearby, with the possibility of a future stop at Spring Street. These stops are absent in the PLL proposal.

Mobility improvements look at user benefits, service to low-income households and service to employment. The only measure available is the proxy for user benefits, which is discussed below as part of cost effectiveness.

Readiness to go to construction is not a stated FTA criterion, but it may have an influence on their decision-making process. As an outside date, the authorization is only good for six years, the maximum expected life of the new Surface Transportation Act. If the project was not approved by FTA and a Full Funding Grant Agreement not signed in that period, it would have to go for reauthorization. The IPL can have a final Environmental Impact Statement in 2003. Adding the Purple Line Loop as an alternative would add 18 to 24 months to the EIS process.

If the PLL is most locally desirable, the most effective means of ensuring the success of the PLL would be to begin with a new DEIS, including Federal agency concurrence on a newly defined Purpose and Need that would focus on the operational benefits of connecting the sides of the Red Line with Metrorail service. Returning to the Purpose and Need statement would mean that circumferential rail in this corridor would be set back by about four years.

2. Staff Critique of WMATA Capital Cost Estimate

M-NCPPC staff finds that the $616M capital cost estimate provided on January 22, 2003, by WMATA for the PLL is not appropriate for comparison to the $371M capital cost estimate provided by MTA for the IPL. Staff suggests that $746M is a more appropriate capital cost estimate for the PLL. The difference of $130M in PLL estimates is attributable to the following items:

- $35M for aerial structure in locations where WMATA presumed an at-grade alignment
- $14M for a parking garage associated with the Connecticut Avenue station
- $81M for levels of project contingency more appropriate for project planning analyses than assumed by WMATA design engineers.

Each of these items is discussed in greater detail below.

Aerial versus At-grade Alignment

The PLL follows the Capital Beltway alignment for approximately two miles. WMATA has not yet developed an explicit profile (i.e., an assessment of the grades and vertical curves) to accompany the concept plan, but has assumed that three segments, totaling approximately 4,550 linear feet, can be built at grade adjacent to the Capital Beltway. Staff disagrees and concludes that all 4,550 feet will require aerial structure, for the following reasons.

- The easternmost of the three segments is between Linden Lane and Rock Creek/Beach Drive. WMATA assumes the PLL will be above Linden Lane and will transition from aerial to at-grade structure approximately 300 feet west of Linden Lane. Linden Lane has an elevation of 282 feet at the north end of the Capital Beltway, so a Metrorail crossing above Linden Lane would need to have an elevation of at least 295 feet. At the Rock Creek bridge, 2,000 feet to the west, the Capital Beltway has an elevation of 225 feet. The 70-foot difference in elevation along 2,000 linear feet is an average grade of 3.5%. WMATA's maximum grade for Metrorail is 4.0%. Therefore, even discounting the complicating effects of developing the maximum grade through vertical curvature, staff finds that the entire segment between Linden Lane and Rock Creek would need to be on aerial structure as the PLL "chases the grade" of the Capital Beltway into the Rock Creek stream valley.

- The central of the three at-grade segments is a 2500-foot segment between the Rock Creek/Beach Drive crossing and the Connecticut Avenue crossing. Within this segment, Rock Creek is immediately adjacent to the Capital Beltway, with typically 60 feet between the edge of current pavement and the stream bank, a result of stream channel relocation when the Capital Beltway was constructed in the 1960s. In this section, staff proposes that the stream channel location and other associated environmental constraints would dictate PLL construction on aerial structure.

- The westernmost of the three at-grade segments is a 1,050-foot segment that is part of the transition between the aerial structure above Connecticut Avenue crossing and the tunnel beneath the Capital Beltway and Locust Hills community. At the eastern end of this segment, the Capital Beltway is located on a berm approximately 40 feet above the Rock Creek stream valley. Again, staff proposes that in consideration of the environmental resources in the stream valley, aerial construction would be warranted rather than lateral extension of the berm up to 40 feet above the stream valley.

The WMATA cost estimate of $616M includes $347M of line profile costs disaggregated by four profile types; at-grade/retained cut, aerial, cut and cover, and mined tunnel. Attachment 5 demonstrates that shifting the 4,550 feet described above from at-grade/retained cut to aerial structure would increase the capital cost by approximately $35M. The unit costs in Attachment 5 reflect WMATA's total cost estimate for each profile type divided by mileage estimated by WMATA for each type. WMATA developed their cost estimates based on the recently completed Blue Line extension to Largo. The resulting unit cost estimates are generally consistent with WMATA planning guidelines. The $103M per mile for mined tunnel costs is a bit lower than might otherwise be expected, but conversely, the average costs per mile for the other three profile types are a bit higher than might otherwise be expected.

Parking Garage at Connecticut Avenue Station

The $616M PLL estimate provided by WMATA includes an aerial station at Connecticut Avenue, but with inconsistent presentation regarding long-term parking capacity. During development of the “P3” alignment for the State’s Capital Beltway Corridor Study, WMATA developed conceptual plans for a 2,000-space garage at Connecticut Avenue. While PLL discussions have suggested that WMATA staff still proposes park-and-ride capacity at the Connecticut Avenue station, none is explicitly included in written materials provided by WMATA.

The travel demand forecasts prepared for this memorandum assumed unconstrained parking at Connecticut Avenue and indicated that approximately two-thirds of the Connecticut Avenue station patrons would arrive via auto (either park-and-ride or kiss-and-ride). Historically, M-NCPPC staff has supported adjacent community efforts to reduce Metrorail park-and-ride garage sizes. In considering all the above factors, staff recommends that some park-and-ride capacity should have been included in the WMATA concept. Using WMATA cost estimate guidelines, staff estimates that a 1,000-space parking structure (a compromise between the 2,000-space concept and no parking at all) would cost approximately $14M.

Contingency

The $616M PL cost estimate provided by WMATA indicates that a 7% contingency is included. This level of contingency may be appropriate at the design stage, but is lower than typically assumed in project planning. For comparison purposes, the $371M cost estimate prepared by MTA for the IPL includes contingency factors for independent cost elements that range from 5% to 40%, with a “weighted average” of 22%. Staff recommends that a 20% contingency factor for all costs is appropriate at this level of project planning, where many design and mitigation elements remain uncertain or unknown.

Table 7 provides a summary of the WMATA and M-NCPPC capital cost estimates for the PLL. Since the Connecticut Avenue station is controversial, the

Table 7: Staff Critique of WMATA Cost Estimates

	WMATA Estimates		M-NCPPC Estimates			
	Source: WMATA, 1/22/03		**With Connecticut Avenue Station**		**Without Connecticut Avenue Station**	
Cost Element	Line Items	Subtotals	Line Items	Subtotals	Line Items	Subtotals
Line Profile						
At-grade/retained cut	$82.921		$45.389		$45.389	
Aerial	$94.403		$166.890		$176.468	
Cut and cover	$52.933		$52.933		$52.933	
Mined tunnel	$116.963		$116.963		$116.963	
SUBTOTAL		$347.220		$382.175		$391.753
Stations						
Walter Reed	$59.696		$59.696		$59.696	
Connecticut Avenue	$60.293		$60.293			
w/1000 space parking deck			$14.000			
SUBTOTAL		$119.989		$133.989		$59.696
Red Line "Tie In" Costs		$34.839		$34.839		$34.839
Other (Mobilization/Real Estate)		$114.434		$114.434		$114.434
SUBTOTAL ESTIMATED COST		$616.482		$665.437		$600.722
Revised contingency assumption						
WMATA contingency at 7%		$40.331		$43.533		$39.300
SUBTOTAL without contingency		$576.151		$621.904		$561.422
MTA contingency at 20%		$115.230		$124.381		$112.284
REVISED ESTIMATED COST		$691.381		$746.285		$673.706

Note: Without the Connecticut Avenue station, the cost of aerial structure increases by approximately $10M to reflect replacement of the 600' platform

M-NCPPC analysis reflects ridership and capital costs for options both "with Connecticut Avenue station" and "without Connecticut Avenue station". As indicated by numbers outlined by bold borders, M-NCPPC estimates that the PLL cost estimate is $746M with the Connecticut Avenue station and $674M without the Connecticut Avenue station.

Certainly the differences in costs between the Purple Line Loop and the Inner Purple Line are not inconsequential. WMATA's preliminary estimate of cost (which does not include adequate amounts for contingences, parking at Connecticut Avenue or the cost of a trail between Silver Spring and Bethesda) is $246 million above the IPL. Most projects that get funding from FTA are matched dollar for dollar with local funds. This project will need an additional $123 million of scarce local funds.

At the risk of going beyond the mandate given to staff, we would offer the following. If the purpose of the Purple Line Loop is to avoid nearby houses, give more breathing space to the Capital Crescent Trail and avoid all noise and visual impacts to some adjacent properties, it may be effective to cut and cover portions of the light rail on the Georgetown Branch right-of-way between Bethesda and Connecticut Avenue. This might increased the estimated $370 million cost by 10%-20%.

3. Cost Effectiveness

As described above, cost-effectiveness has been one of the key measures used by FTA to evaluate New Starts projects. Cost-effectiveness of a proposed major investment is measured in terms of its added benefits and added costs when compared to lower cost options. The FTA guidelines for cost-effectiveness have changed significantly since the Georgetown Branch DEIS was completed in 1996. At the time that the DEIS was completed, the cost-effectiveness formula included was calculated as follows:

$$\textbf{C.E. Index} = \frac{\textbf{Capital Costs + O\&M Costs – Travel Time Savings}}{\textbf{New Transit Riders}}$$

Where:

Capital Costs = change in annualized capital costs compared with Base
O & M Costs = change in operating and maintenance costs compared with Base
Travel Time Savings = value of travel time savings for existing (Baseline) riders annually
New Transit Riders = attraction of new transit riders annually
The DEIS compares the "Build" scenario with TSM and No-Build scenarios. The TSM scenario is the Transportation System Management alternative, designed to achieve the goals of the project without a major investment in new facilities. The Baseline scenario used in the PLL analysis assumes a level of service between the No-Build and TSM alternatives in the DEIS, because it includes significant bus service improvements in the corridor already included in the CLRP.

Current FTA guidelines are being updated to include Hours of Transportation System User Benefits. This measure was not used in this study because the methodology has not been fully adopted in the region at this time. Travel time savings for existing riders does provide an indication of the relative levels of benefits for transit riders who would already be using transit, but would have reduced travel times with the PLL.

The following table shows the cost-effectiveness for the PLL alternative, with and without the Connecticut Avenue station, as compared with the IPL. The figures shown for the IPL are based on the latest available costs and ridership forecasts developed by M-NCPPC for this study. The table presents the annual costs (capital and O&M), annual ridership (total and new riders), and time savings (in hours and dollars). A value of about $11.70/hour was used to convert time savings into dollars, the same value used in the DEIS.

Three cost-effectiveness indices are presented:

- **Cost per New Rider**: the cost-effectiveness as calculated in the Georgetown Branch DEIS.
- **Cost per Total Rider**: Annual costs (with value of time savings subtracted out) are divided by Annual Total Riders (boardings).
- **Cost per Hour Saved**: Annual costs (with value of time savings subtracted out) are divided by Annual Travel Time Savings (in hours).

Table 8: Cost-Effectiveness Indices Using Revised Purple Line Loop Costs from M-NCPPC

	PLL	PLL (No Conn)	IPL
Costs (000's):			
Total Capital	746,285	673,706	371,000
Annualized Capital Costs	55,693	50,277	30,053
Annual O & M	10,000	10,000	5,800
Total Annual Costs	65,693	60,277	35,853
Ridership:			
Total Daily Riders	34,000	29,700	29,000
Annual Daily Riders (thousands)	10,098	8,821	8,613
Daily New Riders	3,850	3,725	2,900
Annual New Riders (thousands)	1,143	1,106	861
Percent of Riders that are New	11.3%	12.5%	10.0%
Time Savings:			
Annual Time Savings (hours) for Base Riders	952,200	900,207	702,700
Value of Time Saved ($ thousands)	11,131	10,523	8,215
Cost-Effectiveness:			
Cost Per New Rider vs Baseline	$47.72	$44.97	$32.09
Cost Per Total Riders vs Baseline	$5.40	$5.64	$3.21
Cost per Hour Saved	$68.99	$66.96	$51.02

The cost-effectiveness measures show that the PLL is not as cost-effective as the IPL. The higher number of new riders on the PLL does not offset the much higher costs compared with the IPL. The resulting cost per new rider is $48 for the PLL versus $32 for the IPL. Cost per hour saved shows the same relative performance with greater time savings for the PLL not offset by much higher costs. The PLL has $69 per hour saved as compared with $51 per hour saved for the IPL.

4. Concerns Regarding Design Criteria

Because the PLL proposal has been developed by WMATA engineers rather than through the National Environmental Policy Act (NEPA) process, minor changes to several critical design criteria that the MTA staff have spent years addressing could have substantial impacts on costs or delays. In addition to NEPA concerns, other WMATA assumptions may need to be changed. For example, WMATA has assumed they can maintain their minimum 18-foot separation from CSX. CSX has informed MTA that this number has been increased to 25 feet. MTA has reflected the additional 7-foot requirement in the IPL conceptual designs.

5. Capital Crescent Trail Completion

The completion of the Capital Crescent Trail will be necessary as a separate project with the PLL and will have some cost associated with it that has not been determined. Completing the trail is included in the costs for the IPL.

6. Other Environmental Impacts

Staff findings on the PLL identify specific concerns regarding environmental impacts. In summary, the natural environmental impacts of the PLL are estimated to be greater than those of the IPL. These are described in greater detail in the context of Federal study delays above. In summary, the natural environmental impacts of the PLL are estimated to be greater than those of the IPL.

7. Reduced Metrorail Service to Northern Montgomery County

The most significant attribute of the Purple Line Loop is the one-seat ride to the Bethesda and Silver Spring CBDs and on to stations south of the CBDs. That attribute will, however, limit the theoretical capacity of stations north of Silver Spring and north of the Medical Center Station. The maximum line capacity of the Metrorail system is 26 trains an hour with eight-car trains. Today, north of Silver Spring and Grosvenor, six-car trains are in use at a pace of ten cars per hour. By 2025, it is anticipated that WMATA could use its full capacity of 26 trains per hour. With the Purple Line Loop, however, half of the trains arriving at Medical Center will come from Silver Spring, the other half from Grosvenor and north. If demands were even, that would mean that a maximum of 13 trains per hour could come from north with the other 13 trains coming from Silver Spring.

Certainly, with the PLL capacity north of Grosvenor could still be increased slightly from today's service of ten trains per hour. With the Purple Line Loop, ridership capacity could be increased by about 75%, with additional cars per trains and more trains per hour. In any case, selection of PLL means that service north of Medical Center and Silver Spring would be at substantially lower levels than it would be with IPL; in essence, perpetuating the “turn back” service.

Findings That Favor Neither IPL nor PLL

1. Feasibility

PLL is feasible to construct from an engineering perspective using the WMATA staff assumptions. The design uses some unusual structures, but there is public land or land from CSX that would allow for construction, and there are no physical constrains that could not be overcome. The DEIS has already resulted in the same finding for the IPL.

2. Effect on Purple Line Extension to New Carrollton

If there is Metrorail between Bethesda and Silver Spring, what happens to the connection from Silver Spring to all points east: Langley Park, College Park and New Carrollton? No matter what technology is used going east from Silver Spring, it may not be prejudiced by the PLL.

A continuation of Metrorail would be challenging. Physically, the rail line runs between the CSX tracks and space for a Y connection going east would be needed. Financially the costs would be very high. Metrorail needs to be always grade-separated and a lot of that separation would be from being underground. This would be a very expensive project, particularly on the basis of cost effectiveness. Getting light rail out of the Silver Spring CBD and through Takoma Park would have some similar challenges.

If the Metrorail Purple Line Loop leads to a light rail connection in Silver Spring, there will be a time added to trips for a transfer, but that would be offset somewhat by reduced travel time from Silver Spring to Bethesda. The increased total travel time and need to transfer will lower ridership projections and make the light-rail extension less cost effective.

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ATTACHMENTS

1. Review of Federal Surface Transportation Bill Reauthorization Process
2. Inner Purple Line Planning History
3. Definition of Environmental Features
4 Staff Critique of WMATA Line Profiles and Impact on Cost

ATTACHMENT 1: REVIEW OF FEDERAL SURFACE TRANSPORTATION BILL REAUTHORIZATION PROCESS

The current Federal surface transportation legislation, titled Transportation Equity Act for the 21st Century (TEA-21), was adopted in 1998 and is due to expire this October, 2003. It succeeded the groundbreaking Intermodal Surface Transportation Efficiency Act (ISTEA), which covered the Federal Fiscal years of 1991-1997. Both of these were very forward-looking bills that brought significant changes to the way our transportation networks are planned and operated and how Federal dollars were allocated and used.

One major aspect of any Federal transportation bill is the allocation of Federal transportation funds. TEA-21 had a spending authority of $215 billion over the life of the legislation, with the actual amounts set each year by Congress, but with a floor of some $203 billion. Much of this was allocated with formulas. However, there were about 1,800 individual “high priority” projects identified in the legislation with specific funds allocated to each of them. These “earmarks” are important for roadway projects as they remove the need for the project to compete with other projects within a state for the funds. In Montgomery County, TEA-21 had the Randolph Road interchange with US 29 as a line-item project.

One important note is that the presence of one of these projects in the bill does not increase the total amount of funds that come to a state. These projects are counted against the formula amount the state receives. However, it does largely assure that the project will be funded during the life of the bill.

For transit projects, the process is somewhat different than for roadways. Transit funds for new construction are separate from highway capital funding. New transit project approval is a multi-step process, with the Federal Transit Administration (FTA) playing a significant role. The general process is:

- Get on the Authorized list as part of the reauthorization bill established by Congress. This makes a project eligible for further review. Then, if on the list, conduct additional planning, engineering, environmental and other work to finalize the definition and design of the project, complete environmental review requirements, obtain a firm cost estimate, and line up non-Federal funding.

- Sign a Full Funding Grant Agreement with FTA, if selected using the “new starts” criteria among other considerations. This identifies the amounts of funds that FTA will request for a project, and what funds the applicant and others will provide.

- Receive an annual appropriation from Congress funding the FTA part of the agreement.

FTA uses the following as their criteria when considering projects for “new starts” funding. This paper does not try to quantify or even identify how the PLL or the IPL would meet these, as producing these is a complex and lengthy process. In Chapters 5 and 6, a few of these characteristics, or close surrogates, are forecast using the information available to staff at this time.

- Mobility improvement, measured by travel time savings, number of low-income households served, and employment near stations
- Environmental benefits, measured by change in regional pollutant emissions, change in regional energy consumption and EPA air quality designation
- Operating efficiencies measured by operating cost per passenger mile
- Cost effectiveness expressed as transportation system user benefits divided by incremental cost
- Transit Supportive Existing Land Use, Policies, and Future Patterns, measured by combined ratings of several factors.

Other factors such as non-Federal funding support and readiness of the project for implementation are also considered.

ATTACHMENT 2: INNER PURPLE LINE PLANNING HISTORY

The IPL is a 4.4-mile master-planned transitway between Bethesda and Silver Spring along historic freight rail alignments. Plans for fixed-guideway (busway or rail) passenger transit service in this alignment have been developed over the past two decades.

- The November 1986 Georgetown Branch Master Plan Amendment designated the right-of-way for “public purposes such as conservation, recreation, transportation, and utilities.”

- The County purchased the westernmost 3.3 miles of Metropolitan Branch right-of-way abandoned by CSX in 1988.

- The January 1990 Georgetown Branch Master Plan Amendment recommended both a trolley and trail within the right-of-way, including 26 explicit recommendations and detailed conceptual plans for both a trail and a single-track trolley configuration.

- The January 1996 Georgetown Branch Transitway/Trail Draft Environmental Impact Statement (DEIS) compared the impacts of busway/trail and light-rail/trail alternatives to a No-Build and a Transportation Systems Management (TSM) alternative consisting of enhanced bus services on existing roadways.

- The Maryland DOT Capital Beltway Corridor Transportation Study began evaluating regional, circumferential, rail transit alternatives in the late 1990s, colloquially described as the “Purple Line”. The study analyzed six transitway alternatives (P1 through P6), three of which incorporated the 4.4-mile Georgetown Branch.

In 2001, the Maryland Transit Administration began project planning for the Capital Beltway Corridor Study “P6” alternative, a light-rail alternative between Bethesda and New Carrollton that incorporates the Georgetown Branch alignment. The State has initiated development of a Draft Environmental Impact Statement (DEIS) for the IPL East (Silver Spring to New Carrollton) and a Supplementary DEIS and Final EIS for the IPL (Bethesda to Silver Spring) that incorporates the need for increased double-track rail sections to accommodate current plans for the IPL East.

ATTACHMENT 3: DEFINITION OF ENVIRONMENTAL FEATURES

Wetlands: According to both Federal and state wetlands statues, a wetland is an area covered or saturated by surface or ground water for a long enough period of time to support a vegetation community that typically can live and adapt to water-saturated soil conditions. Only certain plants are able to grow and thrive in such wet conditions. Also many species of animals use wetlands for some portion of their life. Other species are completely dependent on damp soils and standing pools of water for their long-term survival.

Wetland impacts were defined as the amount of wetlands within the road right-of-way. This definition provides a measure of direct, physical disturbance, but does not necessarily reflect such impacts as: fragmentation of a wetland system; degradation of wetland plant community through reduction in size, introduction of non-native, invasive species along disturbed edges; degradation of a wetland system through change in hydrology in and around the wetland.

Floodplains: Floodplains are low-lying areas adjacent to streams, subject to intermittent flooding. Building permits are restricted within floodplains. This coverage was derived from the USDA Soil Survey of Montgomery County, Maryland, due to the fact that actual floodplain delineations have not been done uniformly over the entire county.

Stream Crossings: Stream crossings have a direct and significant negative impact on water quality. This is not only because sensitive buffer habitat is permanently removed and fragmented, but also crossings allow highly polluted road run-off to drain directly into the stream without the benefit of filtering through a naturalized buffer area.

GIS generally underestimates the location of streams, especially in headwater areas but is useful in comparing impacts among alternatives.

Stream Buffers: These were initially delineated by measuring a buffer of 150 feet from the outer edge of each side of the stream. This was expanded where the wetlands or floodplain extended beyond 150 feet, especially along the main stem of Rock Creek. Stream buffers are important because they generally contain environmentally sensitive areas such as the natural stream channel, riparian forests, floodplains, wetlands and adjacent steep slopes. Alteration of these areas exacerbates watershed erosion/ sedimentation and contributes significantly to water quality degradation.

Park Property: Park property is defined as State, Federal, M-NCPPC, WSSC, Municipal, and Revenue Authority.

Forests: A forest cover layer for the county was created by combining the existing woodland planimetric layer with 1999 state forest resource inventory attribute data. The layer was then updated using the forest inventories completed as part of recent master plans. The resulting updated layer was used as the basis for delineating significant forest.

Significant Forests are defined as upland forest stands that are at least 100 acres in size, but also include riparian forest corridors that are at least 300 feet wide. Impacts to these areas were considered of primary importance to track. Larger forest stands contain more species diversity, provide higher levels of forest functional benefits, and have the potential to provide increasingly rare habitat for forest interior dwelling plant and animal species. Riparian forest corridors provide habitat and are avenues for wildlife movement, and they are critical for the protection of stream resources. Significant forests are extensive along Rock Creek, especially in the low-lying floodplains.

Forest Interior Habitat: is defined as any portion of a forest stand that is at least 300 feet inside the outer edge of the stand. Interior forest habitat losses are a combination of direct disturbance associated with a road, plus loss of interior resulting from the penetration of the forest interior and the creation of new outer forest edges, often resulting in a total loss of interior habitat exceeding direct impacts. There are three sections of affected interior forest north of the beltway in Rock Creek Park.

Historic Properties: The proposed Purple Line Loop Alignment would not take any historic properties. As the CSX right-of-way approaches I-495, the new tracks would tun directly in front of the National Park Seminary Historic District. There is also the Forest Glen Historic District just north of I-495 and east of the CSX right-of-way. This proximity would initiate a review process to determine the extent (if any) of detrimental impact to the historic resources. This process (mandated by Section 106 of the National Historic Preservation Act) would be carried out by the State Office of Historic Preservation. It is M-NCPPC staff's assessment that the result of that process is likely to be a finding of no detrimental impact.

Attachment 5: Staff Critique of WMATA Line Profiles and Impact on Cost

Segments	WMATA conceptual estimate					M-NCPPC staff conceptual estimate		
	Based on WMATA 1/22/03 concept							
	At grade / retained cut	Aerial	Cut/cover	Mined tunnel	TOTAL	At grade / retained cut	Aerial	Cut/co
A	1000				1000	1000		
B			400		400			4
C				1200	1200			
D			800		800			8
E	1900				1900	1900		
F				1100	1100			
G	1100				1100	1100		
H	1500				1500	1500		
I		2000			2000		2000	
J	1000				1000		1000	
K		600			600		600	
L	2500				2500		2500	
M		3300			3300		3300	
N	1050				1050		1050	
O			1500		1500			15
P				3800	3800			
TOTALS	10050	5900	2700	6100	24750	5500	10450	27
Miles	1.90	1.12	0.51	1.16	4.69	1.04	1.98	0
Cost ($M)	$82.921	$94.403	$52.933	$116.963	$347.220	$45.389	$166.890	$52.9
Unit cost ($M) / MI	$43.643	$84.288	$103.790	$100.830		$43.643	$84.288	$103.7

Segments where staff presumes aerial construction will be required are highlighted with borders:

Segment J: Chasing grade from above Linden Lane to Rock Creek

Segment L: Footprint minimization along Rock Creek stream channel

Segment N: Parallel to Capital Beltway berm up to 40' high

Note that the total linear distance does not include 1,200' for the two stations. Costs for this linear distance are included in the station cost.

Unit costs are estimated by dividing WMATA's total cost by profile type by the mileage by profile type

2. Definition of Alternatives Technical Report

Definition of Alternatives Report

September 2008

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1. Introduction

The Maryland Transit Administration (MTA) is undertaking an Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS) to study means for addressing mobility and accessibility issues in the corridor between Bethesda and New Carrollton, in Montgomery and Prince George's Counties, Maryland, just north of the District of Columbia boundary. The study is considering a range of alternatives to improve east-west transit mobility in the 16-mile corridor that connects several major activity centers (Bethesda, Silver Spring, Takoma Park, Langley Park, College Park, and New Carrollton) and several Metrorail lines (both branches of the Metrorail Red Line (Bethesda and Silver Spring stations), the Green Line (College Park station), and the Orange Line (New Carrollton station)). This transit project is intended to provide enhanced transportation choices and improved accessibility for people in the corridor; to support local and county plans for economic development, community revitalization, and transit-oriented development; to improve system efficiency and intermodal connectivity; and to help address the region's air quality issues.

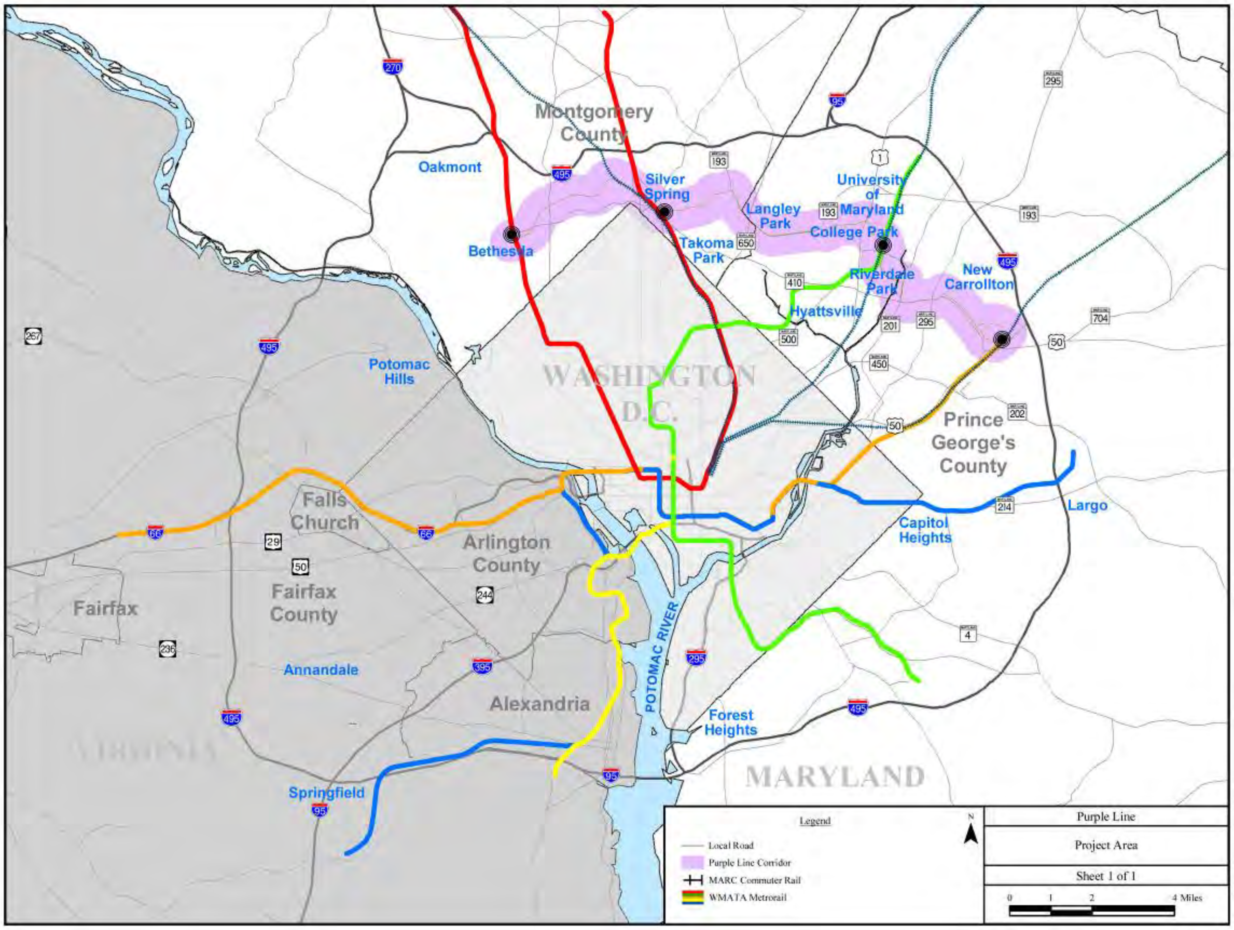
This technical report of the AA/DEIS provides a project overview, a project history, and a discussion of alternatives that were considered but dropped from further study. It describes the eight alternatives under consideration and presents a detailed description of the physical and operational aspects of the project alternatives being considered for the Purple Line. This report covers the No Build and the Transportation Systems Management (TSM) alternatives, as well as six Build Alternatives, and describes routing, stations, frequency and span of service, and supporting feeder bus service.

The Purple Line AA/DEIS examines the different alternatives, ranging from modest investments in shared-use roadways, to major investments in a dedicated guideway, grade-separated where necessary, to determine which mix of improvements achieves the greatest mobility and related benefits, balanced against costs and impacts on communities and the environment. Two modes, light rail transit (LRT) and bus rapid transit (BRT), were identified during the public scoping process as the modes most appropriate for this project.

1.1. Project Purpose and Need

Changing land uses in the Washington metropolitan area have resulted in more suburb-to-suburb travel, while the existing transit system is oriented toward radial travel in and out of downtown Washington, DC. The only transit service available for east-west travel is bus service, which is slow and unreliable because it operates on congested roadways in the corridor between major activity centers. There is no efficient, reliable, and high capacity transit for east-west travel in the corridor. The Purple Line would serve transit patrons whose journey is solely east-west in the corridor, as well as those who want to access the existing north-south Metrorail system. The Purple Line would also provide a direct link to the Brunswick, Camden, and Penn Lines of the Maryland MARC commuter rail system and to Amtrak's Northeast Corridor service at New Carrollton (see Figure 1-1).

Figure 1-1: Project Location



The corridor has a sizeable population that already uses transit and contains some of the busiest transit routes and transfer areas in the Washington metropolitan area. Many communities in the corridor have a high percentage of households without a vehicle. Continued growth projections of population and employment in the corridor indicate that there will be a growing need for corridor transit improvements. The increasingly congested roadway system does not have adequate capacity to accommodate the existing average daily travel demand, and congestion on the existing routes is projected to worsen as traffic continues to grow through 2030. Many communities in the Purple Line Corridor are built out; therefore new road construction or road widening to increase capacity and reduce congestion are not feasible.

North-south rapid transit (Metrorail and MARC trains) serves parts of the corridor, but transit users who are not within walking distance of these rapid transit services must drive or use slow and unreliable buses that often operate over circuitous routes to access the transit stations. Faster and more reliable connections along the east-west Purple Line Corridor to the existing radial rail lines, bus routes, and activity centers within the corridor would improve mobility and accessibility. Enhancing the connectivity of the transit system would improve transit efficiencies, making the system more attractive to a larger number of people.

In addition, a need exists to address poor air quality in the region. The region is classified as a maintenance area for CO, a nonattainment area for $PM_{2.5}$, and a moderate nonattainment area for O_3. The area must come into attainment for $PM_{2.5}$ and O_3 by April 2010 and June 2010, respectively. Changes to the existing transportation infrastructure will help in attaining the Federal air quality standards.

1.2. Project History

The origins of an east-west transit route in this area can be traced to the former railroad freight line spur called the Georgetown Branch. This 11-mile railroad line owned by B & O Railroad carried coal and building supplies on a weekly train from Bethesda to Georgetown until service was discontinued in 1985. The National Park Service purchased the railroad right-of-way between Georgetown and the Washington, DC boundary, and the Montgomery County Council purchased the right-of-way from the Washington, DC boundary to the CSX Metropolitan Branch right-of-way under the National Trails Systems Act in 1988. The Maryland-National Capital Park and Planning Commission (M-NCPPC) was given jurisdiction from the Washington, DC line to Bethesda, and the Department of Public Works and Transportation was given jurisdiction of the right-of-way from Bethesda to Silver Spring for possible development of a "transitway," light rail, or bus, in addition to the Capital Crescent Trail.

The *Georgetown Branch Master Plan Amendment* (November 1986) designated the right-of-way between Bethesda and the Metropolitan Branch as a public right-of-way intended to be used for public purposes, such as conservation, recreation, transportation, and utilities.

In 1986 Montgomery County issued a report entitled *East-West Transitway Feasibility Study*. This study was followed by the County's *Georgetown Branch Corridor Study* in 1989. Both evaluated the use of the Georgetown Branch right-of-way as a transitway.

In October 1988, the Maryland Department of Transportation (MDOT) released *A Study of the Appropriateness and Applicability of Light Rail Transit in Maryland*, which determined that seven of the 24 study areas identified were potentially appropriate for LRT. Of the seven study areas, the Georgetown Branch project, from Bethesda to Silver Spring, was ranked as the most cost-effective.

In 1989, MDOT identified $70 million of projected revenues within the six-year Consolidated Transportation Program (CTP) to be earmarked for the project. In winter 1990/spring 1991, the State legislature approved the FY 1990-1995 CTP which included $70 million for the project – $1.9 million in FY 1991 and $3.8 million in FY 1992 for engineering and design. In May 1990, the MTA conducted further evaluations and cost estimates for the project. The results are summarized in the *Georgetown Branch Trolley/Trail Conceptual Report* (1990). In 1991, the project was suspended because the costs estimated in the 1990 study exceeded the amount allocated by the State.

A report by the Metropolitan Washington Council of Governments (MWCOG), *The Potential for Circumferential Transit in the Washington Region* (August 1993), assessed the potential of circumferential rail, bus, and high occupancy vehicle facilities to provide viable links between suburban residential, commercial, and employment centers to maintain mobility in the Washington metropolitan area. The report concluded that the pattern of suburban land activity inherent in 20-year forecasts would not provide a viable basis for circumferential rail transit along the Capital Beltway or along outer suburban corridors. It also identified the Georgetown Branch connection between the Bethesda and Silver Spring metro stations as the most promising circumferential rail linkage inside the Capital Beltway.

The MTA completed the *Georgetown Branch Transitway/Trail Major Investment Study/Draft Environmental Impact Statement (MIS/DEIS)* in 1996, which considered both a combined light rail and hiker-biker trail and a busway and trail to connect Bethesda to Silver Spring. The document was available for public review and comment on May 24, 1996, and a public hearing was held on June 26, 1996. A Final Environmental Impact Statement was never produced for this study.

In November 1998, the Montgomery County Council endorsed light rail as the preferred mode alternative for the Georgetown Branch, Bethesda to Silver Spring segment.

The incorporation of the Georgetown Branch into a larger Purple Line, envisioned to eventually circle Washington, DC, began with the *Capital Beltway/Purple Line Study* initiated by the Maryland State Highway Administration (SHA) and the MTA in 1996. The study shifted from an original focus on HOV solutions on the Capital Beltway to multimodal transportation improvements in the Capital Beltway corridor. This included the consideration of several heavy rail and light rail lines that extended along the 42-mile segment of the Capital Beltway in Maryland, from the American Legion Bridge to the Woodrow Wilson Bridge. The corridors included routes located along, outside, inside, and crossing the Capital Beltway. In all, six different corridors using either heavy rail (Metrorail) or light rail technology were considered. Of the *Capital Beltway/Purple Line Study* corridors, Options P2 (heavy rail) and P6 (light rail) included the Bethesda to New Carrollton segment. Completed in 2002, the *Capital Beltway/Purple Line Study* recommended the "Inner Purple Line" (inside the Beltway) as the priority transit corridor. The term "Purple Line" was adopted to be consistent with the Washington Metropolitan Area Transit Authority's (WMATA) practice of naming Metrorail routes by color.

In response to this study, a second project was initiated, the *Purple Line East, Silver Spring to New Carrollton*. This project was initiated by WMATA. Simultaneously the MTA began the preparation of a Supplemental DEIS for the Georgetown Branch. Subsequently the Georgetown Branch became known as the ''western'' segment of the Purple Line; the *Purple Line West, Bethesda to Silver Spring*.

In October 2001, Gov. Parris Glendening directed Transportation Secretary John D. Porcari to make planning, funding, and building the 16-mile P6 light rail project the State's top transit priority.

In March 2003, under the direction of the new governor, Robert Ehrlich, the two projects were combined and renamed the *Bi-County Transitway Project*. Transportation Secretary Robert Flanagan announced plans to explore another mode, bus rapid transit (BRT), which would use dedicated lanes on existing roadways to allow buses to move faster than automobile traffic and could be constructed at a lower cost than LRT.

In September 2003, The Federal Transit Administration (FTA) and the MTA published a Notice of Intent (NOI) that they would be preparing an Environmental Impact Statement in accordance to the National Environmental Policy Act (NEPA) of 1969, as amended, on the proposed Bi-County Transitway Project. This NOI extended the previous projects limits beyond Silver Spring to New Carrollton. In addition, MTA announced that it intended to seek Section 5309 New Starts funding for the project.

The MTA initiated a joint DEIS and Alternatives Analysis following FTA's Major Capital Projects policies and procedures.[1]

In January 2007, the project returned to its former name, the Purple Line; the name by which it had continued to be referred by the public and local stakeholders.

1.3. Alternatives Development Process

The MTA has examined a wide range of modes and alignments throughout the long history of this project. In 2003, when the east and west portions of the project were combined and the MTA held a series of public scoping meetings to reinitiate the study, the mode choices were narrowed down to BRT and LRT. The MTA focused on determining the alignments that would best meet the purpose and need, while minimizing impacts and optimizing the service provided. As required by the FTA in an Alternatives Analysis, the MTA worked to develop alternatives that all met the purpose and need but had real differences. Three alternatives were established for each mode at varying levels of investment to compare the benefits and costs.

The alternatives definition has been an iterative process that involved extensive coordination with local stakeholders, including local planning agencies, major employers, elected officials, community groups, property owners, and local residents. The MTA held regular meetings throughout the study with a project team that included local planners, county agencies, and elected officials to ensure that the Purple Line was consistent with local goals and that the MTA was informed of local issues.

The MTA conducted an extensive public outreach process with local residents. The MTA maintained a project website, mailed newsletters to a mailing list of over 60,000 households, and held large public open houses. The MTA met with community and civic associations, agency and elected officials over 280 times between 2003 and 2008 to discuss the project and solicit input from local residents. Beyond this, the MTA developed a community engagement process

[1]Federal Transit Administration, "New Starts Project Planning & Development," 8/21/07, http://www.fta.dot.gov/planning/planning_environment_5221.html, (10/29/07).

called "Community Focus Groups" in the fall of 2004. The MTA organized eight of these groups along the corridor to provide a forum for discussion with local residents on issues and concerns relative to their neighborhoods. The goal was to have small, geographically organized meetings focused on local neighborhood issues relative to the Purple Line. In some communities along the corridor the challenge was not getting people to come to community meetings, but getting a small enough number that would allow for a dialogue rather than presentations. A format was developed with the aid and support of the local jurisdictions. Comprised of representatives of local community and civic associations, these groups met regularly with project planners to discuss in detail local project plans. The focus groups proved to be an effective way to work with local communities. The MTA gained much valuable information at the meetings, both about community concerns and also about the local area. This information ranged from such issues as the details of the traffic circulation of local school buses to double parking by delivery vans on narrow commercial streets. In some cases, alignments were dropped; in others they were modified, based on input received at these meetings. This information allowed the MTA to better design the project and develop plans to address community concerns.

Section 1.2 described the history of the project and its planning up until the definition of the project at the public scoping in September 2003.

1.3.1. Scoping

Public and agency scoping for the Purple Line was held in September 2003. The scoping process began with public notification of four public meetings. The meetings were in the Takoma/Langley area, Silver Spring, Bethesda, and College Park on four evenings in mid-September 2003. More than 350 comments were submitted through the scoping process. Comments covered a broad range of topics, both on general alignment issues and specific routes. Many stated approval or disapproval of the project as a whole. Mode and alignment were the categories that received the most comments.

Scoping for the resource agencies was held September 25, 2003. Invitation letters were extended to 22 regulatory and public agencies. Agency representatives in attendance included:

- Federal Transit Administration
- Federal Highway Administration
- U.S. National Marine Fisheries
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- Washington Metropolitan Area Transit Authority
- Metropolitan Washington Council of Governments
- Maryland Historical Trust
- Maryland Department of Natural Resources

- Maryland State Highway Administration
- Maryland Department of Planning
- Maryland Department of the Environment
- Maryland-National Capital Park and Planning Commission – Montgomery County
- Maryland-National Capital Park and Planning Commission – Prince George's County
- Prince George's County Department of Public Works and Transportation

Agency representatives asked questions and commented on a variety of topics, including fuel type usage for bus vs. light rail alternatives, quality of service, alternative modes being considered (other than LRT and BRT), additional proposed stations in Prince George's County, and engineering issues. Agencies were encouraged to provide comments at the meeting and to submit written comments.

An agency field tour was conducted on December 2, 2003. This helped agency representatives further understand the project and gave them the opportunity to see the corridor and discuss issues.

Three agency meetings were held over the next three years in conjunction with several of the Project Team meetings. The dates of these meetings were October 1, 2004, April 29, 2005, and April 7, 2006. All meetings provided project updates. The October 2004 meeting focused on the screening process used to evaluate the alignments. The April 2005 meeting gave a detailed presentation of the alignments being carried forward at that point. The April 2006 meeting reviewed the status of the environmental analysis and the need for a second maintenance and storage site.

As the alternatives were further refined, additional potential station locations were identified and more detailed information on potential impacts was developed. A second agency field tour was conducted on November 8, 2007. This gave agency representatives another opportunity to discuss project-related issues.

In addition to the larger agency coordination meetings and field reviews, individual coordination was conducted throughout the planning study, as appropriate.

A wide range of alternatives were identified and suggested during the scoping process. In considering these alternatives, the MTA assessed alternatives for reasonableness and relevance to address the project's purpose and need. Alternatives identified during the scoping process that did not support the purpose and need for the Purple Line were not considered "reasonable alternatives" as discussed in the FTA regulations implementing NEPA (23 CFR 771.123). Alternatives that did not pass the reasonableness standard were eliminated from further consideration in the AA/DEIS.

1.4. Modes

Two transit modes, heavy rail and monorail, were suggested during scoping and not carried forward for detailed study. In the previously completed *Capital Beltway/Purple Line Study – Findings and Recommendation Report (2003),* heavy rail (Metrorail) and monorail were eliminated from consideration for the Purple Line corridor due to prohibitive costs and the availability of other viable alternatives.

A heavy rail alternative was eliminated from consideration for the Bethesda to Silver Spring segment in the 1996 *Georgetown Branch Transitway/Trail MIS/DEIS* due to excessive costs projections from the *East West Transitway Feasibility Study*. In July 2000 the MTA reexamined the comparative costs of several alignments between Bethesda and Silver Spring, including double track along the Georgetown Branch right-of-way and double track underground. This report projected the underground costs of approximately $926M and the surface alignment $292M; because of the scale of the cost differential the MTA has not included heavy rail in the study.

The MTA has concluded that monorail technology does not offer appropriate solutions when compared to BRT and LRT. Comparing capital costs for recently constructed LRT and BRT systems around the country to a monorail system similar to the system developed in Las Vegas, Nevada, indicates that a monorail would not likely offer any cost savings. In addition, a monorail would not likely be able to meet the capacity needs associated with this corridor. Higher capacity monorail systems could be constructed, but because the larger vehicles must straddle a larger beam, heavier structures would have to be built and, as a result, turning radii would need to be larger creating substantial visual and property impacts on adjacent communities.

Neither of these modes meets the goal of a cost-effective transit alternative that is rapid, reliable, and environmentally friendly; therefore, the MTA has eliminated monorail and heavy rail alternatives from the study.

The two transit modes are being considered for the Build Alternatives, BRT and LRT are defined below.

Bus rapid transit is a mode of transportation that has characteristics in common with both conventional bus operations and LRT. BRT looks and feels much like a railcar but uses rubber wheeled vehicles. It can operate either on city streets or in a separate busway. BRT is generally faster than traditional local bus service. Like a rail system it has permanent stations, services, and amenities. Vehicles are typically fueled with low emission hybrid electric motors or Compressed Natural Gas. BRT vehicles typically are low floor, making them easier to board, and often have several doors for faster boarding.

Features generally associated with a BRT system include signal priority at intersections, queue jump lanes, and off board fare collection. One advantage of BRT service is that the buses are not restricted to a specially constructed guideway but can operate on regular streets to provide "one seat" feeder bus service.

BRT is new to Maryland, but not to many communities around the world. American cities such as Pittsburgh and Seattle have long benefited from BRT. BRT systems can provide the following:

- Lower capital cost
- Cost-effective alternatives
- High-quality service
- High-performance rapid transit service that can be quickly implemented
- Medium to high capacity service

Light rail transit is an electric railway system that can operate single cars or short trains. LRT can operate in mixed traffic, like traditional streetcars, or in a separate right-of-way. When light rail operates on existing streets in dedicated rights-of-way, signal priority can be used to ensure that the LRT vehicles are not delayed by traffic signals.

A growing number of cities in the United States have LRT systems, including Dallas, Portland, Denver, St. Louis, and San Diego. LRT systems can provide the following:

- Cost-effective alternatives
- High-quality service
- High-performance rapid transit services
- High capacity service

For each mode, low, medium, and high investment alignment alternatives are being evaluated, representing increasing levels of capital investment. All of the Build Alternatives extend the full length between the Bethesda Metro Station and the New Carrollton Metro Station. The intent is that these alternatives while all serving the same markets and providing improvements in the quality of the transit service through improved operating speeds and reliability, vary in the type of running way and amounts of grade separation (tunnel or aerial structure).

1.4.1. Types of Guideway

There are a number of guideway types that the alternatives will utilize. With the exception of the No Build, each alternative uses multiple lane configurations on surface streets, and may include tunnel and elevated segments as well. The three basic types of guideway used in the alternatives are as follows:

- *Shared-use lanes* – When transit vehicles travel in mixed traffic, they are subject to the same speed restrictions and congestion as general traffic. Current bus service in the corridor makes use of shared-use lanes, as does the No Build. Where there is little congestion, limited right-of-way, or high monetary or environmental costs, shared-use lanes can be the best option.

- *Dedicated Surface Lanes* – There are number of ways to dedicate surface lanes on existing roads for transit use. Depending on available right-of-way, traffic volumes, parking needs, and alternative design, transit vehicles would travel either in the curb lane or the median of a roadway. General traffic would be able to cross dedicated lanes.
- *Exclusive Guideway* (tunnels, transit-only lanes, and elevated segments) – Where BRT or LRT vehicles travel in tunnels, elevated segments, or along new alignment, the guideway would be for the exclusive use of transit vehicles. General traffic would not be permitted access to these guideways.

The various dedicated lane configurations have different operating characteristics and different impacts on local traffic and parking. These are outlined below, along with information on the use of traffic signals to optimize transit speeds.

Providing a dedicated lane for transit in the curb lane can be done on one-way streets as well as two-way streets. To avoid the problem of cars turning right in front of buses that are not turning, the curb lane configurations allow for use of the lanes by vehicles making right turns. For this reason, barriers would not be used to separate bus traffic from other traffic. Parking in the curb lane would be prohibited when a street is operating with a dedicated curb lane for transit.

BRT and LRT can also be run in the median of two-way streets. Stations must be located in the median as well, which can require additional right-of-way. Median-lane transit can make turning movements difficult, as left-turning vehicles must cross over dedicated transit lanes unless left turn lanes are provided or left turns are permitted from the transit lane.

1.4.2. Transit Signal Priority

Two types of signal priority are proposed to improve transit operating speeds and service reliability. In addition, a typical use of protected right turns is desirable when using curb lanes marked for buses and right turning traffic only, to clear the lane as quickly as possible.

- ***Extended green times*** - the green phase is extended for 5-10 seconds if a detector indicates a bus approaching the signal. This type of signal priority can significantly improve travel times by reducing the number of signals where the bus has to stop. The 5-10 seconds would be deducted from the cross-street green time.
- ***Advance green for transit queue jump/dedicated lanes*** - The signal would provide a special green to allow the transit vehicle to proceed in advance of general traffic. This is only necessary when the bus does not have a dedicated lane on the other side of the intersection or could not otherwise proceed with general through-traffic. Such situations include when a bus in a queue jump lane must merge with general traffic on the other side of the intersection, or when the bus lanes turn left onto a roadway with shared lanes.

Most of the Purple Line alignments would run along existing roadway rights-of-way. Medium and High Investment Alternatives would have some tunnel sections that would not necessarily follow roadway alignments. All Build Alternatives use the former Georgetown Branch right-of-way, (often referred to as the Master Plan alignment because of its adoption in the *Georgetown Branch Master Plan* in 1986); in combination with a one-mile segment along the CSX Metropolitan Branch railroad right-of-way between Bethesda and Silver Spring; however, the Low Investment BRT Alternative only uses the portion of the Georgetown Branch Right-of-way east of Jones Mill Road to the CSX Metropolitan Branch right-of-way.

1.5. Alignments Dropped from Further Study

Several specific alignments initially suggested received substantial negative feedback from the public as well as city and county councils during the scoping process.

The segment of MD 410, extending east from Bethesda and continuing east of Silver Spring, was not carried forward due to several factors, including a very narrow right-of-way that would have extensive property impacts, grades that were very steep and on which it would be difficult for light rail transit to operate, opposition from a large segment of the public, and a City of Takoma Park resolution in October 2003 that recommended elimination of this alignment from further study. In addition, this alignment east of Silver Spring would not have served the Flower Avenue area, which Montgomery County has targeted for improved transit to support economic development and revitalization.

An underground alignment extending from Paint Branch Parkway and Good Luck Road to Riverdale Road along Brier Ditch was eliminated from further consideration due to concerns from the U.S. Army Corps of Engineers about impacts to wetlands in the area.

Another alignment presented at the scoping meetings that received strong opposition from the surrounding community and the City of New Carrollton was an alignment that extended from Riverdale Road and continued behind the New Carrollton Mall and Shopping Center. This alignment was not carried forward due to this opposition and the potential for greater community impacts than the other alignments under study.

The screening process was iterative throughout the study and included consideration of natural and social environmental impacts, preliminary cost estimates, and input from the public and agencies. As described earlier, the Purple Line study had an extensive public outreach program and met regularly with local community representatives and local jurisdictions. The alignments were refined extensively based on this input.

An example of this type of refinement was the modification of the original Silver Spring/Thayer Avenue design option. This alignment originally cut through the center of Montgomery County Lot #3 which the County had planned for redevelopment. The MTA coordinated with the County and the developer to shift the alignment so as not to preclude the proposed development.

A number of other alternatives were also dropped from further consideration as part of the AA/DEIS process. The following is a brief discussion of why these alignment options have been dropped from further consideration.

1.5.1. The Metrorail (or Purple Line) Loop

The Metrorail Loop alignment was proposed by Montgomery County Executive Duncan in January 2003. This proposed Metrorail (heavy rail) alignment would have extended from the existing Medical Center Metrorail Station in Bethesda north via a tunnel under the Capital Beltway and along the north side of the Beltway, primarily on an aerial structure. It would then cross back over the Beltway, continuing south along the Metropolitan Branch CSX corridor either in a retained cut or in a tunnel to the Silver Spring Transit Center. This alignment would be a continuation of the Metrorail Red Line and, as such, it would have been heavy rail and would not have continued past the Silver Spring Transit Center in the same mode.

Both the MTA and M-NCPPC carried out assessments of this proposed alignment.

The MTA concluded that while the Metrorail Loop could improve operations and provide redundancy for the Metrorail Red Line; these advantages would not have applied to the Purple Line corridor as a whole. Implementation of the Metrorail Loop would not have addressed the issues of system connectivity, mobility, accessibility, and efficiency for the entire corridor that are part of the Purple Line Purpose and Need. Passengers traveling between the Metrorail Loop and destinations east of Silver Spring would have been required to transfer from the Metrorail Loop to LRT or BRT to complete their travel farther east. This alignment would not have provided continuous service for destinations between Bethesda and New Carrollton and would not have addressed the issues of an inadequate and slow-moving transportation network for east-west travel between Bethesda and New Carrollton. Further, serious natural and human environmental impacts are associated with the Metrorail Loop option. This alignment would have required acquisition of right-of-way from Rock Creek Park along the Capital Beltway. This alternative would have also required property from approximately 25 residences along the CSX right-of-way. The Metrorail Loop would not have supported local plans for economic and community development west of Silver Spring because there would be no stations at the Chevy Chase and Lyttonsville communities. Moreover, this alignment would have been a less cost-effective solution to addressing the transportation problems and needs associated with the Purple Line corridor compared to a BRT or LRT alternative for the entire 16-mile corridor. The *Metrorail Loop Proposal Alignment Evaluation* is included as an appendix to this report.

In January 2003, M-NCPPC issued a report recommending that the Metrorail Loop not be carried forward for further detailed study. While recognizing the benefits to the existing Metro rail system, M-NCPPC recommended that the proposal not be carried forward due to a number of considerations. These included: the high cost of the project (estimated at twice that of the Purple Line), lower cost-effectiveness, greater impacts to the natural environment, the inability to serve communities between Bethesda and Silver Spring, and impact to the outer Red Line stations (stations north of Medical Center and Silver Spring). The *M-NCPPC Purple Line Loop* memorandum is included as an appendix to this report.

1.5.2. LRT on Jones Bridge Road

The availability of the Georgetown Branch right-of-way, owned by Montgomery County and designated for use as a transitway and trail, and the potential to build a transitway within a nearly exclusive operating environment with few grade crossings, provide the opportunity for a transit service unimpeded by traffic conflicts and therefore allowing for reliable service and faster speeds between Bethesda and Silver Spring. However, the capital cost of constructing a transitway and trail along this alignment is relatively high, so a lower cost BRT alternative using Jones Bridge Road is being considered between Bethesda and Rock Creek. This alternative consists of in-street running BRT along Jones Bridge Road and Jones Mill Road and along Woodmont Avenue west of Jones Bridge Road, connecting to downtown Bethesda. For BRT this is indeed lower cost, since the buses would be operating on existing roadways; however, light rail service along Jones Bridge Road would require reconstruction of the street for the installation of rails and catenary, and therefore would not offer the same savings over the Master Plan alignment. For this reason, Jones Bridge Road is not being considered for light rail.

1.5.3. BRT and LRT on Brookville Road

An alternative along Brookville Road had been proposed as a lower cost alternative, particularly for BRT which could operate on the existing road. However the need to construct a transitway from Brookville Road along the CSX tracks would have negated the savings and resulted in additional property impacts. In addition, the Brookville Road alignment would have slower travel speeds and potential traffic conflicts with existing traffic for both LRT and BRT. The alignment also interfered with the layout of the maintenance and storage facility on Brookville Road.

1.5.4. 16th Street to East West Highway to Colesville Road (BRT only)

In this low investment BRT option the buses would leave the CSX corridor at 16th Street and continue on 16th to East West Highway and then on to Colesville Road to Wayne Avenue. This option had very poor travel times because of high levels of traffic and several major intersections. The Spring Street to 2nd Avenue at grade option would provide much faster service with similar costs.

1.5.5. BRT and LRT from CSX at Spring Street to 2nd Avenue with an Aerial Crossing of Wayne Avenue

The LRT option required an aerial structure over Colesville Road because of steep grades on 2nd Avenue. This alignment had no direct connection with the Silver Spring Transit Center and would have required passengers to walk through or around the proposed private development to reach the transit center. This poor connectivity is contrary to the goals of the Purple Line. The structure would have had high costs, impacts to the residences on 2nd Avenue, visual impacts to downtown Silver Spring, and traffic impacts to access into the Metro Plaza building. The BRT aerial crossing of Colesville Road along 2nd Avenue was also dropped due to high costs and impacts to adjacent properties.

1.5.6. Tunnel from Sligo Avenue and Piney Branch Road Directly to Takoma/Langley Crossroads

This alignment followed Sligo Avenue to Piney Branch Road where it descended into a tunnel along the alignment of Park Valley Road and emerged near the intersection of University

Boulevard and Anne Street. It would have been aligned to have a station near Columbia Union College and Washington Adventist Hospital in Takoma Park. This alignment was dropped because it did not support the Montgomery County Master Plans for economic redevelopment of the Flower Avenue/Long Branch commercial area because it did not have a station in the neighborhood. The proposed Arliss station of the retained alternatives would serve this area. In addition, this alignment would be very costly compared to other alternatives. At the public meetings there was almost no public support for a station near the college and the hospital along this alignment option.

1.5.7. Sligo Avenue in East Silver Spring, both at Grade, and in Tunnel

The Purple Line alignment on Sligo Avenue at grade would have poor transit operations and major traffic impacts requiring either operation in shared lanes or one-way traffic. The traffic and parking impacts would have adversely impacted the 30 small businesses along this street. The narrow right-of-way would have necessitated significant property impacts and easements. The Wayne Avenue at grade option provided a similar low investment surface option that would operate far better and have fewer community impacts.

A tunnel option under Sligo Avenue was also dropped. This was a high-cost option and would have had required significant property easements. Tunnel segments of shorter lengths and less cost could be used more effectively on the Wayne Avenue or Silver Spring/Thayer alignments.

1.5.8. All Alignments along Colesville Road from the Silver Spring Transit Center

Several alignments were presented at scoping that used Colesville Road north from the Silver Spring Transit Center. One alignment followed Colesville Road north to University Boulevard in Four Corners and turned south at the signalized intersection at University Boulevard. Another alignment followed Colesville Road north to East Franklin Avenue and traveled east to Flower Avenue and then south to Piney Branch Road to University Boulevard. A third alignment followed Colesville Road to East Franklin Avenue and then to University Boulevard.

Colesville Road is six lanes wide with a reversible center lane. It is a heavily used major arterial. Surrounding land uses are generally single-family residential, except in the Silver Spring CBD. The extremely heavy traffic on Colesville Road and constrained right-of-way would make it very difficult to implement dedicated or exclusive lanes for transit. In the 1990s, the Montgomery County Department of Transportation conducted a feasibility study for a busway on US 29 (Colesville Road).[2] After this study, both the Montgomery County Council and M-NCPPC recommended that US 29 not be considered for either a busway or LRT. Because this alignment extends north above the Purple Line corridor and then comes south again before continuing east, it adds more than a mile of additional distance to the alignment. As a result, this alignment significantly lengthens the trip time and increases the operational cost, both of which are counterproductive to the project's goal of providing rapid transit service east-west in the corridor. For these reasons, this alignment is not being retained for detailed study.

[2] Montgomery County Department of Transportation, *US 29 Busway Feasibility Study*, 1996.

1.5.9. Longer Tunnels under Wayne Avenue

Communities members concerned about the impacts of a tunnel portal on Wayne Avenue near Dale Drive requested that the MTA evaluate a longer tunnel. Two tunnels were considered, both alignments descending into tunnel from Silver Spring Avenue west of Georgia Avenue. The first tunnel considered would have passed under Sligo Creek. However, because of the depth required to tunnel under the creek, and the rapidly rising topography east of the creek, this tunnel would not have been able to return to the surface until the alignment was on Piney Branch Road, at Barron Street. This would have been extremely expensive and would not have provided meaningful travel time benefits, therefore would have had substantial negative impacts to the cost-effectiveness of the project. The cost of underground stations is likewise very high, further escalating the cost of this option. For this reason this option was dropped. A second, shorter tunnel with a portal on Wayne Avenue between Sligo Creek and Mansfield Street was evaluated in an effort to find a more financially feasible option. This option, while less costly, would have had major adverse impacts to the residences on the south side of Wayne Avenue. These houses are above the grade of the roadway, with short steep driveways. The street widening required for a tunnel portal would have required property acquisitions from the front yards and driveways of these houses, and retaining walls in these yards. This option also required property from Sligo Creek Park. This tunnel did not provide any travel time benefits, and added to the project cost. For both tunnel options the addition of stations was an issue. The high cost of underground stations weighed against their inclusion, but if stations were not included in these alignments the communities would not benefit from the project, and ridership would be lower. It was determined that these tunnels did not provide sufficient benefit and had such a detrimental effect on the cost of the project that further study was not justified.

1.5.10. University of Maryland Campus Alignment on Paint Branch Drive

This alignment followed University Boulevard northeast to Paint Branch Drive. At Paint Branch Drive it turned south, passing the University of Maryland's Comcast Sports Arena, and joined Campus Drive on the eastern edge of campus. While this alignment would have served the sports arena well and would have been heavily used during special events, it did not serve the central core of the University of Maryland campus. The University of Maryland is quite large and a central station location is more convenient for the greatest number of people.

1.5.11. Paint Branch Parkway to Kenilworth Avenue

This alignment continued east from River Road, just north of the College Park Metro Station on Paint Branch Parkway, to Kenilworth Avenue. This alignment did not have good connectivity to the Metro Station and did not serve the University of Maryland's research park, M Square, currently under development along River Road. This research park will be a major ridership market.

In addition, Paint Branch Parkway is surrounded by wetlands and parklands. As a result, this alignment option would have had much greater environmental impacts and Section 4(f) issues than the River Road alignment option. Section 4(f) of the Department of Transportation Act of 1966 (49 USC 303) declares a national policy "to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites." Section

4(f) of the DOT Act stipulated that the FTA cannot approve the use of land from a significant publicly- owned public park, recreation area, wildlife or waterfowl refuge, or any significant historic site unless the following conditions apply:

- There is no feasible and prudent alternative to the use of land.
- The action includes all possible planning to minimize harm to the property resulting from use.

River Road provides a feasible and prudent alternative to the use of Paint Branch Parkway, so this alignment was dropped from further study.

1.5.12. Paint Branch Parkway to CSX Corridor to East West Highway

This alignment parralleled the CSX and WMATA alignments south from the College Park Metro Station and turned east on East West Highway. This alignment required the use of the CSX right-of-way. CSX has stringent separation requirements that would have added considerably to the project cost. It also did not serve the University's M Square Research Park currently under construction along River Road.

1.5.13. River Road to LafeyetteRoad serving Riverdale MARC Station

The MTA evaluated several alignments which went parallel to the CSX tracks along Lafayette Road to the Riverdale Station of the Camden MARC line before turning left onto East West Highway. While it provided connectivity to the Riverdale Station, and could have supported economic development at this location, the alignment was constrained by the existing residential development and narrow roadways. The engineering constraints added between four and eight minutes of travel time between College Park and Riverdale Park compared to the at grade and tunnel options.

1.5.14. River Road to 51st Avenue to East West Highway

This surface alignment followed River Road from the College Park Metro Station and proceeded on a new surface alignment south connecting to 51st Avenue to East West Highway. This alignment presented Section 4(f) issues with impacts to Anacostia River Park. 51st Street is a small residential street, and an alignment on it would have had major community impacts. These impacts are easily avoidable by using other alignments; therefore this alignment was dropped from further consideration.

1.5.15. Tuckerman Street between Kenilworth Avenue and Veterans Parkway

This alignment began at the intersection of Kenilworth Avenue and River Road and proceeded east in a tunnel under Tuckerman Street with a narrow right-of-way under residences and commercial and county structures, and then crossed under East West Highway and emerged on Veterans Parkway. This alignment was dropped because of high costs and many required underground easements, and because it bypassed an important transit stop at Kenilworth Avenue and East West Highway.

1.5.16. Riverdale Road from Veterans Parkway to Annapolis Road

The Riverdale Road alignment was an option for only BRT because of the steep grades. The alignment had travel times approximately 40 percent longer that those for Veterans Parkway because of the cross streets and the narrower, tight curves of the roadway. Unlike Veterans Parkway, there were potential residential impacts. This option was strongly opposed by both residents of the area and the City of New Carrollton. Given the existence of a viable surface alternative on Veterans Parkway, this alignment was dropped.

1.5.17. Annapolis Road to Emerson Place

This alignment option began at Annapolis Road and Harkins Road, but left Harkins Road to pass to the west of the IRS building and parking structure, then continued on Emerson Place. This alignment was dropped because of its greater potential for community impacts and because it was not substantially different from the Harkins Road alignment, which has few impacts to local residents. This alignment was opposed by the West Lanham Hills community.

2. Alternatives Retained for Detailed Study

The Purple Line study is evaluating a No Build Alternative, a Transportation Management System Alternative, and six Build Alternatives.

2.1. Alternative 1 – No Build Alternative

Federal regulations require that a No Build Alternative be evaluated in an Environmental Impact Statement. For NEPA purposes, the No Build Alternative is the baseline against which the other alternatives are compared for the extent of environmental and community impacts. The No Build Alternative assumes that no new improvements would be made to the transportation system in the study corridor, other than those that are currently in local and regional transportation plans and that have identified funds for implementation by 2030. Thus it consists of the transit service levels, highway networks, traffic volumes, and forecasted demographics for the horizon year of 2030 that are assumed in the Constrained Long Range Plan (CLRP) of the local metropolitan planning organization (MWCOG, in this case).

The western segment of the Purple Line, the former Purple Line West, Bethesda to Silver Spring, is in the CLRP as a project; the eastern portion, Purple Line East, Silver Spring to New Carrollton, is in the CLRP as a study. However, the Purple Line has not been assumed as part of the future transportation network in the travel forecasting model.

The following two projects in the CLRP are major projects in Maryland, but not in the Purple Line corridor.

- The Intercounty Connector is the major highway project in the area and is not expected to have a measurable impact on travel within the Purple Line corridor as it serves different travel markets. Likewise, planned US 29 intersection changes are also not expected to have an impact on the Purple Line.
- The Corridor Cities Transitway from Shady Grove to COMSAT is a committed study, but it is sufficiently far from the Purple Line that there is not expected to be any synergy between the two. It should be noted that the Corridor Cities Transitway has not been included in the future transportation network in the travel forecasting model.

Highway, transit, pedestrian, and bicycle projects and studies in the Purple Line corridor included in the Maryland Consolidated Transportation Program (FY 2007-2012) within the corridor are as follows:

- US 1 (Baltimore Avenue): Reconstruct US 1 between College Avenue and Sunnyside Avenue to improve traffic operations, pedestrian circulation, and safety; it would also accommodate planned revitalization within College Park (project)
- New Hampshire Avenue/University Boulevard: Streetscape and safety improvements for New Hampshire Avenue from Holton Lane to Merrimac Drive and University Boulevard

from 800 feet west of New Hampshire Avenue to 800 feet east of New Hampshire Avenue (project)

- Construction of the Silver Spring Green Trail, an 8-foot-wide bicycle/pedestrian trail on Wayne Avenue from the Silver Spring CBD to Sligo Creek Parkway (project)
- Bethesda Bikeway and Pedestrian Facilities, streetscape improvements (project)
- College Park Trolley Trail, construct shared-use path (project)
- I-95/I-495, Capital Beltway, from American Legion Bridge to Woodrow Wilson Bridge (study)
- University of Maryland Connector, I-95/495 to University of Maryland (study)
- Widening of Kenilworth Avenue from four to six lanes north from River Road to Pontiac Street (project)

Other committed projects in the Purple Line corridor include the following:

- Construction of the Silver Spring Transit Center. This project provides a fully integrated transit center at the Silver Spring Metrorail Station. It includes construction of bus bays for Metrobus and Ride On, an intercity bus facility, a taxi queue area, a kiss-and-ride facility, and a MARC ticketing office. Provision has also been made for the Purple Line and a hiker-biker trail.
- Construction of the Takoma/Langley Transit Center. The project is a joint effort between MTA and SHA. It will include pedestrian safety, roadway and intersection improvements, new sidewalks and crosswalks, and the provision of shelter for patrons awaiting buses. The transit center will be on the northwest corner of the University Boulevard and New Hampshire Avenue intersection in Langley Park. This transit center would be a station on the Purple Line.
- A study for construction of a new entrance to the Bethesda Metro Station mezzanine at the south end of the platform.

WMATA is currently pursuing additional joint development projects at the College Park and New Carrollton Metro Stations. These projects will be mixed-use developments that will take advantage of the metro stations to provide enhanced accessibility. The market for transit at these stations is expected to grow.

Implications of the Defense Base Realignment and Closure Process. When the Base Realignment and Closure (BRAC) Commission decided to close or combine aging bases nationwide, the State of Maryland was a primary recipient of employment from bases closing in other areas. Fort Meade, Aberdeen Proving Ground, Fort Dietrich, Andrews Air Force Base, and the National Naval Medical Center are expected to grow by 20,000 employees when BRAC is fully implemented in 2011. The recent decision to close Walter Reed Army Hospital and move a large number of staff and services to the National Naval Medical Center under BRAC will create a slightly larger market for transit at the Bethesda and National Institutes of Health (NIH) Metro Stations. The shift of 1,750 jobs from Walter Reed Army Medical Center in northeast

Washington, DC to National Naval Medical Center (NNMC) is expected to change commuting patterns in the near term for the positions that are being transferred. The actions noted in BRAC identify a changing picture of employment and visitor trips to the new combined medical center being planned on the site of the NNMC in Bethesda. The NNMC anticipates an increase of approximately 2,200 to 2,500 employees[3] of which an estimated 30 to 50 new riders would use the Purple Line.

The Purple Line AA/DEIS used MWCOG Round 7.0 2030 land use forecasts for employment, households and population in the analysis. The assumed growth for these items was based on normal growth assumptions for each zone in the region. A concern was raised about the implications of this change on the long-term assumptions for this project. However, given the scale of the expected growth excluding the BRAC changes, analysis of the changing trip patterns for the 2030 horizon year indicates that the effects of BRAC will be negligible.

The Bethesda area exists today and in the future as a major employment and population center exclusive of the BRAC changes. Combined employment around the Medical Center Metro Station is expected to grow by over 6,000 jobs to 2030 and population is expected to grow by approximately 700 in that time. The Bethesda CBD is expected to grow by 5,000 jobs and show a population increase of over 12,000 residences in that same period. The BRAC changes, while large, are a small percentage of the expected 72,000 jobs in the entire Bethesda CBD - Medical Center area in 2030.

Therefore, given the access afforded by Purple Line alternatives along the Master Plan alignment and connecting the Metrorail Red Line to the Medical Center Station, the impacts of BRAC on travel in the Bethesda area are notable more for the additional delays expected on area roadways than for the potential contributions to Purple Line ridership.

However, in response to community concerns about the need to better serve the Medical Center area two variations of the Medium BRT Alternative have been proposed. These are described in *Section 2.3, Alternative 4 – Medium Investment BRT*.

A detailed analysis of the impacts of BRAC is presented in Appendix C.

2.1.1. Existing Transit Service

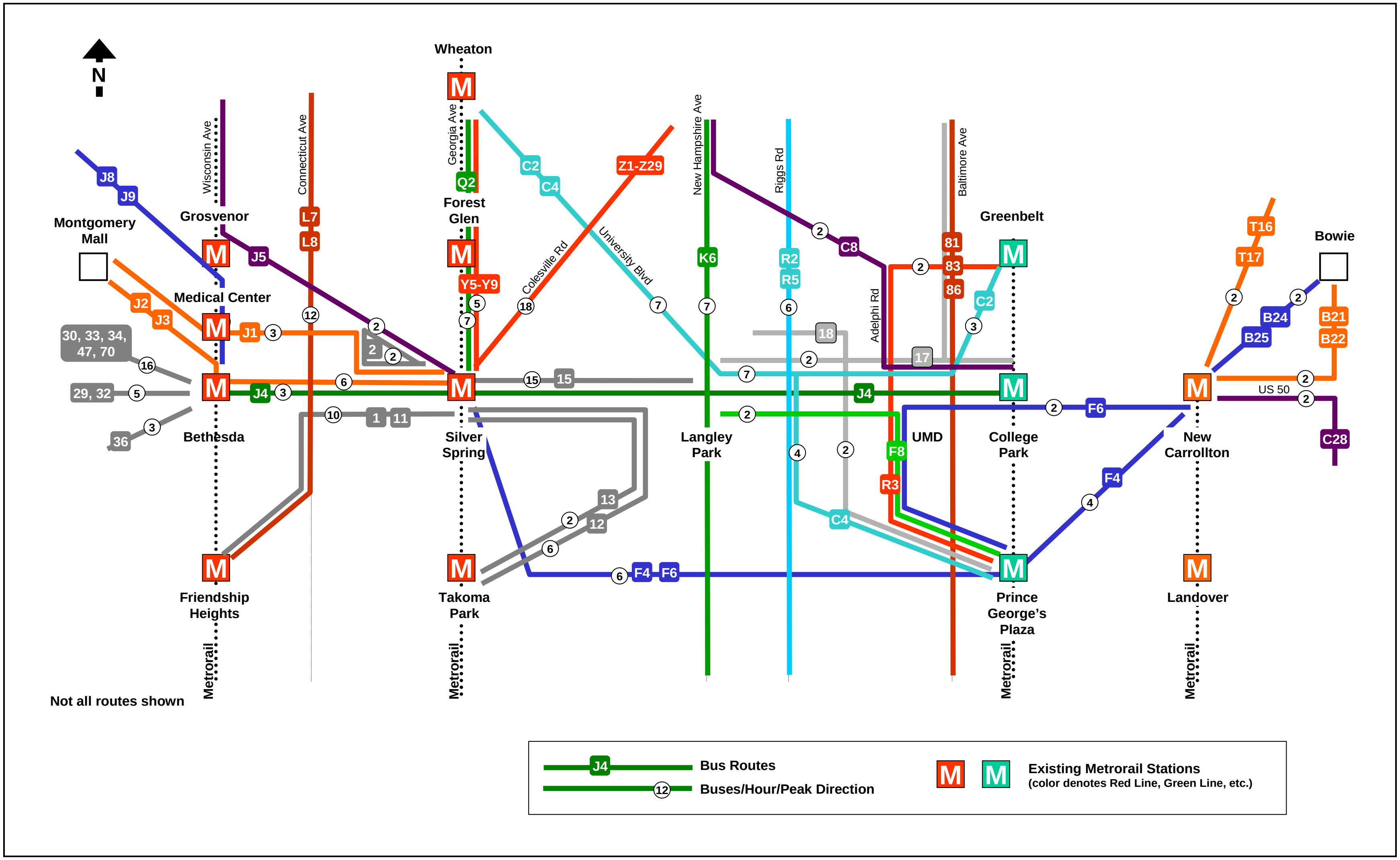
Table 2-1 lists the existing transit services operating east-west within the corridor and their general characteristics. Existing transit consists of several overlapping or interconnecting routes, as shown in Figure 2-1. WMATA operates regional routes, those that are inter-jurisdictional, while each of the counties operates local routes.

[3] http://www.bethesda.med.navy.mil/Professional/Public_Affairs/BRAC/index.aspx, National Naval Medical Center BRAC Facts and FAQs, retrieved 10/17/07.

Table 2-1: Headways for Existing East-West Bus Service within the Corridor (minutes)

Route	Terminal and Intermediate Points	Early Morning	AM Peak	Midday	PM Peak	Evening	Saturday	Sunday	Average Daily Riders
WMATA J1	Montgomery Mall-Medical Center – Silver Spring Metro	--	20	--	20	---	--	--	**6,600**
WMATA J2	Montgomery Mall – Bethesda – Silver Spring Metro	20	17	20	24	15	20	25	
WMATA J3	Montgomery Mall – Bethesda – Silver Spring Metro	--	17	--	24	--	--	--	
WMATA J4	Bethesda Metro – Silver Spring – College Park Metro	--	20	--	20	--	--	--	**1,000**
WMATA C2	Wheaton Metro – Greenbelt Metro	--	22	30	16	--	30	--	**5,200**
WMATA C4	Twinbrook Metro – Prince George's Plaza Metro	10	22	30	16	30	30	16	**7,800**
WMATA F4	Silver Spring – New Carrollton	12	12	40	15	--	30	60	**4,600**
WMATA F6	Silver Spring – New Carrollton	--	20	40	30	--	--	--	**3,100**
Ride On 15	Silver Spring Metro – Langley Park	15	4	12	4	30	12	15	**7,200**
TheBus 17	Langley Park – UM-College Park Metro	45	45	45	45	--	--	--	**40**
UM Shuttle 111	UM – Silver Spring Metro	--	35	75	45	30	--	--	**500**
UM Shuttle 104	UM – College Park Metro	8	8	12	8	20	20	20	**2,500**

Figure 2-1: Existing Transit Service



Metrobus schedules vary by route, with most routes running every day. Ride On schedules also vary by route, with most routes running daily. TheBus buses operate Monday through Friday, with no service on weekends or holidays. Bus headways on all three systems vary by time of day. Transit service to the National Naval Medical Center/National Institutes of Health area is provided from Silver Spring and points east via the J1 route, while the Metrorail Red Line Medical Center Station connects to the entire rail-bus network.

The No Build Alternative would not include any alterations to the existing Metrobus, Ride On, or TheBus systems. It would not include addition of a new mode or new exclusive right-of-way, and would therefore not significantly increase the reliability of the existing transit system. It is expected that increasing roadway congestion will decrease the reliability of the bus service, its adherence to its operational schedule, and the predictability of expected headways and transit travel times.

The fares of the existing transit services in the corridor are described in the following sections.

Metrorail Fares

Regular Metrorail fares ranging from $1.65 to $4.50 are in effect on weekdays from opening to 9:30 AM, 3:00–7:00 PM, and 2:00 AM to closing. Reduced fares ranging from $1.35 to $2.35 are in effect at all other times. These fares are based on distance traveled. Metrorail senior-disabled fares are in effect at all times and are one-half of the regular fare. SmarTrip cards and other multi-trip passes may be purchased at Metrorail stations, Metro sales offices, retail outlets, or Commuter Stores.

Metrobus Fares

The Metrobus fares are summarized in Table 2-2.

Table 2-2: Metrobus Fares (2007)

Regular Fare - Cash	$1.35
Regular Fare – SmarTrip	$1.25
Express Bus Fare	$3.10
Transfers	Free
Metrorail-to-Metro bus transfers	Free

TheBus Fares

TheBus uses a single, flat fare for all trips on its services. Adult fares are as shown in Table 2-3.

Table 2-3: TheBus Fares (2007)

Regular Fare	$0.75
Metrobus and Ride On-to-Transfer	Free
Metrorail-to-TheBus transfer	$0.25
TheBus-to-Metrobus and Ride On Transfer	$0.50

Ride On Fares

Ride On uses a single, flat fare for all trips. Fares for these services are shown in Table 2-4. SmarTrip cards may be used on Ride On.

Table 2-4: Ride On Fares (2007)

Regular Fare or Token	$1.25
Local Bus Transfer (Valid for 2 hours, any direction)	Free
Metrorail-to-Ride On Bus Transfer	$.35

Ride On accepts Metrobus and other local bus transfers at any stop on any route until its expiration time. Metrobus accepts Ride On and other local bus transfers at any stop in their system.

2.2. General Operating Characteristics of TSM and Build Alternatives

The alternatives were developed to test the effectiveness of various alignment options, such as tunnel vs. surface segments. Operational characteristics are for this reason kept as similar as possible for TSM and each of the six Build Alternatives. These include:

- Fare structure
- Hours of service
- Frequency of trunkline service during both peak hours and off-peak hours
- Feeder bus network routes and frequencies
- Station locations and amenities

In certain circumstances, these characteristics do differ between alternatives, depending on the features of the mode or alignment. For example, some stations are not present in one or more alternatives because the alignment is in tunnel and stations in these areas infeasible or the alignment is not in that location. These station locations are:

- NIH/Medical Center – (Low Investment BRT only)
- Fenton Street (not included in High Investment BRT and LRT)

Several station locations vary slightly depending on the Alternative. These station locations are:

- Connecticut Avenue
- Fenton Street
- Arliss Street

2.2.1. Vehicles

Bus service in the No Build would be provided by a range of vehicle types as it is today. Bus service in the TSM would be provided by standard, 40-foot buses. Under the BRT alternatives the vehicles used would be articulated 60-foot buses. These buses would provide a higher capacity than the standard buses (90 passengers/bus vs. 60 for regular buses), and should enhance the quality of the ride as well – providing faster exiting, more comfortable seating, and a smoother ride.

MTA's current policy for all new bus purchases calls for a diesel hybrid fuel system.

In the LRT alternatives, peak period trains are assumed to comprise two-car trains powered by overhead wires. For planning purposes, passenger capacity is 150 per car, for a total of 300 per train.

2.2.2. Service Concept

The diverse land uses and economic base in the Purple Line corridor include residential, commercial, industrial, institutional, and governmental sectors. This generates a wide variety of trip types and purposes that reflect the equally wide range of demographics of the region.

Currently, there is bus service throughout the study corridor, with several of the highest ridership bus routes in the region. The Purple Line alternatives would enhance and expand the existing service by providing a higher speed, higher capacity trunkline transitway.

Purple Line service planning includes not only 2030 plans for the corridor alternatives but also plans for the background local bus network operated in the region. Service plans discussed in detail below for the Transportation System Management (TSM) Alternative and each of the six Build Alternatives endeavor to create a route network as interconnected as possible. Redundant and overlapping service has been proposed for elimination, while other routes have been restructured to provide increased connectivity with the corridor service to provide more convenient, user-friendly service for passengers.

All of the Build Alternatives serve the same markets because the alignments and station locations are quite similar. All alternatives serve downtown Bethesda directly with the trunkline service; however, only the Low Investment BRT Alternative and the two Medium BRT variations (described in *Section 2.3, Alternative 4 – Medium Investment BRT*.) directly serve the National Institutes of Health and the National Naval Medical Center area. All others, including the No Build and TSM Alternatives, serve this market with improved bus service, connecting Silver Spring as well as Metrorail service to Bethesda.

Minor variations may occur in station locations due to actual alignment. For example, the Connecticut Avenue Station could have one of three locations depending on the alternative: at Jones Bridge Road for the Low Investment BRT Alternatives; at the Georgetown Branch right-of-way alignment for the Low Investment LRT, and Medium and High Investment BRT and LRT Alternatives; and at East West Highway for the TSM Alternative. The actual locations of the stations would be determined in later design and engineering phases of the project. The principal difference among alternatives is in their use of shared and dedicated lanes and at grade, tunnel, and elevated running ways.

Table 2-5 provides the station locations, the markets served, and the connecting transit service at each station.

Table 2-5: Proposed Stations, Markets, and Connecting Transit Services

Stations/Stops	Location	Markets Served	Connecting Transit Services
Bethesda Metro Station		Central business and residential district, and transfers	Metrorail Red Line; Metrobus: J2, J3, J7, J9; Ride On: 29, 30, 32, 33, 34, 36, 42, 47, 70, 92
NIH/Medical Center (Low Investment BRT only)	Wisconsin Avenue and Jones Bridge Road	NIH, NNMC, and residential and transfers	Metrorail Red Line; Metrobus: J2, J3, J7, J9; Ride On: 30, 33, 42, 46, 70,
Connecticut Avenue (Low Investment BRT only)	Jones Bridge Road	Residential	Metrobus: L7, L8
Connecticut Avenue (all alternatives except Low Investment BRT)	Georgetown Branch ROW	Local business and residential	Metrobus: L7, L8
Lyttonsville Place	Georgetown Branch ROW	Local business and residential	Ride On: 2,
16th Street and CSX ROW	CSX ROW	Local business and residential, and transfers	Metrobus: J5, Q2, Y5, Y7, Y8, Y9; Ride On: 3, 4, 5, 127
Silver Spring Transit Center	Colesville Road and Wayne Avenue	Central business and residential district, entertainment, and transfers	Metrorail Red Line; MARC Brunswick Line; UM Shuttle 111; Metrobus: F4, F6, J1, J2, J3, J5, Q2, S2, S4, Y5, Y7, Y8, Y9, Z2, Z6, Z8, Z9, Z11, Z13, Z29, 70, 71, 79; Ride On: 1, 2, 3, 4, 5, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 20, 22, 28, 127
Fenton Street and Wayne Avenue (all alternatives except High Investment BRT and LRT)	Wayne Avenue	Central business and residential district, and transfers	Metrobus: F4, F6; UM Shuttle 111; Ride On: 12, 16, 17, 19, 20, 28
Dale Drive	Wayne Avenue	Local residential	Ride On: 3, 12, 19; UM Shuttle 111
Manchester Road	Wayne Avenue	Local residential	Ride On: 12, 13, 19
Thayer Avenue	West of Nolte Avenue		Ride On: 20
Arliss Street	Piney Branch Road	Local business and residential	Ride On: 14, 16, 20, 24
Gilbert Street	University Boulevard	Local business, and residential, and transfers	Metrobus: C2, C4

Table 2-5: Proposed Stations, Markets, and Connecting Transit Services

Stations/Stops	Location	Markets Served	Connecting Transit Services
Takoma/Langley Transit Center (University Boulevard and New Hampshire Avenue)	University Boulevard and New Hampshire Avenue	Local business and residential, and transfers	Metrobus: C2, C4, F8, K6; UM Shuttle 111; Ride On: 16, 17, 18; TheBus: 17, 18
Riggs Road	University Boulevard	Local business and residential,	Metrobus: C2, C4, F8, R5, R1, R2; TheBus: 17, 18
Adelphi Road and Campus Drive	Campus Drive at UMUC	Residential, UMUC, and transfers	Metrobus: C2, C8, F6, F8, R3; TheBus: 17
UM Campus Center		UM	Metrobus: C2, C8, F6; UM Shuttles; TheBus: 17,
UM East Campus	US 1	Commercial, hotel, residential, UM, and transfers	Metrobus: C2, C8, F6, 81, 83, 86; TheBus: 17
College Park Metro Station		M Square Research Park, residential, future mixed-use development, and transfers	Metrorail Green Line; MARC Camden Line; Metrobus: C2, C8, F6, R12, 83, 86; TheBus: 14, 17 CAR: G, H
River Road		M Square research park and residential	Metrobus: F6, R12; TheBus: 14
Riverdale Park	Kenilworth Avenue and MD 410	Local business and residential and transfers	Metrobus: F4, R12, 84, 85; TheBus: 14
Riverdale Road	Veterans Parkway	Local business and residential	Metrobus: F4, 84, 85; TheBus: 14
Annapolis Road	Veterans Parkway	Local business	Metrobus: F13, T18,
New Carrollton Metro Station		Business and residential, including IRS, CSC; future mixed-use development, and transfers	Metrorail Orange Line, MARC Penn Line, Amtrak; Metrobus: B21, B22, B24, B25, B27, B29, B31, C28, F4, F6, F12, F13, F14, R12, T16, T17, T18, 84,85, 88; TheBus: 15, 16, 21, 21X

Notes:
A) Bus operators – Metrobus = WMATA, Ride On = Montgomery County, TheBus = Prince George's County, CAR = Connect a Ride
B) Metrobus J1 discontinued under Low Investment BRT Alternative
C) Metrobus J4 and Ride On 15 replaced by all Purple Line alternatives

No new parking facilities would be constructed as part of the Purple Line. Municipal parking garages exist near the Bethesda and Silver Spring Metro Stations, and transit parking facilities exist at the College Park and New Carrollton Metro Stations.

Additional kiss-and-ride facilities would be considered at the following stations: Connecticut Avenue at the Georgetown Branch right-of-way and Lyttonsville. Silver Spring Transit Center, College Park, and New Carrollton already have kiss-and-ride parking facilities available and the Purple Line would not add more.

2.2.3. Service Characteristics

For the purpose of the alternatives analysis, which is to identify the differences among different levels of investment, a number of the service-related characteristics have been held constant across all the alternatives. These characteristics include the following:

- Hours of service
- Headways
- Fares

Hours of Service

Purple Line services would operate at approximately the same hours as Metrorail including extended hours on weekend nights (Table 2-6). Service would begin at terminal stations at 5:00 AM weekdays and 7:00 AM on Saturday and Sunday and would operate through midnight Sunday through Thursday and until 3:00 AM on Friday and Saturday. All times are approximate and might vary slightly. Because service start time would be scheduled for terminal stations, first trains would leave many stations later than system opening times and last trains would leave earlier than closing times.

Table 2-6: Span of Service for Build Alternatives

Day of Week	Hours
Monday – Thursday	5:00 AM – 12:00 AM
Friday	5:00 AM – 3:00 AM
Saturday	7:00 AM – 3:00 AM
Sunday	7:00 AM – 12:00 AM

Headways

The headways for the TSM and all Build Alternatives would be 6 minutes each direction during peak hours and 10 minutes off-peak (see Table 2-7).

Table 2-7: Build Alternatives Headways

Day of Week	Early AM	Peak	Midday	PM Peak	Evening	Late PM
Weekdays	10 min.	6 min.	10 min.	6 min.	10 min.	10 min.
Saturdays	20 min.	N/A	10 min.	N/A	10 min.	20 min.
Sundays	20 min.	N/A	10 min.	N/A	10 min.	20 min.

Fares

Described below are the fares of Metrobus, followed by the proposed fares for the Purple Line.

Metrobus Fares

The Metrobus fares are summarized in Table 2-8.

Table 2-8: Metrobus Fares (2007)

Regular Fare - Cash	$1.35
Regular Fare - SmarTrip	$1.25
Express Bus Fare	$3.10
Transfers	Free
Metrorail-to-Metro bus transfers	Free

TSM Fare Assumptions

TSM route fare is assumed to be a flat fare following the regular Metrobus fares. Cash fares and multi-trip passes will be accepted by operators upon boarding the vehicle. All fare instruments would be made available at Metrorail stations. SmarTrip cards and other multi-trip passes would also be purchased at Metro sales offices, retail outlets, or Commuter Stores.

LRT and BRT Fare Assumptions

It is assumed that LRT and BRT fares would be a flat fare following the regular Metrobus fares described above. To expedite boarding and alighting, a proof-of-purchase payment method is assumed with tickets purchased from ticket vending machines at stations. Passengers would board through multiple doors to speed loading. Roving, on-board fare inspectors would be required to reduce the incidence of fare evasion, as is typical of most proof-of-purchase operations in the United States. SmarTrip cards and other multi-trip passes would also be purchased at Metro sales offices, retail outlets, or Commuter Stores.

Fare assumptions for the Purple Line, as described above, would initially replicate existing Metrobus fare structure and policies. Purple Line transfers to Metrobus and Metrorail would initially be free. Transfers to other local services will be equal to existing bus-to-bus transfer policies. Fare structure and policy will be re-examined as the Purple Line advances toward implementation when the operator of the Purple Line is determined and agreements among local transit service providers have been reached.

2.2.4. Feeder Bus Service

An extensive and comprehensive bus network is currently in place in the Purple Line corridor, operated by WMATA and the two counties, Montgomery in the west and Prince George's in the east. While many of these routes have a role in serving purely local travel markets, a very large number of them feed the Metro stations at Bethesda, Silver Spring, College Park, and New Carrollton. Thus they are a ready-made feeder bus network for the Purple Line, which would serve those Metro stations. The number of routes performing this feeder function is considerable, 14 routes at Bethesda, 28 routes at Silver Spring, 10 routes at College Park, and 24 routes at New Carrollton. In addition, nine bus routes plus the UM shuttle presently serve the area of the University Boulevard/New Hampshire Avenue intersection. This intersection is the site of the future Takoma/Langley Transit Center, a planned and programmed facility that will serve existing bus routes, as well as the Purple Line, and will provide enhanced amenities to transit patrons. Construction of the transit center is expected to be completed in 2009.

If the Purple Line were built, some feeder bus route revisions would be made to better serve the Purple Line stations. Given the extensive existing bus network, these changes would be relatively minor in scope. Because all six Build Alternatives serve the same markets and have stations that are, for the most part, in the same locations, feeder bus service would be the same for all Build Alternatives.

The span of services of the bus routes that feed the TSM and Build Alternatives would be adjusted to service the market needing extended service times.

2.2.5. Operating Characteristics

The end-to-end travel times, average estimated speeds, and fleet size for the TSM Alternative and each Build Alternative are shown in Table 2-9. As expected, the High Investment LRT Alternative, with strategic grade separation and mostly dedicated or exclusive right-of-way, would have the shortest running time and the highest average speed of all the alternatives.

Table 2-9: Operating Characteristics of Alternatives

Alternative	End-to-End Travel Time, Peak (minutes)	End-to-End Average Speed (mph)	Peak Vehicle Requirement (includes spares)
TSM	108	9	68
Low Investment BRT	96	10	60
Medium Investment BRT	73	13	49
High Investment BRT	59	16	42
Low Investment LRT	62	15	44
Medium Investment LRT	59	16	44
High Investment LRT	50	19	44

Average station-to-station travel time estimates for the Build Alternatives are shown in **Table 2-10**.

The Medium Investment BRT variation via the Jones Bridge Road would have an end-to-end running time of 76 minutes, which would result in an average speed of 13 mph. The other variation, Medium Investment BRT Extended to Medical Center, would have an end-to-end running time of 78 minutes, which would also result in an average speed of 13 mph, although the time to downtown Bethesda, the larger travel market than Medical Center, would be 59 minutes compared to the 76 minutes via the Jones Bridge Road alignment.

Table 2-10: Average Station-to-Station Travel Times (minutes)

Segment Name	TSM	Low Invest. BRT	Med Invest. BRT	High Invest. BRT	Low Invest. LRT	Med Invest. LRT	High Invest. LRT
Bethesda Metro, North entrance to Medical Center Metro	NA	4.7	NA	NA	NA	NA	NA
Bethesda Metro, North entrance to Bethesda Metro, South entrance	NA	NA	5.2	5.2	NA	NA	NA
Medical Center Metro to Connecticut Avenue	NA	6.0	NA	NA	NA	NA	NA
Bethesda Metro, South entrance to Connecticut Avenue	10.8	NA	5.5	5.5	4.0	2.4	2.4
Connecticut Avenue to Grubb Road	7.3	NA	NA	NA	NA	NA	NA
Connecticut Avenue to Lyttonsville	NA	5.2	3.1	3.1	2.3	2.3	2.3
Grubb Road to Silver Spring Transit Center	13.2	NA	NA	NA	NA	NA	NA
Lyttonsville to Woodside/16th Street	NA	2.4	2.4	2.4	2.1	2.1	2.1
Woodside/16th Street to Silver Spring Transit Center	NA	6.2	2.1	2.1	2.8	2.0	2.0
Silver Spring Transit Center to Fenton Street	5.1	4.6	3.1	N/A	3.1	3.1	N/A
Silver Spring Transit Center to Dale Drive	NA	N/A	N/A	2.6	N/A	N/A	3.6
Fenton Street to Dale Drive	4.8	2.8	3.0	N/A	3.8	3.1	N/A
Dale Drive to Manchester Place	2.9	2.3	2.3	2.1	3.1	2.8	2.4
Manchester Place to Arliss Street	4.9	4.8	4.7	1.4	1.4	1.4	1.4
Arliss Street to Gilbert Street	6.6	6.6	3.4	4.0	3.8	3.8	3.8
Gilbert Street to Takoma/Langley Transit Center	4.8	4.8	2.3	2.2	2.2	2.2	2.1
Takoma/Langley Transit Center to Riggs Road	5.8	5.6	2.7	1.7	2.4	2.4	1.7
Riggs Road to Adelphi Road	6.0	5.7	5.6	3.1	3.3	3.3	3.1
Adelphi Road to UM Campus Center	4.0	3.7	2.9	2.6	2.9	2.9	2.6
UM Campus Center to UM East Campus	8.6	8.6	3.0	2.9	3.0	3.0	2.9
UM East Campus to College Park Metro	2.0	2.2	3.0	3.0	3.0	3.0	3.0
College Park Metro to River Road	2.0	1.8	1.9	1.9	1.9	1.9	1.9

Table 2-10: Average Station-to-Station Travel Times (minutes)

Segment Name	TSM	Low Invest. BRT	Med Invest. BRT	High Invest. BRT	Low Invest. LRT	Med Invest. LRT	High Invest. LRT
River Road to Riverdale Park	5.5	5.4	4.3	3.2	4.6	4.6	3.1
Riverdale Park to Riverdale Heights	4.4	4.0	4.7	2.9	4.8	4.8	2.9
Riverdale Heights to Annapolis Road	4.7	4.0	3.6	3.5	3.5	3.5	3.3
Annapolis Road to New Carrollton Metro	4.6	4.4	3.8	3.5	3.9	3.9	3.6
Total Running Time (rounded up to the nearest minute)	**108**	**96**	**73**	**59**	**62**	**59**	**50**

Table 2-11: Comparison of Running Way Characteristics by Alternative

Type Of Running Way	No Build	TSM	Low Invest. BRT	Med Invest. BRT	High Invest. BRT	Low Invest. LRT	Med Invest. LRT	High Invest. LRT
Horizontal Alignment Type (Miles)								
Dedicated	All shared	All shared 15.97	0.67	7.4	7.71	8.62	9.18	8.88
Exclusive			1.97	4.85	9.37	5.73	5.74	8.81
Shared (with traffic)			14.43	4.68	0.15	1.76	1.33	0.16
Vertical Alignment Type (Miles):								
Aerial	All surface	All surface 15.97		1.26	1.63	1.06	1.06	1.73
Surface			17.07	15.66	12.99	14.39	14.5	12.9
Tunnel				0.01	2.61	0.66	0.69	3.22
End-to-end peak period running times Bethesda to New Carrollton (minutes)	--	108	96	73	60	62	59	50

Reliability

The overall reliability of any of the Build Alternatives would be higher than that for the No Build or TSM Alternatives because, for the most part the service, depending on the alternative, would operate in dedicated lanes or exclusive right-of-way, thus removing the service from the potential delays of roadway congestion. In areas where the Purple Line would operate in mixed-use lanes, it is anticipated that queue jumpers and signal prioritization would be implemented where possible. The High Investment Alternatives would have the highest reliability, and the Low Investment Alternatives would have the lowest reliability. Because of the terminal configuration of the High and Medium Investment BRT Alternatives at Bethesda that involve a street-running loop, those two alternatives would not be as reliable as their LRT counterparts. Similarly, the Low Investment BRT Alternative with its operations along Jones Bridge Road between Bethesda and Silver Spring would have lower reliability than the Low Investment LRT Alternative, which would operate in the Georgetown Branch right-of-way, which is an exclusive right-of-way. See Table 2-11 for a comparison of the types of running way for each of the alternatives.

2.3. Alignments of Purple Line Alternatives

2.3.1. Alternative 2 – TSM Alternative

As described by the FTA, transportation system management (TSM) alternatives are relatively low-cost approaches to addressing transportation problems in the corridor. The TSM Alternative represents the best that can be done for mobility without constructing a new transit guideway. Generally, the TSM Alternative emphasizes upgrades in transit service through operational and small physical improvements, plus selected roadway upgrades through intersection improvements, minor widenings, and other focused traffic engineering actions. A TSM Alternative normally includes such features as bus route restructuring, more frequent bus service, expanded use of articulated buses to reduce crowding for passengers, bus lanes, special bus ramps on freeways, expanded park-and-ride facilities, express and limited-stop service, signalization improvements, and improved transfer operations. While the scale of these improvements is generally modest, TSM Alternatives may cost tens of millions of dollars while the build alternatives range up to several hundreds of millions or billions of dollars.

TSM Alternatives are important components of transit studies because they provide a baseline against which all major investment alternatives are evaluated for the FTA's New Starts program. The most cost-effective TSM Alternative generally serves as the baseline against which the selected Build Alternative is compared during the New Starts rating and evaluation process. This process would begin when the MTA applies for permission to initiate preliminary engineering, and would continue through final design.

The TSM Alternative would include improved bus service in the corridor and a new through-route from Bethesda to New Carrollton replacing the existing J4 route and adding service on portions of the F4/F6 routes between College Park and New Carrollton. The TSM bus service would consist of a limited-stop bus route that would make stops consistent with those of the Build Alternatives. The core service improvements under the TSM Alternative include limited-stop bus service, queue jump lanes, selected signal preference strategies, and upgrades to bus stop amenities. Sixty-foot articulated buses would be used.

The TSM service would provide faster one-seat rides between major activity centers, including Medical Center Metro Station, Bethesda Metro Station, Silver Spring Metro Station, Takoma Park, Langley Park, University of Maryland, and the College Park Metro Station. This route would also serve transfers to bus routes operating on radial streets, including those on Wisconsin Avenue, Connecticut Avenue, Colesville Road, Georgia Avenue, New Hampshire Avenue, Riggs Road, US 1, and Annapolis Road. It would serve the long-haul trips now carried by WMATA J2/J3, Ride On 15, and, to a degree, WMATA C2/C4; and is estimated would serve nearly 80 percent of the passengers now boarding those existing routes along this corridor.

From Bethesda the TSM bus route would operate along East West Highway (Montgomery Avenue eastbound, between Woodmont Avenue and East West Highway) and Colesville Road to the Silver Spring Transit Center, and would then follow Wayne Avenue, Flower Avenue, and Piney Branch Road to University Boulevard. From there, the TSM route would operate along

University Boulevard until the University of Maryland campus, following Campus Drive through campus and continuing on Paint Branch Parkway to the College Park Metro Station. After serving the station, the TSM route would continue on River Road, Kenilworth Avenue, East West Highway, Riverdale Road, Veterans Parkway, and Harkins Road to the west side of the New Carrollton Metro Station. Eastbound the TSM route would follow Harkins Road to Annapolis Road back to Veterans Parkway and continue in the reverse order of the eastbound route described above.

A principal difference between the TSM and Build Alternatives is that the TSM service would operate on East West Highway between Bethesda and Silver Spring, rather than along a new guideway facility along the Georgetown Branch and Metropolitan Branch railroad rights-of-way between Bethesda and Silver Spring, as with the Build Alternatives (except under the Low Investment BRT Alternative, which runs along Jones Bridge Road.) Along East West Highway, stops would be located at Connecticut Avenue and at Grubb Road.

Transit service to the National Naval Medical Center/National Institutes of Health area would be provided from Silver Spring and points east through the enhanced J1 service with queue jump lanes and operational or service modifications. The Metrorail Red Line Medical Center Station would continue to provide connectivity to the entire rail-bus network.

As a limited-stop service, TSM bus stops would be located, west to east, at the Bethesda Metro Station, Connecticut Avenue, Grubb Road, Silver Spring Transit Center, Fenton Street, Dale Drive, Manchester Place, Arliss Street, Gilbert Street, Takoma/Langley Transit Center at New Hampshire Ave, Riggs Road, Adelphi Road, University of Maryland campus on Campus Drive, US 1, College Park Metro Station, River Road, Riverdale Park, Riverdale Road, Annapolis Road, and New Carrollton Metro Station. Each stop would be enhanced with upgraded amenities including new and enlarged shelters, concrete pads meeting ADA guidelines, bus and local information, and Next Bus information. The concept is to provide a branded, easily identifiable set of bus routes and bus stops for the enhanced service and to improve those selected bus stops to properly serve the passengers using the service. A map with proposed TSM stop locations is shown in Figure 2-2.

TSM Service Plan

The TSM service is envisioned to be 6-minute peak and 10-minute off-peak throughout the corridor (Table 2-12). With five-minute headways and 15 percent vehicle spares, 68 vehicles would be required to operate the TSM service.

Figure 2-2: TSM Service

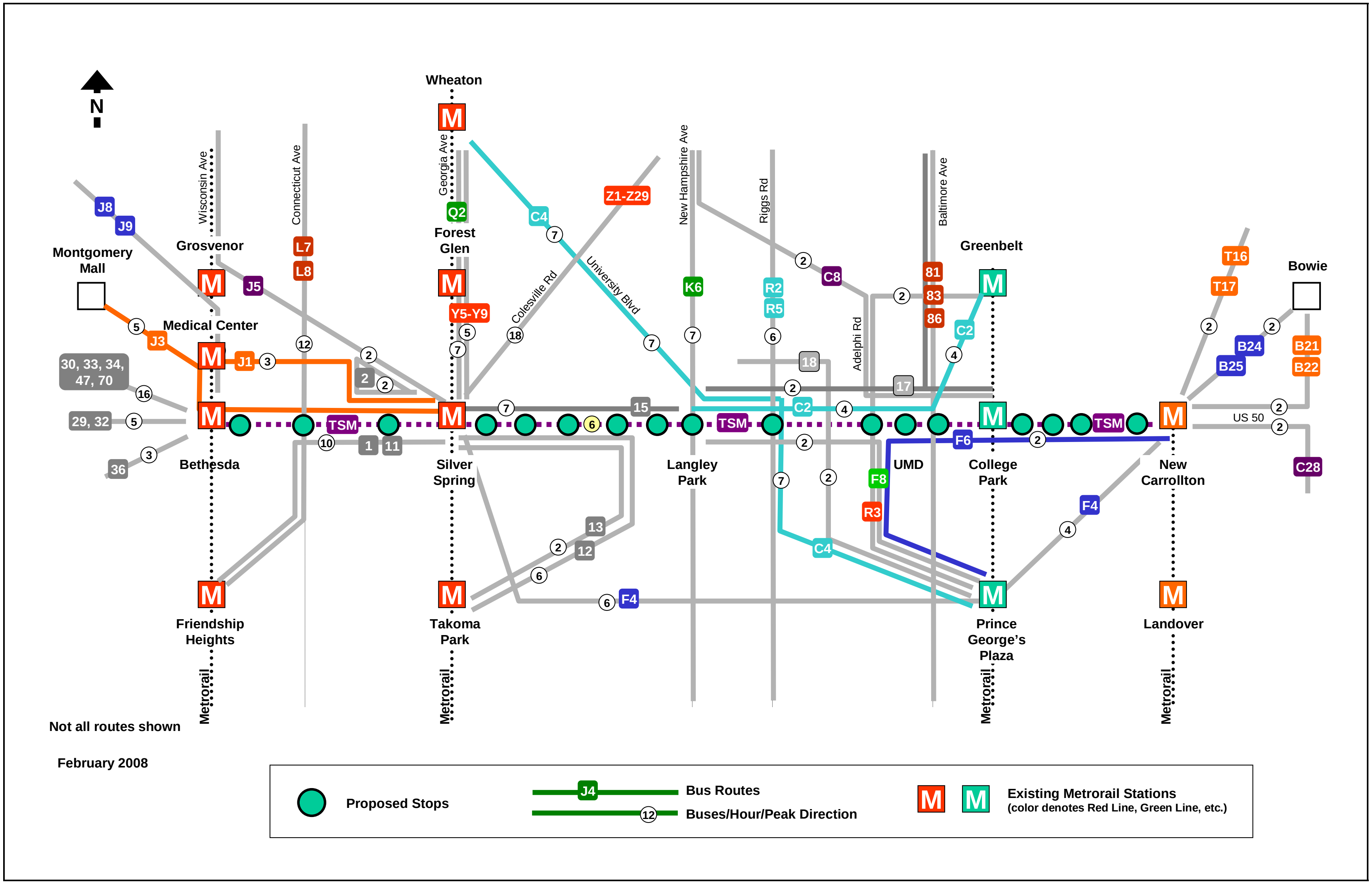


Table 2-12: TSM Bus Headways

Route	Terminal and Intermediate Points	Early Morning	AM Peak	Midday	PM Peak	Evening	Weekend
TSM	Bethesda – New Carrollton	10	6	10	6	10	10
J1	Medical Center – Silver Spring	-	20	-	20	-	-
J3	Eliminate; replace with Ride On 15 service	-	-	-	-	-	-
C2	Terminate at Langley Park Langley Park – Greenbelt	30	15	20	15	30	30
C4	Twinbrook Metro – Prince George's Plaza Metro	10	8	15	8	20	20
F4	Silver Spring – New Carrollton	12	10	30	10		30
F6	Terminate at Prince George's Plaza Prince George's Plaza – New Carrollton	-	15	30	15	-	-
Ride On 15	Bethesda – Langley Park (extend to Bethesda)	15	15	15	15	30	15
TheBus 17	Langley Park–UM–College Park Metro	45	45	45	45	-	-
Shuttle – UM Silver Spring	UM – Silver Spring Metro	-	35	75	45	30	-

Transit Travel Times

End-to-end, the TSM route is 16 miles long, requiring about 108 minutes of running time with an average round trip speed of 9 miles per hour. Today, the bus routes along the alignment, J4, F4, and F6, operate in very difficult circumstances with a wide range of times in each direction and between the AM and PM. Anecdotal reports from WMATA indicate that the J4 route may require 50 percent more time than scheduled on certain runs to complete its trip. These conditions complicate schedule preparation and operations planning. It is assumed TSM measures would somewhat mitigate these conditions; however, 2030 background traffic volumes and traffic congestion levels will be far greater than they are today.There is only limited opportunity for improving transit service travel times and reliability using signal preference strategies along the Purple Line Corridor. The major radial roadways that cross the corridor, such as Connecticut Avenue, Georgia Avenue, New Hampshire Avenue, Kenilworth Avenue, and US 1, are the major sources of delay at intersections. These roadways carry very heavy arterial traffic flows into and out of the District of Columbia and other major activity centers. There is very little opportunity to introduce signal preferences at these intersections without causing major exacerbation of traffic conditions. Queue jump lanes, however, do provide a travel time advantage enabling transit vehicles to get to the intersection and limit the delay to one or two traffic signal cycles.

Transit service to the Bethesda Naval Hospital/National Institutes of Health area would be provided from Silver Spring and points east through the enhanced J1 service with queue jump lanes and operational or service modifications. The Metrorail Red Line Bethesda Station would continue to provide connectivity to the entire rail-bus network.

2.3.2. Build Alternatives

The following section describes various alignments at low, medium, and high levels of investment. Several design options (e.g., tunnel segments, aerial, and at grade alternative horizontal alignments) would serve the same market.

All alternatives would extend the full length between the Bethesda Metro Station in the western portion of the corridor and the New Carrollton Metro Station in the east, with variations in alignment location, type of running way (shared, dedicated, or exclusive), and amount of grade separation. The decision whether to construct dedicated lanes depends on the ability of the service to operate reasonably well without dedication, and on the cost, in dollars or impacts.

Each alternative is identified by the level of investment. A matrix summarizing the BRT build alternatives is presented in Table 2-13 and a matrix summarizing the LRT Build Alternatives is presented in Table 2-14.

While six end-to-end alternatives have been defined and evaluated for the project, the ultimately selected Locally Preferred Alternative could include a mixture of segments from alternatives at different levels of investment.

All alternatives would include incorporation of signal priority and/or queue jump lanes at major intersections where feasible, if the analysis demonstrates that such priority provides significant time savings or reliability.

All alignments that would use the Georgetown Branch right-of-way (except the Low Investment BRT) would include construction of a permanent trail facility alongside the transitway between Bethesda and the Silver Spring Transit Center. This trail would be built following Montgomery County standards for trail design; it would be a 10-foot-wide paved trail with 2-foot shoulders. Between Pearl Street and just west of Jones Mill Road the trail would be on the north side of the transitway; elsewhere it would be on the south side. Access to the trail would be provided at various points along the way, as would crossings over the transitway. The MTA has set a goal of maintaining a landscaped buffer of approximately 10 feet between the trail and the transitway and, wherever possible, that the trail would be built at a slightly higher elevation than the transitway. A barrier, either a fence or a wall, would separate the trail and transitway. All alignments, including the Low Investment BRT, include construction of the trail from Jones Mill Road to the Silver Spring Transit Center. The trail would cross the CSX right-of-way on a new pedestrian bridge east of the existing Talbot Avenue bridge. After crossing the CSX right-of-way the trail would continue on the north side to the Silver Spring Transit Center.

Several design options have been considered. These design options are described following the descriptions of the alternatives.

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Table 2-13: Summary of TSM and BRT Build Alternatives

<table>
<tr><th></th><th colspan="3">Bethesda / Chevy Chase</th><th colspan="4">Silver Spring</th></tr>
<tr><td>TSM Alternative</td><td colspan="2">The TSM goes from the Bethesda Metro Station (north entrance)out to Woodmont Avenue to Montgomery Lane to East West Highway.</td><td>The TSM would operate in mixed traffic, with signal priority treatments implemented where possible to increase schedule adherence. Westbound buses could use existing right-turn lanes to bypass queuing at Jones Mill Road and 16th Street.</td><td colspan="2">At Colesville Road, the TSM would turn left and then right onto Wayne Avenue and right onto Ramsey Street to access the Silver Spring Transit Center. The TSM would operate in mixed traffic with signal priority, where possible.</td><td colspan="2">The buses would exit the SSTC along Ramsey Street, and follow Wayne Avenue in shared lanes to Flower Street. Buses turn right onto Flower Street, operating in shared lanes until Piney Branch Road. Signal priority would be provided, where possible.</td></tr>
<tr><td>BRT</td><td colspan="7"></td></tr>
<tr><td>Alternative 3: Low Investment BRT</td><td>The transitway goes from the Bethesda Metro Station (north entrance) up Woodmont Avenue to Jones Bridge Road.</td><td>On Jones Bridge Road the buses are in shared lanes with queue jump lanes at key intersections.</td><td>At Jones Mill Road the transitway joins the Georgetown Branch right-of-way. A permanent trail will be constructed along the south side of the transitway. There will be two new bridges over Rock Creek, one for the transitway, one for the trail.</td><td>At the CSX corridor the transitway stays on the south side of the CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets at grade.</td><td>Transitway crosses CSX at Spring Street and continues on Second Avenue. Buses enter Silver Spring Transit Center from Ramsey Street.</td><td colspan="2">The buses continue up Wayne Avenue in shared lanes, to Flower Avenue, then Arliss Street.</td></tr>
<tr><td>Alternative 4: Medium Investment BRT</td><td colspan="2">The transitway begins with a one-way counter clockwise loop on Pearl St, East West Highway, Old Georgetown Road, with a stop at the Bethesda Metro Station (north entrance) Edgemoor Lane, Woodmont Avenue on to Georgetown Branch right-of-way alignment. Under the Air Rights Building, there is a direct elevator connection to the Bethesda Metro Station (south entrance). The trail is on the north side of transitway from Pearl Street east.</td><td>The transitway follows the Georgetown Branch right-of-way. There will be two bridges over Connecticut Avenue, one for the transitway, and one for the trail, as well as two new bridges over Rock Creek. The transitway and trail go under Jones Mill Road. Just west of Jones Mill Road the trail crosses to the south side of the transitway.</td><td>At the CSX corridor the transitway stays on the south side of CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets at grade.</td><td>East of Falklands Apartments the transitway crosses over CSX tracks, to arrive at the Silver Spring Transit Center.</td><td>The buses leave the CSX right-of way on Bonifant Street at grade in dedicated lanes.</td><td>Wayne Avenue in shared lanes with added left turn lanes, to Flower Avenue, then Arliss Street.</td></tr>
<tr><td rowspan="3">Alternative 5: High Investment BRT</td><td colspan="2" rowspan="3">The transitway begins with a one-way counter clockwise loop on Pearl St, East West Highway, Old Georgetown Road, with a stop at the Bethesda Metro Station (north entrance) Edgemoor Lane, and Woodmont Avenue on to Georgetown Branch right-of-way. Under the Air Rights Building, there is a direct elevator connection to the Bethesda Metro Station (south entrance). The trail is on the north side of transitway from Pearl Street east.</td><td rowspan="3">The transitway follows the Georgetown Branch right-of-way. There will be two bridges over Connecticut Avenue, one for the transitway, and one for the trail, as well as two new bridges over Rock Creek. The transitway and trail go under Jones Mill Road. Just west of Jones Mill Road the trail crosses to the south side of the transitway.</td><td rowspan="2">At the CSX corridor the transitway stays on the south side of CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets below the grade of those streets.</td><td>East of Falklands Apartments the transitway crosses over CSX tracks, to arrive at the Silver Spring Transit Center.</td><td>Tunnel from Silver Spring Transit Center to Wayne Avenue at Cedar Street</td><td>Wayne Avenue at grade in dedicated lanes, with a tunnel under Plymouth to Arliss Street.</td></tr>
<tr><td>(Design option) Aerial crossing of CSX west of Falklands Apartments with an aerial structure along Metro Plaza.</td><td colspan="2" rowspan="2">(Design option) Silver Spring/ Thayer Avenue tunnel that emerges on Thayer Avenue behind East Silver Spring Elementary School.</td></tr>
<tr><td colspan="2">(Design option) The transitway crosses to the north side of the CSX corridor in a tunnel and continues along the north side.</td></tr>
</table>

Table 2-13: Summary of TSM and BRT Build Alternatives (Continued)

University Boulevard		UM / College Park		Riverdale Park			New Carrollton			
The TSM service turns left on Piney Branch Road and then right on University Boulevard, both in shared lanes. Signal priority would be provided, where possible. Eastbound and westbound buses could use the existing right-turn lanes / shoulder (where available) to bypass queuing.		The buses pass through the University of Maryland campus on Campus Drive and cross US 1 at Paint Branch Parkway. Signal priority would be provided where possible. Westbound buses could utilize the existing right-turn lane at Paint Branch Parkway and US 1 to bypass queuing.		The TSM service follows Paint Branch Parkway and River Road in shared lanes. The buses turn right on Kenilworth Avenue in shared lanes. The buses then turn left onto East West Highway into shared lanes. Buses could utilize existing right turn lanes at MD 410 / MD 295 ramp terminals to bypass queuing. Signal priority would be provided where possible.			TSM service continues onto Veterans Parkway in shared lanes. Westbound buses could use the existing right turn along Veterans Parkway at Riverdale Road to bypass queuing.	TSM service turns left on to Annapolis Road into shared lanes.	The TSM services reach the New Carrollton Station via Harkins Road in shared lanes to arrive at the New Carrollton Metro Station.	**TSM Alternative**
										BRT
The transitway turns left on Piney Branch Road and then right on University Boulevard, both in shared lanes.		The buses pass through the University of Maryland campus on Campus Drive and cross US 1 at Paint Branch Parkway.		The transitway follows Paint Branch Parkway and River Road in shared lanes. The buses enter the College Park Metro Station at the bus loop continuing on River Road in shared lanes.	The buses turn right on Kenilworth Avenue, southbound buses in a dedicated lane, northbound in shared lanes.	The buses turn left at East West Highway into shared lanes.	They continue on Veterans Parkway in shared lanes.	Turning left on Annapolis Road, the buses are in a dedicated lane westbound, and shared lanes eastbound.	The buses turn on to Harkins Road in shared lanes to arrive at the New Carrollton Metro Station.	**Alternative 3: Low Investment BRT**
The transitway turns left on Piney Branch Road and continues in dedicated lanes.	The buses turn right on University Boulevard, in dedicated lanes. All intersections are crossed at grade	The buses pass through the University of Maryland campus in dedicated lanes on Campus Drive.	At Regents Drive (the "M") the buses travel at grade in a new exclusive transitway through the parking lots adjacent to the Armory. At East Campus, the alignment crosses US 1 at grade on Rossborough Lane.	The transitway follows Paint Branch Parkway in shared lanes and enters the College Park Metro Station at the bus loop continuing on River Road in shared lanes.	The buses turn right on Kenilworth Avenue, both directions in dedicated lanes on the west side on the roadway.	The buses turn left at East West Highway in dedicated lanes.	Veterans Parkway in shared lanes. The crossing of Annapolis Road is at grade.	The buses turn left on to Ellin Road into dedicated lanes to arrive at the New Carrollton Metro Station.		**Alternative 4: Medium Investment BRT**
		(Design Option) Campus Drive to Preinkert Drive where the alignment turns south east and continues on new alignment between LeFrak Hall and the South Campus Dining Hall. The alignment continues east on Chapel Drive then on a new alignment to Rossborough Lane where it crosses US 1 at grade.								
The transitway turns left on Piney Branch Road and continues in dedicated lanes.	The buses turn right on University Boulevard in dedicated lanes, with bridges over key intersections, and an underpass at Adelphi Road.	The buses go through the University of Maryland campus in a tunnel under Campus Drive, emerging just past the "M" at Regents Drive	At Regents Drive (the "M") the buses travel at grade in a new exclusive transitway through the parking lots adjacent to the Armory. At East Campus, the alignment crosses US 1 at grade on Rossborough Lane.	The transitway follows Paint Branch Parkway in dedicated lanes until the CSX underpass. It turns right at the College Park Metro parking garage passing through the new station development and along the south side of River Road, in dedicated lanes.	The buses enter a tunnel from River Road to East West Highway at Kenilworth Road.	The buses follow East West Highway at grade in dedicated lanes.	On Veterans Parkway the transitway is in dedicated lanes with an underpass at Annapolis Road.	The buses turn left on to Ellin Road into dedicated lanes to arrive at the New Carrollton Metro Station.		**Alternative 5: High Investment BRT**

Table 2-14: Summary of LRT Build Alternatives

	Bethesda / Chevy Chase		Silver Spring				University Boulevard	
LRT								
Alternative 6: Low Investment LRT	The alignment follows the Georgetown Branch right-of-way. The alignment starts under the Air Rights Building with a direct elevator connection to the Bethesda Metro Station (south entrance). The trail does not go under the Air Rights Building, but off the alignment through Elm Street Park. The trail is on north side of the transitway from Pearl Street east.	The transitway follows the Georgetown Branch right-of-way. The LRT and the trail cross Connecticut Avenue at grade. There would be two new bridges over Rock Creek, one for the transitway, and one for the trail. The transitway and trail go under Jones Mill Road. Just west of Jones Mill Road the trail crosses to the south side of the transitway.	At the CSX corridor the transitway stays on south side of CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets at grade.	East of Falklands Apartments the transitway crosses over CSX tracks, to arrive at the Silver Spring Transit Center.	The LRT leaves the CSX right-of way on Bonifant Street at grade in dedicated lanes.	It travels on Wayne Avenue in shared lanes, entering a tunnel after Manchester Place and continuing under Plymouth to emerge on Arliss Street.	The transitway turns left on Piney Branch Road and continues in dedicated lanes.	The LRT turns right on University Boulevard, in dedicated lanes. All intersections are crossed at grade, except there is an underpass at Adelphi Road.
Alternative 7: Medium Investment LRT	The alignment follows the Georgetown Branch right-of-way. The alignment starts under the Air Rights Building with a direct elevator connection to the Bethesda Metro Station (south entrance). The trail does not go under the Air Rights Building, but off the alignment through Elm Street Park. The trail is on north side of the transitway from Pearl Street east.	The transitway follows the Georgetown Branch right-of-way. There will be two bridges over Connecticut Avenue, one for the transitway, and one for the trail, as well as two new bridges over Rock Creek. The transitway and trail go under Jones Mill Road. Just west of Jones Mill Road the trail crosses to the south side of the transitway.	At the CSX corridor the transitway stays on south side of CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets below the grade of those streets.	East of Falklands Apartments the transitway crosses over CSX tracks, to arrive at the Silver Spring Transit Center.	The LRT leaves the CSX right-of way on Bonifant Street at grade in dedicated lanes.	Wayne Avenue in shared lanes with added left turn lanes, entering a tunnel after Manchester Place and continuing under Plymouth to emerge on Arliss Street.	The transitway turns left on Piney Branch Road and continues in dedicated lanes.	The LRT turns right on University Boulevard, in dedicated lanes. All intersections are crossed at grade except there is an underpass at Adelphi Road.
Alternative 8: High Investment LRT	This alignment starts under the Air Rights Building with a direct elevator connection to the Bethesda Metro Station (south entrance). Under the Air Rights Building the trail is in the tunnel, elevated above eastbound tracks. The trail is on the north side of the tracks between Pearl Street and just west of Jones Mill Road.	The transitway follows the Georgetown Branch right-of-way. There will be two bridges over Connecticut Avenue, one for the transitway, and one for the trail, as well as two new bridges over Rock Creek,. The transitway and trail go under Jones Mill Road. Just west of Jones Mill Road the trail crosses to the south side of the transitway.	At the CSX corridor the transitway stays on south side of CSX corridor, while the trail crosses CSX on a new bridge near Talbot Street Bridge. The transitway crosses 16th and Spring Streets below the grade of those streets.	East of Falklands Apartments the LRT crosses over CSX tracks, to arrive at the Silver Spring Transit Center.	Tunnel from SSTC to Wayne Avenue at Cedar Street	Wayne Avenue at grade in dedicated lanes, with a tunnel under Plymouth to Arliss Street.	The transitway turns left on Piney Branch Road and continues in dedicated lanes.	The trains turn right on University Boulevard in dedicated lanes, with bridges over key intersections, and an underpass at Adelphi Road.
				(Design option) Aerial crossing of CSX west of Falklands Apartments with an aerial structure along Metro Plaza.	(Design option) Silver Spring/ Thayer Avenue tunnel that emerges on Thayer Avenue behind East Silver Spring Elementary School, but with an aerial structure on a portion of Piney Branch Road.			
			(Design option) The transitway crosses to the north side of the CSX corridor in a tunnel and continues along the north side.					

Table 2-14: Summary of LRT Build Alternatives (Continued)

<table>
<tr><th colspan="3">UM / College Park</th><th colspan="3">Riverdale Park</th><th colspan="3">New Carrollton</th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>LRT</td></tr>
<tr><td>The trains pass through the University of Maryland campus in dedicated lanes on Campus Drive.</td><td>At Regents Drive (the "M") the LRT travels at grade in a new exclusive transitway through the parking lots adjacent to the Armory. At East Campus, the alignment crosses US 1 at grade on Rossborough Lane.</td><td>The LRT uses Paint Branch Parkway in shared lanes.</td><td>LRT turns right at the College Park Metro parking garage passing through the new station development and along the south side of River Road, in dedicated lanes.</td><td>The LRT turns right at Kenilworth Avenue into dedicated lanes (both directions).</td><td>The LRT follows East West Highway at grade in dedicated lanes with shared left turn lanes. Shared under BW Parkway.</td><td>On Veterans Parkway the transitway is in dedicated lanes.</td><td>Turning left on Annapolis Road, the LRT is in dedicated lanes on the south/east side of the roadway.</td><td>Turning right on Harkins Road, the LRT is in dedicated lanes on the south side of the roadway to arrive at the New Carrollton.</td><td>Alternative 6: Low Investment LRT</td></tr>
<tr><td>The trains pass through the University of Maryland campus in dedicated lanes on Campus Drive.</td><td>At Regents Drive (the "M") the LRT travels at grade in a new exclusive transitway through the parking lots adjacent to the Armory. At East Campus, the alignment crosses US 1 at grade on Rossborough Lane.</td><td rowspan="2">The LRT uses Paint Branch Parkway in shared lanes.</td><td rowspan="2">LRT turns right at the College Park Metro parking garage passing through the new station development and along the south side of River Road, in dedicated lanes.</td><td rowspan="2">The LRT turns right at Kenilworth Avenue into dedicated lanes (both directions).</td><td rowspan="2">The LRT follows East West Highway at grade in dedicated lanes with shared left turn lanes. Shared under BW Parkway</td><td rowspan="2">On Veterans Parkway in dedicated lanes. The crossing of Annapolis Road is at grade.</td><td rowspan="2" colspan="2">The LRT turns left on to Ellin Road into dedicated lanes on the southeast side of the roadway to arrive at the New Carrollton Metro Station.</td><td rowspan="2">Alternative 7: Medium Investment LRT</td></tr>
<tr><td colspan="2">(Design Option) Campus Drive to Preinkert Drive where the LRT turns south east and continues on a new alignment between LeFrak Hall and South Campus Dining Hall. The LRT continues east on Chapel Drive then on a new alignment to Rossborough Lane and it crosses US 1 at grade.</td></tr>
<tr><td>The trains go through the University of Maryland campus in a tunnel under Campus Drive, emerging just past the "M" at Regents Drive.</td><td>At Regents Drive (the "M") the LRT travels at grade in a new exclusive transitway through the parking lots adjacent to the Armory. At East Campus, the alignment crosses US 1 at grade on Rossborough Lane.</td><td>The LRT uses Paint Branch Parkway in dedicated lanes until the CSX/ Metro underpass at College Park.</td><td>LRT turns right at the College Park Metro parking garage passing through the new station development and along the south side of River Road, in dedicated lanes.</td><td>The transitway enters a tunnel from River Road to East West Highway at Kenilworth Road.</td><td>The LRT follows East West Highway at grade in dedicated lanes in the median.</td><td>On Veterans Parkway the transitway is in dedicated lanes with an underpass at Annapolis Road.</td><td colspan="2">The LRT turns left on to Ellin Road into dedicated lanes on the southeast side of the roadway to arrive at the New Carrollton Metro Station.</td><td>Alternative 8: High Investment LRT</td></tr>
</table>

2.3.3. Alternative 3 – Low Investment BRT

The Low Investment BRT (Figure 2-3) would primarily use existing streets to avoid the cost of grade separation and extensive reconstruction of existing streets. It would incorporate signal, signage, and lane improvements in certain places. This alternative would operate mostly in mixed lanes with at grade crossings of all intersections and queue jump lanes at some intersections. Southbound along Kenilworth Avenue and westbound along Annapolis Road, Low Investment BRT would operate in dedicated lanes. This is the only alternative that would operate on Jones Bridge Road, directly serving the National Institutes of Health and the National Naval Medical Center near Wisconsin Avenue and Jones Bridge Road. It is also the only alternative that would use the bus portion of the new Silver Spring Transit Center. A detailed description of the alternative follows.

From the western terminus in Bethesda, Low Investment BRT would originate at the Bethesda Metro Station bus terminal. The alignment would operate on Woodmont Avenue within the existing curb. At the Bethesda Station, the buses would enter the station via Edgemoor Road and exit onto Old Georgetown Road.

At Wisconsin Avenue, just south of Jones Bridge Road, the transitway would remain on the west side of the road in exclusive lanes in front of NIH. This alternative would then use the existing traffic signal, which would be modified to include a new signal phase to serve BRT movements, at the intersection of Wisconsin Avenue and Jones Bridge Road to turn onto Jones Bridge Road. At that intersection, a queue jump lane would be provided for westbound BRT vehicles to bypass traffic waiting to turn onto Wisconsin Avenue. The Low Investment BRT Alternative would then continue east along Jones Bridge in mixed traffic, using the existing travel lanes. At the intersection of Connecticut Avenue and Jones Bridge Road, a queue jump lane would be provided for westbound BRT vehicles. Some widening would be required at North Chevy Chase Elementary School. The alternative would then continue east along Jones Bridge Road in mixed traffic in the existing travel lanes. The alignment would continue along Jones Bridge Road to Jones Mill Road where it would turn right (south) onto Jones Mill Road. An eastbound queue jump lane would be provided at the intersection with Jones Mill Road to allow BRT vehicles to turn right onto Jones Mill Road.

From Jones Mill Road the alignment would turn east onto the Georgetown Branch right-of-way, where a new exclusive roadway would be constructed, with an adjacent trail on the south side. It would continue on the Georgetown Branch right-of-way, crossing Rock Creek Park on a new bridge, replacing the existing pedestrian bridge. The trail would be on an adjacent bridge. A trail connection to the Rock Creek Trail would be provided east of the bridge. The alignment would continue on the Georgetown Branch right-of-way until the CSX corridor at approximately Kansas Avenue. This alternative includes the construction of a permanent hiker biker trail between Jones Mill Road and Silver Spring.

At this point the alignment would turn southeast to run parallel and immediately adjacent to the CSX tracks on a new exclusive right-of-way. The trail would parallel the transitway, crossing the transitway and the CSX right-of-way east of Talbot Avenue on a new structure and continuing on the north side of the CSX right-of-way. The transitway would continue on a new roadway between the CSX tracks and Rosemary Hills Elementary School, and continue past the school. The transitway would cross 16th Street at grade, where a station would be located. This crossing would be accomplished by the installation of new traffic signals on 16th Street to accommodate the crossing of the transit vehicles. The transitway would continue parallel to the CSX tracks to Spring Street, at which point the buses turn to cross over the CSX tracks on Spring Street. A new traffic signal would be installed at Spring Street. The alignment would continue on Spring Street to 2nd Avenue where it would turn east. Buses would operate in shared lanes on Spring Street and Second Avenue.

Low Investment BRT would cross Colesville Road at grade and continue up Wayne Avenue to Ramsey Street, where the buses would turn right to enter the Silver Spring Transit Center at the second level. The buses would leave the Silver Spring Transit Center and return to Wayne Avenue via Ramsey Street. Low Investment BRT would continue east on Wayne Avenue in shared lanes.

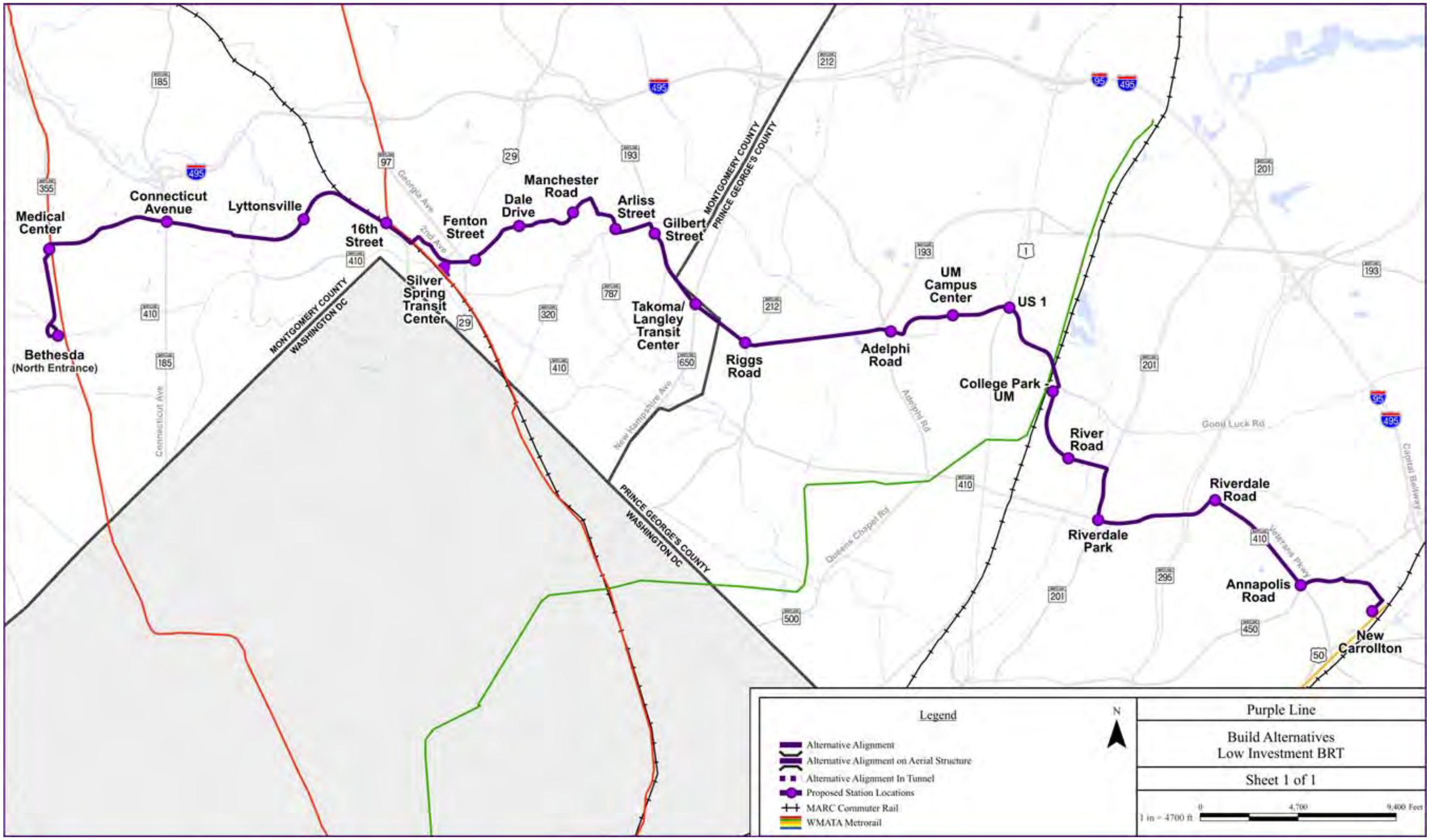
At Flower Avenue, the alignment would turn south to Arliss Street, where it would turn left onto Arliss Street, operating in shared lanes to Piney Branch Road. At Piney Branch Road the alignment would turn left to continue in shared lanes to University Boulevard. Low Investment BRT would follow University Boulevard to Adelphi Road. The lanes on University Boulevard would be shared.

At Adelphi Road the alignment would enter the University of Maryland campus on Campus Drive. The alignment would follow the Union Drive extension, as shown in the University of Maryland Facilities Master Plan (2001-2020), through what are currently parking lots. The alignment would follow Union Drive and then Campus Drive through campus in mixed traffic, and through the main gate at US 1, to Paint Branch Parkway.

Low Investment BRT would operate on Paint Branch Parkway to the College Park Metro Station in shared lanes. The transit vehicles would turn right onto River Road and access the existing bus loop at the station. The alignment would then follow River Road to Kenilworth Avenue in shared lanes.

The Low Investment BRT Alternative would then turn onto Kenilworth Avenue, which would be widened to provide one dedicated transit lane in the southbound direction. Northbound bus rapid transit vehicles would operate in mixed traffic within the existing northbound lanes on Kenilworth Avenue. This alternative would then turn left onto East West Highway, where it would operate in mixed traffic within the existing travel lanes. Continuing continues in shared lanes on Veterans Parkway. This alignment turns left on Annapolis Road. The westbound alignment on Annapolis would be dedicated, but the eastbound lanes would be shared. At Harkins Road the alignment travels in shared lanes to the New Carrollton Metro Station.

Figure 2-3: Low Investment BRT



2.3.4. Alternative 4 – Medium Investment BRT

Medium Investment BRT (Figure 2-4) is, by definition, an alternative that uses the various options that provide maximum benefit relative to cost. Most of the segments are selected from either the Low or High Investment BRT Alternatives.

This alternative follows a one-way counter-clockwise loop from the Georgetown Branch right-of-way onto Pearl Street, East West Highway, Old Georgetown Road, Edgemoor Lane, and Woodmont Avenue and from there onto the Georgetown Branch right-of-way under the Air Rights Building. The BRT stops twice at the Bethesda Metro station, once at the existing bus loop on Edgemoor Lane and again at the new southern entrance to the Metro Station under the Air Rights Building.

The alignment continues on the Georgetown Branch right-of-way with an aerial crossing over Connecticut Avenue and a crossing under Jones Mill Road.

This alignment, and all others that use the Georgetown Branch right-of-way, includes construction of a hiker-biker trail between Bethesda and the Silver Spring Transit Center.

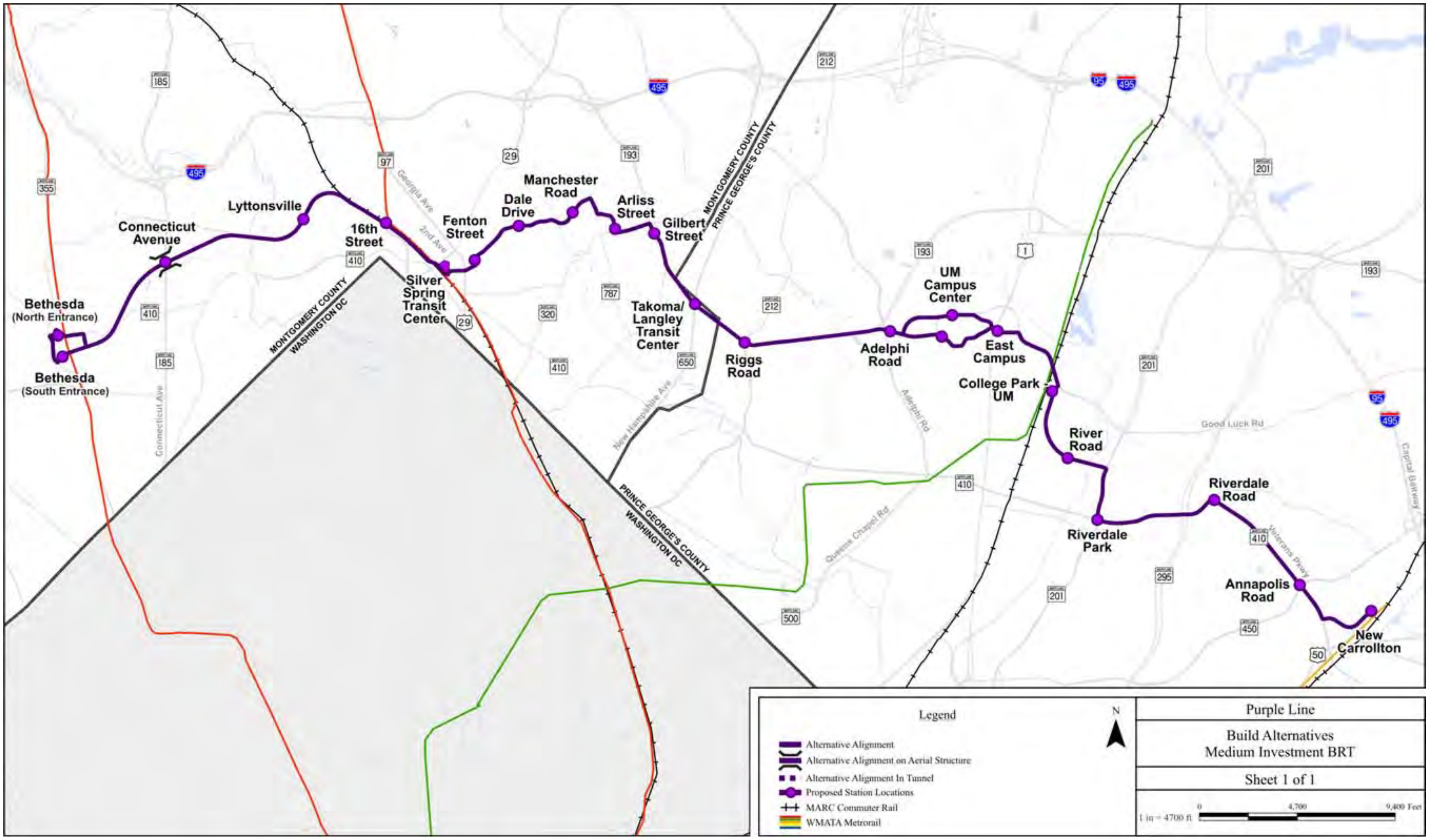
The alignment would continue on the Georgetown Branch right-of-way until the CSX right-of-way. The alignment would cross Rock Creek Park on a new bridge, replacing the existing pedestrian bridge. The trail would be an adjacent bridge. A trail connection to the Rock Creek Trail would be provided east of the bridge. The alignment would continue on the Georgetown Branch right-of-way until the CSX corridor at approximately Kansas Avenue. This segment of the alignment, from Jones Mill Road to the CSX corridor, would be the same for all the alternatives.

Like Low Investment BRT, this alternative would follow the CSX corridor on the south side of the right-of-way, but it would cross 16th Street and Spring Street at the grade of the streets, resulting in new signalized intersections.

After crossing Spring Street, the Medium Investment BRT would rise above the level of the existing development south of the CSX right-of-way. East of the Falklands Chase apartments, Medium Investment BRT would cross over the CSX tracks on an aerial structure to enter the Silver Spring Transit Center parallel to, but at a higher level than, the existing tracks.

The Medium Investment BRT Alternative would exit the Silver Spring Transit Center and turn onto Bonifant Street where it would operate at grade in dedicated transit lanes on the north side of Bonifant Street. Under this alternative, Bonifant Street, between Ramsey Street and Fenton Street, would be converted from two-way operation to one-way operation (either eastbound or westbound). On-street parking would remain along the south curb. The very low volume of westbound or eastbound traffic currently using Bonifant Street between Fenton Street and Georgia Avenue would be diverted to Thayer Avenue, one block to the south. Some minor widening of Bonifant Street is expected between Ramsey Street and Georgia Avenue, where these alternatives would cross at grade using the existing traffic signal. The slight modification would accommodate the conversion of Bonifant Street to one-way operation.

Figure 2-4: Medium Investment BRT



Just prior to Fenton Street the alignment would turn north toward Wayne Avenue. Approaching Fenton Street, these alternatives would turn left and tie into the existing signalized intersection of Fenton Street and Wayne Avenue as a new approach. The traffic signal would be modified to incorporate a new signal phase to accommodate transit movements. This alternative would then continue east, passing through Cedar Street on Wayne Avenue.

The alignment would continue on Wayne Avenue in shared lanes with added left turn lanes at the signalized intersections, to Flower Avenue and then Arliss Street. At Piney Branch Road the alternative would turn left into dedicated lanes and continue on to University Boulevard. Piney Branch Road would be widened to accommodate one new dedicated transit lane in each direction; this alternative would operate in the curb lanes, which would be shared with right-turning traffic along Piney Branch Road. The existing two-way left-turn lane between Arliss Street and Barron Street would be removed, and the unsignalized access points along this segment of Piney Branch Road would be converted to right-in /right-out access.

At University Boulevard, the Medium Investment BRT would turn right onto University Boulevard, which would be widened to accommodate one new dedicated transit lane in each direction. This alternative would operate in the curb lanes, which would also accommodate right-turn movements. Along University Boulevard, for automobile traffic, the lane configurations at the signalized intersections would remain unchanged relative to the No Build Alternative. The intersections at New Hampshire Avenue, Riggs Road, and Adelphi Road would be crossed at grade using the existing traffic signals.

After crossing Adelphi Road, this alternative would continue eastward through the University of Maryland – College Park campus on Campus Drive until reaching the ‘M’ Circle at Regents Drive. Campus Drive would be closed to through vehicle traffic between Union Lane and the ‘M’ Circle (except for other transit vehicles, emergency services, and University service vehicles), consistent with the University’s Master Plan. Automobile traffic through campus would be re-routed to Paint Branch Drive, Regents Drive, and Stadium Drive. The ‘M’ Circle would be re-configured into a pair of T-intersections. The alternative would turn slightly south and enter a new exclusive right-of-way along at grade in a new exclusive transitway through the parking lots adjacent to the Armory, behind the Visitors Center to Rossborough Lane.

Passing behind the Visitor’s Center the alignment would turn onto Rossborough Lane. This new exclusive right-of-way would intersect US 1 at grade as the fourth leg of the existing intersection of US 1 and Rossborough Lane, which will be maintained as part of the proposed East Campus Development. The alternative would then continue through the East Campus Development, along Rossborough Lane, in dedicated transit lanes to Paint Branch Parkway.

The alignment would continue on Paint Branch Parkway and River Road in shared lanes, as with Low Investment BRT. The transit vehicles would turn right onto River Road and access the existing bus loop at the station. The alignment would then follow River Road to Kenilworth Avenue in shared lanes.

At the intersection of River Road and Kenilworth Avenue, this alternative would turn into two newly constructed dedicated transit curb lanes (all widening of Kenilworth Avenue to accommodate these lanes would occur west of the existing western curb line) on Kenilworth Avenue. The signal phasing along northbound Kenilworth Avenue would be modified to eliminate potential conflicts between northbound through traffic and left-turning bus rapid transit vehicles.

The alignment would then turn left onto East West Highway and operate in dedicated curb lanes. The turn from Kenilworth Avenue to East West Highway could be accommodated with minor adjustments to the signal phasing at the intersection and some minor geometric modifications (shifting of stop bars) to accommodate the turning radius of the bus rapid transit vehicle. The alternative would continue east along East West Highway in dedicated transit lanes until reaching the diamond interchange at the Baltimore-Washington Parkway. At the intersections of the northbound and southbound off-ramps, a new signal phase would be added to allow the alternative to leave its dedicated transit lanes and enter the shared lanes beneath the Baltimore-Washington Parkway overpasses. After clearing the overpasses, the alternative would then re-enter dedicated transit curb lanes. The alignment would then turn onto Veterans Parkway in shared lanes. The alternative would then cross Annapolis Road at grade and would continue to Ellin Road before using the traffic signal at Ellin Road to turn into dedicated transit lanes (all widening along Ellin Road would occur to the south of the existing curb line). The alignment would then terminate at the New Carrollton Metro Station.

Medium Investment BRT Variations Serving the Medical Center Area

The Town of Chevy Chase has raised concerns regarding the transit service provided by the Purple Line alternatives to the National Institutes of Health and the National Naval Medical Center (NNMC). With the exception of Low Investment BRT, all the alternatives provide improved bus service between Silver Spring and NNMC as well as the option to transfer to the Metro Red Line at Bethesda to reach NNMC. Low Investment BRT provides more direct service to NNMC, but less direct service to downtown Bethesda by traveling along Jones Bridge Road to the Medical Center area and then along Woodmont Avenue to Bethesda.

Because Low Investment BRT does not have the travel time benefits afforded by Medium Investment BRT east of Jones Mill Road, the Town of Chevy Chase proposed a variation of Medium Investment BRT which uses Jones Bridge Road west of Jones Mill Road, instead of using the county–owned Master Plan alignment that goes directly to Bethesda (see Figure 2-5). This variation would include an additional stop at St. Elmo Street on Woodmont Avenue.

Another variation that would directly serve the Medical Center area would extend the service of Medium Investment BRT from the north entrance of the Bethesda Metro Station, up Woodmont to the NNMC, also including a station at St. Elmo Street (see Figure 2-6). Both variations provide the benefits of Medium Investment BRT and provide a one-seat ride to the Bethesda and NNMC.

Figure 2-5: Medium Investment BRT Using Jones Bridge Road

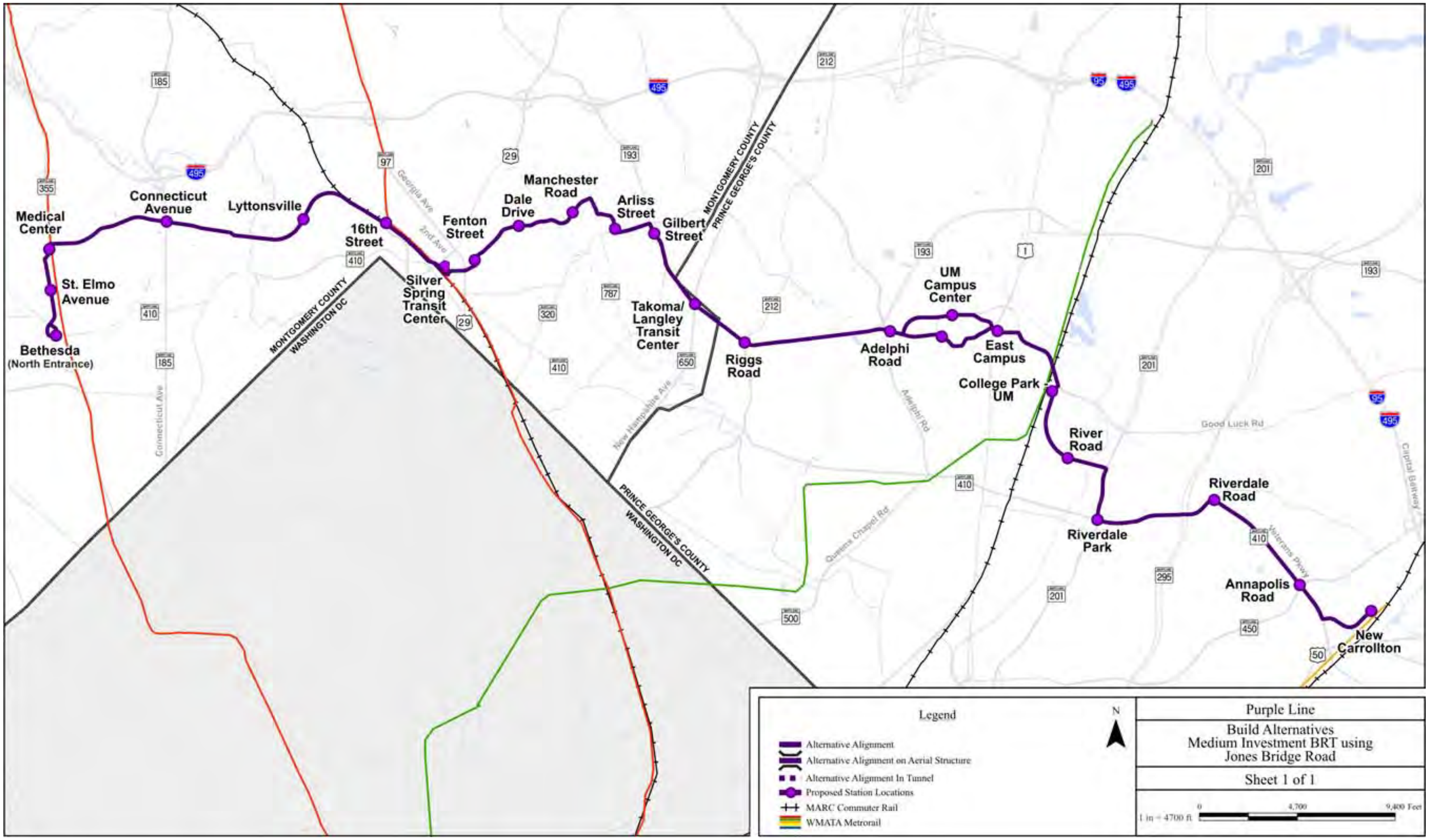
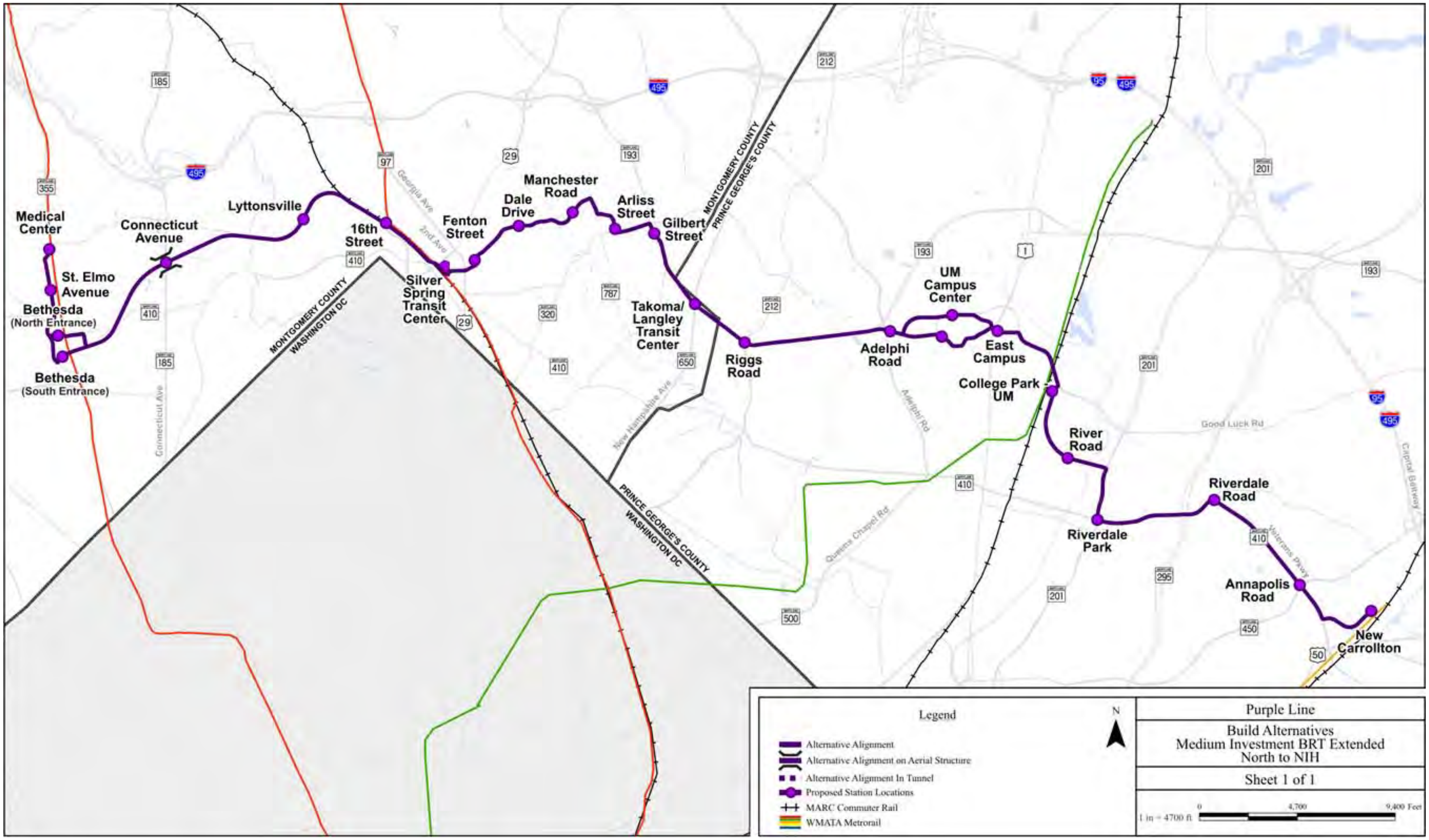


Figure 2-6: Medium Investment BRT Extended North to NIH



2.3.5. *Alternative 5 – High Investment BRT*

The High Investment BRT Alternative (Figure 2-7) is intended to provide the most rapid travel time of the BRT alternatives. It would make maximum use of vertical grade separation and horizontal traffic separation. Tunnels and aerial structures are proposed at key locations to improve travel time and reduce delay. When operating within or adjacent to existing roads, this alternative would operate primarily in dedicated lanes. Like the Medium Investment BRT this alternative that would serve the Bethesda Station both at the existing Bethesda bus terminal at the Metro station and at the new south entrance to the Metro station beneath the Apex Building.

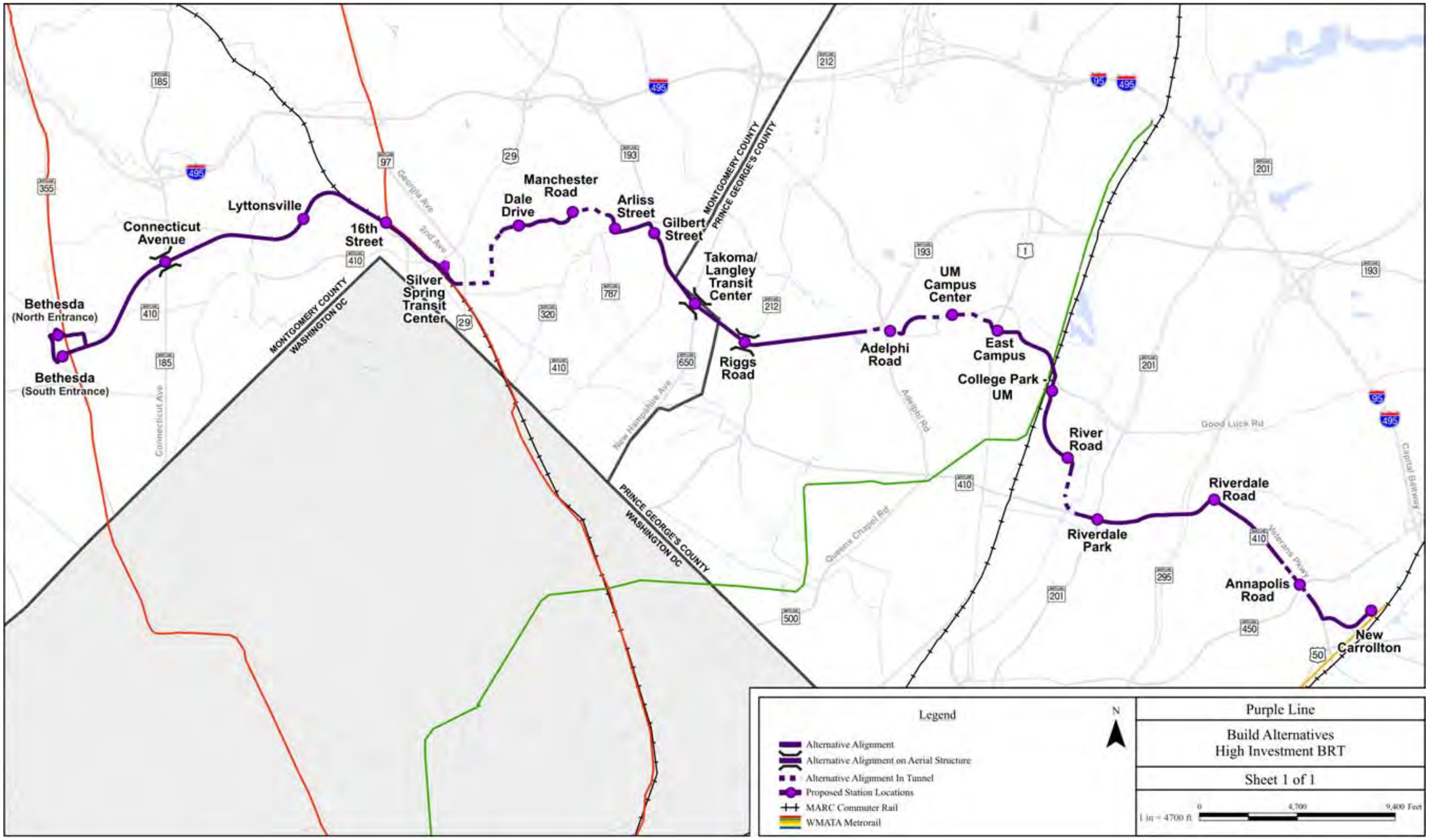
High Investment BRT would follow a one-way loop in Bethesda from the Master Plan alignment onto Pearl Street, then travel west on East West Highway and Old Georgetown Road into the Bethesda Metro Station bus terminal, exit onto Woodmont Avenue southbound, and then continue left under the Air Rights Building to rejoin the Georgetown Branch right-of-way. Elevators would provide a direct connection to the south end of the Bethesda Metro Station in the tunnel under the Air Rights Building.

The High Investment BRT alignment would be the same as Medium Investment BRT until it reaches the CSX corridor, with a bridge over Connecticut Avenue and an underpass under Jones Mill Road. As with the Low and Medium Investment BRT alternatives, this alternative would follow the CSX corridor on the south side of the right-of-way, but it would cross 16th Street and Spring Street below the grade of the streets, at approximately the same grade as the CSX tracks. The station at 16th Street would have elevators or escalators to provide access from 16th Street.

The crossing of the CSX right-of-way would be the same as for Medium Investment BRT. After passing under Spring Street, the Medium Investment BRT would rise above the level of the existing development south of the CSX right-of-way. East of the Falklands Chase apartments, Medium Investment BRT would cross over the CSX tracks on an aerial structure to enter the Silver Spring Transit Center parallel to, but at a higher level than, the existing tracks.

From the Silver Spring Transit Center, High Investment BRT would continue along the CSX tracks until Silver Spring Avenue, where the alignment would turn east entering a tunnel, passing under Georgia Avenue, and turning north under Grove Street to Wayne Avenue. The alignment would return to the surface on Wayne Avenue between Cedar Street and Dale Drive. To accommodate the tunnel portal on Wayne Avenue and provide a higher level of transit service, Wayne Avenue would be reduced from two to one travel lane in each direction. The second existing travel lane would be converted to transit-only use. All on-street parking on Wayne Avenue would be eliminated. New eastbound and westbound left-turn lanes would be provided at the existing traffic signal at Dale Drive and the westbound left-turn movement at the signalized intersection at Mansfield Road would be restricted and that traffic would be re-routed to the intersection at Dale Drive. A new eastbound left-turn lane would be added at Sligo Creek Parkway to accommodate automobile traffic.

Figure 2-7: High Investment BRT



East of Sligo Creek Parkway, Wayne Avenue would be widened by two lanes to provide a dedicated transit lane in the median in each direction. At a point 900 feet east of Sligo Creek Parkway, the High Investment BRT Alternative would turn from Wayne Avenue and enter a tunnel section beneath Plymouth Street. A new signal would be required along Wayne Avenue to allow transit vehicles to enter and exit the median of Wayne Avenue. The tunnel section would cross under Flower Avenue and return to grade along Arliss Street, just east of Flower Avenue.

The alternative would turn left onto Piney Branch Road, which would be widened to accommodate one new dedicated transit lane in each direction; the High Investment BRT Alternative would operate in the median. The existing two-way left-turn lane between Arliss Street and Barron Street would be removed, and the unsignalized access points along this segment of Piney Branch Road would be converted to right-in/right-out access.

At University Boulevard, the alternatives would turn right onto University Boulevard, which would be widened to accommodate one new dedicated transit lane in each direction. The alternative would operate in a protected median section. Along University Boulevard, for automobile traffic, the lane configurations at the signalized intersections would remain unchanged relative to the No Build Alternative. For the High Investment BRT Alternative the signal phasing for the eastbound and westbound left turns at all signalized intersections would need to be converted to protected-only phasing due to the presence of the median-running transitway. A number of existing unsignalized median breaks along University Boulevard may need to be closed to automobile traffic; new traffic signals or active warning signing will also be considered at the remaining locations. The treatment of these unsignalized intersections will be addressed in greater detail during the Preliminary Engineering phase. At the intersections at New Hampshire Avenue and Riggs Road grade-separated crossings for transit vehicles would be provided.

Approaching University of Maryland, the alignment would cross under Adelphi Road. After crossing Adelphi Road, the High Investment BRT Alternative would continue in a tunnel beneath the center of the campus. This alignment would return to grade east of Regents Drive in a new exclusive right-of-way along the south side of the campus intramural playing fields. This new exclusive right-of-way would be same as described for Medium Investment BRT. From here the alignment would be the same as Medium Investment BRT through the East campus development.

The alignment would continue east on Paint Branch Parkway in dedicated lanes. Paint Branch Parkway would be widened to provide one new dedicated transit lane in each direction, west of the existing signal at the intersection of Paint Branch Parkway and the Fire Academy. East of this intersection the transit vehicles would operate in mixed traffic within the existing travel lanes beneath the CSX overpass. To accommodate the transition from the new dedicated transit lanes to shared travel lanes, a new signal phase would be required at the Fire Academy signal to time-separate the transit and automobile movements.

The High Investment BRT would leave Paint Branch Parkway shortly after the WMATA parking garage entrance onto an exclusive right-of-way through a proposed development at the existing College Park Metro Station development site. The alternative would then follow River Road in dedicated lanes.

This alternative would turn from River Road, east of Rivertech Court, and enter a tunnel that would pass underneath an existing park and stream. This tunnel would return to grade in the median of East West Highway, just west of its existing signalized intersection with Kenilworth Avenue. This alternative would cross Kenilworth Avenue at grade and continue east along East West Highway in two new dedicated transit lanes in the median. The existing turning lane would be maintained at the signalized intersections along East West Highway; however, the signal phasing would be modified along East West Highway to convert the eastbound and westbound left turns to protected-only movements. The existing overpasses at the Baltimore-Washington Parkway would be lengthened as part of this alternative and the High Investment LRT Alternative, which would continue east and then turn right into the median of Veterans Parkway.

This alternative would then continue east in new dedicated transit lanes constructed in the existing median of Veterans Parkway and, unlike Medium Investment BRT, would pass under the intersection of Veterans Parkway and Annapolis Road. The alignment would then turn left from the median of Veterans Parkway onto Ellin Road; two new dedicated transit lanes would be constructed on the south side of Ellin Road. A new gate arm or traffic signal would be required at Hanson Oaks Court to separate automobile and transit movements at this unsignalized crossing. These alternatives would then terminate near the New Carrollton Metro Station.

2.3.6. *Alternative 6 – Low Investment LRT*

The Low Investment LRT Alternative (Figure 2-8) would operate in shared and dedicated lanes with minimal use of vertical grade separation and horizontal traffic separation. All LRT Alternatives would serve only the south entrance of the Bethesda Station and would operate there in a stub-end platform arrangement.

This alternative would begin on the Georgetown Branch right-of-way near the Bethesda Metro Station under the Air Rights Building. The hiker-biker trail connection to the Capital Crescent Trail would not be through the tunnel under the Air Rights Building, but rather through Elm Street Park on existing streets. The terminal station would be the Bethesda Metro Station with a connection to the southern end of the existing station platform.

After emerging from under the Air Rights Building, the Low Investment LRT would follow the Georgetown Branch right-of-way, crossing Connecticut Avenue at grade but crossing under Jones Mill Road. The at grade crossing of Connecticut Avenue would be accomplished by adding a new exclusive signal phase to serve LRT movements at the intersection of Connecticut Avenue and Chevy Chase Lakes Drive.

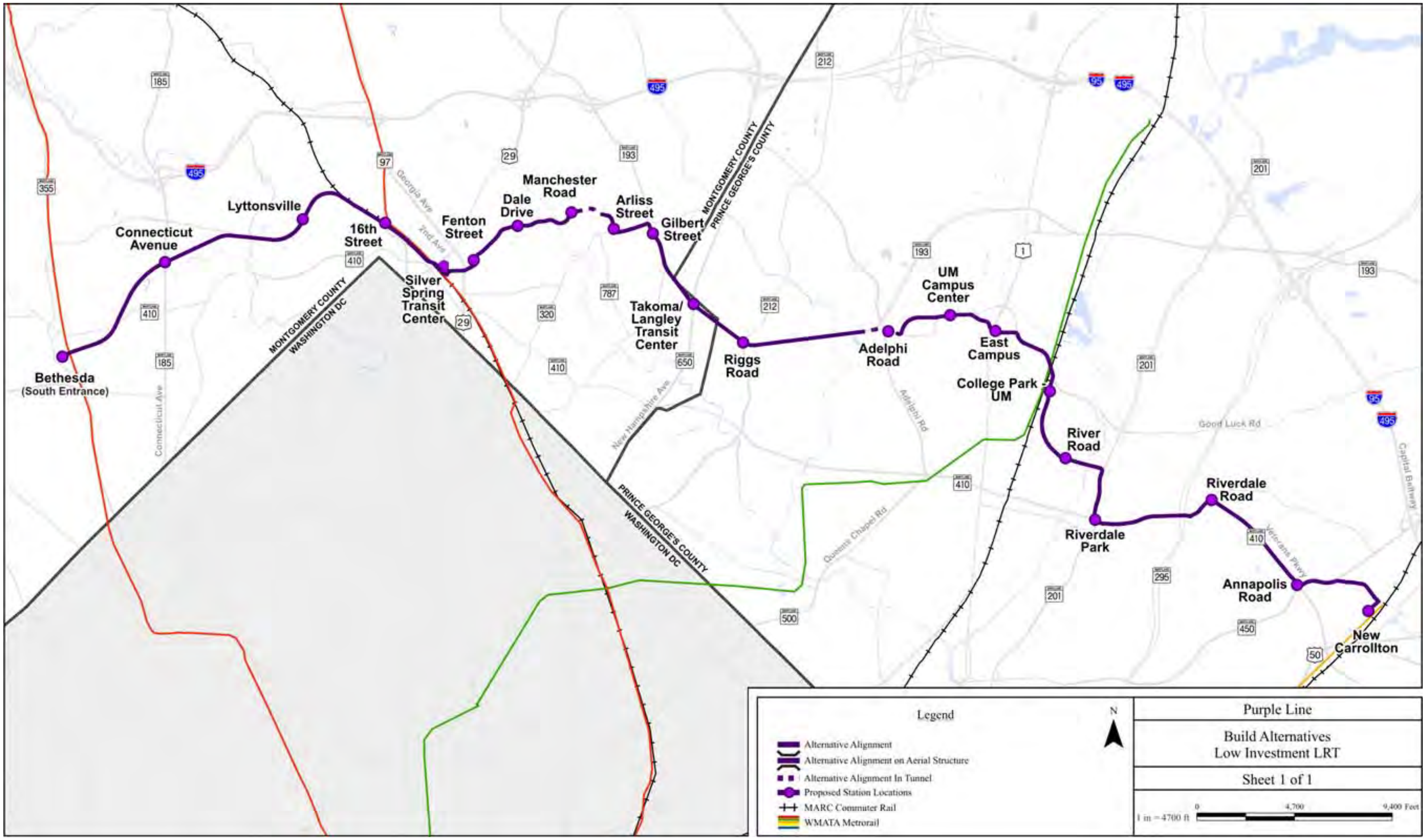
The segment from Jones Mill Road to Spring Street in the CSX corridor would be the same as for Low and Medium Investment BRT with the transitway crossing 16th and Spring Streets at grade at new signalized intersections.

After crossing Spring Street, Low Investment LRT would be the same as the Medium and High Investment BRT Alternatives, crossing the CSX right-of-way east of the Falklands Apartments and entering the Silver Spring Transit Center. This alternative would exit the Silver Spring Transit Center and turn onto Bonifant Street where it would operate at grade in dedicated transit lanes on the north side of Bonifant Street. Two-way traffic would be maintained on Bonifant Street between Georgia Avenue and Fenton Street; this would require the removal of on-street parking along the south curb of Bonifant Street.

Approaching Fenton Street, this alternative would turn left and tie into the existing signalized intersection of Fenton Street and Wayne Avenue as a new approach. The traffic signal would be modified to incorporate a new signal phase to accommodate transit movements. An exclusive westbound left turn lane for transit vehicles would be provided at Fenton Street. The Low Investment LRT would share the existing inside travel lane with left turning and through automobile traffic at Cedar Street. This alternative would then continue east, passing through Cedar Street on Wayne Avenue.

The light rail transit would function as a streetcar east of Cedar Street; the tracks for the alternative would be constructed in the existing inside travel lane in each direction along Wayne Avenue; two travel lanes would be maintained in each direction: the outside travel lanes would carry regular traffic and the inside travel lanes would carry mixed traffic (LRT and autos). The alternative would cross Sligo Creek Parkway Under this alternative the light-rail vehicles in both directions would share the inside travel lanes with left-turning and through passenger car traffic.

Figure 2-8: Low Investment LRT



At a point approximately 900 feet east of Sligo Creek Parkway, the Low Investment LRT Alternative would turn off of Wayne Avenue into a tunnel section beneath Plymouth Street because the grade of Wayne Avenue is too steep for LRT vehicles at this point. A new traffic signal would be required along Wayne Avenue at this location to permit light rail transit vehicles to enter and exit Wayne Avenue. It would return to grade along Arliss Street, just east of Flower Avenue as with High Investment BRT.

The Low Investment LRT alternative would then follow Piney Branch Road and University Boulevard at grade in dedicated lanes as described for High Investment BRT. In keeping with the low investment definition of this alternative, the major intersections of New Hampshire Avenue and Riggs Road would not be grade-separated.

As this alternative approaches Adelphi Road, the grade of the existing roadway is too steep for the type of LRT vehicles being considered so the transitway would cross the intersection below grade.

At Adelphi Road, the alignment would enter the University of Maryland campus on Campus Drive. After crossing Adelphi Road, this alternative would continue eastward through the University of Maryland campus on Campus Drive until reaching the 'M' Circle at Regents Drive. Campus Drive would be closed to through vehicle traffic between Union Lane and the 'M' Circle (except for other transit vehicles, emergency services, and University service vehicles), consistent with the University's Master Plan. Automobile traffic through campus would be re-routed to Paint Branch Drive, Regents Drive, and Stadium Drive. The 'M' Circle would be re-configured into a pair of T-intersections. The alternative would turn slightly south and enter a new exclusive right-of-way along at grade in a new exclusive transitway through the parking lots adjacent to the Armory, behind the Visitors Center to Rossborough Lane. This segment of the alignment is the same as Medium Investment BRT.

Crossing US 1 at grade, Low Investment LRT would pass through the East Campus development on Rossborough Lane to Paint Branch Parkway. The alignment would continue on Paint Branch Parkway in shared lanes. The Low Investment LRT would leave Paint Branch Parkway shortly after the WMATA parking garage entrance onto an exclusive right-of-way through the proposed development at the existing College Park Metro Station.

The alignment would exit the College Park Metro Station and continue in a new exclusive right-of-way returning to dedicated lanes on the south side of River Road. This exclusive right-of-way would turn at Kenilworth Avenue and continue parallel to, and west of, Kenilworth Avenue. The tracks for the alternative would cross the western leg of the intersection of Rittenhouse Street at grade, making use of the existing traffic signal to provide time separation; the signal phasing at Rittenhouse Street would be modified to convert the northbound and southbound left turns to protected-only phasing. Two new gate arms would be required at Quesada Road and Quintana Street to prohibit unsignalized automobile movements when light rail vehicles are approaching.

The alignment would then turn left from Kenilworth Avenue into two dedicated transit lanes in the median of East West Highway. To accommodate these two dedicated median transit lanes, East West Highway would be restriped to eliminate the existing two-way left-turn lane and the existing parking lanes along the north and south curb lanes. The existing signal phasing at the signalized intersections at Mustang Drive and 64th Place would not be modified; however, the left-turn movements from East West Highway would be made from the new median transit lanes, which would be shared for a short distance upstream of these intersections. The alternative would continue east along East West Highway in dedicated transit lanes until reaching the diamond interchange at the Baltimore-Washington Parkway. At the existing signalized intersections of the northbound and southbound MD 295 off-ramps, a new signal phase would be added.

On Veterans Parkway the LRT would be in dedicated lanes in the median.

As for Low Investment BRT, this alignment turns left on Annapolis Road from Veterans Parkway and then right on Harkins Road to the New Carrollton Metro Station, however the lanes on Annapolis would be dedicated in both directions as would the lanes on Harkins Lane.

2.3.7. *Alternative 7 – Medium Investment LRT*

The Medium Investment LRT Alternative (Figure 2-9) is a composite of elements from the Low and High LRT Investment Alternatives. The Medium Investment LRT Alternative incorporates those lower cost features for segments of the Low Investment LRT Alternative that perform reasonably and those of the High Investment LRT Alternative that provide reasonable benefits relative to their higher costs. The principal incremental change for the Medium Investment LRT Alternative is the introduction of several grade separations at major roadways and more dedicated sections along roadways; however, it does not include some of the longer tunnel sections in East Silver Spring or through the University of Maryland as included under the High Investment LRT.

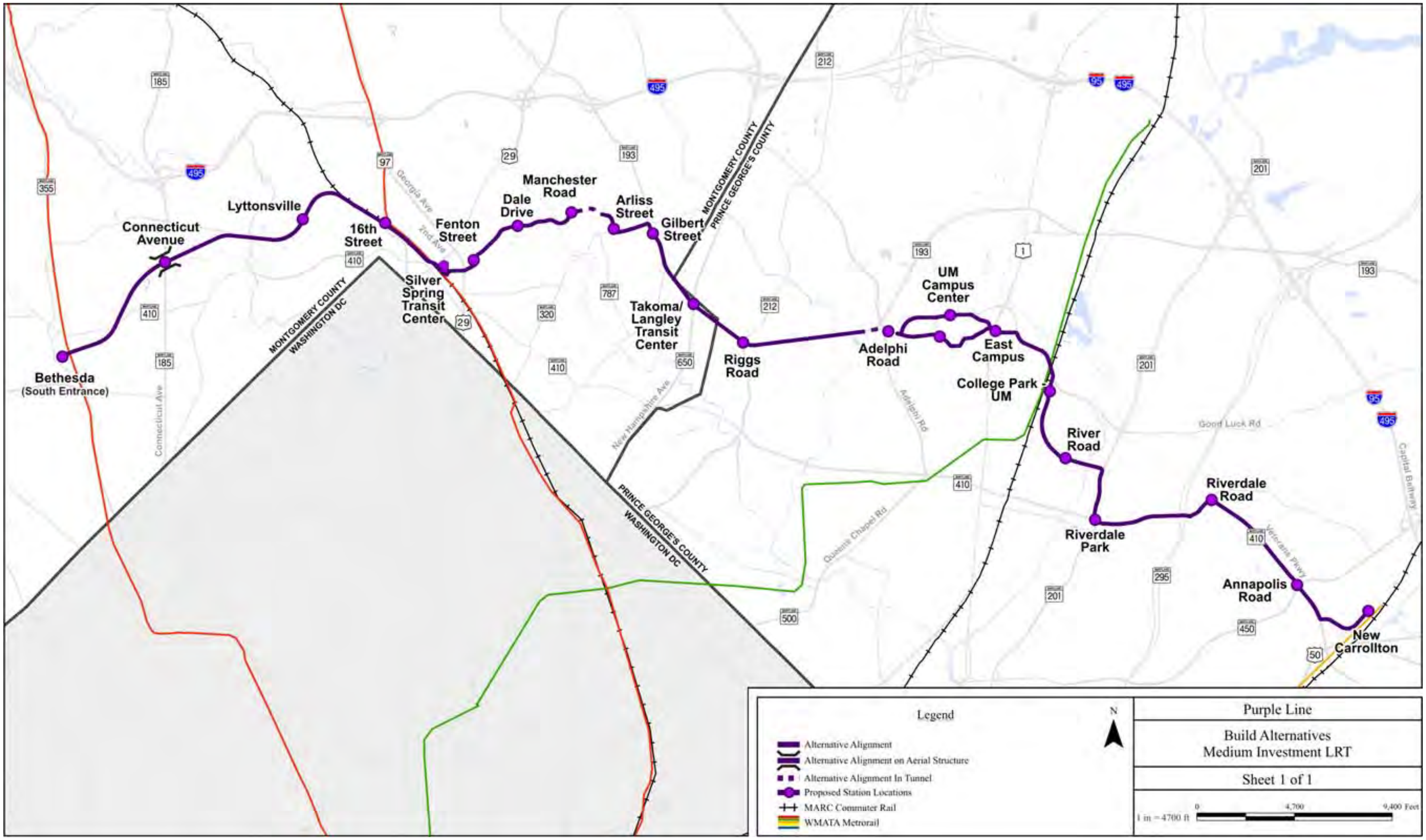
Medium Investment LRT is the same as Low Investment LRT from Bethesda to the CSX corridor, following the Georgetown Branch right-of-way, except that the alignment and the trail would cross over Connecticut Avenue on an aerial structure. As noted earlier, the construction of a permanent hiker–biker trail between Bethesda and Silver Spring is included.

Along the CSX corridor the alignment would be the same as High Investment BRT, grade-separated (below) at 16th and Spring Streets. The alignment would be the same as Medium and High Investment BRT and Low Investment LRT from Spring Street crossing the CSX corridor east of the Falklands Apartments, through the Silver Spring Transit Center.

From the Silver Spring Transit Center the Medium Investment LRT Alternative would turn onto Bonifant Street where it would operate at grade in dedicated transit lanes on the north side of Bonifant Street. Under this alternative, Bonifant Street, between Ramsey Street and Fenton Street, would be converted from two-way operation to one-way operation (either eastbound or westbound). On-street parking would remain along the south curb. The very low volume of westbound or eastbound traffic currently using Bonifant Street between Fenton Street and Georgia Avenue would be diverted to Thayer Avenue, one block to the south. Some minor widening of Bonifant Street is expected between Ramsey Street and Georgia Avenue, where these alternatives would cross at grade using the existing traffic signal. The slight modification would accommodate the conversion of Bonifant Street to one-way operation.

Approaching Fenton Street, these alternatives would turn left and tie into the existing signalized intersection of Fenton Street and Wayne Avenue as a new approach. The traffic signal would be modified to incorporate a new signal phase to accommodate transit movements. This alternative would then continue east, passing through Cedar Street on Wayne Avenue. Wayne Avenue would be widened by one lane between Cedar Street and Fenton Street to accommodate an exclusive westbound left-turn lane for transit vehicles at Fenton Street and a new eastbound left-turn bay for automobile traffic at Cedar Street.

Figure 2-9: Medium Investment LRT



The LRT would function as a streetcar east of Cedar Street; the tracks would be constructed in the existing inside travel lane in each direction along Wayne Avenue; two travel lanes would be maintained in each direction: the outside travel lanes would carry regular traffic and the inside travel lanes would carry mixed traffic (LRT and autos). At the existing signalized intersection at Dale Drive, a new left-turn lane for automobile traffic would be provided in the eastbound and westbound directions. If a station is provided to the east of Dale Drive, then a westbound left-turn lane would not be provided due to engineering constraints. Instead, a dedicated pedestrian pathway would be constructed in the median to allow pedestrians to safely access the station using the signalized crossings at Dale Drive.

For the Medium LRT Alternative, new eastbound and westbound left turn lanes would be provided at Sligo Creek Parkway. East of Sligo Creek Parkway, Wayne Avenue would be widened by two lanes to provide two dedicated transit lanes in the median. At a point approximately 900 feet east of Sligo Creek Parkway, the alternative would turn off of Wayne Avenue into a tunnel section beneath Plymouth Street. A new traffic signal would be required along Wayne Avenue at this location to permit light rail transit vehicles to enter and exit Wayne Avenue. It would return to grade along Arliss Street, just east of Flower Avenue and continue in dedicated lanes on Piney Branch Road as described for High Investment BRT.

At University Boulevard, the alternative would turn right onto University Boulevard, which would be widened to accommodate one new dedicated transit lane in each direction. The alternative would operate in a protected median section. Along University Boulevard, for automobile traffic, the lane configurations at the signalized intersections would remain unchanged. The treatment of these unsignalized intersections will be addressed in greater detail during the Preliminary Engineering phase. The intersection at Adelphi Road would be grade-separated. This segment is that same as Low Investment LRT.

At Adelphi Road, the alignment would enter the University of Maryland campus on Campus Drive. The alignment would follow the Campus Drive alignment to the College Park Metro Station via Rossborough Lane, as described for Medium Investment BRT and Low Investment LRT. After crossing Adelphi Road, this alternative would continue eastward through the University of Maryland campus on Campus Drive until reaching the ‘M’ Circle at Regents Drive. Campus Drive would be closed to through vehicle traffic between Union Lane and the ‘M’ Circle (except for other transit vehicles, emergency services, and University service vehicles), consistent with the University’s Master Plan. Automobile traffic through campus would be re-routed to Paint Branch Drive, Regents Drive, and Stadium Drive. The ‘M’ Circle would be re-configured into a pair of T-intersections. The alternative would turn slightly south and enter a new exclusive right-of-way along at grade in a new exclusive transitway through the parking lots adjacent to the Armory, behind the Visitors Center to Rossborough Lane. This segment of the alignment is the same as Medium Investment BRT.

Crossing US 1 at grade, Medium Investment LRT would pass through the East Campus development on Rossborough Lane to Paint Branch Parkway.

Leaving the East Campus development on Paint Branch Parkway it would be in dedicated lanes, except under the CSX/metro tracks at the College Park Metro Station as described for High Investment BRT. The Medium Investment LRT would follow River Road, Kenilworth Avenue, East West Highway, and Veterans Parkway in dedicated lanes as described for Low Investment LRT.

At the intersection of Veterans Parkway and Annapolis Road the LRT would cross Annapolis Road at grade, turning left at Ellin Road still in dedicated lanes.

2.3.8. *Alternative 8 – High Investment LRT*

The High Investment LRT Alternative (Figure 2-10) would be exactly the same as the High Investment BRT Alternative, except for the Bethesda terminus. The alignment would begin just west of the tunnel under the Air Rights Building. The hiker-biker trail would follow the alignment through the tunnel under the Air Rights Building. Because of physical constraints, the trail would be elevated above the westbound tracks. The trail would return to grade as it approaches Woodmont Avenue. The terminal station would be the Bethesda Metro Station with a connection to the southern end of the existing station platform.

High Investment LRT is intended to provide the most rapid travel time of the LRT alternatives. It would make maximum use of vertical grade separation and horizontal traffic separation. Tunnels and aerial structures are proposed at key locations to improve travel time and reduce delay. When operating within or adjacent to existing roads, this alternative would operate primarily in dedicated lanes. High Investment LRT would be the same as the High Investment BRT Alternative, except for the Bethesda terminus. The alignment would begin just west of the tunnel under the Air Rights Building. The hiker biker trail would follow the alignment through the tunnel under the Air Rights Building. Because of physical constraints, the trail would be elevated above the westbound tracks. The trail would return to grade as it approaches Woodmont Avenue. The terminal station would be the Bethesda Metro Station with a connection to the southern end of the existing station platform.

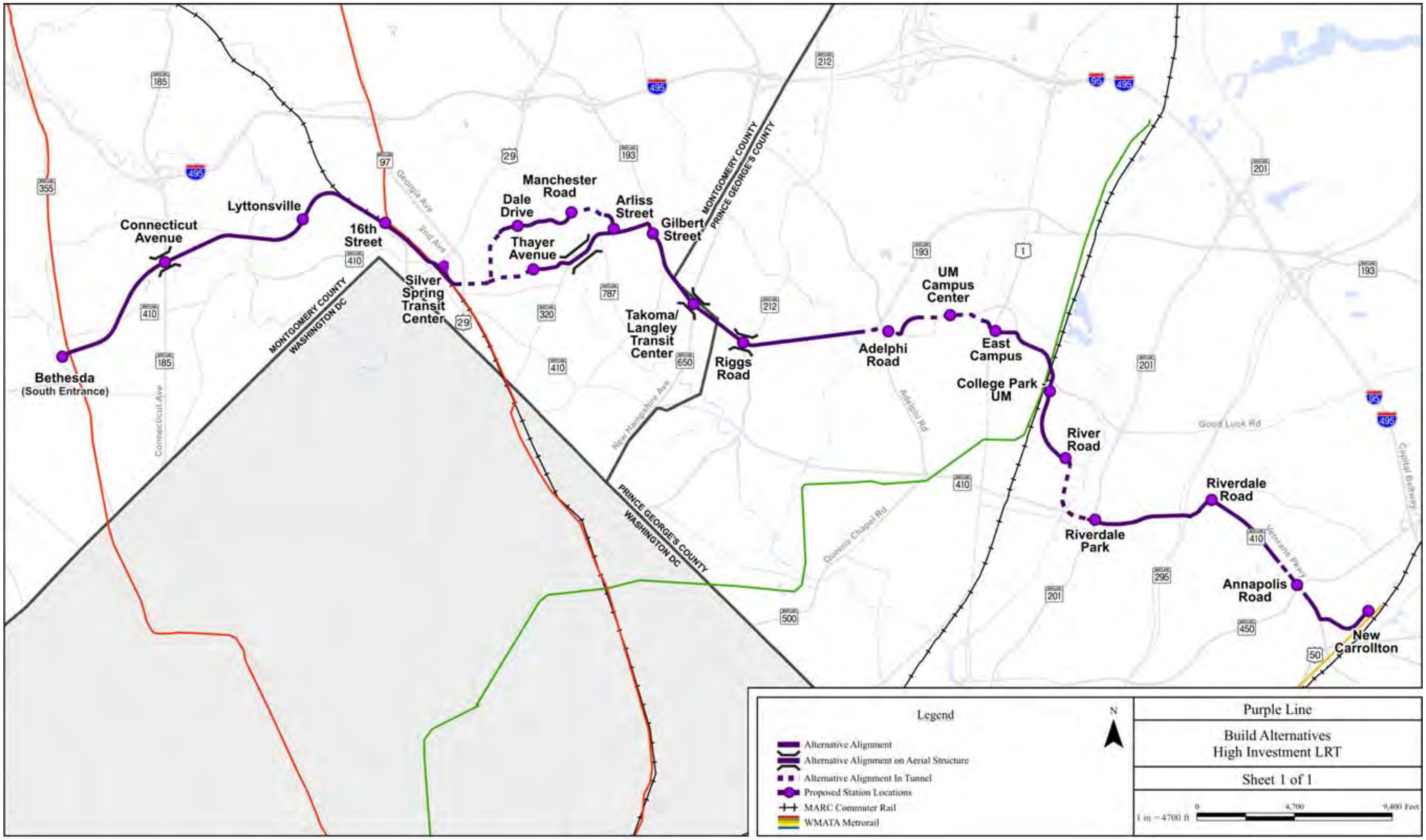
High Investment LRT would begin under the Air Rights Building on the Georgetown Branch right-of-way. Elevators would provide a direct connection to the south end of the Bethesda Metro Station in the tunnel under the Air Rights Building.

The High Investment LRT alignment would be the same as Medium Investment LRT until it reaches the CSX corridor. As with the other alternatives, this alternative would follow the CSX corridor on the south side of the right-of-way, and like Medium Investment LRT, it would cross 16th Street and Spring Street below the grade of the streets, at approximately the same grade as the CSX tracks. The station at 16th Street would have elevators and escalators to provide access from 16th Street.

The crossing of the CSX right-of-way would be the same as for Medium Investment LRT. From the Silver Spring Transit Center, High Investment LRT would continue along the CSX tracks until Silver Spring Avenue, where the alignment would turn east entering a tunnel, passing under Georgia Avenue, and turning north to Wayne Avenue. The alignment would return to the surface on Wayne Avenue near Cedar Street. It would continue on Wayne Avenue in dedicated lanes, crossing Sligo Creek Parkway, and entering a tunnel approximately half-way between Sligo Creek and Flower Avenue, then turning east to pass under Plymouth Street, crossing under Flower Avenue, and emerging from the tunnel on Arliss Street.

High Investment LRT would be the same as Medium Investment LRT on Piney Branch Road and University Boulevard except that the alignment would have grade-separated crossings over New Hampshire Avenue and Riggs Road.

Figure 2-10: High Investment LRT



Approaching University of Maryland, the alignment would cross under Adelphi Road. After Adelphi Road the alignment would follow Campus Drive and turn onto the proposed Union Drive extended. The alignment would enter a tunnel while on Union Drive, prior to Cole Field House, and pass through the campus under Campus Drive. After emerging from the tunnel east of Regents Drive, the alignment would be the same as Medium Investment LRT until Paint Branch Parkway, crossing US 1 at grade; it would pass through the East Campus development on Rossborough Lane to Paint Branch Parkway.

The alignment would continue east on Paint Branch Parkway in shared lanes to the College Park Metro Station. The LRT would enter the College Park Metro Station next to the existing parking garage.

The alternative would then follow River Road in dedicated lanes on the south side of the road. From River Road near Haig Drive, the alternative would turn right and enter a tunnel heading south, roughly parallel to Kenilworth Avenue. Near East West Highway (MD 410), the alignment would turn left and continue in the tunnel under Anacostia River Park. The alignment would transition to a surface alignment west of the Kenilworth Avenue/East West Highway intersection. The alternative would follow East West Highway in dedicated lanes.

High Investment LRT would turn right down Veterans Parkway in dedicated lanes. Unlike Medium Investment LRT, this alternative would cross under Annapolis Road before continuing on Ellin Road to the New Carrollton Metro Station.

2.3.9. *Design Options*

North Side of CSX Design Option

This design option is based on the Georgetown Branch Master Plan. From the eastern end of the Georgetown Branch right-of-way the alignment would cross under the CSX corridor and then continue down the north side of the corridor. It would emerge from the tunnel near Lyttonsville Road in Woodside. The alignment would be below the grade of 16th Street, passing under the bridge, but providing a station at that location. It would also pass under the Spring Street bridge but would begin to rise on an aerial structure over the CSX right-of-way 1,000 feet northwest of Colesville Road due to the location of the Metro Plaza building. The aerial structure over the CSX right-of-way would provide the required 23-foot clearance from top of rail to bottom of structure. The alternative would enter the Silver Spring Transit Center parallel to, but at a higher level than, the existing tracks. The original Georgetown Branch Master Plan was for a four-mile single track transitway. The expansion of the project to 16 miles made the use of single track operationally problematic. A double track alignment has substantial differences due to the physical constraints of this section of the corridor. Compounding this was the fact that the CSXT Corporation expanded the width of the separation they required from the center line of their track to a crash wall between other uses. This required separation had been 15 feet but was expanded to 25 feet in 2001.

South Side of CSX with a crossing west of the Falklands Apartments Design Option

This option would operate on the south side of the CSX, as described either at or below grade at 16th Street. The alignment would cross the CSX corridor between Spring Street and Fenwick Lane. This option would continue along the north side of the CSX right-of-way on an aerial structure over the CSX right-of-way 1,000 feet northwest of Colesville Road, due to the location of the Metro Plaza building. The aerial structure over the CSX right-of-way would provide the required 23-foot clearance from top of rail to bottom of structure. The alternative would enter the Silver Spring Transit Center parallel to, but at a higher level than, the existing tracks.

Silver Spring/Thayer Avenue Design Option

This design option is being considered for the High Investment BRT and LRT alternatives only. It would begin at the Silver Spring Transit Center where the alignment leaves the CSX corridor near Silver Spring Avenue. It would enter a tunnel on Silver Spring Avenue passing under Georgia Avenue and Fenton Street. At approximately Grove Street, the alignment would shift northward to continue under the storm drain easement and backyards of homes on Thayer and Silver Spring Avenues. The transitway would emerge from the tunnel behind the East Silver Spring Elementary School on Thayer Avenue and follow Thayer Avenue across Dale Drive to Piney Branch Road. If the mode selected were LRT, the grade of Piney Branch Road would require an aerial structure from west of Sligo Creek and Sligo Creek Parkway and would return to grade just west of Flower Avenue. This aerial structure requires that the road be widened. For this design option, a station would be located on Thayer Avenue where the alignment would emerge from the tunnel.

University of Maryland Campus via Preinkert/Chapel Drive Design Option

Preinkert Drive is being evaluated as a design option for the Medium Investment BRT and LRT alternatives through the campus of the University of Maryland. The alignment would run from the west on Campus Drive turning right onto Preinkert Drive where it would head southeast. The transitway would turn left to pass directly between LeFrak Hall and the South Dining Campus Hall and then northeast through the Lot Y parking lot. From there, the alignment would run east along Chapel Drive between Memorial Chapel and Marie Mount Hall and eventually would pass to the south of Lee Building at Chapel Fields. The alignment would continue onto Rossborough Lane, passing directly north of Rossborough Inn to cross US 1, and continues east through the East Campus development.

2.3.10. Ancillary Facilities

Stations and Station Facilities

Table 5 provides the station locations, the markets served, and the connecting transit service at each station.

Stations would include shelters, lighting, ticket vending machines, and possibly landscaping and benches, where appropriate. Intelligent Transportation Systems would be used to provide real-time information on transit services at the stations. The station platforms would be approximately 200 feet long and ten feet wide. The stations would usually be incorporated into the existing sidewalks, except where large ridership necessitates a wider platform. Where stations are in the median of a roadway they would likely be 12 to 15 feet wide to provide a greater sense of comfort for transit passengers. Although the actual design of the stations is not part of this stage of the project, the station design would make it readily identifiable as serving the Purple Line.

No new park-and-ride facilities would be constructed as part of the Purple Line. Parking garages exist near the Bethesda and Silver Spring Metro Stations, and at the College Park and New Carrollton Metro Stations.

Additional kiss-and-ride facilities would be considered at the following stations: Connecticut Avenue at the Georgetown Branch right-of-way and Lyttonsville. Silver Spring Transit Center, College Park, and New Carrollton already have kiss-and-ride parking facilities available and the Purple Line would not add more. It has been determined that kiss-and-ride facilities are not needed at the Takoma/Langley Transit Center.

Maintenance and Storage Facilities

LRT and BRT both require maintenance and storage facilities; however, the requirements in terms of location and size are not the same. LRT requires a facility located along the right-of-way while a BRT facility can be located elsewhere. Depending on the construction phasing and mode chosen, two maintenance facilities (one in Montgomery County and one in Prince George's County) are ideal.

The size of the facility depends on the number of vehicles required. A fleet of 40 to 45 LRT vehicles (including spares) would require approximately 20 acres. A BRT facility for the Purple Line would generally require facilities of similar size. The Purple Line would also require storage for non-revenue vehicles and equipment such as: maintenance, supervisory, and security vehicles.

Activities at the maintenance facility would include:

- Vehicle Storage area (tracks for LRT)
- Inspection/Cleaning
- Running Repairs
- Maintenance/Repair
- Operations/Security
- Parking
- Materials/Equipment Storage

Two sites improve operations by providing services and storage near the ends of the alignment. It is possible to have one site provide the majority of the services and the other function as an auxiliary site.

Existing Bus Maintenance Facilities

BRT requires a garage facility; however, this need could possibly be met by sharing an existing bus garage.

The following documents the current capacity, future capacity, and expansion plans at each of the identified bus facilities. Currently, WMATA, Montgomery County, and Prince George's County provide bus service within the corridor. These three agencies operate and maintain the Metrobus, Ride On, and TheBus, respectively. The sections below summarize which agencies have bus maintenance facilities in or around the corridor, the location of each facility, and current and future capacity issues.

WMATA

WMATA has two bus maintenance facilities located near the corridor that service Metrobus – the Landover Bus Garage at 3433 Pennsy Drive, Landover, and the Montgomery Bus Garage at 5400 Marinelli Road, Rockville. These maintenance facilities are located on either end of the corridor. Characteristics of these two facilities are described below.

The Landover bus facility is in Landover approximately 2 miles northeast of the New Carrollton Station. The facility is approximately 58,800 square feet in size and can accommodate up to 250 buses. According to 2006 numbers, the facility currently maintains and stores 167 buses, although WMATA reports describe the facility as being "fully utilized." The majority of buses stored at this facility are diesel-propelled coaches, 40 foot and under in length. The Montgomery bus facility is located in Rockville approximately 5 miles north of the Bethesda Station. The facility is approximately 65,000 square feet in size and can accommodate up to 250 buses. According to 2006 numbers, the facility currently maintains and stores 163 buses but, like the Landover Garage, is described as being "fully utilized." The majority of buses stored at this facility are diesel-propelled coaches, 60 foot and under in length.

Montgomery County – Ride On

Montgomery County has one bus maintenance facility in Lyttonsville to service its Ride On vehicles. This facility is adjacent to the Georgetown Branch right-of-way on Brookville Road and currently maintains 140 buses with projections of reaching 150 buses in the very near future. This facility sits on 50 to 60 acres and has a cross discipline of uses, including highway services, a fueling facility, and salt domes. This facility maintains a variety of 40-foot low-floor buses, including a small percent of 40-foot hybrid buses, 35-foot and 30-foot buses. The bus facility has a bus wash but does not have pull through bus maintenance bays, which would make maintenance on a 60-foot articulated bus difficult.

Montgomery County does plan to build a new bus maintenance facility in 2012-2013 in Clarksburg. However, Clarksburg is over 20 miles from Bethesda, which is too far to serve the Purple Line.

Prince George's County – TheBus

Prince George's County does not have a bus maintenance facility close to the corridor. The closest maintenance facility is in Forestville south of Largo, ten miles south of New Carrollton. This facility currently maintains and stores approximately 90 buses, which is about half of its designed capacity. The maintenance facility is not expected to reach capacity until at least 2012.

Purple Line Maintenance and Storage Facility Sites

A site for a maintenance and storage facility has been identified on Brookville Road in the Lyttonsville area in Montgomery County where the County's Ride On buses and school buses are currently serviced. The Purple Line would require the use of some additional adjacent property. This site could serve either BRT or LRT.

In Prince George's County, a site has been identified on the south side of Veterans Parkway near the West Lanham Shopping Center. This site, the Glenridge Maintenance Facility, is owned by M-NCPPC and currently being used as a maintenance facility for park vehicles.

These two sites provide sufficient capacity for either BRT or LRT operations; and are well located near either end of the alignment.

Several other sites were evaluated. These sites are:

Rivertech Court – This site, off River Road was considered for a maintenance and storage facility. Initially suggested to the MTA by the University of Maryland, the University later announced its intention to sell the property to developers making it no longer available to the MTA.

North Veterans Parkway – This site, located on the north side of Veterans Parkway, is heavily wooded with over 23 acres of forest. The site includes approximately 380 linear feet of streams and 21 acres of highly erodible soils. Because the site includes steep grades it would require extensive grading. This site has substantial environmental impacts and because of the required grading and retaining walls, a high cost. For this reason it was dropped from further consideration.

MTA New Carrollton Property – This site is property owned by the MTA on the east side of the New Carrollton Metro Station. This site includes over two acres of wetlands and 1500 linear feet of streams. In addition it is not particularly conveniently located because it would require the Purple Line to pass under or around the New Carrollton Metro Station. While there is support for extending the Purple Line farther east, and the present project is being planning not to preclude such a future extension, this site would have major costs due to its location east of the New Carrollton Station and tracks. Because of this and because of the substantial water resource impacts, this site was dropped from further consideration.

Haig Court – located on River Road at Haig Court. This site would have only required minimal grading but it includes over 7 acres of forest. It is also very close to the residential neighborhood of Riverdale Park, which is a historic district. This site was dropped from further consideration because of concern about impacts to the community.

Traction Power Substations

Light rail's electric traction power system requires electrical substations approximately every 1.25 miles depending on the frequency and size of the vehicles. These substations, which are approximately 10 feet by 40 feet, do not need to be immediately adjacent to the tracks. This flexibility means the substations can be located to minimize visual intrusions and they can be visually shielded, either by fencing, landscaping, or walls, or they can be incorporated into existing buildings. The number and location of these substations will be determined during the preliminary engineering phase of project development.

The LRT would be powered by an overhead electrical system. This system would include overhead wires used to power the vehicles, poles to support the wires and the traction power substations described above. The overhead wire technology selected by the MTA would be a trolley wire. Trolley wire is a single wire system suspended by poles 17 to 22 feet about the street over each track. The poles would be located either between the two tracks, or on either side of the roadway, depending on the configuration of the alternative at that particular location. The poles are typically located every 100 to 120 feet. Where curves are sharp the poles and support wires would need to be more closely spaced.

Appendix A

Metrorail Loop Proposal Alignment Evaluation

Bi-County transitway

METRORAIL LOOP PROPOSAL

Alignment Evaluation

March 2005

MTA Maryland

INTRODUCTION

The Metrorail Loop proposal calls for a Metrorail connection from the existing Medical Center/National Institute of Health (NIH) Metrorail Station in Bethesda north via a tunnel under the Capital Beltway and along the north side of the Beltway primarily on aerial structure, and crossing back over the Beltway and continuing south along the CSX corridor either in a retained cut or in tunnel to the Silver Spring Transit Center (See Figure 1).

BACKGROUND & PLANNING PROCESS

- MTA's 1996 Georgetown Branch Transitway/Trail Major Investment/Draft Environmental Impact Statement and SHA/MTA's 2002 Capital Beltway/Purple Line Corridor Transportation Study both examined a range of transportation alternatives between Bethesda and Silver Spring. Heavy rail alternatives along the beltway were not recommended by either study because they were determined not to meet the Purpose and Need and because of the high cost of heavy rail.

- In 2000 the General Assembly requested a Joint Chairman's Report evaluating an underground tunnel for the entire Georgetown Branch from Bethesda to Silver Spring. The report included a cost/benefits analysis of the several surface and tunnel alternatives, including Metrorail (heavy rail transit) option. The report determined that a heavy rail transit tunnel alternative would be extremely costly to construct, particularly relative to surface LRT, and would provide only minimal ridership gains; therefore a tunnel alignment was not justifiable from cost and cost-effectiveness perspectives and should not be considered further.

- In April 2002, MTA began the preparation of a Supplemental DEIS (SDEIS) for the Georgetown Branch. This study did not consider heavy rail because of its rejection by the previous studies.

- In the fall of 2002, a new project study was initiated, the Purple Line East, which proposed light rail service from Silver Spring to New Carrollton. Heavy rail transit was not included in the alternatives to be considered because of the finding of the previous SHA/MTA's 2002 Capital Beltway/Purple Line Corridor Transportation Study.

- In early January 2003, the staff of WMATA suggested an alternative to join the two sides of the Metrorail Red Line with a heavy rail transit rail link between the Naval Medical Center and Silver Spring stations, creating a "Red Line Loop." The Montgomery County Executive endorsed this line as an alternative alignment for the Inner Purple Line route.

- On January 8, 2003 the Montgomery County Council requested the Montgomery County Planning Board's review and make a recommendation regarding the Metrorail Loop proposal's feasibility and comparison to the master-planned Georgetown Branch alignment. The Planning Commission Staff (Maryland –National Capital Park & Planning Commission (M-NCPPC)) conducted a review of the Metrorail Loop proposal and recommended that the proposal should not be carried forward for further detailed study. Major factors in this decision were the fact that the project did not meet the existing Purpose and Need, the high cost and impacts, and the anticipated project delays that would arise from pursuing the new option at that time.

- On January 30, 2003 the Montgomery County Planning Board considered the report produced by M-NCPPC staff, public testimony and comments, testimony by the County Executive's staff, as well as answers to Planning Board questions provided by WMATA and MTA. As a result, the Planning Board reaffirmed its support for the Purple Line along the master-planned Georgetown Branch alignment and recommended that the Metrorail Loop not be carried forward for detailed study. On February 4, 2003 the Montgomery County Council considered the Planning Board's recommendation and report on the Metrorail Loop proposal. The Council concurred with the Planning Board and passed a resolution urging the Governor and Maryland delegation to seek construction funding for the Purple Line along the established Master Plan alignment.

- In the summer of 2003, the Georgetown Branch/Purple Line West and Purple Line East studies were combined into one project, the Bi-County Transitway Study, to have consistent project goals and ensure that all build alternatives would be assessed from the perspective of the entire corridor.
- MTA initiated the Scoping Process for Bi-County Transitway Study in early September 2003. Four public scoping meetings were held in the corridor. The modal alternatives presented were:
  - No Build
  - Transportation System Management (TSM)
  - Bus Rapid Transit (BRT)
  - Light Rail Transit (LRT)
- The Metrorail Loop proposal was not one of the alternatives being considered as part of the Scoping Process, since a Metrorail alternative had been rejected in the previous studies. Comments were solicited from the public, including comments on the range of alternatives to be studied. Of the 1,319 comments received there were two comments recommending a heavy rail alignment along the Capital Beltway.
- On March 23, 2004, Montgomery County Director of the Department of Public Works and Transportation, Albert J. Genetti, sent a letter to the MTA requesting that MTA study the Metrorail Loop comprehensively, as required by the Council of Environmental Quality Regulations for Implementing NEPA. MTA agreed to further study of the alternative. In this evaluation, the alternative was determined to be even less appropriate to the goals and objectives of the project and in addressing the purpose and need than it had been to the earlier studies because of the required mode change at Silver Spring. In addition, the cost was projected to be considerably greater than the other proposed alternatives, and the environmental impacts more substantial than previously anticipated due to 4(f) impacts to parklands along the Beltway and greater impacts to communities along the CSX right-of-way.
- In November 2004 five public open houses were held as part of the Definition of Alternatives phase of the project. At these meetings the Metrorail Loop alignment was presented as an "Alignment Not Proposed for Detailed Study". MTA received no comments either supporting the construction of a heavy rail along the Beltway, or opposing the decision to drop the Metrorail Loop from consideration.
- At the request of FTA, Maryland Department of Transportation met with Maryland National Capital Park and Planning Commission, representing the Montgomery County Planning Commission and the County Council, and Montgomery County Department of Public Works, representing the County Executive, on January 14, 2005, to discuss the

reappraisal of the Metrorail loop and explain MTA's decision not to continue any further study of the alternative, with the MTA and M-NCPPC reaffirming their positions.

EVALUATION

- The Metrorail Loop would be Heavy Rail Transit (HRT), which requires either a fully separated transitway or exclusive right-of-way, if built at-grade, in order to safeguard adjacent streets and pedestrians from the third rail.
- The Metrorail Loop proposal would provide high-speed travel between Bethesda and Silver Spring and improve operations for redundancy and flexibility to the Red Line Metrorail service by connecting the two radials of the current "U" shaped configuration.
- While the Metrorail Loop would improve operations and provide a high quality service for the Metrorail Red Line, these advantages do not apply to the Bi-County Transitway corridor as a whole. Implementation of the Metrorail Loop would not address the issues of system connectivity, mobility and accessibility, and efficiency for the entire corridor that are central to the Bi-County Transitway Purpose and Need.

Purpose and Need

Three of the key goals of the Purpose and Need for the Bi-County Transitway are to:

- Increase mobility and enhance accessibility
- Improve transit operations efficiencies
- Support economic and community development

The Bi-County Transitway corridor from Bethesda to New Carrollton contains key activity and employment centers, and is served by a number of transit routes. However, the corridor lacks a convenient, end-to-end east-west rapid transit service. As stated in the Purpose and Need, the Bi-County Transitway corridor needs improved system connectivity and additional capacity to serve east-west travel patterns and to support economic development. The Metrorail Loop does not meet these major goals of the Bi-County Transitway Purpose and Need, as explained below:

- Passengers traveling between the Metrorail Loop and destinations east of Silver Spring would be required to transfer from the Metrorail Loop to light rail transit (LRT) or bus rapid transit (BRT) to complete their trip either to Takoma Park/Langley Park, College Park or New Carrollton.
- The Metrorail Loop would not provide continuous service between Bethesda and New Carrollton. It will not address the issues of an inadequate and slow-moving transportation network for east-west travel between Bethesda and New Carrollton.
- The Metrorail Loop would not allow for the enhanced level of transit connectivity, efficiency, and convenience for the corridor as a whole, since it would introduce a different mode to one segment of the corridor that is not being considered for the other segments of the corridor.
- The Metrorail Loop would not support economic and community development to the same level as the LRT and BRT alternatives. The Metrorail Loop would provide limited

development opportunities west of Silver Spring (no stations at the Chevy Chase, Lyttonsville and Woodside communities).

- The Metrorail Loop proposal would be a less cost-effective solution to addressing the transportation problems and needs associated with the Bi-County Transitway corridor, as compared to a BRT or LRT alternative for the entire 14-mile corridor.
- LRT and BRT options can offer many of the benefits of heavy rail transit (Metrorail) but with more flexibility in design and for less capital cost.

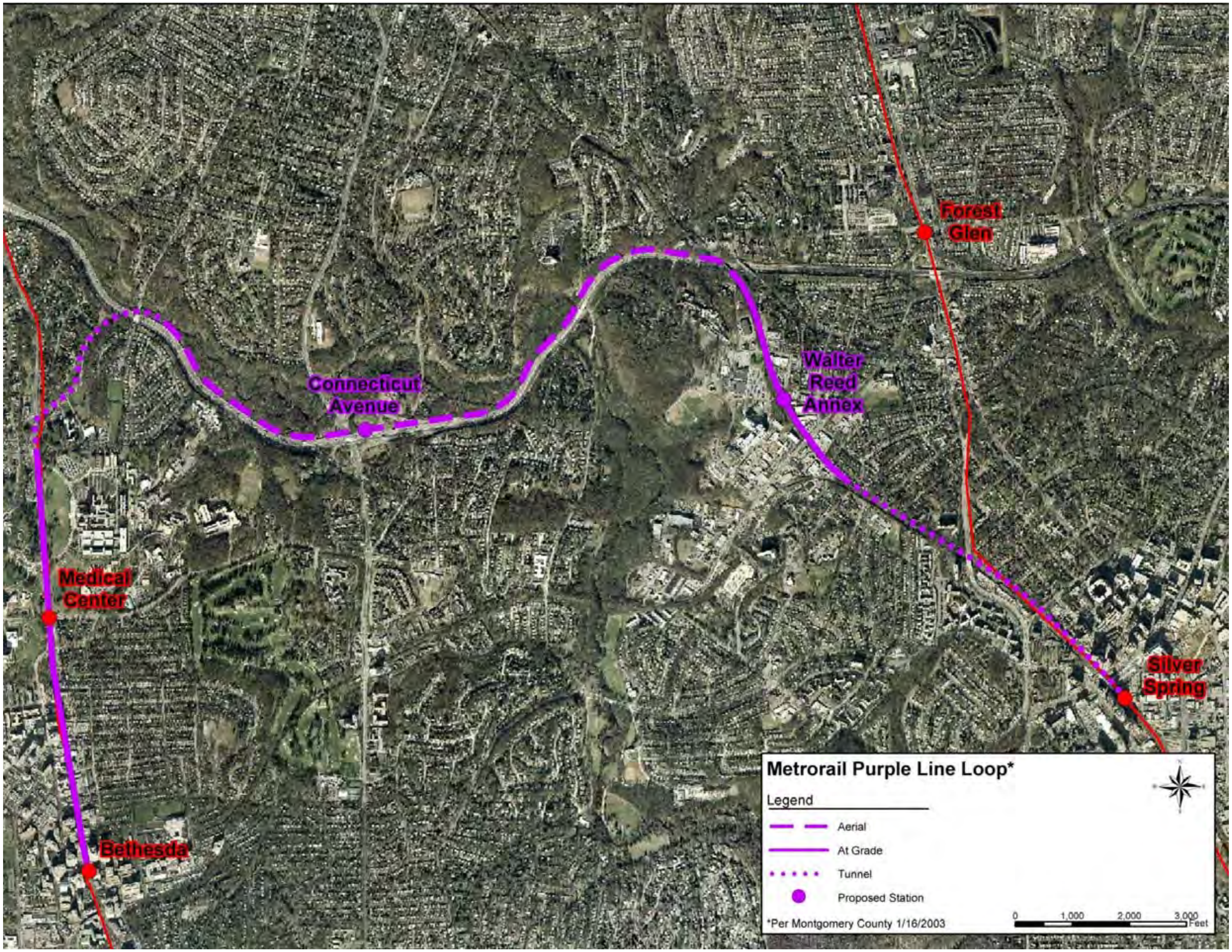
Engineering and Environmental Issues

Other issues associated with the Metrorail Loop that MTA has concerns with include:

- The construction of the Metrorail Loop along the north side of the Capital Beltway would require additional right-of-way in Rock Creek Park. The need to acquire additional parkland would involve serious environmental issues, particularly under Section 4(f) where impacts to publicly owned public parks are not permitted where there exists a feasible and prudent alternative.
- The Metrorail Loop proposal does not account for the Capital Beltway widening for Express Toll Lanes that are currently being considered by the State. If such lanes were implemented, the capital cost and Section 4(f) impacts of the Metrorail Loop would likely be significantly increased.
- The Metrorail Loop may lead to a reduced service/capacity level on the heavily used west leg of the Metrorail Red Line north of NIH and Shady Grove due to trains being diverted to a Bethesda to Silver Spring loop. This concern is especially significant since the Red Line's west leg serves the I-270 Corridor which is expected to experience continued high growth and increased demand, particularly if any of the proposed Corridor Cities transit service improvements currently under consideration are implemented.
- The Metrorail Loop doubles the length of right-of-way that would require coordination/negotiation with CSX. The right-of-way within this corridor is very narrow, and therefore, has both community and railroad operational impacts associated with it. The Metrorail Loop proposal assumes that the existing offset in the CSX corridor of 18 feet between track centerlines would continue to be applied. However, CSX has stated that their current offset requirement of 25 feet from the track centerline to the face of a crash wall would now apply to future Metrorail, LRT or BRT line. As a result, it appears that the Metrorail Loop would impact a total of 25 residential properties, 1 commercial property and the Federal Walter Reed Annex Complex that are located along the CSX right-of-way (compared to 4 residential properties for the master plan alignment).

RECOMMENDATION

The Metrorail Loop option does not effectively address the Bi-County Transitway Purpose and Need and has very high capital costs, compared to the BRT and LRT alternatives under consideration. Therefore, it is recommended that this proposed option be dropped from further study as part of the Definition of Alternatives.


Forest Glen
Connecticut Avenue
Walter Reed Annex
Medical Center
Silver Spring
Bethesda
Metrorail Purple Line Loop*
Legend
Aerial
At Grade
Tunnel
Proposed Station
*Per Montgomery County 1/16/2003
0
1,000
2,000
3,000
Feet

Appendix B

M-NCPPC Purple Line Loop Memorandum

M-NCPPC

MONTGOMERY COUNTY DEPARTMENT OF PARK AND PLANNING

THE MARYLAND-NATIONAL CAPITAL
PARK AND PLANNING COMMISSION

8787 Georgia Avenue
Silver Spring, Maryland 20910-3760

Revised 1-31-03

MEMORANDUM

TO: Montgomery County Planning Board

VIA: Charles R. Loehr, Director
Department of Park and Planning

FROM: County-wide Planning Division

SUBJECT: Review of Proposal by County Executive for Metrorail Purple Line Loop from Silver Spring to Medical Center Metrorail Stations

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RECOMMENDATION

Based on staff analysis of the information available concerning the Purple Line Loop (PLL) proposal, staff recommends that the proposal not be carried forward for further detailed study. This conclusion was arrived at based on the findings shown below, with considerable weight given toward the need to move an approvable project ahead in the project planning process. We find the Inner Purple Line (IPL) is the project that should be advanced.

These recommendations are based on technical data and staff research on the planning and implementation process for Federally-funded projects. The findings regarding a two-year or four-year delay for incorporation of the PLL into the current Purple Line study process are estimates but reflect known procedural time frames. Not having heard the community comments that will be presented at the Board hearing, staff has not attempted to evaluate the community acceptance of the PLL proposal.

In developing our recommendation not to study the Executive's Metrorail proposal further, staff is aware of the lack of Montgomery County political consensus on constructing the Inner Purple Line. Our recommendations are made on the basis of technical thought processes. We leave for others to determine what is necessary to overcome that lack of consensus.

The following sections are found in this memorandum:

I. Findings of Analysis
II. Purpose and Background
III. Description of Purple Line Loop
IV. Inner Purple Line
V. Purple Line Loop Performance
VI. Evaluation and Comparison of Purple Line Loop and Inner Purple Line

I. FINDINGS OF ANALYSIS

Staff finds three distinct advantages to the Purple Line Loop proposal:

- It addresses several known problems with the Inner Purple Line, such as adverse impacts to adjacent property owners, a degraded trail experience, and space constraints associated with adding tracks in the Silver Spring CBD.

- The PLL attracts more new riders than the IPL because it reduces transfers in the Metrorail system and is a faster ride between Silver Spring and Bethesda than the proposed Inner Purple Line light rail.

- The PLL would improve Metrorail operations flexibility and efficiency. Switches and tunnels would allow for several operating configurations between Shady Grove and Glenmont by connecting the Medical Center and Silver Spring Metrorail stations. It also provides redundancy in the Metrorail system that is not now available.

However, the Purple Line Loop raises several grave concerns as well:

- To continue study on the PLL, bringing it to the point where fully-informed decisions can be made about cost, environmental impacts, and all the other needed aspects that go into a Draft Environmental Impact Statement, is likely to take at least two years and possibly longer.

- The PLL costs approximately twice as much as the IPL. Costs of the PLL are very preliminary and would be subject to significant modification due to the very sketch-level nature of the planning to this point. WMATA staff's cost estimate is $616 million. Staff finds that this should be at least $746 million. This estimate is shown in detail in this memorandum. The IPL cost estimate is $371 million. The increase in project cost for the PLL is greater than the proportional increase in ridership.

- The cost effectiveness of the PLL, based on Park and Planning staff estimates of capital costs, is lower than that of the IPL.

- Some assumptions of the design are critical and, if they must be changed, additional problems could arise. The center-to-center offset between the PLL trains and CSX trains is 18 feet in the designs, although recent designs for the IPL have had to use 25 feet based on CSX guidance. WMATA feels their agreement with CSX allows the lower number.

- The completion of the Capital Crescent Trail will be necessary as a separate project with the PLL, and will have some cost associated with it that has not been determined. Completing the trail is included in the costs for the IPL. Similarly, no new south entrance to the Bethesda Metrorail station would be created with the PLL, eliminating one of the benefits of the IPL design.

- Environmental issues can play a major role in the ability of this project to be approved for Federal funding. The PLL impacts substantially more wetlands, floodplains, and forest than the IPL.

- Community impacts such as visual effects, potential noise, vibration, and other aspects have not been well defined due to time constraints and the sketch-level nature of the planning. These impacts will be somewhat dependent upon the types of structure used to support the Metrorail tracks, their heights, and other variables.

- It does not seem that there are appropriate Metrorail station locations on the proposed alignment between Medical Center and Silver Spring, with the possible exception of the Seminary Road/Linden Lane area near the CSX tracks. However, a station there would require significant changes to the land use and adjacent roadway network to be cost-effective.

- The PLL will reduce the future available Metrorail service capacity for stations north of the Medical Center and Silver Spring stations, perpetuating the need for “turn back” service.

Finally, two findings do not affect the relative value of PLL and IPL:

- PLL is feasible to construct from an engineering perspective using the WMATA staff assumptions. The design uses some unusual structures, but there is public land or land from CSX that would allow for construction, and there are no physical constrains that could not be overcome. The DEIS has already resulted in the same finding for the IPL.

- A future rail extension from Silver Spring to Langley Park, College Park and New Carrollton could be constructed with connections to either a Metrorail loop or the Inner Purple Line light rail. There are costs and benefits associated with all combinations of light rail and Metrorail for the sections east and west of Silver Spring.

II. PURPOSE AND BACKGROUND

In mid-January 2003, County Executive Duncan sent to the Montgomery County Council a proposal to link the two sides of the Metrorail Red Line. This link would allow Metrorail trains to travel directly between the Medical Center and Silver Spring stations, creating a loop as well as extension possibilities. Council President Michael Subin sent this proposal to the Planning Board, asking for their review and recommendations to the Council by January 31.

In this paper, the County Executive's proposal is referred to as the Purple Line Loop (PLL) to differentiate it from the Inner Purple Line (IPL). The proposed Inner Purple Line is light rail that would run from the Bethesda Metrorail station via the Georgetown Branch right-of-way to Silver Spring. A continuation being studied from Silver Spring to Langley Park, College Park and to the New Carrollton Metrorail station is described in this memo as the Inner Purple Line East.

The basic question being asked of the staff and Board is:

- **Is this new Purple Line Loop feasible enough to recommend that Maryland DOT and Montgomery County spend time and money on further detailed study?**

- **How does this new proposal compare against the Inner Purple Line?**

For this analysis, most comparisons are done against the transit lines between Bethesda or Medical Center, and Silver Spring. This is the section where most detailed information is available about the two lines and where they are most comparable. Each could be linked to a line that would extend east of Silver Spring; ridership and other benefits, as well as costs, are shown in this paper. However, the planning for the eastern section is of a very sketch-level nature at this time.

The need to complete the decision-making about further study for this project is closely related to the time schedule of the Federal Surface Transportation bill reauthorization. U.S Congress House members must have their projects to the House Transportation and Infrastructure Committee by February 28, 2003. The Board was briefed on the Federal reauthorization process recently, and a summary of relevant information is included as an attachment to this memorandum.

Status of Related Projects

Several other projects related to the PLL proposal are in varying stages of study:

- The Inner Purple Line for its entire length from Bethesda to New Carrollton is in an initial Project Planning stage by the Maryland Transit Administration (MTA). The section from Silver Spring to New Carrollton is in a very early stage of analysis, with an alignment still to be determined. However, the western section, from Silver Spring to Bethesda, is well along in a

Supplemental Draft Environmental Impact Statement (SDEIS). A draft EIS was published in 1996 on this section. The SDEIS was initiated in 2001, identifying the impacts of double-tracking the section and updating other information. The SDEIS and Final EIS are expected to be completed in 2003.

- The Corridor Cities Transitway is a planned transitway from the Shady Grove Metrorail station, north to Clarksburg. This line is being evaluated as either a busway or light rail. A Draft Environmental Impact Statement was published in the spring of 2002, and is in the review process now. A decision on mode and other design alternatives is expected in fall of 2003, with a final EIS in 2004. That would allow for final design to begin.

- SHA is studying the addition of HOV lanes to the Capital Beltway from the American Legion Bridge to the Woodrow Wilson Bridge. This concept, developed in the same inter-modal corridor study that identified the “P6” rail alignment for IPL and IPL East, will be documented in a Draft Environmental Impact Statement likely to be completed during 2004. The concept is supported in the Planning Board’s Transportation Policy Report and a Public Hearing Draft of a Master Plan amendment was released in January 2003 that would add the portion west of I-270 to the Master Plan of Highways. Due to anticipated environmental and community impacts between I-270 and the Prince George’s County line, the County Council has decided to await further information from the SHA study before proposing an HOV lane addition to I-495 east of I-270 in the Master Plan of Highways.

III. DESCRIPTION OF PURPLE LINE LOOP

Operating Methods and Headways

The 4.7-mile[1] PLL would connect the Silver Spring and Medical Center stations on the Red Line using heavy rail cars like those found throughout the rest of the Metrorail system. The PLL would operate initially with a peak hour headway of 6 minutes (10 six-car trains per hour) and could operate with a peak hour headway of 5 minutes (12 eight-car trains per hour)[2] during the year 2025 without acquiring any additional rail cars beyond those WMATA is already planning to purchase in order to meet their year 2025 service goals. The PLL would operate as a true loop, such that Red Line trains that currently terminate at the Grosvenor and Silver Spring stations would instead continue clockwise along the loop from Medical Center and counterclockwise along the loop from Silver Spring.

Physical Alignment

The section numbers indicated in the description of the physical alignment refer to the section illustrations located in the 11" x 17" color overview map. All section illustrations are looking to either the south or east. The sections were provided by WMATA staff.

***Silver Spring Station to 16th Street (MD 390): Section 1-1*:** In the area between the Silver Spring station and 16th Street, the outbound and inbound PLL tracks are separated to provide a more economical engineering solution. From the existing Silver Spring station, the area currently occupied by the pocket/turnaround tracks just north of the station would be converted into a 1000-foot-long retained cut[3] for single track. Beyond the existing station, the outbound (toward Medical Center) track would descend below the grade of the CSX tracks and main Red Line, into the retained cut and then into a 400-foot-long cut-and-cover tunnel to pass underneath the CSX tracks and Spring Street before entering a 1200-foot section of mined tunnel to pass back underneath the Red Line and an 800-foot-long cut-and-cover tunnel to pass underneath 16th Street. The track would emerge on the east side of the CSX tracks northwest of 16th Street, and would be on top of the stacked box configuration shown in Section 2-2.

Beginning northwest of 16th Street, the inbound tracks (toward Silver Spring) are shown at the bottom of the stacked box configuration in Section 2-2. The inbound tracks would remain below grade and break into the existing Red Line tunnel beneath 16th Street, where they would join up with the existing track and proceed along the remainder of the current Red Line route to Silver Spring.

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[1] Length of new construction
[2] The maximum headway for the PLL is 4.6 minutes (13 trains/hour), but has been rounded to the nearest whole number.
[3] A retained cut is basically a cut and cover tunnel without the cover. Sections of the Red Line between Grosvenor and Rockville are in a retained cut.

***16th Street to south of Talbot Street: Section 2-2*:** After emerging from the portals near 16th Street, the line proceeds in a retained cut on the east side of the CSX tracks in a stacked box configuration, outbound tracks on top, inbound tracks on the bottom.

***Transition From South of Talbot Street to North of Talbot Street: Section 3-3*:** The line transitions from the stacked box configuration to a more typical side-by-side double track alignment and passes under the Talbot Street bridge over CSX on the east side of the CSX tracks. Some work would have to be performed on the Talbot Street bridge to accommodate the additional train tracks.

North of Talbot Street to Tunnel Under CSX Tracks: Section 4-4: North of Talbot Street, the line continues in the standard double-track configuration on the east side of the CSX tracks. The total length of the at-grade and retained cut section from the 16th Street tunnel exit to north of Talbot Street is 1900 feet.

***Tunnel Under CSX Tracks: Section 4A-4A*:** The line then descends to a 1100-foot-long mined tunnel under the CSX tracks, emerging on the west side of the CSX tracks just south of Brookville Road. The line passes under the Brookville Road bridge over CSX on the west side of the existing tracks. Some work would have to be performed on the highway bridge to accommodate the additional train tracks.

***North of Brookville Road to Beltway Crossing: Section 5-5*:** After passing under the Brookville Road bridge, the line proceeds 1100 feet either at-grade or in a retained cut in a side-by-side double track configuration on the west side of the CSX tracks to the site of the proposed Walter Reed Annex station, southwest of Montgomery Street. Departing the station site, the line continues for 1500 feet either at-grade or in a retained cut on the west side of the CSX tracks before crossing the Capital Beltway (I-495) on a new bridge parallel to the existing bridges for the CSX tracks and Seminary Road. Immediately following the bridge, the line turns west and continues on an aerial structure, passing over Linden Lane before descending to roughly the same grade as the Beltway itself and continuing on the north side of the Beltway. The total length of the bridge over the Beltway and subsequent aerial structure is 2000 feet.

***North of Capital Beltway to Rock Creek Crossing: Section G-G* and Typical Cross Section** (on bottom left of map): While traveling for a distance of 1000 feet at roughly the same grade as the Beltway or slightly higher in this section, the line is shown on WMATA maps as at-grade.

Rock Creek Crossing to West of Connecticut Avenue (MD 185): Section F-F and Section E-E: The line would cross Rock Creek on a 600 foot-long single-column structure supporting double-track on top, northwest of and parallel to the Beltway crossing of Rock Creek. The line would then return to the at-grade alignment shown in section G-G for a distance of 2500 feet before ascending to an aerial structure and the proposed station in the northwest quadrant of the Beltway interchange with Connecticut Avenue (MD 185). This station would be an aerial station on a bridge long enough to pass over the interchange ramps as well as Connecticut Avenue itself. Section E-E shows the aerial structure on either side of the proposed Connecticut Avenue station. The total length of this aerial structure is 3300 feet.

Descent to Western Tunnel: Section D-D*:* After leaving the aerial section west of Connecticut Avenue, the line descends into a 1050-foot-long retained cut and enters a 1500-foot-long cut-and-cover tunnel parallel to the Beltway, on the north side just east of Cedar Lane.

Mined Tunnel Under Beltway to Medical Center Station: Section C-C: From the cut and cover on the north side of the Beltway, the line enters a mined tunnel that passes underneath the Beltway and turns to the southwest. The mined tunnel continues underneath the public right-of-way for Elmhirst Parkway and beneath parkland owned by the Commission before moving underneath the right-of-way for Cedar Lane. The line would then pass through an underground junction to join with the main branch of the Red Line north of the Medical Center station and continue into the station itself, which is approximately 85 feet underground. The total length of new mined tunnel is 3800 feet.

Potential Stations

Walter Reed Annex, located on the west side of the CSX tracks southwest of Montgomery Street. This station would be at-grade and adjacent to property owned by the U.S. Army. Currently, both walk and auto access to this site is only from the west, with the auto access via either Linden Lane or Brookville Road and then through the Walter Reed Annex.

Connecticut Avenue (MD 185) and the Capital Beltway (I-495), located in the northeast quadrant of the interchange (the area bounded by the on-ramp from northbound Connecticut Avenue to the westbound Beltway/Outer Loop). This station would be on an aerial structure. Auto and bus access to the station and an adjacent parking structure would be via the interchange ramps.

Cost Estimates

WMATA has estimated the capital cost of the PLL as described above at $616 million. Eliminating either of the two new stations would reduce the overall capital cost.

Operating costs depend primarily on the frequency of service along the PLL. Initial operation of the PLL at 6-minute headways (10 six-car trains per hour) would increase Metrorail annual operating costs by approximately $10 million for the increase in vehicle-hours of operation but would not require capital expenditure for new railcars. Year 2025 operation of the PLL at 5-minute headways (12 eight-car trains per hour) would increase annual operating costs by $10 million over base Red Line operations for the year 2025, again for the increase in vehicle-hours.

Future System Expansion

There are three potential system expansion points for the PLL. The first is from Silver Spring east to Takoma Park, Langley Park, College Park, and New Carrollton, generally following the route of the IPL. This extension could be done with either light rail or heavy rail. The second and third potential expansion points would branch off the PLL on the north side of the Beltway. On the west side, the line would branch off prior to the Cedar Lane portal and continue on the north side of the Beltway to Rock Spring Park (via Grosvenor or a new transfer station at Pooks Hill Road), Montgomery Mall, and ultimately Tysons Corner in Virginia. On the east side, the line would branch off prior to the Linden Lane bridge crossing the Beltway and continue on the north side to Four Corners (via Forest Glen), White Oak/FDA, and then turn down New Hampshire Avenue (MD 650) to Langley Park, where it would join the IPL alignment to College Park and New Carrollton. Both of these lines would almost certainly have to be operated as heavy rail. No detailed engineering has been performed on any of the three potential expansions.

Surrounding/Adjacent Land Uses at Proposed PLL Stations

An analysis of job and household data for a half-mile radius around each new station on the Purple Line Loop yielded the following results[4]:

In 2025, the Connecticut Avenue/I-495 station is projected to serve approximately 620 single-family households, no multi-family households, and about 795 jobs. The Walter Reed Annex station is projected to serve about 445 single-family households, 615 multi-family households, and 2,990 jobs. These are roughly the same as current conditions, as little new development is planned for these two areas under current plans.

Tunnel/Rock Conditions

Although detailed geotechnical and feasibility studies will be needed in siting and designing the tunnels of the PLL, an initial examination of the information available from published maps indicates no obvious problem with tunneling through the rocks along the proposed tunnel alignments. Indeed, these same formations have already been tunneled through for Metro in other locations in Montgomery County. However, specific locations of important features, such as depth to bedrock, formation contacts, and the Rock Creek Shear Zone, are subject to mapping resolution limitations and error, and if of geotechnical concern, would have to be assessed and/or verified in the field.

[4] Data rounded to the nearest 5 jobs and households.

IV. Inner Purple Line

The term Inner Purple Line (IPL) generally refers to a rail transit corridor connecting the Bethesda, Silver Spring, and New Carrollton Metrorail stations. The western portion of this corridor, primarily referred to as the Georgetown Branch, is a 4.4-mile master-planned transitway between Bethesda and Silver Spring along historic freight rail alignments. This section has a long and detailed planning history. It is summarized in Attachment 2 of this report. In the following text, the terminology will be:

- "IPL" refers to the Inner Purple Line between Bethesda and Silver Spring, the Georgetown Branch section.

- "IPL East" refers to the Inner Purple Line between Silver Spring and New Carrollton

Inner Purple Line Description

The current design being evaluated for the IPL between Silver Spring and Bethesda includes the following features:

- A double-track light-rail system, except for a portion of single-track adjacent to the Metro Plaza Building northwest of Colesville Road in Silver Spring

- A continuous trail adjacent to the light-rail line, except for a section approximately 1500 feet in length near the CSX Metropolitan Branch junction where the trail follows residential streets in the Rosemary Hills community

- Stations at Bethesda (Metrorail Station), Chevy Chase Lake (Connecticut Avenue), West Silver Spring (Lyttonsville Place), Woodside (16th Street), and Silver Spring (Transit Center).

Inner Purple Line Performance and Impacts from DEIS

The 1996 Draft Environmental Impact Statement for the IPL (Georgetown Branch Transit/Trail) concluded that the primarily single-track light-rail/trail alternative would:

- Carry approximately 19,500 daily riders

- Save travelers 427,400 hours annually

- Have a capital cost of approximately $205M and a cost-effectiveness per new rider of $23.29.

Park and Planning staff have conducted a separate analysis using their forecasting methodology to provide a comparison with the Purple Line Loop. The figures used are somewhat different than those from the DEIS due to different methodologies and future land use assumptions (this analysis uses a year 2025 jobs-and-household forecast, for example, while the DEIS used 2020).

The current capital cost estimate for the IPL is $371M, substantially higher than the 1996 DEIS estimate of $205M. The reasons for the increase are:

- $45M for escalation from 1995 dollars to 2003 dollars

- $100M associated with both the need to double-track the system to incorporate future operating plans for the IPL East extension and to increase the separation from CSX rails from the 18 feet acceptable to CSX in 1996 to the 25 feet now required by CSX

- $21M for locally preferred options described in the DEIS, including an overpass at Connecticut Avenue and underpass at the CSX Metropolitan Branch junction, and trail extensions through the Bethesda and Silver Spring stations

V. PURPLE LINE LOOP PERFORMANCE

Transportation and Mobility Impacts

This section presents the transportation and mobility impacts of the Purple Line Loop. Specifically, this analysis looked at network connectivity, travel demand for the new line including ridership by station, travel time savings, and access to stations. Section 6 compares the results of the PLL with the Inner Purple Line.

1. Demand Forecasting Methodology

The analysis of transportation and mobility impacts performed for this study is based on travel forecasts performed using the M-NCPPC TRAVEL/2 demand model. This analysis used MWCOG Round 6.2 cooperative land-use forecasts for the year 2025 as the primary input to project travel demand. TRAVEL/2 is a regional travel model encompassing the greater Washington-Baltimore region, but with greater network detail within Montgomery County. Travel forecasts from the model are for the three-hour evening peak period.

It should be noted that the level of analysis performed for this study can best be described as sketch-level planning, given the limited time available for study. Travel forecasts developed to support Major Investment Studies in the corridor, such as the Georgetown Branch DEIS and the Capital Beltway Corridor Study, should be more reliable. However, TRAVEL/2 allows for a relative comparison of the Purple Line alternatives using the same methodology.

A summary of key project assumptions is shown in Table 1.

Table 1: Travel Model Assumptions

Input	Assumption
Land Use	MWCOG Round 6.2 Cooperative Forecasts (2025)
Base Highway and Transit Network	2025 Regional Constrained Long-Range Plan network (without Georgetown Branch)
Headways*	Metrorail (PLL): 5 minutes Light Rail (IPL): 6 minutes
Average Transit Speeds, including station stops	Metrorail: 37 mph Light Rail: 29 mph
Station Parking	Unconstrained (no parking charge)
Fare Structure	No Change from Base – assumes average Metro fare based on distance
Drive Access	Uses TRAVEL/2 coding convention, drive access allowed at all new stops
Bus Service in the Corridor	CLRP network assumes 10 minutes headways for bus routes serving the Silver Spring transit center. J2 Bus headway increased to 20 minutes for the PLL and IPL forecasts.
* The one-minute difference in headways between IPL and PLL has a negligible effect on travel demand forecasts.	

2. Travel Patterns in the Corridor

Travel forecasts for the proposed Purple Line Loop provide an indication of the success of the line in terms of increasing transit ridership in the corridor, providing mobility benefits for new and existing transit riders, and supporting the economic viability of the communities connected by the transit line.

Future travel conditions are a function of both the underlying land use patterns and assumptions about the transportation network. According to the Round 6.2 forecasts, both population and employment are expected to increase for the area of Montgomery County inside of the Beltway. Between 2000 and 2025, employment is forecasted to increase by 17.5% and households are expected to increase by 15.3%. Information from the 1997 Census Update Survey reveals that 18.4% of Montgomery County residents work inside the Beltway, a total of about 85,000 workers.

The PLL would provide a critical link between the two legs of the Metrorail Red Line. As a result, it would serve both local and regional transit trips. Many of the riders would be expected to have at least one trip end within the portion of Montgomery County within the Beltway, but there would also be a number of potential through trips on the line – riders that begin and end their trips outside of the corridor.

3. Travel Time Savings

The PLL would average a speed of 37 miles per hour over 5.3 miles between Medical Center and Silver Spring for a total time of 8.6 minutes. Removing the Connecticut Avenue station would increase the average speed slightly to 39.3 miles per hour, decreasing the line time to 8.1 minutes. The current Metrorail time between Bethesda and Silver Spring is 35 minutes; the J2 bus travels between the two centers in 18 minutes.

Table 2 presents travel times for some typical origin-destination pairs for the Baseline and PLL scenarios. Travel times assume a walk connection to transit and include in-vehicle, walk, wait, and boarding times.

Table 2: Transit Times (in minutes) Between Selected Origin-Destination Pairs

Origin-Destination Pair	Base	With PLL
Bethesda to Silver Spring	34	17
Friendship Heights to Wheaton	41	33
Rockville to Takoma Park	50	40
Dupont Circle to Connecticut Ave (new station)	53	30

One measure of the benefits of the new line is the travel-time savings for transit riders. For transit trips that have a time savings with the PLL, the average time saved (as compared with the 2025 Baseline scenario) is 5.7 minutes. This amounts to a total time savings of 3,200 hours daily or 952,200 hours annually. For the PLL without the Connecticut Avenue station, time savings would be 3,030 hours daily or 900,200 hours annually.

4. Impact on Mode Shares

By improving transit service in the corridor, the PLL would attract some new work trips to transit causing a slight increase in the mode share for these trips. A number of factors affect mode share, including in-vehicle travel time, waiting time, walking time, auto availability, and characteristics of the station area such as density and walkability.

Table 3 shows transit mode shares for the Baseline and PLL scenarios. The PLL increases transit shares more in the Silver Spring policy area than for the county as a whole. This policy area includes the Lyttonsville/Walter Reed annex areas. Transit shares are projected to be greater for the home end of the trip, with the PLL increasing the share from 19.3% to 20.6% of work trips. Larger shifts in mode shares in this part of the county are difficult because there is already significant transit usage.

Table 3: Transit Mode Share for Work Trips

	Baseline		**With PLL**	
Area	**Work End**	**Home End**	**Work End**	**Home End**
Montgomery County	9.2%	14.1%	9.4%	14.4%
Policy Areas:				
Bethesda	18.0%	18.5%	18.8%	19.0%
Silver Spring	15.3%	19.3%	16.0%	20.6%

The mode shares shown above suggest that the PLL will primarily serve existing transit riders who are already using bus or rail service. The line may show a larger increase in boardings than in person-trips using transit. The person-trips are called “linked” trips because all of the segments of a transit trips are linked together. Boardings are referred to as “unlinked” trips. For example, a transit passenger who takes a bus to the PLL in Silver Spring, transfers to the Red Line in the direction of Shady Grove, and then walks to a job in Rockville would have three transit boardings (1 on bus, 2 on rail), but only one linked trip. On a regional basis, when compared with the Baseline scenario, the PLL alternative would increase linked transit trips by 1100 in the evening peak period, or 3850 daily trips. If the Connecticut Avenue station were not included in the PLL, there would be fewer new transit trips, about 1060 in the evening peak period, or 3725 daily trips.

5. Projected Ridership on the Purple Line Loop

Table 4 shows the projected evening peak-period ridership for the PLL, with and without the Connecticut Avenue station. The PLL would carry 9,700 evening peak-period passengers with the Connecticut Avenue station and 8,470 passengers without the Connecticut Avenue station.

Because the PLL would be operated as a loop, the segment between the Medical Center and Silver Spring does not reflect the entire ridership of the loop. However, riders who exit and board on this segment are counted as ridership for the new segment of the loop. There may be some through trips that are also using the line but are not shown in this table. For example, a trip from Bethesda to Takoma would use the loop, but would not board or exit along the new segment.

Ridership on the entire Red Line including the PLL includes about 1,500 new boardings not accounted for by the 9,700 riders on the new PLL segment. However, there are roughly the same number, about 1,500 boardings, that are transfers from the PLL to the Red Line. These riders are counted as being on both the Red Line (outside of the PLL) and on the PLL.

Table 4: Evening Peak-Period Ridership for PLL Stations

	With Conn. Ave Station		Without Conn. Ave Station	
	Exits	**Boards**	**Exits**	**Boards**
Medical Center	1,240	2,700	1,630	2,610
Connecticut Ave	1,830	450	n/a	n/a
Walter Reed	1,480	470	1,720	520
Silver Spring	5,150	3,220	5,120	3,060
Evening Peak	**9,700**	**6,850**	**8,470**	**6,190**
Daily Riders	**34,000**		**29,700**	
Annual Riders	**10.10 million**		**8.82 million**	

The evening peak period ridership figures indicate the directionality of trips, with exits representing the home end of trips, and boardings representing the work end of trips in the evening peak period. The transit volumes by segment show a directional imbalance, with heavier flows from west to east. The maximum load point would be just east of Medical Center, with transit volumes of about 6900 eastbound and 2600 westbound.

Projections of daily and annual ridership have been developed by factoring evening peak-period totals. The peak-to-daily factor is a key assumption that affects the daily and annual evaluation measures. There is a range of values for existing Metro stations to convert evening peak period to daily trips, depending on the level of mid-day and non-work trips. The system average is about 3.0, but values can range from 2.6 for New Carrollton to 3.8 for Dupont Circle. To be consistent with the Georgetown Branch DEIS, a peak-to-daily factor of 3.5 was used in this study. A daily-to-annual factor of 297 was also used to generate annual trip estimates.

If the PLL were extended from Silver Spring to New Carrollton, ridership would significantly increase. Evening peak period riders on the entire line from Medical Center to New Carrollton are projected to be 20,500, or about 72,000 daily trips. The Medical

Center to Silver Spring segment would increase from 9,700 to 11,300 evening peak period riders with the line extended to New Carrollton.

6. Access and Egress Modes

The access and egress modes of passengers boarding and alighting at the new stations on the PLL were analyzed as a transportation impact. The travel forecasts conducted for this study assumed that there would be unconstrained parking for “park & ride” trips. Other riders would arrive at the stations as auto passengers, or “kiss & ride”. The forecasts indicate that if drive-access facilities were available, the Connecticut Avenue station would be primarily accessed by automobile, at 67% of the trips. Walk and bus access are expected to have about equal shares of the riders. Walk access to a Connecticut Avenue station would depend on proper facilities for pedestrians. Some existing Metrorail stations that are suburban and isolated in nature do attract walk-access trips. For example, Greenbelt (9.5%), Dunn Loring (12%), and Twinbrook (17%) do not have high residential densities near the station. Bus transfers at the Connecticut Avenue station would depend on routing existing L7 and L8 Connecticut Avenue buses with a direct connection to the new station.

The proposed Walter Reed station would have lower percentages of drive-access trips. The station would have a majority of trips accessing the station by walking. Bus access to the area would be minimal, currently served only by the Ride-On Route 4.

Table 5: 2025 Evening Peak Period Access/Egress Modes for New Stations

	Access/Egress Modes		
STATION	**Drive**	**Walk**	**Bus Transfer**
Connecticut Ave	67%	19%	14%
Walter Reed	43%	54%	4%

7. Highway Traffic Impact

The PLL would have a minimal impact on vehicle miles traveled (VMT). Countywide, the PLL does not change VMT compared with the Baseline scenario. For the section of the county inside the beltway, the PLL reduces VMT by less than 0.1%. There is a very slight 0.2% increase in VMT in the Kensington/Wheaton area, probably as a result of the new park-and-ride trips. Traffic volumes on the Capital Beltway do not show any reduction due to the new transit line. There would likely be local traffic impacts around new stations due to transit riders arriving by automobile.

Purple Line Loop Natural Environmental Impacts

Any transportation facility requiring Federal funds must go through an environmental impact statement. M-NCPPC has a Geographic Information System (GIS) that has information for a number of elements considered as sensitive areas. This is not intended to replace the millions of dollars that will ultimately have to go into detailed studies, but it does provide a preview of areas that may require avoidance, minimization, or mitigation. For the purposes of consistency, the data to create the chart below come from GIS. The chart did not use data from the draft EIS for the Georgetown Branch Trolley. **A map showing critical environmental features is attached to this memorandum.**

The best thinking on the proposed Purple Line Loop is that after following the CSX right-of-way to I-495, it will generally be on the north side of the existing edge of paving but still within SHA's easement for I-495. Staff looked at an area 50 feet from the edge of paving. **Actual impacts would be substantially reduced if the line were supported on piers above the grade of I-495.**

Overall, the PLL will have much greater impacts on the natural environment than the IPL. Its alignment adjacent to Rock Creek Park means it will, by its nature, produce negative effects that will be difficult to avoid.

There are several cautions about the following information. This is a planning level analysis and is based on many simplifying assumptions and should be used as a preliminary screening method. The results are less precise than would be determined from individual project engineering studies and extensive environmental fieldwork. Limitations include the following:

- The locations and extent impact were determined by a 50-foot right-of-way. Areas of disturbance could change significantly as the design process reduces impacts through relocation and design and construction methods.

- Steep slopes are generally not accounted for.

- The right-of-way does not capture project components such as storm water management facilities and staging areas, which create additional areas of disturbance.

- The extent of the environmental features is often more extensive than the indicators available in the GIS. Therefore this tool should be used to compare alignments rather to evaluate a single alignment.

These limitations are acceptable for a planning level review, because the measurements are primarily to be used in relative terms rather than as absolutes. They are a useful composite indicator of relative resource disturbance among these alternatives.

A definition of the terms used in the Environmental Features is in Attachment 3. Note that the PLL assumes 50 feet of disturbance outside the current Beltway pavement. This could be reduced with structures.

Table 6: Environmental Features

Environmental Features (Shown in acres, except as noted)	IPL	PLL
Total Acres of Surface Right-of-Way (not tunnel areas)	27.4	21.5
Wetlands	0.1	2.8
Floodplain	0.9	6.1
Number of Stream Crossings	2	5
Stream Buffers	4.4	7.6
Park Property	0	7.0
Forest	0.9	9.5
Significant Forest (100 acres or more)	0.1	6.3
Interior Forest Habitat (300 feet from edge of forest)	0	5.5
Number of Buildings	2	0
Number of Private Home Lots	0	1
Number of Archeology Sites	6	2
Number of Historic Districts	0	0
Linear Feet of ROW Adjacent to Park Property	1199	6945

Community Impacts of the PLL

A number of area master plans contain references to the Georgetown Branch Trolley/ Trail (now Inner Purple Line western portion), providing guidance to the access, land use, and other features, all supporting this project. Some considered other options. The North and West Silver Spring Master Plan (August 2000) recommends the implementation of the Georgetown Branch Transitway between Silver Spring and Bethesda to reduce demand along East-West Highway. However the Plan also says that “This Master Plan’s proposed land uses and transportation network do not preclude any of the transit modes or alignments which are currently proposed in the CBMIS (The Capital Beltway Major Investment Study).” Transit access to the two major Central Business Districts is not negatively affected by the PLL, so it generally carries out the master plan goals of improving transit use.

Probably the largest change from current plans is in the station locations. The Georgetown Branch Master Plan Amendment specifically recommends a transitway and trail along the Georgetown Branch alignment between Bethesda and Silver Spring. The plan recommends a light-rail line with up to eight stations total, six of them being neighborhood stations in between the terminal stations in the Bethesda and Silver Spring CBDs. It recommends that there be a minimum of five stations built initially: Bethesda CBD, Connecticut Avenue/Chevy Chase Lake, Lyttonsville, Spring Street and Silver Spring CBD. The Plan also recommends three additional stations for future consideration: East-West Highway, Jones Mill Road and Woodside/16th Street. The current Inner Purple Line proposal is consistent with these recommendations and includes five stations. Additional stations could be added in the future.

By comparison, the PLL includes only two new middle stations to serve neighborhoods. However, they are in new locations: the Connecticut Avenue/Chevy Chase Lake station is moved north to Beach Drive where it is no longer near the Chevy Chase Lake commercial neighborhood and is no longer a “walk-to” station. It would become a park and ride station with a parking garage.

The Lyttonsville Road station is moved northeast to the campus of the Walter Reed Army Institute for Research where there are security issues for the campus. There are also access issues for the surrounding neighborhoods due to distance and the fact that access may be limited by Army security. This station would be better located on Linden Lane where the community has access and where it could benefit the reuse of the historic National Park Seminary property. However, the latter site also poses acquisition issues since it is the site of an Army warehouse and salt dome. To date, the Army has not been willing to include the property in the National Park Seminary sale even though it would add significantly to the economic feasibility of restoring and reusing the National Park Seminary site. Without a new site and new warehouse, the Army will likely not be interested in selling or leasing the site.

On the positive side, a station at Linden Lane could increase the land use options and economic feasibility of reuse of the National Park Seminary historic resource.

With the PLL, the 16th Street Station is eliminated. In recent Inner Purple Line studies, the 16th Street station took the place of the one at Spring Street. The PLL would include neither station.

Several master plans may need to be amended to reflect a substitution of the PLL for the IPL alignment.

The alignment that better provides transit to the local neighborhoods also has the greater potential impact on those neighborhoods in terms of views and noise. The necessary community impact mitigation would therefore be greater for the Inner Purple Line which best serves the local neighborhoods than it would be for the PLL alignment.

The PLL would remove the need for a maintenance yard in the Lyttonsville area. The privately-owned land could be used for other industrial uses consistent with the master plan recommendations for that area. The property owned by M-NCPPC at Lyttonsville Road/Lyttonsville Place could be retained for public use such as trailhead parking for the Capital Crescent Trail.

Noise, Vibration and Visual Impacts

It is likely that the PLL will have some negative effects on homes near the alignment. The use of the CSX and Capital Beltway right-of-way means that no homes are directly adjacent to the alignment. However, depending on the height of the structures and location within the right-of-way, homes in some communities may have negative noise, vibration or visual impacts. Only further detailed study could quantify this topic, and the necessary information is not available at this time.

Many of the communities that could be directly affected already have noise walls designed to mitigate traffic noise generated from vehicles on the road surface and not from a higher level. Therefore, the visibility and proximity of an elevated heavy-rail line would be an issue. The neighborhoods that should be evaluated are:

- Forest Glen Park on the south side of the Beltway, particularly Newcastle Avenue
- Jones Mill Road on the south side of the Beltway, particularly Parkview Road
- Kensington Parkway, particularly Glenmoor Drive on both the north and south sides of the Beltway
- Stoneybrook Road near the Mormon Temple on the north side, particularly Hill Street and Campbell Drive

VI. EVALUATION AND COMPARISON OF PURPLE LINE LOOP AND INNER PURPLE LINE

This section compares the PLL and IPL and describes the pertinent findings summarized in Section I of this memorandum.

Benefits of PLL

Staff finds three distinct advantages to the PLL proposal that would make it appealing for further study if they were not outweighed by other factors.

1. PLL Addresses Known Concerns with IPL

Current project planning efforts for the IPL have identified a number of concerns that will be addressed and resolved in the SDEIS and FEIS documentation for the IPL, but would be eliminated if the IPL were functionally replaced by the PLL:

- Issues associated with introduction of the light-rail mode:
  - The yard and shop required along the alignment
  - The short segment of single-track operation at the Metro Plaza Building
  - Need for additional cross-sectional width through the Silver Spring Transit Center
  - Location of tail-tracks at Silver Spring
- Issues associated with the introduction of transit vehicles in the Georgetown Branch right-of-way
  - Mitigation of indirect adverse impacts to adjacent property owners, primarily related to noise/vibration and visual effects
  - Concerns regarding a degraded experience for trail users, particularly in the tunnel under the Apex and Air Rights Buildings in Bethesda
  - Opposition by adjacent property owners, notably the Columbia Country Club

2. PLL Attracts More New Transit Riders

The PLL is projected to attract more new transit riders than the IPL. There are two primary factors that make the PLL more attractive to transit users:

- Slightly higher speeds than the IPL and average of 37 miles per hour compared with 29 miles per hour.
- A reduced need for transfers compared with the IPL. There are more “one-seat rides” with the PLL because it connects directly with the Red Line. The IPL would have a greater number of trips that would transfer at least once between the Purple Line and the Red Line.

The cost-effectiveness calculations included in this section use both new riders (linked) and total riders (unlinked) trips. Total riders gives an indication of the number of users of the new line but this number includes some riders who could take bus or rail under the Baseline scenario. New riders only included those person trips that shifted from an auto mode to a transit mode.

3. <u>PLL Enhances Metrorail Operations Efficiency and Flexibility</u>

There are operating efficiencies in having a Purple Line Loop.

- It would use WMATA's current rolling stock.
- It could start with no additional cars.
- It would not require a new maintenance yard.
- It would provide more options for Metrorail operators to switch trains to different locations in the event of an emergency.
- It would even be possible to bypass downtown and still serve many stations should an emergency require it.
- It would be a "one seat" ride from Silver Spring to Bethesda and all Redline stations to the south.
- In contrast, the **Inner Purple Line** would: add a new technology to the region with all new cars, would require a new maintenance yard, a unique labor force and the development of operating rules for the trolley.

Disadvantages Of PLL

Despite three substantial benefits of PLL described above, staff finds many more concerns with the PLL that form the basis for the recommendation not to introduce the PLL into the current state study process.

1. <u>Federal Study Process Delays</u>

Staff understands from our experience and discussions with MTA that if the PLL is incorporated into the current Purple Line EIS process, it will take approximately two years of data collection, alternatives development, and engineering to bring the PLL to a common level of detail with the IPL. If these efforts result in identifying major environmental issues, the outcome will take much more time and it may be that the Inner Purple Line is the preferred alternative from the perspective of the Federal approval agencies.

FTA Criteria

The Federal Transit Administration (FTA) evaluates new transit projects making its decisions on those projects, with the selected ones obtaining Full Funding Grant Agreements and thereafter appropriations. Specifically they look at mobility improvements, environmental benefits, operating efficiencies, cost effectiveness and supporting land use. The level of local support, as reflected in funds available, and readiness to implement are also considered.

Perhaps the most heavily-weighted factor is **cost effectiveness**. In general terms, cost effectiveness is the cost of the proposed new start (annualized incremental capital plus annualized operating cost) per unit of benefit. The FTA is changing its definition of "benefit". In the last authorization process, FTA used new transit trips as its measure of benefit. They are changing that to total "user benefits" which is calculating the time saving by all users of the new project as well as time saved by roadway users from reduced congestion. As this new measure is still somewhat under development, no one can yet perform these calculations. M-NCPPC staff has provided the old measure of cost per new rider, while recognizing that it does not capture the complexity of the pending FTA criteria.

Staff is using our in-house transportation forecasting computer model to make estimates of ridership and user benefit. It has not been specifically calibrated for this area as would be done for an analysis with more time. Staff is confident, however, in the model's ability to calculate the relative differences of alternate routes. Readers must recognize that the calculation of user benefits will change when the new FTA methodology is available for use. In the absence of the actual user benefit calculation that FTA will use (and not knowing what percentage of the costs will be paid by non-Federal sources for either alignment), staff cannot be certain of each alternative's relative competitiveness for FTA approval. Staff can only make a quick-response assessment on the basis of the information available.

Certainly, the project with the most benefits per dollar of cost has the higher probability of being recommended by FTA. On the comparison made by M-NCPPC, the IPL is more cost effective. The Purple Line Loop's increased ridership, due to increased speed, and time saved by travelers over light rail is not enough to overcome the increase in cost as compared to the IPL.

One proxy for **environmental benefits** is new transit riders; the other is changes to total vehicle miles of travel. Both these measure are related to reduced air pollution. The PLL has more new transit riders and reduces vehicle miles of travel more than the IPL.

On the basis of **land use**, the IPL would rate better. There are certainly no differences in land use in either the Silver Spring CBD or Bethesda CBD, which have stations in the same locations under all routes. The difference is between those major centers. The master plans for the areas covering Connecticut Avenue and Lyttonsville anticipate light rail. There would be one less station on the PLL and the relocation of two intermediate stops would be required. The Connecticut Avenue stop would move to an elevated spot above I-495. Transit-oriented development at this location would be highly unlikely. The Purple Line Loop would replace the Lyttonsville stop to a location along the CSX tracks south of Linden Lane. There would have to be significant zoning changes in the area to take advantage to the accessibility that Metrorail would bring. How much acceptance or resistance there would be for such changes is unknown. The light rail alignment also had a stop at 16th Street to support the existing residential high rises nearby, with the possibility of a future stop at Spring Street. These stops are absent in the PLL proposal.

Mobility improvements look at user benefits, service to low-income households and service to employment. The only measure available is the proxy for user benefits, which is discussed below as part of cost effectiveness.

Readiness to go to construction is not a stated FTA criterion, but it may have an influence on their decision-making process. As an outside date, the authorization is only good for six years, the maximum expected life of the new Surface Transportation Act. If the project was not approved by FTA and a Full Funding Grant Agreement not signed in that period, it would have to go for reauthorization. The IPL can have a final Environmental Impact Statement in 2003. Adding the Purple Line Loop as an alternative would add 18 to 24 months to the EIS process.

If the PLL is most locally desirable, the most effective means of ensuring the success of the PLL would be to begin with a new DEIS, including Federal agency concurrence on a newly defined Purpose and Need that would focus on the operational benefits of connecting the sides of the Red Line with Metrorail service. Returning to the Purpose and Need statement would mean that circumferential rail in this corridor would be set back by about four years.

2. <u>Staff Critique of WMATA Capital Cost Estimate</u>

M-NCPPC staff finds that the $616M capital cost estimate provided on January 22, 2003, by WMATA for the PLL is not appropriate for comparison to the $371M capital cost estimate provided by MTA for the IPL. Staff suggests that $746M is a more appropriate capital cost estimate for the PLL. The difference of $130M in PLL estimates is attributable to the following items:

- $35M for aerial structure in locations where WMATA presumed an at-grade alignment

- $14M for a parking garage associated with the Connecticut Avenue station

- $81M for levels of project contingency more appropriate for project planning analyses than assumed by WMATA design engineers.

Each of these items is discussed in greater detail below.

Aerial versus At-grade Alignment

The PLL follows the Capital Beltway alignment for approximately two miles. WMATA has not yet developed an explicit profile (i.e., an assessment of the grades and vertical curves) to accompany the concept plan, but has assumed that three segments, totaling approximately 4,550 linear feet, can be built at grade adjacent to the Capital Beltway. Staff disagrees and concludes that all 4,550 feet will require aerial structure, for the following reasons.

- The easternmost of the three segments is between Linden Lane and Rock Creek/Beach Drive. WMATA assumes the PLL will be above Linden Lane and will transition from aerial to at-grade structure approximately 300 feet west of Linden Lane. Linden Lane has an elevation of 282 feet at the north end of the Capital Beltway, so a Metrorail crossing above Linden Lane would need to have an elevation of at least 295 feet. At the Rock Creek bridge, 2,000 feet to the west, the Capital Beltway has an elevation of 225 feet. The 70-foot difference in elevation along 2,000 linear feet is an average grade of 3.5%. WMATA's maximum grade for Metrorail is 4.0%. Therefore, even discounting the complicating effects of developing the maximum grade through vertical curvature, staff finds that the entire segment between Linden Lane and Rock Creek would need to be on aerial structure as the PLL "chases the grade" of the Capital Beltway into the Rock Creek stream valley.

- The central of the three at-grade segments is a 2500-foot segment between the Rock Creek/Beach Drive crossing and the Connecticut Avenue crossing. Within this segment, Rock Creek is immediately adjacent to the Capital Beltway, with typically 60 feet between the edge of current pavement and the stream bank, a result of stream channel relocation when the Capital Beltway was constructed in the 1960s. In this section, staff proposes that the stream channel location and other associated environmental constraints would dictate PLL construction on aerial structure.

- The westernmost of the three at-grade segments is a 1,050-foot segment that is part of the transition between the aerial structure above Connecticut Avenue crossing and the tunnel beneath the Capital Beltway and Locust Hills community. At the eastern end of this segment, the Capital Beltway is located on a berm approximately 40 feet above the Rock Creek stream valley. Again, staff proposes that in consideration of the environmental resources in the stream valley, aerial construction would be warranted rather than lateral extension of the berm up to 40 feet above the stream valley.

The WMATA cost estimate of $616M includes $347M of line profile costs disaggregated by four profile types; at-grade/retained cut, aerial, cut and cover, and mined tunnel. Attachment 5 demonstrates that shifting the 4,550 feet described above from at-grade/retained cut to aerial structure would increase the capital cost by approximately $35M. The unit costs in Attachment 5 reflect WMATA's total cost estimate for each profile type divided by mileage estimated by WMATA for each type. WMATA developed their cost estimates based on the recently completed Blue Line extension to Largo. The resulting unit cost estimates are generally consistent with WMATA planning guidelines. The $103M per mile for mined tunnel costs is a bit lower than might otherwise be expected, but conversely, the average costs per mile for the other three profile types are a bit higher than might otherwise be expected.

Parking Garage at Connecticut Avenue Station

The $616M PLL estimate provided by WMATA includes an aerial station at Connecticut Avenue, but with inconsistent presentation regarding long-term parking capacity. During development of the “P3” alignment for the State’s Capital Beltway Corridor Study, WMATA developed conceptual plans for a 2,000-space garage at Connecticut Avenue. While PLL discussions have suggested that WMATA staff still proposes park-and-ride capacity at the Connecticut Avenue station, none is explicitly included in written materials provided by WMATA.

The travel demand forecasts prepared for this memorandum assumed unconstrained parking at Connecticut Avenue and indicated that approximately two-thirds of the Connecticut Avenue station patrons would arrive via auto (either park-and-ride or kiss-and-ride). Historically, M-NCPPC staff has supported adjacent community efforts to reduce Metrorail park-and-ride garage sizes. In considering all the above factors, staff recommends that some park-and-ride capacity should have been included in the WMATA concept. Using WMATA cost estimate guidelines, staff estimates that a 1,000-space parking structure (a compromise between the 2,000-space concept and no parking at all) would cost approximately $14M.

Contingency

The $616M PL cost estimate provided by WMATA indicates that a 7% contingency is included. This level of contingency may be appropriate at the design stage, but is lower than typically assumed in project planning. For comparison purposes, the $371M cost estimate prepared by MTA for the IPL includes contingency factors for independent cost elements that range from 5% to 40%, with a “weighted average” of 22%. Staff recommends that a 20% contingency factor for all costs is appropriate at this level of project planning, where many design and mitigation elements remain uncertain or unknown.

Table 7 provides a summary of the WMATA and M-NCPPC capital cost estimates for the PLL. Since the Connecticut Avenue station is controversial, the

Table 7: Staff Critique of WMATA Cost Estimates

	WMATA Estimates		M-NCPPC Estimates			
	Source: WMATA, 1/22/03		**With Connecticut Avenue Station**		**Without Connecticut Avenue Station**	
Cost Element	Line Items	Subtotals	Line Items	Subtotals	Line Items	Subtotals
Line Profile						
At-grade/retained cut	$82.921		$45.389		$45.389	
Aerial	$94.403		$166.890		$176.468	
Cut and cover	$52.933		$52.933		$52.933	
Mined tunnel	$116.963		$116.963		$116.963	
SUBTOTAL		$347.220		$382.175		$391.753
Stations						
Walter Reed	$59.696		$59.696		$59.696	
Connecticut Avenue	$60.293		$60.293			
w/1000 space parking deck			$14.000			
SUBTOTAL		$119.989		$133.989		$59.696
Red Line "Tie In" Costs		$34.839		$34.839		$34.839
Other (Mobilization/Real Estate)		$114.434		$114.434		$114.434
SUBTOTAL ESTIMATED COST		$616.482		$665.437		$600.722
Revised contingency assumption						
WMATA contingency at 7%		$40.331		$43.533		$39.300
SUBTOTAL without contingency		$576.151		$621.904		$561.422
MTA contingency at 20%		$115.230		$124.381		$112.284
REVISED ESTIMATED COST		$691.381		$746.285		$673.706

Note: Without the Connecticut Avenue station, the cost of aerial structure increases by approximately $10M to reflect replacement of the 600' platform

M-NCPPC analysis reflects ridership and capital costs for options both "with Connecticut Avenue station" and "without Connecticut Avenue station". As indicated by numbers outlined by bold borders, M-NCPPC estimates that the PLL cost estimate is $746M with the Connecticut Avenue station and $674M without the Connecticut Avenue station.

Certainly the differences in costs between the Purple Line Loop and the Inner Purple Line are not inconsequential. WMATA's preliminary estimate of cost (which does not include adequate amounts for contingences, parking at Connecticut Avenue or the cost of a trail between Silver Spring and Bethesda) is $246 million above the IPL. Most projects that get funding from FTA are matched dollar for dollar with local funds. This project will need an additional $123 million of scarce local funds.

At the risk of going beyond the mandate given to staff, we would offer the following. If the purpose of the Purple Line Loop is to avoid nearby houses, give more breathing space to the Capital Crescent Trail and avoid all noise and visual impacts to some adjacent properties, it may be effective to cut and cover portions of the light rail on the Georgetown Branch right-of-way between Bethesda and Connecticut Avenue. This might increased the estimated $370 million cost by 10%-20%.

3. Cost Effectiveness

As described above, cost-effectiveness has been one of the key measures used by FTA to evaluate New Starts projects. Cost-effectiveness of a proposed major investment is measured in terms of its added benefits and added costs when compared to lower cost options. The FTA guidelines for cost-effectiveness have changed significantly since the Georgetown Branch DEIS was completed in 1996. At the time that the DEIS was completed, the cost-effectiveness formula included was calculated as follows:

$$\textbf{C.E. Index} = \frac{\textbf{Capital Costs + O\&M Costs – Travel Time Savings}}{\textbf{New Transit Riders}}$$

Where:

Capital Costs = change in annualized capital costs compared with Base
O & M Costs = change in operating and maintenance costs compared with Base
Travel Time Savings = value of travel time savings for existing (Baseline) riders annually
New Transit Riders = attraction of new transit riders annually

The DEIS compares the "Build" scenario with TSM and No-Build scenarios. The TSM scenario is the Transportation System Management alternative, designed to achieve the goals of the project without a major investment in new facilities. The Baseline scenario used in the PLL analysis assumes a level of service between the No-Build and TSM alternatives in the DEIS, because it includes significant bus service improvements in the corridor already included in the CLRP.

Current FTA guidelines are being updated to include Hours of Transportation System User Benefits. This measure was not used in this study because the methodology has not been fully adopted in the region at this time. Travel time savings for existing riders does provide an indication of the relative levels of benefits for transit riders who would already be using transit, but would have reduced travel times with the PLL.

The following table shows the cost-effectiveness for the PLL alternative, with and without the Connecticut Avenue station, as compared with the IPL. The figures shown for the IPL are based on the latest available costs and ridership forecasts developed by M-NCPPC for this study. The table presents the annual costs (capital and O&M), annual ridership (total and new riders), and time savings (in hours and dollars). A value of about $11.70/hour was used to convert time savings into dollars, the same value used in the DEIS.

Three cost-effectiveness indices are presented:

- **Cost per New Rider**: the cost-effectiveness as calculated in the Georgetown Branch DEIS.
- **Cost per Total Rider**: Annual costs (with value of time savings subtracted out) are divided by Annual Total Riders (boardings).
- **Cost per Hour Saved**: Annual costs (with value of time savings subtracted out) are divided by Annual Travel Time Savings (in hours).

Table 8: Cost-Effectiveness Indices Using Revised Purple Line Loop Costs from M-NCPPC

	PLL	PLL (No Conn)	IPL
Costs (000's):			
Total Capital	746,285	673,706	371,000
Annualized Capital Costs	55,693	50,277	30,053
Annual O & M	10,000	10,000	5,800
Total Annual Costs	65,693	60,277	35,853
Ridership:			
Total Daily Riders	34,000	29,700	29,000
Annual Daily Riders (thousands)	10,098	8,821	8,613
Daily New Riders	3,850	3,725	2,900
Annual New Riders (thousands)	1,143	1,106	861
Percent of Riders that are New	11.3%	12.5%	10.0%
Time Savings:			
Annual Time Savings (hours) for Base Riders	952,200	900,207	702,700
Value of Time Saved ($ thousands)	11,131	10,523	8,215
Cost-Effectiveness:			
Cost Per New Rider vs Baseline	$47.72	$44.97	$32.09
Cost Per Total Riders vs Baseline	$5.40	$5.64	$3.21
Cost per Hour Saved	$68.99	$66.96	$51.02

The cost-effectiveness measures show that the PLL is not as cost-effective as the IPL. The higher number of new riders on the PLL does not offset the much higher costs compared with the IPL. The resulting cost per new rider is $48 for the PLL versus $32 for the IPL. Cost per hour saved shows the same relative performance with greater time savings for the PLL not offset by much higher costs. The PLL has $69 per hour saved as compared with $51 per hour saved for the IPL.

4. Concerns Regarding Design Criteria

Because the PLL proposal has been developed by WMATA engineers rather than through the National Environmental Policy Act (NEPA) process, minor changes to several critical design criteria that the MTA staff have spent years addressing could have substantial impacts on costs or delays. In addition to NEPA concerns, other WMATA assumptions may need to be changed. For example, WMATA has assumed they can maintain their minimum 18-foot separation from CSX. CSX has informed MTA that this number has been increased to 25 feet. MTA has reflected the additional 7-foot requirement in the IPL conceptual designs.

5. Capital Crescent Trail Completion

The completion of the Capital Crescent Trail will be necessary as a separate project with the PLL and will have some cost associated with it that has not been determined. Completing the trail is included in the costs for the IPL.

6. Other Environmental Impacts

Staff findings on the PLL identify specific concerns regarding environmental impacts. In summary, the natural environmental impacts of the PLL are estimated to be greater than those of the IPL. These are described in greater detail in the context of Federal study delays above. In summary, the natural environmental impacts of the PLL are estimated to be greater than those of the IPL.

7. Reduced Metrorail Service to Northern Montgomery County

The most significant attribute of the Purple Line Loop is the one-seat ride to the Bethesda and Silver Spring CBDs and on to stations south of the CBDs. That attribute will, however, limit the theoretical capacity of stations north of Silver Spring and north of the Medical Center Station. The maximum line capacity of the Metrorail system is 26 trains an hour with eight-car trains. Today, north of Silver Spring and Grosvenor, six-car trains are in use at a pace of ten cars per hour. By 2025, it is anticipated that WMATA could use its full capacity of 26 trains per hour. With the Purple Line Loop, however, half of the trains arriving at Medical Center will come from Silver Spring, the other half from Grosvenor and north. If demands were even, that would mean that a maximum of 13 trains per hour could come from north with the other 13 trains coming from Silver Spring.

Certainly, with the PLL capacity north of Grosvenor could still be increased slightly from today's service of ten trains per hour. With the Purple Line Loop, ridership capacity could be increased by about 75%, with additional cars per trains and more trains per hour. In any case, selection of PLL means that service north of Medical Center and Silver Spring would be at substantially lower levels than it would be with IPL; in essence, perpetuating the “turn back” service.

Findings That Favor Neither IPL nor PLL

1. Feasibility

PLL is feasible to construct from an engineering perspective using the WMATA staff assumptions. The design uses some unusual structures, but there is public land or land from CSX that would allow for construction, and there are no physical constrains that could not be overcome. The DEIS has already resulted in the same finding for the IPL.

2. Effect on Purple Line Extension to New Carrollton

If there is Metrorail between Bethesda and Silver Spring, what happens to the connection from Silver Spring to all points east: Langley Park, College Park and New Carrollton? No matter what technology is used going east from Silver Spring, it may not be prejudiced by the PLL.

A continuation of Metrorail would be challenging. Physically, the rail line runs between the CSX tracks and space for a Y connection going east would be needed. Financially the costs would be very high. Metrorail needs to be always grade-separated and a lot of that separation would be from being underground. This would be a very expensive project, particularly on the basis of cost effectiveness. Getting light rail out of the Silver Spring CBD and through Takoma Park would have some similar challenges.

If the Metrorail Purple Line Loop leads to a light rail connection in Silver Spring, there will be a time added to trips for a transfer, but that would be offset somewhat by reduced travel time from Silver Spring to Bethesda. The increased total travel time and need to transfer will lower ridership projections and make the light-rail extension less cost effective.

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ATTACHMENTS

1. Review of Federal Surface Transportation Bill Reauthorization Process
2. Inner Purple Line Planning History
3. Definition of Environmental Features
4 Staff Critique of WMATA Line Profiles and Impact on Cost

ATTACHMENT 1: REVIEW OF FEDERAL SURFACE TRANSPORTATION BILL REAUTHORIZATION PROCESS

The current Federal surface transportation legislation, titled Transportation Equity Act for the 21st Century (TEA-21), was adopted in 1998 and is due to expire this October, 2003. It succeeded the groundbreaking Intermodal Surface Transportation Efficiency Act (ISTEA), which covered the Federal Fiscal years of 1991-1997. Both of these were very forward-looking bills that brought significant changes to the way our transportation networks are planned and operated and how Federal dollars were allocated and used.

One major aspect of any Federal transportation bill is the allocation of Federal transportation funds. TEA-21 had a spending authority of $215 billion over the life of the legislation, with the actual amounts set each year by Congress, but with a floor of some $203 billion. Much of this was allocated with formulas. However, there were about 1,800 individual “high priority” projects identified in the legislation with specific funds allocated to each of them. These “earmarks” are important for roadway projects as they remove the need for the project to compete with other projects within a state for the funds. In Montgomery County, TEA-21 had the Randolph Road interchange with US 29 as a line-item project.

One important note is that the presence of one of these projects in the bill does not increase the total amount of funds that come to a state. These projects are counted against the formula amount the state receives. However, it does largely assure that the project will be funded during the life of the bill.

For transit projects, the process is somewhat different than for roadways. Transit funds for new construction are separate from highway capital funding. New transit project approval is a multi-step process, with the Federal Transit Administration (FTA) playing a significant role. The general process is:

- Get on the Authorized list as part of the reauthorization bill established by Congress. This makes a project eligible for further review. Then, if on the list, conduct additional planning, engineering, environmental and other work to finalize the definition and design of the project, complete environmental review requirements, obtain a firm cost estimate, and line up non-Federal funding.

- Sign a Full Funding Grant Agreement with FTA, if selected using the “new starts” criteria among other considerations. This identifies the amounts of funds that FTA will request for a project, and what funds the applicant and others will provide.

- Receive an annual appropriation from Congress funding the FTA part of the agreement.

FTA uses the following as their criteria when considering projects for “new starts” funding. This paper does not try to quantify or even identify how the PLL or the IPL would meet these, as producing these is a complex and lengthy process. In Chapters 5 and 6, a few of these characteristics, or close surrogates, are forecast using the information available to staff at this time.

- Mobility improvement, measured by travel time savings, number of low-income households served, and employment near stations
- Environmental benefits, measured by change in regional pollutant emissions, change in regional energy consumption and EPA air quality designation
- Operating efficiencies measured by operating cost per passenger mile
- Cost effectiveness expressed as transportation system user benefits divided by incremental cost
- Transit Supportive Existing Land Use, Policies, and Future Patterns, measured by combined ratings of several factors.

Other factors such as non-Federal funding support and readiness of the project for implementation are also considered.

ATTACHMENT 2: INNER PURPLE LINE PLANNING HISTORY

The IPL is a 4.4-mile master-planned transitway between Bethesda and Silver Spring along historic freight rail alignments. Plans for fixed-guideway (busway or rail) passenger transit service in this alignment have been developed over the past two decades.

- The November 1986 Georgetown Branch Master Plan Amendment designated the right-of-way for “public purposes such as conservation, recreation, transportation, and utilities.”

- The County purchased the westernmost 3.3 miles of Metropolitan Branch right-of-way abandoned by CSX in 1988.

- The January 1990 Georgetown Branch Master Plan Amendment recommended both a trolley and trail within the right-of-way, including 26 explicit recommendations and detailed conceptual plans for both a trail and a single-track trolley configuration.

- The January 1996 Georgetown Branch Transitway/Trail Draft Environmental Impact Statement (DEIS) compared the impacts of busway/trail and light-rail/trail alternatives to a No-Build and a Transportation Systems Management (TSM) alternative consisting of enhanced bus services on existing roadways.

- The Maryland DOT Capital Beltway Corridor Transportation Study began evaluating regional, circumferential, rail transit alternatives in the late 1990s, colloquially described as the “Purple Line”. The study analyzed six transitway alternatives (P1 through P6), three of which incorporated the 4.4-mile Georgetown Branch.

In 2001, the Maryland Transit Administration began project planning for the Capital Beltway Corridor Study “P6” alternative, a light-rail alternative between Bethesda and New Carrollton that incorporates the Georgetown Branch alignment. The State has initiated development of a Draft Environmental Impact Statement (DEIS) for the IPL East (Silver Spring to New Carrollton) and a Supplementary DEIS and Final EIS for the IPL (Bethesda to Silver Spring) that incorporates the need for increased double-track rail sections to accommodate current plans for the IPL East.

ATTACHMENT 3: DEFINITION OF ENVIRONMENTAL FEATURES

Wetlands: According to both Federal and state wetlands statues, a wetland is an area covered or saturated by surface or ground water for a long enough period of time to support a vegetation community that typically can live and adapt to water-saturated soil conditions. Only certain plants are able to grow and thrive in such wet conditions. Also many species of animals use wetlands for some portion of their life. Other species are completely dependent on damp soils and standing pools of water for their long-term survival.

Wetland impacts were defined as the amount of wetlands within the road right-of-way. This definition provides a measure of direct, physical disturbance, but does not necessarily reflect such impacts as: fragmentation of a wetland system; degradation of wetland plant community through reduction in size, introduction of non-native, invasive species along disturbed edges; degradation of a wetland system through change in hydrology in and around the wetland.

Floodplains: Floodplains are low-lying areas adjacent to streams, subject to intermittent flooding. Building permits are restricted within floodplains. This coverage was derived from the USDA Soil Survey of Montgomery County, Maryland, due to the fact that actual floodplain delineations have not been done uniformly over the entire county.

Stream Crossings: Stream crossings have a direct and significant negative impact on water quality. This is not only because sensitive buffer habitat is permanently removed and fragmented, but also crossings allow highly polluted road run-off to drain directly into the stream without the benefit of filtering through a naturalized buffer area.

GIS generally underestimates the location of streams, especially in headwater areas but is useful in comparing impacts among alternatives.

Stream Buffers: These were initially delineated by measuring a buffer of 150 feet from the outer edge of each side of the stream. This was expanded where the wetlands or floodplain extended beyond 150 feet, especially along the main stem of Rock Creek. Stream buffers are important because they generally contain environmentally sensitive areas such as the natural stream channel, riparian forests, floodplains, wetlands and adjacent steep slopes. Alteration of these areas exacerbates watershed erosion/ sedimentation and contributes significantly to water quality degradation.

Park Property: Park property is defined as State, Federal, M-NCPPC, WSSC, Municipal, and Revenue Authority.

Forests: A forest cover layer for the county was created by combining the existing woodland planimetric layer with 1999 state forest resource inventory attribute data. The layer was then updated using the forest inventories completed as part of recent master plans. The resulting updated layer was used as the basis for delineating significant forest.

Significant Forests are defined as upland forest stands that are at least 100 acres in size, but also include riparian forest corridors that are at least 300 feet wide. Impacts to these areas were considered of primary importance to track. Larger forest stands contain more species diversity, provide higher levels of forest functional benefits, and have the potential to provide increasingly rare habitat for forest interior dwelling plant and animal species. Riparian forest corridors provide habitat and are avenues for wildlife movement, and they are critical for the protection of stream resources. Significant forests are extensive along Rock Creek, especially in the low-lying floodplains.

Forest Interior Habitat: is defined as any portion of a forest stand that is at least 300 feet inside the outer edge of the stand. Interior forest habitat losses are a combination of direct disturbance associated with a road, plus loss of interior resulting from the penetration of the forest interior and the creation of new outer forest edges, often resulting in a total loss of interior habitat exceeding direct impacts. There are three sections of affected interior forest north of the beltway in Rock Creek Park.

Historic Properties: The proposed Purple Line Loop Alignment would not take any historic properties. As the CSX right-of-way approaches I-495, the new tracks would tun directly in front of the National Park Seminary Historic District. There is also the Forest Glen Historic District just north of I-495 and east of the CSX right-of-way. This proximity would initiate a review process to determine the extent (if any) of detrimental impact to the historic resources. This process (mandated by Section 106 of the National Historic Preservation Act) would be carried out by the State Office of Historic Preservation. It is M-NCPPC staff's assessment that the result of that process is likely to be a finding of no detrimental impact.

Attachment 5: Staff Critique of WMATA Line Profiles and Impact on Cost

Segments	WMATA conceptual estimate Based on WMATA 1/22/03 concept					M-NCPPC staff conceptual estimate		
	At grade / retained cut	Aerial	Cut/cover	Mined tunnel	TOTAL	At grade / retained cut	Aerial	Cut/co
A	1000				1000	1000		
B			400		400			4
C				1200	1200			
D			800		800			8
E	1900				1900	1900		
F				1100	1100			
G	1100				1100	1100		
H	1500				1500	1500		
I		2000			2000		2000	
J	1000				1000		1000	
K		600			600		600	
L	2500				2500		2500	
M		3300			3300		3300	
N	1050				1050		1050	
O			1500		1500			15
P				3800	3800			
TOTALS	10050	5900	2700	6100	24750	5500	10450	27
Miles	1.90	1.12	0.51	1.16	4.69	1.04	1.98	0
Cost ($M)	$82.921	$94.403	$52.933	$116.963	$347.220	$45.389	$166.890	$52.9
Unit cost ($M) / MI	$43.643	$84.288	$103.790	$100.830		$43.643	$84.288	$103.7

Segments where staff presumes aerial construction will be required are highlighted with borders:

Segment J: Chasing grade from above Linden Lane to Rock Creek

Segment L: Footprint minimization along Rock Creek stream channel

Segment N: Parallel to Capital Beltway berm up to 40' high

Note that the total linear distance does not include 1,200' for the two stations. Costs for this linear distance are included in the station cost.

Unit costs are estimated by dividing WMATA's total cost by profile type by the mileage by profile type

Appendix C

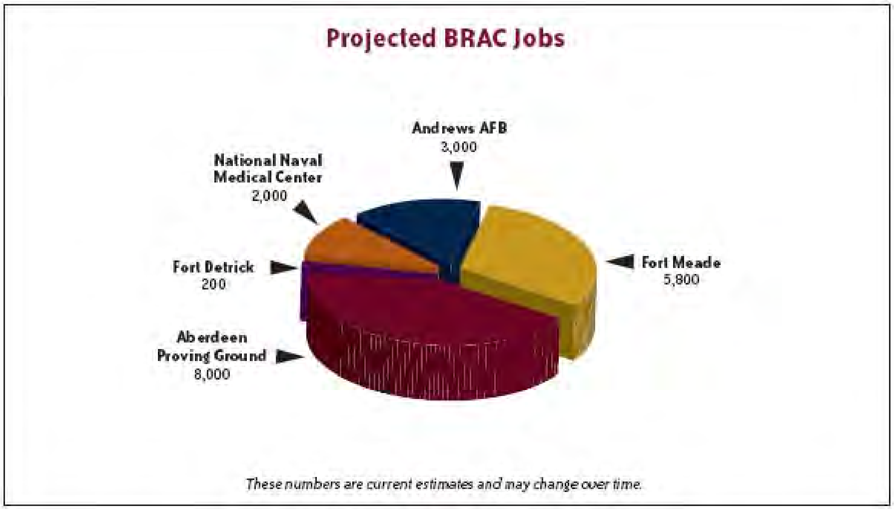
An Assessment of the Base Realignment and Closure Activities on AA/DEIS Travel Assumptions for the Purple Line

An Assessment of the Base Realignment and Closure Activities on AA/DEIS Travel Assumptions for the Purple Line

Introduction - This report documents the changes to employment associated with Base Realignment and Closure (BRAC) activities at Bethesda Naval Hospital relative to the population and employment forecasts used in the AA/DEIS documents for the Purple Line AA/DEIS. This assessment includes an examination of the total employment changes in the Bethesda / Naval Hospital area, the expected origin location and travel patterns of work trips, and the potential effects on the usage of Purple Line alternatives and the potential effects of the BRAC vehicular traffic increase on the performance of the Purple Line alternatives, specifically the BRT Low Investment Alternative which would operate on Jones Bridge Road/Wisconsin Avenue and adjacent to the National Naval Medical Center (NNMC) in Bethesda..

BRAC Proposal for Bethesda Naval Hospital

Maryland is expecting an influx of 20,000 jobs statewide as a result of latest proposed BRAC plans. The graphic below depicts the distribution of jobs for various facilities in Maryland.



Source: MDOT

As a result of BRAC, some of the existing functions of the Walter Reed Army Medical Center (WRAMC) in Washington DC will be transferred to the National Naval Medical Center in Bethesda, while other functions at Walter Reed will be transferred to Fort Belvoir in northern Virginia. The combined Bethesda facility – to be called the Walter Reed National Military Medical Center (WRNMMC) - will be the regional facility for both inpatient and outpatient care for both active and retired military personnel and a specialty center for severely injured military personnel. The military is combining the functioning of its Medical College complex located at the Bethesda facility with patient care to better integrate medical education and care functions at one location.

Planning and design is underway for the additional infrastructure at the facility needed at the WRNMMC, including additional medical facilities to support inpatient and outpatient services, additional lodging, a fitness facility and a new parking garage. There will be family quarters built to house families of service members who are working through the programs.

The BRAC legislation has identified a date of September 15, 2011 as the date for completion of the merger process and closure of the WRAMC. It is expected that by that time 2,200 additional staff members and an estimated 1,860 daily visitors will be added to the Bethesda campus. Of the 2,200, approximately 1,750[1] are expected to transfer from Walter Reed with the remaining 450 to be new staff to be added for maintenance and support.

One of the primary functions of the new facility will be to care for seriously injured service members with facilities to be added for traumatic brain injury, post traumatic stress disorder and aftercare spaces for those recovering from in-patient services. Air Force, Navy, and Army functions for these services will all be combined into one facility.

The 2005 estimated employment level at the NNMC facility was estimated at approximately 8,100 workers. The expected increase of 2,200 workers would bring the total to 10,300; representing a 27% increase over current employment levels at the facility.

Expected trip generation and travel patterns

The NNMC DEIS contains information on the expected travel impacts to the surrounding road network associated with the increase in jobs at the combined facility. The analysis uses a transit mode split of 15% and the addition of 2,500 jobs. 2,500 jobs were used as a “worst case” scenario typical of traffic impact analysis.

Based the analysis, the impact of the shifting employment and visitor increases at the new facility is expected to generate approximately 860 additional trips into and out of the facility in the AM peak and approximately 910 additional trips into and out of the facility in the PM peak. The AM and PM peak hours for NNMC traffic were noted as being 6:30-7:30 AM and 4:15-5:15 PM. The AM and PM peak hours for the background traffic were noted as being 7:45–8:45 AM and 5:00–6:00 PM.

These trips were distributed geographically and temporally for this analysis based on current percentages of traffic traveling into and out of the gates and then analyzed for impacts to the surrounding road network.

Travel in the Bethesda / NNMC area will be affected by the increase in traffic associated with the increase in trips to the new WRNMMC. Peak hour volume increases were presented in the DEIS, based on the analysis noted above. The change in peak hour volumes attributable to base traffic includes:

[1] BRAC Program Manager - NNMC

    - A 3% increase to the intersection at Rockville Pike and West Cedar in the AM peak
    - A 7% increase to the intersection at Rockville Pike and North Drive in the AM peak
    - A 3% increase to the intersection at Rockville Pike and Jones Bridge Road in the PM peak
    - A 4% increase to the intersection at Jones Bridge Road and Connecticut Avenue in the PM peak

Trips beyond the immediate study area and to the surrounding areas were also noted. The traffic generated is expected to add:

- 21 trips in the peak hour at the Jones Mill Road and East West Highway interchange (an increase of 2%) for the AM peak
- 39 trips in the peak hour (for the analysis lane) at Jones Mill Road and East West Highway (an increase of 3%) for the PM peak.

Planned Improvements

BRAC legislation does not allow the commitment of funds to improve facilities beyond the borders of the bases themselves. Therefore Maryland Department of Transportation and Montgomery County have begun to assess impacts and determine the scope and timing of improvements in the base area. There have been a number of initiatives put in place. Some of these include:

- A study of improvements to the entry/exit gates (design and operations) at the combined facility
- An assessment of the potential of widening Rockville Pike along the WRNMMC frontage to accommodate widening of the roadway
- A study of improving the Metro station access
- Intersection improvements in areas noted as providing poor or degraded levels of service

The most recent State of Maryland Consolidated Transportation Program (CTP) includes the funding for the following project or initiatives:

<u>Transit</u>

- $201 million for the MARC Growth and Investment Plan
    - $52 million for new MARC passenger coaches
    - $125 million for MARC Penn Line improvements
    - $17 million for MARC Camden Line improvements
- $20 million for Commuter Bus Program
- $9.0 million for Assessment of Transit Needs for BRAC
- $6.8 million to Locally Operated Transit Systems

Specific to the NNMC the CTP includes:

Improvements Specific to National Naval Medical Center

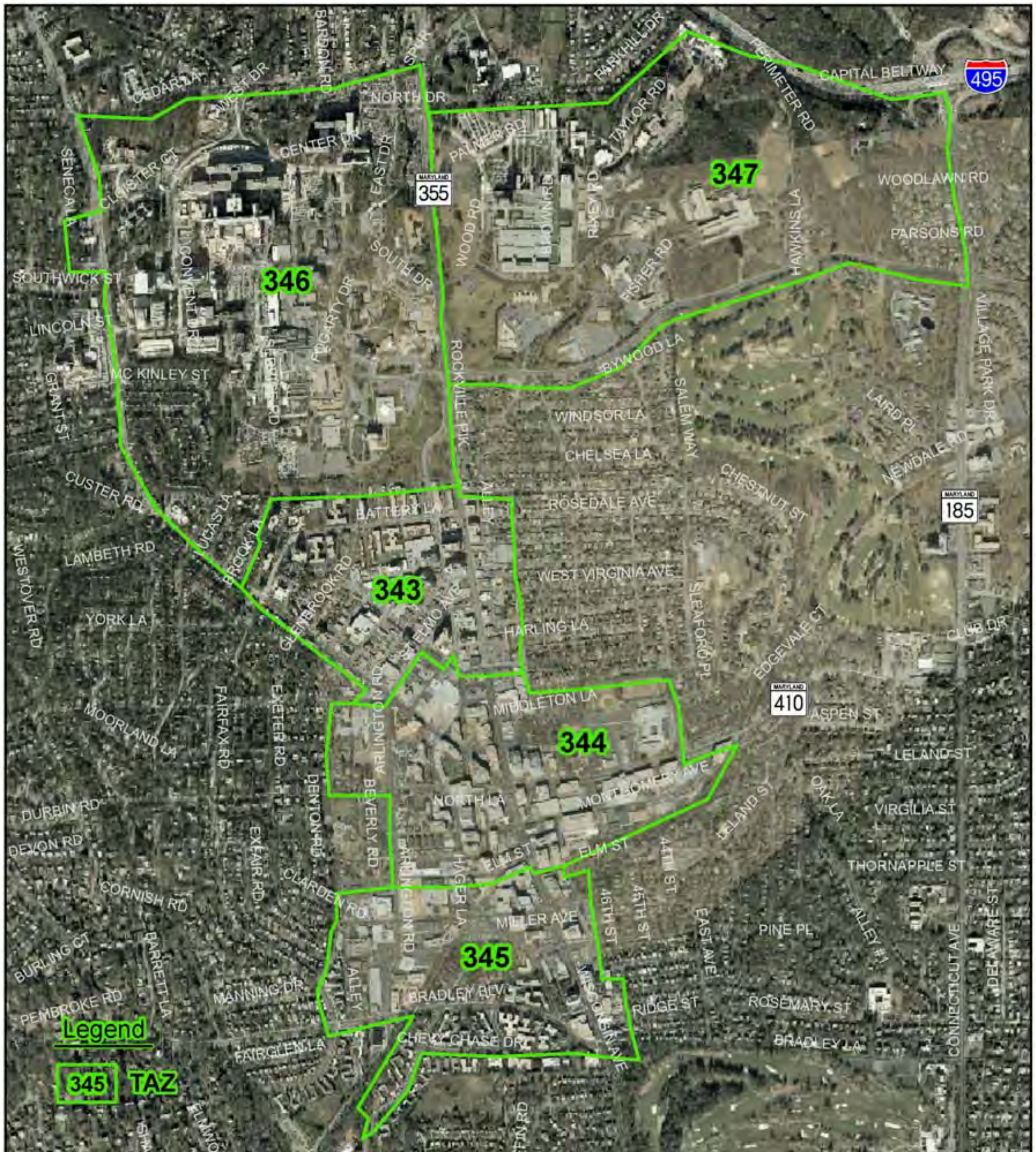
- $44.8 million in high priority intersection improvements; currently evaluating:
    - MD 355 @ West Cedar Lane
    - MD 355 @ Jones Bridge Road
    - MD 187 @ West Cedar Lane
    - MD 185 @ Jones Bridge Road
- Additional $100 million for Purple Line Engineering and Design
- $5 million for support of Ride-On for bus replacements

The findings from these studies and the timing for implementation of any associated improvements will not be available for review for some time.

Population and Employment Changes in the Study Area

Population and employment in the NNMC study area is expected to increase as a result of organic growth (non-BRAC related) in addition to the BRAC changes.

The Metropolitan Washington Council of Governments (MWCOG) released its most recent land use forecasts the Round 7.1 forecast which identifies expected future population and employment in the Medical Center / Bethesda CBD area. Figure 2 below identifies the expected land use growth for traffic analysis zones in the area as identified in this process. Zone 347 as shown below contains the NNMC/WRNMMC facility. For the entire Bethesda area population is expected to increase by 13,108 to 2030 and employment is expected to increase by 11,598 to 2030.



Population & Employment Growth

Expected Population & Employment Growth - 2005 to 2030 [Bethesda / NIH / NNML]

TAZ	2005TOTPOP	2005TOTEMP	2030TOTPOP	2030TOTEMP	PERCENT CHANGE IN POPULATION	PERCENT CHANGE IN EMPLOYMENT
343	3634	7202	9328	7897	156.7%	9.7%
344	3895	19572	8128	22558	108.7%	15.3%
345	2968	8996	5479	10386	84.6%	15.5%
346	828	18053	965	22080	16.5%	22.3%
347	813	8142	1346	10642	65.6%	30.7%

Source: MWCOG Round 7.1 Forecasts

Land Use Assumptions – Purple Line AA/DEIS

The table below compares the land use changes used in the Purple Line AA/DEIS and the most recent MWCOG forecast. The Purple Line AA/DEIS used the MWCOG Round 7.0 forecasts and later updates will use the Round 7.1 forecasts. As noted, the WRNMCC addition of 2,200 jobs is a partial contributor to the overall job increase of 4500 jobs (Round 7.0) or over 6,000 jobs (Round 7.1) forecasted at the NNMC area to the year 2030 with additional organic growth expected at NIH and WRNMCC combined. Residential growth is expected to be only in the 500 to 700 range. In contrast, the Bethesda CBD area is expected to show larger increases in population and employment adding an additional 12,000+ residences and 5,000 jobs.

Table 1 - Aggregate Growth for Bethesda CBD and NIH/WRNMCC

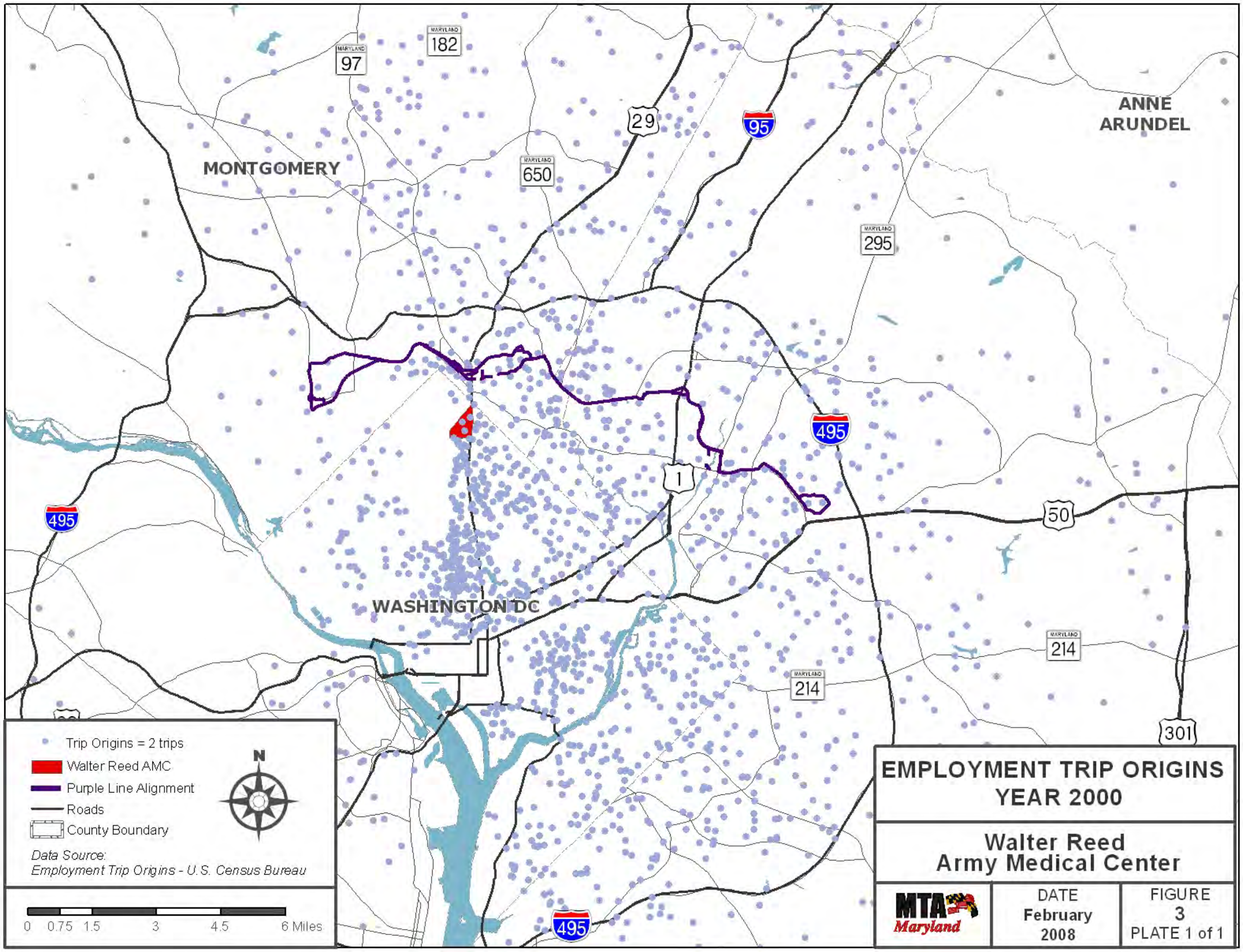
	2005 TOT POP	2030 TOT POP	% Change	2005 TOT EMP	2030 TOT EMP	% Change
Bethesda						
Round 7.0	11446	23184	103%	34833	41567	19%
Round 7.1	10497	22935	118%	35770	40841	14%
NIH/NMC						
Round 7.0	1222	1762	44%	23801	28302	19%
Round 7.1	1641	2311	41%	26195	32722	25%

Overall, with the exception of the employment levels at NNMC, the changes in land use projections between Rounds 7.0 and 7.1 are comparable.

BRAC employment growth at Bethesda Naval Hospital

Walter Reed Army Medical Center in northeastern Washington, D.C. currently has approximately 6,000 workers. Of those, approximately 1,750 are expected to be transferred to the new facility in Bethesda. The remaining 450 associated with BRAC will be added to support ongoing efforts at the base.

In order to assess the potential effects of these employment shifts on the Purple Line ridership analysis, the home locations for workers currently working at Walter Reed were identified and their home location compared to the Purple Line service area. The next three figures show the existing employee trip origins for travel to the Walter Reed facility (assuming travel originates from the home location), existing trip origins to the NNMC complex and the predicted trip origins to the new combined facility for the year 2030.



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Trip Origins = 2 trips
Walter Reed AMC
Purple Line Alignment
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Data Source:
Employment Trip Origins - U.S. Census Bureau
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EMPLOYMENT TRIP ORIGINS
YEAR 2000
Walter Reed
Army Medical Center
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DATE
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FIGURE
3
PLATE 1 of 1

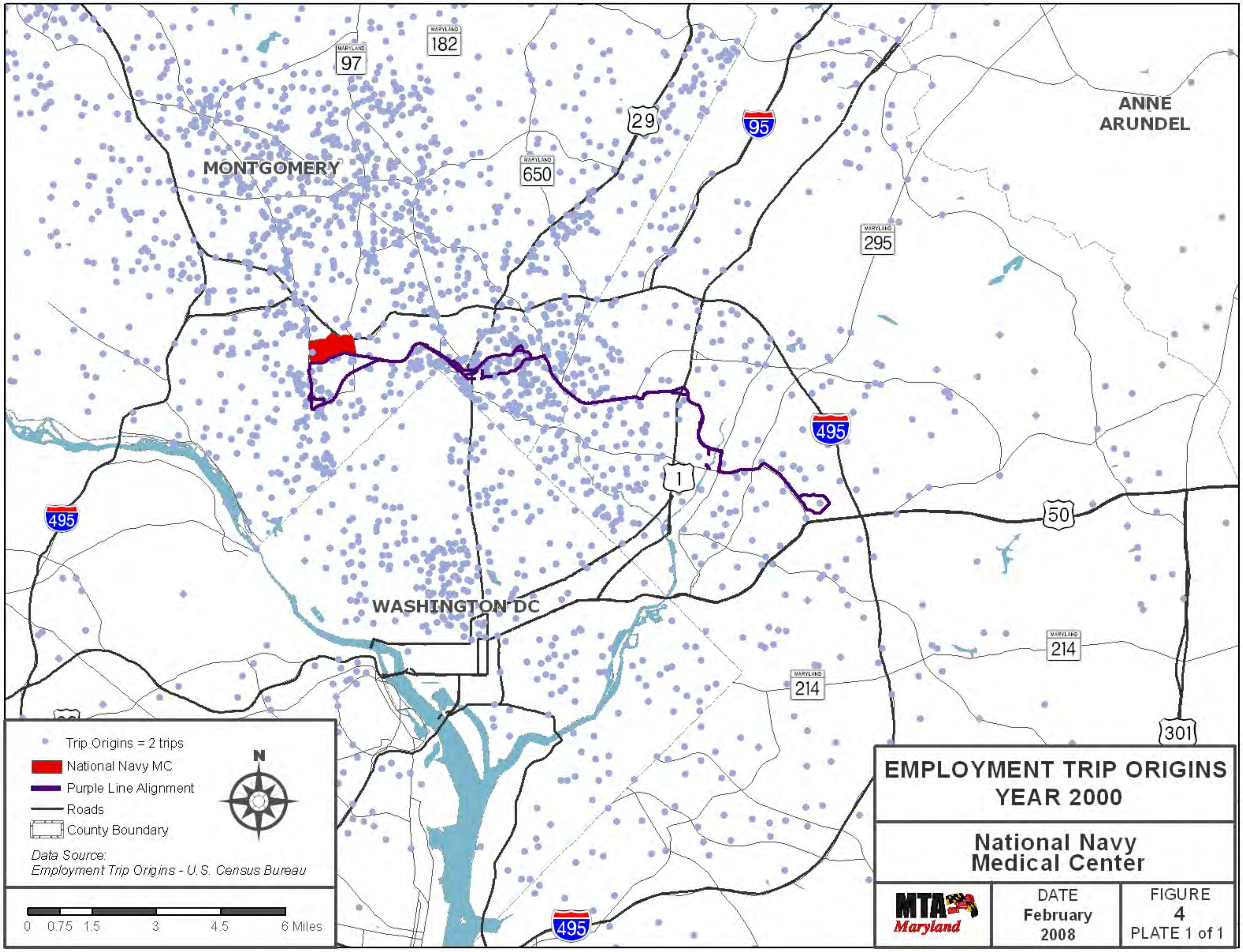

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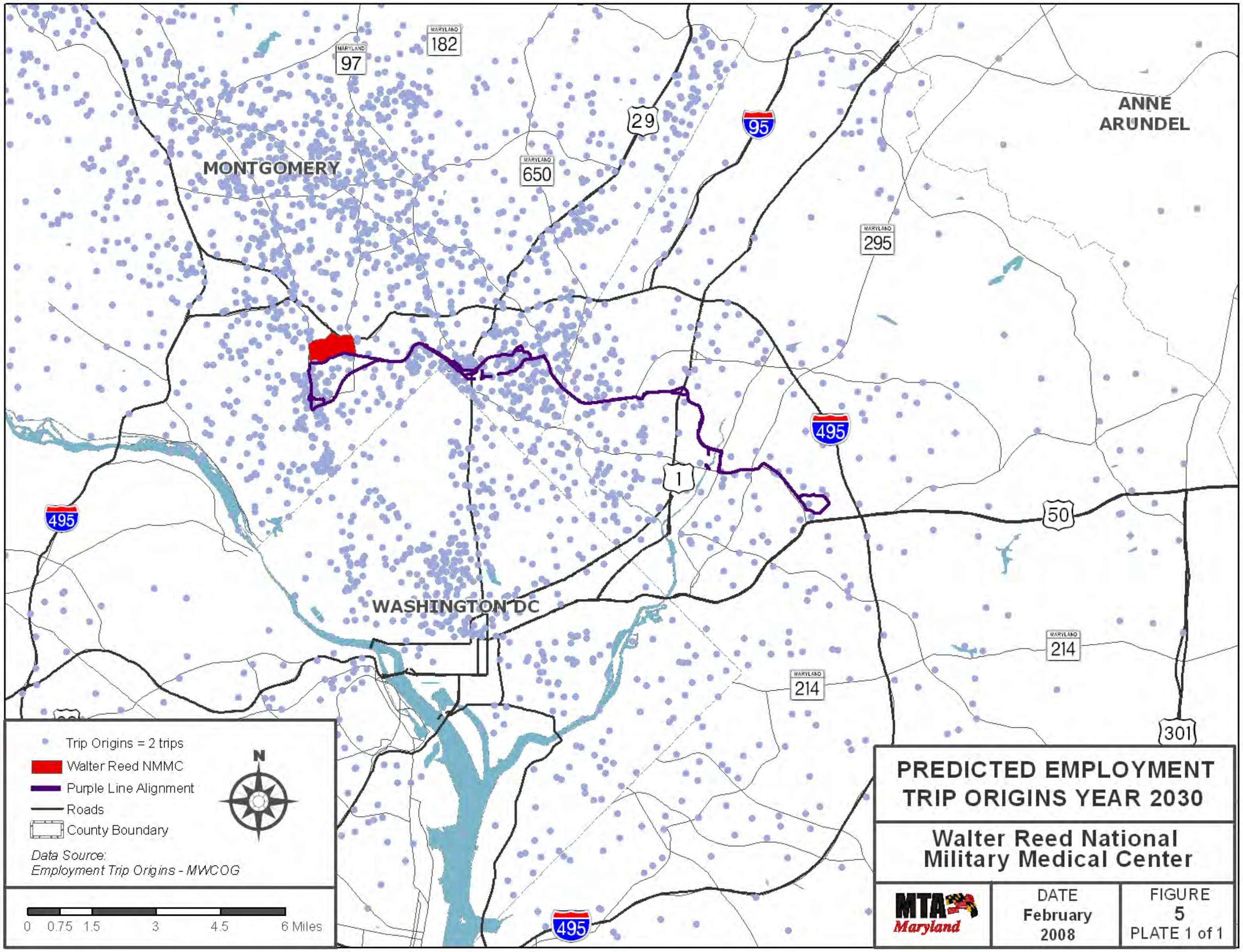
FIGURE
4
PLATE 1 of 1



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Data Source:
Employment Trip Origins - MWCOG
N
0 0.75 1.5 3 4.5 6 Miles
PREDICTED EMPLOYMENT TRIP ORIGINS YEAR 2030
Walter Reed National Military Medical Center
MTA Maryland
DATE February 2008
FIGURE 5 PLATE 1 of 1

Based on this analysis, approximately 650 Walter Reed employees currently live within the Purple Line service area. With the NNMC DEIS figure that approximately 30% of theses employees will be transferred as part of the BRAC changes (1,750 out of 6,000), a total customer market of approximately 200 customers would be added to the peak hour (employment) trips to and from the new WRNMCC on a daily basis. Using a 30% transit mode share, approximately 60 current Walter Reed employees would use transit and some portion of these employees would potentially use the Purple Line transit service for travel to the WRNMCC in the peak hour. This trip could either by way of the Master Plan alignment to Bethesda with a transfer to the Metrorail Red Line to the Medical Center Station or, in the one case of the BRT Low Investment Alternative, a route along Jones Bridge Road although the station would be on Wisconsin Avenue (Rockville Pike) just south of Jones Bridge Road. Under all the alternatives, existing bus services from Silver Spring Metro Station/Transit Center to the WRNMCC area would still be available.

Travel Times

The Purple Line alternatives have their western termini at Bethesda at the Bethesda Metrorail Station. One alternative, BRT Low Investment, would operate on Jones Bridge Road, which boarders the WRNMCC site along its southern edge. The station for the service would be on Wisconsin Avenue (Rockville Pike) south of the Jones Bridge Road intersection, twelve hundred feet south of the Medical Center Station that is located close to the security control entrance to the WRNMCC. Based on the operations plan for the Purple Line travel times from the Silver Spring Metrorail Station to Bethesda Metrorail Station and Medical Center Metrorail Station were derived given future traffic conditions. Travel times between Silver Spring station and the tunnel entrance to NNMC on Rockville Pike were calculated for comparison. Table 2 below identifies the results of this analysis

Table 2 - Travel Time Analysis - Silver Spring to WRNMMC and Bethesda CBD

Travel Time Analysis - BRAC Impacts

Silver Spring to Medical Center

Alternative	Travel Time
Low BRT	24.8
Med BRT	20.6
High BRT	20.6
Low LRT	18.7
Med LRT	16.3
High LRT	16.3

Silver Spring to Bethesda CBD

Alternative	Travel Time
Low BRT	24.5
Med BRT	13.1
High BRT	13.1
Low LRT	11.2
Med LRT	8.8
High LRT	8.8

Assumptons:

Trip times calculated - Silver Spring Metro Station to tunnel / entrance to NNMC on Rockville Pike

At Bethesda Staton:

2 minute walk time - platform to platform

3 minute travel time Bethesda - Medical Center (WMATA)

2.5 minute transfer delay at Bethesda station (WMATA)

At Medical Center BRT stop:

5 minute walk time - Medical Center BRT station to pedestrian tunnel at entrance to NNMC

As a comparison it is estimated that TSM alternative improvements for transit connections between Silver Spring and Bethesda would yield transit service improvements that would allow for a 32 minute trip by bus between Bethesda Center and Silver Spring. A similar analysis for travel between Silver Spring and Medical Center identifies an expected future transit travel time (via bus) of over 35 minutes.

Traffic in the Bethesda/NIH/WRNMCC Area

The potential increase in employment at the combined medical facility could be expected to worsen conditions along this roadway and could affect travel time for the Low Investment BRT alternative.

As part of the Purple Line AA/DEIS, a peak hour traffic operations analysis was conducted for the signalized intersections along the study corridor. Using 2005 field collected traffic counts as the base, peak hour projections were developed for the year 2030 based on an average annual growth rate of 1 percent per year over the 25-year period. In other words, the Purple Line traffic projections assume that during the peak hours, traffic will increase by approximately 25 percent over 2005 levels. The methodology used to determine this growth rate, which was based on the change in trips in the study area TAZs and an analysis of several key volume screenlines, was coordinated with the Maryland State Highway Administration, who concurred with the approach. It is important to note that while an average growth rate of 1 percent per year was assumed, traffic growth does not have to be linear. A specific major event, such as the expansion at NNMC, could result in faster growth during a short period, while the total growth over the 25-year horizon would be expected to represent an average increase of 1 percent per year.

In comparison, the NNMC DEIS developed Year 2011 peak hour traffic projections based on standard traffic impact study procedures. These 2011 peak hour traffic projections included both the NNMC expansion and new trips associated with 11 proposed nearby developments. A comparison of the Year 2011 peak hour traffic projections to the existing traffic volumes at several key intersections along Jones Bridge Road indicate increases in the total peak hour traffic by 2011 of 5 to 10 percent. This equates to an average annual growth rate of between 1 and 2 percent. In applying an average annual growth rate of 1 percent per year, the Purple Line traffic projections accommodate the growth in peak hour traffic expected due to BRAC and allow for increased growth in traffic of approximately 15 percent between 2011 and 2030.

It was therefore concluded that the assumptions built into the Purple Line traffic analysis were conservative enough to reflect expected 2030 traffic conditions within a reasonable variance percentage. Travel time analysis was conducted for conditions noted in the Purple Line analysis. Further travel delay was not added the Purple Line traffic analysis or the Low Investment BRT alternative operations plan to reflect the impact of BRAC as the Purple Line analysis included a sufficient level of growth to reflect the effects.

Analysis Findings

The analysis conducted for this study point to a few conclusions:

- Notwithstanding the growth in BRAC employment and organic growth in the NNMC area, the amount of growth forecasted for the Bethesda area is much higher. Downtown Bethesda remains a much larger travel market for a direct Purple Line transit service than the NNMC area.

- The impacts of BRAC implementation employment and activity growth in the Bethesda area will have a nominal affect on Purple Line transit ridership and traffic conditions in the area around the combined WRNMMC facility.

- The total impact of BRAC growth on potential Purple Line transit ridership is limited when evaluating existing home locations for WRAMC employees.

- Transit travel time to NNMC from Silver Spring and points east are comparable if not faster using the Purple Line alternatives operating along the Master Plan alignment to Bethesda and connecting to the Metrorail Red Line to Medical Center than transit service on Jones Bridge Road.

- Additional travel time delays to the Bethesda CBD as a result of the BRAC traffic increases would adversely affect the operation of the BRT Low Investment alternative, if it were chosen over other options.

3. Purple Line DEIS Re-Evaluation

DEIS RE-EVALUATION

August 8, 2012

Transit Development & Delivery
100 South Charles Street
Tower Two, Suite 700
Baltimore, Maryland 21201

Table of Contents

Appendix A Figures

Appendix B Environmental Re-Evaluation Consultation Checklist

1 Purpose of Re-Evaluation

The Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS) for the Purple Line project was signed by FTA on September 30, 2008. Subsequently, the Notice of Availability for the AA/DEIS was published in the Federal Register on October 17, 2008. Since 2008, the project has undergone further study in preparation for submittal of the Final Environmental Impact Statement (FEIS). As more than three years have passed since the circulation of the AA/DEIS, a Re-Evaluation is required under FTA's regulations (23 CFR 771.129).

This Re-Evaluation has been prepared to assess the significance of any new information or changed circumstances. It presents new information and changes in the affected environment, along with refinements made to the Preferred Alternative. Currently available information indicates that no changes in the affected environment or in the project require the preparation of a supplement to the DEIS. MTA will continue to monitor changes in the affected environment and in the project throughout the development of the FEIS and, if appropriate, MTA will prepare additional documentation to assess the significance of any new information or changed circumstances. All potential impacts will be fully assessed in the FEIS/Section 4(f) Evaluation, and any comments received on the FEIS will be addressed and appended to the Record of Decision (ROD).

2 Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS)

The Purple Line AA/DEIS included a detailed analysis of a No Build alternative, a Transportation System Management (TSM) alternative, bus rapid transit (BRT) alternatives, and light rail transit (LRT) alternatives. The BRT and LRT alternatives included low, medium, and high investment alternatives. The AA/DEIS presented the environmental resources in the study area and potential impacts associated with each of these alternatives.

In August 2009 the Governor of Maryland announced the identification of a Locally Preferred Alternative (LPA). The LPA was a combination of the medium and high investment LRT alternatives with some design refinements. The project is now in the Preliminary Engineering phase where more detailed design studies are being prepared and environmental studies and analyses are being conducted for the Preferred Alternative. The results of these additional studies will be presented in the FEIS/Section 4(f) Evaluation.

3 New Information / Changes in Affected Environment

3.1 New/Updated Data

The corridor has remained generally unchanged since the preparation of the AA/DEIS. Typical of many studies in the NEPA process, updated data is generated over time and will be incorporated into the FEIS/Section 4(f) Evaluation. This includes new US Census data and updated land use and population data generated by the Metropolitan Washington Council of Governments (MWCOG). Consistent with the availability of new data, the future design year of

2040 will be used in the FEIS for ridership forecasts and air quality analyses rather than the projections to 2030 that were presented in the AA/DEIS.

Base mapping has also been updated, and any new features, such as the construction or demolition of homes or buildings, are captured on the new mapping. Finally, the identification of resources continues to be updated based on more detailed information such as the formal delineation of Waters of the US. This updated information will be used as the basis of impact assessments presented in the FEIS/Section 4(f) Evaluation.

In October 2007, the "Stormwater Management Act of 2007" (Act) became effective in the State of Maryland. The Act requires that the principles of environmental site design be implemented to the maximum extent practicable through the use of nonstructural best management practices and other effective site design techniques. While the Act was enacted prior to the October 2008 publication of the AA/DEIS, no implementing regulations or guidance had been issued at that time. Subsequently, in response to the Act, Maryland's stormwater management regulations were revised in May 2009, and the Maryland Department of the Environment (MDE) updated the "Maryland Stormwater Guidelines for State and Federal Projects" (Guidelines) in April 2010. Since April 2010, the Guidelines have been fully implemented, resulting in the requirement of all state and federal projects to be in compliance with the Guidelines. These new guidelines would have been applied to all of the alternatives under consideration. They have been incorporated into the design of the Preferred Alternative while minimizing potential impacts to sensitive resources and would not have changed the identification of the Preferred Alternative.

3.2 Resource Identification since the AA/DEIS

3.2.1 Park Resources. It has been determined that two properties identified as potential Section 4(f) park resources in the AA/DEIS and Preliminary Section 4(f) Evaluation do not meet the definition of a resource requiring protection by Section 4(f) and therefore will not be included in the FEIS/Section 4(f) Evaluation. These properties are the Park Police Headquarters and the Northern Area Maintenance Office (adjacent to Glenridge Community Park). The Purple Line Preliminary Section 4(f) Evaluation also included multiple listings for sub-units within several larger parks rather than the park as a whole. These sub-units will be combined in the FEIS/Section 4(f) Evaluation so that the entire park resource can be evaluated and discussed as a single resource. For example, Sligo Creek Stream Valley Park Unit 1, Unit 2, and Sligo Cabin Neighborhood Park will be presented and discussed as part of the overall Sligo Creek Stream Valley Park.

In the AA/DEIS, the Baltimore-Washington Parkway was identified as a Section 4(f) resource based on its status as a historic property listed in the National Register of Historic Places (NRHP). After the AA/DEIS, the National Park Service advised MTA that the Parkway also should have been denoted as a park. Therefore, the Parkway is now considered a Section 4(f) resource based on its status as a historic property and as a park. The recognition of the park status of the Parkway would not have altered the selection of the LPA or identification of the Preferred Alternative. The Baltimore-Washington Parkway is a long linear feature that crosses the study area in a north-south direction. The Purple Line travels east-west through this area and a crossing of the Parkway cannot be avoided. All alternatives considered in the AA/DEIS proposed that the Purple Line would cross under the Baltimore-Washington Parkway at Riverdale Road. This was done to minimize impacts on the Parkway by crossing under the Parkway at an existing roadway. Since the AA/DEIS was published, MTA has continued to consult with the NPS to ensure that the design of the Preferred Alternative minimizes harm to the Parkway as required by Section 4(f) and includes appropriate mitigation measures. The results of this coordination and the full Section 4(f) analysis will be documented in the FEIS.

3.2.2 Historic Resources . A detailed survey of potential historic resources was conducted in support of the AA/DEIS including a review of previous inventories and surveys, historic maps, archival records, aerial photographs, property deeds, construction information, and field reconnaissance. Resources, including buildings, structures, objects, districts, and sites more than 50 years old, were evaluated for eligibility for listing in the NRHP. Select resources less than 50 years old were evaluated if they appeared to have the potential to be exceptionally important according to NRHP guidelines. Preliminary determinations of eligibility were made for properties that were either previously identified but not evaluated or newly identified. At the request of the Maryland Historical Trust (MHT) early in project development, formal determinations of eligibility for potential Section 106 resources were not prepared during the AA/DEIS phase. Now that the project is in the FEIS phase, determinations of eligibility are being developed, and the findings will be incorporated in the FEIS. New Section 106 resources were identified along the corridor beyond those included in the AA/DEIS; however, the implementation of the Purple Line is not anticipated to have adverse effects on these resources. Based on more detailed engineering and a better understanding regarding construction techniques to be used for the project, determinations of effect will be formally prepared and coordinated with the MHT. This information will be included in the FEIS/Section 4(f) Evaluation, and appropriate mitigation will be developed.

When the AA/DEIS was completed, it was thought that there would only be one historic property, the Falkland Apartments, that would be adversely affected by the project. As formal analysis and Section 106 consultation continues, there appear to be additional instances where previously identified Section 106 resources may be adversely affected by the proposed project. The potential adverse effects are not the result of any design modifications; they are based on a better understanding of the potential effects on the resources. This includes potential impacts to the Talbot Avenue Bridge, which will need to be replaced to accommodate the proposed Purple Line. All BRT and LRT alternatives followed the same alignment through this area and would have had the same impact on the structure. As a result, there may also be an adverse effect on the Metropolitan Branch, B&O Railroad of which the Talbot Avenue Bridge is a contributing element. If an adverse effect results in a Section 4(f) use, a Section 4(f) Evaluation will be prepared, with an assessment of avoidance, measures to minimize harm, and mitigation.

The bridges carrying the Baltimore-Washington Parkway over Riverdale Road would have to be reconstructed to provide sufficient span length over the Purple Line as well as the roadway. Though the Baltimore-Washington Parkway in total is designated as a historic resource, the bridges in question are modern and are not historic features within the resource. Ongoing coordination with the National Park Service has helped inform decisions regarding bridge types and construction staging. These decisions have informed the determination of effect to this resource and it is anticipated that there will be no adverse effect.

Two other previously identified resources of note under further study to determine potential effects and mitigation, as appropriate, are the Columbia Country Club and the University of Maryland. The Preferred Alternative traverses through the Columbia Country Club on the county-owned rail right-of-way. During the AA/DEIS phase, this right-of-way was not initially thought to be within the boundary of the historic resource. However, in preparing the formal Determination of Eligibility there may be a small portion of the county-owned land that is within the historic boundary as the country club has encroached on the county's property for years and has developed tees and greens in this space. Therefore, a minor encroachment may be included in the historic boundary to include these contributing elements. At the request of the Country Club and in order to minimize impacts to these contributing elements a slight shift in the alignment is being developed. A minor lateral shift to the north of approximately 12 feet at its maximum point would serve to avoid and minimize impacts to the resource and is being developed in coordination with the Country Club. It would avoid the more sensitive tees and greens on the south side of the right-of-way. It is also being developed with terraced landscaped areas and would therefore encroach on the historic property to the north. The formal determination of effect is under development and will be included in the FEIS however the alignment, as mitigated with the shift, the overall design and associated landscaping, is anticipated to result in no adverse effect.

Following the publication of the AA/DEIS, the alignment of the Purple Line through the University of Maryland (UMD) was the focus of much comment and discussion. To address these concerns MTA has been working collaboratively for over a year with the UMD Purple Line working group. Regular meetings have addressed issues ranging from alignment and station locations to electromagnetic interference (EMI) and vibration. As part of this effort, the MTA and UMD re-affirmed the alignment included in the AA/DEIS with minor refinements to address future development on campus and to consolidate vehicular access and address local vehicular and pedestrian traffic patterns on campus. During this process, UMD prepared its updated Facilities Master Plan (FMP). The FMP includes the Purple Line alignment and stations consistent with the Preferred Alternative. MTA will continue to work with UMD throughout preliminary engineering and final design. Documentation supporting the determination of eligibility and the effects determination are under development and appropriate mitigation measures will be incorporated into the design of the Preferred Alternative.

Ongoing coordination regarding each resource is continuing and appropriate mitigation measures are being incorporated into the design. This will be included in the determination of effects. The results of all the coordination, studies, and analyses will be included in the FEIS/Section 4(f) Evaluation.

4 Changes to the Project

The Preferred Alternative continues to be defined as an approximately 16-mile LRT alignment with 21 proposed stations and is not substantially different than the alternatives assessed in the AA/DEIS (See Figure 1). The Preferred Alternative is located along the same general alignment as presented in the AA/DEIS. Refinements presented in this Re-Evaluation primarily consist of minor lateral shifts of the transitway from either the middle of the road (usually requiring roadway widening to accommodate the transitway) to the side of the road or from the side of the road to the middle of the road, or vertical adjustments between crossing a road at grade or at a different grade. Other minor refinements pertain to the stations and the two yard and shop facilities. All refinements are intended to reduce impacts resulting from the proposed project and/or improve traffic and transit operations, and they are a consequence of input received from the public and stakeholders through the NEPA process, combined with more detailed engineering and study by the MTA.

The following sections outline the alignment and layout as presented in the AA/DEIS, the impetus for the refinements, the resulting recommendation, changes in anticipated impacts, and the extensive outreach efforts that supported each decision. The discussion included in this Re-Evaluation focuses on those areas of the environment with anticipated changes in effect. Effects were assessed using a similar level of design development as the alternatives presented in the AA/DEIS. A full analysis of the Preferred Alternative will be included in the FEIS/Section 4(f) Evaluation.

4.1 Refinements to the Alignment

4.1.1 Crossing of Adelphi Road

Alignment as Presented in the AA/DEIS. All of the proposed alternatives followed Campus Drive across Adelphi Road towards the University of Maryland (UMD). Both the Low and Medium Investment BRT alternatives crossed Adelphi Road at-grade. The High Investment BRT and all LRT alternatives crossed Adelphi Road below grade. In the alternatives with a below-grade crossing, the West Campus station was below the grade of the parallel Campus Drive roadway adjacent to a retaining wall. When the AA/DEIS was published, the existing grade of University Boulevard was thought to be too steep for light rail vehicles. The LPA included the below-grade crossing.

Impetus for Change. The MTA has been collaboratively working with UMD to coordinate the design and alignment of the Purple Line through campus. During working sessions, UMD representatives requested that MTA reconsider the at-grade crossing of Adelphi Road. Specific issues UMD raised included pedestrian access/circulation, visibility of the station relating to its connection to both University of Maryland University College (UMUC) and main campus, station usage, and security for passengers waiting at the station.

Recommendation. As a result of further study, the recommendation that will be included in the Preferred Alternative is to cross Adelphi Road at-grade. MTA developed an option whereby the vertical profile of the transitway was adjusted to allow the Purple Line to climb slightly in the median of University Boulevard so it can meet the elevation of Campus Drive prior to the proposed at-grade crossing of Adelphi Road. Consequently, the proposed West Campus station would be at street level, on the south side of Campus Drive.

Changes in Anticipated Impacts. The revised transitway profile allows the station to be at-grade with Campus Drive, rather than the previous below grade condition. To the west of Adelphi Road, the project footprint is increased because the Purple Line is at-grade and cannot run below the roadway (See Figure 2).

There would be no changes in anticipated impacts to natural or cultural resources as there are none in the vicinity of the intersection. Local access and circulation patterns would be improved with the at-grade option providing improved pedestrian access and crossing of the roadway, and greater visibility at the station is preferable from a safety standpoint. The at-grade refinement would result in an expected transit delay of approximately 69 seconds. The intersection of Campus Drive and Adelphi Road was projected to operate at a level of service (LOS) E/E (am/pm) in the design year under the grade-separated option. The at-grade crossing of the Purple Line would take some time from the signal phase; however, the signal to the west at the split with University Boulevard serves to meter traffic. The combination of metered traffic, proposed turning movement improvements, and a proposed re-timing of the signal at Campus Drive and Adelphi Road would result in a projected LOS D/E (am/pm). The at-grade configuration is being coordinated with and incorporated into the Prince George's County Transit Oriented Development (TOD) study for the West Campus Station. Finally, the at-grade crossing would be much easier to construct while maintaining traffic on Adelphi Road and would save the proposed Purple Line project an estimated $96M.

Summary of Outreach. Based on the initial request from UMD, the at-grade configuration was first presented at a regularly scheduled coordination meeting between UMD and MTA. UMD representatives were pleased that preliminary engineering studies demonstrated the option could work, and UMD reiterated their support for the at-grade crossing based on station design, access, safety, and visibility considerations. The at-grade option was then presented by MTA at a Project Team meeting with representatives from Prince George's County and the Maryland State Highway Administration (SHA) in attendance.

Subsequently, the at-grade option was presented at a University of Maryland Neighborhood Work Group meeting held on April 30, 2012 which pertained to the design of the Purple Line through three stations in the vicinity of the University of Maryland including the West Campus station. Following the meeting, mapping showing the option was posted on the project website.

In conjunction with MTA's efforts, the Maryland-National Capital Park and Planning Commission (M-NCPPC) Prince George's County Planning Department initiated its TOD Study, intended to prepare development strategy plans to maximize the TOD potential at five proposed Purple Line stations that are not within approved sector or transit district development plans. The proposed West Campus station near Adelphi Road is one of the five stations under study. As part of the TOD study, M-NCPPC held a series of public meetings for each station area. The first West Campus station meeting was held in January 2012 with additional meetings in February and April of 2012. The at-grade crossing of Adelphi Road was discussed at the April 2012 meeting, which was attended by representatives from MTA's Purple Line team.

4.1.2 Alignment along Kenilworth Avenue from River Road to East West Highway

Alignment as Presented in the AA/DEIS. The AA/DEIS included several alternatives running along Kenilworth Avenue. In the Low Investment BRT alternative, the Purple Line shared the northbound outside travel lane with other traffic, and in the southbound direction the proposed BRT would travel in a dedicated outside lane. The Medium Investment BRT was located in exclusive outside lanes. The Low and Medium Investment LRT alternatives proposed an exclusive transitway on the west side of the Kenilworth Avenue. In each case, the right-of-way along Kenilworth Avenue was expanded to accommodate the proposed transitway. The LPA in this area included an exclusive transitway on the west side of Kenilworth Avenue.

Impetus for Change. Following the publication of the AA/DEIS, through regular and ongoing coordination with SHA, the MTA learned of future plans for highway improvements at the intersection of River Road and Kenilworth Avenue required to accommodate future development related to the M Square development on River Road. In addition, the long term plans for Kenilworth Avenue were listed in SHA's Highway Needs Inventory as a future 6-lane roadway in contrast to the existing 5-lane roadway section.

As a result of this new information, the MTA shifted the proposed LRT alignment farther to the west to accommodate these future plans, but the shift resulted in numerous additional potential displacements along Kenilworth Avenue. After presenting this information to community and project stakeholders, members of the public and representatives from Prince George's County and the Town of Riverdale Park expressed concern over the additional potential displacements and requested that MTA work with SHA to re-assess the need for roadway widening and to consider options that would minimize impacts.

A collaborative effort was initiated between MTA, SHA, and Prince George's County to re-assess the future transportation needs in the Purple Line corridor along Kenilworth Avenue in light of the changing nature of the area and other ongoing projects. The portion of Kenilworth Avenue to the south of the proposed Purple Line alignment was previously narrowed from 6 to 4 lanes, and there is a present effort to convert the existing wide shoulders to bike lanes and wider sidewalks. The conversion of the roadway paving to pedestrian and bicycle facilities is, in a large part, a reaction to high transit use and increasing pedestrian activity in the area. The portion of Kenilworth Avenue in the Purple Line corridor is expected to reflect the conditions to its south more than the conditions found to the north of the corridor, with the introduction of a Purple Line station expected to further emphasize the need for better bicycle and pedestrian access and connections.

The MTA also re-assessed future travel demands. The need for the proposed improvements at the intersection of River Road and Kenilworth Avenue in order to accommodate future development at M Square was confirmed. However, further traffic analysis demonstrated that a future 6-lane roadway section on Kenilworth Avenue was not warranted. In fact, not all of the existing 3 southbound lanes were needed for the entire length of Kenilworth Avenue within the project corridor. Numerous options were considered, some at the suggestion of the community and some as a result of MTA's analysis.

Recommendation. The option identified as best addressing community concerns while meeting both traffic and transit operational needs is a 5 to 4 lane roadway configuration, with the transitway in the median of Kenilworth Avenue. This recommended option includes sidewalks on both sides of the roadway (currently sidewalks only exist along portions of the southbound lanes), bicycle-compatible outside travel lanes, all previously planned intersection improvements at River Road and a 5-lane section through the intersection of River Road that transitions down to 4 lanes to the south. This "5 to 4 option" reduces the number of potential business displacements along Kenilworth Avenue to 3 and avoids some displacements initially anticipated in the AA/DEIS. In addition, by locating the transitway in the median, access to adjacent businesses could be maintained, and the transitway would serve as an access management tool focusing crossings to signalized intersections. Local roads would be maintained with right-in/right-out access. The overall reduction in the width of the right-of-way and resulting reduction in potential business displacements were the primary reasons for this recommendation (See Figure 3).

Changes in Anticipated Impacts. There are no anticipated impacts to natural or cultural resources along Kenilworth Avenue. The number of potential displacements was reduced from 9 to 3 including avoidance of a church, a bowling alley, two restaurants, a tire shop, and a bakery. (Note: Not all of these were included in the AA/DEIS as the potential future roadway widening was not known at the time.) Once the roadway is widened, transitway construction would be confined to the median of Kenilworth Avenue, resulting in fewer construction impacts to adjacent businesses. The reduced roadway section would allow for the addition of sidewalks on the east side of Kenilworth Avenue, thus improving local pedestrian access and circulation.

The "5 to 4 option" would require a minor change to operations at the intersection of River Road and Kenilworth Avenue, however analyses prepared by the MTA and reviewed and approved by both SHA and Prince George's County demonstrate acceptable performance levels of the roadway and intersection. A minor transit delay of approximately 34 seconds would be incurred as the train enters the median of Kenilworth Avenue. The transitway would serve as an access management tool, consolidating left-turns and entrances. Finally, due in large part to the reduction in potential displacements, an anticipated project cost savings of $23M would result from the implementation of the "5 to 4 option," with the added benefit of businesses remaining an integral part of this vibrant community.

Summary of Outreach. On February 12, 2011 the MTA held a joint meeting with the Central Kenilworth Avenue Revitalization Plan (CKAR) at St. Bernard's Parish to provide the community updated plans, including the potential for new impacts to their community. The MTA, CKAR, and Prince George's County worked together to publicize this meeting sending invitations to the project Neighborhood Work Group mailing lists for this area, other residents within a geographic area, and representatives of area community associations, and by posting fliers at local establishments. Approximately 100 people attended the February 12th meeting, including representatives from four potentially impacted properties or businesses. At this meeting the MTA presented project-related plans superimposed on aerial mapping, defining the alignment along River Road, Kenilworth Avenue, and Riverdale Road. Potential additional displacements of businesses along Kenilworth Avenue were described and demarcated on the maps.

The MTA extended an invitation to owners of all potentially displaced properties to meet with MTA individually. The property owners were contacted via phone and were mailed a letter. Four meetings were held, one with the owners of 6220 Kenilworth Avenue (unimproved lot), one with the owner of 6322 Kenilworth Avenue (Rinaldi's Riverdale Bowl), one with the owner of 6328 Kenilworth Avenue (Tires R Us), and one with the representative from 6410 Kenilworth Avenue (First Korean Presbyterian Church of Maryland). MTA project representatives also met with the owner of Total Automotive, a property along Quesada Road.

At the request of the community, MTA arranged for a meeting with the local business community, which was held on July 12, 2011 at the Riverdale Park Town Hall. The MTA employed a variety of tools to notify the community of this meeting. Initially the MTA notified the two area business associations, the Riverdale Park Business Association and CKAR, who in turn notified their members. Additionally MTA representatives walked along the Purple Line Corridor in the area of Kenilworth Avenue and Riverdale Road from River Road to the East Pines Shopping Center handing out fliers to area businesses. The MTA also used this time to update their mailing list of all the businesses in the corridor in order to mail invitations to the meeting. The invitation for the meeting was sent to the properties along the corridor, as well as the property owner of record for any potentially displaced properties. Prince George's County and Town of Riverdale Park staff were also notified of the meeting, and they notified their constituents.

Forty-four people attended the meeting held on July 12, 2011 including representatives of nine of the potentially displaced or impacted properties or businesses. In total, the MTA met with owners or representatives of 11 of the potentially impacted properties or businesses in this area. At this meeting the community was shown the current plans for the Purple Line along River Road, Kenilworth Avenue, and Riverdale Road. Attendees voiced concern over the loss of their businesses and the impacts to the community. They requested further study and analysis of options that might allow businesses to remain and reduce other potential impacts to properties in this area of the project corridor.

Community members and business owners offered several ideas, including working with SHA to reduce the amount of land needed for future roadway widening, elevating the proposed transitway on a structure over the current businesses, impacting the park instead of the businesses, and finding other alternatives that would not require potential property displacements.

In November 2011, the MTA held a series of four Open Houses, with each meeting located in a different location in the corridor. At these meetings, information was presented on the overall project and the LPA, as refined at that time. Meeting notices were sent to over 60,000 people including everyone on the project mailing list and anyone who had attended and signed in at a previous meeting.

After the July 2011 meeting, the MTA worked diligently with SHA and Prince George's County to define viable options for this part of the project area. Several different options with varying horizontal and vertical alignments were considered, and detailed analyses of each was conducted. This effort resulted in the recommended "5 to 4 option", which will be included in the Preferred Alternative. Once evaluations were complete, the resulting information was presented to the community by MTA.

A Neighborhood Work Group meeting was held on April 12, 2012, at which the MTA presented the findings of the most recent studies and the resulting recommended transitway alignment and roadway configuration through the Kenilworth Avenue portion of the project area. Prior to the Neighborhood Work Group meeting, all businesses on Kenilworth Avenue between River Road and Riverdale Road received fliers regarding the meeting date, time, place, and agenda. As they were distributing fliers, project staff took every opportunity to explain how the alignment had been shifted to run down the middle of the road to reduce business impacts. As part of this outreach effort, project representatives spoke directly with the owners of Pollo Fiesta, Tires R Us, and Flor de Puebla Bakery (by phone) to inform each owner that the currently proposed refinement to the alignment would mean that their businesses would no longer be potentially displaced by the Purple Line. Thirty people attended the meeting on April 12th, including the business owners of Rinaldi's Riverdale Bowl and PG Brake & Front End and representatives from the Riverdale Business Association and CKAR. The community expressed its appreciation for all the hard work completed by the MTA and strong support for the proposed refinements of the "5 to 4 option" in this area. A representative of the First Presbyterian Korean Church came to the University of Maryland neighborhood work group meeting later in April to gather information. A follow-up meeting was held in June 2012 between the MTA and the church to focus on specific details regarding the project and the church property.

Following the April 12th meeting, an MTA representative either visited or called each owner of the businesses along Kenilworth Avenue that are still identified as potential displacements by the proposed Purple Line project.

The proposed Riverdale Park station is included as one of the five stations under study as part of M-NCPPC's TOD study. As part of the study, M-NCPPC held a series of meetings for each station area. The first meeting for the Riverdale Park station was held in December 2011 with additional meetings in January and April of 2012. The alignment leading up to the station was presented and discussed at each meeting. In addition, representatives from MTA's Purple Line team attended each meeting and listened to community comments. The April 2012 meeting included the refined alignment with the narrowed "5 to 4 option" roadway section and alignment of the Purple Line in the median of Kenilworth Avenue.

MTA's outreach will continue with strong participation expected from the residential and business community along Kenilworth Avenue, as well as representatives from CKAR, the Town of Riverdale Park, and Prince George's County.

4.1.3 Alignment through intersection of Kenilworth Avenue and East West Highway

Alignment as Presented in the AA/DEIS. As discussed above in Section 4.1.2, the low and medium investment LRT alternatives were located adjacent to the west side of MD 201. Heading south, they crossed the Kenilworth Avenue/East West Highway intersection at-grade entering the southeast quadrant where there was a proposed station.

Impetus for Change. Members of the public and representatives of Prince George's County and the Town of Riverdale Park expressed their concern regarding the level of traffic congestion at this intersection both at meetings and through written comment. At regular ongoing coordination meetings, representatives of SHA also expressed concerns regarding the proposed at-grade crossing of the Purple Line through the busy intersection of Kenilworth Avenue and East West Highway. SHA was primarily concerned that the introduction of the Purple Line would only exacerbate existing problems at this already heavily congested intersection. Traffic and operational analyses supported this concern and indicated delays to the light rail system as well as further delays to vehicular traffic.

Recommendation. Based on input from project stakeholders and supporting technical analysis, the aerial crossing was included as part of the Locally Preferred Alternative (LPA) announced by the Governor of Maryland in August 2009. The transitway would have started climbing along the west side of Kenilworth Avenue in order to span the intersection before it would enter the southeast quadrant and a proposed elevated station. At the time this recommendation was made, the alignment did not change from the AA/DEIS medium investment alternative, but rather the vertical profile of the transitway changed. A grade-separated alignment refinement through the intersection of Kenilworth Avenue and East West Highway is being proposed in the Preferred Alternative. This section discusses the change from an at-grade condition to a grade-separated condition; the refinement of changing from the west side to the middle of Kenilworth Avenue is discussed above in Section 4.1.2.

Changes in Anticipated Impacts. This refinement did not change the horizontal alignment of the alternative and therefore had no change to anticipated "footprint" impacts along Kenilworth Avenue. Consistent with other displays in this Re-Evaluation, Figure 4 shows the comparison of the original at-grade crossing on the west side of Kenilworth Avenue as shown in the AA/DEIS to the current Preferred Alternative with a grade-separated crossing from the median of Kenilworth Avenue. By traversing over the intersection, the existing operations of the intersection are not expected to change (an improvement over the alternatives in the AA/DEIS). Transit operations realized a substantial improvement avoiding delays at the intersection which improved overall transit travel times by 90 seconds. The aerial alignment would have also allowed some entrances along Kenilworth Avenue to remain open under the bridge structure. While the refined option would introduce a visual change in the community, both the community and representatives of Prince George's County and the Town of Riverdale Park expressed an opinion that the elevated station could represent a real opportunity to anchor transit oriented redevelopment surrounding the station area. Although the alignment and station location were shifted closer to East West Highway, the potential business displacements remained the same. The area for future TOD was maximized.

Summary of Outreach. The aerial option for traversing the Purple Line over the intersection of Kenilworth Avenue and East West Highway has been shared with the public since before the publication of the AA/DEIS, including at a Community Focus Group meeting held in April 2008. At the April 2008 meeting, MTA stated that "due to traffic congestion an aerial option over the intersection of Kenilworth Avenue and MD 410 is being evaluated."

At the time of the Purple Line public hearings (November 2008) and during the subsequent comment period, members of the public, elected officials, and staff from Prince George's County continued their support of a grade-separated crossing of the intersection. This was further supported through ongoing coordination with SHA. Representatives from the Town of Riverdale Park and other stakeholders requested that the MTA continue to evaluate an aerial option in the area of the Kenilworth Avenue/East West Highway intersection stating that an aerial option could be a part of the redevelopment of the area, and it would help to avoid the congested intersection.

Additional detailed studies, completed subsequent to SHA and the community expressing concerns, confirmed the operational issues associated with crossing at-grade both in terms of traffic and transit delays. Though implementing an aerial structure would increase the capital cost of the project (as compared to the at-grade proposal), preliminary studies demonstrated a substantial increase in efficiency of the system, making the aerial structure a cost-effective solution. The decision to move forward with the aerial structure was backed by the local community, Prince George's County, local elected officials, and SHA.

The aerial crossing of the intersection was included in the announcement of the LPA in August 2009. It was included in the description of the project provided in press releases, project newsletters, and posted on the project's website. At that time it was noted that MTA would continue to work with the County and the community to fully integrate the elevated station into their future plans for the area. Plans for the aerial crossing were presented again at a public briefing for the Town of Riverdale Park in January 2010. The community meeting was publicized by MTA with invitations to those who signed up for the Community Focus Groups as well as the general public. In addition, Prince George's County and the Town of Riverdale Park assisted with advertising the meetings.

On February 12, 2011 the MTA held a joint meeting with CKAR at St. Bernard's Parish to provide updated project information and get feedback on the updated plans and potential impacts to the community. The MTA, CKAR, and Prince George's County worked together to publicize this meeting. These efforts included sending invitations to the project Neighborhood Work Group mailing lists for this area, other residents within a geographic area around this portion of the alignment, representatives of local community associations, and by posting fliers at local establishments. The collaborative outreach efforts resulted in approximately 100 people participating in the meeting.

At the February 12th meeting, the MTA presented plans superimposed on aerial mapping, displaying the project corridor in the vicinity of the Kenilworth Avenue/East West Highway intersection including the proposed aerial crossing of the intersection. After details of the aerial structure concept and the at-grade option had been presented, some residents voiced their support for the aerial structure, while other residents supported an at-grade option. State Senator Paul Pinsky spoke to the crowd and indicated that he had requested that the MTA evaluate the aerial structure because he felt it would best serve the community and the project in the long term due to existing heavy traffic congestion at the intersection, which is only expected to get worse. Questions arose regarding what the bridge might look like, but given the preliminary stage of development, specific details regarding structural design and aesthetics were not available but would be the topic of future meetings.

At the request of the community, MTA arranged for a meeting with the local business community, which was held on July 12, 2011 at the Riverdale Park Town Hall. The MTA employed a variety of tools to notify the community of this meeting. Initially the MTA notified the two area business associations, the Riverdale Park Business Association and CKAR, who in turn, notified their members. Additionally MTA representatives walked along the Purple Line Corridor area of Kenilworth Avenue and Riverdale Road from River Road to the East Pines Shopping Center handing out fliers to area businesses. The MTA also used this time to update their mailing list of all businesses in the corridor in order to mail invitations to the meeting. The invitation for the meeting was sent to the properties along the corridor, as well as the property owner of record for any potentially displaced properties. Prince George's County and Town of Riverdale Park staff were also notified of the meeting, and they notified their constituents. Forty-four people attended the July 12, 2011 meeting.

In November 2011, the MTA held a series of four Open Houses, with each meeting located in a different location in the corridor. At these meetings, information pertaining to the overall project and the LPA, as refined at that time, was presented. Meeting notices were sent to over 60,000 people, including everyone on the project mailing list and anyone who had attended and signed in at a previous meeting.

The station at this location is included as one of the five stations under study as part of M-NCPPC's TOD study. As part of the study, M-NCPPC held a series of meetings for each station area. The first meeting for the Riverdale Park station was held in December 2011 with additional meetings in January and April of 2012, which were attended by representatives from MTA's Purple Line team. The aerial crossing of the Kenilworth Avenue/East West Highway intersection and proposed station location was presented and discussed at each meeting.

As part of MTA's community outreach program, Neighborhood Work Groups meet regularly, with the latest meeting in this area held on April 12, 2012. Such outreach efforts will continue as the project develops, with strong participation expected from the residential and business community located in the vicinity of the Kenilworth Avenue and East West Highway, as well as representatives from CKAR, the Town of Riverdale Park, and Prince George's County.

4.1.4 Alignment along Riverdale Road from Kenilworth Avenue to Veterans Parkway

Alignment as Presented in the AA/DEIS. The AA/DEIS included several roadway/transitway configurations along Riverdale Road. In the Low Investment BRT alternative, the Purple Line shared the outside lanes of Riverdale Road with other traffic. The Medium and High Investment BRT alternatives were located in exclusive lanes on the outside of Riverdale Road. For the LRT alternatives, the Riverdale Park station was located in the southeast quadrant of the intersection of Kenilworth Avenue and East West Highway. After leaving the station, the alignment shifted into the median of Riverdale Road. The Low and Medium Investment LRT alternatives were located in the middle of Riverdale Road with left turning vehicular traffic sharing the transitway. The High Investment LRT alternative was also located in the middle of Riverdale Road but in exclusive lanes. For all of these alternatives except the Low Investment BRT, the right-of-way along Riverdale Road would be expanded to accommodate the transitway.

Impetus for Change. Representatives from Prince George's County, including elected officials, and community members expressed concerns with the median running alternatives along Riverdale Road. The Low and Medium Investment alternatives required left turning vehicles to share the transitway with trains, and the High Investment alternative required left turning vehicles to cross the tracks. The High Investment alternative also had increased residential impacts. With each proposed LRT alternative, homes and businesses along this stretch of Riverdale Road would be restricted to right-in/right-out access. In order to accommodate the proposed transitway, Riverdale Road would have to be widened, resulting in strip takings of adjacent properties and re-grading of front yards and driveways. Since existing residences closest to the Baltimore-Washington Parkway are located on very small lots, some with steep driveways, there was a concern that the strip takings would be too much of a burden and result in severe impacts to the property owners. Therefore Prince George's County representatives requested that an alignment option be developed which would locate the transitway on the south side of Riverdale Road. The resulting transitway location would result in no conflict between trains and left-turning vehicles but would require additional residential displacements. However, County representatives indicated that based on preliminary discussions with the owners of potentially displaced residences, the residents might prefer total acquisition and relocation over a partial property taking.

During subsequent outreach sessions involving the community, and potentially affected property owners specifically, the preference for total acquisition was confirmed. Residents voiced concerns that properties are small, with their houses dangerously close to the street, and they have already experienced passing motorists crashing into fences, mailboxes, and parked vehicles. Being restricted to right-in/right-out access was viewed as a significant problem. For these reasons, residents indicated that they would rather be displaced than to stay with the additional restrictions and impacts. A preliminary assessment conducted in March 2010 assessing the potential partial acquisitions associated with the median option along this portion of Riverdale Road concluded that for at least 7 of the homes in question the damages associated with the partial acquisitions were considered so severe that those parcels should be considered total acquisitions.

Recommendation. The recommended project refinement that will be included as part of the Preferred Alternative is to shift the transitway alignment from the median of Riverdale Road to an exclusive transitway on the south side of Riverdale Road. Engineering studies, traffic and transit operational analyses, consideration of impacts and safety, and extensive community outreach were performed in order to make this recommendation. Primarily because of operational issues associated with the Baltimore-Washington Parkway interchange at Riverdale Road, the decision to align the proposed transitway on the south side of Riverdale Road near the interchange, where the Purple Line is proposed to run under the Baltimore-Washington Parkway, was made earlier than for the rest of Riverdale Road. Locating the transitway in the center travel lanes of Riverdale Road under the Baltimore-Washington Parkway would have conflicted with the left turn bays associated with the diamond interchange ramps and would have resulted in substantial impacts to the operation of the interchange.

Changes in Anticipated Impacts. There are no natural or cultural resources along this portion of the alignment from Kenilworth Avenue to the Baltimore-Washington Parkway. Neither option provides substantially different advantages or disadvantages in terms of traffic operations, traffic safety, transit travel times, or capital costs. However, the options do offer distinct advantages and disadvantages in three key areas: property impacts, transit operational reliability, and engineering feasibility/constructability. In terms of property impacts, the median option would require eleven fewer displacements along this portion of Riverdale Road. The south side option would provide for much more reliability in transit operations along the corridor compared to the median option, which would require left turns to share the transitway and would require an at-grade crossing of eastbound Riverdale Road to transition the Purple Line from the median to the south side of the roadway. The south side option, which would be located outside of the existing Riverdale Road roadway footprint, would be easier to construct than the median option, and maintenance of traffic during construction would be simpler than if the transitway were being constructed in the median of Riverdale Road (See Figure 5).

The MTA and Prince George's County expressed deep concern regarding the potential increase in residential displacements. However, after consultation with community members, Prince George's County representatives determined that the quality of life of the community would be more adversely affected by the median option than the south side option. To more fully understand the community concerns, particularly the concerns of those residents who may potentially be displaced, the MTA embarked on an extensive outreach program (as summarized below) prior to any decisions or recommendations.

Summary of Outreach. After studying the County's suggestion to shift the Purple Line to the south side of Riverdale Road, MTA embarked on an extensive outreach effort, specifically focused on the potential new displacements. The following summarizes the targeted outreach to those homeowners, along with outreach efforts aimed at the broader community.

To engage the community in a discussion about the possibility of shifting the Purple Line alignment, two public meetings were held in March 2010. The MTA first met on March 16, 2010 with residents who live on the south side of Riverdale Road, specifically with property owners whose homes would be displaced under the proposed south side alignment shift. The purpose of this meeting was to present detailed mapping of the two options and to provide property owners with ample time and opportunity to ask questions of the MTA and provide input on the options.

Due to the nature of the potential change in impacts, targeted outreach was conducted. Twenty-one letters (in both English and Spanish) were sent out to the residents of the homes along Riverdale Road and all property owners that were listed at a different address than Riverdale Road, inviting them to the meeting. The invitation letters provided the meeting date, time, location, and meeting topic. Representatives from Prince George's County Planning Department of the M-NCPPC and the Department of Public Works and Transportation, along with local elected officials, were also invited to attend the meeting. In addition to sending invitation letters, the MTA also placed reminder phone calls, when numbers were available, and went door-to-door, notifying residents at each residence of the meeting. Seven properties were represented at the March 16th meeting including owners of six of the potential new displacements. Purple Line project staff members provided Spanish language translation throughout the meeting.

Mapping of the median option and the south side option were presented by the MTA and those in attendance were given time and opportunity to ask questions and encouraged by the MTA to comment on both options. To better relate to the proposed project configuration, residents identified their own homes on the project map. After outlining the reasons for considering the south side option, the MTA explained how each option would affect the residents in attendance. For the remainder of the meeting, homeowners reviewed available maps, asked questions, and discussed options.

Key issues pertaining to the median option, as identified by homeowners include:

- The loss of property through strip takings on already small parcels,
- The prohibition of left turns into and out of driveways,
- The resulting need to make u-turns to access homes, and
- The existing safety concerns with living on a busy street that many thought would be further compounded by moving the roadway closer to their homes.

Nearly all of the residents in attendance stated that, given the extent of the impacts associated with the median option, they would prefer to be displaced entirely rather than remain on even smaller lots with their homes closer to the roadway. A definite preference for the south side option over the median option was expressed. The MTA requested that residents share the information presented at this meeting with their neighbors who were not in attendance and encourage everyone to attend the community meeting scheduled for later in the week.

The second meeting regarding the Riverdale Road options was an Eastpines Community Association meeting, held on March 18, 2010. The president of the Eastpines Community Association went to each house on Riverdale Road and to the houses behind Riverdale Road to personally invite residents to the meeting. Fifty-three people attended this meeting including individuals representing an additional three of the potentially displaced properties who had not attended the March 16th meeting. Two of these three individuals represented properties identified as potential new displacements resulting from the south side option. The other individual represented a property potentially displaced by either option.

MTA presented an overview of the project and provided a detailed description of the two options using large aerial maps with the proposed Purple Line superimposed. The presentation was made in English, and was summarized in Spanish, and the project newsletter and fact sheet were available in both English and Spanish. Whereas the March 16th meeting focused on the area with potential displacements, this meeting focused more broadly on the project area along Riverdale Road. There was an excellent exchange of ideas and questions. Residents, especially those who live along Riverdale Road, echoed many of the same comments as those expressed at the March 16th meeting relating to the median and south side options of the transitway alignment. Other issues discussed include:

- Access to and from the communities along Riverdale Road, especially east of the Baltimore-Washington Parkway,
- Safe pedestrian crossings of Riverdale Road,
- Pedestrian access to the proposed stations along Riverdale Road, and
- General questions about transit and traffic operations.

Based on the input received at the March 16 and March 18, 2010 meetings, and supporting project analysis, the MTA and Prince George's County jointly endorsed the south side option along Riverdale Road between Kenilworth Avenue and Veterans Parkway. The MTA remains extremely concerned about the impact of the additional displacements associated with the south side option and has continued to closely coordinate with the affected property owners.

Another public meeting was held on February 12, 2011, with notification efforts by both the MTA and CKAR. Fliers noting the meeting date, time, location and agenda were either mailed or delivered directly to local community associations, owners of properties potentially affected by the project, and area residents. The goal of this meeting was to present the updated plans for the Purple Line in the Riverdale Park area, which included showing the community the shift to the south side of Riverdale Road. CKAR and the MTA worked together to notify the community of the meeting. This included sending out a flier to the local community associations, the properties potentially impacted by the alignment shift, and residents who lived in the area. In total, 103 people attended the February 12th meeting, seven of whom were residents of potentially displaced homes. This included one resident who had not attended either the March 16th or March 18th meetings. During the meeting Dannielle Glaros, Chief of Staff for Prince George's County Councilmember Eric Olson, stated that Prince George's County had requested that the MTA consider an option with a shift in the proposed transitway location to the south side of Riverdale Road because of the benefits it would have for the community. Ms. Glaros stated that if the Purple Line were in the median it would still result in the acquisition of strips of property from the front yards of the houses on the south side of Riverdale Road. Ms. Glaros further explained that at community meetings in the Spring of 2010 many residents who would be directly impacted had expressed their preference for total displacement by the project instead of the partial takings and resulting property and roadway conditions.

In April 2011 the Purple Line project website was updated to include aerial photographs and engineering drawings that reflected the shift of the proposed Purple Line transitway alignment to the south side of Riverdale Road and indicated the potential new property impacts due to the shift of the proposed alignment.

In July 2011 the MTA held a meeting with the businesses in Riverdale Park. The focus of this meeting was the Purple Line alignment from the River Road Station to the Beacon Heights station, and the impacts to the businesses in this area. For this meeting notification was sent to all of the businesses along the alignment in this area, CKAR and the Riverdale Park Business Association. There were 44 individuals in attendance at the meeting. The shift to the south side was presented and explained, but was not a major point of discussion.

In November 2011, the MTA held a series of four Open Houses, with each meeting located in a different location in the corridor. These meetings presented information on the overall project and the LPA, as refined at that time, which included the shift to the south side of the roadway. Meeting notices were sent to over 60,000 people, including everyone on the project mailing list and anyone who had attended and signed in at a previous meeting.

In total, owners of 8 of the additional 11 properties that would potentially be displaced by the shift in the Purple Line alignment from the median of Riverdale Road to the south side of Riverdale Road attended at least one of the community meetings held regarding the proposed alignment refinement. Owners of the other potential displacement properties were invited through mailings, delivery of fliers to residences, and through personal invitation via door–to-door contact.

Two of the five stations under study as part of M-NCPPC's TOD study are along Riverdale Road, the Riverdale Park Station near Kenilworth Avenue and the Riverdale Road/Beacon Heights Station east of the Baltimore-Washington Parkway. As part of their study, M-NCPPC held a series of meetings for each station area, attended by representatives from MTA's Purple Line team. For the Riverdale Park Station, the first was held in December 2011 with additional meetings in January and April of 2012. For the Riverdale Road/Beacon Heights Station, the first meeting was held in November 2011 with additional meetings in February and March of 2012. The alignment of the Purple Line on the south side of Riverdale Road was presented and discussed at each meeting.

4.1.5 Alignment along Veterans Parkway

Alignment as Presented in the AA/DEIS. In each of the LRT alternatives presented in the AA/DEIS, the proposed Purple Line transitway would have been located in the median of Veterans Parkway. The Low Investment LRT alternative turned off Veterans Parkway at Annapolis Road while the others followed Veterans Parkway to Ellin Road. The Medium Investment LRT alternative crossed Annapolis Road at grade and the High Investment LRT alternative crossed below Annapolis Road.

Impetus for Change. The Prince George's County Parks Department Northern Area Maintenance Office property (Glenridge) located adjacent to the Glenridge Community Park was identified as the most promising location for a proposed light rail yard and shop in Prince George's County and was included in the AA/DEIS. The Glenridge site is located adjacent to the west side, or southbound direction, of Veterans Parkway. Once this site was identified, the alignment in the area was reconsidered to provide safe and efficient access to the yard. The original median alignment would have required transit vehicles entering and exiting the yard to cross southbound traffic on Veterans Parkway. It was also difficult to accommodate the lead tracks and switches required for the yard in the median. An alignment on the west side of the roadway would not require the transit vehicles to cross vehicular traffic.

Recommendation. To provide improved access to the proposed Glenridge yard and shop and avoid impacts to traffic on Veterans Parkway, the alignment was shifted from the median to the west side of Veterans Parkway. This shift can be accommodated primarily within the State-owned highway right-of-way along Veterans Parkway.

Changes in Anticipated Impacts. Glenridge Community Park, a Section 4(f) resource located adjacent to this portion of Veterans Parkway, would incur impacts from the proposed project. However, the proposed refinement in which the transitway is shifted from the median to the west side of Veterans Parkway would not result in additional impacts to the park. There are no cultural resources along this portion of the alignment. The alignment in the median would have impacted the existing drainage on both sides of Veterans Parkway, whereas the alignment along the side of Veterans Parkway impacts the existing drainage for only the southbound roadway. The alignment along the side of Veterans Parkway impacts a stormwater management pond that will be reconstructed as part of the project (See Figure 6).

Summary of Outreach. This refinement was made shortly after the publication of the AA/DEIS. It was included in the announcement of the LPA in August 2009. This information was included in press releases, project newsletters, and posted on the project's website. All project mapping and information since that time has shown the alignment on the side of Veterans Parkway. This includes the November 2011 Open Houses as well as smaller community meetings in the Beacon Heights, Annapolis Road, and New Carrollton areas. It has also been incorporated into Prince George's County planning and associated outreach efforts including the Central Annapolis Road Sector Plan and the M-NCPPC TOD Study for the Riverdale Road/Beacon Heights Station east of the Baltimore-Washington Parkway.

4.1.6 Crossing of Annapolis Road

Alignment as Presented in the AA/DEIS. In both the Medium and High Investment LRT alternatives, the Purple Line transitway followed Veterans Parkway across Annapolis Road to Ellin Road. The Medium Investment alternative crossed Annapolis Road at grade while the High Investment alternative crossed below grade. The shift from the median to the southwest side of Veterans Parkway is discussed above in Section 4.1.5. This section focuses on the treatment of the crossing of Annapolis Road itself.

Since the AA/DEIS included alternatives with at-grade crossings of Annapolis Road, the proposed change in vertical separation at the intersection of the proposed Purple Line at Annapolis Road is not a change from the AA/DEIS; however, it is a change from the LPA. The LPA included the grade-separated crossing of Annapolis Road with the Purple Line crossing below Annapolis Road.

Impetus for Change. The below-grade crossing of Annapolis Road by the Purple Line presented many challenges pertaining to project design and proposed construction. The proposed Annapolis Road station would have been located under Annapolis Road with the grade-separated option. While this provided good access to both sides of Annapolis Road, it presented safety concerns and placed the station away from pedestrian activity occurring at street level. Additional project elements such as stairs and elevators would have been required to accommodate vertical circulation for access to the station. The grade-separated alignment also would have resulted in a direct conflict with a 66" water main, resulting in the need to relocate that portion of the water line. Maintenance of traffic on Annapolis Road would have been difficult during the multi-phased construction of a new bridge carrying Annapolis Road over the Purple Line, since no reasonable detour routes currently exist. Finally, large retaining walls would have been required to accommodate the grade separation, the cost of which, combined with the cost of the bridge structure itself, would have resulted in a very costly road crossing and station. During project-wide value planning exercises, options were considered to address many of these challenges.

Recommendation. The Preferred Alternative will include an at-grade crossing of Annapolis Road with an at-grade station east of Annapolis Road.

Changes in Anticipated Impacts. In order to facilitate this change, the Glenridge maintenance facility would be set at a slightly higher elevation than anticipated in the AA/DEIS; however it would still be lower than the surrounding park, neighborhood and school. This refinement would reduce the amount of excavation from the previous option. There will be a transit delay of approximately 46 seconds due to the at-grade crossing of the transitway at Annapolis Road. The intersection is projected to operate at a level of service (LOS) D/D (am/pm) in the design year with the grade separated option. While the Purple Line would take some time from the signal phase, it is still projected to operate at LOS D/D (am/pm) with proposed intersection improvements. While this is different than the option included in the LPA that coordinated with the County's Sector Plan, it works well with potential TOD and may be beneficial because it brings people and activity up to street level. As shown in Figure 7, this refinement puts the station on one side of Annapolis Road rather than between the two sides. There will be improved pedestrian connections at street level. Finally, this option may improve safety in the short term by having the station at-grade. The proposed station under the roadway would have been out of sight with little activity until a point when the area is redeveloped. Even after local redevelopment the station would not be as visible with areas hidden below the bridge.

There would be a minor shift in the alignment as it approaches the intersection to provide adequate space for sidewalks and pedestrian refuge areas. This refinement would result in additional encroachment into the Giant Food parking lot, and on the east side the proposed station location and transitway would affect some of the drive through lanes of a bank. Further study is needed to determine if this refinement would impact the bank to the point of a potential total displacement. There would be no changes in anticipated impacts to natural or cultural resources. Finally, this refinement will be much easier to construct while maintaining traffic, and will save an estimated $17M.

Summary of Outreach. This is one of the most recent recommended refinements. After a full engineering, operational, environmental and other analysis the option was first presented to the Maryland State Highway Administration (SHA) in May and June 2012 to discuss the traffic effects of the at-grade crossing. It was then presented to Prince George's County in June 2012. Following the presentation to the County, targeted outreach is planned with the owners of the properties where there are anticipated changes in physical impacts including the shopping center and bank. A meeting will be scheduled with the Annapolis Road Neighborhood Work Group in the Fall of 2012. The meeting will be advertised on the project website, and notices will be sent out to anyone who signed up for the group as well as the adjacent property owners. As with all other neighborhood work group meetings, information will be posted on the project website and outreach will continue. MTA will continue outreach and coordination efforts as the study progresses.

4.2 Refinements to Stations

The Preferred Alternative has the same 21 stations that were included in the AA/DEIS. They are located at the same general location/crossroads and serve the same communities. As the design progresses, and with input from the neighborhood work group meetings, the stations are being developed in more detail with station access, circulation, station amenities, etc. In some cases this refinement has resulted in minor shifts to the platform within the overall station area but the locations of the 21 stations remain consistent with the AA/DEIS.

4.3 Refinements to Yards and Shops

Layout as Presented in the AA/DEIS. The AA/DEIS presented the need for maintenance and storage facilities and identified sites on Brookville Road in Lyttonsville in Montgomery County and along Veterans Parkway at the site of the Northern Area Maintenance Office (Glenridge) in Prince George's County. The AA/DEIS also presented information on other sites and why they were dropped from further consideration. The Lyttonsville and Glenridge sites were identified as the most promising at the time of the AA/DEIS, and these two sites remain the preferred sites for storage and maintenance activities.

The AA/DEIS did not show the two sites on any of the alternatives mapping. However, mapping displayed at the public hearing and on the project's website showed an outline of each site as envisioned at that time. Potential impacts were assessed based on those general site outlines and preliminary track configurations. However the activities that would be performed at each site had not been developed to a level of detail to present at that time.

At the Public Hearings in support of the AA/DEIS, the Lyttonsville yard was shown bounded by Brookville Road on the north, the Purple Line on the south, from the existing Montgomery County maintenance facility on the west to a point east of Lyttonsville Place near the intersection of Garfield Avenue. The Glenridge yard was shown in the approximate location of the current County park maintenance facility. Since that time, the sites have been developed in more detail and presented to the public a number of times in differing levels of detail.

Impetus for Change. Several factors have influenced the design of each site since the publication of the AA/DEIS including:

- Updated ridership and transit travel time estimates have increased the total projected fleet size resulting in an increase in the maintenance and storage needs.
- More detailed design for each yard has refined the layout of each facility.
- Coordination with Prince George's County regarding potential impacts to Glenridge Park and the fields at Glenridge Elementary School has influenced the layout of the Glenridge facility.
- Re-programming of the sites was studied to reduce redundant activities, minimize impacts, and reduce costs.

The maintenance and storage facilities have been refined based on the factors listed above as well as input from the community and stakeholders. Due to the increased fleet size and resulting additional site requirements, the yards were trending larger than anticipated in the AA/DEIS. More detailed mapping, refined design criteria, more detailed yard operational analyses, and stormwater management requirements resulted in changes to the yards not anticipated in the AA/DEIS. The Lyttonsville site would have extended further east of Lyttonsville Place, closer to the residential community and would have resulted in additional potential business displacements. This shift towards a larger yard was met with much community concern and comments. These concerns were a major factor in MTA's decision to develop the refinements recommended as part of the Preferred Alternative. The Glenridge site would have also been enlarged and would have had impacts to the Glenridge Community Park and the recreational facilities at the Glenridge Elementary School.

In addition, at the time of the AA/DEIS it was envisioned that approximately half the fleet would be stored in each location, and the maintenance and operations activities would be split. However, this arrangement resulted in some redundant activities as certain functions (car wash, interior cleaning, daily servicing, etc.) would have to be located at each site. Maintenance buildings were required at each location with associated materials storage, locker rooms, training/break rooms, and other employee services.

Recommendation. A more detailed assessment of the overall storage and maintenance functions has resulted in a proposed re-programming of the two sites. The locations remain the same; however, the current proposal redistributes the functions to allow for better efficiencies, less redundancies, and reduced impacts. This re-programming results in the Lyttonsville site being used primarily for storage, daily cleaning/servicing, and the operations center. The Glenridge site would be used primarily for maintenance activities. In addition, in order to reduce impacts to the Glenridge Park and Glenridge Elementary School, a more linear configuration was developed in consultation with the Prince George's County Parks Department and is being recommended for the Glenridge facility rather than the loop configuration contemplated in the AA/DEIS.

Changes in Anticipated Impacts. Each yard would have increased in size as compared to the information presented in the AA/DEIS based on the larger fleet size and the additional information as to the specific design and site requirements. Working with stakeholders, the

MTA has worked to reduce the size of the facilities and anticipated impacts in each area. In addition, the proposed re-programming eliminates redundancies and best fits each facility into its setting.

As shown on Figure 8, the proposed Lyttonsville Yard is in the same location and approximately the same size as the yard anticipated in the AA/DEIS with a minor additional encroachment into the parking/storage area of the WSSC property and is located primarily west of Lyttonsville Place. With the Preferred Alternative, much of the storage yard will be covered by a parking deck, minimizing potential visual, noise, or light effects. In addition, the operations center and offices will be housed in a building facing Lyttonsville Place. Storage activities are west of Lyttonsville Place between other industrial uses and further from residential areas. Finally, the Preferred Alternative preserves most of the land fronting Brookville Road east of Lyttonsville Place for potential future redevelopment, a condition strongly supported by the community. The Preferred Alternative minimizes impacts by "stacking" underground stormwater management, the storage tracks, and the parking deck rather than a more traditional linear extension that would have required more property and resulted in additional impacts.

The proposed Glenridge Maintenance Facility is in the same location as presented in the AA/DEIS; however, a linear configuration is being recommended rather than the "loop" configuration anticipated in the AA/DEIS (See Figure 9). This linear configuration was developed in conjunction with the county parks department, and while it displaces approximately three additional acres of park land, it avoids impacts to the recreational facilities within the park, including the path and pavilions. The linear configuration included in the Preferred Alternative also avoids over one acre of impacts to the recreational facilities at the Glenridge Elementary School. Finally, there would be approximately 2.6 acres of residual land from the existing County maintenance facility that could be transferred to the park and school, which would allow the development of a second full-size field and improved drainage and screening. During the formal coordination with the County regarding these two Section 4(f) properties, the County agreed that the linear configuration resulted in less impact to the recreational resources within the Section 4(f) properties and was preferred. In addition, re-programming the yard results in a larger maintenance building with most of the activity at the site occurring indoors. These refinements reduce potential visual, light, or noise effects to adjacent properties. Finally, retaining walls have been included to avoid impacts to a stream and maximize the space available for future recreational activities.

Summary of Outreach. Lyttonsville and Glenridge have been identified as the recommended locations for the yard and shop facilities since the development of the AA/DEIS. They were shown on the mapping provided at the public hearings on the AA/DEIS. In addition, the locations have been shown on project mapping, on the project website, and presented at public meetings since that time. Detailed information on the exact yard layout or the specific activities to be performed at each yard was not available at the time of the AA/DEIS. The types of activities typically performed at light rail yards were described, and conceptual layouts were shown, as appropriate. As layouts were developed in more detail, materials were presented at public meetings for review and comment.

The displays at the public hearings in November 2008 showed the outline of the Lyttonsville yard bounded by Brookville Road and the Purple Line from the county maintenance facility to east of Lyttonsville Place. This is approximately the same size and location of the yard included in the Preferred Alternative. Notices for the hearings were sent to the project mailing list of over 60,000 names, and advertisements were published in local newspapers. Materials from the hearings, including the mapping showing the yard, were posted on the project website.

Since the public hearings, there has been extensive outreach in the Lyttonsville area. The proposed yard is adjacent to the Lyttonsville station, and there is an active community and Neighborhood Work Group. MTA presented information on the alignment, station, and proposed yard and shop at a community meeting in February 2009. At that time, data showed the need to expand the yard, and future storage tracks were shown extending further east of Lyttonsville Place. This expansion would have resulted in an increase in potential business displacements as compared to the AA/DEIS. Similar mapping was shown at a Community Focus Group meeting in October 2009. The Locally Preferred Alternative included a yard at Lyttonsville, and mapping of the LPA showed the expanded yard east of Lyttonsville Place. In order to address the increased fleet size, updated design criteria, and operational issues within the yard, a design option was developed. The LPA and design option were presented to the community at a Neighborhood Work Group Meeting in September 2011. The community was concerned with the expanded size of the yard, the increase in potential business displacements, and the encroachment into the residential areas. In order to provide an additional opportunity for review and comment, an additional Neighborhood Work Group meeting was held in October of 2011. MTA recorded the community's concerns and committed to looking at options that would reduce impacts and push the bulk of the yard west of Lyttonsville Place similar to the configuration shown in the AA/DEIS. At the invitation of the community, members of MTA's Purple Line team toured Lyttonsville with community representatives in December 2011 to further understand the history of the community and their concerns.

MTA developed a refined configuration in response to community concerns and presented it at a Neighborhood Work Group meeting in March 2012. The refined configuration encroached on the WSSC property and required a shift in the end of Brookville Road. This, as well as the need for parking, resulted in potential business displacements on the north side of Brookville Road. However, the yard did not extend further east of Lyttonsville Place than what was shown in the AA/DEIS, it did not encroach into the residential area, it reduced the number of potential business displacements, and it preserved the land along Brookville Road for future redevelopment. The refinement received overwhelming community support and residents were pleased that MTA responded to their concerns. The MTA also committed to continue to look for opportunities to further reduce impacts. The recommended re-programming of the yard and the configuration included in the Preferred Alternative does this. It eliminates the need to realign Brookville Road and avoids the potential business displacements north of Brookville Road. This further reduction in impacts will be shared at the next neighborhood work group meeting.

Throughout the refinement of the yard design, targeted meetings were conducted with the owners of businesses along Brookville Road who may have been potentially displaced by the options. Recently, Montgomery County initiated a Sector Plan process for this area. The County plan incorporates the Purple Line with the location of the Lyttonsville station and yard. Two meetings have been held on the sector plan in March and May 2012. The Purple Line is included on the County's mapping, and representatives from MTA's Purple Line team attended each meeting and were available to answer questions and listen to comments from the community.

Outreach for the Glenridge yard followed a different path. While the Lyttonsville site is in a built up area between industrial/commercial and residential uses, the Glenridge site is largely bounded by Veterans Parkway, Glenridge Community Park, and the Glenridge Elementary School. Due to the sensitivity of the Section 4(f) resources and the desire to minimize and mitigate impacts, detailed coordination with the County Parks Department was carried out in parallel with overall public outreach. There is ongoing coordination between the MTA and Prince George's County through regular coordination meetings as well as formal Project Team meetings. These meetings include regular updates on all aspects of the project. A formal Section 4(f) coordination meeting was held in January 2012 between the MTA Purple Line Team, the Maryland-National Capital Park and Planning Commission's (M-NCPPC) Prince George's Department of Recreation and Parks, and Prince George's County Department of Public Works regarding Glenridge Community Park and the potential use of the Northern Area Maintenance Office for the construction of the Glenridge Yard and Shop. During that meeting, the potential use of portions of the park and Glenridge Elementary School by the Purple Line was discussed. At that time and through subsequent communications, the M-NCPPC gave input on the options under consideration and stated their preference for the linear configuration. This was confirmed at a follow up meeting in June 2012.

As with Lyttonsville, the Glenridge site was identified in the AA/DEIS and shown on mapping at the Public Hearings in November 2008. The location was presented at meetings of both the Beacon Heights and Annapolis Road Neighborhood Work Group meetings. However, due to the ongoing refinements and park coordination, no detailed layouts were developed or presented. In addition, the design of the yard was being coordinated with the refinement at Annapolis Road. The re-programming of the yard also presented additional opportunities to look at a parking deck and underground stormwater management to further reduce impacts. The refined yard will be presented at a meeting planned with the Annapolis Road Neighborhood Work Group in the Fall of 2012 as well as a follow-up meeting with the Riverdale Road/Beacon Heights Neighborhood Work Group. The meetings will be advertised on the project website, and notices will be sent out to anyone who signed up for the group as well as the adjacent property owners. As with all other neighborhood work group meetings, information will be posted on the project website, and outreach will continue.

4.4 Design Refinement Associated with Preliminary Engineering

The further refinement of the Preferred Alternative will continue through Preliminary Engineering and will be documented as part of the FEIS/Section 4(f) Evaluation and any comments provided on the FEIS will be addressed in the ROD. The refinements are typical of projects that move from planning and advanced conceptual engineering into Preliminary Engineering. Examples of the types of refinements typical of the preliminary engineering phase include:

- Basic design refinements that are typical of projects as they move into more detailed design including responding to changes in base mapping and design criteria.
- Localized design refinements to respond to community or environmental concerns, design constraints and/or operational issues.
- Locations for traction power substations (TPSS) and other ancillary facilities.
- Construction staging areas and access.

The AA/DEIS included a discussion of TPSS and noted the approximate distance between each unit. It was stated that the number and location of the substations would be determined during the preliminary engineering phase. Similarly, the AA/DEIS included a discussion of overhead wires and poles with typical pole spacing.

5 Conclusion

Based on the findings of this Re-Evaluation, it is our opinion that a supplement to the DEIS is not required. The Preferred Alternative would not result in significant environmental impacts that were not evaluated in the AA/DEIS. In addition, there is no new information or change in circumstances that would result in significant environmental impacts not evaluated in the AA/DEIS. Therefore, no additional supplemental DEIS documentation is warranted beyond this Re-Evaluation and consultation and that the changes described above would be appropriately assessed in the FEIS/Section 4(f) Evaluation. MTA will continue to make refinements to avoid impacts to sensitive resources, if prudent and feasible, and will take measures to minimize harm and mitigate unavoidable impacts. MTA will continue to monitor changes in the affected environment and in the project throughout the development of the FEIS and, if appropriate, MTA will prepare additional documentation to assess the significance of any new information or changed circumstances. All potential impacts will be fully assessed in the FEIS/Section 4(f) Evaluation, and any comments received on the FEIS will be addressed and appended to the Record of Decision (ROD).

Appendix A
Figures

Appendix B
Environmental Re-Evaluation Consultation Checklist

4. A Comparison of Diesel Light Rail Vehicles to Electric Light Rail Vehicles, with Reference to the Purple Line

A COMPARISON OF DIESEL LIGHT RAIL VEHICLES TO ELECTRIC LIGHT RAIL VEHICLES, WITH REFERENCE TO THE PURPLE LINE

In the Alternatives Analysis and Draft Environmental Impact Statement the MTA has assumed that the light rail vehicles used for the Purple Line (if selected) would be electrically powered by an overhead wire system. At recent public meetings the MTA has been asked to consider the use of a diesel powered light rail vehicle which would not use an overhead wire system.

MTA is not opposed to the consideration of vehicles which could minimize impacts to the corridor. The use of diesel light rail vehicles would not only reduce the visual effects of the transitway from the wires, but would also reduce concern about tree branches overhanging the transitway, particularly along the Georgetown Branch right-of-way. It has also been suggested that the capital costs for the system would be lower because there would be no need for the wires and poles, nor for traction power substations.

Diesel-electric light rail vehicles (the most common approach to diesel powering light rail vehicles) are essentially ordinary electric light rail vehicles with an onboard power source. An electric light rail vehicle draws its power from the overhead lines, while a diesel-electric light rail vehicle produces its own power from a diesel engine that turns an alternator. The diesel engine and alternator require additional space in the vehicle, resulting in a higher floor or a loss of passenger capacity.

While there are a number of potential vehicles, the MTA has looked at the diesel light rail vehicles currently in use in North America. The MTA believes it is necessary to evaluate vehicles that are in operation and have a proven "track" record. The three diesel services operating in North America are the River Line in Camden, New Jersey; the Sprinter in San Diego; and the O-train in Ottawa, Ontario. The River Line is most like the Purple Line in its characteristics, and its vehicle is most appropriate of the three for street-running operations. This vehicle is a Stadler GTW 2/6 low-floor. The Sprinter and O-train both operate in standard railroad rights-of-way, and are not comparable to the Purple Line. For comparison the Siemens S70 is shown in Figure 4. This electric light rail vehicle is currently in use in Houston, Charlotte and San Diego; and is typical of the vehicles being considered for the Purple Line.

Figure 1: Camden River Line Diesel Light Rail

Figure 2: Ottawa O-Train Diesel Light Rail

Figure 3: San Diego Sprinter Diesel Light Rail

Figure 4: Houston Electric Light Rail

The following is a discussion of key characteristics that would be relevant in the selection of a vehicle and propulsion mode for the Purple Line.

Turning Radius

Diesel-electric vehicles are approximately the same size as electric light rail vehicles, but they tend to be less suitable for the streetcar type operations that characterize the Purple Line running environment. The diesel vehicles require a much greater turning radius, making street-running operations difficult. Generally the curvature limit for the diesel vehicles is 250 to 300 feet, however the Stadler vehicle used for the River Line was modified by the manufacturer to reduce the turning radius to 130-140 feet. Because most of the Purple Line is street-running and must follow the geometry of existing streets and communities, the MTA has a recommended minimum radius of 110 feet for the Purple Line, but has allowed an absolute minimum of 60 feet. The MTA has limited consideration of vehicles to those that can meet an 82-foot turning radius. There is no diesel vehicle currently available that meets the turning radius requirement for the Purple Line

Acceleration

Diesel light rail vehicles accelerate more slowly than electric light rail vehicles because diesel engines have a lower power production capacity than what can be provided by an overhead wire system. The Stadler vehicle accelerates at 2.0 mph per second. Electric light rail vehicles generally accelerate at 3.0 mph per second, 50% faster that the Stadler vehicle. This can have a substantial impact on travel times for systems with many stations and traffic stops. The Purple Line has 21-22 stations and will have some required traffic stops, despite the implementation of transit signal priority where feasible, and therefore would be expected to experience slower travel times with a diesel vehicle.

Passenger Capacity

The passenger capacity of diesel electric light rail vehicles is constrained by the presence of the diesel engine, the alternator, and the drive shaft which take up considerable space in the vehicle. The Stadler vehicle has a capacity of 184 passengers (seated and standing) while the Siemens S70 (used for comparison; and typical of the family of electric light rail vehicles being considered) has a passenger capacity of 241. These capacity figures are fore 90 foot vehicles. The high ridership projects for the Purple Line, particularly for the LRT alternatives indicate the need to maximize capacity. The Purple Line capacity needs are based on an assumption of trains made up of two 90-foot cars during peak hours. The long life span of these vehicles means that the choice of vehicles will have implications for many years and they must meet the future demand.

Low Floor

The MTA has assumed a vehicle with a floor height of between 10 and 14 inches. While this is higher than a standard curb height of 6-8 inches; it does still allow a sidewalk with a slightly higher profile to be used as a station platform. Diesel vehicles, even where "low-floor", have a floor height of approximately 24 inches. This is substantially higher than a standard sidewalk and would required significant modification of the platform areas for joint passenger and local pedestrian use and for ADA compliance; and would make the stations incompatible with existing roadway and pedestrian environments.

Cost Savings

Diesel light rail vehicles would have capital cost savings resulting from the lack of an overhead wire system and the traction power substations. This, combined with the lower passenger capacity, is why diesel light rail is often recommended for systems with lower ridership projections. However, the cars tend to cost 30-50% more than electric LRT vehicles and maintenance costs are potentially higher as maintenance now includes the diesel generator, as well as the electric components. Diesel vehicles would incur the cost of fueling facilities. The slower travel times discussed above could result in the need for additional vehicles.

Emissions

Any vehicle would create emissions and a comparison of the relative merits of one system to another requires identification of the exact vehicle, not possible when comparing one class of vehicles to another. More relevant for the Purple Line is the location of the emissions discharge. Being in a non-attainment area under the federal Clean Air Act for fine particulate matter (PM2.5) the emission of local sources for PM2.5 from the diesel vehicles would likely exacerbate existing conditions.

Other issues

Noise generation and potential ground pollution from fuel spill and leakage are two other potential issues which would need to be considered in more detail should diesel vehicles be further studied.

Visual Effects of Overhead Wire Systems

The MTA has been sensitive to the issue of visual effects from an overhead wire system. In order to minimize visual impacts it was decided to use a trolley wire system rather than a catenary. A catenary wire is composed of a "messenger wire" that supports the contact (electrified) wire from above. Thus a catenary system has two sets of wires over each track. A trolley wire system is simpler and has only one wire over each track. See Figures 5 and 6.

Figure 5: Trolley Wire System

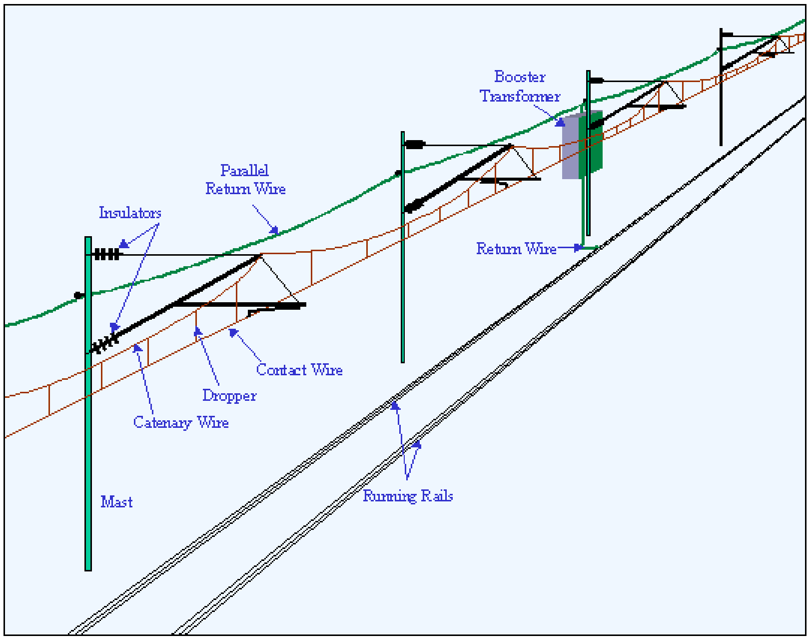


Figure 6: Catenary System

In many cases the overhead wires can use existing poles or attached the wires to buildings. The poles of the wires can be combines with decorative lighting. See Figure 7.

Figure 7: Denver; Trolley Wires attached to Decorative Light Poles

In conclusion, the MTA believes that the existing diesel electric vehicles are not appropriate for the Purple Line for a number of reasons.   Chief among these is the inability of diesel vehicles to make tight turns, slower acceleration, lower passenger capacity, and no true low floor. The MTA does not believe that the proposed trolley wire system would be an unacceptable visual effect.

There are vehicles currently under development with other propulsion systems such as the Bombardier PRIMOVE catenary-free tram and the Kawasaki Swimo hybrid-powered streetcar. The MTA will monitor the development and operational experience of these systems, and as the appropriate phase of the project for vehicle selection arrives, one of these systems may emerge as the most appropriate for the Purple Line.

5. Medium Investment BRT Variations Serving Medical Center Purple Line AA/DEIS

White Paper
Medium Investment BRT Variations Serving Medical Center
Purple Line AA/DEIS

Introduction

The Maryland Transit Administration, in response to a request by the Town of Chevy Chase, has conducted additional analysis of two routing variations for the Medium BRT option. The purpose of conducting this analysis was to determine if improved access to the Medical Center station area would provide benefits to the Purple Line project and perhaps provide impetus to consider alternatives that provide improved service to that area. The idea was forwarded that with employment and visitor growth at the National Naval Medical Center (NNMC) – to be re-named the Walter Reed National Military Medical Center (WRNMMC) – with Base Realignment and Closure (BRAC) activities there might be a positive impact on Purple Line ridership.

The variations tested for the Medium BRT options were developed through input from Sam Schwartz Engineering (SSE) – a consulting firm hired by the Town of Chevy Chase to represent their concerns on the project. The basics of the two developed alternatives were to explore routing options that would provide a "one seat ride" to both the Medical Center Station Area and to downtown Bethesda.

The analysis methodology used included the re-coding of the Medium BRT option in the project demand forecasting model to determine results of the two scenario options combined with a new BRT stop location near the intersection of Woodmont Avenue and St. Elmo Street in the northern Bethesda CBD area. Results of this assessment are presented in the following pages.

The MTA, throughout the project, has reiterated that the components of the various alternatives could be re-compiled as variations of the basic build alternatives where technically possible. As an example, this could include segments of Low-Investment BRT linked to Medium or High Investment BRT. The analysis presented in this white paper then represents an exploration of that type of linked improvement scenario. The environmental impacts of the various components would be comparable to the assessments of the Build alternatives in the DEIS. The benefits to travel through user benefit hours are outlined below. Results of calculations of FTA cost effectiveness measures for the two variations are also presented for comparison.

Demand Forecasting Model

The Purple Line project uses a model specifically adapted from the Metropolitan Washington Council of Governments (MWCOG) for use on the project. Background on the model development process has been included below for reference.

Maryland Transit Administration (MTA) developed a common travel demand forecasting model and procedures for two Alternatives Analyses in two separate corridors in the Washington DC regional modeling area. The intention was to use the same No Build forecast as the starting point for future forecasts for both the Corridor Cities Transitway (CCT) and the Purple Line (PL). Preliminary work on the CCT forecasts indicated that some enhancements to the Washington Metropolitan Council of Governments (MWCOG) travel model would be required to provide transit corridor-level alternative analysis travel forecasts.

The enhanced model described in this document is referred to as the Maryland Alternatives Analysis Model, or the MDAA. It is based on the officially adopted MWCOG model version 2.1D#50, as modified by MWCOG for the 2007 Conformity Analysis, and referred to here as the COG Model. The COG model is a classic four step model with a static six iterations of feedback through trip generation, distribution, mode choice, and assignment. The COG mode choice model is a simple multinomial model that relies upon the path builder to distinguish choices among primary transit modes. It does not disaggregate transit trips into the various transit modes or transit access modes, nor does it accommodate transit assignment.

The COG Model was not fully developed to accommodate comprehensive transit analysis, and therefore a MWCOG model transit component post processor was developed, typically referred to as the COG Transit Component. Starting from the person trip tables that result from the sixth iteration of the full model feedback, the Transit Component applies a more sophisticated mode choice model which distinguishes between bus, bus/Metrorail, Metrorail only and commuter rail trips. Walk, Park and Ride, and Kiss and Ride trips are modeled separately and transit assignment is included. Full documentation of the Transit Component can be found in *Post MWCOG - AECOM Transit Component of Washington Regional Demand Forecasting Model Users Guide*, prepared by AECOM Consult, Inc. and dated March 2005.

The 2005 Transit Component was the starting point for modifications made for initial rounds of forecasts for the CCT. Additional modifications included edits to the networks, zones, and all files that are related to zonal-based demographics and walk percentages, to address corridor-level conditions and reporting needs. Changes were made to the Transit Component scripts in order to accommodate the new zone structure and network modifications. The resulting model referred to here as the CCT Model, was the starting point for the MDAA.

The MDAA starts with the CCT Model and incorporates modifications to improve confidence in transit forecasts in these two corridors. The MDAA replaces the COG Model home-based work trip distribution with the Census Transportation Planning Package (CTPP). The mode choice model is a nested logit model with bus, Metrorail, commuter rail, light rail and bus rapid transit alternative transit modes. A park-and-ride station capacity restraint model was implemented to account for limited capacity at key stations.

The MDAA was used to test all project alternatives for this project through coding modifications to station locations and routing. Resulting corridor ridership figures were used in later calculations. As part of the Federal New Starts coordination process the MTA demand forecasting team met with Federal Transit Administration (FTA) demand forecasting representatives to discuss methodology applied to insure that it meets federal guidelines.

<u>Variations Tested</u>

As noted above two variations providing access to the Medical Center station area have been assessed for comparison to the Medium BRT alternative defined and analyzed during preparation of the Draft Environmental Impact Statement (DEIS). The Medium BRT alternative as defined in the DEIS provides improved BRT service the length of the corridor at an estimated cost of $580 million dollars. The two variations to this alternative that were tested are identical to the Medium BRT alternative from east to west through the station at Lyttonsville. From there access to Bethesda and the Medical Center station are differs from service assumptions in the DEIS. For the purposes of this analysis the two alternatives have been termed: “Medium BRT – Jones Bridge Road” and “Medium BRT – Medical Center Access”. Both alternatives assume a new station at the intersection of Woodmont Avenue and St. Elmo Street, providing access to the population center in the area – a new station location not included in project analysis to date.

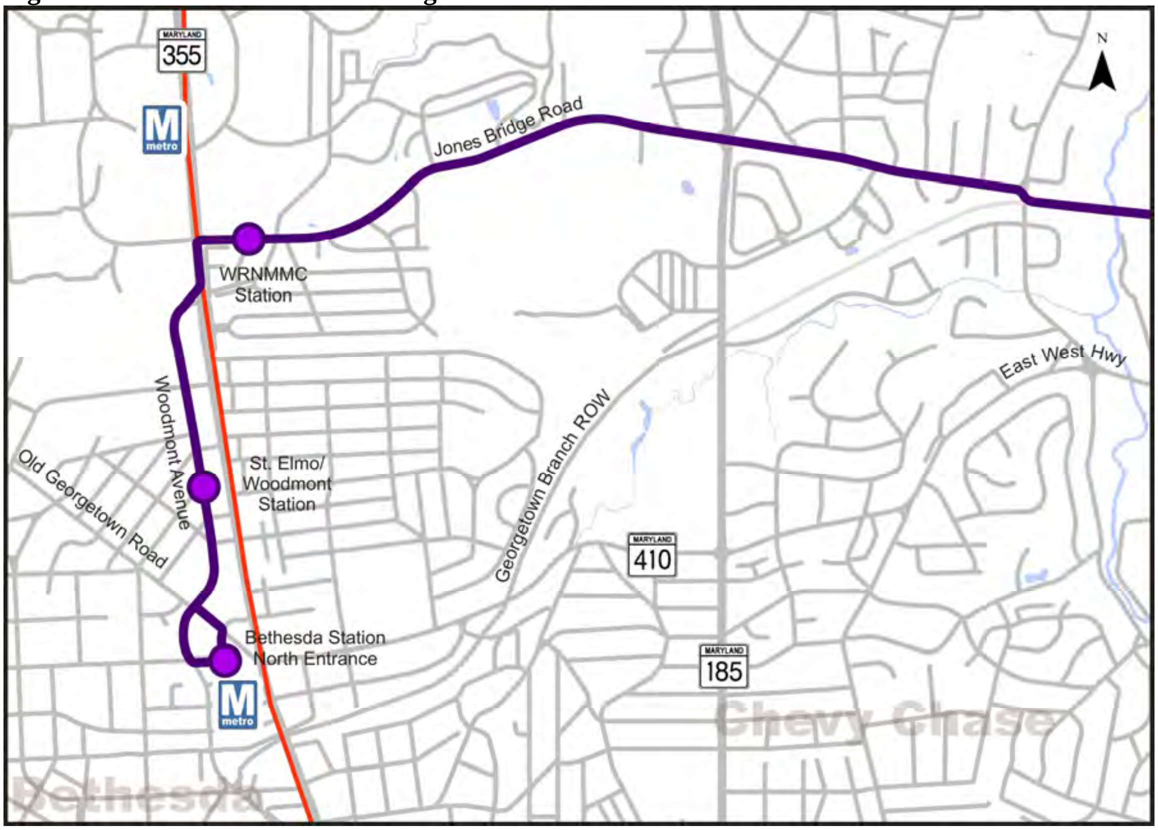
Access to the Medical Center area is different for the two alternative variations. The Medium BRT – Jones Bridge Road alternative assumes a new station at the northeast corner of the Jones Bridge Road / Rockville Pike intersection with full access to the Red Line Metro station. The Medium BRT – Medical Center Access variation assumes a connection to the existing Medical Center Metro Station transit area. For the purposes of this analysis full transit access (Metro rail and bus) has been assumed to be similar for both station locations.

Medium BRT – Jones Bridge Road

Figure 1 below graphically depicts variation 1 to the Medium BRT option – the Medium BRT – Jones Bridge Road variation. From Lyttonsville the variation travels along the Master Plan alignment to Jones Mill Road. At this point the variation follows the alignment described by the Low Investment BRT alternative – traveling along Jones Bridge Road to a new station area at the northeast corner of the Jones Bridge Road / Rockville Pike intersection. From this station the variation crosses the intersection to Woodmont Avenue and the new station at Woodmont Avenue and St. Elmo Street. The BRT vehicles would then travel along Woodmont Avenue to the western terminus at the Bethesda Metro station. BRT vehicles would turn around at the Bethesda Station to begin eastbound service.

It should be noted that full transit access at the Medical Center station has been assumed for this analysis. That is that transfers between Metrorail and the Purple Line and between buses and the Purple Line are all possible at this station location.

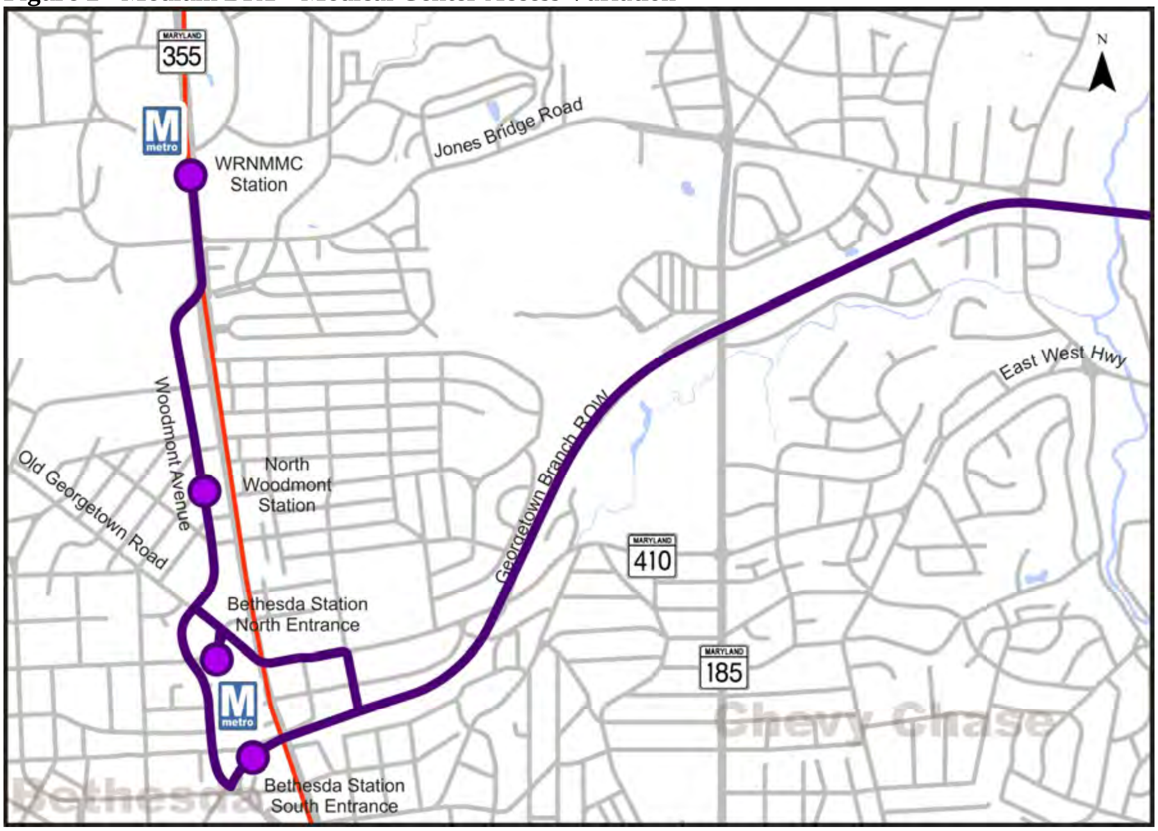
Figure 1 - Medium BRT - Jones Bridge Road Variation



Medium BRT – Medical Center Access

Figure 2 below graphically depicts variation 2 to the Medium BRT options – the Medium BRT – Medical Center Access variation. From Lyttonsville the variation travels along the Master Plan alignment to the Connecticut Avenue station. From this station the variation continues along the Master Plan alignment to Pearl Street where it travels on-street to the Bethesda Metro Station – North Entrance. From the Bethesda Metro Station the variation travels along Woodmont Avenue to the new station at the intersection of Woodmont Avenue and St. Elmo Street. BRT vehicles would then travel from this station location to Rockville Pike to the western terminus at the Medical Center Metro station. The BRT vehicles would then travel south along Rockville Pike to Woodmont Avenue to the new station at Woodmont Avenue and St. Elmo Street. The vehicles would then travel to the Bethesda Metro Station - South Entrance before re-entering the Master Plan alignment and access to Connecticut Avenue and the remaining stations to the east.

Figure 2 - Medium BRT - Medical Center Access Variation



Technical Analysis

The technical analysis conducted for the testing of variations to the Medium BRT alternative applied the same methodology as that used in project alternatives tested to date, including the determination of ridership estimates and associated capital and operating cost estimates. These estimates were used to determine the cost per user benefit hour – one of the criteria the FTA uses in assessing the viability of New Starts projects. A table which compares ridership estimates, capital cost estimates, operation and maintenance costs and costs effectiveness measures of the alternative variations as compared to the Medium BRT alternative have been included below.

Estimates for the Medium BRT – Jones Bridge Road variation have been determined based on the assumption that a $60 million dollar investment would be required to provide the connection from the proposed station area to the Medical Center Metro platform as well as to provide a grade-separated connection across Rockville Pike for travelers to both NIH and the new Walter Reed facility. This level of connectivity (as well as full bus transfers) was assumed in the modeling effort as noted above.

For the purposes of this analysis an estimate of user benefit hours has also been presented which assumes that this cost is not part of this variation for the purposes of providing a point of comparison.

Table 1 - Analysis Results - Medium BRT Variations

Measure	Medium Investment BRT (DEIS)	Variation 1 Medium Investment BRT via Jones Bridge Road	Variation 2 Medium Investment BRT extended to Medical Center
2030 Daily Boardings	52,000	50,000	58,000
Change Relative to Med Invest. BRT	NA	-2,000	6,000
2030 Annual User Benefits (hours)	5,008,000	4,783,000	5,244,000
Change Relative to Med Invest. BRT	NA	-225,000	236,000
Capital Costs (2007 dollars)	$580,000,000	$597,000,000	$585,000,000
Change Relative to Med Invest. BRT	NA	$17,000,000	$5,000,000
Annual O&M Cost (2007 dollars in millions)	$17,300,000	$17,300,000	$18,300,000
Change Relative to Med Invest. BRT	NA	$0.00	$1,000,000
FTA Cost-Effectiveness Measure (cost per hour of User Benefit) relative to TSM	$14.01	$15.62 $14.04 w/o New South Medical Center Entrance	$13.43

Conclusion

Variation 1 – Medium BRT - Jones Bridge Road shows that the travel time increase of the longer routing to the larger Bethesda travel market results in a loss of 2,000 daily boardings and 225,000 hours of annual user benefits relative to the Medium Investment BRT alternative. The FTA cost effectiveness index for this variation increases to $15.62 with the new station entrance - which is essential for the connection to the Metrorail Red Line at Medical Center. Without the capital costs associated with this entrance, the index goes to $14.04.

Variation 2 – Medium BRT – Medical Center Access - extending the service to Medical Center from Bethesda increases the daily boardings by 6,000 and the annual user benefits by 236,000 hours. The cost effectiveness index for Variation 2 improves to $13.43 with this routing. This result indicates the benefits of serving the major Bethesda market directly while also providing a one-seat ride to the Medical Center area.

6. Review of Proposed SHA BRAC-Related Intersection Improvements along Jones Bridge Road and their Effect on the Purple Line Plans

Review of Proposed SHA BRAC-Related Intersection Improvements along Jones Bridge Road and their Effect on the Purple Line Plans

May 2009

The Maryland State Highway Administration (SHA) has developed preliminary improvement concepts for the intersections of Jones Bridge Road and MD 355 (Wisconsin Avenue / Rockville Pike) and the intersection of Jones Bridge Road and MD 185 (Connecticut Avenue). These improvements are intended to help mitigate the effects of the increase in automobile traffic expected along this corridor due to the Base Realignment and Closure (BRAC) activities at the National Naval Medical Center. The Medical Center will be expanded by approximately 2,200 employees to accommodate a number of activities currently conducted at Walter Reed Army Medical Center in Washington, D.C. The newly expanded facility will be called the Walter Reed National Military Medical Center. In addition to the new employees, approximately 1,800 new visitors are expected at the facility each day.

Description of SHA Improvements Under Evaluation

To address the additional transportation demands of the expanded Medical Center, SHA has developed improvement concepts at four intersections. Two of these intersections, Jones Bridge Road at MD 355 and Jones Bridge Road at MD 185, are located along the proposed alignment of the MTA's Purple Line Low Investment BRT Alternative. SHA's preliminary concepts for each intersection are described below. Plans showing the existing conditions, the SHA's proposed improvements, and the SHA improvements with the Purple Line are provided following page 6.

*Jones Bridge Road at MD 355***:** At this location the geometric improvements are focused along southbound MD 355, with minor widening along Center Drive, where it exits the National Institutes of Health (NIH) campus.

- Westbound Approach: Modify lane use to provide two left-turn lanes, one through lane, and one right-turn lane.
- Eastbound Approach: Widen approach by one lane. New lane usage of one left-turn lane, two through lanes, and one right-turn lane.
- Southbound Approach: Widen approach by one lane. New lane usage of one shared through/right-turn lane, two through lanes, and two left-turn lanes.
- Northbound Approach: No changes.

Jones Bridge Road at MD 185: At this location widening is proposed along all four approaches, with the most significant widening on the east leg of the intersection. The existing curb-to-curb width of Jones Bridge Road is approximately 60 feet; the SHA proposal would result in an increase in the roadway width of 50 percent to over 90 feet.

- Westbound Approach: Widen approach by one lane. New lane usage of two right-turn lanes and two through lanes.
- Eastbound Approach: Widen approach by two lanes. New lane usage of three

left-turn lanes, two through lanes, and one right-turn lane. Realign receiving lanes to line up with approach lanes.

- Southbound Approach: Widen approach by one lane. New lane usage of three through lanes and one right-turn lane.
- Northbound Approach: Widen approach by two lanes. New lane usage of four through lanes and one right-turn lane.

MTA Evaluation of Improvements

Traffic: The AA/DEIS plans for the Purple Line on Jones Bridge Road were based on the existing conditions, since at that time SHA has no plans to make any improvements at these two intersections prior to the project horizon year in 2030. The following projected intersection levels of service and average delay per vehicle were included in the AA/DEIS for the No Build condition.

Table 1: Projected Traffic Level of Service and Average Delay per Vehicle, 2007
(from AA/DEIS)

Intersection	AM Peak	PM Peak
Jones Bridge Rd at MD 355	E (76 sec/veh)	F (157 sec/veh)
Jones Bridge Rd at MD 185	F (228 sec/veh)	F (217 sec/veh)

These two intersections were re-analyzed with the proposed SHA improvements, using MTA's 2030 traffic projections to determine if the SHA improvements would substantially change the projected traffic operations at these intersections and require a revision of the improvements along Jones Bridge Road for the Low Investment BRT Alternative. If the SHA improvements were sufficiently effective, it was possible that the queue jump lanes planned for the Purple Line would not be needed. The results of this updated analysis are presented in Table 2.

Table 2: Projected Traffic Level of Service and Average Delay per Vehicle in 2007 with SHA's Proposed Concepts

Intersection	AM Peak	PM Peak
Jones Bridge Rd at MD 355	E (71 sec/veh)	F (84 sec/veh)
Jones Bridge Rd at MD 185	F (110 sec/veh)	F (90 sec/veh)

The updated results indicate that these two intersections would continue to operate at LOS E and LOS F during the peak periods in 2030 even with the proposed SHA improvements. However, the average delay per passenger vehicle during these periods is expected to be significantly reduced relative to the intersection configurations assumed in the AA/DEIS.

It is important to note that these improvements are not expected to substantially affect the BRT travel times along the corridor. The provision of queue jump lanes in the Low

Investment BRT Alternative in the AA/DEIS significantly reduced the delays for the BRT along Jones Bridge Road. The SHA improvements would allow for some minor changes in the signal timings at these intersections which would slightly reduce the delay to BRT vehicles, but to provide reasonable transit speeds and reliability, the Purple Line would still need queue jump lanes on Jones Bridge Road.

MTA next evaluated the specific approaches where queue jump lanes for BRT vehicles had been proposed in the AA/DEIS: the westbound Jones Bridge Road approach at MD 355 and the westbound Jones Bridge Road approach at MD 185. In each case, the approach is projected to continue to operate at LOS F with extensive queuing during the peak periods. However, based on this evaluation, the length of the queues along these two approaches would be reduced by approximately 15 percent in 2030 if the SHA preliminary concepts were fully implemented. Based on these results, the length of the proposed queue jump lanes on these two approaches could be reduced accordingly, potentially reducing right-of-way costs and property impacts east and west of the intersection.

Property Impacts:

The MTA's plans for the Purple Line were carefully developed to provide a reliable rapid transit service, while minimizing property takes, particularly for residential properties. The MTA's original plans for the Low Investment BRT Alternative in these areas only took strip takes from seven properties, none of which were private residences. No homes were displaced.

In order to implement the SHA preliminary concepts to accommodate the new BRAC activities, properties along Jones Bridge Road near the intersections of MD 335 (Rockville Pike) and MD 185 (Connecticut Avenue) would be impacted. With the proposed SHA improvements, there would be property taken from nine parcels on Jones Bridge Road but no residences displaced. However, if the Purple Line were implemented in addition to the SHA improvements, the widening of Jones Bridge Road by SHA would push the Purple Line into private property resulting in 23 parcels having property taken and three residences being displaced.

The property takes and impacts were identified using the assumptions used in the AA/DEIS:

- The limit of impact was assumed to extend five feet back from the edge of sidewalk and edge of pavement.
- The impacts due to the station platform were assumed to extend 15 feet from the back of the platform.

Table 3: Property Takes and Displacements

See figures following page 6 for lot locations

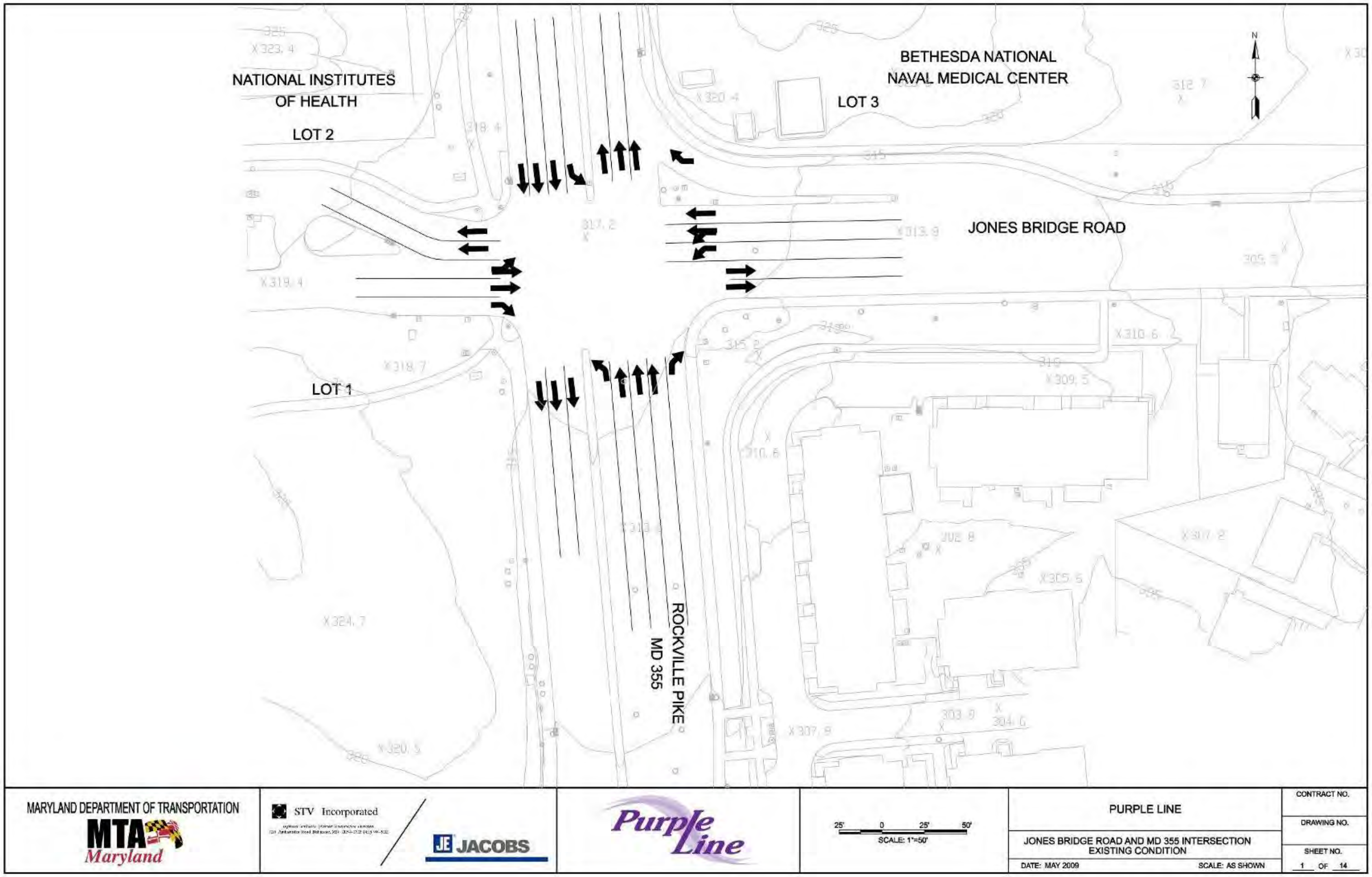
Intersection	Lot #	Figures	Location	Total Area of Lot (sq. ft.)	AA/DEIS Purple Line			SHA Proposed Improvements			SHA Proposed Improvements and Purple Line		
					Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take	Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take	Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take
MD 355 (Rockville Pike) Intersection	1	Fig. 1, 2, 3	National Institutes of Health: Southeast corner of intersection	5,022,123	85,104	<1%	NO	8,570	<1%	NO	89,283	2%	NO
	2	Fig. 1, 2, 3,	National Institutes of Health: Northeast corner of intersection	2,101,845	--	--	--	2,685	<1%	NO	3,991	<1%	NO
	3	Fig. 1, 2, 3, 4, 5	National Naval Medical Center	4,780,015	51,809	1%	NO	--	--	--	28,007	1%	NO
MD 185 (Connecticut Avenue) Intersection	4	Fig. 7, 11	Private residence	15,279	--	--	--	384	3%	NO	384	3%	NO
	5	Fig. 7, 11	Private residence	13,544	--	--	--	728	5%	NO	728	5%	NO
	6	Fig. 6, 7, 8, 11, 12	Howard Hughes Medical Institute	96,4796	1,546	<1%	NO	16,740	2%	NO	24,318	3%	NO
	7	Fig. 7, 11	North Chevy Chase Park	431,950	--	--	--	4,545	1%	NO	8,901	2%	NO
	8	Fig. 7, 11	Private residence	9,015	--	--	--	--	--	--	1,557	17%	NO
	9	Fig. 7, 11	Private residence	7,210	--	--	--	--	--	--	276	4%	NO
	11	Fig. 7, 11	Private residence	20,071	--	--	--	--	--	--	48	<1%	NO
	12	Fig. 7, 11	Private residence	19,800	--	--	--	--	--	--	434	2%	NO
	13	Fig. 7, 11	Private residence	7,508	--	--	--	--	--	--	215	3%	NO
	14	Fig. 7, 8, 11, 12	Private residence	6,227	--	--	--	--	--	--	299	5%	NO

Intersection	Lot #	Figures	Location	Total Area of Lot (sq. ft.)	AA/DEIS Purple Line			SHA Proposed Improvements			SHA Proposed Improvements and Purple Line		
					Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take	Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take	Amount of Lot Used (sq. ft.)	% of Lot Used	Total Property Take
MD 185 (Connecticut Avenue) Intersection	15	Fig. 7, 8, 11, 12	Private residence	9,873	--	--	--	--	--	--	446	5%	NO
	16	Fig. 6, 8, 12	Private residence	11,046	--	--	--	--	--	--	522	5%	NO
	17	Fig. 6, 8, 12	Private residence	16,279	--	--	--	--	--	--	664	4%	NO
	18	Fig. 6, 8, 9, 12, 13,	Community Association Property	31,428	4673	15%	NO	6,550	21%	NO	6,550	21%	NO
	19	Fig. 6, 9, 13	Community Association Property	32,135	6617	21%	NO	12,001	37%	NO	12,001	37%	NO
	20	Fig. 9, 10, 13, 14		17,119	--	--	--	--	--	--	3 426	20%	NO
	21	Fig. 6, 9, 13	Private residence	18,996	--	--	--	--	--	--	3 312	17%	NO
	22	Fig. 6, 9, 13	Private residence	7,497	--	--	--	--	--	--	**1,096**	**15%**	**YES**
	23	Fig. 6, 8, 9, 12, 13	Private residence	13,821	--	--	--	--	--	--	**2,005**	**15%**	**YES**
	24	Fig. 6, 8, 12	Private residence	13,525	--	--	--	564	4%	NO	**3,964**	**29%**	**YES**
	N1	Fig. 9, 10, 13, 14	North Chevy Chase Elementary School	221,546	4469	2%	NO	--	--	--	--	--	--
	N2	Fig 10, 14	North Chevy Chase Elementary School	128,862	3187	2%	NO	--	--	--	--	--	--

Financial Realities

The proposed intersection improvements presented by SHA have been developed to identify what would be required to optimize traffic operations. These intersection improvements are both extensive and costly; and they have not been formally planned or programmed. It is not likely that all the suggested improvements for these two intersections would be implemented; given the estimated cost of over $50-$75 million for these two intersections, and the available budget for these two intersections and two other BRAC related improvement projects on Rockville Pike of $36 million. SHA will have to select a portion of these improvements for implementation. This analysis has been presented as a "worst case" study, with full acknowledgement that since the Jones Bridge Road improvements would likely be less than proposed, the resulting property impacts from those improvements and the Purple Line Jones Bridge Road alternative would be fewer.

Figure 1: Jones Bridge Road and MD 355 (Rockville Pike) Existing Conditions



Purple Line

Figure 2: Jones Bridge Road and MD 355 (Rockville Pike) with SHA Improvements

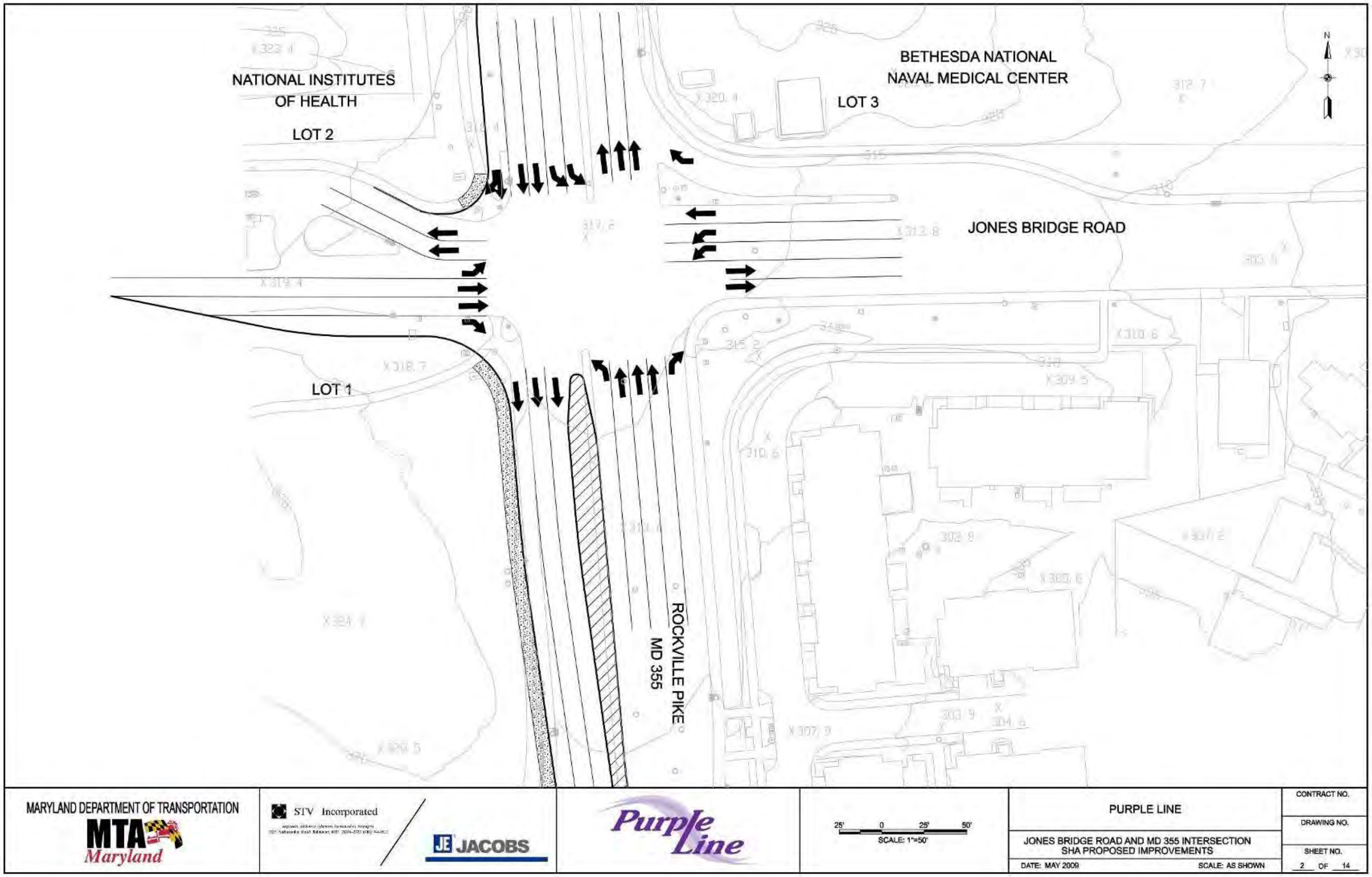


Figure 3: Jones Bridge Road and MD 355 (Rockville Pike) with SHA Improvements and the Purple Line

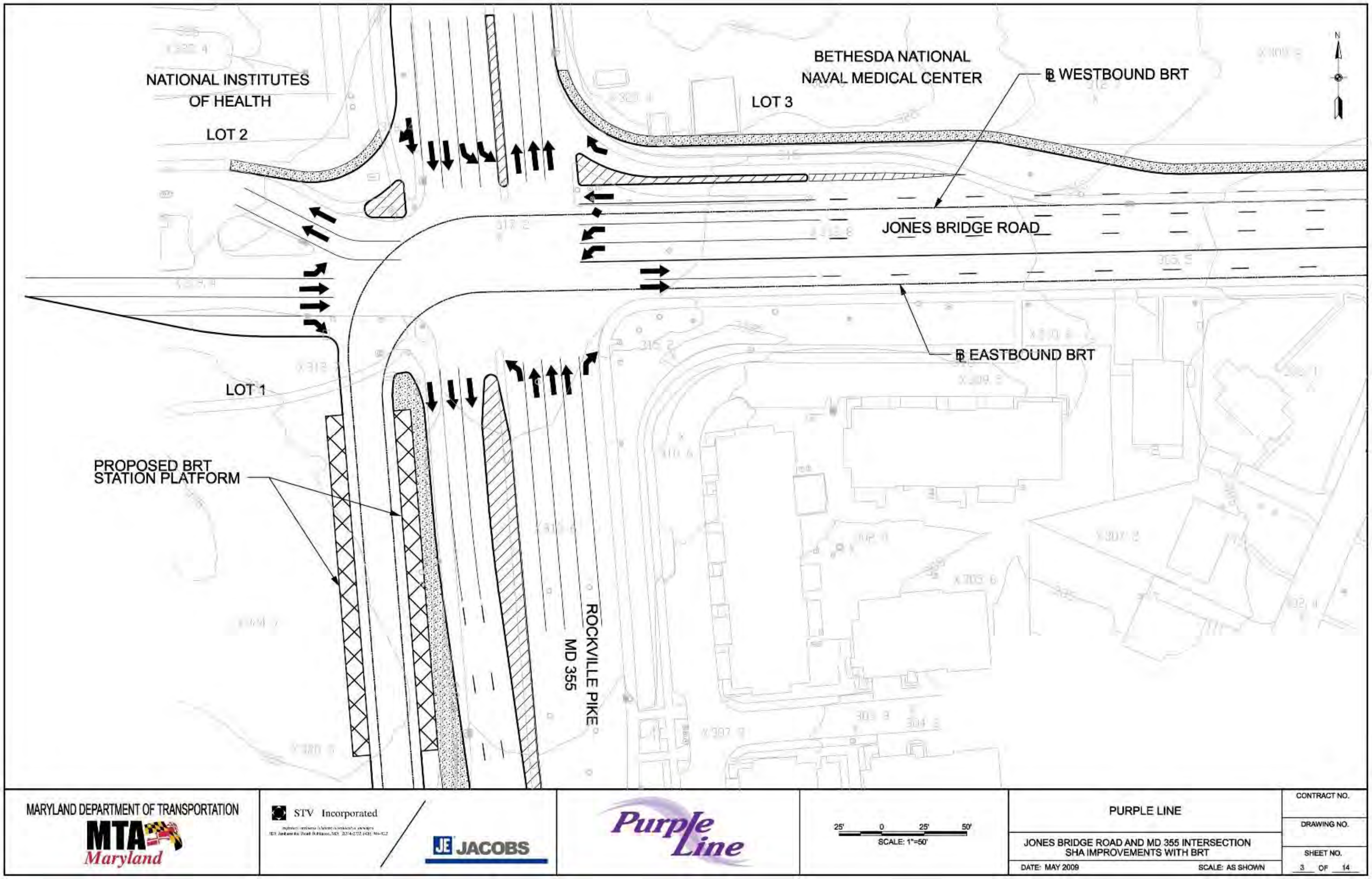


Figure 4: Jones Bridge Road east of MD 355 (Rockville Pike) with SHA Improvements and Purple Line

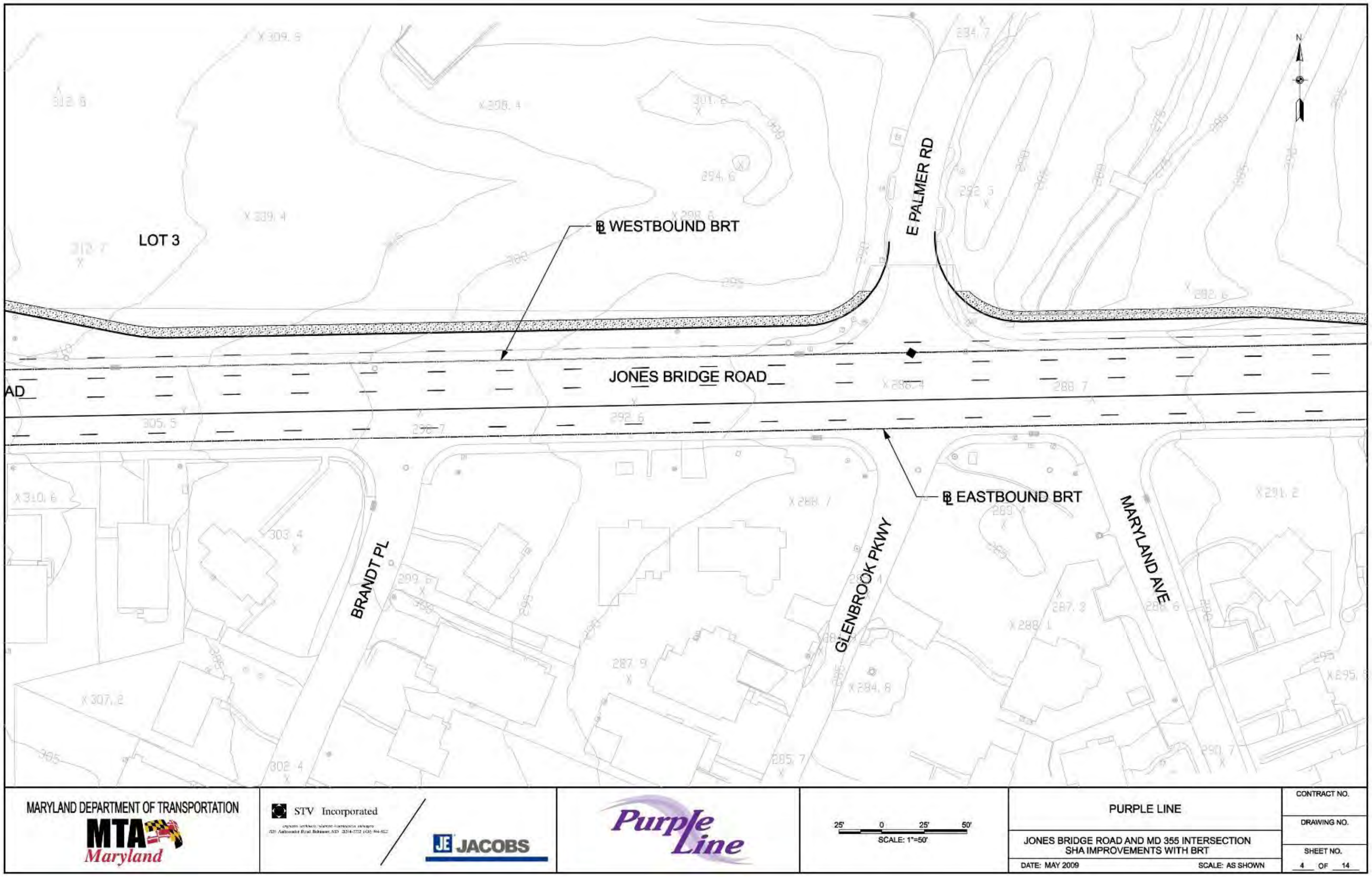


Figure 5: Jones Bridge Road east of MD 355 (Rockville Pike) with SHA Improvements and Purple Line

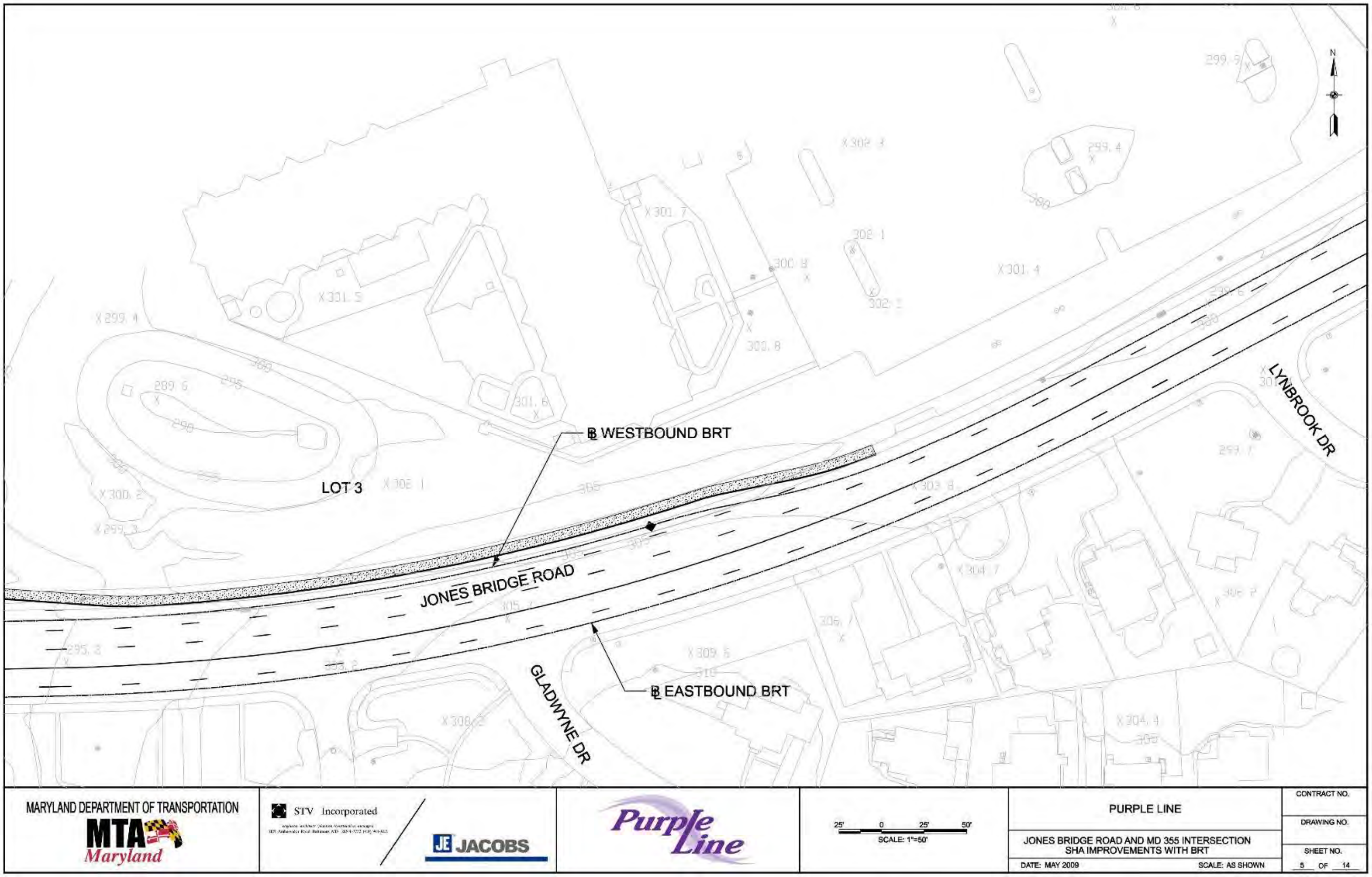


Figure 6: Jones Bridge Road and MD 185 (Connecticut Avenue) Existing Conditions

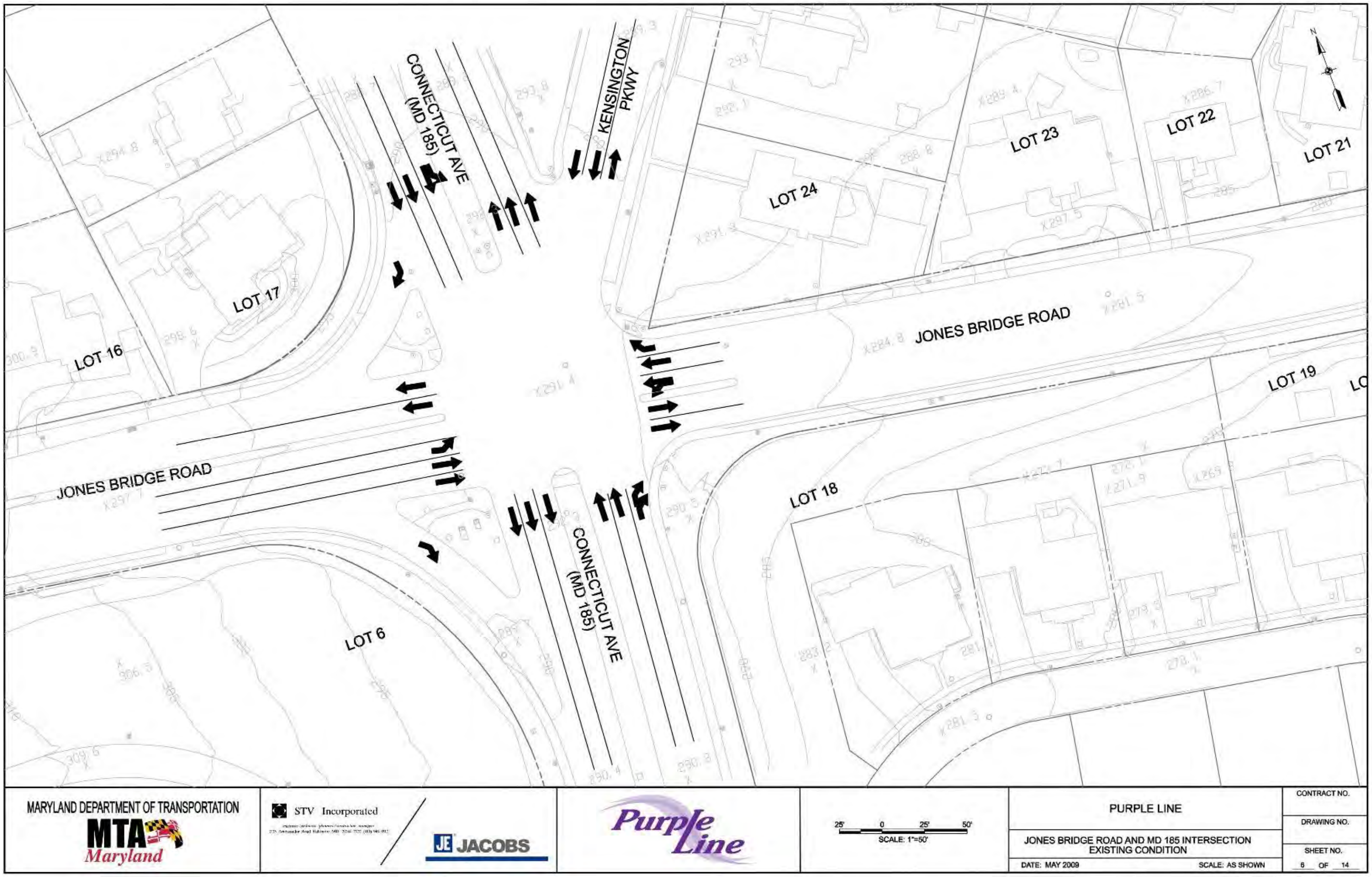


Figure 7: Jones Bridge Road west of MD 185 (Connecticut Avenue) with SHA Improvements

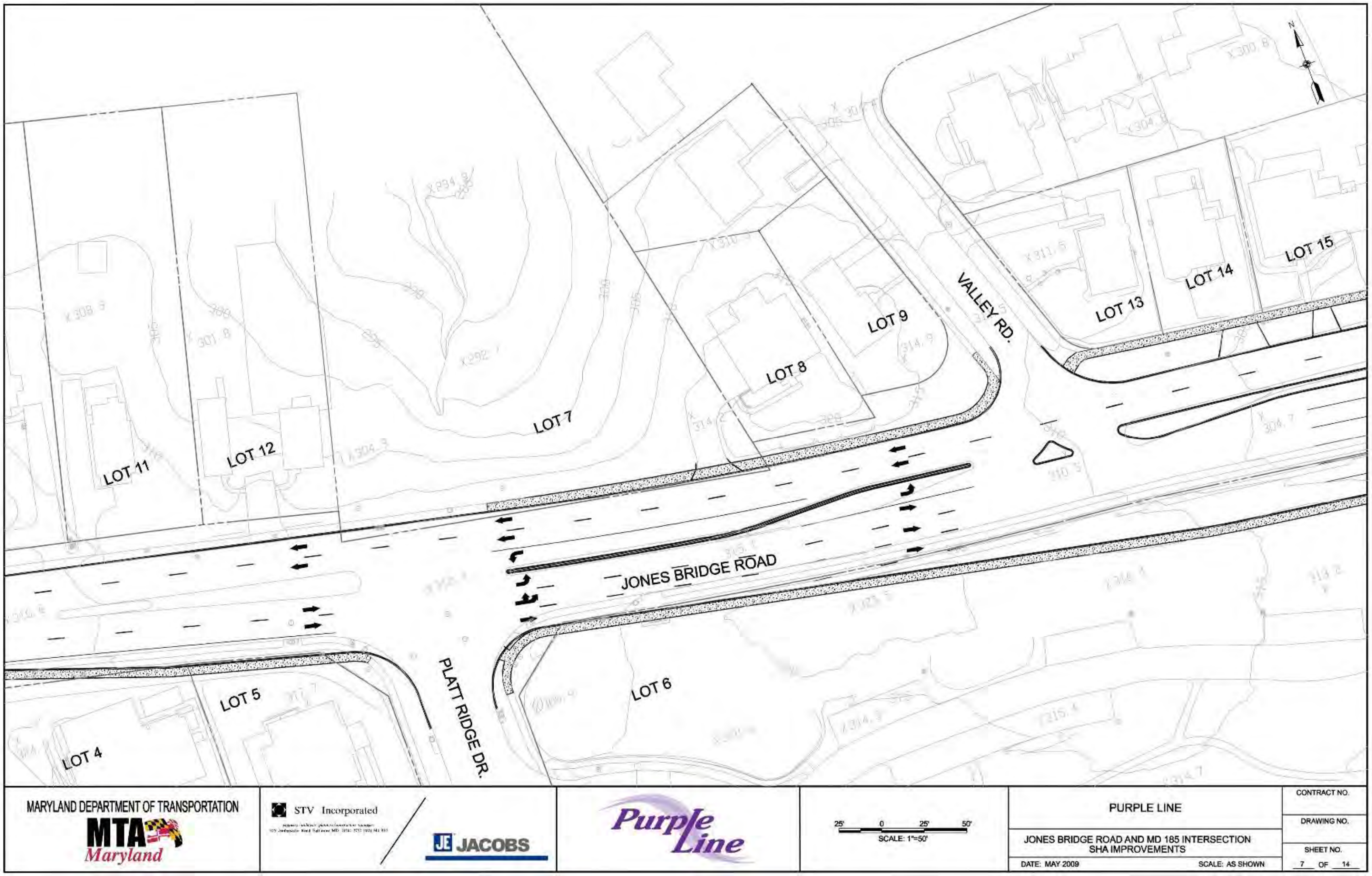


Figure 8: Jones Bridge Road and MD 185 (Connecticut Avenue) with SHA Improvements

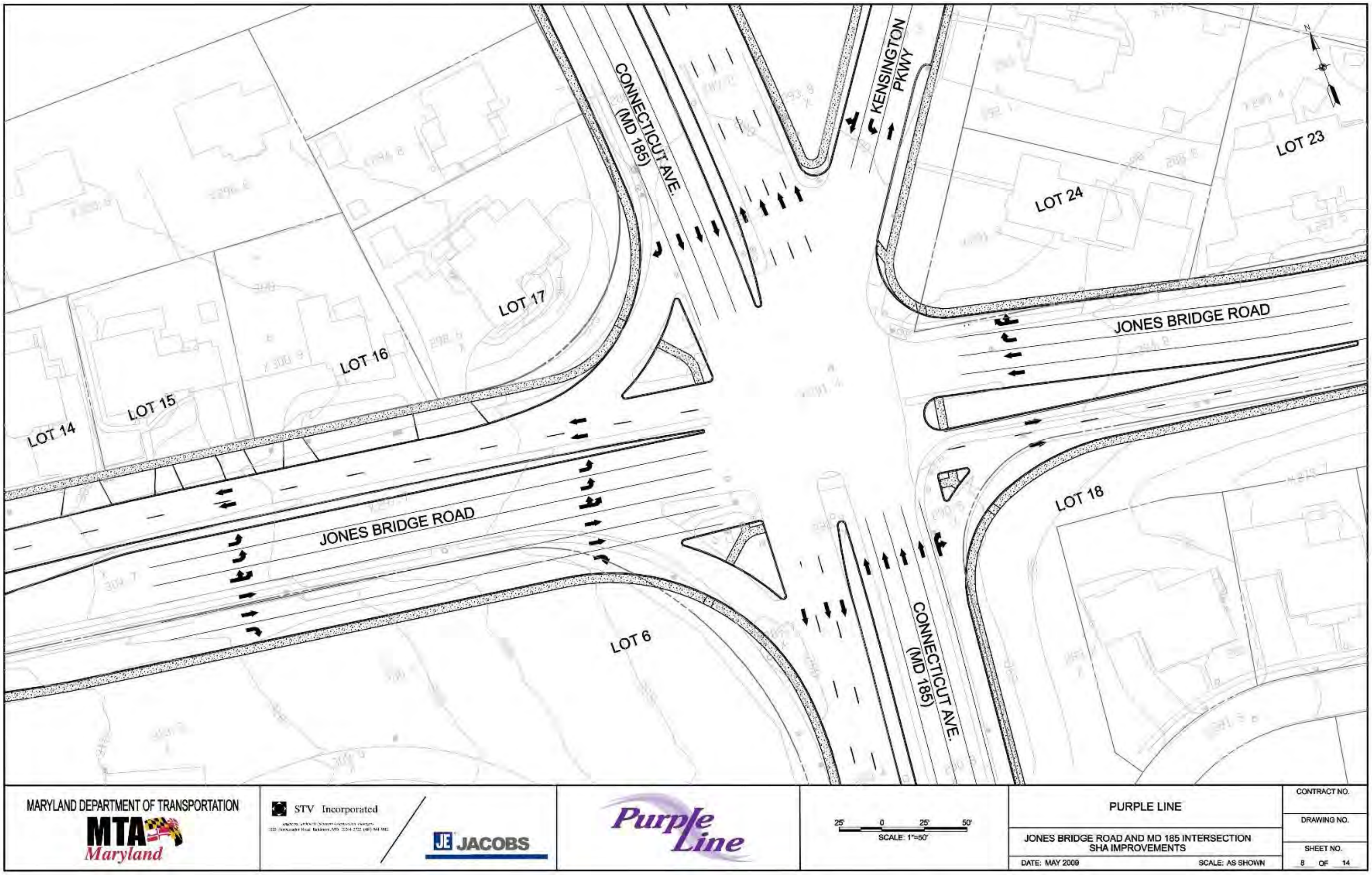


Figure 9: Jones Bridge Road east of MD 185 (Connecticut Avenue) with SHA Improvements

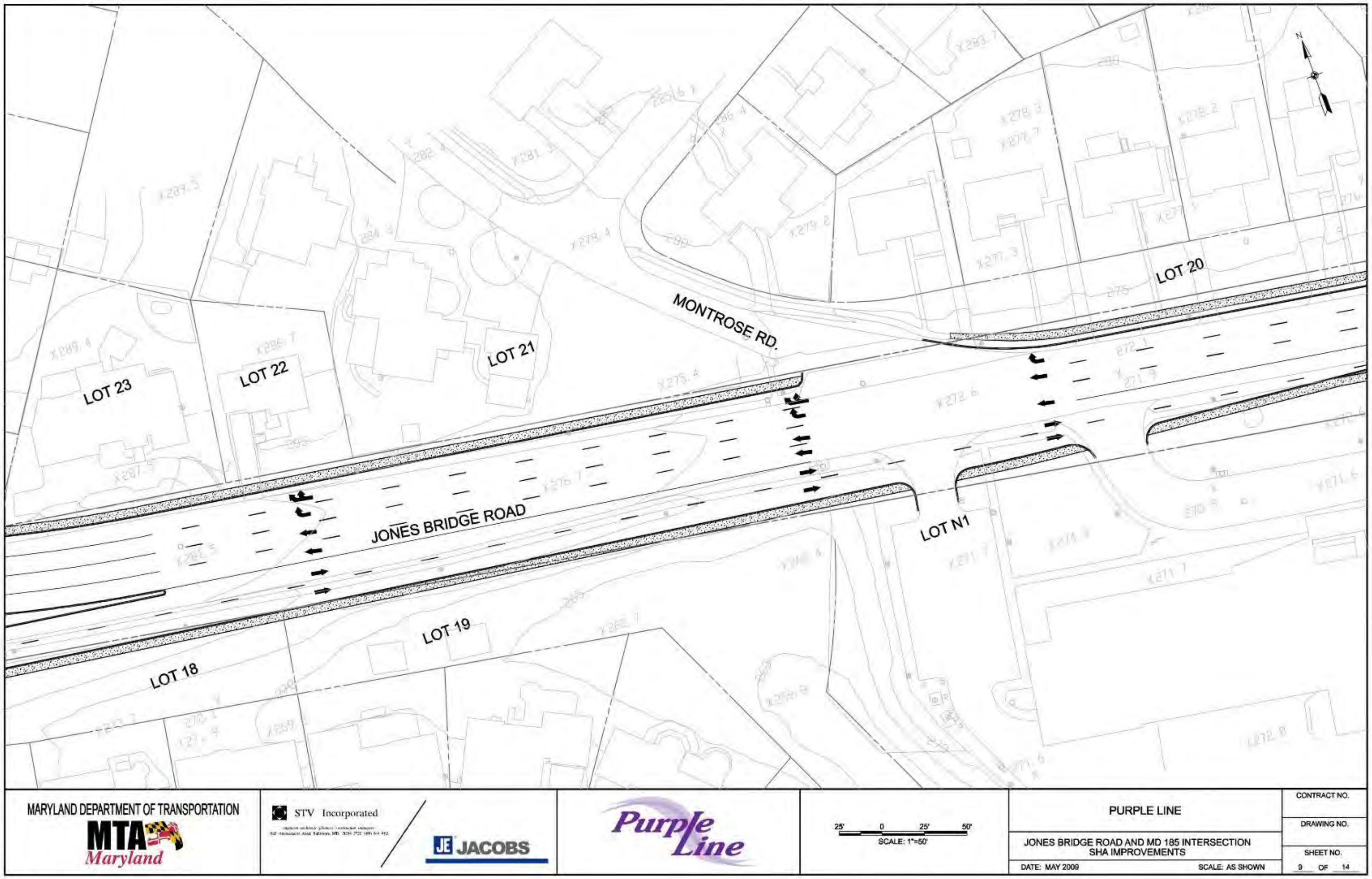


Figure 10: Jones Bridge Road east of MD 185 (Connecticut Avenue) with SHA Improvements

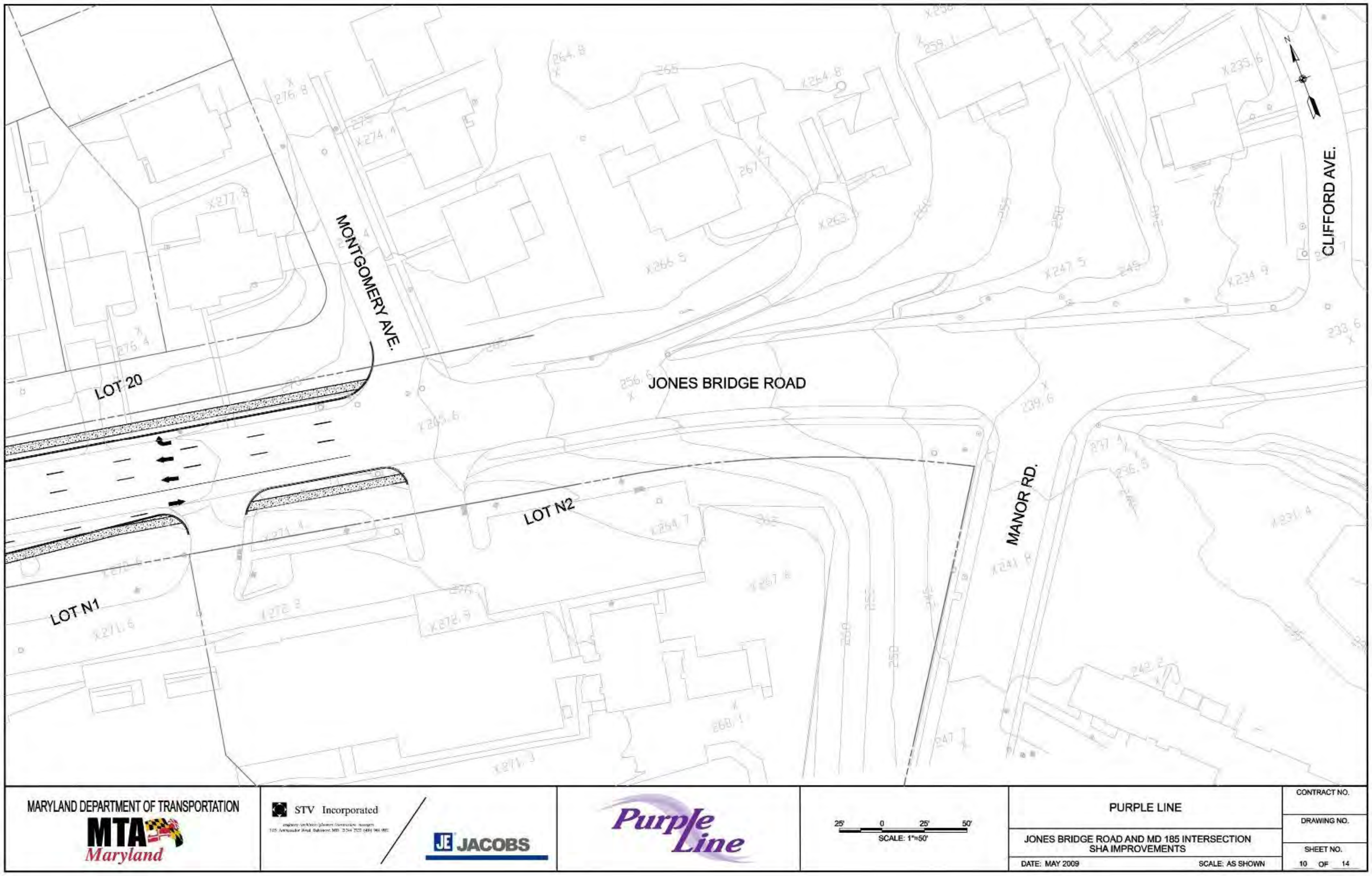


Figure 11: Jones Bridge Road west of MD 185 (Connecticut Avenue) with SHA Improvements and the Purple Line

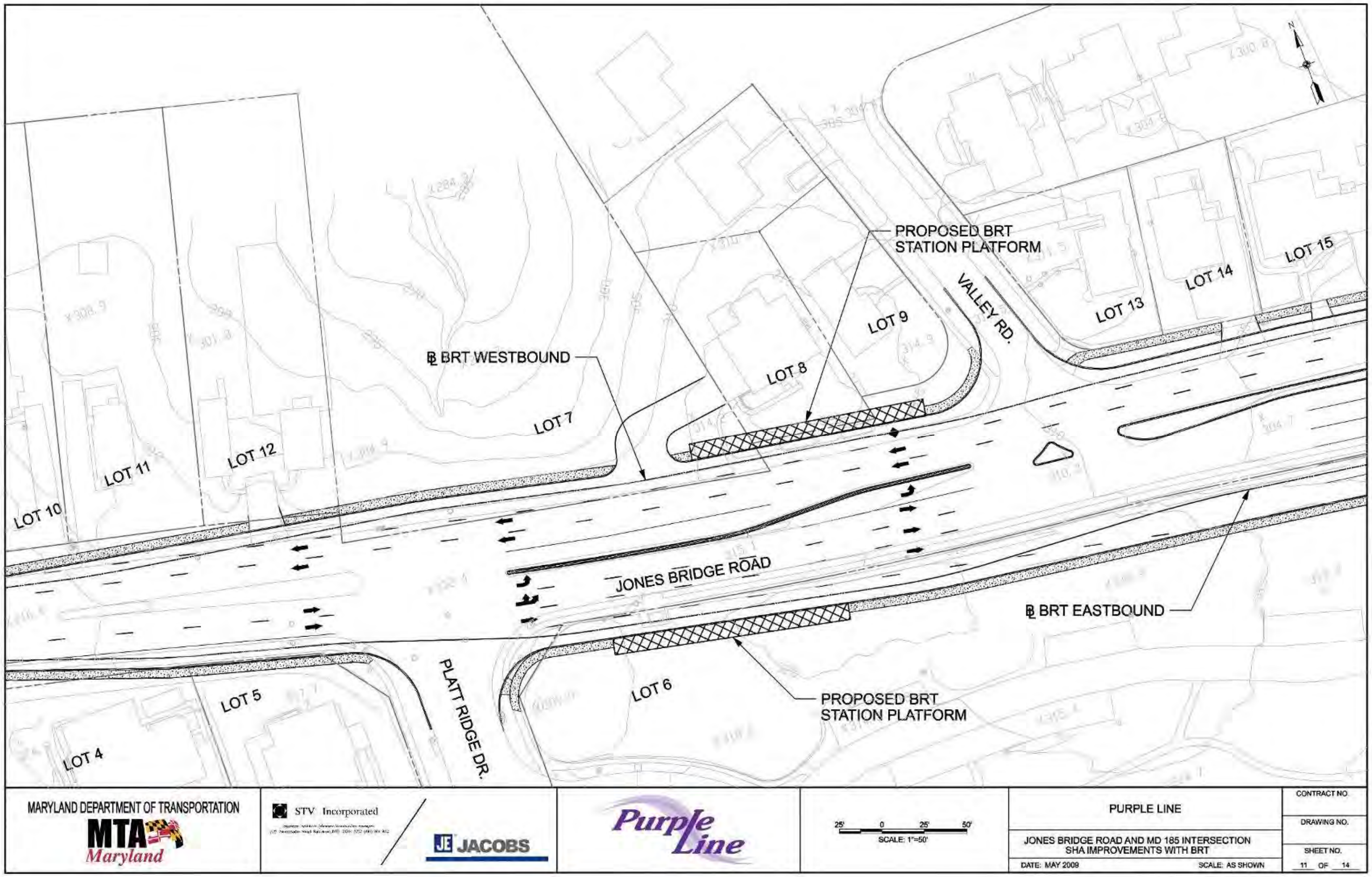


Figure 12: Jones Bridge Road and MD 185 (Connecticut Avenue) with SHA Improvements and the Purple Line

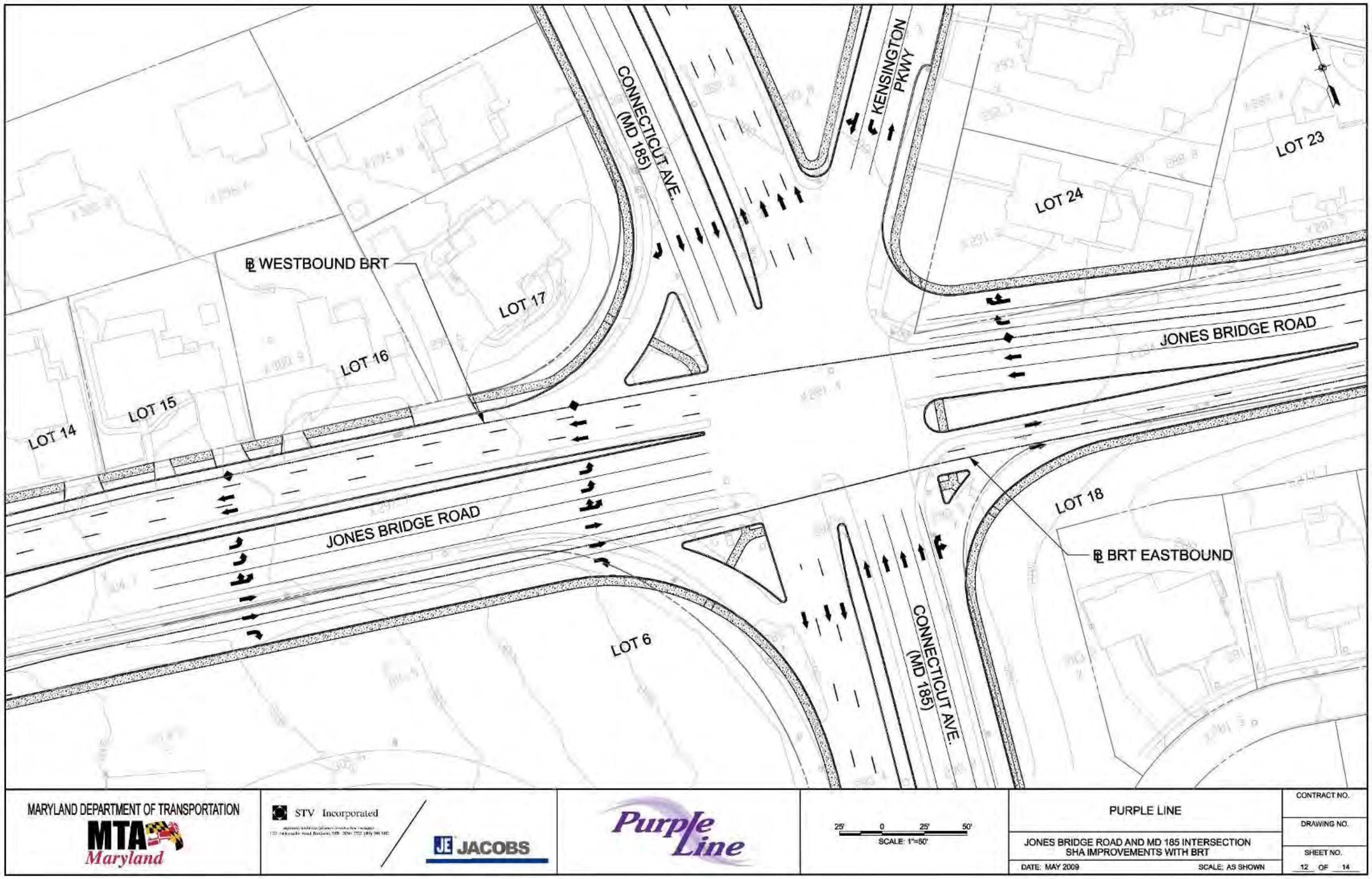


Figure 13: Jones Bridge Road east of MD 185 (Connecticut Avenue) with SHA Improvements and the Purple Line

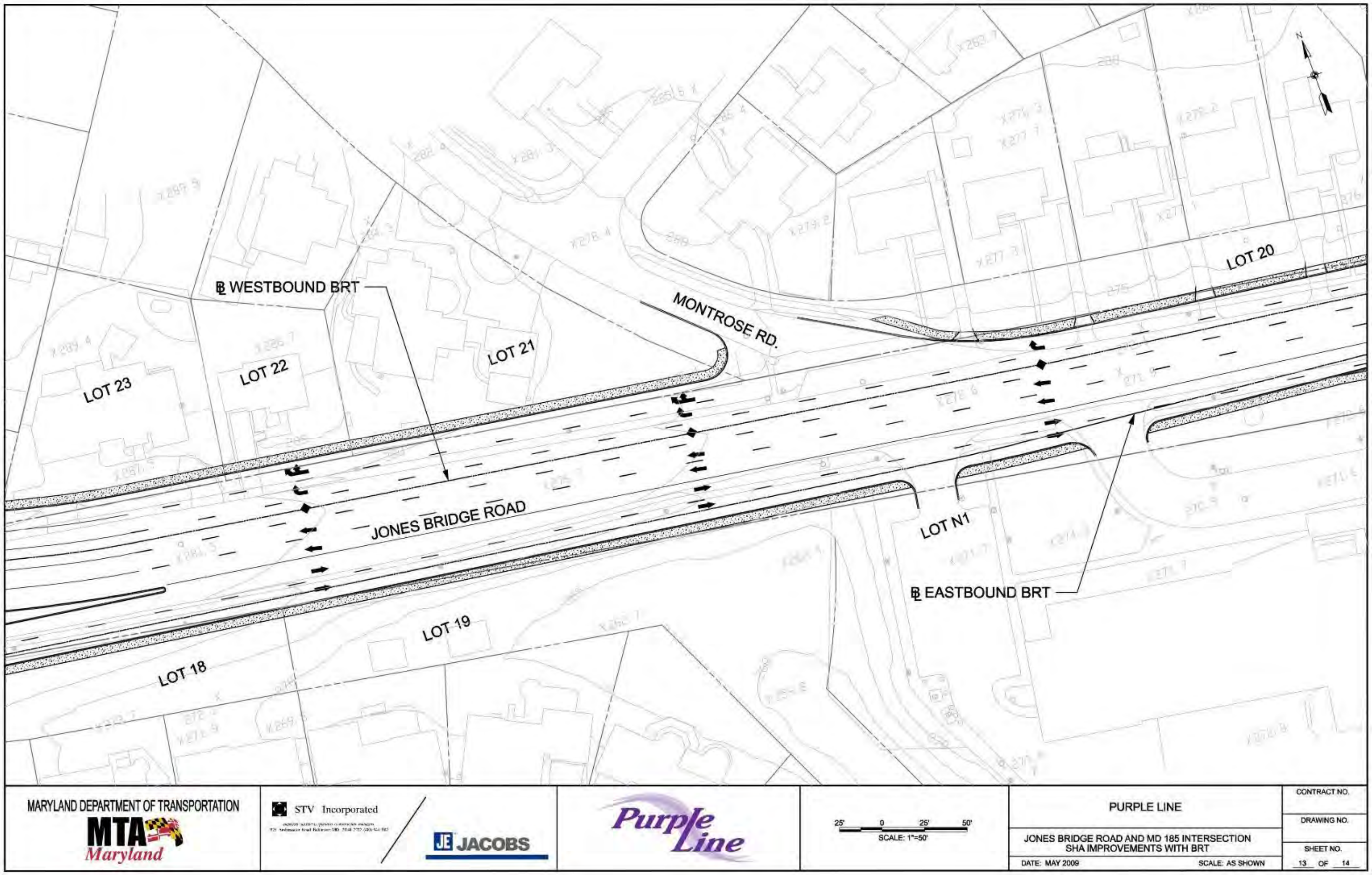
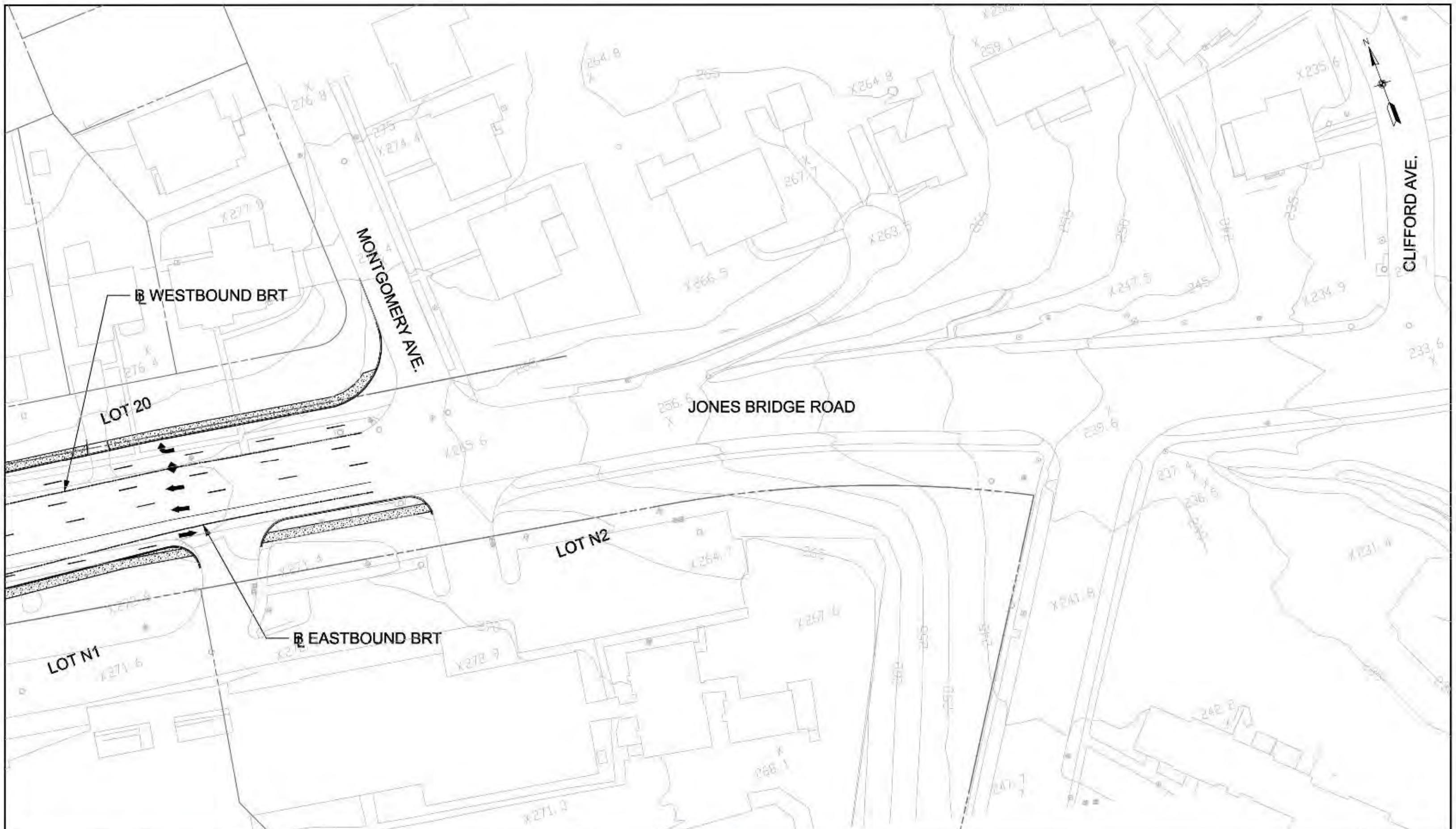


Figure 14: Jones Bridge Road east of MD 185 (Connecticut Avenue) with SHA Improvements and the Purple Line



MARYLAND DEPARTMENT OF TRANSPORTATION MTA Maryland	STV Incorporated / JACOBS	Purple Line	25' 0 25' 50' SCALE: 1"=50'	PURPLE LINE JONES BRIDGE ROAD AND MD 185 INTERSECTION SHA IMPROVEMENTS WITH BRT DATE: MAY 2009 SCALE: AS SHOWN	CONTRACT NO. DRAWING NO. SHEET NO. 14 OF 14

7. Evaluation of LRT Options between Silver Spring Transit Center and Mansfield Road

Evaluation of LRT Options between the Silver Spring Transit Center and Mansfield Road

September 2009

Evaluation of LRT Options between the Silver Spring Transit Center and Mansfield Road

EXECUTIVE SUMMARY

Since the initiation of the Purple Line, the MTA has evaluated many alignments for this area, including surface and tunnel alignments. In considering these alternatives, the MTA, in consultation with Montgomery County and the Maryland - National Capital Park and Planning Commission, assessed the alignments for reasonableness and relevance to the project's purpose and need. Options were also presented to the public throughout the alternatives development process and the alternatives were modified based on agency and public input.

The segment of the Purple Line corridor between the Silver Spring Transit Center and Long Branch presents a number of challenges. The topography of the area includes a stream valley with steep grades which the Purple Line must cross. There is no major east-west commercial roadway in this area. Wayne Avenue is a county-classified arterial roadway, but it is more residential in character than other roads in the corridor that serve the same transportation function.

Some of the residents along Wayne Avenue have opposed a surface alignment because of concerns about adverse effects to the neighborhood. They expressed a broad range of concerns including vehicular traffic, pedestrian safety (particularly for school children), and diversion of traffic on to local streets. Noise, community disruption, and concerns regarding roadway widening have also been mentioned.

The Montgomery County Council and County Executive Isiah Leggett, while endorsing the Purple Line and supporting the Medium Investment Light Rail (LRT) alternative (which includes a surface alignment on Wayne Avenue), have requested, along with community members, a study of a tunnel from the Silver Spring Transit Center to Mansfield Road, primarily running under Wayne Avenue, prior to the selection of the Locally Preferred Alternative (LPA). MTA conducted the study and presented the results at a community meeting on May 20th, 2009. A summary of the meeting and other Purple Line public involvement efforts in Silver Spring area are included later in this report. Although the findings and conclusions of this analysis were completed prior to the selection of the LPA, MTA continued to refine this report based on input from the community and Montgomery County.

MTA has conducted a detailed evaluation of all the alignment options in this corridor in order to identify the most desirable option to carry forward in the LPA. The options, both in the AA/DEIS and subsequent studies, were evaluated and compared in several key areas: engineering feasibility, traffic operations, transit reliability, property impacts, and potential environmental impacts including impacts to natural/cultural resources, parklands, air quality and noise quality. The options were also analyzed in other areas including property access, construction impacts, capital costs and cost effectiveness. The results of this evaluation are summarized in this report.

DESCRIPTION OF THE CORRIDOR

Downtown Silver Spring has experienced extensive redevelopment in the last 10 years. Major projects are being developed with nearly $1 billion in public and private investment in renovations and new construction. This development, centered on the multimodal Silver Spring Metro station, is urban in character with a mix of commercial, residential, and entertainment uses. As part of a public/private venture at the existing Silver Spring Metro station, the MTA, Montgomery County, and WMATA are building a new expanded multi-modal transit center with adjacent transit-oriented development. The transit center will serve Metrorail, MARC commuter rail, and WMATA Buses, Montgomery County Ride On, and intercity buses. The Silver Spring Transit Center is also designed to accommodate a station for the Purple Line. The County has leveraged this exceptional accessibility by successfully encouraging dense development in the area with zoning and density bonuses around the transit center. The eastern Silver Spring, Long Branch, and Takoma Park communities are characterized by well established residential neighborhoods that are compactly developed, containing a mix of single-family and multi-family dwellings.

OPTIONS UNDER CONSIDERATION

The following describes the LRT alternatives studied in the Silver Spring area only. There were three Light Rail Transit (LRT) build-options included in the AA/DEIS, along with a No Build option and a Transportation Systems Management (TSM) option.

Light Rail Alternatives included the AA/DEIS

Low Investment Light Rail Transit

The Low Investment LRT Alternative would leave the CSX right-of way and the Silver Spring Transit Center and meet Bonifant Street at grade, in dedicated lanes. It would turn into the site of the future County Library just west of Fenton Street. A station would be built in the site, integrated into the library development. The light rail would continue through the site to the intersection of Fenton Street and Wayne Avenue. It would travel on Wayne Avenue in shared lanes, entering a tunnel east of Manchester Road due to excessively steep grades on Wayne Avenue and continuing under Plymouth Street to emerge on Arliss Street. The transitway would turn left on Piney Branch Road and would continue in dedicated lanes. East of the Silver Spring Transit Center stations were proposed at Fenton Street, Dale Drive, and Manchester Place. Since the release of the AA/DEIS the MTA has agreed to consider delaying the construction of the stop at Dale Drive, but to build the alignment to accommodate a future station as specified by Montgomery County.

Medium Investment Light Rail Transit

The Medium Investment LRT Alternative is the same as the Low Investment LRT Alternative except that it would travel on Wayne Avenue in shared lanes with some added left-turn lanes at the signalized intersections to improve traffic performance. Like the Low Investment Light Rail alternative, the alignment would enter a tunnel east of Manchester Road and continue under Plymouth Street to emerge on Arliss Street. The transitway would turn left on Piney Branch Road and would continue in dedicated lanes. East of the Silver Spring Transit Center, stations were proposed at Fenton Street, Dale Drive, and Manchester Place. As noted above, the MTA will consider deferring the construction of the Dale Drive station.

High Investment Light Rail Transit

The High Investment LRT Alternative would extend in tunnel from the Silver Spring Transit Center to Wayne Avenue just east of Cedar Street. It would continue east on Wayne Avenue at grade, in dedicated lanes with a single traffic lane in each direction, to the tunnel under Plymouth Street to Arliss Street. The transitway would turn left on Piney Branch Road and would continue in dedicated lanes. East of the Silver Spring Transit Center, stations were proposed at Dale Drive and Manchester Place. As noted above, the MTA will consider deferring the construction of the Dale Drive station.

Silver Spring/Thayer Avenue Design Option

High Investment LRT Alternative also has a design option which would extend in tunnel from the Silver Spring Transit Center, but instead of turning north under Grove Street, would continue in tunnel under the backyards of the houses on Silver Spring Avenue and Thayer Avenue. The alignment would return to the surface on Thayer Avenue behind the East Silver Spring Elementary School. A station would be located just east of the portal on Thayer Avenue. The transitway would continue along Thayer Avenue to Piney Branch Road where it would turn left. Once on Piney Branch Road the transitway would be on an elevated structure taking it over Sligo Creek and Sligo Creek Parkway until just east of Manchester Road. The transitway would continue on Piney Branch Road to University Boulevard in dedicated lanes, with a station near Arliss Street. It should be noted that there is no public or County support for this option.

Option considered after DEIS

Tunnel to Mansfield Road

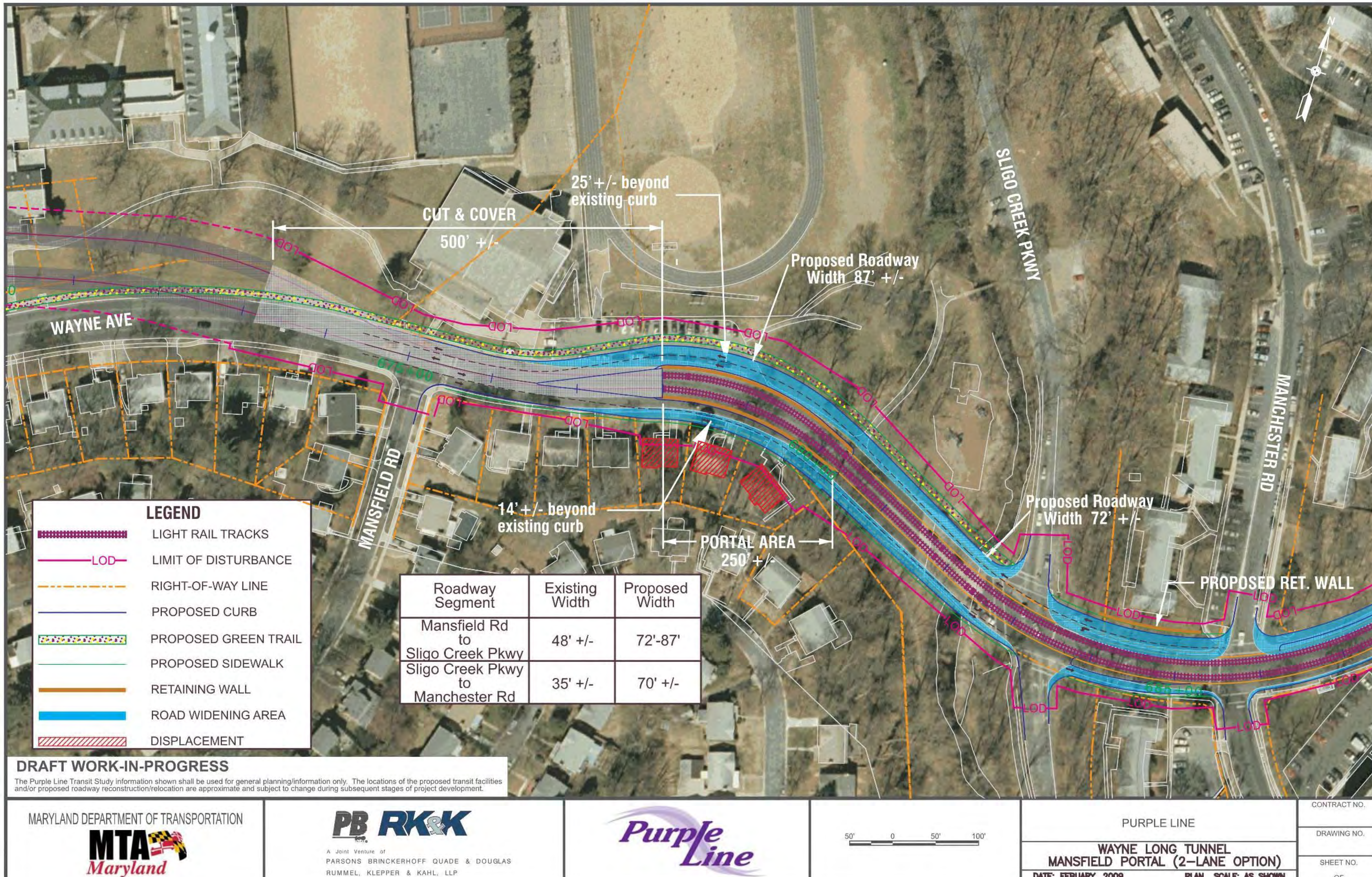
As described above, in response to community concerns regarding a surface transit alignment along Wayne Avenue, a tunnel option was studied with a portal on Wayne Avenue between Mansfield Road and Sligo Creek Parkway (See Figure 1).

Under the Mansfield Road tunnel option the length of the transitway on Wayne Avenue at grade would be reduced by approximately ½ mile. The alignment would be underground at the Sligo Creek Elementary and Silver Spring International Middle Schools. There would not be a station near Fenton Street south of the Silver Spring Library because of the excessively high costs of underground stations.

Other Options

Other options were suggested by the public which were evaluated including a tunnel extending under Sligo Creek. These options were not feasible due to cost and engineering constraints and are not presented in detail in this paper.

Figure 1: Plan of Tunnel to Mansfield Road



COMPARISON OF WAYNE AVENUE ALTERNATIVES

The following analysis compares the alignment options in the downtown Silver Spring and east Silver Spring area. A number of factors were considered in the analysis including impacts to property, access, the natural environment, and parking. The analysis also evaluated travel times, costs, cost-effectiveness, reliability, and ridership.

Table 1: Comparison of LRT Alternatives from the Silver Spring Transit Center to University Boulevard

Alternative	**Low Inv. LRT: At grade in shared lanes**	**Medium Inv. LRT: At grade in shared lanes with added left turn lanes**	**High Inv. LRT: Tunnel to Cedar Street, dedicated on Wayne Avenue**	**Tunnel to Mansfield Road**
Stations	Fenton Street Dale Drive [1] Manchester Place Arliss Street	Fenton Street Dale Drive, Manchester Place Arliss Street	Dale Drive Manchester Place Arliss Street	Manchester Place Arliss Street
Displacements	1 commercial building on Bonifant Street, 1 duplex on Plymouth Street, and 1 house at Arliss Street and Flower Avenue	1 commercial building on Bonifant Street, 1 duplex on Plymouth Street, and 1 house at Arliss Street and Flower Avenue	1 duplex on Plymouth Street and 1 house at Arliss Street and Flower Avenue	3-4 houses on Wayne Avenue, 1 duplex on Plymouth Street, and 1 house at Arliss Street and Flower Avenue
Other Impacts	Loss of street trees; Loss of parking during construction; Access impacts to Wayne Avenue Garage and Silver Spring Elementary School	Loss of street trees; Loss of parking during construction; Access impacts to Wayne Avenue Garage and Silver Spring Elementary School	Loss of street trees; Potential property impacts for ventilation shafts; Loss of parking during construction; Longer construction duration	Loss of street trees; Potential property impacts for ventilation shafts; Right-In/Right-Out access for several houses; Loss of parking during construction; Longer construction duration
Permanent underground easements for tunnels (acres)	1	1	6	9
Capital Cost from SSTC to University Blvd[2]	$178 million	$179 million	$296 million	$352 million
Cost Effectiveness for entire project	$26.51	$22.82	$23.71	$23.90
2030 Travel Times	10.0	9.0	6.0	5.4
Parkland Impacts (acres)	0.14	0.15	0.15	0.41
On-Street Parking Restrictions or Removal	Expanded peak hour restrictions on Wayne Avenue	Expanded peak hour restrictions on Wayne Avenue	Elimination of all on-street parking on Wayne Avenue east of Cedar Street	On-street parking on Wayne Avenue is already prohibited east of the proposed tunnel portal

[1] As noted, construction of the Dale Drive station may be deferred.
[2] Costs, Cost-effectiveness, and Travel Times all assume a station at Dale Drive for all alternatives except the Tunnel to Mansfield Road.

Property

The property displacements identified in Table 1 are based on conceptual planning and engineering, and are intended to provide information on the general order of magnitude of property impacts, as well as allow a comparison of the impacts of the alternatives within the East Silver Spring area.

All of the alternatives require some widening of the public right-of-way along Wayne Avenue. However, for much of Wayne Avenue the public right-of-way is actually quite wide, so the additional turn lanes for the Medium Investment alternative would not require much private property. However, many residents may not be aware that some of the property they consider as their front yard is actually public right-of-way.

The tunnel portal at Mansfield Road would make Wayne Avenue wider than the other alternatives in this segment because; two traffic lanes in both directions are maintained due to its proximity to the Plymouth tunnel required for all light rail options, the required additional widening (approximately 10 feet) for the tunnel portal, and the additional dedicated transit lanes. In the eastbound direction, two lanes were assumed to match the current configuration of Wayne Avenue, where two lanes approach Sligo Creek, with one lane becoming a left-turn only lane at Sligo Creek Parkway, and the second lane functioning as a through/right-turn lane.

The widening extends on both sides of Wayne Avenue into private residential property and parklands. Neither side is well suited for widening. The houses on the south side of Wayne Avenue sit above the roadway, meaning retaining walls would be needed where the roadway is widened, and the presence of parkland on the north raises the issue of impacts under Section 4 (f) of the US DOT Act of 1966. The amount of property required from three or four houses on Wayne Avenue is so great (see Figure 1) that it would result in the displacement of those residents. In addition, the remaining three houses on Wayne Avenue, east of Mansfield Road would be limited to right-in and right-out access.

As noted above, all alternatives would require strip acquisitions of residential property. The amount of property taken from parcels along Wayne Avenue for the alternatives evaluated in the AA/DEIS varies. Low Investment LRT, for which no turning lanes would be added, would require the smallest property acquisitions on Wayne Avenue. Medium Investment LRT requires property acquisition from those locations where the roadway is widened to add left-turn lanes. Approximately 40% (2,110 feet) of Wayne Avenue between Fenton Street and the Plymouth portal is widened, at least to some extent, in varying widths to account for tapering of the roadway, for the left-turn lanes. The approximate widening for each option is shown in Table 2.

All tunnel alternatives have sections of their alignment between downtown Silver Spring and Flower Avenue located beneath private property. Construction of any of these tunnel sections will require the purchase of an underground easement from each property owner. Also, depending on the length of the tunnel segment, private property on the surface may likely be required for ventilation shafts and other tunnel safety features.

Any tunnel option has its greatest impact at the portal area. A tunnel portal requires approximately eight feet of additional roadway width for the retaining walls and structure, and has a considerable visual impact, and, when in the median of a roadway, can have accessibility and mobility impacts to adjacent properties. This is particularly true for the Mansfield Road portal because of the proximity of the houses to the roadway and the grade differential between the street and the houses. The three houses in the area just west of the tunnel portal, where the roadway widens for the portal, would have the access to their driveways limited to right-in/right-out only.

Table 2 – Average Width of Property Requirements beyond Public Right-of-Way

Note: this does not account for widening for the Green Trail

		Fenton Street to Cedar Street	Cedar Street to Greenbrier Drive	Greenbrier Drive to Dale Drive	Dale Drive to Mansfield Road	Mansfield Road to Sligo Creek Parkway	Sligo Creek Parkway to Plymouth Portal
Distance		900 ft	900 ft	700 ft	1200 ft	800 ft	1000 ft
Low Investment LRT	North side	2'±	0'±	0'±	1'±	8'±	5'±
	South side	0'±	0'±	0'±	0'±	0'±	0'±
Medium Investment LRT	North side	9'±	2'±	2'±	7'±	12'±	5'±
	South side	2'±	0'±	0'±	0'±	0'±	0'±
High Investment LRT	North side	-	12'±	10'±	7'±	12'±	5'±
	South side	-	10'±	4'±	0'±	5'±	0'±
Tunnel to Mansfield Road	North side	-	-	-	0'±	20'±	5'±
	South side	-	-	-	0'±	11'±	0'±

Access

Access to residences and business along the entire length of Wayne Avenue will be impacted to varying degrees under both a surface and tunnel alignment. As the project progresses, MTA will continue to address a number of access issues which have been identified for the Wayne Avenue alignment. Several issues have already been addressed under a surface alignment. MTA has modified its original concept, which did not include an eastbound left-turn lane into the Whole Foods parking lot, to include a left-turn lane. This left-turn lane will allow through traffic, including the light rail, to travel unimpeded by traffic attempting to turn left into the Whole Foods parking lot. This modification was in response to community concerns and a meeting with the property manager of the facility. It should be noted that this modification did result in increased right-of-way needs in the area.

MTA will also continue to work with Montgomery County to address access issues at both the Wayne Avenue Garage and Sligo Creek Elementary School. MTA and the County do not believe that either of these issues are fatal flaws to a surface route alignment.

Under the tunnel option to Mansfield Road, the additional area needed for the tunnel portal would also result in changes of access for some of the driveways of the houses along the south side of Wayne Avenue. Access to and from the driveways of the three houses immediately east of Mansfield Road would be limited to a right-in/right-out only. This restricted access to homes would be considered a substantial adverse impact to these residential properties.

Visual Impacts

Potential visual impacts are largely similar for all of the Build Alternatives. The incorporation of the Purple Line on an existing road is considered compatible with the current character of the roadways. For the LRT alternatives, the LRT operations would be similar to the existing bus routes that operate on the roadways; however, the required infrastructure (rails, wires and power traction substations) would result in some greater effects, but still would be suitable for the corridor.

For all of the Build Alternatives, the crossing of Sligo Creek Parkway on Wayne Avenue would require widening of the existing bridge, which would represent a visual effect. If the Silver Spring/Thayer Avenue design option were selected, Thayer Avenue would undergo a considerable change in visual character as it is a narrow, quiet, residential street with a canopy of mature trees. Likewise, the aerial structure required for the LRT on Piney Branch Road for the same design option would result in substantial visual changes both for local residents and users of the Sligo Creek Trail.

The tunnel portal at Mansfield Road would have a direct visual impact from Sligo Creek Park and the remaining houses east of Mansfield Road. Also, due to its placement on the primary roadway serving the community, building a tunnel portal at this location would create a visual impact affecting the overall community.

Natural Environment

The primary environmental resource located in this area is Sligo Creek. Generally, adverse effects to the environment are not expected from any of the Build Alternatives because they travel along the existing road. The widening required will not have major effects to the natural environment. The increased impervious surface would require appropriate stormwater management. The stormwater treatment plans would need to be approved by the Maryland Department of the Environment. The tunnel to Mansfield Road, because it requires the most widening at Sligo Creek Parkway, would have the greatest impact of all the alternatives, but as noted, the impacts are relatively minor.

Parklands

The tunnel to Mansfield Road would require approximately 0.4 acre of property from Sligo Creek Stream Valley Park and Sligo Cabin Neighborhood Park. While not a large amount, this is more than what is required under the other LRT alternatives (See Table 1). The tunnel to Mansfield Road would require property from Sligo Cabin Neighborhood Park and the parking lot for the playing fields of the Silver Spring International Middle School. The playing fields and parking lot are part of Sligo Creek Stream Valley Park. Under Section 4(f) of the US DOT Act of 1966 the use of parklands for a federally funded or approved transportation project is only permissible when there is no "feasible or prudent" alternative to the use. Given the alternatives under consideration it is possible that this option would not be acceptable to the Maryland-National Capital Park and Planning Commission, which has jurisdiction over the parks, and/or FTA. The case for a *de minimis* impact finding under recent legislative changes would need to be carefully reviewed for applicability if this option were carried forward. In addition, these parklands may be protected under Section 6(f) of the Land and Water Conservation Funds Act under which the Secretary of Interior must approve any conversion of property acquired or improved with funding assistance under this act.

Travel times

The tunnel to Mansfield Road would provide a travel time shorter than the Low, Medium, and High Investment LRT Alternatives described in the AA/DEIS. Both the Tunnel to Mansfield Option and the High Investment LRT Option (with tunnel to Cedar Street) are notably faster (more than 3 minutes) than the Low and Medium Investment LRT Alternatives which operate at-grade the entire segment between the Silver Spring Transit Center and the Plymouth Street Tunnel. The tunnel options are faster both because of the lack of interaction with traffic and signalized intersections, but also because the two options have one or two fewer stations than the surface options. Each additional station adds a minimum of one half minute to the travel time. It should also be noted that when they return to grade, all of the tunnel options then operate in dedicated lanes. Specifically, the High Investment alternatives from the AA/DEIS would operate in a tunnel between the Silver Spring Transit Center and a point just east of Cedar Street; between Cedar Street and Sligo Creek Parkway, two of the existing general purpose traffic lanes (one in each direction) would be replaced by dedicated transit-only lanes; between Sligo Creek Parkway and the entrance to the Plymouth Tunnel, two new dedicated transit-only lanes would be constructed. For the Mansfield Road tunnel option, between the tunnel portal east of Mansfield Road and the entrance to the Plymouth Tunnel, two new dedicated transit lanes would be built in addition to the existing traffic lanes.

Cost

The estimated capital cost for the tunnel to Mansfield Road is $352 million from the Silver Spring Transit Center to University Boulevard. This alternative has the longest length of tunnel and therefore the highest cost. The costs are considerably lower for the Low and Medium Investment LRT Alternatives ($178 - $179 million) which include only the required tunnel under Plymouth Street.

Cost-Effectiveness and Affordability

A key measure used in the FTA's evaluation of transit projects is the cost-effectiveness index, which measures the relative advantages of a proposed transit system compared to a baseline alternative. This index relates the capital and operating costs of a transit system to each hour of user benefit (travel time savings, etc) which are derived from that system.

The Medium and High Investment LRT Alternatives have cost-effectiveness values which would satisfy the current criteria for a "Medium" ($15.00 to $23.99) cost-effectiveness rating from the FTA. The Low Investment LRT Alternative would satisfy the current criteria for a "Medium-Low" ($24.00 to $30.00) cost-effectiveness rating. The Tunnel to Mansfield Option would satisfy the "Medium" cost-effectiveness with a rating of $23.90. A "medium" or better is required for funding eligibility. These costs are based on the costs from the AA/DEIS in 2007 dollars which would be updated.

While all the alternatives and options are currently expected to meet the federal cost-effectiveness requirements, it must be remembered that the affordability of the project is a critical consideration. The ability of an option to meet the cost-effectiveness index is immaterial if that option is beyond the financial capacity of the State of Maryland. Moreover, the lower the cost effectiveness value, the higher the chance for federal funding due to the high competition for limited federal funds by projects throughout the country.

Transit Reliability

The reliability of transit operations can be adversely impacted due to conflicts with other traffic. This can happen at intersections and when regular traffic is in the same lanes as the transit vehicles.

The alternatives with tunnel or exclusive right-of way would have the highest reliability because they would not be subjected to interference from traffic. Therefore, the High Investment alternatives would have the highest reliability, and the Low Investment alternatives would have the lowest reliability.

The tunnel to Mansfield Road would have slightly more reliability than the High Investment LRT with a tunnel to Cedar Street due to the fact that it is in tunnel for a longer distance, including at the intersections of Wayne Avenue with Dale Drive and Mansfield Road. However, under the High Investment LRT option because the transitway would operate in dedicated lanes and traffic volumes along Mansfield Road, in particular, are quite low, the delays at these signals would be minimal.

While dedicated or exclusive right-of-ways are the most desirable operating environment for transit systems due to the faster and more reliable travel times which can be attained, operations in mixed traffic (within shared lanes) are also common and can provide reliable travel times. For the Purple Line, operations in mixed traffic are proposed for two segments: Wayne Avenue (between Fenton Street and Sligo Creek Parkway) and Paint Branch Parkway (between Rossborough Lane and River Road). By providing separate left-turn lanes and using signal priority strategies to reduce the delay at the traffic signals along Wayne Avenue, it is expected that consistent and reliable travel times can be attained along this segment. Also, by operating in the inside lanes, rather than the curb lanes, the potential for unexpected delays, such as those due to illegally stopped or parked vehicles, trucks making deliveries, or broken down vehicles (which are typically moved to the right side of the road), should be reduced.

Effects on Traffic

As documented in the AA/DEIS, MTA evaluated the potential impact of the Purple Line on traffic operations in the downtown Silver Spring area (west of Fenton Street). The transitway will connect with a stop at the third level of the Silver Spring Transit Center. After departing the transit center on an aerial structure, the transitway will turn to the east and return to grade just east of the existing intersection of Ramsey Street and Bonifant Street. Starting at this point and continuing along Bonifant Street until its intersection with Georgia Avenue, the transitway would operate in dedicated lanes along the south side of the roadway. As the transitway crosses Georgia Avenue it would transition from the south side of the roadway to the north side.

East of Georgia Avenue, the transitway would operate in dedicated lanes along the north side of the roadway until approximately 100 feet west of Fenton Street. At that location, the transitway would leave the Bonifant Street right-of-way and enter the future Silver Spring library site where a station would be located.

For automobile traffic, between Ramsey Avenue and Georgia Avenue, Bonifant Street would be converted to a one-way configuration. While this configuration could be either eastbound or westbound, a westbound orientation provides advantages for allowing vehicles to access the future transit center and the large public parking garage along Bonifant Street. East of Georgia Avenue, two options were also considered for Bonifant Street: two-way traffic (with no on-street parking) or a one-way configuration (with an on-street parking lane along the south curb). Again, either an eastbound (preferred) or westbound configuration could be used for the one-way option. The decision on the configuration of Bonifant Street will be made by Montgomery County.

In the AA/DEIS, for the Medium LRT Alternative, traffic was reassigned within the network to reflect one-way westbound traffic on Bonifant Street west of Georgia Avenue, and one-way eastbound traffic on Bonifant Street east of Georgia Avenue. Westbound traffic from Bonifant Street was assumed to use Thayer Avenue. Eastbound traffic was assumed to use Ramsey Avenue, Dixon Avenue, and Wayne Avenue. At the intersections of Wayne Avenue and Dixon Avenue and Georgia Avenue and Thayer Avenue, the additional traffic resulted in a change in the intersection levels of service (LOS) from LOS A to LOS B in the AM peak in 2030.[3] No changes in the levels of service at any of the intersections studied were observed during the PM peak. The analysis showed that in 2030, the proposed conversion of Bonifant Street to one-way operation on both sides of Georgia Avenue would have negligible impacts to traffic operations in the downtown Silver Spring area.

Several questions have been raised by the community regarding the Purple Line crossing of Georgia Avenue at grade and whether this would significantly impact traffic operations in the downtown area. The proposed crossing would occur at the existing signalized intersection of Bonifant Street and Georgia Avenue, so no new traffic signals would be required along Georgia Avenue. Also by converting Bonifant Street to the preferred one-way traffic patterns, no new signal phases would be required due to the Purple Line, thus maintaining the current amount of green-time available for traffic along Georgia Avenue.

One of the key existing issues at the intersection of Georgia Avenue and Bonifant Street is its proximity to the major intersection of Wayne Avenue and Georgia Avenue, approximately 350 feet to the north. Because traffic on Georgia Avenue is required to stop for a longer time period to serve the heavier east-west traffic volumes along Wayne Avenue than it is required to serve east-west traffic on Bonifant Street, northbound traffic on Georgia Avenue often receives a green signal at Bonifant Street, while the signal is still red at the downstream intersection at Wayne Avenue. Drivers are often observed entering the intersection and subsequently blocking east-west traffic. To facilitate the passage of light rail vehicles through this area, it will be necessary to carefully review the coordination between signals along the corridor to manage traffic and reduce the potential for traffic to queue within this intersection. It is important to note that the passage of light rail through this area would not worsen this existing problem.

MTA also evaluated the effects of the Build Alternatives on traffic operations along Wayne Avenue during the morning and afternoon peak hours using the traffic analysis software Synchro, which utilizes capacity analysis methodologies presented in the Year 2000 Highway Capacity Manual. The results of this analysis are summarized in Table 3. Under the No Build condition, the intersections of Wayne Avenue and Dale Drive and Wayne Avenue and Sligo Creek Parkway are expected to operate near their capacity in 2030. The tunnel to Mansfield Road would avoid impacts to the intersection of Wayne Avenue and Dale Drive, but would

[3] Level of Service is a qualitative description of traffic operation based on delay and maneuverability. It can range from "A" representing free flow conditions to "F" representing gridlock.

negatively impact the intersection of Wayne Avenue and Sligo Creek Parkway, resulting in LOS F operations during the peak period.

Table 3: Impacts on 2030 Intersection Peak Hour Level of Service (AM/PM)

Alternative	Projected 2030 Level of Service				
	Wayne Ave at Fenton St	**Wayne Ave at Cedar St**	**Wayne Ave at Dale Dr**	**Wayne Ave at Mansfield Rd**	**Wayne Ave at Sligo Creek Pkwy**
No Build	C/C	C/D	C/E	A/A	E/E
Low Inv. LRT: At grade in shared lanes	C/D	B/D	B/D	A/A	C/E
Medium Inv. LRT: At grade. in shared lanes with added left turn lanes	C/D	B/D	B/D	A/A	C/E
High Inv. LRT: Tunnel to Cedar St., dedicated on Wayne Ave.	C/C	C/C	F/F	D/C	F/F
Tunnel to Mansfield Road	C/C	C/D	C/E	A/A	F/F

The Low Investment LRT Alternative, which would operate in shared lanes, is not expected to substantially impact traffic operations at the signalized intersections along Wayne Avenue. The Medium Investment LRT Alternative, which would operate in shared lanes but include widening for left-turn lanes at critical locations, is expected to improve overall traffic operations along the corridor relative to the No Build condition and Low Investment LRT Alternative. While the overall intersection levels of service do not change under the Medium LRT compared to the Low LRT, the overall delay per vehicle at these intersections does decrease under the Medium LRT option One adverse impact of the Low and Medium Investment LRT alternatives is that the level of service of the intersection of Fenton and Wayen would be degraded from C to D in the PM peak period.

The High Investment LRT Alternative, which would provide dedicated transit lanes for the LRT, east of the tunnel to Cedar Street, by converting two of the four existing travel lanes, is expected to negatively impact intersection operations along Wayne Avenue, particularly at the critical intersections at Dale Drive and Sligo Creek Parkway. Under the High Investment LRT Alternative, these two intersections are projected to operate at LOS F during the peak periods in 2030, with increased delay for motorists.

Ridership, Accessibility, and Equity

Table 4 shows the estimated daily boardings at each station between downtown Silver Spring and Manchester Place. The data indicates that the High Investment LRT Alternative, with a tunnel to Cedar Street, would attract 7 percent more boardings at the four Silver Spring area stations than the surface-running Medium Investment LRT Alternative and 17 percent more boardings at these stations than the Low Investment LRT Alternative. All of these are the alignments as defined in the AA/DEIS with a station at Dale Drive. However, it must be remembered that ridership is primarily a function of travel time and accessibility. The High Investment Alternative, offering faster travel times throughout the corridor would attract more total riders for the entire project.

Table 4: Year 2030 LRT Alternative Daily Station Boardings

Alternative		SSTC	Fenton Street	Dale Drive	Manchester Place	Total Boardings for Station Group
Low Inv. LRT: At grade in shared lanes	**AA/DEIS**	11,100	700	1,300	800	13,900
Medium Inv. LRT: At grade in shared lanes with added left turn lanes	**AA/DEIS**	12,200	700	1,400	900	15,200
High Inv. LRT: Tunnel to Cedar St., dedicated on Wayne Ave.	**AA/DEIS**	13,600	N/A	1,500	1,200	16,250
High Inv. LRT: Tunnel to Mansfield Road	**Community Request**	13,650	N/A	N/A	1,400	15,050
Medium Inv. LRT: Tunnel to Mansfield Road	**Community Request**	13,450	N/A	N/A	1,200	14,650
Medium Inv. LRT without Dale Drive Station*	**Community Request**	12,200	1,200	N/A	1,100	14,500

* Alignment would be built to accommodate a station at a future date

To provide a comparison that isolates the ridership changes resulting from the inclusion of a tunnel along Wayne Avenue, the travel forecasting model was used to develop projections for an option that used the Medium Investment LRT outside of East Silver Spring, but included a tunnel option to Mansfield Road. This model indicates that the number of boardings in the Silver Spring area for the tunnel to Mansfield Road is 14,650. Because the tunnel option is slightly faster than the Medium Investment LRT Alternative on the surface, this option has a marginally higher ridership than the community-requested Medium Investment LRT without a station at Dale Drive.

Under the Medium Investment LRT Alternative, if the Dale Drive surface station is eliminated, of the 1,400 projected riders, about 500 would switch to the Fenton Street station, 200 would switch to the Manchester station and 700 would not use the Purple Line.

One of the key objectives of the Purple Line is to provide neighborhood access and stations within comfortable walking distance, generally considered to be a ¼ mile radius from the station (See Figure 2). This is especially important since new park-and-ride lots would not be provided as part of the project. The tunnel options do not meet that objective nearly as well as the surface options, particularly the Mansfield tunnel because it does not have a station near the future County library (Fenton Street and Wayne Avenue) and at Dale Drive. The distance between the Silver Spring Transit Center and the station at the Plymouth portal is almost 1 ½ miles leaving that area without convenient access to the Purple Line. This compares to an average distance for the entire 16-mile Purple Line corridor of approximately 3/4 mile between stations.

Parking

Along Wayne Avenue under the Low and Medium Investment LRT Alternatives, the existing time-of-day/day-of-week parking restrictions would be expanded to ensure reliable transit operations during the peak periods. During off-peak periods, it is expected that on-street parking would be permitted in the curb lanes on Wayne Avenue west of Mansfield Road, as it is today.

East of Mansfield Road on Wayne Avenue parking is not permitted today, nor under any of the Build alternatives. If a station is provided at Dale Drive, parking in the eastbound curb lane on Wayne Avenue in the vicinity of the station would need to be prohibited at all times.

Parking on Wayne Avenue would not change from what it is today under the Tunnel to Mansfield Road alternative, however, for the Mansfield tunnel option, much, if not all of the existing parking for the playing fields adjacent to the Silver Spring International Middle School would need to be removed to provide the necessary width for the tunnel portal and the County's planned Green Trail; and on-street parking would not be available in this area to replace the lost parking. This lot currently has parking for approximately 20 to 25 cars.

Construction Impacts

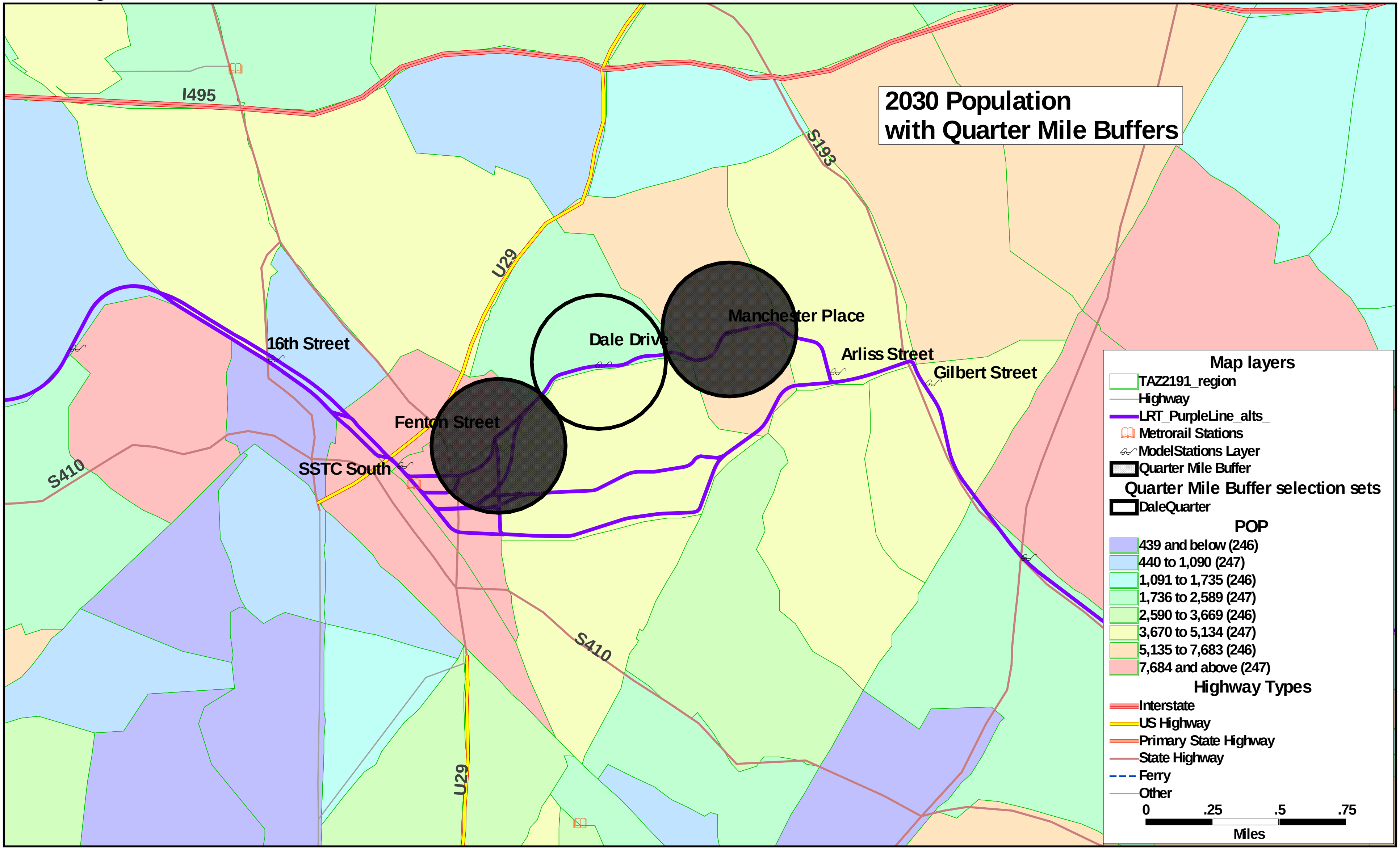
For all of the alternatives, maintenance of traffic will be challenging during construction activities, which will likely complicate and extend the duration of construction. Though it is anticipated that emergency and resident access will be maintained, portions of Wayne Ave will likely need to be partially or fully closed for periods of time for construction. These closures are expected to be continuous (the road will not be able to be reopened at night). Several driveways would be restricted to right-in/right-out permanently as well.

For all tunnel alternatives, construction of the cut-and-cover section and portal area would require several months to complete. Depending on the soil conditions, maintenance of traffic requirements, and weather conditions, completion of the structural work is estimated to take eight to twelve months. Most utilities currently in the roadway will need to be relocated to avoid conflicts with the portal and cut-and-cover sections of the alignment. Prior to the construction of the cut-and-cover section and the portal it is estimated that the utility relocations and lane widening for maintenance of traffic would take approximately four to six months.

Following completion of the tunnel and cut-and-cover section the new roadway, storm drains, and conduits for Wayne Avenue would be constructed. This construction could take another four to six months. While some of this work may be done concurrently, under the worst case scenario we estimate the total duration of construction in this area to be between 16 to 24 months. In addition to construction impacts such as noise, the cut-and-cover construction would temporarily adversely affect traffic operations for the community to a greater extent than the other alternatives along Wayne Avenue.

Under the tunnel to Mansfield Road, during the construction period it is assumed that no parking would be allowed from approximately 300 feet west to 600 feet east of Mansfield Road and that only one lane of through-traffic would be maintained in each direction.

Figure 2 - Quarter-Mile Station Buffers



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PUBLIC INVOLVEMENT IN THE SILVER SPRING AREA

The MTA conducted an extensive public involvement program throughout the Purple Line planning process with periodic large open houses; newsletters; a website; Community Focus Groups; and meetings with community and civic associations, major stakeholders, and local elected officials.

Since Scoping in 2003, MTA has held over 110 meetings with community groups in the Silver Spring and Takoma Park areas. MTA also established Community Focus Groups for downtown Silver Spring, East Silver Spring, and University Boulevard. In total, 75 community groups were invited to the Community Focus Groups from downtown Silver Spring, East Silver Spring, and the Takoma/Langley Park communities.

In 2008 alone, over 20 community meetings were held in or near the East Silver Spring community. These included four meetings with the Park Hills Civic Association and Seven Oaks/ Evanswood Civic Association, both of which include neighborhoods along Wayne Avenue.

At these community meetings the MTA presented information, received feedback on the proposed alternatives and accommodated requests by community groups to evaluate additional alternatives to determine if the impacts of the Purple Line could be reduced without significantly increasing the overall project cost and adversely affecting the project's cost-effectiveness and affordability. Throughout the alternatives development process, the alternatives were modified and further refined in response to community input and in order to address as many community concerns as possible. These modifications included the alignment through the library site, the evaluation of shared lanes, the addition of left-turn lanes at key intersections on Wayne Avenue, the importance of maintaining parking on Wayne Avenue during off-peak periods and several individual access modifications.

Several large meetings with East Silver Spring community groups were held in March and April 2008, prior to the release of the AA/DEIS. At these meetings, MTA presented the residents with the findings of its evaluation of the proposal for a tunnel under Wayne Avenue with a portal at Mansfield Road. The community was presented with preliminary information regarding cost, impacts to property, travel times, and ridership for the proposed tunnel option; and shown how these compared to the other alternatives through Silver Spring.

May 20th 2009 Community Meeting

After the AA/DEIS Public hearings held in November of 2009, at the request of local elected officials and community groups in the area, MTA conducted further analysis of the tunnel options as presented in this paper. On May 20th, 2009 the MTA held a community meeting to present the findings in this paper and answer questions.

Three hundred eighty meeting invitations were sent out to local community leaders, residents living along Wayne Avenue, and those on the project mailing list with addresses in the Silver Spring area. The meeting was attended by 55 people. The discussion after the presentation by the MTA reflected a diversity of opinions.

Many residents remained concerned about the community impacts of a surface option. Impacts specifically noted were noise, loss of trees, construction, the extent of the widening on Wayne

Avenue, and changes to the traffic patterns. Several people stated that they did not believe the impacts of the surface option were adequately addressed in the AA/DEIS. The renderings showing full grown trees were questioned. Some residents felt that property takes from 54 houses was a more onerous impact than the complete displacement of three houses.

Other residents supported the surface alignment and the Dale Drive station. It was noted that the tunnel option provided benefits to people outside Silver Spring, while depriving the local community of convenient access to the improved transit service.

The ridership projections were questioned, particularly for Dale Drive. Some felt the projections assumed additional development at that station area. It was commented that residents around Fenton Street were unaware of the surface construction impacts and would likely be very upset when construction starts.

CONCLUSION

Wayne Avenue is currently a well-used transit route, and the major transportation corridor through the area. Light rail transit can operate safely in this type of environment, as it has in hundreds of cities around the world. The surface alignment takes minimal amounts of private property and allows parking on Wayne Avenue to continue to be permitted during off-peak hours. Traffic is improved at some intersections with the Purple Line in place, compared to the No Build Alternative because of the addition of left-turn lanes. Tunnel options would have substantial impacts at the portal areas and would be costly. The Mansfield tunnel option would provide fewer stations in Silver Spring communities, including the elimination of the station near the future Silver Spring library and Dale Drive, and thereby, serve residents living in this portion of the corridor less effectively.

The tunnel to Mansfield Road would reduce or eliminate impacts to the portion of Wayne Avenue west of Mansfield Road. Natural environmental impacts would not be substantially different for this option. Parkland impacts are not substantially greater, but the existence of "feasible and prudent" alternatives with smaller impacts make Section 4(f) is a consideration.

This option would have major adverse impacts to the residences on the south side of Wayne Avenue east of Mansfield Road. Three houses would likely be displaced, and the remaining houses in this section of Wayne Avenue would be subject to accessibility and mobility impacts.

The tunnel to Mansfield Road cost is much greater, nearly twice the cost of the at-grade Medium Investment Alternative. However, the tunnel provides faster overall travel times and therefore slightly higher total project ridership, but fewer stations and less transit accessibility. This tunnel would provide only minimal travel time benefits compared to the High Investment Alternative which includes a tunnel to Cedar Street, and adds approximately $50 million to the project cost, making it much higher than the Medium Investment Alternative. There are travel time benefits, but the cost is twice as high. However, the overall cost-effectiveness for this alternative does remain within the FTA's "medium" range.

It bears repeating that while all the alternatives and options are currently expected to meet the federal cost-effectiveness requirements, the affordability of the project is a critical consideration. The ability of an option to meet the cost-effectiveness index is immaterial if that option is beyond the financial capacity of the State of Maryland. In these times of fiscal constraint the cost and benefits of the various elements of the project must be carefully weighed to avoid inclusion of elements that would render the entire project not viable or reduce the cost effectiveness making the project less competitive for scarce federal funding.

The MTA has concluded that this tunnel option would not reduce adverse community effects when compared to the tunnel portal near Cedar or the Medium Investment LRT Alternative, and in fact would escalate the magnitude of those effects, while simply transferring them to another location on Wayne Avenue. Further, this longer tunnel option would not serve the community with walkable, easily accessible neighborhood stations as well as the other Wayne Avenue surface options. Based on the impacts to the residents in the tunnel portal area, the additional costs, and the reduced accessibility to the Purple Line for the community, it was determined that this tunnel option did not provide sufficient benefits to justify its inclusion in the AA/DEIS or to continue its design.

8. Evaluation of the Light Rail Options on Paint Branch Parkway

Evaluation of the Light Rail Options on Paint Branch Parkway

August 2008

This memo describes the assumptions and findings of the analysis conducted for the Purple Line light rail alignments between Rossborough Lane and the College Park Metro parking garage along Paint Branch Parkway in Prince George's County. The analysis was conducted at the request of Prince George's County to document the impacts of shared use on traffic and transit operations. To analyze potential impacts, two different traffic simulation programs (*Synchro* and *VISSIM*) were used which produce various measures of effectiveness.

Purple Line Options

The following three options were examined:

1. *Option 1: Shared Lanes.* The Purple Line light rail vehicles operating in shared-use lanes along Paint Branch Parkway between Rossborough Lane and the Metro parking garage.
2. *Option 2: Dedicated Lanes except under the CSX/WMATA Underpass.* The Purple Line light rail vehicles operating along a dedicated alignment parallel to Paint Branch Parkway between Rossborough Lane and the Fire Training Academy intersection. They then operate in shared-use lanes along Paint Branch Parkway between the Fire Training Academy intersection and the Metro parking garage.
3. *Option 3: Dedicated Lanes.* The Purple Line light rail vehicles operating along a dedicated alignment parallel to Paint Branch Parkway between Rossborough Lane and the Metro parking garage. This option would require the reconstruction and widening of the underpass of the CSX and WMATA tracks.

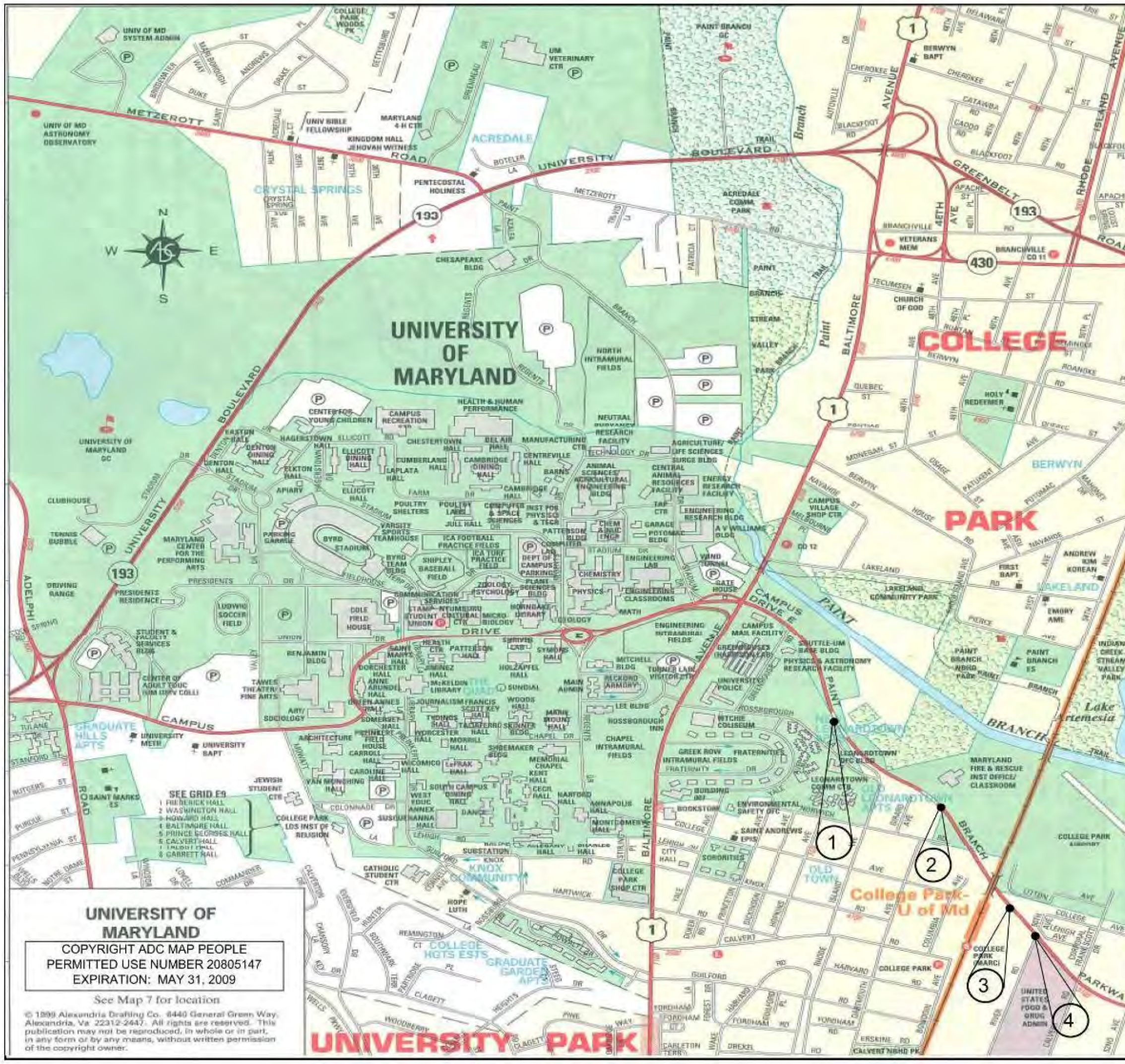
Study Methodology

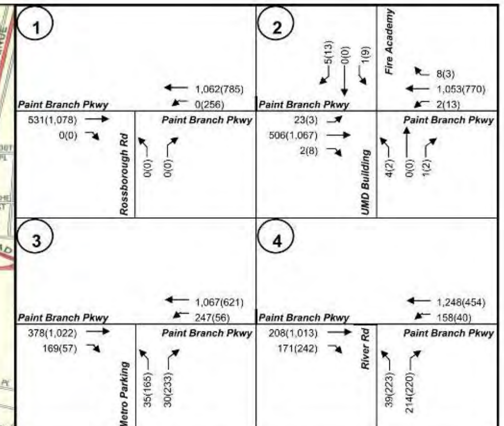
There are four intersections along Paint Branch Parkway which have been included in the analysis:

- Paint Branch Parkway at Rossborough Lane (which will be constructed as part of the East Campus Development),
- Paint Branch Parkway at the Fire Training Academy,
- Paint Branch Parkway at the Metro parking garage,
- Paint Branch Parkway at River Road.

Traffic counts were obtained at each of the three existing intersections in May 2007 and March 2008. (See Figure 1) Using these counts, Year 2030 volumes were derived based on a growth rate prescribed by the State Highway Administration, plus the trips expected to be generated by the University of Maryland's East Campus Development. (See Figure 2) The resultant annual growth rate of 1.9% is consistent with the Maryland-National Capital Park & Planning Commission's estimate of between 1.5% and 2.0%.

The analysis assumes the Purple Line will operate at 6-minute headways, resulting in 10 light rail vehicles running in each direction during peak hours.



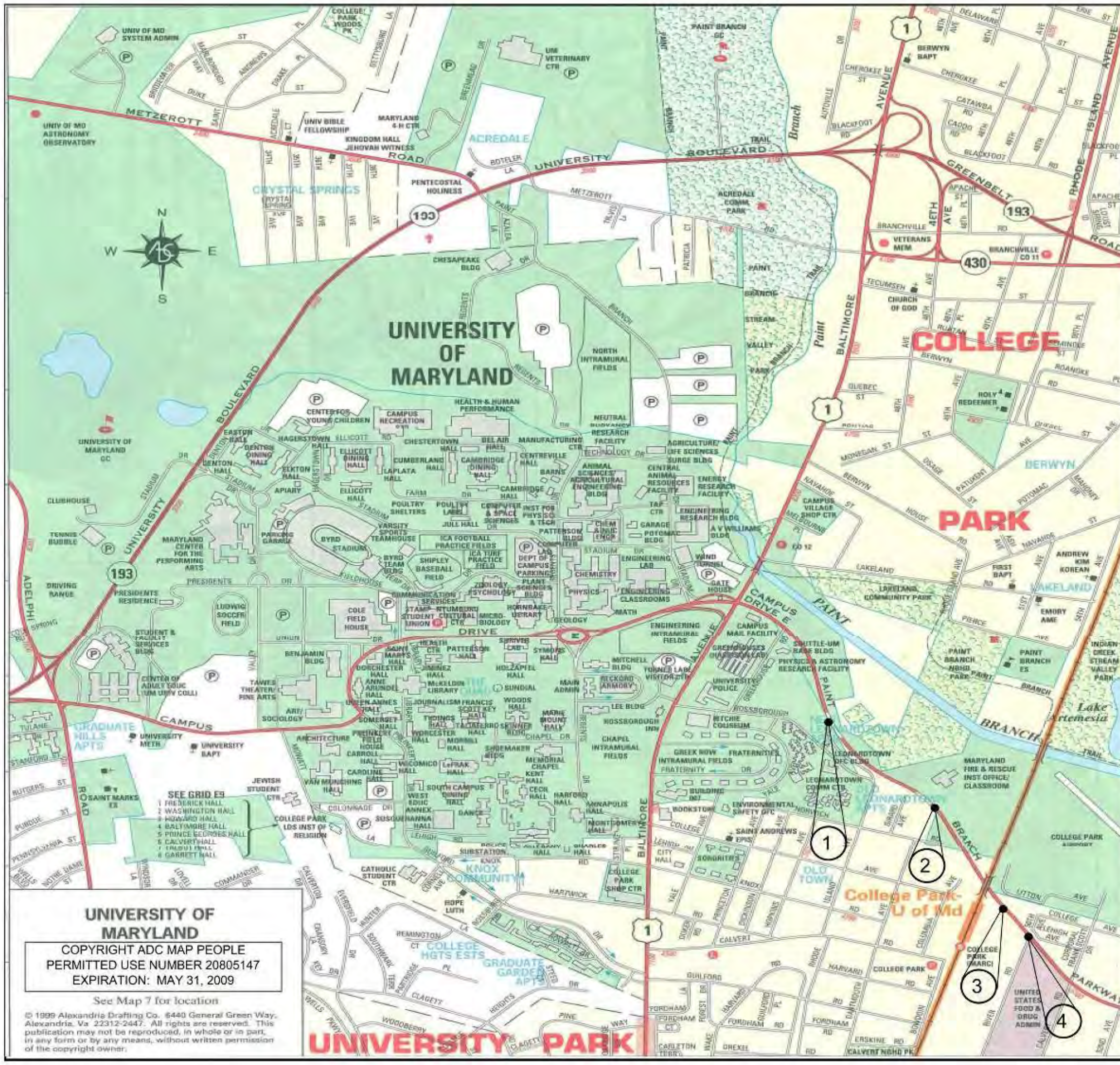


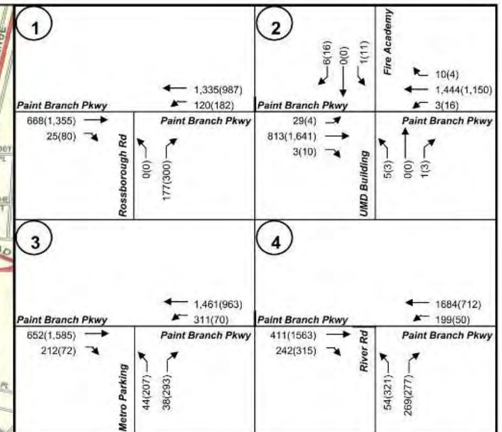
AM (PM) Peak Hour Traffic Volumes

Purple Line

University of Maryland Traffic Study

Figure 1
Paint Branch Parkway
2007 AM and PM Peak Hour Traffic Volumes





AM (PM) Peak Hour Traffic Volumes

Purple Line

University of Maryland Traffic Study

Figure 2
Paint Branch Parkway
2030 AM and PM Peak Hour Traffic Volumes

Traffic Analysis and Findings

The 2030 total volumes were coded into *Synchro* along with optimized signal timings and used to determine several measures of effectiveness for the 2030 No Build scenario and for each of the three Build options. Table 1 shows the resulting Delay, Volume-to-Capacity ratio (v/c), and Level of Service (LOS) at each intersection for each option.

Table 1: 2030 Intersection Capacity Analysis

			Rossborough Lane	Fire Academy	Metro Parking Garage	River Road
2030 No Build	**AM (PM) Peak Hour**	**Delay sec/veh**	3.4 (8.4)	13.0 (16.4)	5.6 (16.3)	16.9 (25.7)
		v/c	0.41 (0.73)	0.44 (0.51)	0.60 (0.80)	0.57 (.63)
		LOS	A (A)	B (B)	A (B)	B (C)
Option 1: Shared Lanes	**AM (PM) Peak Hour**	**Delay sec/veh**	7.0 (10.8)	13.1 (16.8)	8.3 (19.0)	16.9 (25.7)
		v/c	0.57 (0.70)	0.44 (0.51)	0.64 (0.81)	0.57 (.63)
		LOS	A (B)	B (B)	A (B)	B (C)
Option 2: Dedicated & Shared Lanes	**AM (PM) Peak Hour**	**Delay sec/veh**	3.4 (8.4)	13.4 (17.2)	8.5 (19.0)	16.9 (25.7)
		v/c	0.41 (0.73)	0.45 (0.54)	0.65 (0.81)	0.57 (.63)
		LOS	A (A)	B (B)	A (B)	B (C)
Option 3: Dedicated Lanes	**AM (PM) Peak Hour**	**Delay sec/veh**	3.4 (8.4)	13.1 (16.8)	5.6 (16.3)	16.9 (25.7)
		v/c	0.41 (0.73)	0.44 (0.51)	0.60 (0.80)	0.57 (.63)
		LOS	A (A)	B (B)	A (B)	B (C)

As shown in Table 1, none of the Purple Line Options have much of an impact on intersection operations and each intersection operates at an adequate level of service.

In addition to the *Synchro* analysis, analyses of 2030 conditions were also performed using the microsimulation tool *VISSIM*. The *VISSIM* analysis provides a visual simulation of each Option, as well as light rail travel times between Rossborough Lane and the Metro parking garage intersection. Tables 2 and 3 show the light rail travel time in seconds for each Option during the 2030 AM and PM peak hours.

Table 2: AM Peak Hour Light Rail Travel Times

	Travel Time (seconds)		
	Option 1: Shared Lanes	**Option 2: Dedicated & Shared Lanes**	**Option 3: Dedicated Lanes**
Eastbound	131	120	109
Westbound	129	145	100
Average	130	132	104

Table 3: PM Peak Hour Light Rail Travel Times

	Travel Time (seconds)		
	Option 1: Shared Lanes	**Option 2: Dedicated & Shared Lanes**	**Option 3: Dedicated Lanes**
Eastbound	147	146	94
Westbound	163	190	102
Average	155	168	98

Tables 2 and 3 show that, on average, Options 1 and 2 have similar travel times, while Option 3 is faster by 60 seconds in the PM peak hour and approximately 30 seconds in the AM peak hour.

Cost

The third option, which requires the widening of the CSX/WMATA underpass has substantial additional costs. The need to maintain CSX and WMATA operations requires that a temporary bridge be constructed. This preliminary cost estimate does not include right-of-way acquisition costs. The costs are presented in the table below.

Table 4: Preliminary Cost Estimate for Widening the CSX/WMATA Underpass

(2008 Dollars)

Widening Underpass				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Mobilization 5% of Sub-Total	LS	$1,476,339	1	$1,476,339
Class 3 Excavation	CY	$40	30,000	$1,200,000
Support of Excavation	LS	$1,600,000	1	$1,600,000
Modify Existing Retaining Walls	LS	$500,000	1	$500,000
New Light Poles	EA	$3,500	10	$35,000
New Retaining Walls	LS	$3,600,000	1	$3,600,000
New Cut-Off Walls	SF	$35	5,000	$175,000
New Pump Station	LS	$1,600,000	1	$1,600,000
Extend Twin Pipe Culvert	LF	$1,200	50	$60,000
Modify Existing Abutment	LS	$800,000	1	$800,000
Build New Abutment	LS	$1,700,000	1	$1,700,000
Provide New CSX Bridge (62' Span)	SF	$600	2,542	$1,525,200
Provide New WMATA Bridge (62' Span)	SF	$600	2,542	$1,525,200
Provide Detour for CSX	LF	$1,000	2,000	$2,000,000
Provide Temporary CSX Bridge	LS	$4,000,000	1	$4,000,000
Provide Detour for WMATA	LF	$1,500	2,000	$3,000,000
Provide Temporary WMATA Bridge	LS	$4,000,000	1	$4,000,000
Demo 200 LF of Retaining Wall 4	LS	$90,000	1	$90,000
Maintenance of RR (2 Years)	LS	$2,000,000	1	$2,000,000
Demo Building #1	SF	$6	13,437	$80,622
Demo Building #2	SF	$6	5,961	$35,766
			40% Contingency	$12,401,251
			Sub Total	**$43,404,378**
Track Work			**Sub Total**	**$1,603,320**
	TOTAL CONSTRUCTION COST			**$45,007,698**
FTA SCC Category 80				
Preliminary Engineering			4%	$1,800,308
Final Design			6%	$2,700,462
Project Management for Design and Construction			5%	$2,250,385
Construction Administration & Management			8%	$3,600,616
Insurance			2%	$900,154
Legal, Permits, Review Fees by other Agencies, cities, etc.			3%	$1,350,231
Surveys, Testing, Investigation, Inspection			3%	$1,350,231
Start Up			1%	$450,077
FTA SCC Category 90				
Unallocated Contingency (FTA SCC Category 10-50)			5%	$720,123
Unallocated Contingency (FTA SCC Category 60-80)			2%	$288,049
	TOTAL PROJECT COST			**$60,418,334**

Pros and Cons of the Three Options

The following provides a summary of the pros and cons for each option:

Option 1: Shared Lanes

Pros

- No additional signal phase is needed at Rossborough Lane.
- No additional signal phase is needed at the Fire Training Academy intersection.
- Light rail vehicles rarely stop at the Fire Training Academy signal because there is very little traffic from the side street at this intersection.
- Little to no widening would be required along Paint Branch Parkway, including under the CSX/WMATA Bridge. This means impacts to the historic College Park Airport, the proposed East Campus development, wetlands, and trees would be negligible.
- Average travel times for this option are slightly faster than Option 2.
- The cost for this option is significantly less than for Option 3.

Cons

- Light rail travel times are slightly slower than Option 3.
- The shared use alignment may take drivers some time to adjust to.

Option 2: Dedicated and Shared Lanes

Pros

- No widening would be required under the CSX/WMATA bridge.
- The cost for this option is significantly less than for Option 3.

Cons

- An additional signal phase would be required at Rossborough Lane for westbound vehicles. The resulting intersection configuration would be awkward with westbound traffic turning left from Paint Branch Parkway and light rail vehicles turning left from their exclusive alignment (see *VISSIM* simulation). Eastbound right-turning light rail vehicles would not be required to stop which could distract or confuse eastbound drivers who come around a turn and may not realize that the light rail vehicle is turning onto an exclusive alignment.
- This configuration of the intersection at Rossborough Lane would likely be more difficult for pedestrians.
- An additional signal phase would be required at the Fire Training Academy intersection. This would impact vehicular travel times along Paint Branch Parkway because the side street phase at this intersection is rarely called in its existing state.

- Some widening would be required along Paint Branch Parkway. This means there is a possibility of some impact to wetlands or trees, and to the amount of space available for the East Campus development.
- Light rail travel times are slightly slower than Options 1 and 3.
- The shared use alignment may take drivers some time to adjust to.

Option 3: Dedicated Lanes

Pros

- Travel time is faster than Options 1 and 2 by about 30 seconds in the AM peak hour and 60 seconds in the PM peak hour.
- No additional signal phase would be required at the Fire Training Academy intersection.

Cons

- An additional signal phase would be required at Rossborough Lane for westbound vehicles. The resulting intersection configuration would be awkward with westbound traffic turning left from Paint Branch Parkway and light rail vehicles turning left from their exclusive alignment (see *VISSIM* simulation). Eastbound right turning light rail vehicles would not be required to stop which could distract or confuse eastbound drivers who come around a turn and may not realize that the light rail vehicle is turning onto an exclusive alignment.
- Widening would be required along Paint Branch Parkway, including under the CSX/WMATA bridge. Adverse environmental impacts to the historic College Park Airport, wetlands, parklands, and trees are possible. Widening under the bridge would be an exceptional engineering challenge due to the water table and the need for uninterrupted service to the rail lines utilizing the bridge. This option would likely require full closure of Paint Branch Parkway at some point resulting in major traffic impacts for local roadway users.
- Widening the underpass would also have substantial costs: preliminary estimates are in excess of $60 million.
- The travel time benefits for this option are greatly outweighed by the costs. The costs for this option may be so prohibitive, as to place the Purple Line in an uncompetitive position for funding.

Conclusion

Based on an analysis of the 2030 No Build conditions as well as for three Purple Line options, it can be concluded that the Purple Line has little to no impact on traffic operations, whether operating in shared use lanes or along an exclusive alignment. Results from the *Synchro* analysis indicate that there is little to no difference in delay, volume to capacity ratio, and level of service between the 2030 No Build and each of the three Build options. None of the intersections operate at a LOS worse than C during either of the peak hours.

Option 1, shared use between Rossborough Lane and the Metro parking garage, provides the most benefit from a traffic, safety, and cost perspective. Unlike Option 2, Option 1 would not require additional signal phases at either the Rossborough Lane or Fire Training Academy intersections. Option 1 would also eliminate the awkward intersection configuration at Rossborough Lane that Options 2 and 3 would create. Option 1 has faster average light rail travel times than Option 2 and would generally allow light rail vehicles to pass through the Fire Training Academy signal without stopping. Since no widening would be required, impacts to trees, wetlands, historic sites, proposed development and the CSX/Metro Bridge would be minimal resulting in Option 1 being significantly less costly and more cost effective than Option 3.

9. Metrorail Loop Proposal Alignment Evaluation

METRORAIL LOOP PROPOSAL

Alignment Evaluation

March 2005

INTRODUCTION

The Metrorail Loop proposal calls for a Metrorail connection from the existing Medical Center/National Institute of Health (NIH) Metrorail Station in Bethesda north via a tunnel under the Capital Beltway and along the north side of the Beltway primarily on aerial structure, and crossing back over the Beltway and continuing south along the CSX corridor either in a retained cut or in tunnel to the Silver Spring Transit Center (See Figure 1).

BACKGROUND & PLANNING PROCESS

- MTA's 1996 Georgetown Branch Transitway/Trail Major Investment/Draft Environmental Impact Statement and SHA/MTA's 2002 Capital Beltway/Purple Line Corridor Transportation Study both examined a range of transportation alternatives between Bethesda and Silver Spring. Heavy rail alternatives along the beltway were not recommended by either study because they were determined not to meet the Purpose and Need and because of the high cost of heavy rail.

- In 2000 the General Assembly requested a Joint Chairman's Report evaluating an underground tunnel for the entire Georgetown Branch from Bethesda to Silver Spring. The report included a cost/benefits analysis of the several surface and tunnel alternatives, including Metrorail (heavy rail transit) option. The report determined that a heavy rail transit tunnel alternative would be extremely costly to construct, particularly relative to surface LRT, and would provide only minimal ridership gains; therefore a tunnel alignment was not justifiable from cost and cost-effectiveness perspectives and should not be considered further.

- In April 2002, MTA began the preparation of a Supplemental DEIS (SDEIS) for the Georgetown Branch. This study did not consider heavy rail because of its rejection by the previous studies.

- In the fall of 2002, a new project study was initiated, the Purple Line East, which proposed light rail service from Silver Spring to New Carrollton. Heavy rail transit was not included in the alternatives to be considered because of the finding of the previous SHA/MTA's 2002 Capital Beltway/Purple Line Corridor Transportation Study.

- In early January 2003, the staff of WMATA suggested an alternative to join the two sides of the Metrorail Red Line with a heavy rail transit rail link between the Naval Medical Center and Silver Spring stations, creating a "Red Line Loop." The Montgomery County Executive endorsed this line as an alternative alignment for the Inner Purple Line route.

- On January 8, 2003 the Montgomery County Council requested the Montgomery County Planning Board's review and make a recommendation regarding the Metrorail Loop proposal's feasibility and comparison to the master-planned Georgetown Branch alignment. The Planning Commission Staff (Maryland –National Capital Park & Planning Commission (M-NCPPC)) conducted a review of the Metrorail Loop proposal and recommended that the proposal should not be carried forward for further detailed study. Major factors in this decision were the fact that the project did not meet the existing Purpose and Need, the high cost and impacts, and the anticipated project delays that would arise from pursuing the new option at that time.

- On January 30, 2003 the Montgomery County Planning Board considered the report produced by M-NCPPC staff, public testimony and comments, testimony by the County Executive's staff, as well as answers to Planning Board questions provided by WMATA and MTA. As a result, the Planning Board reaffirmed its support for the Purple Line along the master-planned Georgetown Branch alignment and recommended that the Metrorail Loop not be carried forward for detailed study. On February 4, 2003 the Montgomery County Council considered the Planning Board's recommendation and report on the Metrorail Loop proposal. The Council concurred with the Planning Board and passed a resolution urging the Governor and Maryland delegation to seek construction funding for the Purple Line along the established Master Plan alignment.

- In the summer of 2003, the Georgetown Branch/Purple Line West and Purple Line East studies were combined into one project, the Bi-County Transitway Study, to have consistent project goals and ensure that all build alternatives would be assessed from the perspective of the entire corridor.

- MTA initiated the Scoping Process for Bi-County Transitway Study in early September 2003. Four public scoping meetings were held in the corridor. The modal alternatives presented were:

  - No Build
  - Transportation System Management (TSM)
  - Bus Rapid Transit (BRT)
  - Light Rail Transit (LRT)

- The Metrorail Loop proposal was not one of the alternatives being considered as part of the Scoping Process, since a Metrorail alternative had been rejected in the previous studies. Comments were solicited from the public, including comments on the range of alternatives to be studied. Of the 1,319 comments received there were two comments recommending a heavy rail alignment along the Capital Beltway.

- On March 23, 2004, Montgomery County Director of the Department of Public Works and Transportation, Albert J. Genetti, sent a letter to the MTA requesting that MTA study the Metrorail Loop comprehensively, as required by the Council of Environmental Quality Regulations for Implementing NEPA. MTA agreed to further study of the alternative. In this evaluation, the alternative was determined to be even less appropriate to the goals and objectives of the project and in addressing the purpose and need than it had been to the earlier studies because of the required mode change at Silver Spring. In addition, the cost was projected to be considerably greater than the other proposed alternatives, and the environmental impacts more substantial than previously anticipated due to 4(f) impacts to parklands along the Beltway and greater impacts to communities along the CSX right-of-way.

- In November 2004 five public open houses were held as part of the Definition of Alternatives phase of the project. At these meetings the Metrorail Loop alignment was presented as an "Alignment Not Proposed for Detailed Study". MTA received no comments either supporting the construction of a heavy rail along the Beltway, or opposing the decision to drop the Metrorail Loop from consideration.

- At the request of FTA, Maryland Department of Transportation met with Maryland National Capital Park and Planning Commission, representing the Montgomery County Planning Commission and the County Council, and Montgomery County Department of Public Works, representing the County Executive, on January 14, 2005, to discuss the reappraisal of the Metrorail loop and explain MTA's decision not to continue any further study of the alternative, with the MTA and M-NCPPC reaffirming their positions.

EVALUATION

- The Metrorail Loop would be Heavy Rail Transit (HRT), which requires either a fully separated transitway or exclusive right-of-way, if built at-grade, in order to safeguard adjacent streets and pedestrians from the third rail.
- The Metrorail Loop proposal would provide high-speed travel between Bethesda and Silver Spring and improve operations for redundancy and flexibility to the Red Line Metrorail service by connecting the two radials of the current "U" shaped configuration.
- While the Metrorail Loop would improve operations and provide a high quality service for the Metrorail Red Line, these advantages do not apply to the Bi-County Transitway corridor as a whole. Implementation of the Metrorail Loop would not address the issues of system connectivity, mobility and accessibility, and efficiency for the entire corridor that are central to the Bi-County Transitway Purpose and Need.

Purpose and Need

Three of the key goals of the Purpose and Need for the Bi-County Transitway are to:

- Increase mobility and enhance accessibility
- Improve transit operations efficiencies
- Support economic and community development

The Bi-County Transitway corridor from Bethesda to New Carrollton contains key activity and employment centers, and is served by a number of transit routes. However, the corridor lacks a convenient, end-to-end east-west rapid transit service. As stated in the Purpose and Need, the Bi-County Transitway corridor needs improved system connectivity and additional capacity to serve east-west travel patterns and to support economic development. The Metrorail Loop does not meet these major goals of the Bi-County Transitway Purpose and Need, as explained below:

- Passengers traveling between the Metrorail Loop and destinations east of Silver Spring would be required to transfer from the Metrorail Loop to light rail transit (LRT) or bus rapid transit (BRT) to complete their trip either to Takoma Park/Langley Park, College Park or New Carrollton.
- The Metrorail Loop would not provide continuous service between Bethesda and New Carrollton. It will not address the issues of an inadequate and slow-moving transportation network for east-west travel between Bethesda and New Carrollton.
- The Metrorail Loop would not allow for the enhanced level of transit connectivity, efficiency, and convenience for the corridor as a whole, since it would introduce a different mode to one segment of the corridor that is not being considered for the other segments of the corridor.
- The Metrorail Loop would not support economic and community development to the same level as the LRT and BRT alternatives. The Metrorail Loop would provide limited

development opportunities west of Silver Spring (no stations at the Chevy Chase, Lyttonsville and Woodside communities).

- The Metrorail Loop proposal would be a less cost-effective solution to addressing the transportation problems and needs associated with the Bi-County Transitway corridor, as compared to a BRT or LRT alternative for the entire 14-mile corridor.
- LRT and BRT options can offer many of the benefits of heavy rail transit (Metrorail) but with more flexibility in design and for less capital cost.

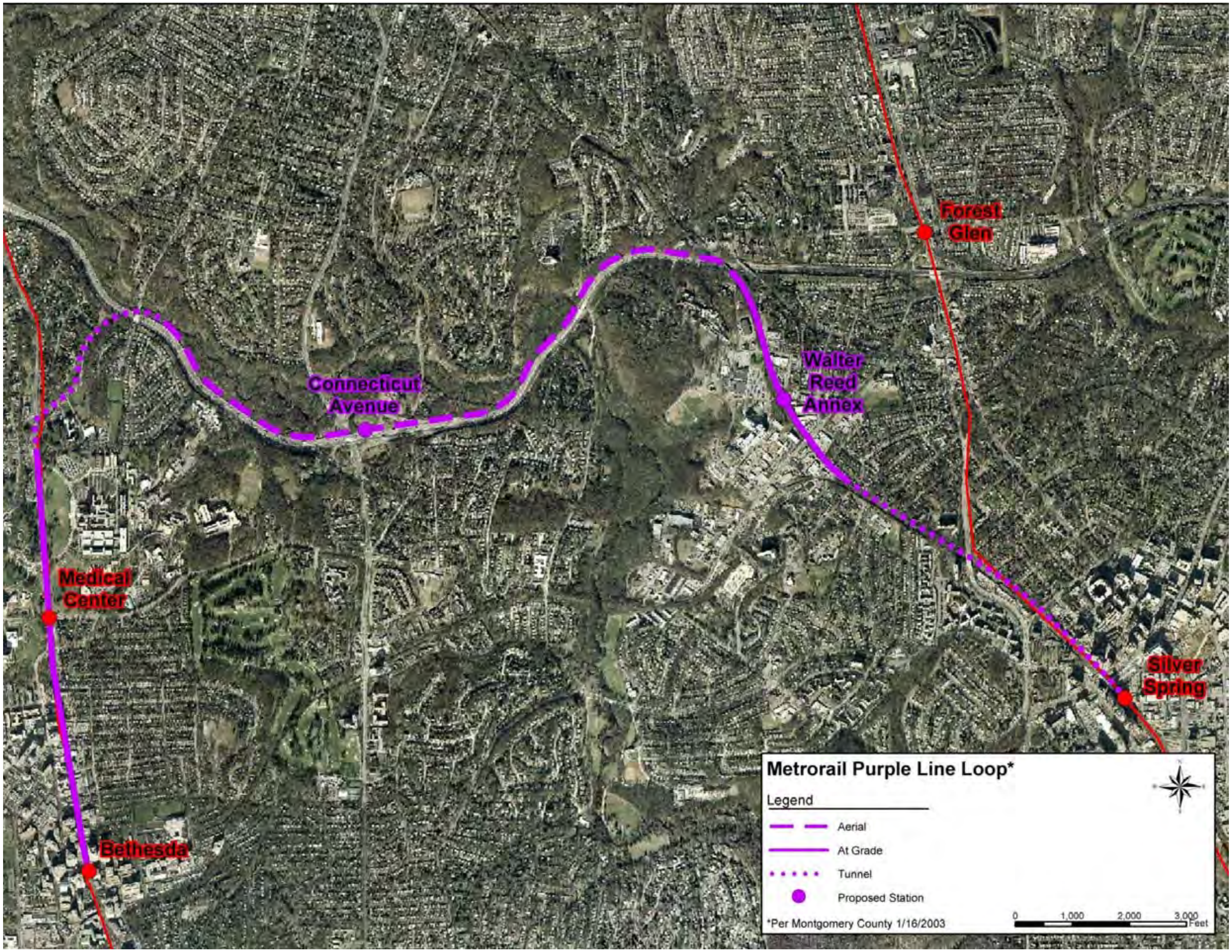
Engineering and Environmental Issues

Other issues associated with the Metrorail Loop that MTA has concerns with include:

- The construction of the Metrorail Loop along the north side of the Capital Beltway would require additional right-of-way in Rock Creek Park. The need to acquire additional parkland would involve serious environmental issues, particularly under Section 4(f) where impacts to publicly owned public parks are not permitted where there exists a feasible and prudent alternative.
- The Metrorail Loop proposal does not account for the Capital Beltway widening for Express Toll Lanes that are currently being considered by the State. If such lanes were implemented, the capital cost and Section 4(f) impacts of the Metrorail Loop would likely be significantly increased.
- The Metrorail Loop may lead to a reduced service/capacity level on the heavily used west leg of the Metrorail Red Line north of NIH and Shady Grove due to trains being diverted to a Bethesda to Silver Spring loop. This concern is especially significant since the Red Line’s west leg serves the I-270 Corridor which is expected to experience continued high growth and increased demand, particularly if any of the proposed Corridor Cities transit service improvements currently under consideration are implemented.
- The Metrorail Loop doubles the length of right-of-way that would require coordination/negotiation with CSX. The right-of-way within this corridor is very narrow, and therefore, has both community and railroad operational impacts associated with it. The Metrorail Loop proposal assumes that the existing offset in the CSX corridor of 18 feet between track centerlines would continue to be applied. However, CSX has stated that their current offset requirement of 25 feet from the track centerline to the face of a crash wall would now apply to future Metrorail, LRT or BRT line. As a result, it appears that the Metrorail Loop would impact a total of 25 residential properties, 1 commercial property and the Federal Walter Reed Annex Complex that are located along the CSX right-of-way (compared to 4 residential properties for the master plan alignment).

RECOMMENDATION

The Metrorail Loop option does not effectively address the Bi-County Transitway Purpose and Need and has very high capital costs, compared to the BRT and LRT alternatives under consideration. Therefore, it is recommended that this proposed option be dropped from further study as part of the Definition of Alternatives.


Forest Glen
Walter Reed Annex
Connecticut Avenue
Medical Center
Silver Spring
Bethesda
Metrorail Purple Line Loop*
Legend
Aerial
At Grade
Tunnel
Proposed Station
*Per Montgomery County 1/16/2003
0
1,000
2,000
3,000
Feet

10. Implications of the Defense Base Realignment and Closure (BRAC) Process

Implications of the Defense Base Realignment and Closure (BRAC) Process

When the BRAC Commission decided to close or combine aging bases nationwide the state of Maryland was a primary recipient of employment from bases closing in other areas. Fort Meade, Aberdeen Proving Ground, Fort Dietrich, Andrews Air Force Base and the National Naval Medical Center are expected to grow by 20,000 employees when BRAC is fully implemented in 2011. The shift of 1,750 jobs from Walter Reed Army Medical Center in northeast Washington DC to National Naval Medical Center (NNMC) (to be renamed the Walter Reed National Military Medical Center) is expected to change commuting patterns in the near term for the positions that are being transferred. The actions noted in BRAC identify a changing picture of employment and visitor trips to the new combined medical center being planned on the site of the NNMC in Bethesda with the overall addition of 2,200 jobs and an increase in hospital visitors as noted in the NNMC DEIS.

The Purple Line AA/DEIS used MWCOG Round 7.0 2030 land use forecasts for employment, households and population in the analysis. The assumed growth for these items was based on normal growth assumptions for each zone in the region. A concern was raised about the implications of this change on the long-term assumptions for this project. However, given the scale of the expected growth excluding the BRAC changes, analysis of the changing trip patterns for the 2030 horizon year indicates that the effects of BRAC will be negligible.

Technical analysis has identified that approximately 60 peak hour trips could be added on the Purple Line as a result of jobs changing from Walter Reed to the future Walter Reed National Military Medical Center (WRNMMC) based on the home location of current employees of the Walter Reed facility. Additional work travel will be carried by the surrounding road network, Metro system and local bus network. Some have suggested that this shift in jobs may make a Purple Line alignment serving the NNMC area directly, such as represented by the Low Investment BRT Alternative, which would run along Jones Mill Road, the more appropriate alternative in response.

However, the Bethesda area exists today and in the future as a major employment and population center exclusive of the BRAC changes. Combined employment around the Medical Center Metro Station is expected to grow by over 6,000 jobs to 2030 and population is expected to grow by approximately 700 in that time. The Bethesda CBD is expected to grow by 5,000 jobs and show a population increase of over 12,000 residences in that same period. The BRAC changes, while large, are a small percentage of the expected 72,000 jobs in the Bethesda CBD / Medical Center area in 2030.

In addition, the congested traffic conditions expected along Jones Bridge Road contribute travel delay to trips arriving from the east. Travel to the WRNMMC via the Master Plan alignment combined with a transfer to the Red Line is expected to be comparable, or even quicker, than the travel time for the Low Investment BRT Alternative to the common end point. And, the attractiveness of travel to and from the Bethesda CBD from the east would be expected to be significantly affected with the significant travel delay associated with travel along Jones Bridge Road. The table below highlights expected travel times to the Medical Center entrance and Bethesda CBD from Silver Spring given expected future conditions for Build Alternatives.

Travel Time Analysis - BRAC Impacts

Silver Spring to Medical Center

Alternative	Travel Time
Low BRT	24.8
Med BRT	20.6
High BRT	20.6
Low LRT	18.7
Med LRT	16.3
High LRT	16.3

Silver Spring to Bethesda CBD

Alternative	Travel Time
Low BRT	24.5
Med BRT	13.1
High BRT	13.1
Low LRT	11.2
Med LRT	8.8
High LRT	8.8

Assumptons:

Trip times calculated - Silver Spring Metro Station
to tunnel / entrance to NNMC on Rockville Pike

At Bethesda Staton:

2 minute walk time - platform to platform
3 minute travel time Bethesda - Medical Center (WMATA)
2.5 minute transfer delay at Bethesda station (WMATA)

At Medical Center BRT stop:

5 minute walk time - Medical Center BRT station to pedestrian
tunnel at entrance to NNMC

Therefore, given the access afforded by Purple Line alternatives along the Master Plan alignment and connecting the Metrorail Red Line to the Medical Center Station, the impacts of BRAC on travel in the Bethesda area are notable more for the additional delays expected on area roadways than for the potential contributions to Purple Line ridership.

11. Visitor Trips to the Walter Reed National Military Medical Center

Visitor Trips to the Walter Reed National Military Medical Center

August 2008

Visitor Trips to the Walter Reed National Military Medical Center
Maryland Transit Administration

Introduction

The Maryland Transit Administration has received comments from community leaders on the potential impacts of the Base Realignment and Closure (BRAC) Plan and the potential selection of the Jones Bridge Road alignment to address traffic concerns. Earlier this year the MTA issued a report identifying potential riders on the Purple Line resulting from BRAC employment shifts based on geographic analysis of home locations for employees currently working at Walter Reed. The findings of that report indicated that ridership would not be greatly increased due to the dispersion of employee home locations and the limited number of employees that are within the identified Purple Line service area.

This report is issued as an addendum to that earlier report and details analysis of the impact of the over one million annual visitor trips to the combined facility after it opens in 2011.

BRAC Background

The relocation of Walter Reed Army Medical Center (WRAMC) in Washington, DC to National Naval Medical Center (NNMC) in Bethesda, MD is part of a congressionally mandated defense base realignment and closure (BRAC) plan. This relocation will result in the new Walter Reed National Naval Medical Center (WRNNMC), which will merge tertiary care (inpatient services of a complex nature) and primary care services such as family health care, with services existing at NNMC. It will also serve as teaching hospital for graduate and post-graduate educational programs.

Accommodating the new services at the new WRNNMC involves the construction and possible demolition of facilities. These facilities will support various inpatient and outpatient services with an added focus on cardiological and neurological traumas. Facilities are also being planned to provide additional administrative offices; transitional housing for military patients, their families, and supporting aftercare staff; a fitness center; and additional parking. While there are ongoing plans for other construction on the existing NNMC site—an on-site day care and expansion of the naval lodge and naval exchange facilities—they are not part of the BRAC activities being addressed by the NEPA process.

NEPA Process Findings

The Department of the Navy published the Final Environmental Impact Statement (FEIS) for WRNNMC in March 2008. The study considered three alternatives. Two alternatives have similar designs, differing in the construction or demolition of certain facilities within the base differs, thus affecting internal circulation. The third alternative is the no-build option, giving baseline conditions for the study area without the base relocation. The FEIS, however, only considered the first two alternatives because the only way to implement the no-build alternative is to change the congressional law for BRAC activities.

Trip generation and estimation for employees

NNMC staff used a conservative estimate of 2,500 employees relocating to the new WRNNMC because of BRAC activities. An actual estimate of 2,200 more closely represents the employee transition to the new WRNNMC; this comprises 1,750 employees from WRAMC and 450 new support and maintenance staff.[1] The conservative value, however, accounts for additional staff

[1] David "Ollie" Oliveria, BRAC Program Manager, NNMC Bethesda

that may locate to the base because of ongoing or future on-base projects. For example, the three on-base projects previously mentioned will add 136 employees to the site. Off-base projects, which were not included in transportation impact analyses for the FEIS, should not add additional staff.

NNMC staff expects some employees to arrive on base during non-peak hours or use the transitional housing on base. This information affects the AM and PM peak-hour calculations, but has no significant impact on estimated daily trips made by employees. The FEIS study assumed that all of the conservatively estimated 2,500 employees entered and left WRNNMC each day, giving an employee trip estimate of 5,000 per weekday.

Trip generation and estimation for visitors and patients

The FEIS gives detailed explanations of trip generation methodology and calculation of trips made by visitors and patients. The report references ITE's *Trip Generation Informational Report—Seventh Edition*[2] to determine the number of daily trips based on a combination of three land use types: hospital, military base, and research and development facility. The study also applied a trip reduction factor of 15%[3] to account for those visitors and patients traveling by transit. This reduction, however, only applies to trips occurring during the AM or PM peak hours. Although the study derived trips based on the number of employees, the counts also include trips made by visitors, patients, and other users.

NNMC staff estimates an additional 484,000 annual visitors and patients to the future WRNNMC. Average daily travelers range from 1,692 (for weekday and Saturday appointments) to 1,862 (for weekday appointments only). Using the latter value as a conservative estimate and assuming most appointments will be made on weekdays, NNMC determined 3,760 daily trips (1,880 incoming and 1,880 outgoing trips) will generated by WRNNMC. Assuming 260 annual weekdays (52 weeks/year * 5 weekdays/week), 977,600 additional trips are expected to be made by visitors and patients annually.

Traffic Impacts and Mitigation Recommendations

A forecast of traffic surrounding NNMC to Year 2011 shows that the BRAC relocation will cause a noticeable increase to intersection volumes. Five intersections will come close to level-of-service (LOS) failure or exceed LOS F because of the projected peak-hour traffic. Four of these intersections will fail, even in the absence of the base relocation. The most significant impact that is directly attributable to the relocation will be at the intersection of Rockville Pike and North Drive: its critical lane volume (CLV) will exceed the current threshold, going from 1504 to 1605 vehicles (threshold is 1600). CLVs of other intersections will also experience increases above their current levels. These increases will not cause those intersections to fail, but regular commuters will notice the growth in traffic.

The FEIS offers several recommendations for mitigation measures to offset the impending traffic impacts. Some external mitigation measures include adding additional turn lanes or lengthening turn lanes to accommodate increased automobile traffic at surrounding intersections. The FEIS also recommends studies for traffic signals to see if certain intersections warrant their installation. Internal mitigation measures include performing additional studies at the NNMC gates to improve safety and security, reducing queues on and off base, and reducing damage to security stations. The Maryland State Highway Administration is currently conducting a study to determine potential mitigation strategies at study area intersections.

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[2] The estimates derived from the informational report are based on land uses in suburban areas offering little to no transit service, pedestrian amenities, or TDM programs.

[3] This transit mode share is a conservative estimate that Maryland-National Capital Park and Planning Commission (M-NCPPC) recommended for use in the EIS.

The Bethesda location of NNMC facilitates travel by public transportation for many of its employees and visitors. Its location is also more directly accessible by transit (via the Red Line) than the current location of WRAMC in the District of Columbia. For these reasons, the Navy expects more people to use transit to access the new WRNNMC than WRAMC. The Navy has also committed to continue its efforts to reduce single-occupancy-vehicle (SOV) travel to the new WRNNMC. Currently, NNMC has a transportation coordinator to help implement transportation management programs for its employees. Furthermore, the FEIS recommends numerous transportation-demand-management measures to reduce the peak hour impacts of SOVs to the area.

One recommendation for improvement from the FEIS pertains to transit and involves investigating the feasibility of a pedestrian connection between the Medical Center Metrorail station and NNMC to reduce pedestrian and vehicle conflicts along Rockville Pike near NNMC's south gate. Various alternatives for improving this connection, including grade-separated (above or below ground) pedestrian crossings, are currently under study by the Washington Area Metropolitan Transit Authority.

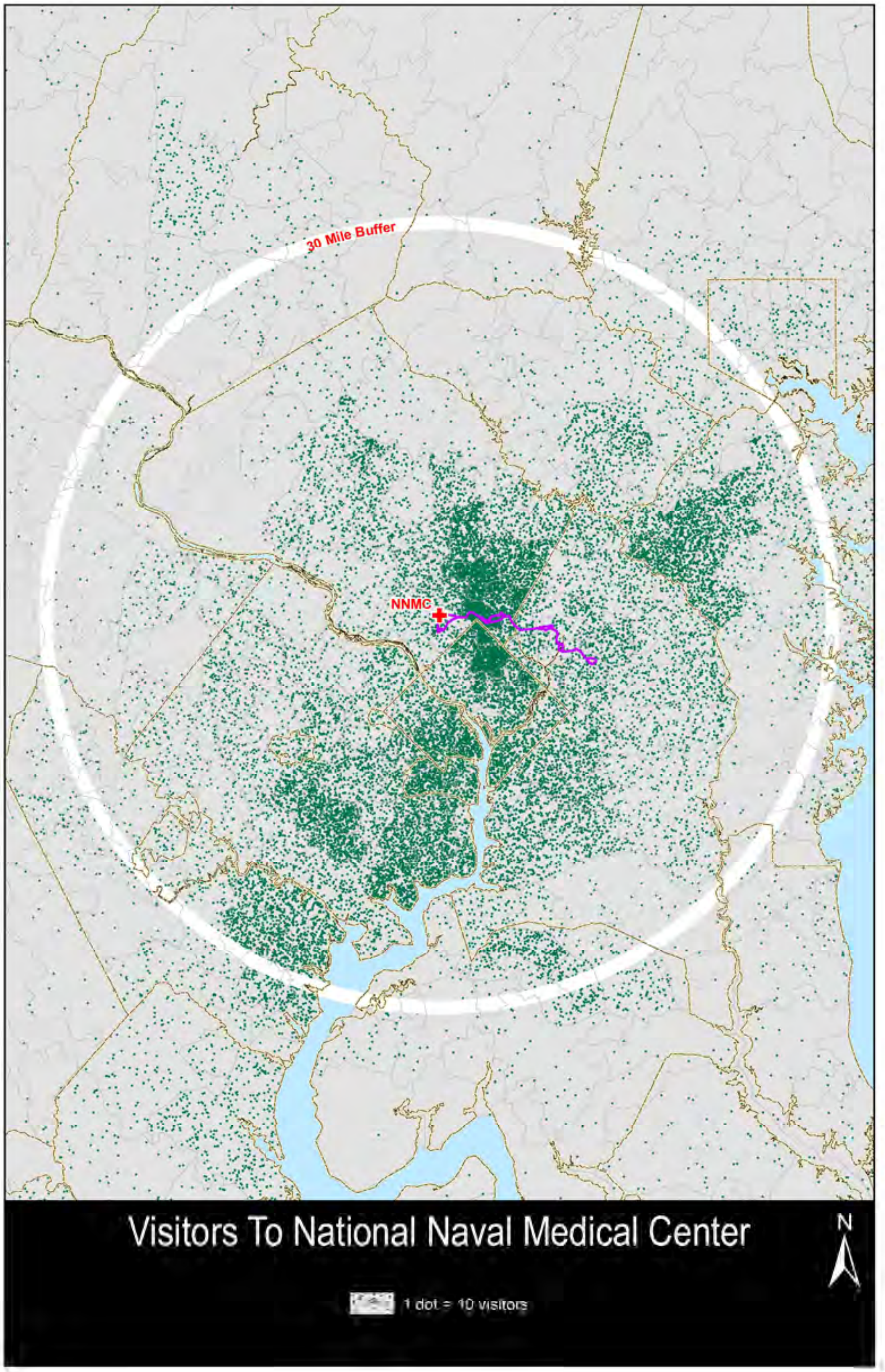
Additionally, the Bethesda-Chevy Chase Master Plan called for increased feeder bus service, especially in the eastern portion of the master plan's study area. Another recommendation is for fringe parking that will offer about 750 spaces at locations surrounding NNMC and the Bethesda central business district to intercept automobiles traveling to the area. M-NCPPC staff has already identified two parcels of land that could accommodate up to 250 parking spaces to implement this traffic control measure. A final recommendation is to reserve parking at existing and new park-and-ride locations for employees of the combined facility. Plans call for these off-site facilities along the routes of future transit corridors, including the Purple Line. Shuttles can also include these lots in their schedules for locations that are not easily accessible to transit.

<u>Background on Data Sources</u>

In an effort to determine the total number of visitors and patients that could be expected to use the combined medical facility via the Purple Line the MTA contacted representatives from both the existing NNMC and Walter Reed facilities to identify data resources that may be available. Representatives from NNMC were able to supply a data base of approximately 460,000 home addresses indexed by zip code for existing visiting patients to the facility. This database was reviewed and it was determined that patients represent the primary pool of those coming to the facility daily; actual visitors (contractors, employee visitors, patient visitors) were a very small fraction of the overall number.

The map depicted in Figure 1 denotes the distribution of home locations for visitors to National Naval Medical Center.

Figure 1 - National Naval Medical Center Annual Visitors - Home Locations



A few notes from the analysis of the supplied data:

- 350,000 of the annual trips noted in the database were for trips from within 100 miles (assumed to be daily trips).
- 308,000 annual trips were from within 30 miles (shown on the map).
- By far the largest percentage (10%) was for military personnel stationed at Walter Reed who traveled from that facility to NNMC for medical care.

Further discussions with NNMC personnel[4] on data collection methods and noted issues with the geographic distribution of the data points led to the clarification of the following:

- The geographic area for care at NNMC includes an area from Philadelphia to central Virginia to West Virginia. The majority of trips are short (< 100 miles) trips from regional locations.

- Many of those noted with addresses over 100 miles distant from the facility are most likely recent military transfers to the Washington area who have not yet completed the process to change their home address and provided identification listing older home locations.

Further clarification on the availability of on-base accommodations was requested as this could affect the estimate of the number of patients traveling daily to the facility who might access the facility via Purple Line transit – i.e. those that would be expected to stay in hotels or points off-site to access the facility. A summary of expected on-base accommodations for patients and visitors after BRAC improvements are made includes:

- The Navy Lodge – a hotel for visiting military personnel. This 106 room facility is currently fully-occupied most nights. The Lodge is expecting to expand to 300 rooms to accommodate future demand. The Lodge also accommodates military personnel who travel to Bethesda to visit the sites, but preference is maintained for patients.

- There are currently 15 rooms available for family members of military personnel (Fisher Houses) who are visiting patients at the facility. The number of facilities is being expanded to 42 rooms to meet increased demand.

- There will be 323 non-hospital rooms available to military patients who require long-term care or are receiving treatment for injuries that require longer stays.

There are then approximately 450 rooms available nightly to accommodate the visitor/patients who are expected to be on-site at the expanded facility or who have business on base or, in the case of the Navy Lodge, are visiting the area. This is in addition to the total number of hospital beds at the facility and other lodging available for military personnel working at the facility. It was noted in conversations with base personnel that higher level of demand for facilities is a direct result of military activity.

In conversations with base personnel it was also noted that parking on the facility is free for visitors. The impact of this condition was not addressed or quantified in this report – however it would be expected that it would affect trip decision-making for those traveling to the base for medical care.

Analysis Methodology

After it was determined that the database was an appropriate estimator for future conditions the study team derived an analysis methodology by which to determine expected contributions from visitor/patient trips to Purple Line travel estimates.

[4] Jeffrey Miller, Brian Hillis, Roberta Williams - NNMC

The chosen analysis methodology used to determine the potential range of daily visitors to the combined WRNNMC facility who would use the Purple Line included the following basic steps:

- Define the geographic distribution of current visitors to the NNMC facility.
- Assume a similar geographic distribution for future trips at the combined facility as are noted for current visitors.
- Geographically "grow" the number of existing visitors to reflect the total number of visitors expected to the facility on an annual basis.
- Calculate the resulting annual number of visitors who would be expected to utilize the Purple Line as a way to access the facility.
- Reduce the annual number to a daily number to identify the impact to daily travel on the Purple Line.

To conduct an analysis to yield results that would be appropriate for this level of generalized by analysis a broad assumption was made to determine a potential trip reduction for visitors/patients staying on-site. A rough estimate of 100,000 annual patients and visitors were assumed to be overnight stays – a very conservative (low) occupancy rate (385 visitors/patients per day would be assumed to stay on base) for future on site hospital and non-hospital facilities as a conservative estimate.

Results of the analysis to derive an estimate of trips that could be expected to originate in the Purple Line service area are presented in Table 1 below.

Table 1 - Analysis of Expected Future Visitor Trips to WRNMMC

Analysis of Visitor Trips to WRNMMC after BRAC		
Existing Conditions:		
Good Records - Existing Trips to Facility w/in 100 miles	300,000	
Number of Trips Determined to be within Purple Line Service Area	13,700	
Percentage trip total to NNMC from within PL service area	4.60%	
Post - BRAC		
Future Annual Visitors (combined)	940,000	
Overnight Visitor Reduction	100,000	
Total Pool of Transit Eligible Visitor Trips	840,000	
Assumed Origins from Within PL service area	38,640	4.60%
Daily Visitors - Purple Line access (260 visitor days)	149	
Total Daily Trips (100% Transit Trips from w/in PL service area)	297	High
Daily Trips - 50% Transit Trips from w/in PL service area	149	Medium
Daily Trips - 30% Transit Trips from w/in PL service area	89	Low

<u>Conclusion</u>

MTA analysis of potential visitor trips to the combined facility after BRAC actions have been fully implemented was conducted using methods to assume the highest possible figure for riders. Conservative methods applied to trip origin location, military personnel access and overnight stays were utilized. Using this method it has been assumed that the maximum number of visitors expected to potentially utilize the Purple Line would be 149 daily.

12. Comparison of Harkins Road to Ellin Road for the Purple Line Alignment

Comparison of Harkins Road to Ellin Road for the Purple Line Alignment

December 2009

Introduction

As part of the Purple Line Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS) six Build Alternatives were studied by the MTA. For the segment between Veterans parkway and the New Carrollton Metro station three alignment options were considered for both light rail and Bus Rapid Transit (BRT). In the first option (High Investment light rail and High Investment BRT) the transitway would travel south along Veterans Parkway and cross below the intersection of Veterans Parkway and Annapolis Road in a cut-and-cover tunnel. The transitway would then continue along Veterans Parkway, turning east onto the south side of Ellin Road, and then continue to the New Carrollton Metro Station. The second option (Medium Investment light rail and Medium Investment BRT) would follow the same alignment as the High Investment option; however, the transitway would cross the intersection of Veterans Parkway and Annapolis Road at grade. In the third option (Low Investment light rail and Low Investment BRT) the transitway would travel south along Veterans Parkway and turn east on Annapolis Road at grade. The transitway would travel on the southeast side of Annapolis Road. The transitway would remain at grade following Annapolis Road, turning east at Harkins Road, then turning southwest to enter the New Carrollton Metro Station.

The Locally Preferred Alternative selected by Governor Martin O'Malley after the completion of the AA/DEIS designated inclusion of the High Investment Light Rail alignment (Ellin Road) in the segment from Veterans Parkway to the New Carrollton Metro Station.

One of the major factors in this decision was the strong support for this option from Prince George's County government, including Park and Planning, the County Council, and the Department of Public Works and Transportation. Prince George's County has expressed very strongly the need for a future extension of the Purple Line farther east into the County as a "one-seat ride". A "one-seat ride" means that a passenger does not need to transfer or change to another vehicle. The County has requested that the design of the Purple Line not preclude this proposed future extension of the transitway. The MTA and the County have considered various options for this potential extension and the option that as was identified as most feasible and appropriate would continue the Purple Line northeast along Ellin Road/85th Street after the intersection of Harkins Road and Ellin Road. The transitway would then turn southeast and cross over the existing WMATA/Amtrak tracks and WMATA maintenance facility near the Capital Beltway. This potential extension is only at the very broadest conceptual level, but the design of the Purple Line should accommodate it, or considerable public expense would be incurred at the time of the construction of the future extension.

Many factors were considered in the selection of the Locally Preferred Alternative. The first step in an Alternatives Analysis is the identification of the purpose of the proposed project and what need the project is intended to meet. The Purpose and Need identifies larger project goals and specific objectives. A wide range of measures are indentified to see how well the proposed alternative meets the objectives. Many of these are easily quantified, such as travel time for the proposed transit service, added delay to vehicular traffic, number of projected riders, costs, and so on. Others are less easily measured, such as visual impacts to a local community. As may be expected, the ultimate decision requires a weighing of the alternatives and consideration of the tradeoffs of their potential benefits or impacts.

At the request of the Hanson Oaks community, the MTA has prepared this more detailed write-up of the light rail alternative on Harkins Road, and an explanation of why Ellin Road was selected for the Locally Preferred Alternative. The following information summarizes the details of the analysis of the Harkins Road alternative and as explanation of the factors considered in the decision-making process.

Description of Existing Roadways and Land Uses

Annapolis Road and Harkins Road

Existing Roads: Between Veterans Parkway and Harkins Road, Annapolis Road consists of three lanes in each direction, separated by a grass and/or concrete median. There are also left-turn lanes along this segment of Annapolis Road. The existing speed limit on Annapolis Road is 35 miles per hour. The maximum roadway grade along this segment of Annapolis Road is approximately one percent.

Harkins Road consists of two lanes in each direction, with left-turn lanes at cross streets and parking lot entrances. The lanes are separated by a grass median, except as they approach the intersection with Annapolis Road. The existing speed limit on Harkins Road is 30 miles per hour. The maximum roadway grade along Harkins Road is approximately six percent.

*Surrounding Land Uses***:** Annapolis Road, between Veterans Parkway and Harkins Road, is surrounded by commercial development on both sides. Behind the commercial areas are single family homes. The commercial development is auto-oriented strip development. The West Lanham Hills Volunteer Fire Department is also located on the south side of Annapolis Road.

Harkins Road is surrounded by commercial development and wooded areas between Annapolis Road and West Lanham Drive. East of West Lanham Drive, Harkins Road is surrounded by a wooded area backing single family homes, large office buildings (the Internal Revenue Service National Headquarters Complex and the CSC building) and parking lots.

Veterans Parkway and Ellin Road

Existing Roads: Between Annapolis Road and Ellin Road, southbound Veterans Parkway has three through lanes and a left-turn lane at Ellin Road. Northbound Veterans Parkway has two through lanes. The existing speed limit on Veterans Parkway is 45 miles per hour.

Ellin Road consists of two lanes in each direction. To the east, the lanes are separated by a grass median between Hanson Oaks Drive and the New Carrollton Metro Station. There are left-turn lanes at all cross streets, and there is also a right-turn lane on westbound Ellin Road at the intersection with Veterans Parkway. The existing speed limit on Ellin Road is 30 miles per hour.

Surrounding Land Uses: The land uses along Ellin Road are residential, parks, open space, and institutional.

On the north side of Ellin Road at the intersection with Veterans Parkway is the West Lanham Hills Neighborhood Recreation Center. The park is a nine-acre facility and consists of playgrounds, a community center, ball courts, a trail, and shelters. A narrow wedge of wooded park property extends along Ellin Road approximately 500 feet (halfway between Veterans Parkway and Hanson Oaks Drive). On the south side of Ellin Road is a wooded area. Farther east as one approaches the New Carrollton Metro Station there are residential properties on both sides of Ellin Road. A narrow wooded strip buffers the houses from the road on both sides.

East of Hanson Oaks Drive on the south side is a large stormwater management facility, an access road to the Amtrak, CSX, and WMATA railroad tracks, and a Pepco substation. Beyond that is the New Carrollton Metro Station which serves Metrorail, MARC, Amtrak, and local buses.

The north side is residential until Emerson Place. East of Emerson Place at the corner of Harkins lane and Ellin Road is the previously mentioned Internal Revenue Service (IRS) National Headquarters Complex.

Engineering Feasibility

The MTA identified basic engineering design criteria for the Purple Line. These criteria define things such as how sharp a turn the light rail tracks can make, and how steep a grade the transitway can be. The current design criteria for the Purple Line stipulate that the maximum grade for the transitway is six percent. On both Ellin Road and Harkins Road the maximum existing grade is approximately six percent, meeting the design criteria for surface (at-grade) operations.

Harkins Road

On Harkins Road therefore, it is possible to construct the transitway adjacent to the southwest side of Harkins Road, cross Ellin Road at-grade, turn to the southwest, and enter into the New Carrollton Metro station. The Purple Line platform would be adjacent and parallel to the Metrorail and MARC tracks. This would provide a convenient connection to the New Carrollton Metro station, one of the Purple Line project objectives; however, the transit vehicles would be heading to the southwest which would preclude Prince George’s County’s plan for the future extension of the transitway.

As a result of this issue, the MTA evaluated the engineering feasibility of several other options along Harkins Road. In one variation, the transitway would be constructed adjacent to the southwest side of Harkins Road, cross Ellin Road at-grade, and then turn to the northeast. This alignment would point the transitway in the northeast direction, which would meet Prince George’s County’s plan for the extension of the transitway. However, this alignment would not provide a good connection between the proposed Purple Line platform and the existing Metrorail and Amtrak/MARC platforms because the light rail platform would be located at least 600 feet northeast of the existing Metrorail and Amtrak/MARC platforms.

The at-grade option on Harkins Road is currently shown to operate adjacent to the southwest side of Harkins Road next to the Internal Revenue Service National Headquarters Complex. This issue is discussed later in this memo.

The MTA also studied the feasibility of a bringing the Purple Line down Harkins Road and then continuing straight in a tunnel underneath the existing Amtrak, Metro, and WMATA tracks. The thought was that this would allow the Purple Line to return to the surface on the east side of the New Carrollton Station and continue on the future extension of the transitway. The transitway would be in a tunnel under Ellin Road, and provide an underground platform below the existing WMATA park-and-ride lot. On the east side of the Metro tracks are parking garages and the WMATA maintenance facility: the Purple Line would need to return to grade between these facilities if it were to extend farther east. This would mean that the Purple Line station would be approximately 400 feet northeast of the existing Metrorail platform and so would not have a good connection to the existing WMATA and Amtrak/MARC platforms.

This option presented several challenges for its future extension. Because of the depth of the tunnel and the distance required to return the Purple Line to the surface, the eastern tunnel portal would begin along the access road to the WMATA maintenance facility and it would continue through the intersection of Garden City Drive and Corporate Drive. The tunnel portal would eliminate the existing access to the WMATA maintenance facility. It would also eliminate access to the WMATA parking garages from Corporate Drive, and require the relocation of the Garden City Drive and Corporate Drive intersection. While these challenges and costs would not be part of this Purple Line project, they would borne by a future extension.

The required depth for the Purple Line in a deep tunnel underneath the Amtrak and WMATA tracks would be approximately 50 feet below the existing ground. To get under the existing tracks the light rail would have to descend at a much steeper grade than six percent, which is not within the Purple Line design criteria. The tunnel could be extended to make use of a more gradual grade, but the tunnel option would need to begin with a tunnel portal on Annapolis Road immediately east of Garrison Road. The portal would extend approximately 550 feet west of the Annapolis Road/Harkins Road intersection. The portal would eliminate access to the three businesses between Garrison Road and Harkins Road.

Ellin Road

The Ellin Road alignment begins with the alignment passing under Annapolis Road. This would involve cutting into the hill for the Purple Line and putting Annapolis Road on a structure over the light rail. Because Annapolis Road has been constructed on an elevated berm, the Purple Line would be able to return to the surface directly after passing under Annapolis Road. While this has been referred to as a tunnel, it is actually not, and is considerably simpler and less costly to construct than a tunnel. In effect Annapolis Road will be put on a bridge over the Purple Line.

The Purple Line would continue along Veterans Parkway on the southwest side, off the existing roadway. At the intersection of Ellin Road the Purple line would cross on to Ellin. The Purple Lien would be built on the south side of Ellin Road. The transitway would run adjacent to the Pepco substation and would require a small retaining wall along the front of the Pepco property and also some minor right-of-way takes. Coordination with Pepco has begun in order to identify any requirements and concerns that Pepco may have.

Just past the Pepco substation the Purple Line would turn into the site of the existing New Carrollton Metro station bus drop off area and kiss-and-ride facility. This area would be redesigned. The Purple Line platform would be directly parallel to the existing tracks and immediately adjacent to the bus bays and the entrance to the Metro. The existing pedestrian tunnel would be extended to serve the Purple Line platform so that passengers needing to access the Metro, MARC and Amtrak services could pass under the Purple Line tracks.

Traffic Operations and Purple Line Travel Times

Impacts to traffic operations are generally seen at intersections or where the transitway would cross existing roads.

Harkins Road

The Harkins Road alternative would add almost one minute of travel time to the Purple Line. This is largely due to the turn at the intersection of Annapolis Road and Veterans Parkway. The Harkins Road option would require a new phase at the signal of Annapolis and Veterans specifically for the light rail to turn left. While the intersection would operate at Level of Service F even without the construction of the Purple Line, the average delay would increase substantially.

The transitway would also cross two public streets, 77th Avenue and Garrison Road, both of which would need some form of traffic signal.

Ellin Road

Because the Purple Line would pass under Annapolis Road, there would be no delay at this intersection.

Ellin Road and Veterans Parkway

There currently exists a left-turn phase of the signal for traffic turning left from Veterans Parkway on to Ellin Road. Under the south side option this signal phase would be modified to stop the eastbound traffic allowing the Purple Line vehicles to turn on to Ellin Road. The AA/DEIS indicates that this intersection would operate at LOS B during both peak hours under the No-Build condition, but would degrade to LOS C during the AM peak and LOS D during the PM peak with the south side option. However, even with the impacts of the transitway, the resulting levels of service fall into the range which is considered acceptable.

Ellin Road and Hanson Oaks Drive

The south side option would include the installation of a traffic signal at Hanson Oaks Drive. This would also permit the addition of a signalized crosswalk for pedestrians crossing Ellin Road. Turns from Ellin Road would be stopped while a Purple Line vehicle was passing. The south side option would provide a signal at this intersection resulting in a safer crossing for pedestrians, especially children, between the West Lanham community and the Hanson Oaks community. This signal would provide the Hanson Oaks community safer access into and out of their community especially during peak traffic periods.

This signal would provide some reduction in the speed of traffic on Ellin Road increasing safety for pedestrians and local traffic.

Community Impacts

Harkins Road

The Harkins Road option would operate largely in areas with commercial land uses.

Ellin Road

The Ellin Road alignment would operate near residential areas. There are homes on both sides of Ellin Road. On the south side the closest residences in Hanson Oaks range from 63 feet to 131 feet from the transitway. The MTA does not believe that the operation of a light rail line is incompatible with a residential community. Indeed much of the Purple Line is planned through and along residential areas, particularly in Chevy Chase, Lyttonsville, and Silver Spring.

Business Impacts

Harkins Road

The Harkins Road option would cross 14 commercial driveways on Annapolis Road which serve eight separate commercial properties. Each of these driveways would need either some sort of active traffic control (signals), or new access created from a different street, or the businesses would be displaced.

The at-grade variations of the Harkins Road alternative would require a permanent displacement of one business at the intersection of Annapolis Road and Harkins Road. The Harkins Road surface alignment would impact access to eight commercial properties, possibly resulting in their displacement.

The tunnel variation of the Harkins Road Alternative would entirely eliminate access to three businesses. While the Purple Line would not need the actual property for the transitway, the elimination of access would render these properties unusable as commercial property and would likely result in their displacement.

Ellin Road

The Ellin Road alternative impacts no commercial properties. The Ellin Road option would require a property take from the Pepco Substation, however this would be a strip of property and would not effect Pepco operations.

Capital Costs

The fundamental elements of a light rail transit system, such as the tracks and the power supply system (including catenary wires and poles), are essentially the same for these two options. The tunnel option is considerably more. The surface option on Harkins Road is estimated to be approximately $13 million, while the tunnel option would be approximately $162 million. The Ellin Road option includes the cost of an underpass at Annapolis Road and an extension of the pedestrian tunnel to the Amtrak/Metro/MARC platforms and the estimated cost for this option is $25 million. All costs are given are in 2009$. The capital cost of the project is certainly important since the selected alternative must be affordable; however, the cost is merely one of the factors considered. This being said, the cost of the Harkins Road tunnel option, at $162 million, is so much higher than the cost of the two surface options that it is not a acceptable option.

Noise

Noise analyses were conducted for both alignments. These analyses are done by measuring the existing noise levels and then adding the projected noise from the proposed project. The federal government has defined levels of noise acceptable in residential and other noise sensitive areas. In response to community concerns from residents of Hanson Oaks, additional measurements were taken at a residential property. The noise measurements were consistent with the earlier analysis and did not predict any noise impacts from the light rail. The Harkins Road option also has no projected noise impacts. A detailed explanation of the noise analysis and the methodology is provided in the Purple Line Noise and Vibration Technical Report available on the Purple Line website at http://www.purplelinemd.com/aadeis.

Public Facilities

The alignment along Annapolis Road would pass directly in front of the West Lanham Hills Volunteer Fire Department. The Fire Station would be able to pre-empt the signal (including stopping the light rail) to depart the fire station; so delaying service would not be a problem. However the light rail tracks would eliminate the Fire Station driveway.

Federal Facility Requirements

The at-grade option on Harkins Road is currently shown to operate adjacent to the southwest side of Harkins Road next to the Internal Revenue Service National Headquarters Complex. This option would require permanent right-of-way impacts to the federal property. To date, no coordination has been completed between the MTA and the federal government to determine what, if any, requirements there would be for the Purple Line to travel adjacent to the southwest side of Harkins Road. In general, if constructing a transitway this close to a federal building, certain measures must be taken to secure the safety of the building. The windows for a number of floors must be bomb-proof in addition to the basement and walls being reinforced. These measures can become quite costly. If property cannot be taken from the IRS Headquarters, the transitway would need to be in shared lanes on Harkins Road, which would impact the existing traffic in the area.

Summary / Conclusions

MTA considered three different options on Harkins Road: at-grade on Harkins Road, turning southwest at the New Carrollton Metro station; at-grade on Harkins turning northeast at the New Carrollton Metro station; tunnel underneath Ellin Road and the existing Metrorail and Amtrak/MARC tracks. All three of these options can be constructed, but all are problematic, with substantial issues. However, the cost of a tunnel underneath Ellin Road and the existing Metrorail and Amtrak/MARC tracks is so high that the tunnel is precluded from further consideration.

The at-grade options on Harkins Road are not substantially different from each other in cost or impacts. Both have a substantially lower cost than the tunnel and they meet the purpose and need of the Purple Line Study. However, the at-grade variations would either preclude Prince George's County's plan to extend the Purple Line further south or not provide a convenient connection to the existing Metrorail/Amtrak/MARC platforms.

The Harkins Road options all result in impacts, including displacements, to local businesses.

The Ellin Road alternative is faster, meets project goals of connectivity to Metro, MARC and Amtrak better, minimizes impacts to businesses, and facilitates a future extension without incurring excessive project costs. While the transitway would pass by residential areas, this is typical of other areas of the project and has minimal impact to the communities.

The MTA has concluded that the Ellin Road option does not have unacceptable impacts to the local communities, and works best from a transit operations perspective.

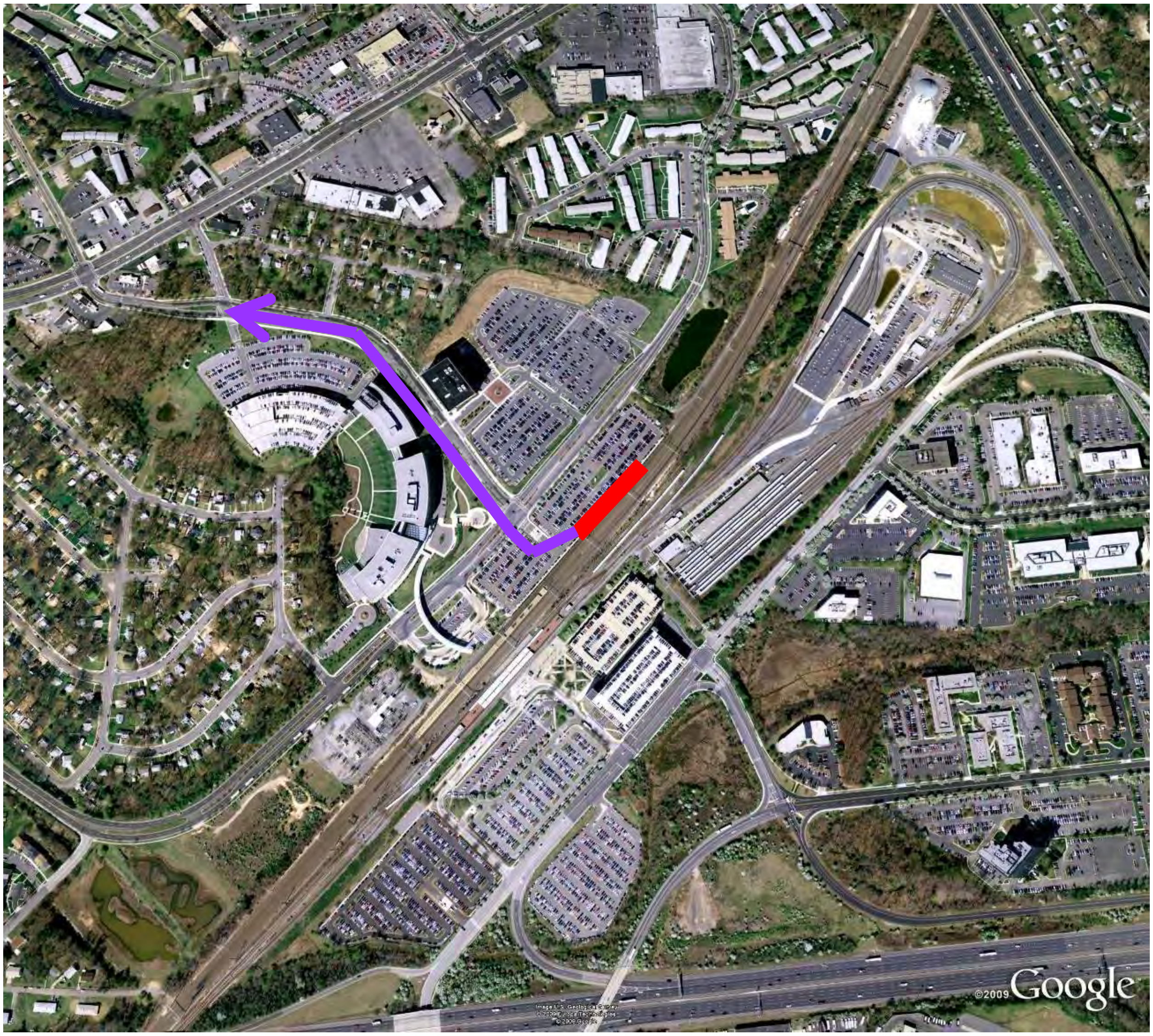
Figure 1: Harkins Road Option turning south (precluding future extension)

Proposed Purple Line alignment

Proposed Purple Line station location

Note: Alignment and station locations as shown are purely illustrative

Figure 2: Harkins Road option platform to the north east

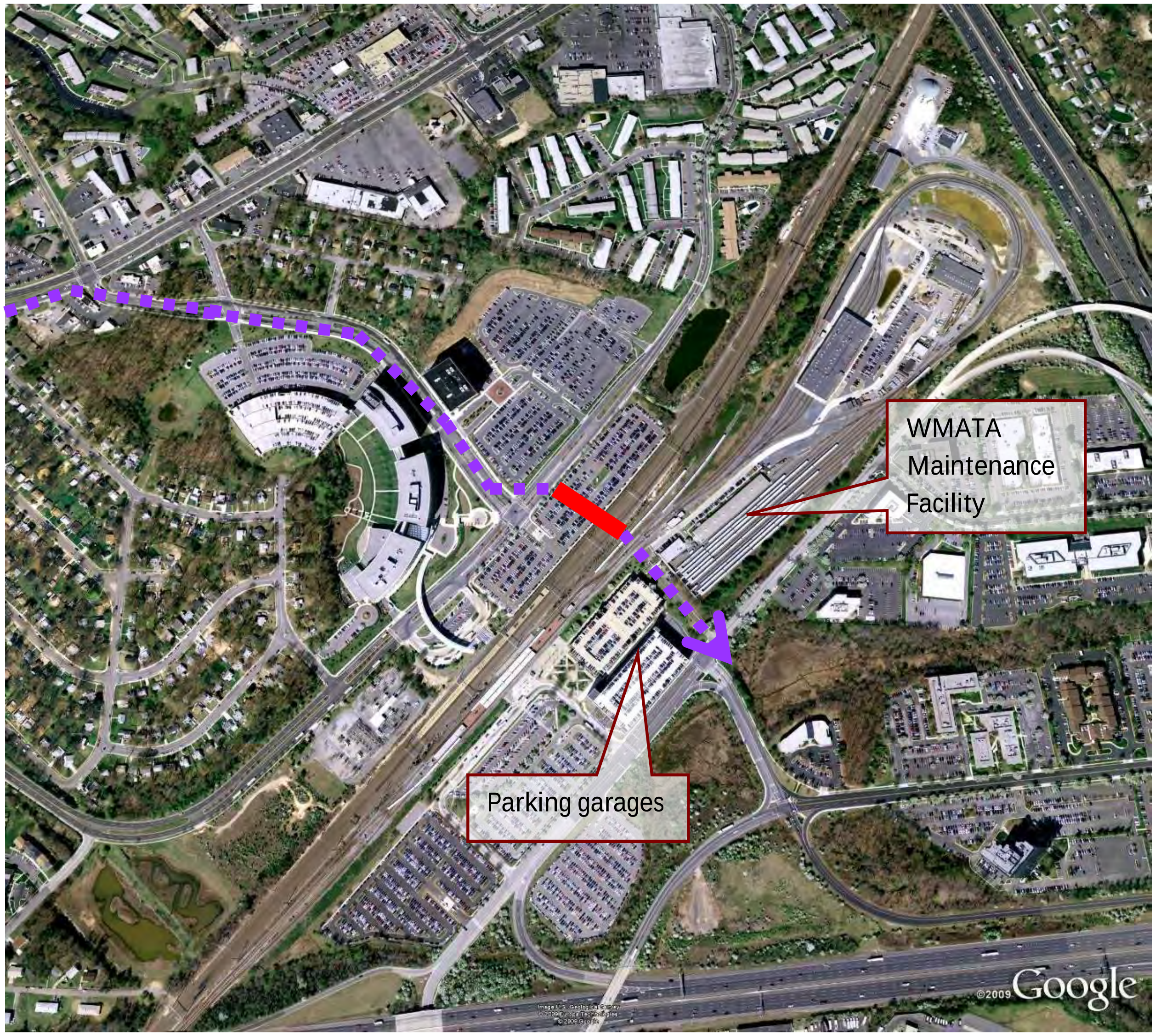


Proposed Purple Line alignment

Proposed Purple Line station location

Note: Alignment and station locations as shown are purely illustrative

Figure 2: Harkins Road option in tunnel



Proposed Purple Line alignment in tunnel

Proposed Purple Line station location

Note: Alignment and station locations as shown are purely illustrative

13. Evaluation of Options for MD 410 Corridor

Evaluation of Options for MD 410 Corridor

April 2010

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EXECUTIVE SUMMARY

The Purple Line AA/DEIS evaluated both shared and dedicated transit lanes along MD 410/Riverdale Road, between MD 201/Kenilworth Avenue and MD 410/Veterans Parkway. After the publication of the AA/DEIS, Prince George's County staff and elected officials met with the MTA and requested a further evaluation of options for this segment of the project. The two options which emerged from this initial analysis were a shared lane (for transit vehicles and left-turning automobile traffic) / transitway median option and an option with dedicated transit lanes on the south side of the roadway. **Based on the analysis and the March 16 and March 18, 2010 public input of these two options, the MTA and Prince George's County jointly endorse the South Side Option along MD 410/Riverdale Road between MD 201/Kenilworth Avenue and MD 410/Veterans Parkway. The MTA remains extremely concerned about the impact of the additional displacements associated with the South Side Option and will continue to closely coordinate with the affected property owners, elected officials, and Prince George's County staff to minimize these impacts and assist affected property owners and residents.**

The following report compares the two options. Under the first option (the median option), the transitway would be located in the median of MD 410 west of the southbound ramps of MD 295/Baltimore-Washington Parkway. This option would then cross to the south side of MD 410 and remain along the south side until the intersection with MD 410/Veterans Parkway. Under the second option (the south side option), the transitway would depart the aerial station at Riverdale Park and remain on the south side of MD 410 until the intersection with MD 410/Veterans Parkway.

MTA has conducted a detailed evaluation of these two options in order to identify the most desirable option to carry forward into Preliminary Engineering. The options were evaluated and compared in four main areas: engineering feasibility, traffic operations, transit operations, and property impacts. The results of this evaluation are summarized in this memorandum. For several other key areas, including natural / cultural resources, Section 4(f), air quality and noise quality, these two options are not expected to result in substantially different impacts.

Table 1: Comparison of Options for Key Decision Factors

Factors	Median Option	South Side Option
Engineering Feasibility / Constructability		✓
Community Access	✓ (slight)	
Traffic Operations		
Levels of Service		✓ (slight)
Safety		✓ (slight)
Transit Operations		
Reliability		✓
Average Travel Times		✓ (slight)

Property Impacts		
Displacements (Total Takes)	✓ (substantial)	
Strip Takes	✓ (slight)	
Temporary Construction Easements		✓ (slight)

✓ - Indicates that this option offers greater benefits for this factor.

MTA will continue to refine the Purple Line alignment for the South Side Option through advanced conceptual engineering study. In particular, MTA will assess the engineering, safety, operational property issues, and public comments associated with the potential 64th Avenue Connector, the potential realignment of Mustang Drive with 62nd Place, and the MD 410/Purple Line traffic operations, roadway access and traffic control from the Baltimore-Washington Parkway (MD 295) Interchange east to Veterans Parkway, among others.

A. DESCRIPTION OF THE MD 410 CORRIDOR

There are several distinct roadway cross-sections and operational areas along MD 410 / Riverdale Road between MD 201 / Kenilworth Avenue and MD 410 / Veterans Parkway. Between MD 201 and a point west of 61st Place, MD 410 consists of three travel lanes in each direction, separated by a grass and concrete median. Between 61st Place and 64th Avenue, MD 410 consists of two lanes in each direction, separated by a center two-way left-turn lane; there is also a striped parking lane in each direction with this segment. Between 64th Avenue and 67th Avenue, MD 410 has a six-lane cross-section, consisting of two through lanes and a left-turn lane in each direction; separate right turn lanes are provided at the MD 295 / MD 410 interchange leading to the on ramps. East of 67th Avenue, MD 410 consists of two travel lanes in each direction.

There are five existing traffic signals along this segment of Riverdale Road, they are located at: Mustang Drive / 62nd Avenue, 64th Avenue, MD 295 southbound Ramp terminal, MD 295 northbound Ramp terminal, and 67th Avenue / 67th Court. There are eight unsignalized intersections of municipal streets and MD 410 between Kenilworth Avenue and Veterans Parkway: 58th Avenue / Riverdale Road, 61st Place, 63rd Avenue, 63rd Place, Eastpine Drive, 66th Avenue, 67th Place, and Fernwood Terrace. Additionally, there are numerous private business and residential driveways which access MD 410 along this segment.

B. OPTIONS UNDER CONSIDERATION

There are currently two options under consideration for the MD 410 (Riverdale Road) segment of the Purple Line alignment.

Under the first option (the median option), the transitway would leave the aerial station at Riverdale Park (located in the southeast quadrant of the MD 201 / MD 410 signalized intersection), and continue on an aerial structure along the south side of MD 410, over Riverdale Road and the eastbound lanes of MD 410 before returning to grade in the median of MD 410, just west of 61st Place. The transitway would then continue in a curbed median section to the intersection of 64th Avenue, and a six-lane cross-section would be created (two travel lanes and one shared left-turn/transit lane in each direction). At the intersection of MD 410 and the southbound MD 295 ramps, the transitway would transition from the median of MD 410 to the south side of the roadway. The transitway would continue on the south side of the roadway beneath a widened Baltimore-Washington Parkway overpass. The transitway would continue on the south side, crossing 66th Avenue and 67th Avenue, before arriving at the at-grade Riverdale Road Station. A new eastbound right-turn lane and a new westbound left-turn lane would be added along MD 410 at the intersection with 67th Avenue.

Under the second option (the south side option), the transitway would leave the aerial station at Riverdale Park (located in the southeast quadrant of the MD 201 / MD 410 signalized intersection), and continue on an aerial structure along the south side of MD 410 before returning to grade along the south side of MD 410, west of 61st Place. The transitway would then continue along the south side of MD 410, crossing Mustang Drive, and Eastpine Drive. The existing 63rd Avenue access to MD 410 would be closed and end prior to the tracks with a cul-de-sac. The transitway would continue on the south side of the roadway beneath the Baltimore-Washington Parkway overpass (which would be rebuilt). The transitway would continue on the south side, crossing 66th Avenue and 67th Avenue, before arriving at the at-grade Riverdale Road Station. With the exception of new eastbound right-turn lanes at Mustang Drive and 67th Avenue, and a new westbound left-turn lane at 67th Avenue, the existing cross-section along MD 410 would be maintained.

C. PUBLIC INVOLVEMENT

To engage the community about the possibility of shifting the Purple Line alignment, two meetings were held. The MTA first held a meeting specifically for the residents that live on the south side of Riverdale Road and therefore would be directly impacted by the alignment shift. This meeting was held Tuesday, March 16, 2010 at the William Wirt Middle School at 62nd Place & Tuckerman Street, Riverdale, Maryland, 20737 from 6:30 pm to 8:30 pm. The purpose of this meeting was to allow the residents and homeowners who would be directly affected by the alignment shift time to review the mapping in detail and ask questions of the MTA.

Twenty-one letters (in English and Spanish) were sent out to both the residents of the homes along Riverdale Road and any property owners that were listed at a different address. Prince George’s County staff and elected officials were also invited to attend the meeting. In addition to mailing the invitation letters the MTA conducted reminder phone calls and went door-to-door at each residence to notify them of the meeting. Seven properties were represented at the March 16, 2010 meeting. Project staff members were also available to provide Spanish language translation throughout the meeting.

For the second meeting on this issue the MTA attended the Eastpines Community Association meeting. This meeting was held on Thursday, March 18, 2010 at the Community Building on

5819 Eastpine Drive. The Eastpines Community Association President, Norman Livsey, went to each house on Riverdale Rd and the houses behind Riverdale Road to invite them to the meeting. At this meeting 53 people attended, including people representing an additional three of the potentially displaced properties.

In total, 10 of the additional 18 properties that would be displaced by the shift in the Purple Line alignment attended one of the two community meetings held about this topic.

At the first meeting, MTA focused on the two options under consideration – running down the median of Riverdale Road as included in the Locally Preferred Alternative and the option to run down the south side of Riverdale Road. MTA and the County explained the reason for the consideration of the south-side option including issues outlined in this report. After an overview of the two options, residents identified their homes on the maps and MTA explained how each option would affect the residents in attendance. The remainder of the meeting was spent with the homeowners reviewing the maps, asking questions and discussing the options. Some of the key issues associated with the Median option that the homeowners identified included:

- The loss of property through strip takes on already small parcels,
- The restrictions on left turns into and out of driveways,
- The resulting need to make u-turns to access homes, and
- The existing safety concerns with living on a busy street that many thought would be further compounded by moving the roadway closer to their homes.

Most of the residents in attendance stated that given the impacts associated with the median option, they would rather be relocated by the South Side option than remain with impacts to their properties and access. Residents were encouraged to share the information with any of their neighbors who were not in attendance and to encourage them to attend the community meeting scheduled for later in the week.

For the second meeting, MTA attended the Eastpines Community Association meeting. MTA presented an overview of the project and walked through the two options using large aerial maps. The presentation was also summarized in Spanish and the project newsletter and fact sheet were available in both English and Spanish. While the first meeting with the property owners focused on the area with potential displacements, this meeting looked at a broader area along Riverdale Road. There was an excellent exchange of ideas and questions.

Residents, especially those who live along Riverdale Road, echoed many of the same comments as those expressed at the first meeting as it relates to the median vs. south-side discussion of the alignment. Other issues discussed included:

- Access to/from the communities along Riverdale Road, especially east of MD 295,
- Safe pedestrian crossings of Riverdale Road,

- Pedestrian access to the stations along Riverdale Road, and
- General questions about transit and traffic operations.

While this report focuses on the decision of median vs. south side alignment along Riverdale Road, the other issues relating to traffic, access, and pedestrian mobility/safety will continue to be addressed as the design progresses and additional follow-up meetings will be held to present information to the community.

D. ENGINEERING FEASIBILITY / CONSTRUCTABILITY

MTA has evaluated the engineering feasibility and constructability of these two options. This evaluation included creating a conceptual design of the transitway curvature, determining the structures required for each option, considering impacts to the existing roadway, and locating areas for construction staging.

1. Median Option

Engineering Feasibility

In most areas, the median option would need to follow the curvature of the existing roadway, therefore necessitating slightly tighter curves than could be used for the south side option. In addition, this option would require an S-curve to transition from the median to the south side of MD 410. Overall, the tighter curvature for this option results in slower speeds (15 to 35 mph) for the transit vehicles along the corridor and a slightly longer travel time. Noise analysis conducted for the Alternatives Analysis / Draft Environmental Impact Statement determined for five noise sensitive receptors along MD 410 that no noise impacts would result when compared to the FTA noise criteria. The median option would also only allow for embedded track while the transitway is in the median of MD 410. The embedded tracks would be required to allow vehicles at certain locations to perform turn movements over the tracks.

In terms of structures, the median option requires an aerial structure that is 2,510 feet long to provide the required clearance over the intersections of MD 410 and MD 201 and MD 410 and Riverdale Road. In addition to the aerial structure this option would require driveway reconstruction and the construction of small retaining walls along all of the residential properties on the south side of MD 410 as well as elimination of on-street parking. While in the median between 61st Avenue and 64th Avenue, this option would require a closed drainage system underneath the transitway.

This option would cause an impact to National Park Service property surrounding MD 295; however the median option does not result in a significantly larger or smaller impact than the south side option.

Constructability

The median option would have significant impacts to the existing roadway and vehicular traffic operations along the MD 410 corridor during construction. These impacts could include lane closures, lane shifts, or temporary detours depending on the location of the construction efforts along MD 410. The potential impacts to traffic operations could require time of construction restrictions, and would likely lengthen the overall construction period in this area. In addition to the traffic impacts during construction, there would be minimal room available for construction staging, making it difficult to access the proposed transitway.

2. South Side Option

Engineering Feasibility

The south side option allows for minor adjustments to the curvature of the transitway as it does not need to precisely follow the existing roadway; allowing the LRT to achieve slightly higher speeds along this corridor than the median option. The geometry of this option allows the transitway to operate at a speed of up to 35 mph for the majority of MD 410 (roadway traffic speeds will be governed by the posted civil speed limit along the corridor). A noise analysis of the five noise sensitive receptors with the south side option has not been conducted but will be required if the south side option is selected over the median option. The south side option would also provide greater flexibility for selecting the type of track used along MD 410. This option would make it feasible to use ballasted track, embedded track or grass tracks, and allows for the MTA, Prince George's County, and the community to make a decision as to what best fits the character of the surrounding area. Grade crossings would be required when the transitway crosses existing side streets or driveways.

In terms of structures, the south side option requires an aerial structure that is 2,196 feet long to provide the required clearance over the intersections of MD 410 and MD 201 and MD 410 and Riverdale Road. This aerial structure is 314 feet shorter than the aerial required in the median option. The south side option would also maintain the existing on-street parking on the north side of MD 410 between 62nd Place and 64th Avenue. This option would allow for either an open or closed drainage system for the transitway.

The south side option would cause an impact to the National Park Service property surrounding MD 295; however the south side option does not result in a significantly larger or smaller impact than the median option.

Constructability

The south side option would have very minimal disruption to traffic along the existing MD 410 corridor during construction. However, there would be minor disruptions to cross streets along the south side of MD 410. These disruptions would take place while track is being constructed across the cross street or driveway, and would be expected to have relatively short durations. The south side option would also provide more room for construction staging, making it easier to access the proposed transitway than if it were to be constructed in the median. As a result of these factors, this option would have an overall faster construction time than the median option.

E. TRAFFIC OPERATIONS

MTA has evaluated the potential impact of these two options on the operations of general purpose traffic utilizing MD 410 and the various cross-streets which intersect MD 410 along this segment. This evaluation included anticipated changes in local access patterns to the residential communities along MD 410, changes to intersection levels of service due to the re-routing of traffic and consolidation of turning traffic to a limited number of locations, and any expected improvements in safety along the corridor due to the modifications suggested accommodating the transitway.

1. Median Option

a. Changes to Access

The median option would alter existing traffic patterns along MD 410, between 61st Place and 67th Place.

<u>61st Place to MD 295 Southbound Ramps:</u> Currently, between 61st Place and 64th Avenue, vehicles can turn left from MD 410 at any location by using the center two-way left-turn lane; vehicles can also turn left onto MD 410 from any of the intersection cross-streets or private driveways. Operations along this section would change substantially under this option. The transitway would operate in a curbed median section, between 61st Place and the MD 295 Southbound Ramp Terminal and vehicles would not be permitted to turn left to or from MD 410 except at the existing signalized intersections at Mustang Drive/62nd Place and at 64th Avenue. Current engineering plans indicate that left turns at those locations would be made from the adjacent transit lane. Under this option, the unsignalized intersections at 61st Place, 63rd Avenue and 63rd Place, and all private driveways would be restricted to right-in / right-out access only. Eastpine Drive would be converted to a cul-de-sac with no access to MD 410. Vehicles wishing to turn left from 63rd Avenue and 63rd Place would have two options: either make a right turn from those intersections and then make the first available U-turn at the signalized intersections at 64th Avenue or Mustang Drive / 62nd Place, or use existing roadways (for example, Roanoke Avenue and Patterson Street) to access 62nd Place and Mustang Drive and then make a left turn at those signalized intersections. Traffic exiting from Eastpine Drive would be redirected to use Patterson Street and Mustang Drive to access MD 410. Vehicles wishing to turn left from any of the nineteen private driveways along this section would need to make a right turn from that driveway and then make a U-turn at the signalized intersections of Mustang Drive / 62nd Place or 64th Avenue.

MD 295 Southbound Ramps to MD 410 / Veterans Parkway: In this section, the transitway would operate along the south side of MD 410. The use of a side-running transitway requires that all crossings must be carefully managed to ensure that vehicles do not queue on the tracks while waiting to make a turn from a side street or a private driveway. Currently, it is proposed that 66th Avenue and 67th Place end in a cul-de-sac so that these streets no longer intersect Riverdale Road. Traffic from 66th Avenue and 67th Place could utilize Patterson Street and 67th Avenue to access MD 410. All private driveways accessing MD 410 along the south curb line would need to be closed under this option. In some cases, the closure of these driveways may require a property to be purchased in full. In other cases, alternative access may be available (via 67th Avenue, for example). The only points where traffic would be permitted to cross the transitway would be at the signalized intersections of MD 410 with the SB MD 295 ramp terminal, the NB MD 295 ramp terminal, and 67th Avenue. Exclusive left-turn phasing would be required at the SB MD 295 ramp terminal and 67th Avenue (a new westbound left-turn lane would be required at this intersection as well). Eastbound right-turn lanes and right-turn-on-red prohibitions would be required at the SB 295 ramp terminal and 67th Avenue. Right turns on red would also need to be prohibited from 67th Avenue northbound and the northbound MD 295 off-ramp.

b. Capacity Analyses

To quantify the potential impact of these two options on the traffic operations along the MD 410 corridor, a SYNCHRO network was developed. Both Existing (2005) and No Build (2030) conditions, in terms of intersection delay and levels of service and arterial travel speeds and levels of service, were evaluated. Then the potential access modifications (restricted left turn movements, street closures, etc) expected due to each of these two options were considered. In each case, diverted traffic was reassigned to what was estimated to be the shortest (in terms of time) alternative route within the network, and the signal phasing and lane configurations were modified to reflect the influence of the Purple Line. Then the intersection and arterial levels of service were evaluated for comparison to the 2030 No Build condition. A full summary of the intersection levels of service for both the AM and PM peak hours for existing (2005), 2030 No-Build, and the two 2030 Build options can be found in Appendix A.

The capacity analysis results indicate that these five signalized intersections would experience a degradation in the level of service, relative to the No Build condition, under the median-running option:

Table 2: Impacts to Level of Service under Median Option

Intersection	AM Peak Period		PM Peak Period	
	No Build	Median Option	No Build	Median Option
MD 410 at 62nd Place / Mustang Drive	LOS B	LOS D	LOS D	LOS E
MD 410 at 64th Avenue	LOS A	LOS C	LOS A	LOS D
MD 410 at MD 295 SB Ramps	LOS C	LOS D	LOS C	LOS E
MD 410 at MD 295 NB Ramps	LOS C	LOS C	LOS B	LOS C
MD 410 at 67th Avenue	LOS B	LOS C	LOS B	LOS D

In three of the five instances where a degradation in the intersection level of service is expected, the intersections are still projected to operate at LOS D or better, which is typically considered acceptable for urban intersections. At two intersections, MD 410 at Mustang Drive / 62nd Place and MD 410 at the MD 295 Southbound ramps, LOS E operations are projected during the PM peak under this option.

SYNCHRO also provides the opportunity to consider the arterial level of service for the segment of MD 410 between Kenilworth Avenue and Veterans Parkway. Table 3 summarizes the arterial travel times, speeds, and levels of service for all options. As Table 3 indicates, the PM peak arterial levels of service are not expected to change under the median option. During the AM peak, the eastbound arterial level of service is projected to degrade from LOS D to LOS E under this option. The average directional speeds along MD 410 are projected to decrease by between approximately 10 and 25 percent under this option, relative to the No Build condition, resulting in a corresponding increase in travel time under this option.

Table 3: Arterial Level of Service, Riverdale Road (MD 410)

		AM				PM			
Scenario	Dir.	Signal Delay	Travel Time	Arterial Speed	Arterial LOS	Signal Delay	Travel Time	Arterial Speed	Arterial LOS
2005 Existing	EB	94.5	229.1	20.8	D	168.8	303.4	15.7	E
	WB	228.5	368.7	13.6	E	219.1	359.3	14.0	E
2030 No Build	EB	103.3	237.9	20.0	D	354.2	488.8	9.8	F
	WB	337.5	477.7	10.5	F	460.2	600.4	8.4	F
2030 Median Option	EB	169.0	303.7	15.7	E	483.9	618.5	7.7	F
	WB	373.9	514.1	9.8	F	439.2	579.5	8.7	F
2030 South Side Option	EB	116.2	250.9	19.0	D	416.9	551.6	8.6	F
	WB	435.2	575.5	8.7	F	469.1	609.4	8.2	F

Overall, the median option is expected to result in a minor degradation in traffic operations at the signalized intersections along the MD 410 corridor. The primary causes for this are the inclusion of protected left-turn movements to separate possible conflicts between transit vehicles and passenger vehicles, the routing of additional left-turning traffic to and from MD 410 through these signalized intersections, and the inclusion of an additional signal phase at the intersection of MD 410 and the MD 295 SB Ramps to allow the transitway to transition from the median to the south side of MD 410.

c. Safety

It is expected that this alternative would improve safety for general purpose traffic along the MD 410 corridor compared to the existing conditions. Currently, between 61st Avenue and 64th Avenue, vehicles can make permissive left turns from MD 410 at any location from the center two-way left-turn lane, and vehicles from all driveways and unsignalized cross-streets can make left turns onto MD 410. The existing configuration creates a substantial number of conflict points where the paths of left-turning vehicles and through vehicles cross. Under the median option, left-turning traffic would be managed, with left turns to and from MD 410 only allowed at two designated locations, both of which are signalized and would provide an opportunity to time-separate conflicting traffic streams.

However, the current proposal includes provision for the automobile left turns to be made from the adjacent transit lane. This would create a new conflict point in each direction where left-turning automobile traffic needs to merge onto the adjacent transit lane. In addition, a stopped transit vehicle waiting behind a left-turning automobile could prevent other MD 410 left-turning automobile traffic from leaving the eastbound through lane and entering the transit lane because the transit vehicle is occupying the queuing space. This situation will cause difficult, erratic and unsafe decisions to occur at the 62nd Place and 64th Avenue signalized intersections.

East of 64th Avenue, access to and from MD 410 would be limited to the signalized intersections at MD 295 southbound ramp terminal, MD 295 northbound ramp terminal, and 67th Avenue; this would reduce the number of potential conflict points along MD 410 by closing a number of unsignalized private driveways and truncating two municipal streets. Additionally, left and right-turn lanes would be added at 67th Avenue to separate turning vehicles from the through travel lanes; this would reduce the potential for rear-end collisions at this intersection.

This option is not expected to substantially improve or degrade pedestrian safety along the corridor. Marked crosswalks with pedestrian signals would be maintained at each of the traffic signals along the corridor and sidewalks conforming to SHA standards would be installed along the rebuilt portions of the roadway.

In summary, this option is expected to have positive benefits for traffic safety along the Riverdale Road corridor.

d. Emergency Vehicle Access

While access to and from a number of streets would be restricted for general purpose traffic, there are design options available which would permit full access for emergency vehicles so that response times would be minimally impacted.

2. South Side Option

a. Changes to Access

The south side option would alter existing traffic patterns along MD 410, between 61st Place and 67th Place.

<u>61st Place to MD 295 Southbound Ramps:</u> Currently, between 61st Place and 64th Avenue, vehicles can turn left from MD 410 at any location by using the center two-way left-turn lane; vehicles can also turn left onto MD 410 from any of the intersection cross-streets or private driveways. Operations along this section would change substantially under this option, which would provide a transitway along the south side of MD 410. The existing five-lane cross-section would be maintained along MD 410, with two travel lanes in each direction and center two-way left-turn lane. However, the transitway would require the acquisition of a number of private residences and businesses along the south side, which would reduce the number of driveways on the south side of MD 410 along this section. Additionally, 63rd Avenue and Eastpine Drive would become cul-de-sac streets that no longer intersect MD 410 under this option. The preceding two factors would obviate the need for a continuous westbound left-turn lane along MD 410. At 64th Avenue, a new fourth intersection leg (Eastpine Drive / 64th Avenue Connector) would be added to the intersection. The 64th Avenue Connector would operate as a one-way northbound roadway to link the neighborhood with MD 410. Vehicles from 63rd Avenue wishing to access MD 410 would use Patterson Street and the signalized intersection at Mustang Drive to do so while traffic from Eastpine Drive would use either the 64th Avenue Connector or Patterson Street and Mustang Drive to access MD 410. At Mustang Drive, a new eastbound MD 410 right-turn lane and exclusive phasing for westbound MD 410 left turns would be required. Additionally, right turns on red would need to be prohibited along northbound Mustang Drive and the 64th Avenue Connector. Eastbound left turns to 62nd Place, 63rd Avenue, 63rd Place, 64th Avenue, and the private driveways along the north curb line would not be materially impacted by this alternative.

<u>MD 295 Southbound Ramps to MD 410 / Veterans Parkway (same as Median Option):</u> In this section, the transitway would operate along the south side of MD 410. The use of a side-running transitway requires that all crossings be carefully managed to ensure that vehicles do not queue on the tracks while waiting to make a turn from a side street or a private driveway. Currently, it is proposed that 66th Avenue, and 67th Place would become cul-de-sac streets that no longer intersect MD 410. Traffic from 66th Avenue and 67th Place could use Patterson Street and 67th Avenue to access MD 410. All private driveways accessing MD 410 along the south curb line

would need to be closed under this option. In some cases, the closure of these driveways may require a property to be purchased in full. In other cases, alternative access may be available (via 67th Avenue, for example). The only points where traffic would be permitted to cross the transitway would be at the signalized intersections of MD 410 with the SB MD 295 ramp terminal, the NB MD 295 ramp terminal, and 67th Avenue. Westbound left-turn lanes and exclusive left-turn phasing would be required at the southbound MD 295 ramp terminal and 67th Avenue. Eastbound right-turn lanes and right-turn-on-red prohibitions would be required at the SB 295 ramp terminal and 67th Avenue. Right-turns-on-red would also need to be prohibited from 67th Avenue northbound and the northbound MD 295 off-ramp.

b. Capacity Analyses

Capacity analyses conducted for the South Side option indicate that, similar to the Median option, five of the existing signalized intersections would experience a degradation in the level of service compared to the No-Build condition. These results coincide with expectations, since additional turning traffic from minor streets is re-routed through the signalized intersections under this alternative. The five intersections expected to be impacted under this option are:

Table 4: Impacts to Level of Service under South Side Option

Intersection	AM Peak Period		PM Peak Period	
	No Build	South Side Option	No Build	South Side Option
MD 410 at 62nd Place / Mustang Drive	LOS B	LOS E	LOS D	LOS D
MD 410 at 64th Avenue	LOS A	LOS B	LOS A	LOS B
MD 410 at MD 295 SB Ramps	LOS C	LOS D	LOS C	LOS D
MD 410 at MD 295 NB Ramps	LOS C	LOS B	LOS B	LOS C
MD 410 at 67th Avenue	LOS B	LOS C	LOS B	LOS D

These results are quite similar to the results projected for the median option. The main difference is that the intersection of MD 410 and 62nd Place / Mustang Drive is projected to operate at LOS E in both the AM and PM peak hours under the South Side option. This option was projected to operate at LOS E only during the PM peak hour under the median option.

Referring back to Table 3, the arterial levels of service along MD 410 are not expected to change under the South Side option. However, the average speed along the arterial is projected to decrease by between approximately 10 and 20 percent under this option, relative to the No Build condition, resulting in a corresponding increase in travel times for automobile traffic along this corridor.

Overall, the south side option is expected to result in a minor degradation in traffic operations at the signalized intersections along the MD 410 corridor. The primary causes for this are the inclusion of protected left-turn movements to separate possible conflicts between transit vehicles and passenger vehicles, and the routing of additional left-turning traffic to and from MD 410 through these signalized intersections.

c. Safety

It is expected that this alternative would improve safety for general purpose traffic along the MD 410 corridor compared to the existing conditions. Currently, between 61st Avenue and 64th Avenue, vehicles can make permissive left turns from MD 410 at any location from the center two-way left-turn lane, and vehicles from all driveways and unsignalized cross-streets can make left turns onto MD 410. The existing configuration creates a substantial number of conflict points where the paths of left-turning vehicles and through vehicles cross. Under this option:

- Transitway right of way would be dedicated exclusively to transit vehicle use with no shared lanes with automobile traffic;
- All south side MD 410 driveways would be closed between 61st Avenue and 64th Avenue;
- Westbound MD 410 left turns would only be allowed at Mustang Drive, which is signalized and would provide an opportunity to time-separate conflicting traffic streams;
- Left turns to MD 410 from the south would be allowed at Mustang Drive and the 64th Avenue Connector;
- Eastbound MD 410 right turns at Mustang Drive would be accomplished from an exclusive right turn lane that would be separately signalized to cross the transitway;
- Eastbound left turn opportunities would be maintained.

East of 64th Avenue, access to and from MD 410 would be limited to the signalized intersections at the MD 295 southbound ramp terminal, the MD 295 northbound ramp terminal, and 67th Avenue; this would reduce the number of potential conflict points along MD 410 by closing a number of unsignalized private driveways and truncating two municipal streets. Additionally, left and right-turn lanes should be added at 67th Avenue to separate turning vehicles from the through travel lanes; this would reduce the potential for rear-end collisions at this intersection.

In summary, this option is expected to have positive benefits for traffic safety along the Riverdale Road corridor and all existing opportunities for eastbound left turns would be maintained though this option would not reduce the number of conflict points by the same amount as the median option. SHA also retains the potential to implement other MD 410 improvements in the future.

This option is not expected to substantially improve or degrade pedestrian safety along the corridor. Marked crosswalks with pedestrian signals would be maintained at each of the traffic signals along the corridor and sidewalks conforming to SHA standards would be installed along the rebuilt portions of the roadway.

d. Emergency Vehicle Access

While access to and from a number of streets would be restricted for general purpose traffic, there are design options available which would permit full access for emergency vehicles so that response times would be minimally impacted under this option.

3. Summary of Traffic Operations

A detailed analysis of traffic operations along the MD 410 corridor indicates that the impact of both options to both the intersection and arterial levels of service would be quite similar. Overall, the south side option appears to perform slightly better than the median option; this is primarily due to the need for the transitway to transition out of the median at 64th Avenue under the median option.

From a safety standpoint, both options are expected to substantially improve safety for motorists travelling along this corridor, both by reducing the number of potential vehicle conflict points and shifting turning movements (particularly left turns) to signalized intersections where they can be actively controlled. However, the median option is expected to provide slightly greater safety benefits. Lastly, both options can be designed minimize the impact to emergency response times.

Based on this evaluation, it appears the two options currently under consideration would have similar impacts to traffic operations and similar safety benefits. Other factors, particularly transit operations, should be used to select a preference between these alternatives.

F. TRANSIT OPERATIONS

MTA evaluated these two options in terms of transit operations. Two particular areas were considered: travel time reliability and overall travel times along the corridor.

1. Reliability

Travel time reliability is an important factor in determining the attractiveness of a transit system to potential riders. Travel time reliability means that the service's published schedule can be met and riders can come to rely on the service as a dependable means of transportation.

The two options under consideration for the Riverdale Road corridor would operate differently and therefore would result in differences in the travel time reliability which could be attained along this segment of the alignment.

2. Median Option

For the median option, the primary challenge to travel time reliability is the current proposal to allow eastbound left turns at 64th Avenue and eastbound and westbound left turns at Mustang Drive / 62nd Place to be made from the adjacent transit lane. This "shared turn lane" design would mean that as a transit vehicle approaches either of these intersections, intending to go straight through, there could be automobile traffic queued on the transitway, waiting to turn left across the opposing traffic stream. So, while the signal indication may be green for through traffic along MD 410 (which would include the Purple Line transit vehicle), the vehicle may be required to wait until the left-turning traffic clears the tracks. There are a number of ways to mitigate this situation. The first, and most effective, would be to provide for a separate eastbound left-turn lane at 64th Avenue and separate eastbound and westbound left-turn lanes at Mustang Drive / 62nd Place. These separate left-turn lanes would eliminate the need for auto traffic to use the transit lanes at any point along Riverdale Road; however, provision of these left-turn lanes would likely require eight to ten additional property displacements along the corridor. Another mitigation approach would be to include advance detectors along the transitway which detect when a transit vehicle is approaching and modify the signal operation to give priority to the left-turn traffic which is queued on the transitway. This approach would likely negatively impact the opposing stream of through traffic. Also, for the intersection at Mustang Drive / 62nd Place, if transit vehicles were approaching from both directions at the same time, some logic would be required to determine which transit vehicle should be prioritized to move the through intersection.

Another component of the median option which may negatively impact its travel time reliability is the need for the transitway to transition from the median to the south side of MD 410 at the intersection of MD 410 and the MD 295 southbound ramps. For this analysis, it has been assumed that this transition would occur as a new signal phase at this intersection. Introducing a new signal phase at an intersection increases the delay for all movements. Under the south-side option, the transit vehicles travelling east-west can always run concurrently with the eastbound and westbound auto movements along MD 410 (which are by far the highest volumes along this corridor and receive the majority of the green time, increasing the likelihood that the transit vehicles arrive during a green light and do not need to stop at the various signals). Under this scenario, the transit vehicle movement could be considered a minor movement which would receive limited amounts of green time (sufficient to allow the transition across the eastbound lanes), increasing the likelihood of arriving on a red light. Again, advance detection could be used to modify the phasing at this intersection to prioritize the transit vehicle movements, but this priority would negatively impact eastbound traffic along MD 410.

Another potential reliability concern associated with this transition from the median to the south side would be the potential for queuing from the downstream signalized intersection at the northbound MD 295 ramp terminal intersection to extend back towards the crossing of the eastbound lanes. If queued vehicles are present at the crossing location, the transit vehicle will not be able to proceed which could add travel time to certain trips and negatively reliability. Again, it may be possible to mitigate this concern by providing queue detectors along MD 410 which modify the phasing at the downstream signal to allow eastbound traffic to proceed (or modify the phasing at the upstream signal to stop eastbound traffic from proceeding towards the crossing). However, the signal system would become quite complex if there are multiple priorities which must be considered. Alternatively, regulatory signing and enforcement could be used to deter drivers from queuing at the transit crossing.

3. South Side Option

For the south side option, the primary challenge to travel time reliability would be the potential for vehicles turning left or right from Mustang Drive, 64th Avenue Connector, the northbound MD 295 off-ramp, and 67th Avenue to stop or queue on the transitway. If these turning vehicles queue on the transitway during the green phase for the transit vehicles, they would disrupt the ability of the transit vehicles to move through the corridor. This issue could be mitigated by locating the stop bars on all four roadways on the south side of the two transit lanes, by prohibiting right-turn-on-red movements, and by providing regulatory signing instructing drivers to not stop on the transitway. However, it is possible that some drivers, particularly those wishing to make right turns, may ignore the various restrictions and attempt to cross the transitway on a red signal. Given that the drivers' sight distance is likely to be restricted from the required location of the stop bars, these drivers may pull out onto the transitway without realizing that there is no gap available for them to enter the general purpose lanes on MD 410. It should be noted that this concern is also present for the median option; however, in that case, the driver's sight distance is potentially limited for right turns from side streets east of MD 295 at MD 295 northbound off-ramp and 67th Avenue.

However, for the south side option, there would be no need for automobile traffic to share the dedicated transit-lanes at any point along Riverdale Road. There would also be no transition required from the median of the roadway to the south side of the roadway, which introduced two potential concerns regarding service reliability to the median option.

4. Travel Times

A qualitative assessment of these two options indicates that the travel times for transit vehicles along this portion of MD 410 would be similar between the two options. The transition from the median to the south side along with the sharing of the transitway with left-turning traffic at Mustang Drive, 62nd Place, and 64th Avenue, would likely reduce the speeds attainable under the median option relative to the south side option.

While the south side option can be expected to provide slightly faster travel times along this segment; the difference between the two alternatives is expected to be less than a minute, which is minimal for a segment of this length.

5. Summary of Transit Operations

Based on this evaluation, the south side option can be expected to provide for more consistent and reliable travel times along this segment of the Purple Line.

G. PROPERTY IMPACTS

MTA also conducted an evaluation of the likely property impacts should these options be implemented along MD 410/Riverdale Road. Quantification of these property impacts is based on the current conceptual-level design and these impacts are likely to be modified as more detailed engineering is conducted.

1. Median Option

The median option would operate in the median between 61st Place and 64th Avenue; by sharing the tracks with the left-turn movements at Mustang Drive, 62nd Place, and 64th Avenue, this option could be constructed without requiring a large number of total property acquisitions in this segment. Some widening of MD 410 beyond the existing right-of-way would be required, resulting in strip property acquisition from a number of property owners. Additionally, temporary construction easements would need to be obtained from a number of properties fronting MD 410 along this corridor. In the vicinity of the MD 295 interchange with MD 410, several properties would be severely impacted, resulting in five displacements. In addition to these displacements, 1.04 acres of property would need to be permanently acquired, and 3.08 acres of temporary construction easement would need to be acquired.

Table 5: Property Impacts

Type of Impact	Median Option	South Side Option
Total Displacements(#)	5 total (3 residential, 2 commercial)	23 total (21 residential, 2 commercial)
Strip Takes (acres)	1.47	2.08
Temporary Construction Easements (acres)	1.52	1.09

2. South Side Option

The south side option is expected to result in substantially higher numbers of total takes along the corridor than the median option. Because this option runs to the south of the existing MD 410 roadway footprint, it would severely impact numerous properties fronting MD 410 along the south side. In total twenty-three properties would need to be acquired in total to accommodate this option. In addition, 1.19 acres beyond the right-of-way (not resulting in a displacement) would need to be acquired from certain property owners. Temporary construction easements, totaling 2.60 acres, would also need to be acquired from property owners to accommodate the south side option.

3. Summary of Property Impacts

The south side option would require a larger number of displacements of property owners along the MD 410 corridor. The south side option would also require more permanent property acquisition in the form of strip takes than the median option. The median option would require a greater amount of temporary construction easements to be acquired along the corridor.

H. CAPITAL COSTS

MTA has conducted a qualitative assessment of the capital costs for these two options. The fundamental elements of a light-rail transit system, such as the track work and the power supply system (including catenaries), are essentially the same for these two options. Both options require the reconstruction of the MD 295 / Baltimore-Washington Parkway bridges over MD 410 and the Purple Line, which is a significant component of the total cost along this segment. The median option would require a longer (and therefore more costly) aerial structure leaving the Riverdale Park station to cross into the median while the south side option will require longer MD 295 / Baltimore-Washington Parkway bridges over MD 410 and the Purple Line. The median option will require the complete reconstruction of MD 410 / Riverdale Road (west of 64th Avenue) and the associated maintenance of traffic costs. On the other hand, the south side option would require eighteen additional total property acquisitions and relocations, resulting in higher ROW costs than the median option. Based on this evaluation, the capital costs for these options would not differ substantially.

I. OTHER CONSIDERATIONS

There are two additional aspects of these two options which may merit consideration in selecting an option to carry forward.

MD 410 / Riverdale Road Highway Improvements

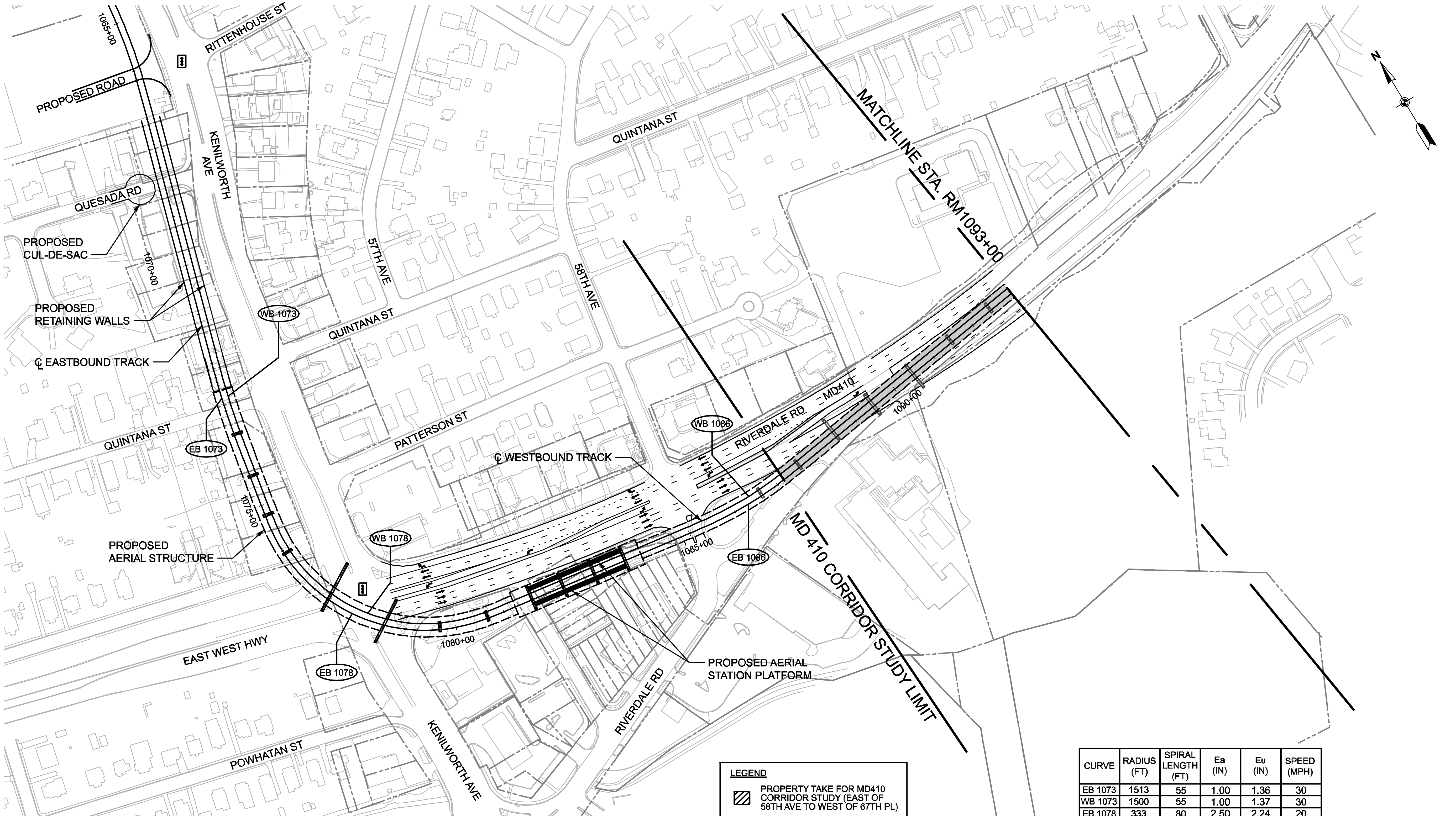
The Maryland State Highway Administration may consider improving MD 410 (Riverdale Road) simultaneous to the Purple Line project with the South Side Option. Improvements may include adding left turn bays, eliminating the center-turn lane, streetscape treatments, adding a curbed, landscaped median and other safety and operational features. These improvements would be examined jointly with the Purple Line project improvements to ensure overall roadway and light rail vehicle operations safety.

Streetscape / Green Space Improvements

While the south side option would require the displacement of 23 property owners, the approximately 30-foot wide transitway itself would not require the use of all the acquired property. With this option, west of 64th Avenue, it may be possible to develop streetscape improvements or make creative use of the excess property as community green space to improve the overall aesthetics of the MD 410 corridor. With the median option, it would be difficult to provide streetscape improvements or new green space along the segment of the corridor west of 64th Avenue.

J. CONCLUSIONS

MTA has evaluated two options for the Purple Line alignment along MD 410 / Riverdale Road between the Riverdale Park Station and the Riverdale Road Station. In several key areas, neither option provides substantially different advantages or disadvantages. These areas include: capital costs, traffic operations, traffic safety, and transit travel times. On the other hand, the options do offer distinct advantages and disadvantages in three key areas: property impacts, transit operational reliability, and engineering feasibility / constructability. In terms of property impacts, the median option would require eighteen (18) fewer displacements along this corridor. The south side option would provide for much more reliability in transit operations along the corridor compared to the median option, which would share lanes with left-turn movements at certain locations and need to transition at-grade from the median to the south side of the roadway. The south side option, which is located outside of the existing MD 410 roadway footprint, would be easier to construct than the median option; maintenance of traffic would be simpler than if the transitway were being constructed in the median of the MD 410. Lastly, the south side option may provide a greater opportunity to provide a benefit to the community, in the form of streetscape improvements or new public green space. From the varying affects and impacts of the two options, MTA and Prince George's County staff determined the South Side Option represented the best overall Purple Line alignment along MD 410/Riverdale Road as the resulting community quality of life would be more adversely affected by the Median Option. MTA and Prince George's County will continue to refine the Purple Line South Side Option for MD 410 / Riverdale Road from MD 201 / Kenilworth Drive to MD 410 / Veterans Parkway.



LEGEND

PROPERTY TAKE FOR MD410 CORRIDOR STUDY (EAST OF 58TH AVE TO WEST OF 67TH PL)

EXISTING SIGNALIZED INTERSECTION

CURVE	RADIUS (FT)	SPIRAL LENGTH (FT)	Ea (IN)	Eu (IN)	SPEED (MPH)
EB 1073	1513	55	1.00	1.36	30
WB 1073	1500	55	1.00	1.37	30
EB 1078	333	80	2.50	2.24	20
WB 1078	320	80	2.50	2.43	20
EB 1086	713	90	2.75	2.26	30
WB 1086	700	90	2.75	2.33	30

DRAFT WORK-IN-PROGRESS

The Purple Line Transit Study information shown shall be used for general planning/information only. The locations of the proposed transit facilities and/or proposed roadway reconstruction/relocation are approximate and subject to change during subsequent stages of project development.

PLOTTED: TUESDAY, JULY 13, 2010 AT 10:40 AM
FILE: C:\WORKING\CIVIL\DMS27782\RIVERDALE ROAD-MEDIAN 1.DGN

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PURPLE LINE

RIVERDALE ROAD MEDIAN OPTION
STA. RM1087+16 TO STA. RM1093+00

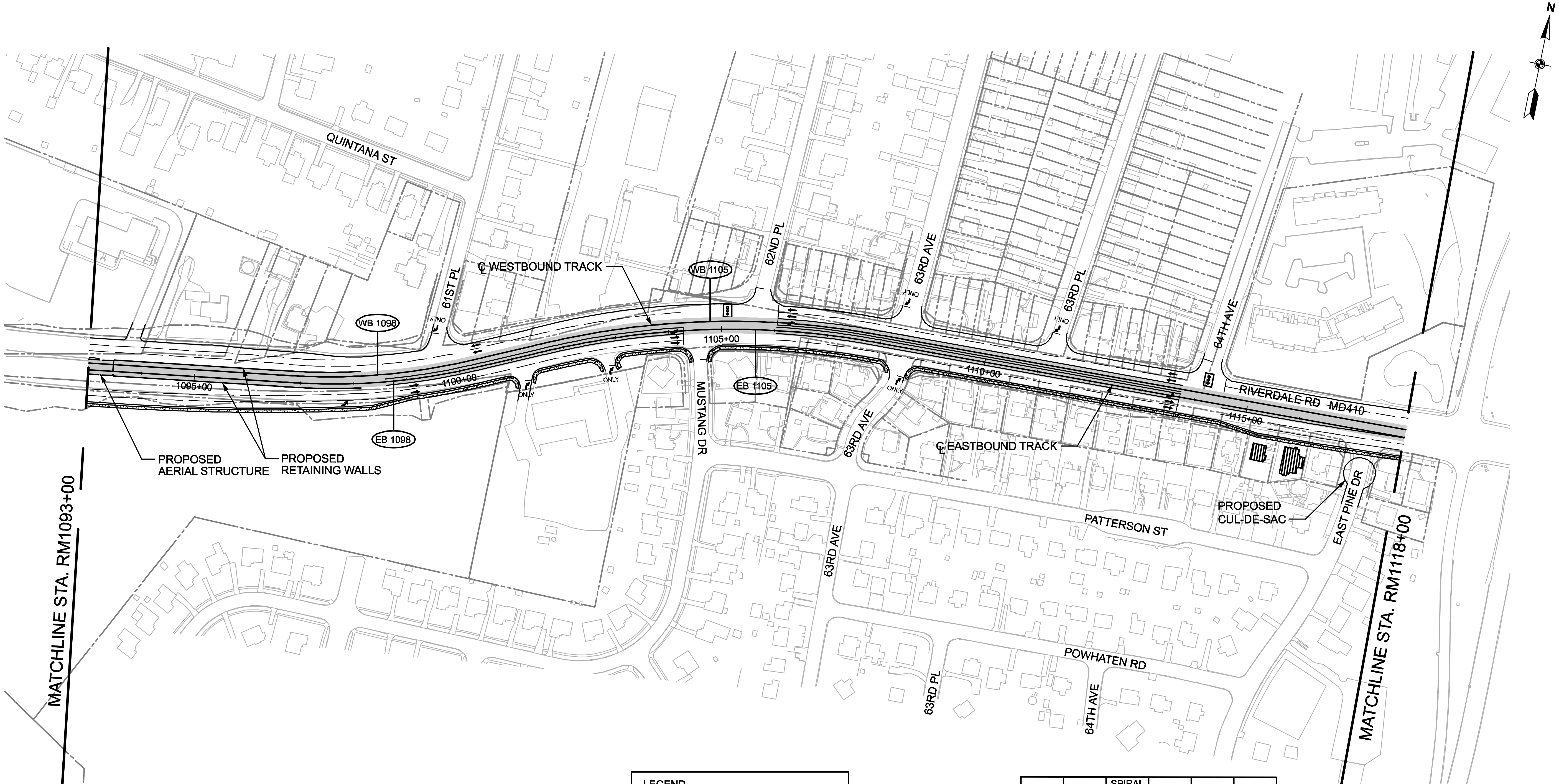
DATE: APRIL 2010

SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO.
RM-1

SHEET NO.
1 OF 3



LEGEND

- PROPERTY TAKE FOR MD410 CORRIDOR STUDY (EAST OF 58TH AVE TO WEST OF 67TH PL)
- EXISTING SIGNALIZED INTERSECTION

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EB 1098	1163	60	1.50	1.58	30
WB 1098	1150	60	1.50	1.59	30
EB 1105	1500	55	1.00	1.37	30
WB 1105	1513	55	1.00	1.35	30

DRAFT WORK-IN-PROGRESS

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RIVERDALE ROAD MEDIAN OPTION
STA. RM1093+00 TO STA. RM1118+00

DATE: APRIL 2010 SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO.
RM - 2

SHEET NO.
2 OF 3

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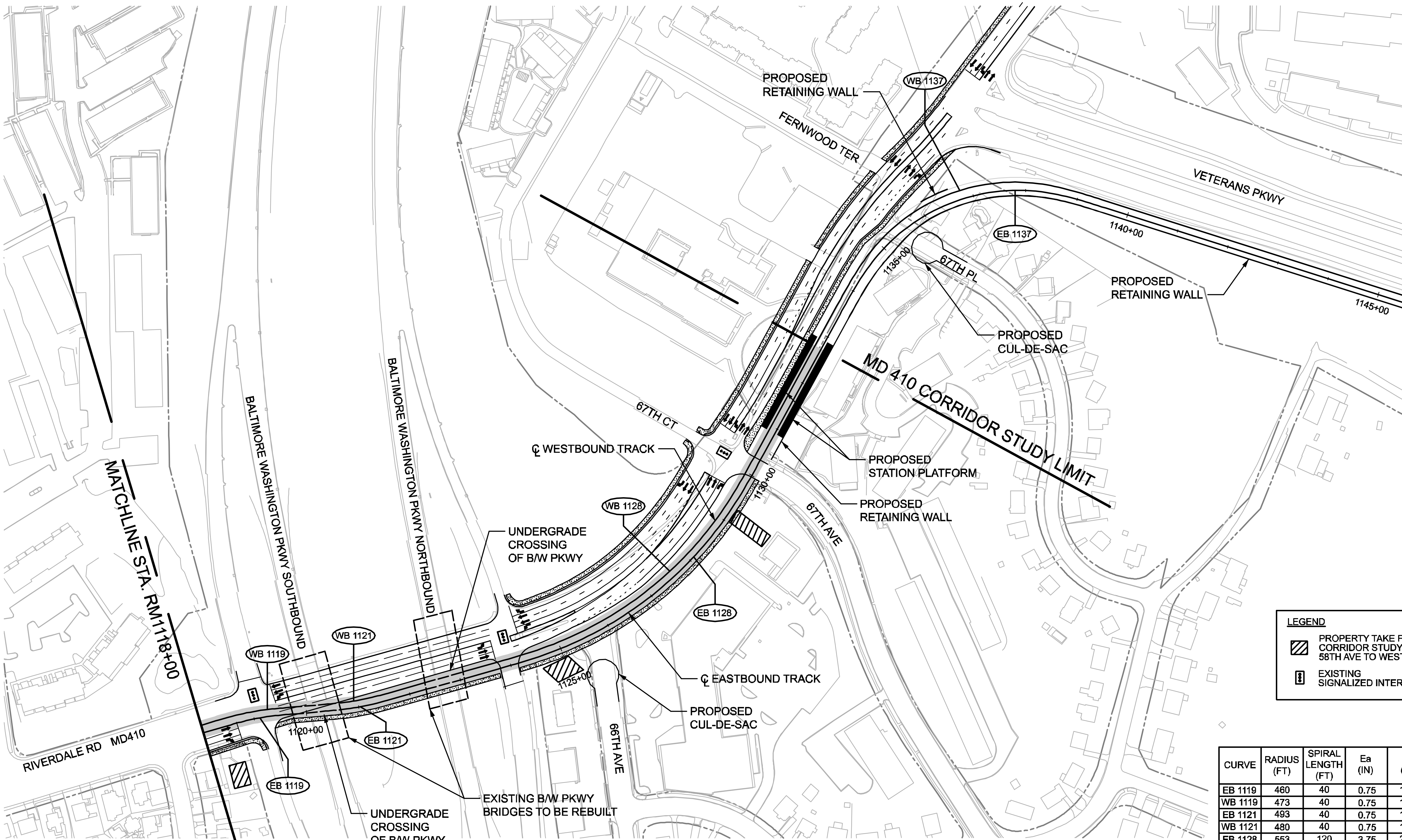

LEGEND

- PROPERTY TAKE FOR MD410 CORRIDOR STUDY (EAST OF 58TH AVE TO WEST OF 67TH PL)
- EXISTING SIGNALIZED INTERSECTION

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EB 1119	460	40	0.75	1.18	15
WB 1119	473	40	0.75	1.13	15
EB 1121	493	40	0.75	1.06	15
WB 1121	480	40	0.75	1.11	15
EB 1128	553	120	3.75	2.71	30
WB 1128	540	120	3.75	2.86	30
EB 1137	350	125	4.00	3.05	25
WB 1137	363	125	4.00	2.80	25

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RIVERDALE ROAD MEDIAN OPTION
STA. RM1118+00 TO STA. RM1132+82

DATE: APRIL 2010 SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO.
RM - 3

SHEET NO.
3 OF 3

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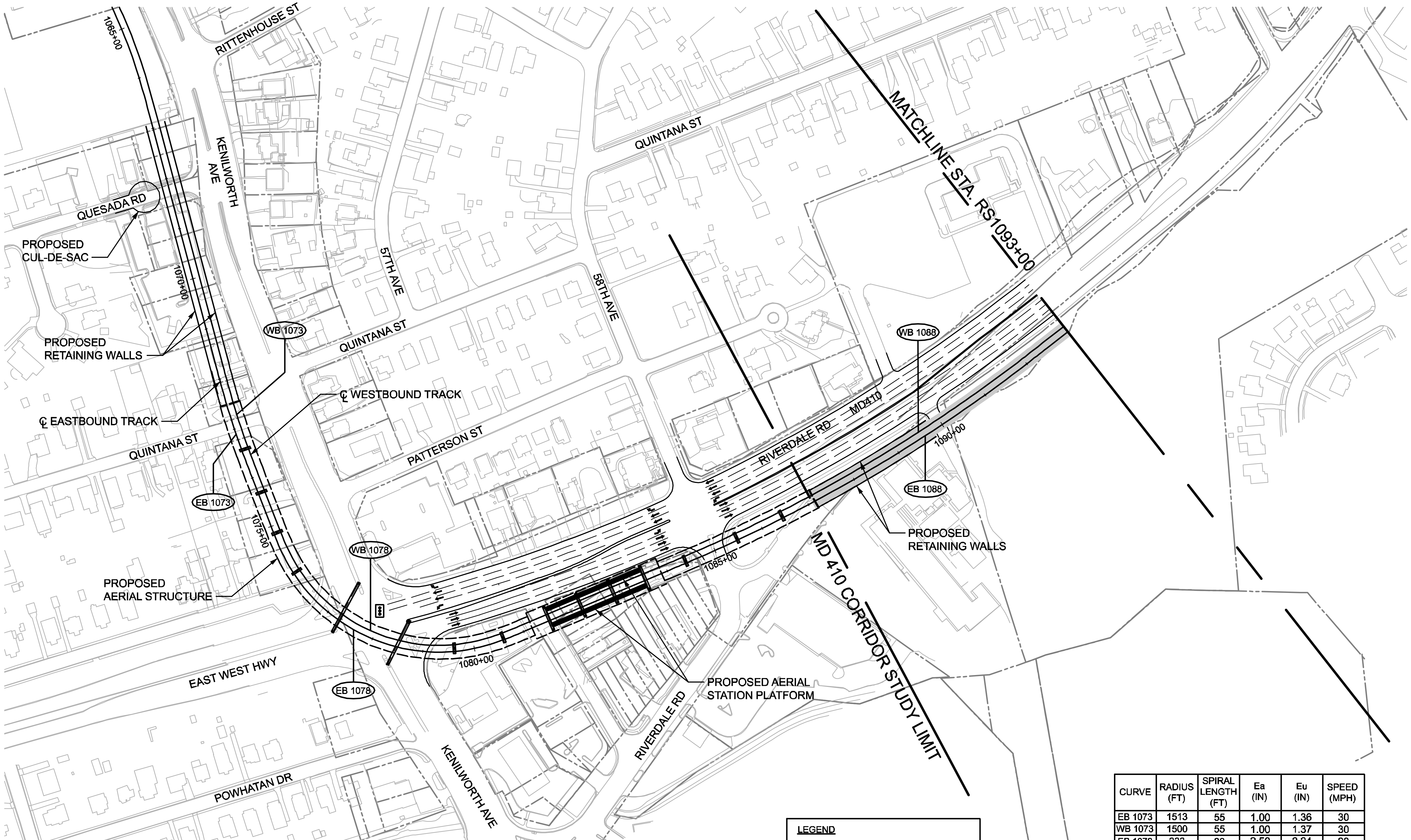

CURVE	RADIUS (FT)	SPIRAL LENGTH (FT)	Ea (IN)	Eu (IN)	SPEED (MPH)
EB 1073	1513	55	1.00	1.36	30
WB 1073	1500	55	1.00	1.37	30
EB 1078	333	80	2.50	2.24	20
WB 1078	320	80	2.50	2.43	20
EB 1088	2993	50	0.50	1.12	35
WB 1088	2980	50	0.50	1.13	35

LEGEND

- PROPERTY TAKE FOR MD410 CORRIDOR STUDY (EAST OF 58TH AVE TO WEST OF 67TH PL)
- EXISTING SIGNALIZED INTERSECTION

DRAFT WORK-IN-PROGRESS

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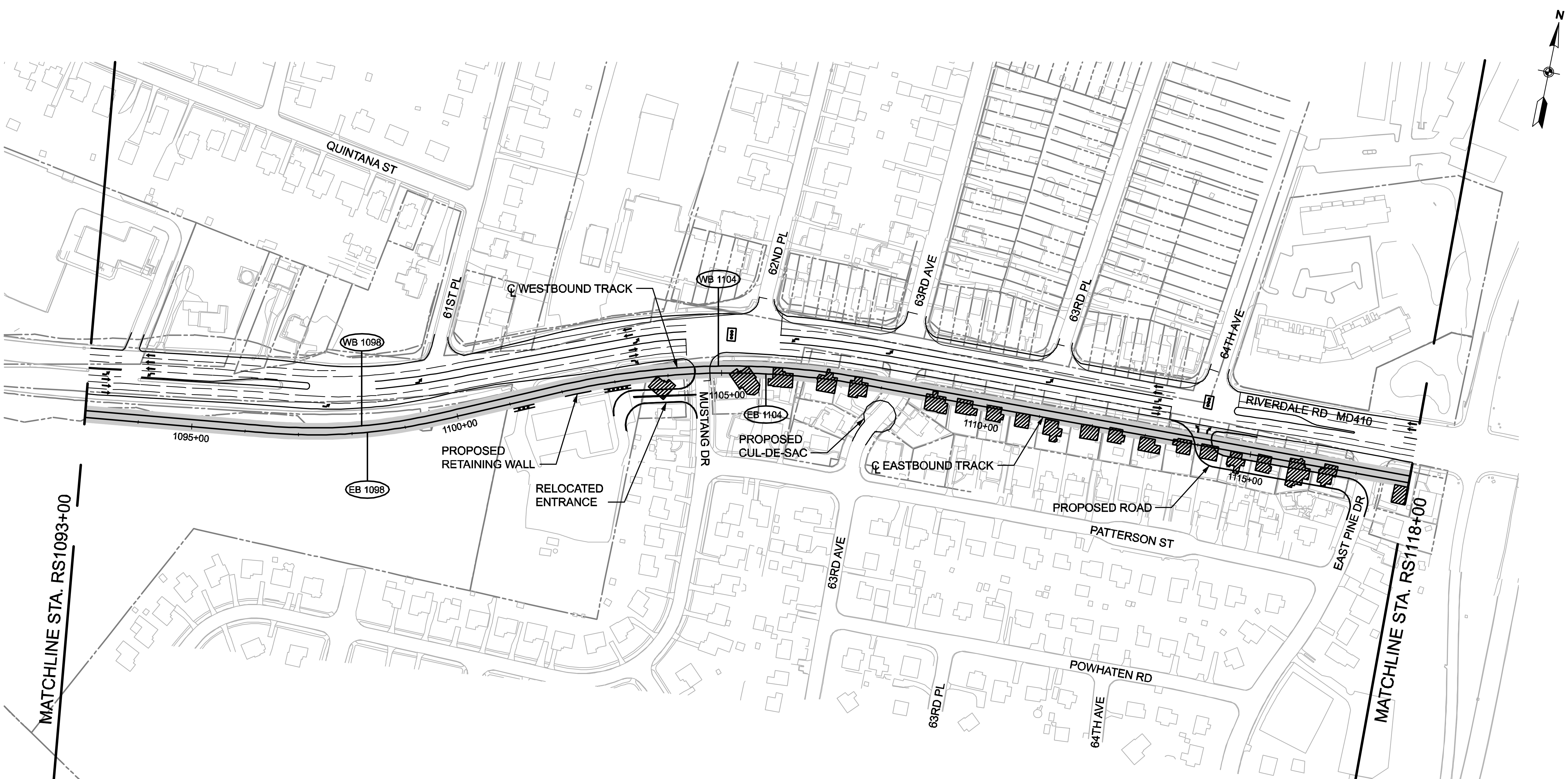
RIVERDALE ROAD SOUTH OPTION
STA. RS1087+09 TO STA. RS1093+00

DATE: APRIL 2010 SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO. RS-1

SHEET NO. 1 OF 3



LEGEND

- PROPERTY TAKE FOR MD410 CORRIDOR STUDY (EAST OF 58TH AVE TO WEST OF 67TH PL)
- EXISTING SIGNALIZED INTERSECTION

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EB 1098	1013	100	2.50	2.28	35
WB 1098	1000	100	2.50	2.34	35
EB 1104	1400	115	2.25	2.27	40
WB 1104	1413	115	2.25	2.23	40

DRAFT WORK-IN-PROGRESS

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PURPLE LINE

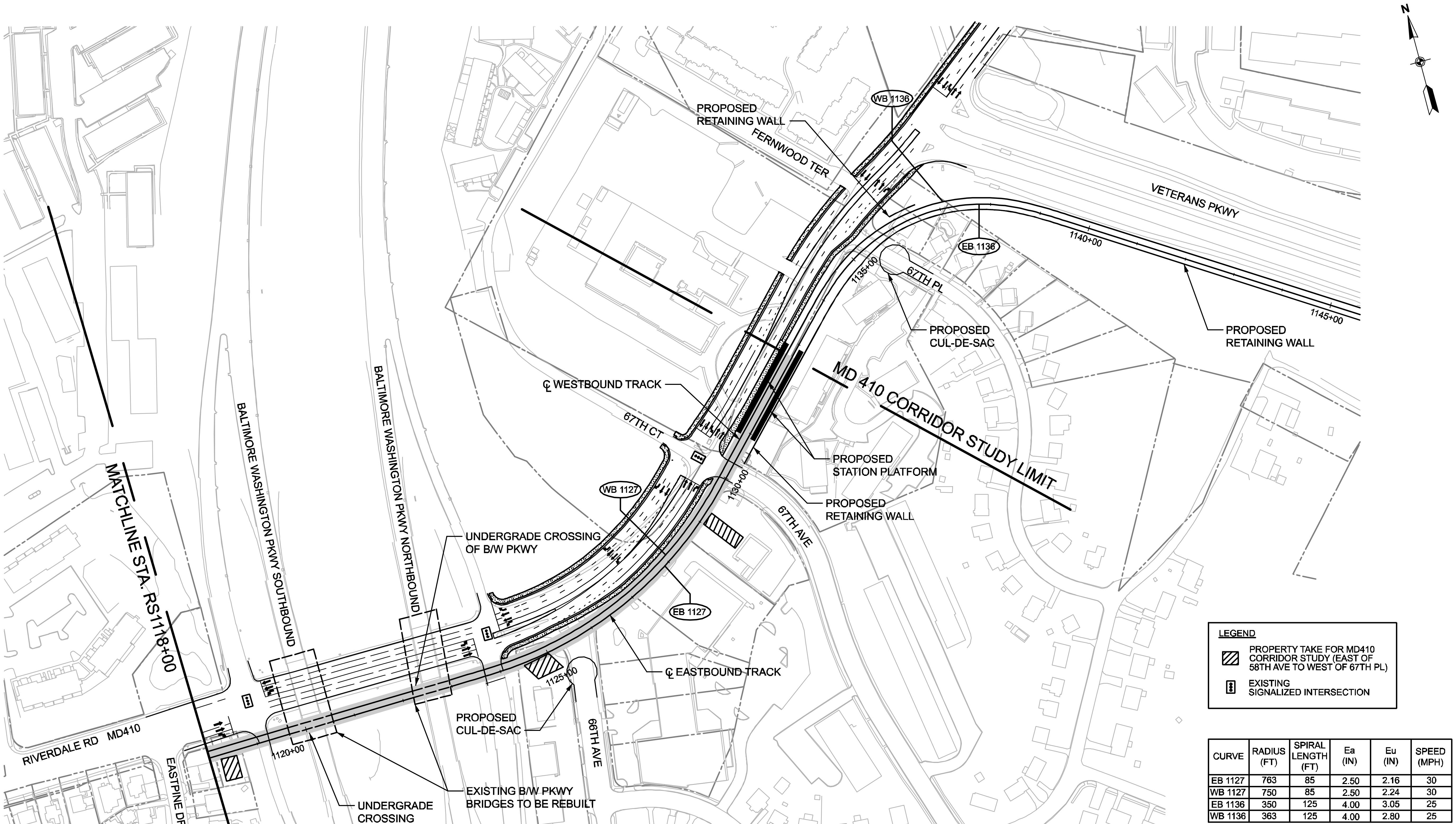
RIVERDALE ROAD SOUTH OPTION
STA. RS1093+00 TO STA. RS1118+00

DATE: APRIL 2010 SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO.
RS - 2

SHEET NO.
2 OF 3



CURVE	RADIUS (FT)	SPIRAL LENGTH (FT)	Ea (IN)	Eu (IN)	SPEED (MPH)
EB 1127	763	85	2.50	2.16	30
WB 1127	750	85	2.50	2.24	30
EB 1136	350	125	4.00	3.05	25
WB 1136	363	125	4.00	2.80	25

DRAFT WORK-IN-PROGRESS

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RIVERDALE ROAD SOUTH OPTION
STA. RS1118+00 TO STA. RS1132+72

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DRAWING NO.
RS - 3

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14. Wayne Avenue LRT Surface Alignment East of Manchester Road

PURPLE LINE

Memorandum to File

Date: **August 24, 2007**

To: **Mike Madden, MTA**

From: **Joe Romanowski**

Subject: **Wayne Avenue LRT Surface Alignment**

Background

During the conceptual design phase, MTA studied several LRT alternatives through the East Silver Spring Community from Fenton Street to Flower Avenue which included:

- Wayne Avenue - Surface from Fenton Street to approximately 500' east of Manchester Road, tunnel east of Manchester Road.

- Silver Spring/Thayer Avenue – Tunnel from west of Fenton Street to Thayer Avenue, surface along Thayer Avenue to Piney Branch Road.

- Sligo Avenue (Surface) – Surface from west of Fenton Street to Piney Branch Road.

- Sligo Avenue Tunnel – Tunnel from west of Fenton Street to Piney Branch Road.

Following the completion of Phase I of the conceptual design, MTA recommended that Sligo Avenue surface and Sligo Avenue tunnel alternatives not be considered for future studies as part of the Purple Line.

The decision to drop the Sligo Avenue surface alignment removed the only "end to end" Purple Line surface alignment through the East Silver Spring Community. Both the Wayne Avenue and the Silver Spring/Thayer Avenue alternatives require portions of the alignments to be constructed as cut and cover or bored tunnels.

In an effort to provide a surface LRT alternative through the East Silver Spring Community MTA studied a surface LRT alignment along Wayne Avenue east of Manchester Road as an alternative to the LRT Plymouth Street tunnel alignment.

Wayne Avenue between Manchester Road and Flower Avenue is approximately 35' wide from curb to curb and operates currently as a two lane roadway with a left turn lane at

Flower Avenue. Right-of-way along this section of Wayne Avenue is 60’ wide. The grades are steep and approach 9.5% in one section.

LRT Recommended Maximum Grade

MTA prefers that the Maximum Mainline Grade be 6% or less. For short lengths, less than 1500’, MTA prefers a grade of 7% or less.

TRB - Criteria/recommendations

Prefer: 4% for sustained grades
Maximum: 6% for grades 2500’ or less
Minimum: 7% for grades 500’ or less

WMATA – LRT Criteria

Prefer: Maximum grade be 6% or less
Maximum: 7.5% for grades 1000’ or less

LRT Surface Alignment

To provide fast/dependable LRT service along this section of Wayne Avenue dedicated lanes will be required for the Light Rail Transitway.

Adding dedicated lanes will require widening the roadway from 35’± to 48’±’ from curb to curb. In addition to widening the roadway, the grades along Wayne Avenue will have to be reduced to accommodate Light Rail Vehicles.

MTA studied both a 7% and 8% track grade. In order to accommodate a 7% track grade, portions of the roadway would have to be raised more than 10’. An 8% track grade will also require raising a section of the roadway approximately 8’. The requirement to widen and raise the roadway sections will have significant impacts on the adjacent residential community. A minimum 100’ radius will be required for the light rail vehicle to negotiate the 90^{o} turn at Wayne Avenue and Flower requiring the taking of the house on the southeast corner. A light rail surface alignment along East Wayne Avenue will require the taking of a minimum of 2 homes, possibly 5 homes.

In addition, a wall to retain the additional fill material, will be required along portions of the new roadway to minimize impacts to adjacent properties.

<u>Conclusion</u>

As a result of the major impacts a light rail surface alignment would have on the residential community, MTA has decided not to include a surface light rail alternative along his section of Wayne Avenue as part of the Purple Line Study.

15. Jones Bridge Road Alignment Issues Discussion

EXECUTIVE SUMMARY

JBR Alignment: The Jones Bridge Road (JBR) Alignment, an alternative to the Georgetown Branch Master Plan Alignment, provides Bus Rapid Transit from Bethesda Metro Station to Jones Mill Road, via Woodmont Ave. in Bethesda and Jones Bridge Road, crossing major intersections at Wisconsin Avenue and Connecticut Avenue (see Figure 1).

Existing Conditions:

- Major congestion (**Level of Service F**) currently experienced at Jones Bridge Road intersections with Wisconsin Avenue and Connecticut Avenue. **Level of Service E** operations experienced at Jones Bridge Road/Jones Mill Road (eastern terminus of alignment).
- Woodmont Avenue intersections operate well today during peaks, with extra capacity provided by restricting on-street parking during peak periods.
- JBR Alignment existing travel time: **AM – 10 minutes** eastbound, **9 minutes** westbound
PM – 12 minutes both eastbound and westbound

Traffic Growth:

- Traffic forecasts are not available, but likely to show corridor growth in the range of 1 to 2 percent per year. The Naval Medical Center BRAC initiative will add 1,000 jobs at this site.
- Travel times could increase noticeably for future traffic.

Jones Bridge Road Alignment Proposed BRT Improvements:

- Based on current and future travel times and reliability, improvements are needed along the Jones Bridge Road alignment to enable competitive travel times with those that would be provided by the improvements proposed along the Georgetown Branch Master Plan alignment.
  - For comparison, the Georgetown Branch alignment would take **3.5 minutes** during both peaks, a **savings of 65%** over existing travel times.
- The following layered improvements are proposed for the JBR Alignment:
  a) Transit Signal Priority for BRT – saves a total of **0.5 to 1 minute** travel time along Jones Bridge Road
  b) WB Queue jump lanes at Wisconsin Ave. and Connecticut Ave. and an EB queue jump lane at Jones Mill Rd (500 to 1,000 feet in length depending on location) – save a total of about **2 minutes** travel time
  c) Shared operations in two travel lanes per direction, requiring the restriction of on-street parking, are proposed along Woodmont Avenue during the peak periods. On-street parking would be maintained off-peak.
- Total BRT Travel Time Savings for JBR Alignment with Improvements = **3 minutes (25% less than existing)**
- Considered grade separation at Connecticut Ave. for Jones Bridge Road traffic, but the travel time savings (1-2 minutes) were not sufficient enough to warrant the impacts and cost.
- Also considering a roundabout at Jones Mill Road. This may provide improved intersection operations, but is likely to result in direct property impacts.

- Considered dedicated lanes on Woodmont and JBR, but no appreciable travel time savings were gained since the mid-block roadway links operate well today – the intersections are where improvements are needed, as provided with the queue jump lanes. However, dedicated lanes can provide improved travel time reliability.

Property Impacts:

- Woodmont Avenue – Right of way and roadway widening **not required**.
- National Institutes of Health (NIH) – 50 ft. right of way widening in area front of the NIH library for provision of a transit station on the west side of Wisconsin Avenue. Total property required approximately 0.8 acres.
- Jones Bridge Road at Wisconsin Avenue (Westbound 900’ queue jump lane) – Impacts to property occupied by the **National Naval Medical Center** and the **Washington Metropolitan Area Transit Authority (WMATA)**. Impacts could range from **5 – 10 feet**.
- Jones Bridge Road at Connecticut Avenue (Westbound 750’ queue jump lane) – Impacts to **four (4)** residential properties. Impacts could range from **5 – 10 feet**.
- Jones Bridge Road at Jones Mill Road (Eastbound 500’ queue jump lane) – Impacts to **three (3)** residential properties. Impacts could range from **5 – 10 feet**.
- **Three (3)** additional property impacts could be required to connect the BRT alignment from Jones Bridge Road to the Master Plan alignment east of Jones Mill Road.

Community Concerns: During focus group and community meetings, the residents expressed the following concerns with the JBR alignment:

- Pedestrian Safety
- Impacts to North Chevy Chase Elementary School
- Traffic Impacts – capacity/operations issues
- Additional Noise
- Impacts to Historic Properties

1. INTRODUCTION /BACKGROUND

- The Bi-County Transitway Study includes Jones Bridge Road and Woodmont Avenue as an alignment alternative for Bus Rapid Transit (BRT). The alignment would run from the Bethesda Metro Station in downtown Bethesda using Woodmont Avenue up to the National Institutes of Health/National Naval Medical Center area to the north, where it would run along Jones Bridge Road across Connecticut Avenue (MD 185) to Jones Mill Road.

- At Jones Mill Road, the alignment would join up with the Master Plan alignment using the former Georgetown Branch right-of-way to cross Rock Creek Park and continue eastward toward Silver Spring and the areas to the east.

- Previous study work has determined that the Jones Bridge Road alignment would not be suitable for Light Rail Transit so only BRT is under consideration for this alignment.

- This paper highlights the principal technical issues and expressed community concerns identified thus far for the Jones Bridge Road alignment, including the most current traffic analysis findings.

- As the ability of BRT to operate within the traffic environment along the alignment is the most central technical issue with the Jones Bridge Road alignment, the analysis and findings has been conducted with the direct involvement of the **Maryland State Highway Administration**.

2. TRAFFIC CONDITIONS

The physical characteristics of the existing roadways are as follows:

Jones Bridge Road:

- One travel lane per direction between Jones Mill Road and Connecticut Avenue (MD 185) with additional turn lanes at intersections, and with on-street parking on the south side only between Jones Mill Road and Brierly Court

- Two travel lanes in each direction, between Connecticut Avenue (MD 185) and Wisconsin Avenue (MD 355), with additional turn lanes at intersections.

Woodmont Avenue:

- During peak periods, generally two travel lanes per direction between Wisconsin Avenue and Old Georgetown Road (MD 187). Along northbound Woodmont Avenue, parking is presently permitted between Old Georgetown Road (MD 187) and St. Elmo Avenue during the PM peak period. On-street parking is also permitted along portions of Woodmont Avenue during off-peak periods. Figure 1 includes additional detail on the parking restrictions along the corridor.

- South of Old Georgetown Road (MD 187), all four lanes are southbound on Woodmont Avenue.

Existing Traffic Conditions

Traffic Operations on Jones Bridge Road and Woodmont Avenue

- 13-hour turning movement traffic counts were conducted at the 7 signalized intersections on Jones Bridge Road and 8 signalized intersections on Woodmont Avenue.

- Level of Service analyses were conducted at each intersection for the AM and PM peak hours of operation. The results are summarized in Figure 1.

- The worst operations were identified along **Jones Bridge Road** at the intersections with Jones Mill Road, Connecticut Avenue (MD 185), and Wisconsin Avenue (MD 355). The intersections of Jones Bridge Road with Wisconsin Avenue (MD 355) and Connecticut Avenue (MD 185) are currently operating at **Level of Service F (failing conditions),** with 1 to 3 minutes of delay for traffic on Jones Bridge Road during both the AM and PM peak hours. The Jones Mill Road intersection operates at Level of Service E (approaching capacity).

- Observations along the corridor verify these findings; numerous vehicles were observed waiting in the queue for more than one cycle to pass through these intersections.

- The analysis results indicated that none of the intersections along **Woodmont Avenue** are currently operating over-capacity, with the use of the parking lane during the peaks.

Existing Corridor Travel Times

Travel time runs were conducted along the proposed BRT alignment during the AM and PM peak hours of operation. The results of these existing travel time runs are summarized in Table 1.

TABLE 1: Existing Corridor Travel Times

Direction of Travel	AM Peak			PM Peak		
	Travel Time	Total Stopped Time (%)*	Average Travel Speed	Travel Time	Total Stopped Time (%)*	Average Travel Speed
West to East: Rock Creek Park to Bethesda Metro (Distance: 2.7 miles)	10 min	5 min (50%)	16 mph	12 min	6 min (50%)	14 mph
East to West: Bethesda Metro to Rock Creek Park (Distance: 2.7 miles)	9 min	5 min (55%)	18 mph	12 min	7 min (55%)	14 mph
Proposed Georgetown Branch Alignment (Distance: 2 miles)	3.5 min (@ 35 mph)					

*The majority of this delay on the alignment occurs at Wisconsin Avenue (MD 355) and Connecticut Avenue (MD 185)

- Today, it takes **between 9 and 12 minutes** to travel one-way along the Jones Bridge Road / Woodmont Avenue alignment during the peak travel periods. This does not include any transit stops.

- This compares to a possible alignment along the Georgetown Branch of about 3.5 minutes one-way travel time; including an aerial crossing of Connecticut Avenue, but not including any possible transit stops.

Future Growth in the Corridor

- The traffic analyses and corridor travel times presented above are representative of existing (2006) conditions along the Jones Bridge Road and Woodmont Avenue corridors. For the Bi-County Transitway study, traffic will be projected to a horizon year of 2030 (when the forecasting models are available). While both corridors are relatively built-out, with minimal space available for new development, historical trends indicate that some traffic growth can be expected along these corridors (likely 1-2 percent annually).

- In addition, the Naval Medical Center, located on the north side of Jones Bridge Road, is expected to add approximately 1,000 jobs in the coming years as a result of the current BRAC. The addition of these jobs along the corridor should also result in additional traffic growth along the study alignments.

- This additional future traffic will exacerbate the poor operations at the intersections of Jones Bridge Road with Connecticut Avenue (MD 185) and Wisconsin Avenue (MD 355), further increasing the travel time along this alignment. While the proposed improvements do assume some growth in traffic, it may be necessary to lengthen the queue jump lanes once 2030 traffic projections are available.

3. TRANSIT SERVICE / OPERATIONS

There are a number of options available for providing attractive travel time savings for BRT service operating in mixed traffic, including:

- Providing transit signal priority (TSP):
    - Extending or shortening signal phases to favor approaching BRT vehicles. Signal timing returns to normal after 1-2 cycles to limit the impacts on cross-street traffic;

- Providing queue jump lanes at congested intersections (for BRT to jump ahead of stopped vehicles);
    - Providing a lane at congested intersections for approaching BRT vehicles to exit the traffic stream advance to the front of the queue. This improvement is often combined with transit signal priority.

- Dedicated lanes for transit-vehicles throughout a corridor; and

- Providing grade-separated crossings at congested intersections, such as Connecticut Avenue (MD 185).

<u>Implications of Shared-Lane Operations with No Additional Priority Treatments</u>

- Operating a BRT system in shared mixed-traffic lanes is a low-cost alternative which does not require expansion of the existing roadway network. However, when operating a BRT system on a shared lane, the BRT operations are constrained by the prevailing traffic conditions.

    - For Jones Bridge Road and Woodmont Avenue corridors, the current trip between Rock Creek Park and the Bethesda Metro station takes approximately 9 to 12 minutes in each direction. (Future travel times are likely to be worse as traffic continues to grow).

    - Approximately 50% of the travel time along this 3-mile corridor is due to stopped delay at the signalized intersections; particularly at Connecticut Avenue (MD 185) and Wisconsin Avenue (MD 355) . The “user-perceived” travel time along a corridor is often longer than the actual travel time when the vehicle is stopped for a significant portion of the trip.

- To attract transit ridership, the travel time and cost of using the transit system need to be competitive with the auto trip. Operating the BRT in shared traffic lanes between Rock Creek

Park and Bethesda (with no additional BRT priority treatments) would offer **no travel time advantage** to the transit user.

- For comparison purposes, operating a BRT system along the 2-mile Georgetown Branch alignment at 35 mph would result in a travel time of approximately 3.5 minutes (with no stops at stations) for the trip between Rock Creek Park and Bethesda Metro. This compares with the existing 9 to 12 minute trip (with no stops at stations) along Jones Bridge Road and Woodmont Avenue, with no improvements to the corridor.

4. OPTIONS TO IMPROVE BRT PERFORMANCE

- To improve the transit travel time along the Jones Bridge Road and Woodmont Avenue corridors, potential improvement options were considered. Preliminary analyses have been conducted for these options to provide an estimate of the transit travel time savings for each option. Two proposed improvement options along Jones Bridge Road are summarized below:

TABLE 2: BRT Improvement Options

Improvement	Pros / Cons	Cost	2006 Est. Transit Travel Time Improvement	Property Impacts
Transit Signal Priority (TSP) in shared-use lanes	P: Increased schedule adherence & reliability C: Increased delay (preliminary estimate of 5-10 seconds per vehicle) on major cross streets	Low – Existing systems range in cost from $8,000 to $35,000 per intersection (per FTA)	Minor – 5 to 10% Approximately 0.5 – 1 minutes	None
Transit Queue Jump Lanes at Intersections 1. JBR/MD 355 2. JBR/MD 185 3. JBR/Jones Mill Rd	P: Improved transit travel time on corridor C: Long queue jump lanes (500 to 1000 ft) required	Medium – requires some roadway widening and right-of-way acquisition at intersections	Medium – Approximately 2 minutes total	7 Residential Properties & 3 Publicly-owned properties (See attachments for specific impacts)

- The preliminary analyses indicate that the transit travel times could be improved by **3 minutes (around 25%)** with a combination of these transit priority improvements. These options would also provide reliability for the transit service along the corridor, which is something the existing bus service is unable to provide.

- Additionally, MTA considered providing grade separation for Jones Bridge Road through traffic at the intersection of Jones Bridge Road and Connecticut Avenue (MD 185). In addition to the significant impacts along Jones Bridge Road resulting from this improvement, this option was determined to **not be cost-effective**, as it would only provide travel savings between 1 and 2 minutes along the corridor.

- Along Woodmont Avenue, it is proposed that the BRT and auto traffic operate in two (2) shared travel lanes per direction during the AM and PM peak periods from Old Georgetown Road (MD 187) to the proposed station along the west side of Wisconsin Avenue (MD 355) at NIH.
  - This proposal would require the restriction of on-street parking currently permitted during the PM peak along northbound Woodmont Avenue between Old Georgetown Road (MD 187) and St. Elmo Avenue.
  - If necessary, one of these travel lanes could be dedicated for BRT vehicles during the AM and PM peak periods. Based on the existing 2006 traffic volumes, dedicating a lane for transit would result in Level of Service E at the traffic signal at Woodmont Avenue and Battery Lane for auto traffic. All other signals along Woodmont Avenue would still operate at Level of Service D or better under this configuration.
  - Off-peak, the on-street parking which is currently permitted would be maintained and the BRT and auto traffic would operate in shared lanes.

5. PROPERTY IMPACTS

- The improvements being considered along Woodmont Avenue and Jones Bridge Road to provide reduced travel times for the BRT will not require the taking of any homes and businesses. However easements and right of way will be required as noted below. The locations of the proposed property impacts are indicated on the drawings JB-1 through JB-6.
  - Woodmont Avenue – Right of way and roadway widening not required.
  - National Institute of Health – Will require a right of way take on the west side of Wisconsin Avenue between Woodmont Avenue and Jones Bridge Road, in front of NIH library building, approximately 0.8 acres (Right of way widening approximately 50 feet).
  - Jones Bridge Road, Westbound at Wisconsin Avenue
    - Will require roadway widening for a single BRT queue jump lane and temporary construction easements from adjacent property owners. This queue jump lane requires an 11 foot widening of the roadway and is 900’ in length.
    - Impacts to property occupied by **National Naval Medical Center** and property owned by the **Washington Metropolitan Area Transit Authority (WMATA)**. Impacts could range from 5 – 10 feet.
  - Jones Bridge Road, Westbound at Connecticut Avenue
    - Will require roadway widening for a single BRT queue jump lane and temporary construction easements from adjacent property owners. This queue jump lane requires an 11 foot widening of the roadway and is 750’ in length.

      - **Four (4)** residential properties impacted. Impacts could range from 5 – 10 feet.
  - Jones Bridge Road, Eastbound at Jones Mill Road
      - Will require roadway widening for a single BRT queue jump lane and temporary construction easements from adjacent property owners. This queue jump lane requires an 11 foot widening of the roadway and is 500' in length.
      - **Three (3)** residential properties impacted. Impacts could range from 5 – 10 feet.
      - **Three (3)** additional properties could be impacted in order to connect the Jones Bridge Road BRT alignment to the Master Plan alignment east of Jones Mill Road.

6. COMMUNITY CONCERNS

In addition to property takes, community residents are also concerned about:

  - Pedestrian safety
  - North Chevy Chase Elementary School
  - Traffic impacts
  - Noise
  - Impacts to historic properties

- Pedestrian safety, particularly for school children, has been a continual theme at community meetings.

- Traffic congestion on Jones Bridge Road can be substantial, an increasing numbers of drivers seek alternate routes to East West highway and the Capital Beltway. The intersection of Jones Bridge Road and Connecticut Avenue is repeatedly mentioned as a problem for the community. Residents are concerned about access from some of the smaller side streets onto Jones Bridge Road. Other issues are the number of school buses which use Jones Bridge Road, the capacity for service vehicles, and the impact of job relocations to NIH and NNMC under BRAC.

- Noise is another community concern. Some residents are already unhappy with the noise levels generated by the existing traffic and are concerned about the additional noise generated by the BRT.

- Community members are also apprehensive about possible adverse impacts to the Montgomery County Historic District of Hawkins Lane, just east of the NNMC.

16. University Boulevard LRT Trackway Alignment

Memorandum

Parsons Brinckerhoff
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1600 J. F. Kennedy Boulevard
Philadelphia, Pennsylvania 19103-2815
215 209 1207
Fax: 215 561 9525

TO: **Greg Benz**

FROM: **Jack W. Boorse**

DATE: **September 11, 2007**

SUBJECT: **Purple Line – University Boulevard LRT Trackway Alignment**

This is in response to the request for an evaluation of potential traffic impacts that would result from the installation of an LRT trackway on two alternative alignments along University Boulevard (and a short segment of Campus Drive) between Piney Branch Road and President's Drive. This evaluation has been completed and the findings are presented in this memorandum. They include (1) identifying locations where there would be conflicts with LRT movements and determining appropriate measures to address those conflicts and (2) research of industry practice throughout the United States for traffic control on comparable roadside LRT alignments.

BACKGROUND

Among the options under consideration for a segment of the Purple Line east of Silver Spring is a double-track LRT line that would follow University Boulevard and Campus Drive between Piney Branch Road and President's Drive. Two alternative trackway alignments are being considered, one along the north side and the other in a widened median of the two roads

Median alignments are relatively common on LRT systems, including those that have been redeveloped from older trolley lines. There are variations of station configurations and policies regarding median openings but, in general, this is a proven design concept.

A double-track, side-of-road alignment is less common. There are some inherent drawbacks to this configuration, which are discussed in this memorandum. Nevertheless, it is not unprecedented and the examples in the US have been identified.

EVALUATION OF PROPOSED ALIGNMENTS

Conceptual plans of the two alignment alternatives were examined on a site-specific basis. Each potential interface with vehicle movements has been identified and a recommended method of regulating the conflict has been determined. Critical interfaces with pedestrian movements were also identified.

The detailed findings are presented in Appendix A of this memorandum. All intersections of public streets are listed (in geographic order from west to east) regardless whether they would be impacted by the project, or not. For those intersections at which there would be an impact a recommended method of addressing that impact is presented. In certain cases a second method is suggested as an option. At intersections where the vehicle movements generated by the cross street would not intercept LRT movements (and consequently no change of traffic control would be needed) that condition is noted.

Not all driveway intersections are listed. They are included and discussed only in cases where there would be a project related impact.

At certain locations pedestrian movements, other than those on signalized intersection crosswalks, would be generated by the project. These locations are included on the lists in their geographic juxtaposition.

RESEARCH OF INDUSTRY PRACTICE

The entire trackway alignments of 20 LRT systems in the US were reviewed and any segments of these systems that are comparable to the Purple Line ***Side Alignment Alternative*** were identified. Segments considered comparable were those where a reserved trackway, comprising two tracks, directly abuts a parallel street or highway. Single-track contraflow or concurrent flow reserved lanes were not deemed comparable or contributory to the evaluation. Segments satisfying these criteria were found on ten of the 20 systems. Each such segment is described in Appendix B of this memorandum.

On these ten systems the nearly universal practice is to provide positive time-separation of rail movements on this type of alignment from conflicting vehicular movements by means of traffic signals. The one exception is a unsignalized intersection in Boston where a low-speed segment of the trackway crosses a low-volume local street. At some locations the signalization is enhanced with special passive or active signing. Along one highway in Minneapolis, at intersections where train speeds are relatively high, the traffic signal control is supplemented (not supplanted) by automatic gates.

SUMMARY AND RECOMMENDATIONS

Adoption of the ***Side Alignment Alternative*** would require approximately 56 roadway and/or traffic modifications. The nature of these actions ranges from relatively minor signal timing changes to major alterations such as complete closure and physical removal of street segments or driveways.

Some of these closures could lead to a need to acquire large and expensive properties with severe economic and community impacts. One or more of these major impacts could prove to be a “fatal flaw” in this alternative.

On the other hand, keeping some of the minor streets and driveways open to avoid such impacts could present a traffic control dilemma. In theory, both signalization and stop-sign control are options. In practice neither may be a good choice.

Stop-sign control is essentially incompatible with this trackway alignment for two reasons. Motorists approaching from the side street or driveway and executing the requisite stop upstream from the trackway may not have adequate visibility of oncoming traffic on the major street. However, if they stop closer to the intersection and are delayed by traffic flow on the major street they would be in the trajectory of any oncoming LRT train. There is also a potential hazard with turning movements from the major street into the cross street or driveway. These motorists would not have a good view of trains traveling in the same direction and approaching the point of conflict from behind them. Given these realities, from a rail transit safety and operations perspective, stop-sign control is inadequate and signalization is essentially mandatory.

However, from a highway operation perspective the installation of closely spaced and possibly unwarranted signalization is undesirable, especially if they are programmed to include additional phases to serve the transit movements. The agencies having jurisdiction over the roadway simply may not permit it at some locations. Furthermore, signalization entails significant capital and operating costs.

Selection of the ***Median Alignment Alternative*** would require only about 25 intersection modifications, ranging from relatively minor signal timing changes to reconfiguration of roadway geometry. It would have relative modest impacts on property access and, at most locations, no negative impact on traffic capacity.

This alternative would involve a general widening of the host roadways which might require the acquisition of slivers of land, but such would not lead to any denial of access or major property takes. Moreover, the widening of the median could provide a corollary benefit in that it would likely make it feasible to accommodate “U” turns concurrent with left turns at selected signalized intersections. The opportunity for motorists to reverse direction legally and safely might make it more acceptable to eliminate median openings (and the need for signalization) at some of the minor intersections. This is discussed further in Appendix A.

Given all of the above, the evaluation of the two alternatives weighs heavily in favor of the ***Median Alignment Alternative***. Nevertheless, regardless of which alternative might be selected, all vehicular movements that cross the trackway at grade should be controlled by traffic signals. At any locations where there is a practical or legal reason why signalization cannot be installed to temporally separate the conflicting vehicular movement(s) the street or driveway carrying those movements would have to be eliminated.

If any clarification of the foregoing or further information is needed please let me know.

C: Monica Meade
Joe Romanowski
Jeff Kuttesch

UNIV BLVD 70911d

APPENDIX A
Site-specific discussion of impacts

Side Alignment Alternative

Intersection/Location	**Findings**
Piney Branch Road	LRT movements in both directions would conflict with all left-turn movements and all but one through movement. The current signal phasing would not provide the necessary time separation. An additional exclusive signal phase for LRT movements would be required.
2 driveways (unsignalized)	The two driveways on the westbound side southeast of Piney Branch Road would have to be closed. Access to the parking area served by these driveways would still be available via an existing driveway on Piney Branch Road.
Gilbert Street	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.
Driveway (unsignalized)	The driveway on the westbound side University Boulevard between Gilbert Street and Seek Lane and the associated parking lot would have to be closed.
Seek Lane	Eastbound left-turn, westbound right-turn and all southbound movements from the driveway leg would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to time-separate the westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
Bayfield Street	The location of the trackway would not require revision of traffic control at the public street intersection since there would be no conflicts between vehicular and LRT movements, but there are other factors that need to be considered. The station, as currently proposed, would be constructed on the right-of-way of an existing frontage road that provides access to adjacent apartments. That would require closing this road and the driveways connecting it with the westbound lanes of University Boulevard. Although such closure would cause impacts on property access, it would eliminate vehicular movements across the trackway and, at first view, would seem to preclude the need for traffic control. However, a passenger station at this location would generate significant pedestrian traffic across University Boulevard and across the

trackway. This could require the installation of mid-block signal control.

Forston Street — The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.

Carroll Avenue — The southbound right-turn movement would have to be signalized. A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

Navaho Drive — Southbound movements and westbound right-turn movements would conflict with LRT movements Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

Merrimac Drive — Eastbound left-turn, westbound right-turn and all southbound movements (from the north leg) would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements from LRT movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

Angle parking zone — There are 45 parking stalls oriented at 90^{o} to the curb along the westbound side of University Boulevard, between Merrimac Drive and Lebanon Street. It would be necessary to eliminate all of this parking.

Lebanon Street — Eastbound left-turn, westbound right-turn and all southbound movements (from Lebanon Street) would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. A protected-only phase for the eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

Anne Street — The project would not require revision of traffic control since there would be no conflicts between vehicular and LRT movements. However, it probably would be necessary to eliminate the unsignalized crosswalk a short distance east of this intersection.

Driveway (unsignalized)	The first driveway on the westbound side east of Lebanon Street would have to be closed. This would not deny access since the next driveway to the east serves the same parking area and it is signalized
Driveway (signalized)	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction. This signalization could be devised to provide safe passenger access to the station from the south side of University Boulevard.
New Hampshire Avenue	The northwest corner would need to be reconfigured to eliminate the separate right-turn lane. Southbound right turns would have to be executed within the intersection so that the signalization would time-separate them from the LRT movements. The current protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
2 driveways	The two driveways on the westbound side between New Hampshire Avenue and Edwards Place, the eastern of which is signalized, and the median opening associated with the signalized driveway would have to be closed. Alternative access to the property they serve would be available via Edwards Place and also via an existing signalized driveway on New Hampshire Avenue.
Edwards Place	Westbound right-turn movements and all southbound movements would conflict with LRT movements Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
14th Avenue	Eastbound left-turn, westbound right-turn and all southbound movements (from 14th Avenue) would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. A protected-only phase for the eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

2 driveways (unsignalized)	At present, there are two driveways on the westbound side of University Boulevard between 14th Avenue and 15th Avenue, each of which serves a 20-space residential parking lot. They are connected to the street network via a frontage road. The proposed trackway alignment would supplant the frontage road, requiring the closure of these driveways and the associated parking lots. Replacement of the lost parking spaces would, at best, entail a radical reconfiguration of parking facilities at the affected apartment complex. At worst, it could require acquiring the properties served by these driveways.
15th Avenue	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
Driveway (unsignalized)	The first driveway on the westbound side east of 15th Avenue would have to be closed. Access to the parking area served by this driveway would still be available via an existing driveway on 15th Avenue.
Driveway (unsignalized)	The second driveway east of 15th Avenue would have to be closed. Unless arrangements could be made for internal access via either of the adjacent private properties, this closure would likely entail taking this property.
Driveway (unsignalized)	The third driveway east of 15th Avenue would have to be closed. Access to the parking area served by this driveway would still be available via existing driveways on Riggs Road.
Riggs Road	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
16 driveways (unsignalized)	All of the driveways on the westbound side between Riggs Road and Phelps Road would have to be closed. These driveways serve 11 different properties. The property at the west end has a second driveway on Riggs Road and the property at the east end has a second driveway on Phelps Road. Closure of the driveways on University Boulevard would not totally deny access to these two properties. However, access to the other nine properties is entirely dependent upon the driveways that would be closed. Those closures would probably require the taking of these nine properties.

Guilford Road	The project would not require revision of traffic control since there would be no conflicts between vehicular and LRT movements.
Phelps Road	Southbound and westbound right-turn movements would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
Driveway (unsignalized)	The first driveway on the westbound side west of 23rd Avenue would have to be closed. Access to the parking area served by this driveway would still be available via an existing driveway that forms the north leg of the 23rd Avenue intersection.
23rd Avenue	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
2 driveways (unsignalized)	The pair of driveways on the westbound side east of 23rd Avenue appear to be unidirectional (in and out) geared to serve a take-out window. This situation would not seem to lend itself to preserving access by means of the signalized driveway belonging to the adjacent property to the west, even if that property owner were agreeable to such an arrangement. These driveways would have to be closed, probably entailing the taking of this property.
24th Avenue (south leg)	The project would not require revision of traffic control of the public street intersection since there would be no conflicts between vehicular and LRT movements. However, eastbound left-turn movements into the driveway on the north side of this intersection would conflict with LRT movements and it would be necessary to prohibit that turn movement and to modify the median island accordingly.
2 driveways (unsignalized)	The two driveways on the westbound side between the south and north legs of 24th Avenue would have to be closed. Access to the parking area served by these driveways would still be available via an existing driveway on the north leg of the 24th Avenue.
24th Avenue (north leg)	Westbound right-turn movements and all southbound movements would conflict with LRT movements Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic

whenever a train approaches in either direction.

Driveway (unsignalized)	The driveway on the westbound side east of the north leg of 24th Avenue would have to be closed. Access to the parking area served by this driveway would still be available via four other existing driveways located on the north leg of the 24th Avenue, West Park Drive and Judson Street.
25th Avenue	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.
West Park Drive	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.
Driveway (unsignalized)	The driveway on the westbound side 800 feet east of West Park Drive and the 18-car parking lot that it serves would have to be closed. Also, the median would need to be reconfigured to eliminate the eastbound left-turn lane. Vehicle access to the park land would still be available via the driveway on the south side. Pedestrian access to the archery range could be retained if it is feasible to develop a walkway between the range and the south side parking area along the east bank of Northwest Branch Stream beneath the University Boulevard bridge.
Driveway (unsignalized)	The driveway intersection on the eastbound side 800 feet east of Park Drive could remain open since none of the vehicle turning movements generated by this driveway would intercept the trackway.
Temple Street	Eastbound left-turn, westbound right-turn and all southbound movements would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction. Alternatively, traffic might be routed to/from the Tulane Drive intersection via the existing frontage road on the north side of University Boulevard. That would allow the closure of this intersection thereby avoiding all conflicts with LRT movements and any need for signalization.
Tulane Drive	Westbound right-turn and southbound movements would conflict with LRT movements. Signalization would be required to provide the necessary temporal separations. A protected-only phase for eastbound left-turns (not currently permitted) would provide adequate time separation of those movements. Another phase would be needed to separate westbound right-turn movements from LRT movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic

whenever a train approaches in either direction. This signalization could also accommodate those pedestrians crossing University Boulevard who might find it difficult to do so at Campus Drive. If Temple Street traffic were to be routed through this intersection, as described above, the median would need to be reconfigured to redirect the eastbound left-turn movements from Temple Street to Tulane Drive.

Campus Drive — LRT movements in both directions could be executed concurrently with the existing phase serving the westbound through movements on University Boulevard. An exclusive signal phase for LRT movements would not be required. However, the roadway would need to be reconfigured to substitute a pair of left-turn lanes for the existing through lanes leading to eastbound University Boulevard.

Adelphi Road — The current signal phasing would not provide temporal separation of LRT movements and conflicting vehicular movements. A protected-only phase for eastbound left-turns would be needed to provide adequate separation. Another phase would be needed to separate westbound right-turn movements. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

2 driveways (unsignalized) — The driveways on the north side of Campus Drive 200 and 400 feet east of Adelphi Road would have to be closed. Circuitous access could still be available via the internal roadway network, which connects with President Street north of Campus Drive and with the eastbound lanes of University Boulevard.

President Street — Eastbound left-turn, westbound right-turn and all southbound movements would conflict with LRT movements Signalization would be required to provide the necessary temporal separations. If no exclusive westbound right-turn lane or pocket is provided it would be necessary to stop all westbound traffic whenever a train approaches in either direction.

APPENDIX A
Site-specific discussion of impacts
(Continued)

Median Alignment Alternative

Intersection/Location	Findings
Piney Branch Road	LRT movements in both directions could be executed concurrently with the existing protected-only phase serving the left-turn movements from University Boulevard. An exclusive signal phase for LRT movements would not be required.
Gilbert Street	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.
Seek Lane	If the existing median opening and left-turn movements from University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection and to provide a protected-only phase for those left turns, but an exclusive signal phase for LRT movements would not be required.
Bayfield Street	The proposed closure of the median opening would eliminate westbound left-turn movements. The right-turn movements in and out of Bayfield Street would not conflict with LRT movements and would not be affected by the project.
Forston Street	The proposed passenger station would generate significant pedestrian movement across University Boulevard, which would require signal control. The signalization at Carroll Avenue should be expanded to also control Forston Street and a marked crosswalk that would connect the southeast corner of this intersection with the east end of the station.
Carroll Avenue	A protected-only phase for eastbound left-turns would provide adequate time separation of those movements from the LRT movements. This phase could also accommodate pedestrian movements between the northwest corner and the east end of the station. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow eastbound U-turn movements on University Boulevard concurrently with the left-turn movements.
Navaho Drive	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.
Merrimac Drive	If the existing median opening and left-turn movements from University

	Boulevard are to be retained as proposed, it would be necessary to signalize this intersection and provide a protected-only phase for those left turns, but an exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
Lebanon Street	If the existing median opening and the eastbound left turn are to be retained as proposed, it would be necessary to signalize this intersection. A protected-only phase for eastbound left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Alternatively, if the median were to be closed signalization would not be needed. Eastbound traffic could access Lebanon Street via a left turn onto New Hampshire Avenue and a second left turn onto Lebanon Street.
Anne Street	The project would not require revision of traffic control since there would be no conflicts between vehicular and LRT movements. However, it would probably be necessary to eliminate the unsignalized crosswalk a short distance east of this intersection.
2 driveways (signalized)	As currently proposed, left-turn movements into and out of the driveways on both sides of University Boulevard about 400 feet west of New Hampshire Avenue would be blocked by the station structure. Signalized, mid-block crosswalks would be needed to provide safe passenger access to the station. Alternatively, if the station were positioned about 80 feet eastward it would allow the median opening to be retained for cross traffic and left-turn movements onto – but not off of – University Boulevard. This would require signalization that could also accommodate pedestrian movements to and from the station via a crosswalk at the east end of the platform.
New Hampshire Avenue	A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
2 driveways (signalized)	The proposed closure of the median opening serving driveways on both sides of University Boulevard about 400 feet east of New Hampshire Avenue would eliminate all left-turn movements. The right-turn movements into and out of these driveways would not conflict with LRT movements and would not be affected by the project. (Also see Note 1)
Edwards Place	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.

14th Avenue	If the existing median opening and left-turn movements from University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection. A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. (Also see Note 1)
Driveway (unsignalized)	If the existing median opening and westbound left-turn movements into the driveway on the south side of University Boulevard about 600 feet east of 14th Avenue are to be retained as proposed, it would be necessary to signalize this intersection. A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. (Also see Note 1)
15th Avenue	A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
Riggs Road	A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
Driveway (unsignalized)	If the existing median opening and westbound left-turn movements into the driveway on the south side of University Boulevard about 500 feet east of Riggs Road are to be retained as proposed, it would be necessary to signalize this intersection. A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. (Also see Note 1)
Guilford Road	If the existing median opening and left-turn movements from University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection. An exclusive signal phase for LRT movements would not be required. (Also see Note 1)
Phelps Road	The project would not require revision of traffic control at this intersection since it does not propose to create a median opening and the current southbound and westbound right-turn movements would not conflict with LRT

movements.

23rd Avenue	A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
24th Avenue (south leg)	If the existing median opening and left-turn movements from University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection. A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements and an exclusive signal phase for LRT movements would not be required. Alternatively, if the median opening were eliminated westbound traffic on University Boulevard could reach this leg of 24th Avenue via a left turn at 23rd Avenue and a second left turn on Lewisdale Drive. (Also see Note 1)
24th Avenue (north leg)	The project would not require revision of traffic control at this intersection since southbound and westbound right-turn movements would not conflict with LRT movements.
Driveway (unsignalized)	If the existing median opening and eastbound left-turn movements into the driveway 250 feet west of 25th Avenue are to be retained, it would be necessary to signalize this intersection. A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements and an exclusive signal phase for LRT movements would not be required. (Also see Note 1)
25th Avenue	The project would not require revision of traffic control at this intersection since there would be no conflicts between vehicular and LRT movements.
West Park Drive	A protected-only phase for left-turns from University Boulevard would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
2 driveways (unsignalized)	If the existing median opening and left-turn movements from University Boulevard into these driveways are to be retained as proposed, it would be necessary to signalize this intersection. An exclusive signal phase for LRT movements would not be required. Alternatively, if the median opening were eliminated signalization would not be required. The parking areas on both sides of University Boulevard would still be accessible, but only via right-turn

movements. These movements would not conflict with the LRT movements. (Also see Note 1)

Temple Street	If the existing median opening and left-turn movements from eastbound University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection. An exclusive signal phase for LRT movements would not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements. Alternatively, traffic might be routed to/from the Tulane Drive intersection via the existing frontage road on the north side of University Boulevard. That would allow the closure of this intersection and thereby avoid all conflicts with LRT movements and any need for signalization.
Tulane Drive	If the existing median opening and left-turn movements from westbound University Boulevard are to be retained as proposed, it would be necessary to signalize this intersection. An exclusive signal phase for LRT movements would not be required. This signalization could also accommodate those pedestrians crossing University Boulevard who might find it difficult to do so at Campus Drive. If Temple Street traffic were to be routed through this intersection, as described above, the median would need to be reconfigured to redirect the eastbound left-turn movements from Temple Street to Tulane Drive. In that case the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements.
Campus Drive	The existing signalization includes a phase that would accommodate LRT movements in both directions. An exclusive signal phase for LRT movements would not be required.
Adelphi Road	A protected-only phase for left-turns from Campus Drive, in lieu of the current split phasing, would provide adequate time separation of those movements from the LRT movements. An exclusive signal phase for LRT movements would then not be required. Also, the proposed widening of the median would probably make it feasible to allow U-turn movements on University Boulevard concurrently with the left-turn movements. Safe pedestrian access to the station at its currently proposed location would probably require the installation of a signalized, non-intersection crosswalk. However, if the station and the associated segment of tangent trackage were re-positioned about 90 feet westward the intersection signalization could be designed to include control of a crosswalk to provide access to the west end of the platform.
President Street	If all of the existing movements at this intersection are to be retained as proposed, it would be necessary to signalize it. A protected-only phase for eastbound left-turns from Campus Drive would provide adequate time separation of those movements from the LRT movements. An exclusive

signal phase for LRT movements would not be required.

Note 1:

At locations where an opening in the median would be closed a major impact would be the loss of any ability to execute left turns either from or onto University Boulevard. However, if there were nearby U-turn opportunities a relatively convenient alternative routing would be available for those movements. Motorists currently turning left from University Boulevard at a particular street or driveway would instead continue to the next signalized intersection and execute a “U” turn, which would then allow them to return to that street or driveway where they would turn right and continue to their destination. Those now turning left onto University Boulevard would instead turn right, proceed to the next signalized intersection and execute a “U” turn, after which they would be traveling in the desired direction on University Boulevard.

Consequently, should it prove feasible to operate U-turn movements on University Boulevard at certain intersections it would lessen an impact of some of the proposed median closures. It might also allow additional median openings at private driveways and lower volume intersections to be eliminated, thereby avoiding the need for signalization.

The intersections on University Boulevard at which signal-controlled U-turn movements would be keyed to these median closures are:

New Hampshire Avenue
15th Avenue
Riggs Road
23rd Avenue
Park Drive
Tulane Drive (not currently signalized)

Median openings might be eliminated at:

The two driveways 400 feet east of New Hampshire Avenue (currently signalized)
14th Avenue
The driveway 600 feet east of 14th Avenue
The driveway 500 feet east of Riggs Road
Guilford Road
24th Avenue (south leg)
The driveway 250 feet west of 25th Avenue
The two driveways 800 feet east of Park Drive

APPENDIX B
Current Industry Practice

Listing of Side Alignment LRT Trackways in the United States

BOSTON

Commonwealth Avenue

A 4-lane east/west roadway with the trackway along the north side. The street is two-way and no on-street parking is permitted. All vehicular crossings of the trackway are at public street intersections and all but one are signalized.

HOUSTON

Fannin Street

A 4-lane north/south street with the trackway along the west side. The street is two-way and no on-street parking is permitted. All roadway crossings of the trackway are signalized. The signals are phased to time-separate vehicle and pedestrian movements from conflicting rail car movements.

JERSEY CITY

Hudson Street

A 2-lane north/south street with the trackway along the east side. The street is one-way southbound and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of public streets. The signals are phased to time separate vehicle and pedestrian movements from conflicting rail car movements.

MINNEAPOLIS

Hiawatha Avenue (Minnesota Route 55)

A 4-lane north/south highway with the trackway along the west side. The highway is two-way and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of public streets. The signals are phased to time-separate vehicle and pedestrian movements from conflicting train movements and are supplemented with automatic gates.

Minnehaha Avenue

A 2-lane north/south street with the trackway along the west side. The street is two-way and no on-street parking is permitted. The only roadway crossing of the trackway is at a signalized street intersection. The signals are phased to time separate vehicle and pedestrian movements from conflicting train movements.

NEWARK

Mc Carter Highway (New Jersey Route 21)

A 4-lane north/south highway with the trackway along the west side. The highway two-way and no on-street parking is permitted. All roadway crossings of the trackway, except one, are at signalized intersections of public streets. The exception is a service driveway at the New Jersey Performing Arts Center that crosses the trackway, but connects with only the southbound lanes of the highway. The trackway crossing is signalized while the driveway interface with the highway is controlled by passive signing. At all trackway interfaces the signals are phased to time separate vehicle and pedestrian movements from conflicting rail car movements.

***PHILADELPHIA* (Metropolitan Area)**

Island Avenue

A 4-lane north/south street with the trackway along the west side. The street is two-way and no on-street parking is permitted. All roadway crossings of the trackway are signalized. The signals are phased to time-separate vehicle and pedestrian movements from conflicting rail car movements.

Garrett Road

A suburban 4-lane street oriented on a northeast-southwest bearing with the trackway along the northwest side. The street is two-way and no on-street parking is permitted. All roadway crossings of the trackway are signalized. The signals are phased to time-separate vehicle and pedestrian movements from conflicting rail car movements.

PORTLAND

NE Holladay Street

A 2-lane east/west street with the trackway along the north side. The street is one-way eastbound and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of driveways or public streets. The signals are phased to time separate vehicle and pedestrian movements from conflicting train movements.

SACRAMENTO

Arden Way

A 4-lane east/west street with the trackway along the south side. The street is two-way and on-street parking is permitted on the north side. All roadway crossings of the trackway are signalized. The signals are phased to time-separate vehicle and pedestrian movements from conflicting rail car movements.

SALT LAKE CITY

Wasatch Drive

A 4-lane north/south street with the trackway along the west side. The street is two-way and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of driveways or public streets. The signals are phased to time separate vehicle and pedestrian movements from conflicting train movements.

***SAN JOSE* (Metropolitan Area)**

North Mathilda Avenue

A 6-lane north/south suburban highway with the trackway along the west side. The street is two-way and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of public streets. The signals are phased to time separate vehicle and pedestrian movements from conflicting train movements.

West Moffett Park Drive

A 4-lane east/west suburban street with the trackway along the north side. The street is two-way and no on-street parking is permitted. All crossings of the trackway are at signalized intersections of public streets. The signals are phased to time-separate vehicle and pedestrian movements from conflicting rail car movements.

SUMMARY

Of the twenty US light rail systems currently operating in the United States, ten have trackway segments that are comparable to the *Side Alignment Alternative* under consideration for University Boulevard. Three of the ten systems have two such segments and the other seven have only one. The majority of those segments are less than 1,000 yards in length with only a few roadway interfaces.

Along the 13 segments identified there was only one intersection on one street that was not signalized. This is Readsdale Street in Boston, which is a lightly trafficked local street situated on a low-speed segment of trackway. Of Boston's five LRT lines, three (including the Commonwealth Avenue Line) emerged from a more extensive streetcar network in which motorists became accustomed to the presence of rail cars in a roadway environment. The stop-sign control at this intersection should be considered atypical of the current industry practice.

Thus, it can be said that on US light rail systems it is essentially universal practice to provide positive temporal separation of conflicting vehicular and LRT movements on side alignment trackways by means of traffic signals.

17. Stadium Drive Alternative Alignment

Technical Memorandum

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TO: **Greg Benz**

FROM: **Jack W. Boorse**

DATE: **December 7th, 2007**

SUBJECT: **Purple Line – Stadium Drive Alternative Alignment**

This is in response to the request for an evaluation, from a traffic and rail operations perspective, of the feasibility of routing the Purple Line trackage through the western and central part of the University of Maryland campus via Stadium Drive in lieu of Campus Drive. This evaluation has now been completed and the findings are presented herewith.

<u>Background</u>

Under the subject alternative the trackage on University Boulevard (MD 193) would extend northeastward beyond the Campus Drive junction to the intersection of Stadium Drive where it would curve southeastward into the campus. From there the trackway would follow Stadium Drive to its intersection with either Paint Branch Drive or Regents Drive. One of these two streets would host the trackway between Stadium Drive and Campus Drive. From there the alignment would depend upon which connector street is used as well as other factors yet to be decided.

<u>Evaluation</u>

The evaluation was limited to matters related to rail and traffic operations with an end purpose of determining if this alignment might be reasonably feasible. Station locations have not been designated and their impact is not included in the evaluation.

In this memorandum the segment common to both alternatives is addressed first, followed by a separate discussion of each of the two sub-alternatives.

COMMON SEGMENT

<u>University Boulevard</u>

From a traffic engineering perspective it would be feasible to locate the trackway at grade in the median of University Boulevard at its intersections with Campus Drive and Adelphi Road. Both of these intersections are signalized and the trains could move through each of them on the regular phase serving the through traffic on University Boulevard. No additional signal phases would be required.

However, any signal priority that might be given to the train movements at either of these intersections would be limited to what could be achieved by advancing or extending the phase serving those movements by a few seconds within the cycle when such a time shift would avoid delaying a train approaching just before the beginning or near the end of that phase. Trains arriving at other times would experience some signal delay. Also, whenever a shift of the common phase serving the train and through traffic movements would occur there would be some shortening of one or more other phases in the cycle.

If, for civil engineering reasons, the trackway were to be constructed below grade through these two intersections such grade separation obviously would eliminate any signal delay of the trains. It would also avoid any impact on non-parallel traffic movements that might result from the phase shifting mentioned above.

With either vertical configuration the tracks would be installed in the median between the Adelphi Road and Stadium Drive intersections. An alternative alignment along the southeast side of University Boulevard was examined and found to have considerably greater potential traffic impacts than the median alignment. Matters relating to that alignment will be discussed in a separate memorandum.

<u>University Boulevard – Stadium Drive Intersection</u>

At this intersection the eastbound train movement (a right-turn from the median across the eastbound through lanes) would require a separate signal phase, which could also service the westbound train movements. That phase would be callable by approaching trains in either direction and could be shared with all westbound Stadium Drive movements.

The westbound train movements could also operate during the phase serving Stadium Drive but they would conflict with the (very low volume) through movements from the Golf Course Access Road approach. This might be addressed by excluding the Golf Course Access Road approach from the Stadium Drive phase whenever a westbound train would be detected.

Given that the phase(s) serving the train movements would also serve major movements of general traffic, it is not anticipated that this re-programming of the signal cycle would have a significant impact on traffic operations.

<u>Stadium Drive</u>

In the segment between University Boulevard and the circle at Valley Drive there are two travel lanes in each direction. The trains would utilize the inside lanes throughout the segment. The westbound trains would enter the exclusive left-turn lane as they approach the University Boulevard intersection. All of these lanes would remain open to general traffic.

An alternative that could be considered is a modification of the median on the approach to University Boulevard to host a single-track reserved lane that would allow westbound trains to bypass any vehicle queue that might form in the exclusive left-turn lane. The current width of the median is insufficient to accommodate the entire width of such a trackway. It would have to be widened by a few feet. However, the adjacent eastbound lanes appear to have very generous widths and by narrowing them to a standard width it may be possible to free up enough street width to accommodate the widened median without relocating either curb.

There are other potential configurations that could position the eastbound or both tracks in a reserved median. These options would require physical reconfiguration of the street. Also, they would generate a conflict between train and vehicle movements in the eastbound direction that would not occur with the shared lane configuration.

If the traffic circle is retained the trackage could be fitted into the existing lanes for shared use. There would be transitional movements by the eastbound trains across circle traffic in the northeast quadrant as they diverge from the circle. These conflicting maneuvers could probably be managed by variable message signing that would be activated by those trains and signalization would not be necessary.

Comment on the option of replacing the circle with a “Y” intersection and how the trackage and train operation might be fitted into such will have to await information regarding the geometry of the intersection.

The segment east of the circle comprises only two travel lanes. With the exception of three marked spaces on the eastbound side in a widened section of the roadway just west of Byrd Stadium and a short frontage road opposite the north face of the stadium, there are no provisions for curb parking or loading in this segment. Train movements would be blocked by any vehicle (illegally) stopped at the curb. Also, within this segment there are intersections at which left turns from Stadium Drive are legal. Rail movements could be impeded when motorists preparing to execute a left turn at any of these intersections would pause in the travel lane (i.e. on the track) while yielding to opposite-direction traffic. These potential impediments are not viewed as fatal flaws, but they are conditions that would diminish the quality of the rail service.

There is another condition that, although it occurs only sporadically, could cause total blockage of train movements in both directions for significant periods of time. The segment of Stadium Drive east of Valley Drive skirts the north face of Byrd Stadium along which a number of gates are located. Immediately before and after games the presence of these gates generates crowds that occupy the entire width of the roadway making it virtually impassible for vehicular traffic. While this traffic can (and does) detour to other streets during these blockages, rail movements obviously could not. The reliable level of service that the Purple Line would be required to provide could not be achieved unless this operational impediment can be mitigated.

Measures to address this condition that were given consideration included (1) Assigning police vehicles to escort each train through the crowds, (2) Strictly confining pedestrian activity to the south sidewalk with enforcement by campus police personnel, and (3) Closing all gates on the north face for use as entrances at any time and as exits except during an emergency evacuation. The achievability of any of these measures is not considered likely and none of them should be relied upon to deal with this potential impediment.

A concept that is promising would be to accept the reality that crowds will form in the roadway during most events at Byrd Stadium and treat this congregation in the roadway as a physical condition that needs to be bypassed. This would involve constructing an exclusive trackway along an alignment generally parallel to and some distance north of the Stadium Drive roadway in this area.

The west end of this trackway would connect with the trackage in Stadium Drive at the intersection near the southwest corner of the dormitory complex and then follow a course as close as practicable to the south building in that complex, leaving a large area on the north side of the stadium (and a segment of Stadium Drive) available for the crowds. The east end of this exclusive trackway would connect with trackage in the traffic lanes of Stadium Drive at a point near the northeast corner of the stadium. The conflicting train and vehicular movements at each end of the exclusive trackway should be time-separated by signalization.

The land on which this trackway would be constructed is free of any buildings but there is a complex of paved walkways that would have to be reconfigured. One or two of the walkways would necessarily have to cross the trackway and some type of active pedestrian control devices would be needed.

PAINT BRANCH DRIVE SUB-ALTERNATIVE

Stadium Drive – Paint Branch Drive Intersection

The right-turn movement by eastbound trains at this intersection would be concurrent with general traffic and would not create any new conflicts. The curb on the southwest corner might have to be reconfigured to accommodate the minimum turn radius of the rail cars. The intersection should be signalized to address vehicle conflicts with westbound train movements and pedestrian interfaces with train movements in both directions.

Paint Branch Drive

Reportedly, the segment between Stadium Drive and Campus Drive experiences lengthy vehicle queues during peak periods. This condition would cause serious delay to the rail operation if the trains traveled in the vehicle traffic lanes. To address this it would be necessary to create an exclusive median trackway that would allow the trains to bypass these queues. By relocating the west curb and southbound lane approximately 25 feet westward sufficient right-of-way could be provided for the construction of a median trackway.

Paint Branch Drive – Campus Drive Intersection

At present, this intersection is not signalized. Signal control would be needed to temporally separate train movements from conflicting pedestrian and vehicular movements.

The eastbound trains (which would be traveling geographically southward on Paint Branch Drive) would turn left into an exclusive trackway in the existing median of Campus Drive. This movement could be executed concurrently with the southbound vehicular traffic on a common signal phase.

Westbound trains would approach this intersection from an exclusive trackway in the existing median of Campus Drive and would turn right into Paint Branch Drive. This movement would conflict with the westbound through movement on Campus Drive and, in order to provide time separation of these movements it would be necessary to insert an additional phase into the signal cycle called by the detection of an approaching westbound train. That phase could be shared with southbound traffic on Paint Branch Drive.

Campus Drive

In the short segment between Paint Branch Drive and US 1 (Baltimore Avenue) the tracks would be located within the existing oval-shaped median, but each on its own alignment. The westbound track would be installed along the north edge and the eastbound track along the south edge. At present this median hosts a decorative guard house near its eastern tip and a smaller building at the western tip. Both of these structures would have to be relocated to wider parts of the median so that they could be bypassed by the tracks.

Campus Drive – US1 (Baltimore Avenue) – Paint Branch Parkway Intersection

The trains would operate in median trackways on the west (Campus Drive) and east (Paint Branch Parkway) legs of this intersection. The tracks would be straddled by the left-turn lanes on these two legs.

None of the current phases would provide time separation of the train movements from all vehicular movements. The phasing would have to be reprogrammed to provide this temporal separation and the revised phasing would have measurable negative impact on traffic operations at an intersection that already has a capacity deficiency. While not quite a “fatal flaw”, this potential impact is a major drawback of this sub-alternative.

Paint Branch Parkway

The segment of Paint Branch Parkway east of US1 would be reconfigured to include a median trackway. This would entail reconstruction that would increase the total roadway width to a dimension that might exceed the width of the right-of-way.

Some conceptual plans show the tracks in the curb lanes. That positioning would create at least one potential problem in that motorists would be inclined to use the track lanes as a shoulder for emergency parking, tire changing, cell phone dialing, etc., potentially blocking passage of the trains. A curbed median alignment would avoid this problem.

REGENTS DRIVE SUB-ALTERNATIVE

Stadium Drive – Regents Drive Intersection

At present, this intersection is controlled by multi-way STOP signs. This control might satisfactorily accommodate the rail operation. Nevertheless, a possible need for signalization should not be dismissed.

Regardless of the type of intersection traffic control, the track configuration would need to be designed to fit into the current lane use pattern, which includes an exclusive lane for eastbound right turns and a pocket for northbound left turns. These two turn movements would be executed by the trains and the trackage would need to be installed in those lanes. The curb on the southwest corner might have to be reconfigured to accommodate the minimum turn radius of the rail cars.

Regents Drive

Between Stadium Drive and Fieldhouse Drive there are four lanes, comprising: a parking lane along the west curb, a southbound mandatory right-turn lane (into Fieldhouse Drive) and a through lane in each direction. The trains would operate in the through lanes. The alignment of southbound lane includes a reverse curve to thread it between the northbound left-turn pocket in the south leg of the Stadium Drive intersection and the mandatory right-turn lane. The southbound track would have to follow that alignment. Between Fieldhouse Drive and Campus Drive there is only one lane in each direction. The trains would share these lanes with general traffic. Pedestrian activity across Regents Drive might require signalization of the Fieldhouse Drive intersection.

An alternative alignment comprising a reserved trackway along the east side of Regents Drive and the north side of Campus Drive was examined briefly. This would have the same serious drawback as the Paint Branch Drive sub-alternative in that it would negatively impact the already capacity-deficient Campus Drive/US1/ Paint Branch Parkway intersection.

Regents Drive – Campus Drive Intersection

At present, this intersection is configured as a small traffic circle. It would be difficult to integrate train movements into the traffic patterns at this circle.

A better concept would be to adopt the roadway geometry shown on Page 35 of the September 21, 2007 Project Briefing document, which preserves the grassed core of the circle with the decorative “M”, but alters the roadway alignments to form two separate intersections, one with an inverted “Y” configuration northwest of the circle and the other with a “T” configuration east of the circle. The trackway would skirt the southwest quadrant of the preserved circle and extend from there southeastward into a reserved right-of-way. Signalization of these two intersections would time-separate conflicting train movements.

Reserved Right-of-Way

Between Campus Drive and Paint Branch Parkway the trackway would be reserved, possibly integrated with new roadways. That trackway would intercept two roadways.

Immediately south of Campus Drive it would cross the re-routed leg of Regents Drive on the south side of the circle. That crossing would include a pedestrian crosswalk on the north side of the trackway. As noted previously, this interface should be regulated by standard highway signals operated by a semi-actuated controller. The phase serving the pedestrian and train movements would be callable.

About midway between Regents Drive and Paint Branch Parkway the tracks would cross US1. Preferably, this would be a single crossing accommodating both tracks, but it could be two single-track crossings about 400 feet apart as shown on some conceptual plans. If at any of these crossings the trackway would be integral with a roadway, such intersections should be controlled by standard highway signals.

Non-intersection crossings might also be controlled by traffic signals or by railroad-type flashing lights supplemented by automatic gates. In determining the type of control at least two matters should be taken into account, which are coordination of this control with the signalization at Campus Drive / Paint Branch Parkway and the detection of any trains that would be halting at a station on the immediate approach to the crossing.

Paint Branch Parkway Junction

The exclusive trackway would intercept Paint Branch Parkway 1,000 feet or more east of the US 1 intersection. From that point eastward the trains would operate in a widened median of Paint Branch Parkway. This would require them to cross the eastbound lanes. As with the US 1 non-intersection crossing, either standard highway traffic signals or flashing lights with automatic gates might be appropriate. Westbound traffic would not cross any trackage and would be unaffected by the train movements.

Paint Branch Parkway

As noted previously, some conceptual plans show the tracks in the curb lanes. That positioning would create some potential problems that a median alignment would avoid.

CONCLUSIONS

Adoption of the Paint Branch Drive sub-alternative would require routing the trackage through the Campus Drive/US1/Paint Branch Parkway Intersection. The signal re-phasing that would be necessary to accommodate train movements would measurably reduce the already insufficient capacity of this heavily trafficked intersection. While probably not a "fatal flaw", this is a serious drawback.

With the Regents Drive sub-alternative the traffic impact of train operation could be completely avoided at this busy intersection. Moreover, adoption of this sub-alternative could provide a less circuitous routing of the trains through the campus.

There are everyday conditions at several locations along the common segment of this routing that would cause some impediment to train operation in the form of minor delays, but these are not viewed as fatal flaws. On the other hand, pedestrian interface at Byrd Stadium on game days is a very serious issue that must be mitigated and a means of doing this has been described in this memorandum.

Subject to the above stated precautions, this evaluation indicates that, from a transit and traffic operations perspective, a Stadium Drive routing could be made to work.

C: Monica Meade
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18. Approach to Decision on Alignment on MD 410

Approach to Decision on Alignment on MD 410

A couple of options exist for the preferred alignment for the Purple Line on MD 410 between Kenilworth Avenue and Veterans Parkway. The Town of Riverdale Park, Prince George's County staff, and elected officials have been coordinating with the MTA on several modifications of the alignment described in the AA/DEIS. The two options being compared are a median alignment, and one on the south side of MD 410. Both options include the widening of the underpass of the Baltimore Washington Parkway.

For comparability, the two alignments should be compared between stations 1085, the approximate location of the aerial Riverdale Park transit stop, and 1135, the Riverdale Road stop, across the current location of the Park Police headquarters. This will ensure that travel times, impacts, and costs are comparable.

Factors to be evaluated include:

- Engineering feasibility
- Capital cost
- Traffic operations
  - on MD 410
  - on side streets
- Purple Line transit operations
  - Functionality/reliability
  - Travel times
- Housing displacements and property takes

There are less quantifiable issues particularly related to housing displacement and property takes. The south side option would result in the displacement of many residential properties. Prior to the selection of this option the MTA and the county would need to meet with the owners of these properties to ascertain the level of support or opposition to this option. If selected, the MTA must have the full, public support of the county and local officials for the option.

Other environmental factors are assumed to be similar for the two options. However should a differentiating environmental impact be identified, it should be considered in the evaluation.

Once the MTA project team determines a preference for a preferred alignment, there should be meetings with Price George's County and Town of Riverdale to get input and concurrence, especially if the south side option is preferred.

19. Comparison of Stadium Drive Alternative Alignments

Comparison of Stadium Drive Alternative Alignments

19 December 2007

The following is a supplement to the Technical Memorandum regarding the Stadium Drive Alternative Alignment dated December 7th, 2007. In that memorandum there was an allusion to a variant of that alternative that would have situated the trackway along the southeast side of University Boulevard east of Adelphi Road, rather than in the median, that would be discussed separately. The following is that discussion in which these two options are evaluated and compared.

MEDIAN ALIGNMENT

A median alignment would only occupy land within the existing University Boulevard right-of-way and would have no impact on abutting properties. The trackway could be fitted between the existing curbs with plenty of room left over for landscaping.

Unlike west of Campus Drive, the median in this segment has no openings that would generate conflicting vehicle and train movements. Throughout the segment the trackway would be completely free of potential operational interferences. Furthermore, because the existing vehicle movements into and out of driveways in this segment do not cross the median they would not be affected in any way by the trackway or the train operation.

The only train interface with vehicle traffic would be at a track crossing of the eastbound lanes of University Boulevard at the Stadium Drive intersection. The existing signalization of this intersection could be re-programmed to time-separate the conflicting train and vehicle movements and it could be done with very minimal, almost negligible, impact.

At present, there are two phases in the cycle that serve movements on University Boulevard: (1) westbound through/right with a protected left turn and (2) westbound through/right and eastbound through with a permitted left turn. There would be no need to alter either of these to phases to accommodate the train movements.

The phase that currently serves vehicle movements approaching from both Stadium Drive and the Golf Course Access Road would have to be altered, but only in those cycles when a train would be passing through the intersection. In those cycles this phase would serve only the movements from the Stadium Drive approach. These movements would not conflict with train movements and they could share that phase. The deletion of the phase that serves the Golf Course Access Road approach would occur between 10 and 20 times per hour.

The right-turn movements into and out of the Stadium Drive leg are not currently signal controlled. There would be no need to change this since these movements would not conflict with train movements in either direction.

Given the extremely low volume on that approach and that none of the higher-volume movements would be affected, the overall negative impact on the intersection of this phasing alteration would be minimal at worst and in many cycles, zero.

SIDE ALIGNMENT

A trackway alignment along the eastbound side of University Boulevard would be partly, or entirely, on land beyond the existing highway right-of-way. Near the south corner of the Stadium Drive intersection some of this land accommodates a storm water retention basin.

This trackway would intercept turning movements into and/or out of three driveways. Each vehicle/train conflict would require some type of traffic control.

The more difficult conflict to handle would be the right turn into an entrance driveway across both tracks. Control by means of passive signing would be woefully inadequate and active devices would have drawbacks.

A train-activated, blank-out NO RIGHT TURN sign, even if supplemented with a train pictogram, probably would not be sufficient to produce dependably the necessary time separation of conflicting movements, particularly those involving eastbound trains that would be approaching behind the motorists' normal view.

Railroad-type flashing lights with an automatic gate would be more effective in controlling the turning movements, but they could create an element of confusion. The flashing lights would be visible to the vast majority of motorists traveling in the eastbound through lanes who would be continuing past the driveway and not crossing the tracks. Flashing lights could cause those unfamiliar with the local condition to brake unnecessarily while others, who would know that the flashers did not apply to them, would not slow. Rear-end collisions would likely ensue.

At an exit driveway a different type of problem would likely occur. Passive devices might be sufficient to alert motorists to the possible approach of trains in both directions. For more emphasis train activated warning devices could be installed. However, the greater problem here would not be fully addressed by any such devices.

Motorists preparing to enter University Boulevard from a driveway, when pausing to wait for a break in traffic flow, would almost certainly do so at a point close to the edge of the highway so that they might enter quickly and more safely when they have the opportunity. Such positioning would place some part of their vehicle on the trackway. Whenever a train would approach the dilemma and hazard that would result is obvious. This is the potential situation that was discussed previously when we were considering (and rejecting) the side alignment alternative for University Boulevard west of Campus Drive.

On Stadium Drive between University Boulevard and Valley Drive a side alignment would intercept at least one driveway. This would create the same types of problems as discussed above, although they would be less severe. Vehicle speeds on Stadium Drive are modest in this segment, as would be the train speeds. Collisions would probably be "fender benders".

SUMMARY

A median trackway alignment would require no private land acquisition or easement. The traffic impact would be limited to an occasional delay of one very low volume movement. No vehicle movement with any significant volume would be affected. All vehicle movements conflicting with train movements would be positively controlled by standard traffic signals.

A side trackway alignment would affect University property, probably including some storm water retention basins. It would create traffic conflicts that do not currently exist and which would be difficult to control with standard devices. There would be a probability of a variety of secondary safety impacts on through traffic and on train movements. From a traffic perspective this alignment is clearly the inferior of the two.

20. Kenilworth Avenue Alignment

Technical Memorandum

Parsons Brinckerhoff

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TO: **Greg Benz**

FROM: **Jack W. Boorse**

DATE: **November 20, 2008**

SUBJECT: **Purple Line – Kenilworth Avenue Alignment**

More than one conceptual design has been put forth for a proposed LRT trackway alignment along Kenilworth Avenue between River Road and MD 410. You have requested a fresh approach to this, taking into account the previous work and the matters discussed at the meeting of September 10. This memorandum and the accompanying sketches present findings in response to that request.

BACKGROUND

At the north end of this segment the trackway along Kenilworth Avenue would curve westward to connect with an at-grade trackway located along the south side of River Road. The south end of this segment would connect with an aerial structure above the intersection of Kenilworth Avenue and Maryland 410. No at-grade stations are contemplated within this segment.

At present two alignment options are under consideration, one along the center of the street and the other along the west side. An east side option is not under consideration since nearly all of the abutting properties on the west side are commercial or institutional while all of the abutting properties along the east side are residential.

The center option would entail a crossing of the southbound lanes of Kenilworth Avenue, while the west side option would not. Both options would overpass the Kenilworth / MD 410 intersection and would have no traffic impact there.

A recent development is the concept suggested by Joe Romanowski to construct a service road network some distance west of Kenilworth Avenue that would extend from River Road to Quesada Road and would provide an alternative access for properties on the west side of Kenilworth Avenue. This is a promising concept in that it would significantly reduce traffic conflicts by allowing the closure of some driveways on the west side and the construction of a median/trackway that would be continuous, except for one opening at Rittenhouse Street. The alignments discussed in this memorandum and depicted in the associated sketches

The service road alignments shown on the sketches would require property acquisition. They also presuppose implementation of the anticipated extensive redevelopment of the shopping center including building demolition.

FINDINGS

Sketch 201-1a

The connection of the trackway along the south side of River Road with an alignment in the median of Kenilworth Avenue would entail acquisition of private land on the southwest corner of the River Road / Kenilworth Avenue intersection. It would also create a non-intersection track crossing of the southbound lanes of Kenilworth Avenue about 150 feet south of River Road. Given the positioning of the crossing, the recommended method of traffic control would be flashing lights with and automatic gates. These train-activated devices would need to be interconnected with, and influence the operation of, the signalization at the River Road / Kenilworth Avenue intersection. This occasional (10-20 times per hour) actuation of the automatic gates and alteration of the signal cycle at the River Road intersection is not anticipated to have any unacceptable impact on traffic operations.

The north end of the aforementioned service road network would form an intersection with River Road about 400 feet west of Kenilworth Avenue. That intersection would also include an at-grade crossing of the trackway. This intersection/crossing would be controlled by traffic signals programmed to provide callable phases to separately serve train movements and vehicle movements on the service road. Given this programming and the traffic volumes this is not expected to impact traffic operations significantly.

The existing median on Kenilworth Avenue is not wide enough to accommodate the trackway, particularly if the catenary is going to be supported by a pole line between the two tracks. Its width would need to be increased to about 29 feet. In the zone immediately south of the track crossing the west curb would be set back about two feet so that the southbound lanes could be shifted westward and the median could be widened on the west side. Apparently that setback could be accomplished without disturbing the existing sidewalk, but might involve acquisition of a sliver of land between the sidewalk and the west right-of-way line.

Sketch 201-2a

At a point approximately 500 feet south of River Road the alignment of the trackway would transition eastward and the median would need to be widened on the east side. To provide space for that widening the shoulder on the northbound side would be converted into the outside travel lane and the existing outside lane would become the inside lane. No land would need to be acquired.

The median opening and northbound left-turn lane for the convenience store would be eliminated. Diverted left-turn movements would use the new service road system for access via alternative routings.

Sketch 201-3a

The service road network would include a segment that would align with Rittenhouse Street, creating a conventional 4-leg intersection with Kenilworth Avenue. At this reconfigured intersection the Kenilworth Avenue roadway would need to be wide enough to accommodate not only the trackway/median, but also two left-turn pocket lanes on Kenilworth Avenue. The conversion of the east shoulder into a travel lane alone would not provide sufficient width to accommodate these mid-street features. To gain the needed width it would be necessary to shift the southbound lanes westward by about 22 feet at the intersection and to set back the west curb line between a point approximately 250 feet north of Rittenhouse Street and one about 300 feet south of that intersection. This would involve property acquisition, primarily from the aforementioned shopping center property.

The existing signalization at the Rittenhouse Street intersection would need to be re-programmed to time-separate the train movements from conflicting vehicular and pedestrian movements.

Southward from the Quesada Road intersection the profile of trackway would rise above that of the Kenilworth Avenue roadway on a ramp that would lead to an aerial structure. If this ramp structure cannot be fitted into the same 29-foot width as the at-grade trackway it might be necessary to shift the southbound lanes westward which could require a modest setback of the west curb and widening of the right-of-way that would entail the taking of a sliver of land.

Sketch 201-4a

The south end of the ramp would be about 150 feet north of Quintana Street where it would connect with an aerial structure. Presumably the columns and bents supporting that structure could be located such that the roadway geometry at the Quintana Street, Patterson Street and Md 410 intersections would not need to be altered significantly, if at all. Current intersection traffic operations at these intersections should not be materially affected.

West Side Alignment Alternative

It has been noted that if the trackway were to be installed along the west side of Kenilworth, rather than in the median, the non-intersection track crossing south of River Road could be avoided. Obviously, that is so but, unfortunately, such an alignment would create several other conditions that would be quite problematic and possibly unacceptable.

A more severe impact would be experienced by the church property on the southwest corner of the River Road / Kenilworth Avenue intersection. The westward shift of the trackway alignment would invade this property deeply, forcing the taking of a larger land area than that required for the median option. More seriously, it would create highly undesirable traffic conditions at the church parking lot driveways as well as others on the west side of the road.

At the north (exit) church lot driveway, with the current passive traffic control (a Vehicle Code requirement for traffic in the driveway to stop and yield to traffic on the public highway, whether a STOP sign is posted, or not) an emerging vehicle would halt on the trackway and could be held there for some period of time by a continuing flow of traffic on Kenilworth Avenue. Such a vehicle would be stopped in the paths of approaching trains in both directions. At the church lot entrance (south) driveway vehicles turning off of Kenilworth Avenue would cross both tracks. The eastbound – geographically southbound – trains would be approaching from behind, far out of a driver's normal view through the windshield.

Between the church property and the shopping center there are four more driveways, each of which serves both entering and emerging traffic. Potential hazards the same as those described above would be created at each of these driveways.

The only form of traffic control that would fully address these potentially hazardous situations would be signalization of these driveways as intersections. Such would not likely receive SHA approval. The probability is that all six of these driveways would have to be eliminated.

Although the rear of these properties would be linked to the service road and would not be totally isolated by the driveway closures, loss of all direct access from and egress to Kenilworth Avenue could lead to a taking of these properties in their entirety. That would not be a desirable outcome.

In summary, the west side alternative would create serious problems that would not occur with the median alignment. Its singular positive element would be the avoidance of an at-grade track crossing of the southbound lanes of Kenilworth Avenue south of River Road. As noted previously, the impacts of this crossing do not appear to be significant.

CONCLUSION

The median alignment, in concert with a service road network behind the properties on the west side of Kenilworth Avenue, as depicted in the associated sketches does not appear to have any fatal flaws. It would involve the acquisition of some private land but most would be slivers or small areas. Except for the anticipated redevelopment of the shopping center opposite Rittenhouse Street, no building demolition would be involved.

At an appropriate stage of the project the concept should be analyzed in more detail to evaluate the degree of the various traffic impacts and determine any need for mitigation measures.

21. Opportunity for Use of Single Track along the Georgetown Branch Right-of-Way

Opportunity for Use of Single Track along the Georgetown Branch Right-of-Way

Updated July 8, 2010

Summary

Introducing a single-track segment between Bethesda and Connecticut Avenue would significantly compromise travel time savings, service frequency, passenger carrying capacity, and the maintenance and operating reliability of the entire Purple Line, thereby reducing the effectiveness, efficiency, and the return on a $1.5 billion investment. These issues are compounded for the Purple Line because of the restriction on having a tail track or pocket track at the Bethesda terminal station and train lengths limited to a two-car train. <u>The reduction in the amount of tree clearing hoped for from building a trail and single-track segment would not be achieved because of the amount of space needed to construct the permanent trail, associated buffers, and the transit facility.</u> A single-track segment between Bethesda and Connecticut Avenue would have adverse impacts to the ENTIRE Purple Line system in Montgomery County and Prince George's County. These impacts would be:

- Longer travel times to the riding public – due to the need to wait for trains in the opposing direction; a delay along any part of the entire line would be compounded by this single-track section,
- Less frequent service – trains would not be able to operate at below seven-minute headways, resulting in a less convenient, attractive service (the Purple Line operating plan currently assumes six-minute headways),
- Lower passenger capacity due to less frequent service, which will limit future ridership growth,
- Overall restrictions to operations and maintenance, requiring night-time maintenance work or total service shut down between Bethesda and Silver Spring to perform required maintenance.

Introduction

The Montgomery County Council and Executive endorsed and recommended the Medium Investment Light Rail Transit (LRT) alternative, running along the Master Plan alignment between Silver Spring and Bethesda, for the Purple Line locally preferred alternative. As part of that endorsement, they requested that the MTA examine the implications of constructing and operating a segment of single-track LRT in the western portion of the Master Plan alignment; as means of reducing the amount of trees that would need to be removed within the available right-of-way. The purpose of this paper is to evaluate the opportunities for introducing a single-track segment into the Purple Line LRT; and its effects on service capacity, service headways, and operational reliability. The area identified as presenting an opportunity for the possible use of a single-track segment is between Bethesda and the western boundary of the Columbia Country Club with the Master Plan alignment.

In examining the opportunity for single tracking, it should be noted that the section of the Purple Line between Bethesda and Silver Spring is estimated to be the segment with the highest passenger loads. This means that this segment determines the line's maximum service capacity and therefore requires a certain number of trains at a peak period headway. Current projections indicate that Medium Investment LRT alternative would have a peak hour, peak direction load of some 2,200 to 2,300 passengers per hour while operating on a headway or minimum interval of six minutes with two-car trains. The Transportation Research Board's *Transit Capacity and Quality of Service Manual – 2nd Edition*, states that single-track section with two-way operations is the greatest capacity constraint on light rail lines.

Use of Single-Track Segments in other Light Rail Systems

Four cities in the United States, San Diego, Portland, Sacramento, and Baltimore, constructed their original LRT lines with single-track segments. In these examples, the use of single track sections was done to save construction funds because of then-existing budgetary limits. In each of these cases, the headways originally operated were in the range of 15 minutes. Indeed, Baltimore was required to lengthen its headways to 17 minutes to accommodate the operating limitations of its multiple single-track sections. In all four cases the operational and service limitations of single-track were recognized early. These limitations are:

- Longer travel times – this is due to the need to wait for trains in the opposing direction,
- Less frequent service – resulting in a less convenient, attractive service,
- Lower passenger capacity due to less frequent service, not allowing for future ridership growth,
- Overall operational and maintenance flexibility.

Eventually in all four cities funding was provided to add the second track for most of their route mileage. The additional cost required to double-track those portions was greater than the amount saved initially. In addition, the service disruption had significant adverse impacts to passengers.

In the case of Baltimore, the decision was made to close the entire line to allow for faster reconstruction despite the inconvenience to passengers. Because of additional neighborhood impacts along the alignment (since the new tracks were closer to residences) the project created strong community opposition. New environmental analysis was required, further adding to the time and the expense. The closing of the service resulted in substantial loss of ridership that was not recovered for several years. The additional cost was far higher due to the escalation of costs, including the not insubstantial mobilization cost. During the closing of the service the MTA still had infrastructure maintenance costs for the tracks and overhead wire system despite the fact the project generated no revenue.

Suggested Purple Line Single-Track Segment

The single-track segment identified for consideration extends along the former Georgetown Branch right-of-way generally between the western edge of the Columbia Country Club and Pearl Street; a distance of approximately 3,500 feet.

Headway Impacts

With a top speed of 45 mph, the one-way running time for the single track segment would be about two minutes. To this must be added a minimum allowance of 60 seconds in order to clear the interlocking (track switch), move the track switch over, and verify its position, and clear the interlocking for operation in the opposing direction.

Based on detailed train operational simulation analyses, train intervals shorter than seven minutes would be precluded, higher than the six-minute peak headways needed for the Purple Line. Even with this level of headways, there would be no margin for error. This would be true even if the train ready to enter the single track had its doors closed, ignored intending passengers wanting to board, and left the instant that the signals cleared.

With a minimum headway of seven minutes, only eight trains would run between Bethesda and Connecticut Avenue in the peak hour. This would be a reduction in passenger-carrying capacity of 20% from the planned six-minute headway. In specific capacity terms, this would reduce capacity to some 2,300 passengers per hour which, while just adequate for the initial projection of ridership, would provide preclude the ability to accommodate future ridership growth.

Service Reliability Impacts

East of Silver Spring, the Purple Line is an approximately 12-mile long, at-grade route almost all of which is subject to traffic signal and other traffic-related impacts. Several segments of the alignment in particular have the potential to be sources of delay and uncertainty in the schedule. These areas are:

- *Wayne Avenue*. In this one-mile segment the LRT is in shared lanes with added left turn lanes. While traffic analyses indicate that this segment would operate well despite the shared lanes, there nonetheless exists the potential for delay.
- *University of Maryland*. This segment, while in dedicated lanes, is an area of heavy pedestrian traffic, which increases the potential for unanticipated delays and unpredictability.
- *Paint Branch Parkway*. This half-mile segment is also in shared lanes, and like Wayne Avenue, is not anticipated to be the source of traffic delays, but the potential exists.

Any delay in these three areas (or elsewhere) would have significant impacts on the operations of the single-track segment. Delays to the eastbound trains, in turn, would then cause delay to successive westbound trains, resulting in delays that would cascade through the peak period and possibly beyond, resulting in poor reliability.

With the single-track, late-running westbound trains might not be able to make their scheduled eastbound departures. Previous directions for the County have precluded the introductions of an operational tail track or pocket track at the Bethesda terminal station to store "back-up" train. Single-track here would preclude operating any additional eastbound trains to fill in gaps in service with a "rippling effect" all the way east to New Carrollton.

Poor service reliability would have a significant impact on the quality of service that the Purple Line is intended to offer. This, of course, would have a negative impact on the anticipated ridership of the line as well as its capacity to handle growth in future travel demand. The current bus service is sufficiently unreliable at the present time that consideration is being given to eliminating express bus trips since they don't achieve their scheduled running times, being stuck in the same traffic as their local counterparts. Instituting a new rail service with the same lack of reliability would fly in the face of the basic objective of making this investment; namely to provide a transit service superior to the existing bus service which it replaces.

Maintenance Impacts

The operational impacts to the Purple Line have been discussed thus far, but another significant issue would be the maintenance of the single-track sections. With the existence of a second track, routine maintenance could be performed on one track during daylight hours while running service on the second track. This would typically be done during off-peak hours when headways are low. Along a single-track segment between Bethesda and Silver Spring, maintenance would have to be performed when service is not operating; i.e. between midnight and 5AM on weeknights, and 3AM and 7AM on weekends. Track and overhead wire maintenance late at night would have substantial adverse impacts to the adjacent properties, including lighting and noise. An alternative proposed to minimize community impacts may well result in different, but more onerous impacts. In addition labor costs would be higher. Alternately, the single-track segment could be taken out of service and rail service shut down on that portion of the line, adversely impacting ridership and inconveniencing passengers. In order to maintain service a shuttle bus service would need to be operated between Bethesda and Connecticut Avenue, requiring passengers to transfer to a slower service.

Systemwide Effects

The impacts of using single-track in this segment extend throughout the 16-mile Purple Line corridor in Montgomery County and Prince George's County, far beyond this single track segment. Providing a single-track section between Bethesda and Connecticut Avenue would have significant adverse impacts on the riding public throughout the corridor. As noted above, riders between Bethesda and New Carrollton would see their service's reliability, frequency, and speed substantially impaired as a result of introducing a single-track segment. In addition to limiting capacity, the length of the headways has an impact on the attractiveness of the service to passengers.

Reduction in Tree Loss

The intent of this request to explore the construction and operation of a single-track segment in the western portion of the Master Plan alignment is to reduce the amount of trees that would need to be removed within the available right-of-way. It is expected that to construct the trail, the double-track transitway, and the associated buffers; the trees in most of the typical 66-foot right-of-way would need to be removed. New trees and landscaping would be planted into the buffers and along the side of the transitway and trail when construction was completed. While building a trail and single-track transitway would reduce the width required for permanent use by 10-12 feet, construction of that arrangement would still require clearing of most of that 66-foot width. As the trail would be largely at a different elevation than the transitway along the master plan alignment, construction of one track of the transitway would require access from the side. When building one track, the construction equipment would use the space for the other track and vice versa. Therefore, the hoped-for intent that building a segment of trail and single-track segment would reduce the amount of tree clearance from what would be required for building a trail and double-track segment not likely be achieved.

Conclusion

In sum, introducing a single-track segment between Bethesda and Connecticut Avenue would significantly compromise travel time savings, service frequency, passenger carrying capacity, and the maintenance and operating reliability of the Purple Line, thereby reducing the effectiveness, efficiency, and the return on a $1.5 billion investment. The reduction in the amount of tree clearance hoped for from building a trail and single-track segment would not likely be achieved. For the many reasons stated above the MTA strongly opposes single-tracking any portion of the Purple Line.

22. Results of Simulations of Magnetic Fields Generated by the Double Feeder High-Low Power Supply System

Results of Simulations of Magnetic Fields Generated by the Double Feeder High-Low Power Supply System

April 23, 2010

Table of Contents

Introduction

The University of Maryland has understandable concerns about the potential adverse effects of light rail transit-generated electromagnetic interference (EMI) on equipment and research activities being conducted on campus in proximity to the proposed Purple Line light rail. The MTA has identified a solution by using a combination of a double feeder "high low" power supply system at the transitway source, supplemented by active cancellation and/or shielding that would protect individual research equipment. To mitigate the potential EMI effects the MTA is proposing to install the double feeder system as part of the project construction and could agree to install, as a project expense, active cancellation or passive shielding systems for existing equipment and future equipment within a certain distance of the light rail alignment. The MTA would work with the University to determine the appropriate distance. The MTA's paper *Electromagnetic Emissions and Mitigation Measures* (2/16/10) presented the results of analysis and the experience of peer research universities in the United States.

The MTA has conducted further simulations of magnetic fields created by the Purple Line traction power system and vehicles to assist in assessing the need for and the costs of magnetic shielding and cancellation equipment required to protect University of Maryland research equipment.

This new simulation tool was developed to include the three dimensional effects of the magnetic fields generated by a traction power system using the double feeder high-low mitigation system described in this report. This design is intended to provide an optimal level of cancellation at the source of the fields generated by the traction power currents.

The effects of the geomagnetic perturbation caused by the ferrous structure of the material have been taken into account by adding the maximum geomagnetic field components observed during a test conducted in Minneapolis for the Central Corridor Light Rail Project.

The results of the simulations show a substantial reduction in the generated magnetic fields when using a double feeder high-low system compared with no mitigation. Fields are very low when the trains are not in the immediate vicinity of the observation point.

The Double Feeder High-Low System

In the double feeder high-low system, the power feeder cables are placed below the rails of each track (Figure 1). One cable is run under and a few feet outside each rail. At every contact wire support pole a riser is run from both feeder cables for that track up the pole to the contact wire.

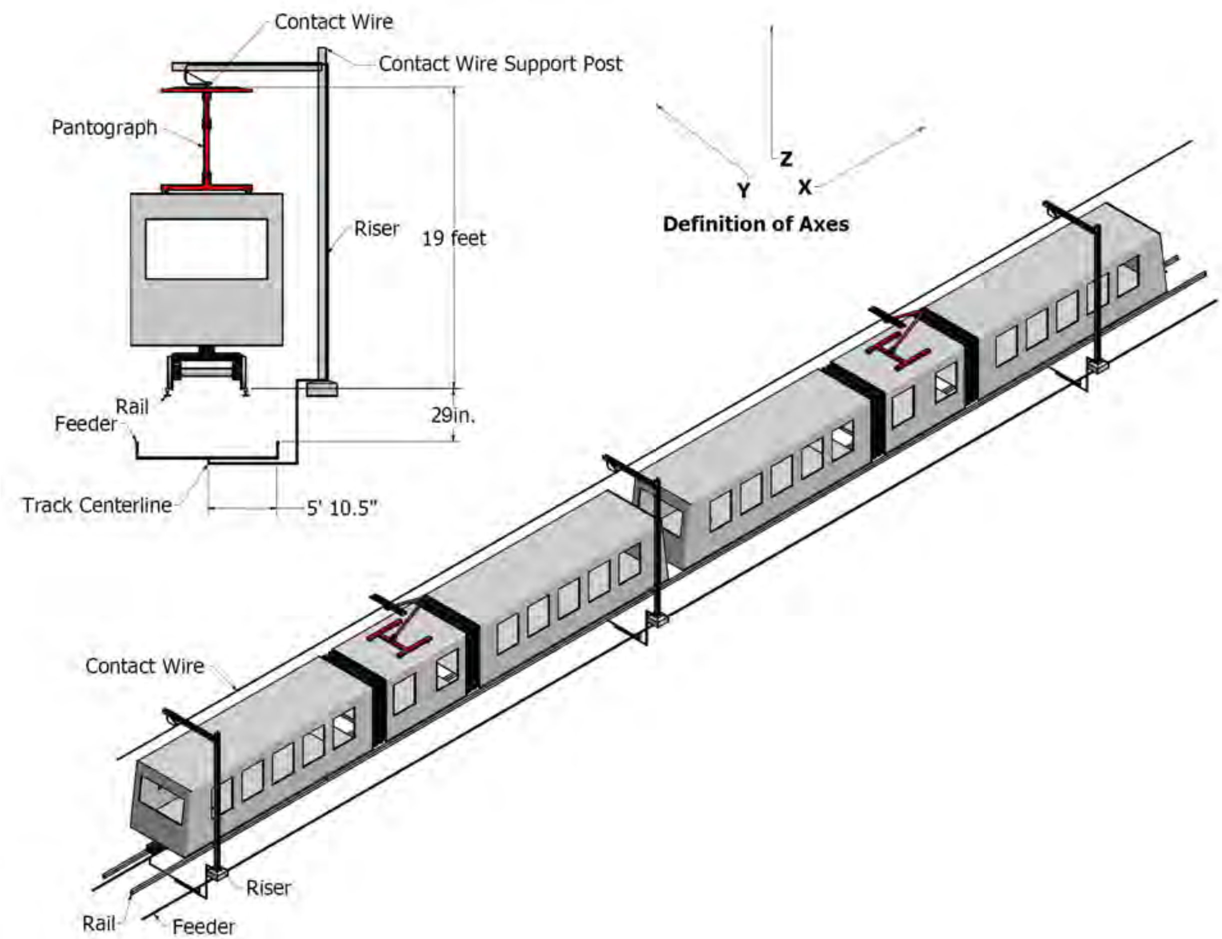


Figure 1: Drawing of the Double Feeder High-Low System

The location of the feeder cables is 29 inches below top of rail and 5 feet 10 ½ inches from the track center, a little over 3 feet outside each rail for this calculation. Final design may deviate from these dimensions based on right of way restrictions, but will be optimized for field cancellation. The feeders used in the simulation are 750 kcmil copper cables. The contact wire is 4/0 AWG cable. Design calculations are based upon 15% wear of the contact wire. Worst case calculation is based upon 30% wear of the contact wire. The feeder cables for each track are cross bonded rail to rail at each riser and a 750 kcmil riser cable carries the current up the pole to the contact wire. The contact wire height is 19 feet.

The basic concept applied is to keep the power and return currents in close proximity to each other in order to obtain as much magnetic field cancellation as possible throughout the section.

In order for a high-low mitigation system to be effective, cross bonding between track 1 and track 2 for both power and return must be made outside the mitigation area and both power and return must connect between track 1 and track 2 at the same location, e.g. a substation (Figure 2). Cross bonding is when the running rails are connected together to reduce the impedance of the return path for the traction current. Usually, where there are two tracks, all four running rails would be cross bonded; however, in this instance, it is vital that the traction current in the catenary wire is returned to the substation only via the rails underneath that specific catenary wire so that the magnetic fields cancel out correctly.

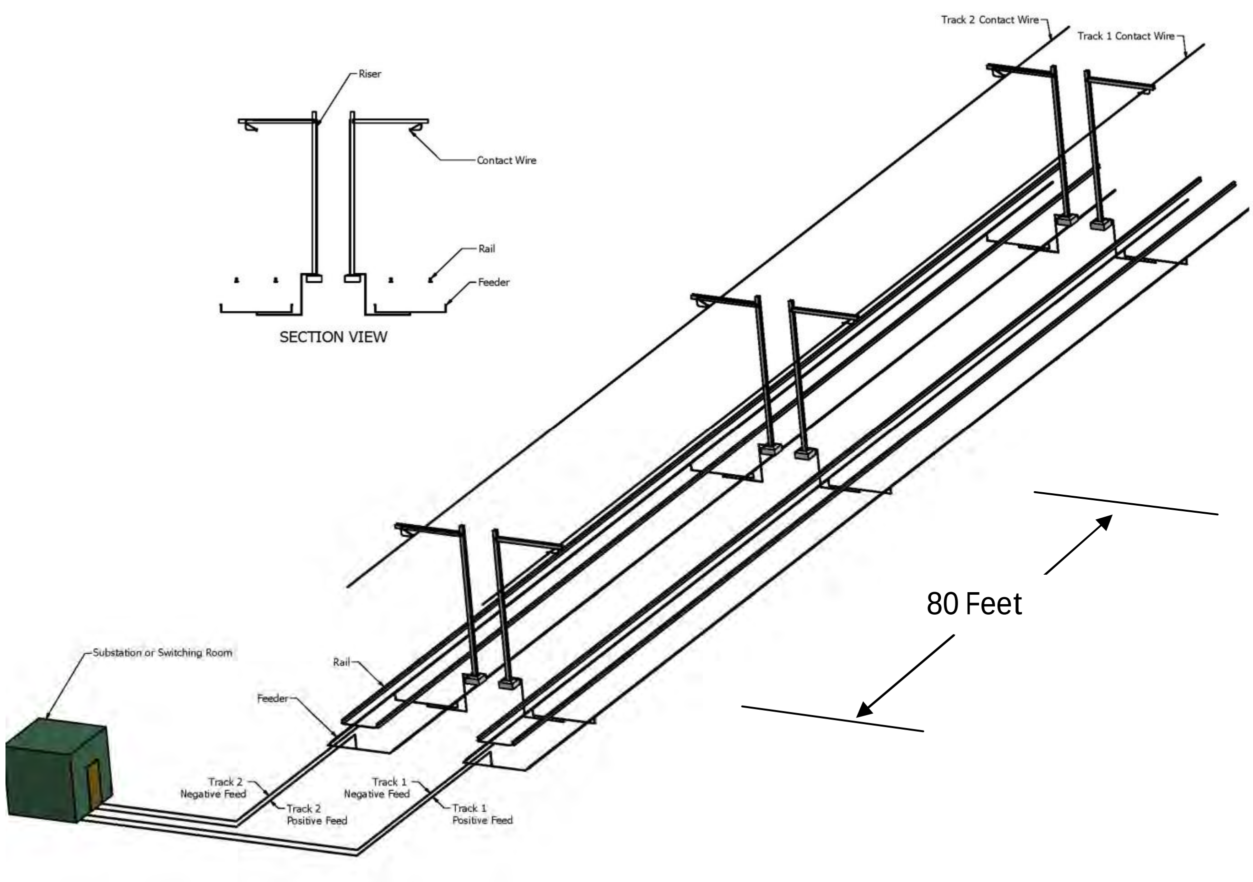


Figure 2: Power Distribution Layout

Simulation

The simulation was run for the worst case event: two 2-car trains passing each other in opposite directions with each car drawing 500 Amperes (Figure 3). In the simulation, the point where the two cars pass each other is moved from left to right past the observer to calculate the worst case field distortion for every position of the trains relative to the observation point. The simulation was also run for the more typical case of a single train passing through the campus.

The worst case for current distribution in the system is seen when the majority of current comes from only one substation, which could be caused by a high load differential between substations, for example should one substation not be operating. To simulate this effect, the substation on one end of the mitigation area is loaded with an additional 3000 A load, while the substation at the other end of the section is unloaded.

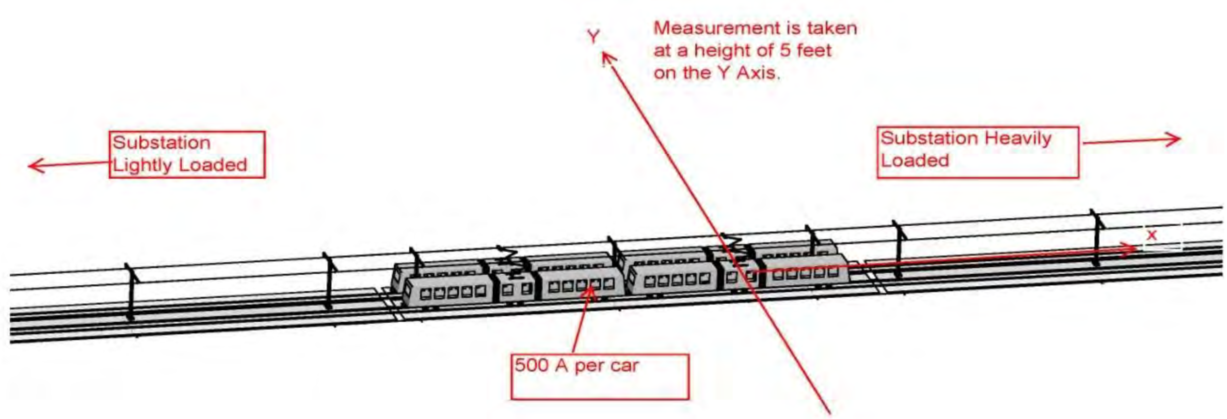


Figure 3: Simulation Conditions

In order to estimate the total disturbance generated by the vehicle, the resultant field generated by the traction current may be summed with the resultant distortion generated by the ferrous mass of the vehicle. For this purpose geomagnetic test data obtained from the Central Corridor Light Rail project in Minneapolis was added to the calculated traction power resultant. Refer to Appendix Section A1.3 for more details of the geomagnetic distortion. The peaks of the two magnetic disturbances were aligned and the two resultant fields were added with worst case vector addition.

Appendix 1 gives full background details for the simulation method.

Simulation Results

Simulation results are shown as three dimensional graphs. The physical ground plane is shown on the X-Y plane, and the resultant field distortion is shown in the vertical axis. The "height" of the floor is varied in the graphs so that the distortion footprint may be easily visualized at different field strengths. This also makes it easy to compare the effect of the high-low mitigation system with the field that would be generated without the mitigation.

The graphs illustrate the combined distortion of two 2-car trains coinciding on opposite tracks (as shown in Figure 3 above) with each car drawing 500 Amperes. The field is plotted starting from 75 feet from the centerline of the nearest track. Magnetic field strength is charted in milligauss (mG). The graphs show the magnetic field distortion as the trains move from 700 feet before the observer to 700 feet beyond the observer. The simulation was also run to determine the effect of the more typical situation of a single 2-car train passing through the University campus.

Figure 4 shows the resultant field that is generated purely by the traction current, before the geomagnetic distortion is added.

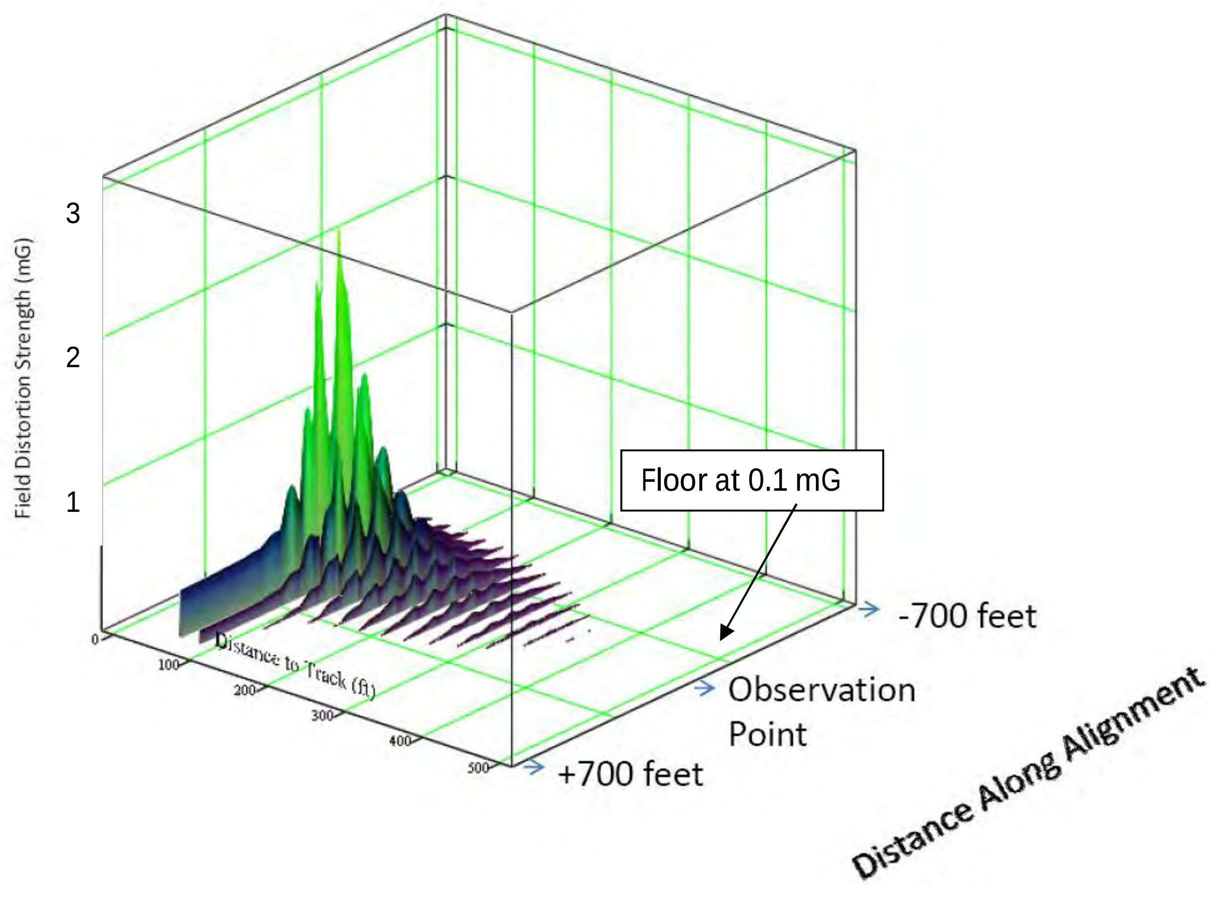


Figure 4: 3-D Magnetic Field due to Traction Power Only - Resultant above 0.1 mG with Double Feeder System (Two Trains Meeting)

As shown in Figure 5, the total magnetic field distortion due to the sum of the traction current field, and the distortion due to the geomagnetic field, attenuates to 0.1 mG occurs within approximately 450 feet.

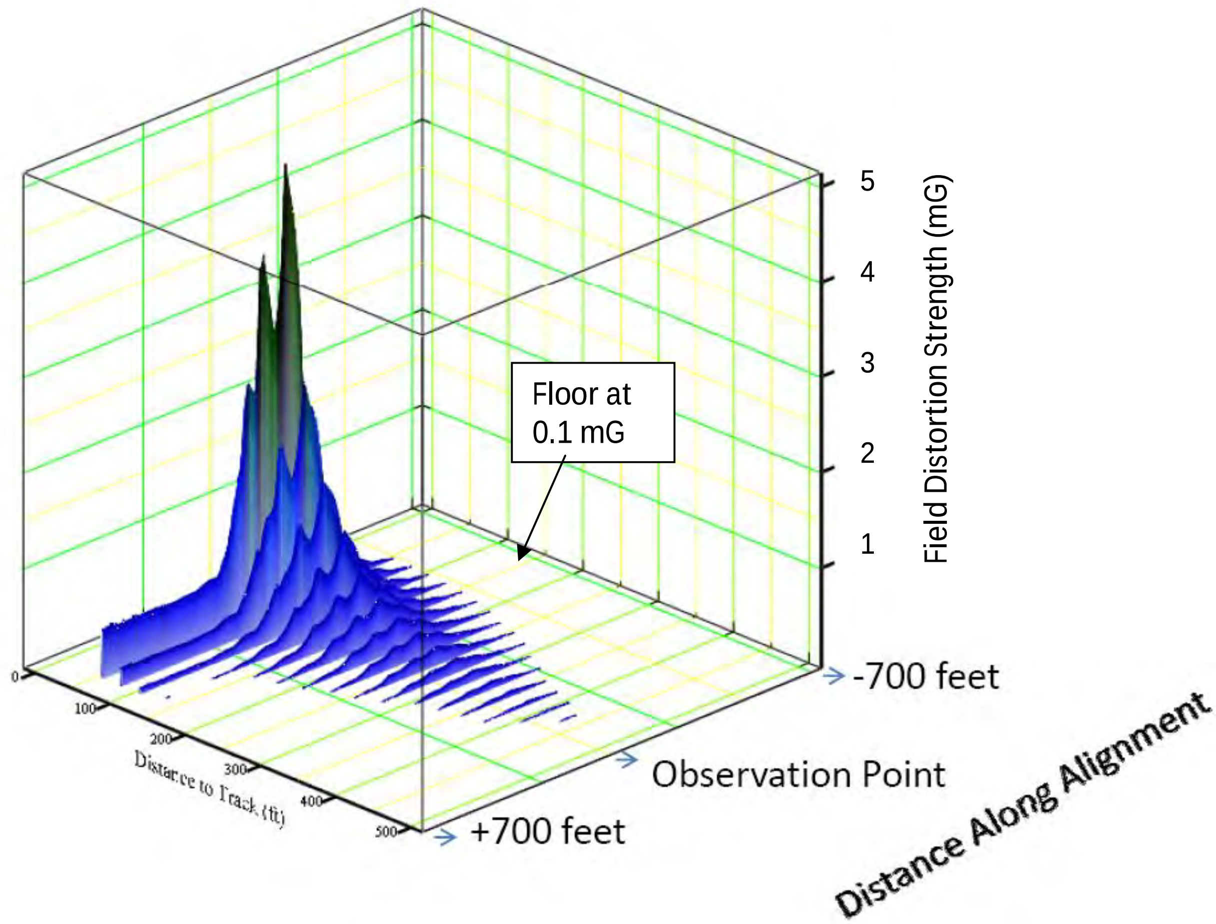
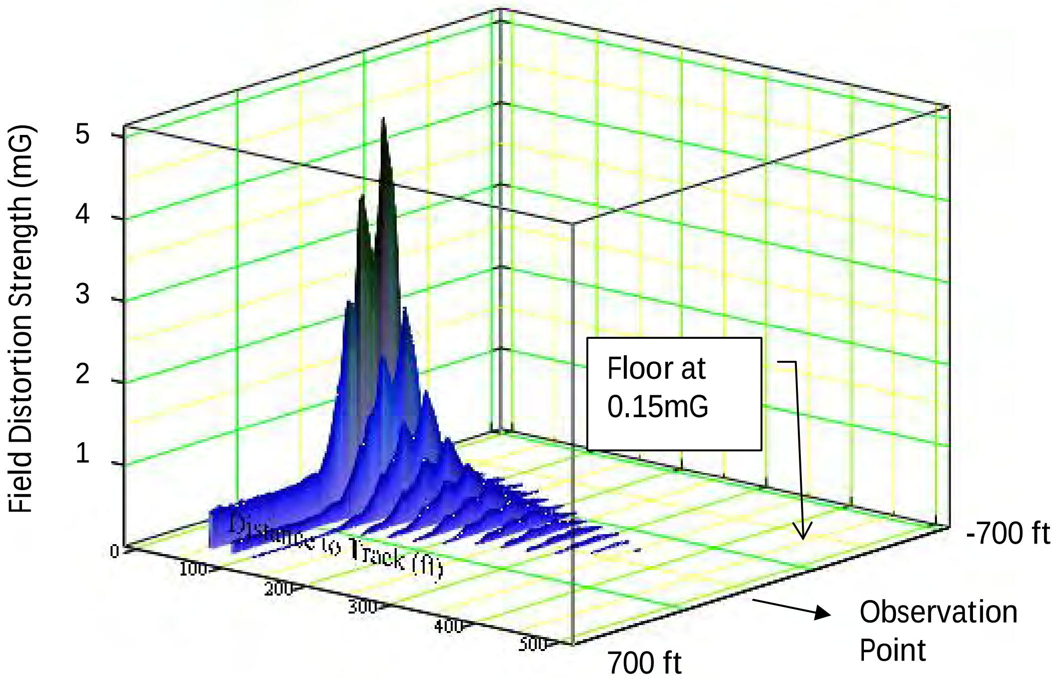


Figure 5: Traction Power + Geomagnetic Field Disturbance above 0.1 mG of Two Trains meeting with High-Low System - Measurements at 5 feet vertical and 20 feet before the riser

As shown in Figure 6, attenuation to 0.15 mG occurs within 375 feet of the alignment.



$R_{combined3d}$

Figure 6: Combined Traction Power Plus Geomagnetic Disturbance above 0.15 mG of Two Trains meeting with High-Low System - Measurements taken at 5 feet vertical, 20 feet before Riser

As shown in Figure 7, attenuation to 1 mG occurs within approximately 150 feet, and the field strength is less than 5mG at 75 feet from the alignment.

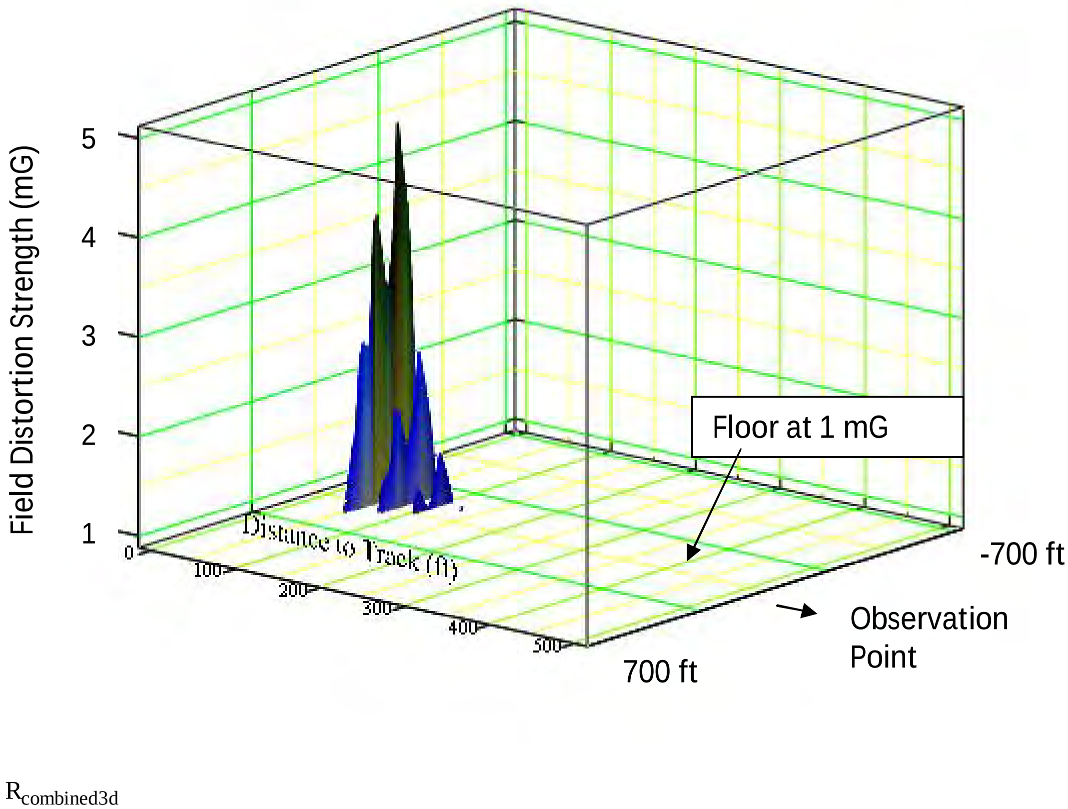


Figure 7: Combined Traction Power Plus Geomagnetic Disturbance above 1 mG of Two Trains meeting with High-Low System - Measurements taken at 5 feet vertical, 20 feet before riser.

Results were also obtained for the case of a single train passing through the University campus, which would be the typical situation. It can be seen (Figure 8) that the overall magnetic distortion footprint is smaller than for the case of two trains passing. At the 0.1mG level, the footprint extends out to approximately 350 feet, as compared with approximately 450 feet for the case of two trains passing.

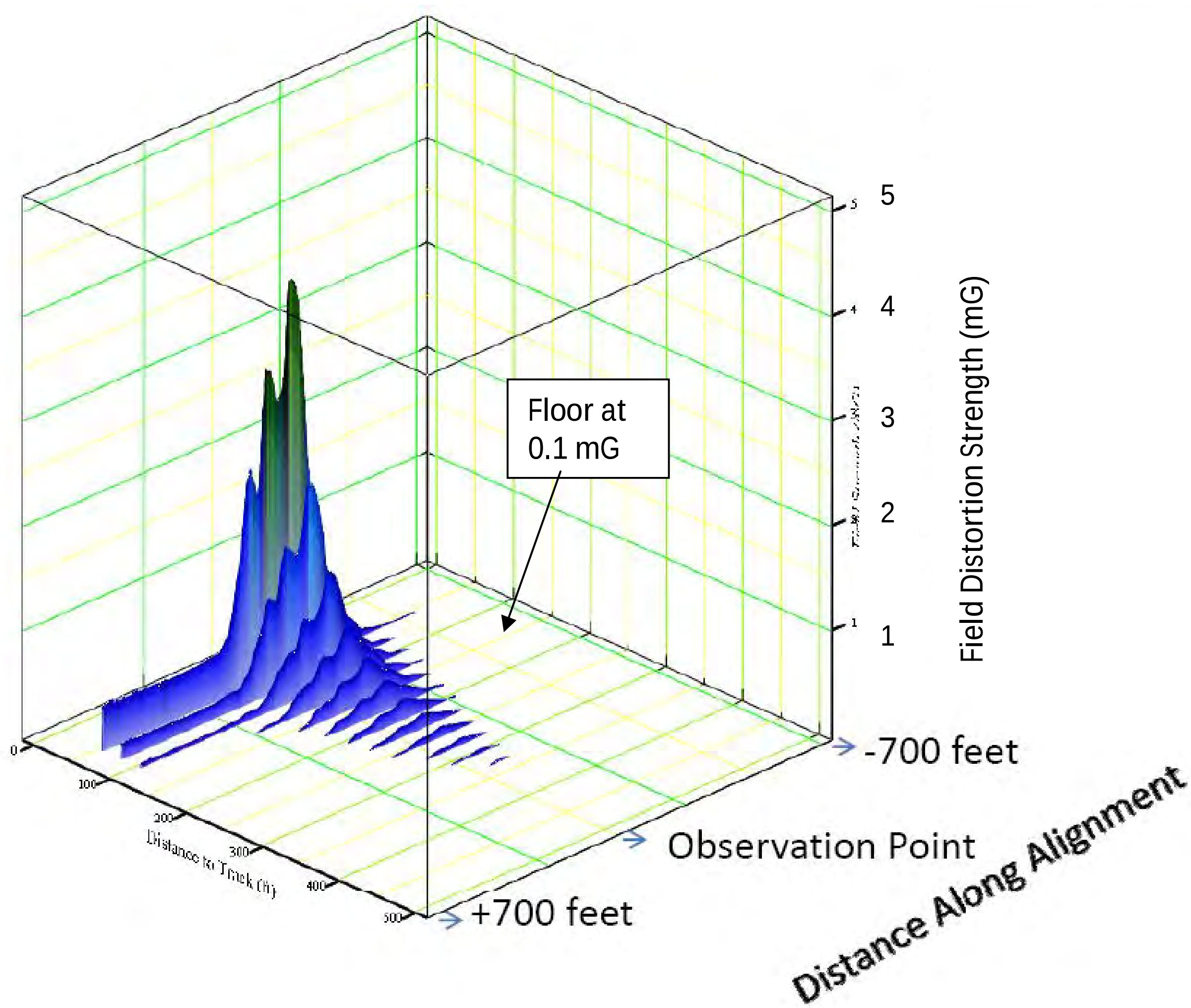


Figure 8: Traction Power + Geomagnetic Field Disturbance above 0.1 mG of a Single Train with High-Low System - measurements at 5 feet vertical and 20 feet before the riser

3-D Comparison of High-Low Power Supply System to No Mitigation

Figure 9 below shows the field disturbance from an unmitigated system. The disturbance is large and persists when the train is not directly in front of the observation site.

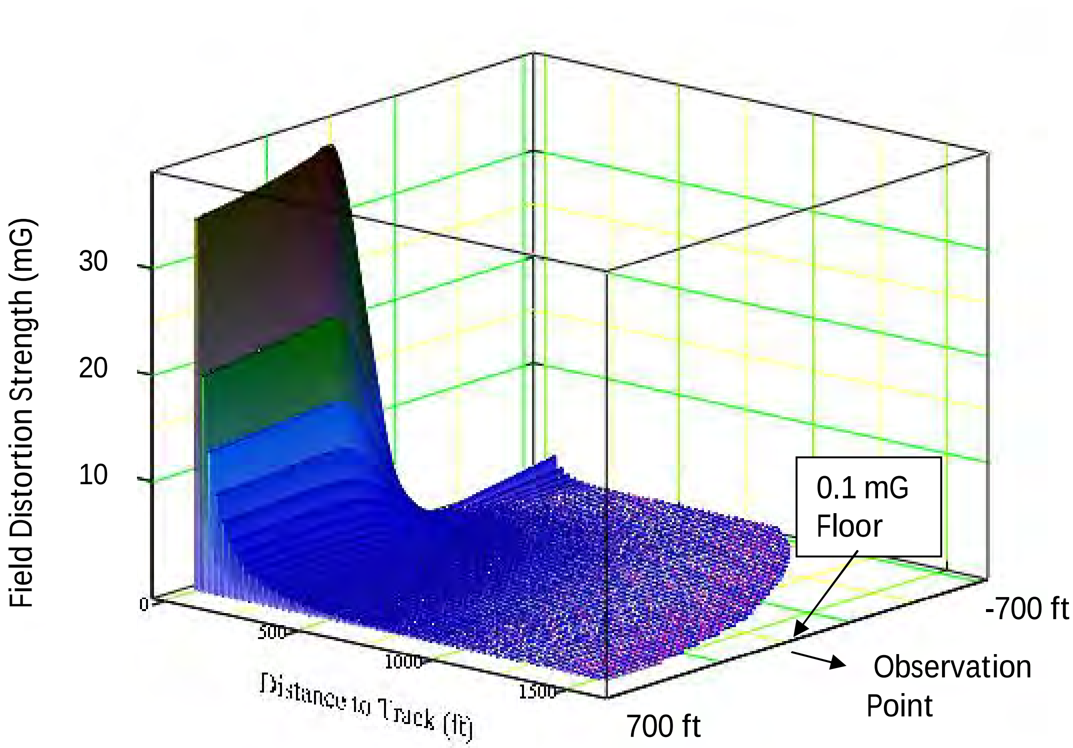


Figure 9: Unmitigated System Combined Traction + Geomagnetic Distortion of Two Trains meeting - Observer at 5 Feet Vertical and 20 Feet before a Riser

The simulation result (Figure 5) shows that the double feeder high-low system reduces the magnetic field distortion to a much lower level when compared to an unmitigated system (Figure 9). With mitigation in place, the distortion is mostly confined to a bubble around the train.

Figure 5 shows that attenuation to 0.1 mG occurs within 450 feet of the alignment rather than 1600 feet (as seen in Figure 9) with the unmitigated power distribution arrangement.

Variations of Traction Power Field with Position between Riser Poles

In order to select the measurement position that would provide the largest field disturbance, the MathCAD simulation program was used to calculate traction power fields at 20-foot intervals between riser poles, as well as at various heights.

The results presented below show that the resultant fields are slightly stronger when the measurement is taken 20 feet before a riser pole.

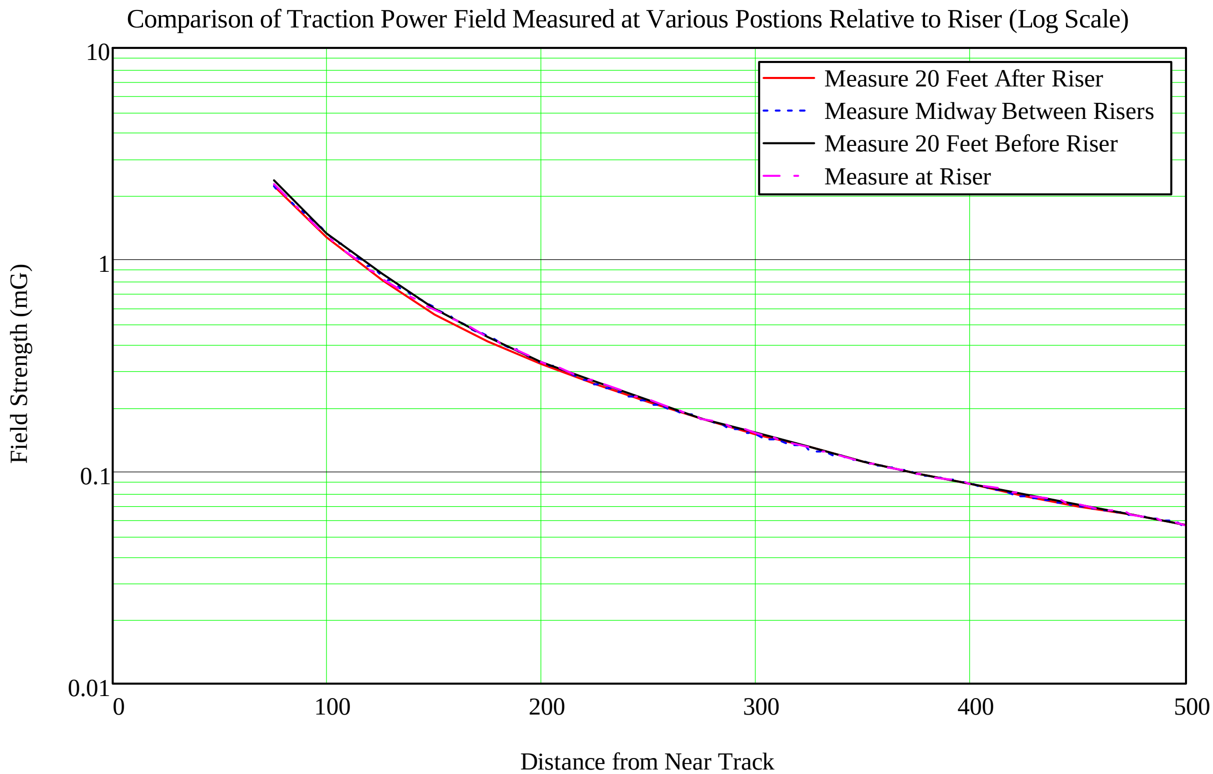


Figure 10: Maximum Traction Power Field Measured at Various Positions Relative to the Risers (Log Scale)

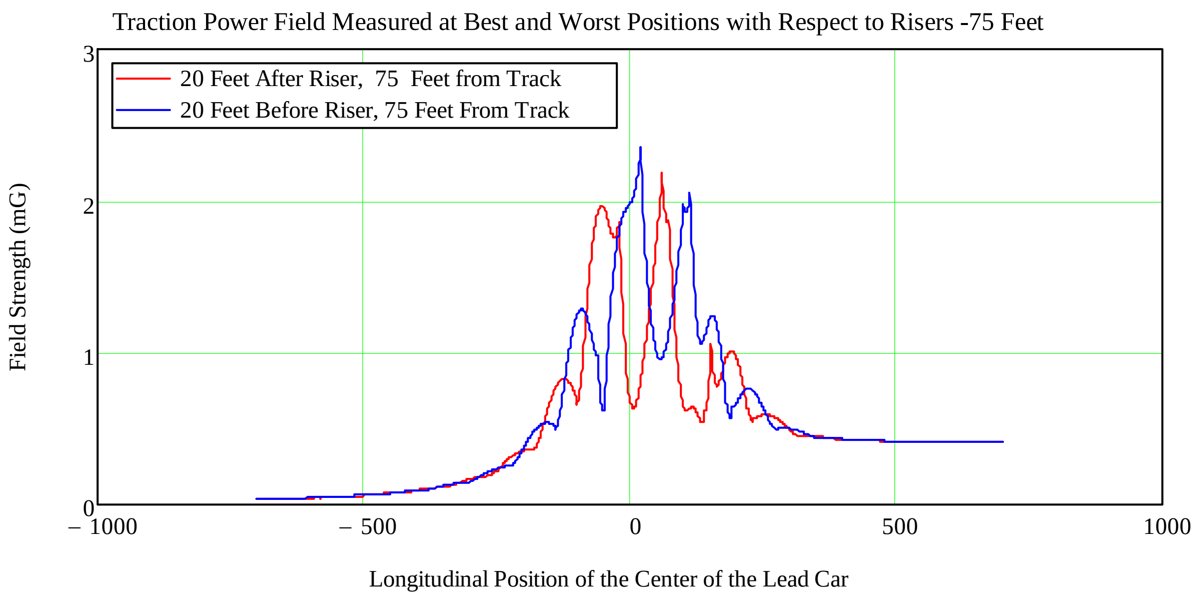


Figure 11: Traction Power Field Measured at 75 Feet from the Best and Worst Longitudinal Positions

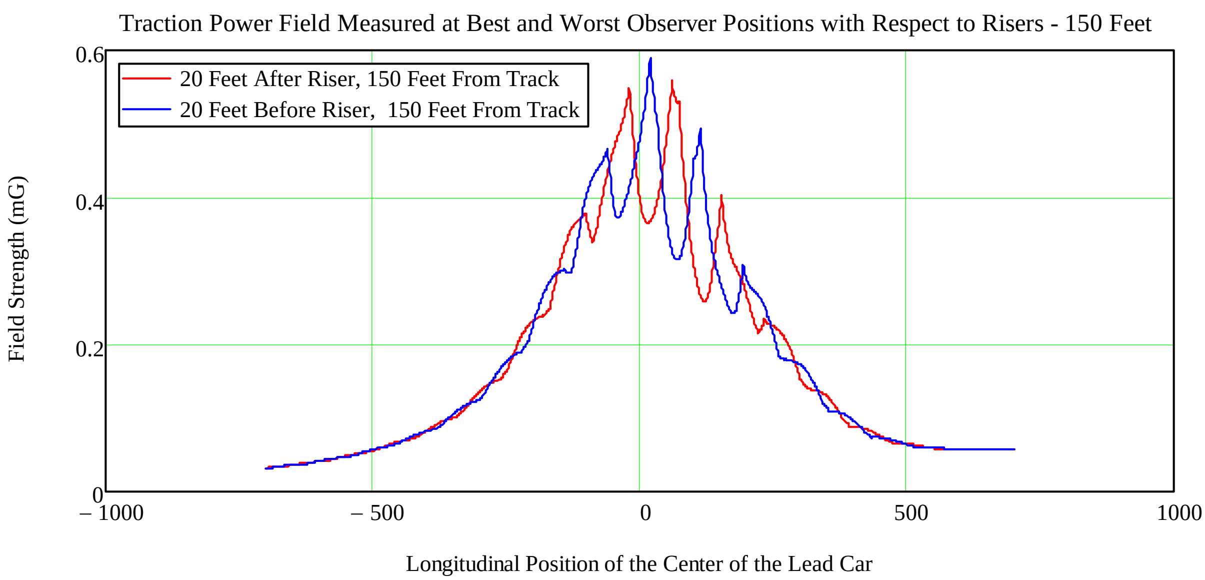


Figure 12: Traction Power Field Measured at 150 Feet from the Best and Worst Longitudinal Positions

As can be seen above, the differences in magnitude measured at various locations between risers as the trains move by are small. Nevertheless, all further calculations were made with the measuring instrument located in the worst longitudinal position, 20 feet before a riser.

Variation of Traction Power Field with Height

Simulations were run with the traction power magnetic field calculated for measurement points at various heights with respect to the ground plane. The vertical distances simulated were -10 feet, 5 feet and 20 feet above the ground plane.

Figure 13 and Figure 14 show that the maximum traction power field resultant is slightly higher at 5 feet above ground and 10 feet below ground than at 20 feet above ground, consequently, the results are presented for a height of 5 feet above ground level.

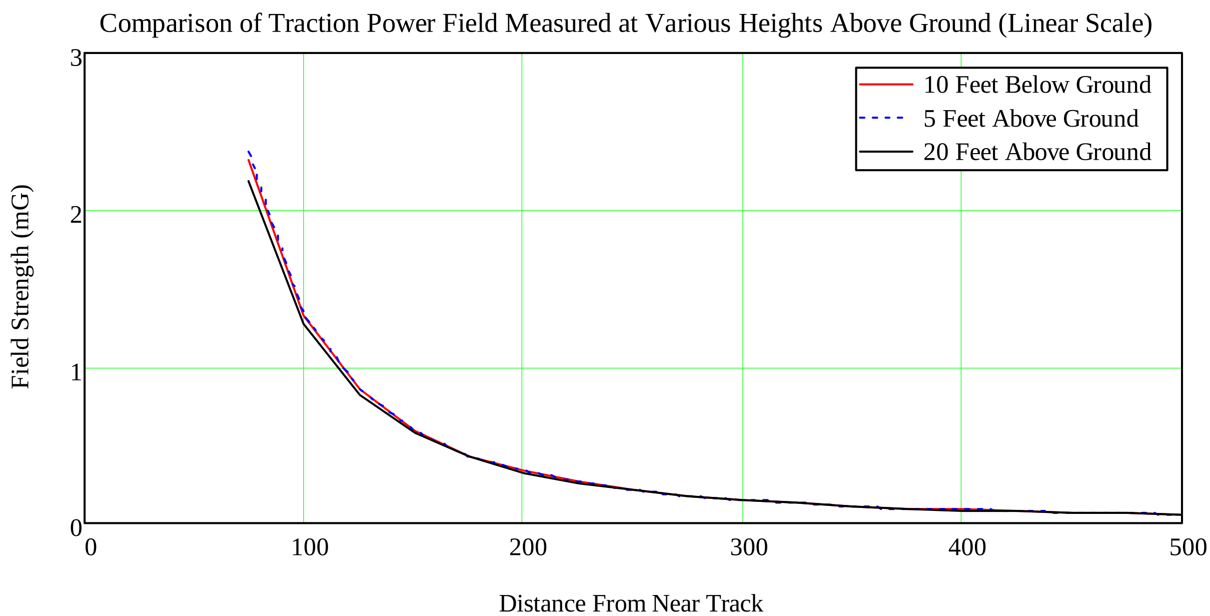


Figure 13: Comparison of Maximum Traction Power Field at Various Heights (linear scale)

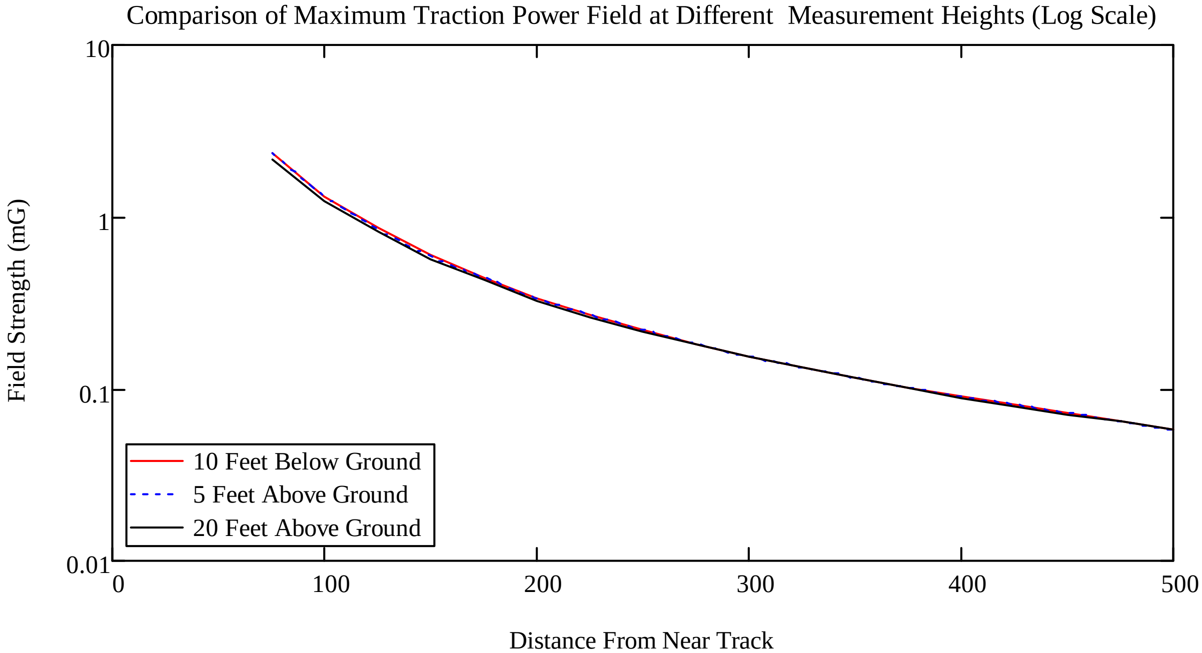


Figure 14: Comparison of Maximum Traction Power Fields at Various Heights (log scale)

As can be seen in the graphs above the difference with height is small and decays to insignificance within 200 feet from the tracks.

The Effect of Contact Wire Wear

In order to examine effect of the full range of contact wire wear, the combined traction power and geomagnetic field resultant was calculated for new contact wire, wire with a 15% cross sectional loss, and wire with a 30% cross sectional loss. Thirty per cent wear is the recommended replacement point.

The results are displayed in
Figure 15 and
Figure 16 below in logarithmic and non-logarithmic scales.

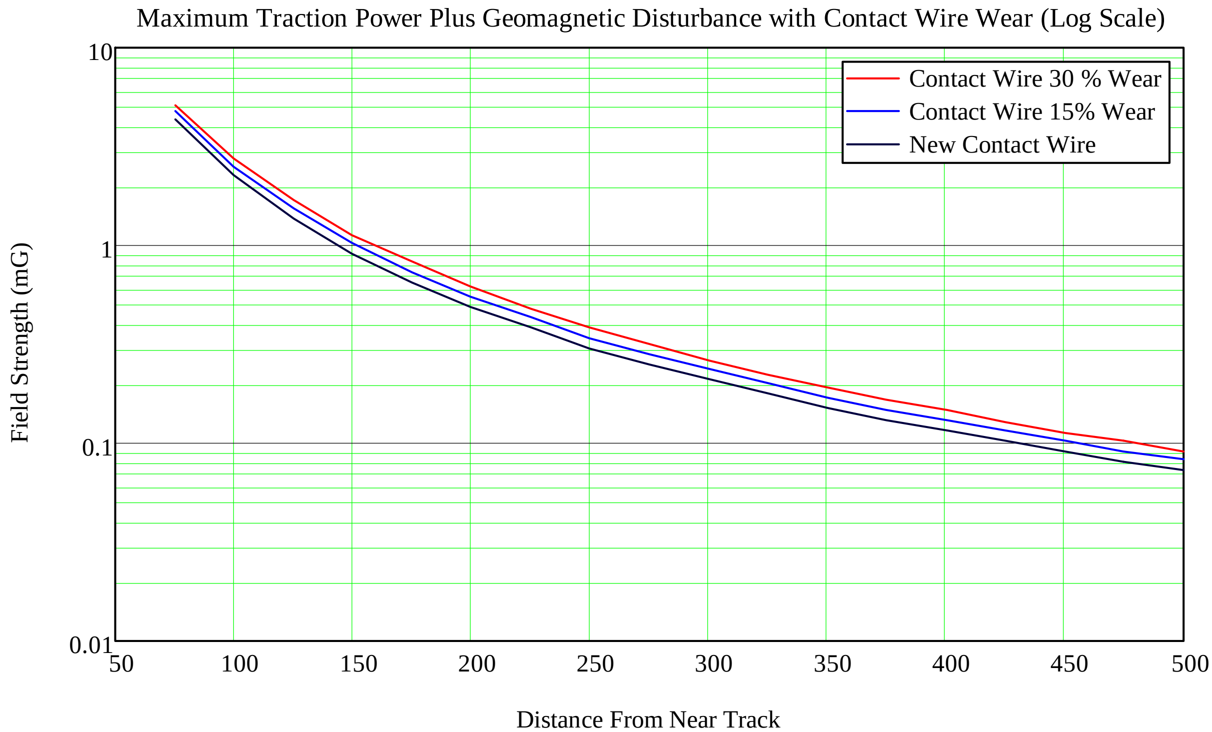


Figure 15: Maximum Traction Power + Geomagnetic Disturbance with Contact Wire Wear (log scale)

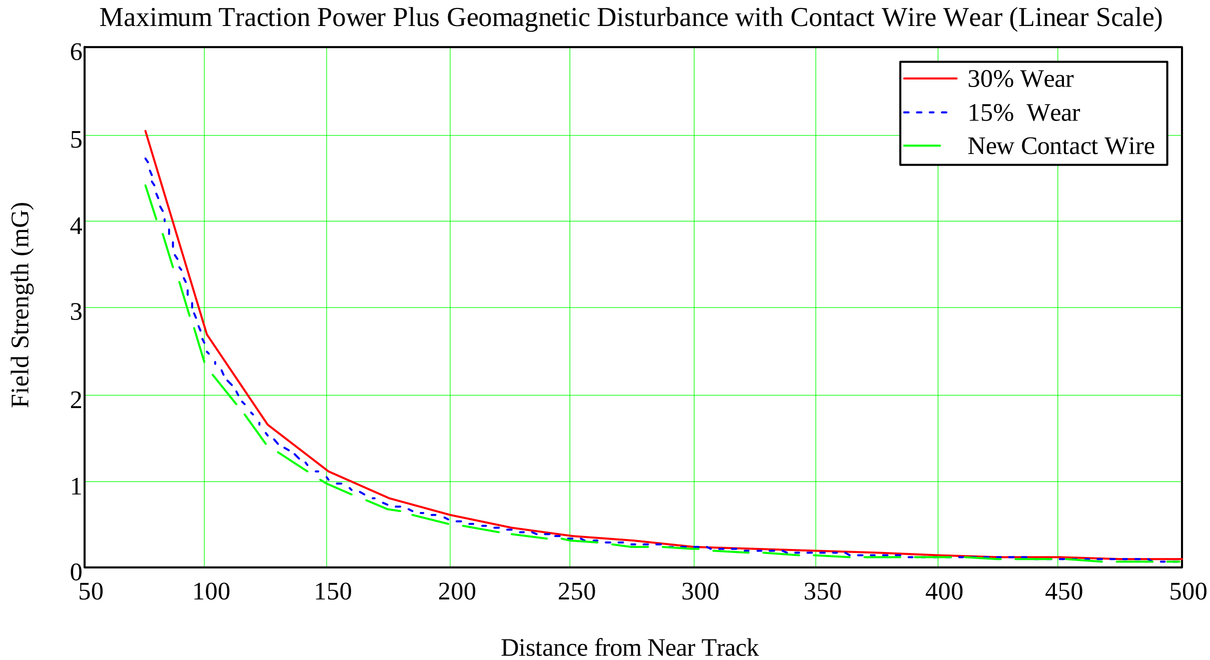


Figure 16: Effect of Contact Wire Wear on Combined Traction Power plus Geomagnetic Disturbance (linear scale)

Clearly wear of the contact wire does not significantly degrade the high-low power supply system.

Conversion of Simulation Results into Magnetic Distortion Contour Maps

As described above, the result of the simulation is a 3-D graph that shows a magnetic distortion "bubble". In order to ascertain the effect that the bubble has on sensitive instruments, it is necessary to plot the footprint of the bubble onto a map of the affected area.

As explained above, the floor of the 3-D graph may be adjusted to see the footprint at any specific magnetic field strength. If the graph is tilted and rotated to get a top-down view, a contour of the footprint at that field strength is obtained.

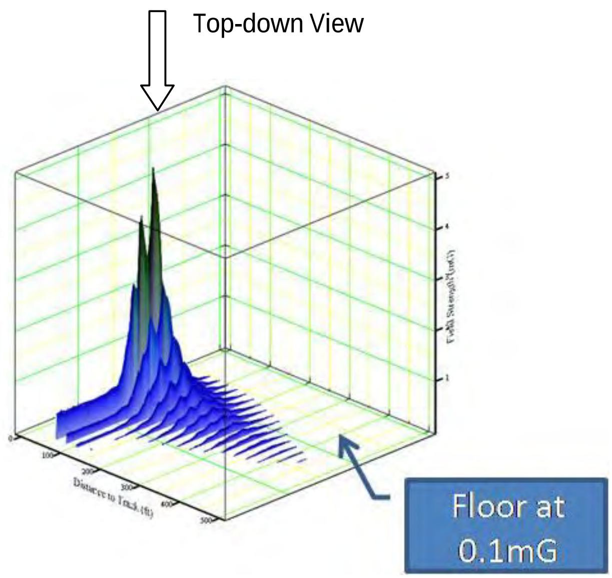


Figure 17: 3-D View of Magnetic Distortion Due to Two 2-Car Trains Passing – with 0.1mG Floor

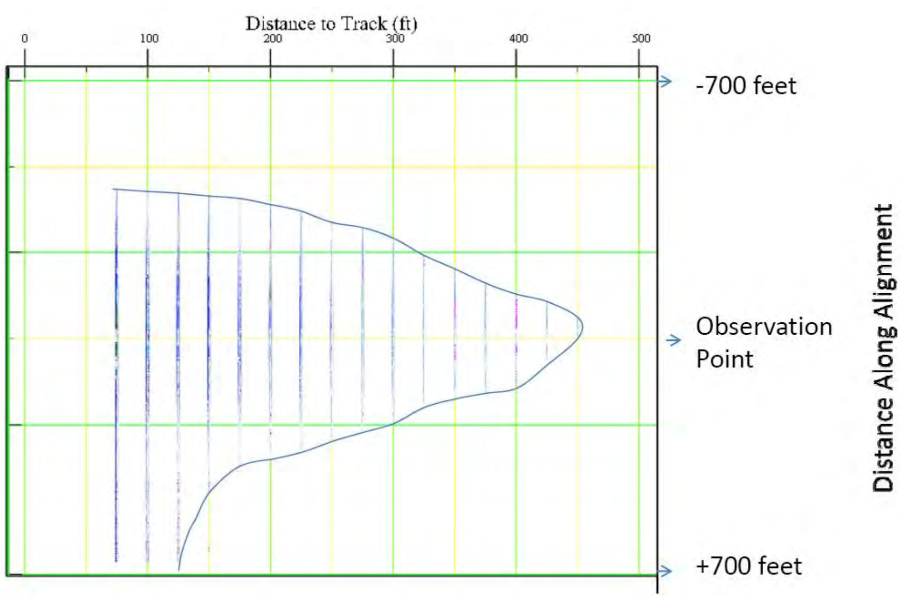


Figure 18: View of Magnetic Distortion Due to Two 2-Car Trains Passing – Top-Down View of the 0.1mG Floor

If a top-down view is obtained for 3-D graphs with different floor level, then a set of contours may be obtained for a specific condition. These contours may then be transferred to a map of the alignment in question, so that the extent of the disturbance may be seen for various buildings adjacent to the alignment.

In the map below,
Figure 19 and close up in
Figure 20, the contours are shown for the situation where two 2-car trains are meeting near the center of the map. The substation at the western end of the alignment is assumed to be heavily loaded, so that the majority of the traction current flows from the eastern end of the alignment. This is why there is a disturbance field to the eastern end along the alignment, but not at the western end. For evenly loaded substations, the contours would spread evenly on both sides, and be closer to the alignment away from the location of the trains.

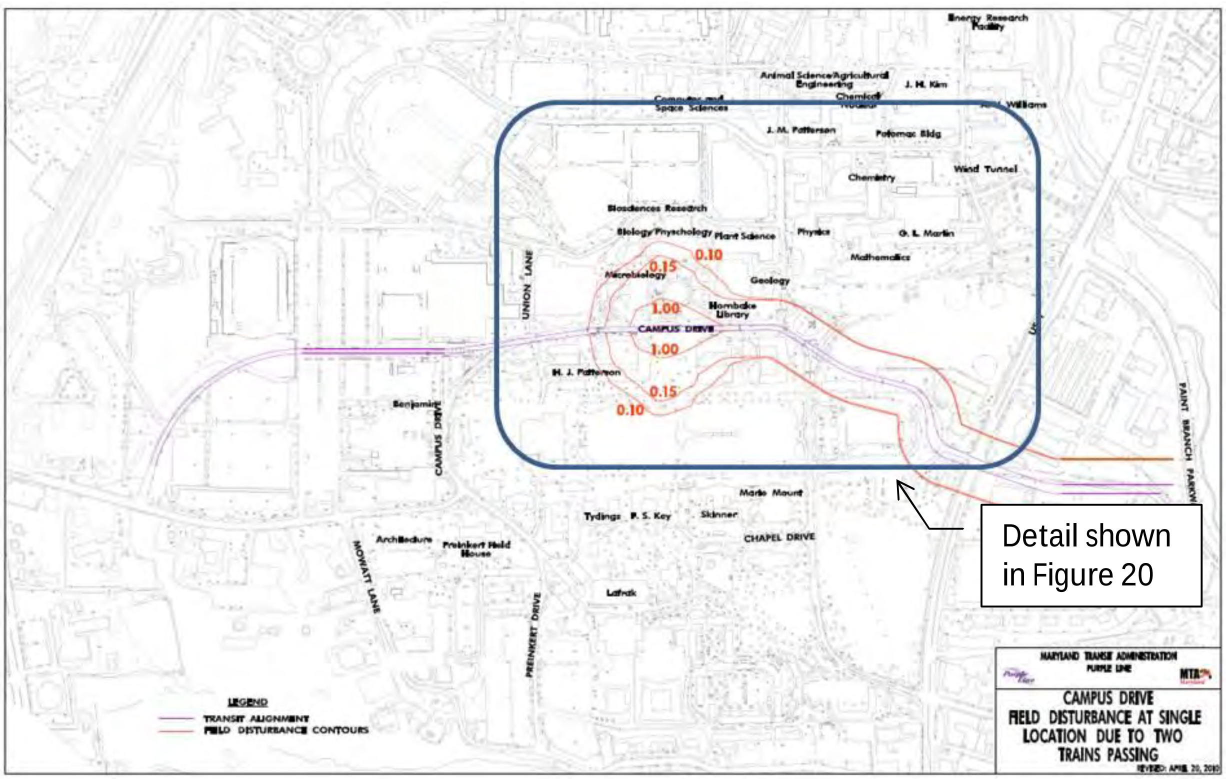


Figure 19: Contour Map to Show Instantaneous Magnetic Footprint of Light Rail Vehicle

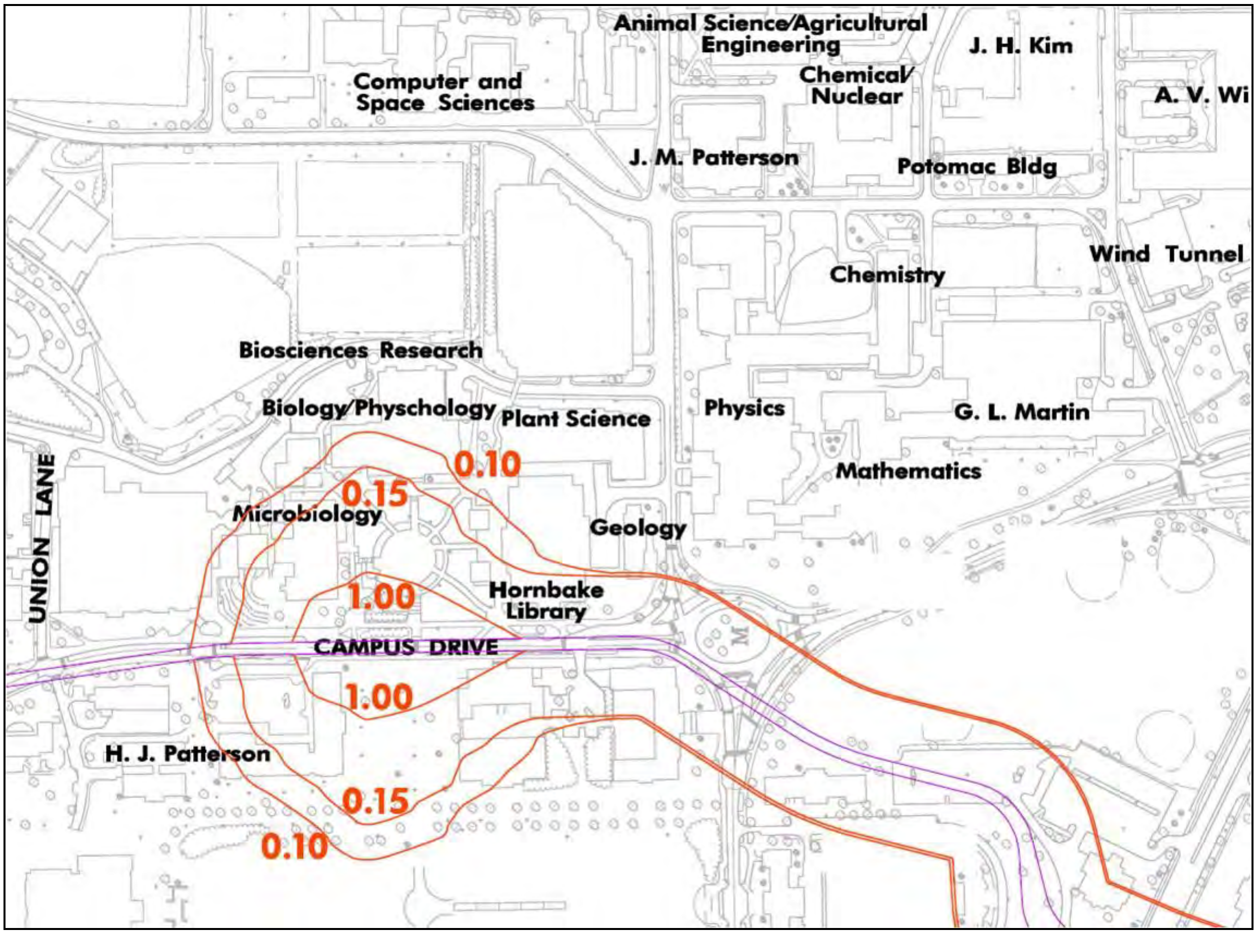


Figure 20: Detail of Section of Contour Map to Show Instantaneous Magnetic Footprint of Light Rail Vehicle

The maps above show the instantaneous magnetic fields across the affected area, which appears as a bubble on the alignment. In practice, whenever the trains are drawing current from the substation to create a magnetic field, it follows that they are also moving along the alignment. This means that the "bubble" also moves along the alignment. In order to visualize the effect that this moving bubble will have, another contour map may be drawn to show the peak distance that a specific value of the distortion to the magnetic field reaches. This will show the maximum envelope of the "bubble".

On the same contour map, it is also possible to plot the locations of specific instrumentation types, so that it is possible to see where additional local mitigation (e.g. active magnetic field cancellation equipment) may be required. The map below, (Figure 21 and close up in Figure 22) shows the locations of certain instrument types on the campus of the University of Maryland. This information is derived from data publically available on the internet. This data is correct to the best of MTA's knowledge; however, it is understood that the precise location of the instrumentation may change over time as working spaces are reconfigured etc. It is further understood that there are probably more instruments on the campus than are shown. When their locations are identified, the map will be updated.

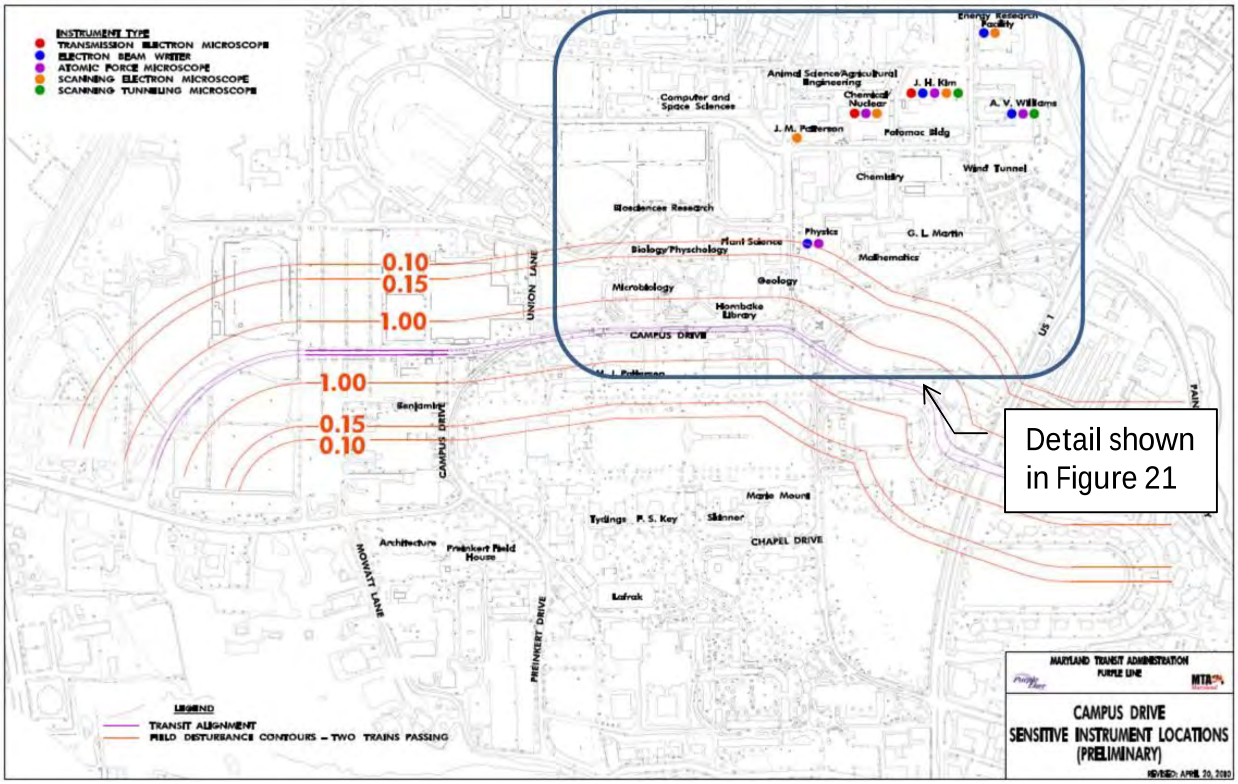


Figure 21: Contour Map to Show the Envelope of the Magnetic Distortion "Bubble"

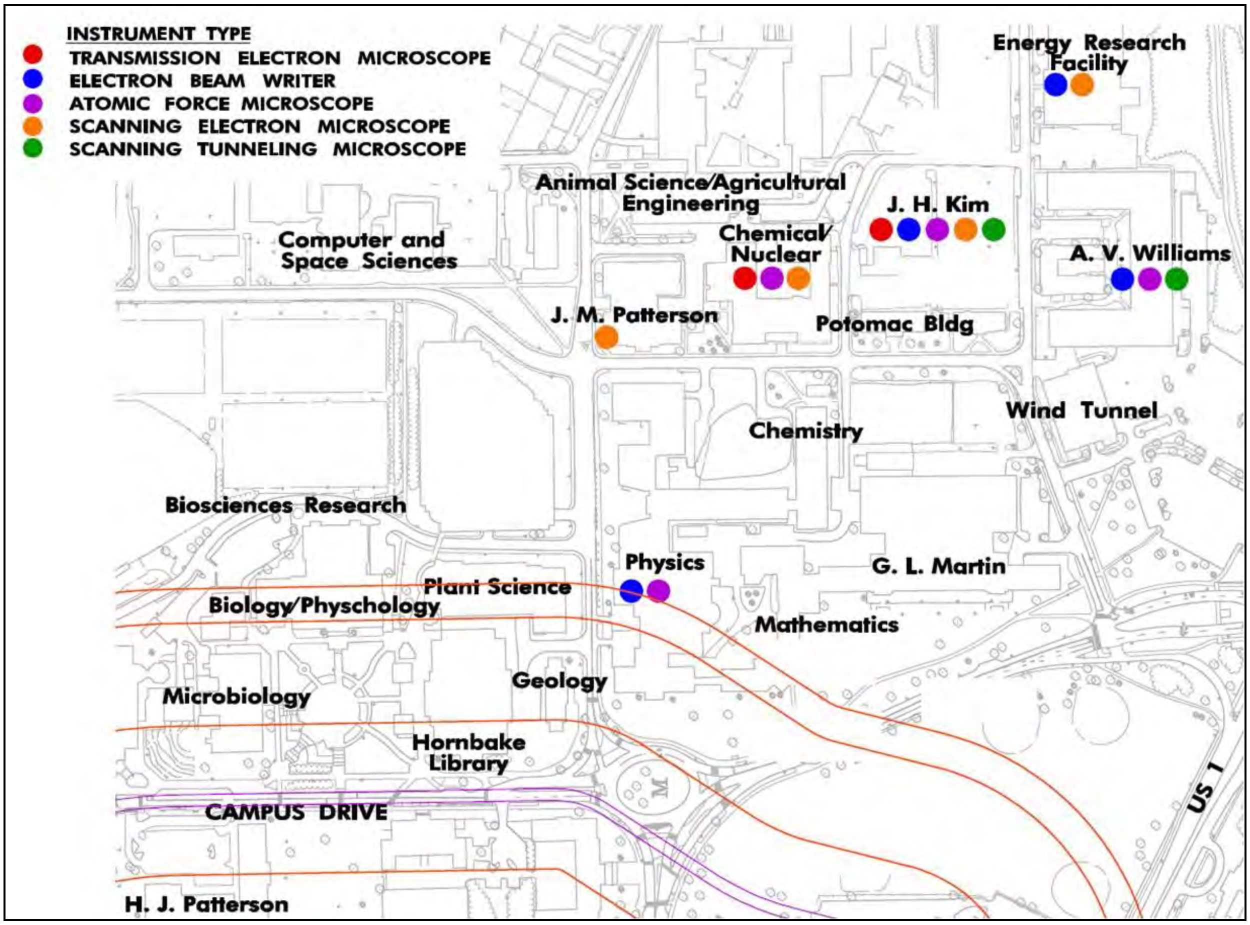


Figure 22: Contour Map to Show the Envelope of the Magnetic Distortion "Bubble" (Detail)

Conclusions

The results of the simulation indicate that with the double feeder high-low power supply system and a current limit of 500 A per car, the total field disturbance will not exceed levels which can be compensated for by active cancellation equipment. This supports the MTA's proposal as presented in the paper *Electromagnetic Emissions and Mitigation Measures*.

For the worst case condition of two 2-car trains passing, beyond 475 feet from the Purple Line, total field disturbance levels would be below 0.1 mG and most sensitive equipment would not require any shielding or active cancellation protection. Under the more typical condition of a single 2-car train passing through the campus, the total field disturbance would be less than 0.1mG beyond a distance of 350 feet.

Beyond 165 feet from the Purple Line, total field disturbance levels would be below 1 mG.

Appendix 1: Simulation Model and Assumptions

The simulation model is based on calculating the currents in the various elements of the traction power/vehicle system as the two trains occupy consecutive positions along the tracks. The fields generated by these currents are then calculated. The model uses two features to facilitate computations:

1. The model looks in detail at the currents in the car, and in the sections of track, feeder cables and contact wire for two risers in front of and behind the center of the car. Outside the two risers on either side of the car the model divides the current between the feeder cables and the contact wire in accordance with their resistance. As a result there is no current flow in the risers beyond the first two risers. A P-spice model confirmed that over 99% of the current transfer between the feeder cables and the contact wire occurs within two risers on either side of the pantograph. Therefore, the error introduced by this assumption is negligible.

2. The calculations of currents and fields are done for each car and for the effect of substation voltage differential. The results from each car and the substation differential are then superimposed to get the effect of either two 2-car trains passing, or a single 2-car train.

A1.1 Superposition

The model takes advantage of the superposition principle from both circuit and field theory.

The superposition principle in circuit theory allows the superposition of the effects of different voltage and current sources to calculate the total currents and voltages in any part of the circuit. An approximation is made in this model that each car changes the overall distribution circuit resistances very little and hence one can safely add the currents and resulting fields produced by each source in each element to get the overall result.

In addition to using the per car circuit approximation shown in Figure 24, the simulation model accounts for the influence of current produced by each car on the current-carrying elements in other cars. Where return currents from one car or from the substation run through an area occupied by another car, the current divides between the track and the internal cabling of the second car in accordance with parallel path current division. To be conservative it is assumed that negligible current flows through the car body since the effect of this path is to slightly reduce the net traction power field.

A1.2 Distortion of Traction Power Fields by Ferrous Material in the Vehicle

The model is based on the assumption that high permeability material will not be used for the car shell and that as the distance from the track becomes many times the car width, the distortion effect dissipates. Approximate two dimensional modeling indicates that, if anything, the distortion effect will reduce the net field from the car currents at the distances of concern.

For vertical currents, the model assumes that the fields from vertical currents within the car structure are not attenuated by the steel skeleton. However, 100% attenuation is assumed for vertical currents passing through the trucks. For the riser currents, no attenuation is assumed. These assumptions provide a very conservative picture of cancellation of riser pole currents by descending vehicle currents.

A1.3 Geomagnetic Perturbation

In the model presented the resultants of the geomagnetic distortions recorded in a test in Minneapolis for the Central Corridor Light Rail Project were added to the calculated traction power resultant field to get a combined resultant field disturbance.

The Minneapolis rolling tests were conducted with 3-car trains on an east-west track similar to the mitigation area at the University of Maryland.

The test cars were heavier and contain more steel than will be used for the Purple Line. The static tests conducted in Minneapolis showed that the maximum distortion of the Z-axis field at 75 feet with a 3-car train was only 18% less than with two 2-car trains coinciding on adjacent tracks. Since the Purple Line vehicles are anticipated to be much lighter than the Minneapolis vehicles used in the test, no compensation for a second 2-car train was used in the model.

The Minneapolis test data was taken for distances from the track of 25 feet, 50 feet, 75 feet, 84 feet and 100 feet. The data was recorded against time. The data was converted to field versus car position charts based on the length of the cars and the distance between the bumps for each car in the resultant graph.

In order to account for geomagnetic distortion for all distances including those beyond 100 feet, an equation was generated to fit the decay data of the peak resultants of the experimental geomagnetic data. The resultant graph is shown in Figure 23 below.

In an effort to provide a conservative estimate of worst case distortion, the peak resultant geomagnetic distortion is aligned with the peak resultant traction power field. The geomagnetic distortion and traction power field curves are then superimposed with worst case vector addition to provide the most conservative result.

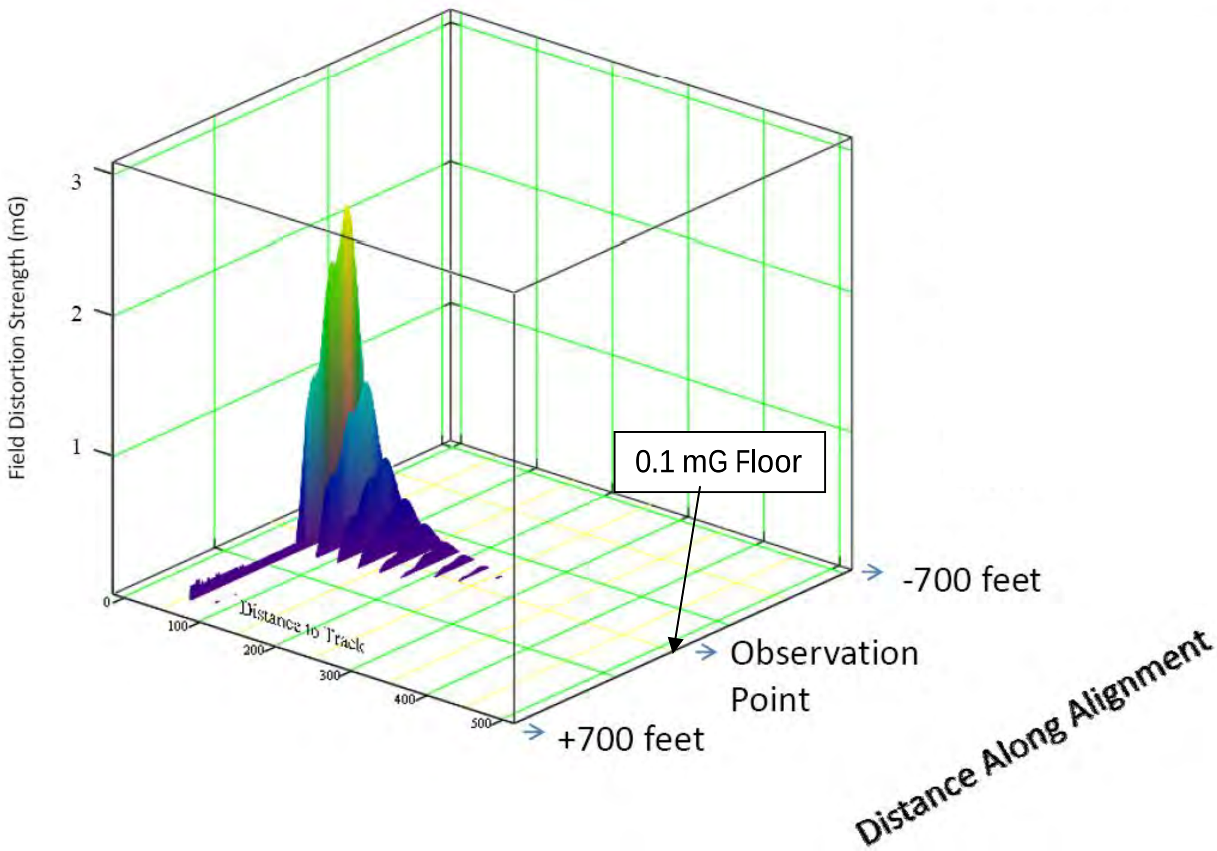


Figure 23: 3-D Graph of Geomagnetic Field Disturbance Based on Minneapolis Test

A1.4 The Circuit Model

The per car circuit model used is shown in Figure 24. The currents in each element are recalculated every foot as the trains are moved from left to right. Mesh Equations with a matrix solution are used.

While return currents are calculated for each track, the track current in each track is divided equally between the rails for magnetic field calculation.

The currents are calculated for each car. Using the principle of super position the effects of the substation voltages are only calculated for the first car. For the subsequent cars the voltage sources in the substations are treated as short circuits.

Where one car's return current goes through the area of track occupied by another car, the track current is split between the car return cabling and the track underneath it for purposes of calculating fields. This effect is relatively small but has been included for accuracy.

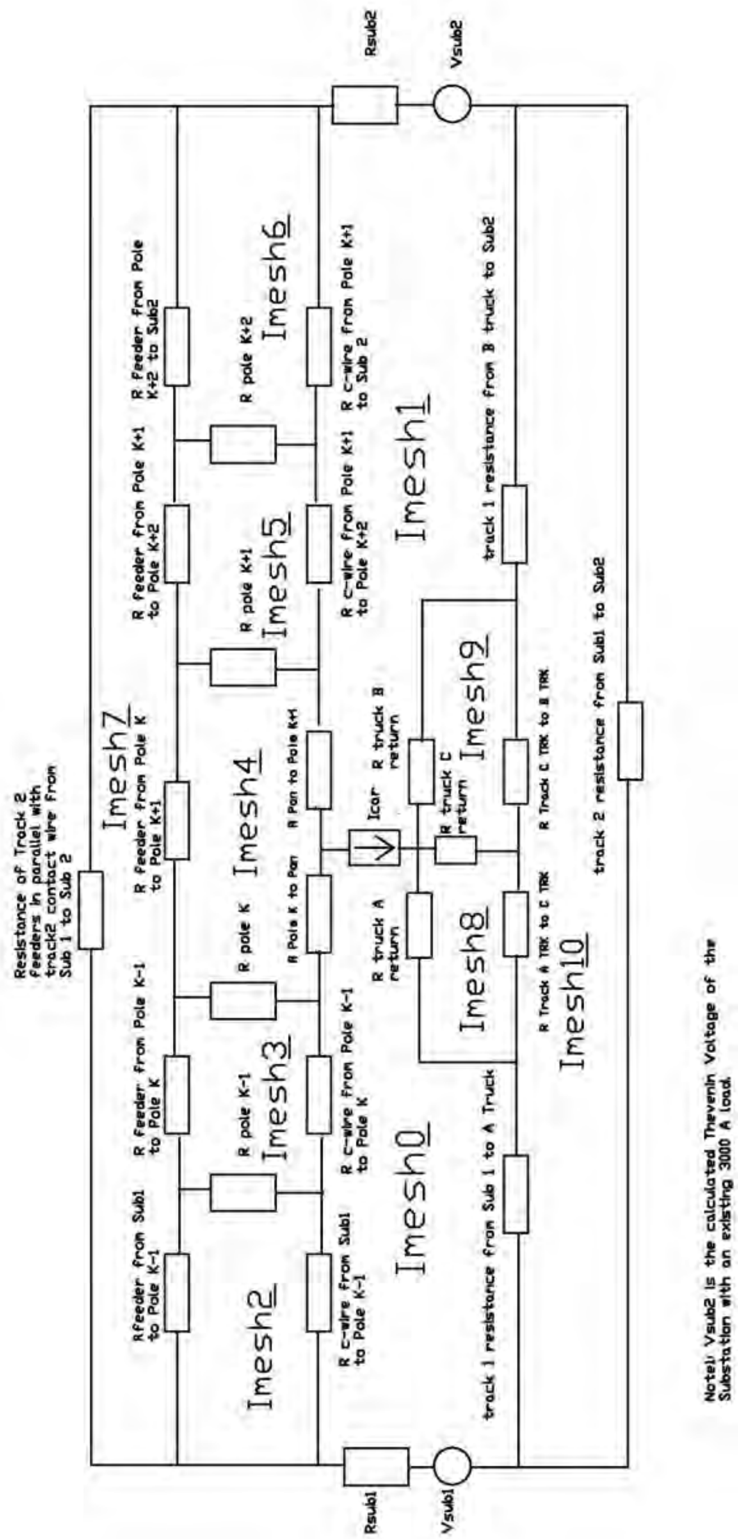


Figure 24: Circuit Model for Mesh Equations

A1.5 Calculating the Field

The field at the observer's position generated by each circuit element is calculated during each iteration using the Biot-Savart Law applied to a length of straight wire.

$$\mathbf{B} = \int_a^b \mu \cdot I \cdot \frac{\mathbf{r} \times \mathbf{dl}}{4 \cdot \pi \cdot R^2}$$

Where:
B = the magnetic flux density vector
R = the scalar distance between the current element of length *dl*.
r = the unit vector in the direction from the current element to the measurement point
I = the scalar current in the element
dl = the vector of the infinitesimal integration length
μ = permeability constant.
a and b are the ends of the wire length

The Z-Axis B-field generated by each longitudinal current element is calculated using the following function:

$$B_{HZ}(I, start, end, h, H_E, d) = \int_{\frac{start}{3.281}}^{\frac{end}{3.281}} \frac{\mu \cdot 10^7}{4 \cdot \pi} \cdot \frac{I \cdot \frac{\sqrt{d^2 + (H_E - h)^2}}{\sqrt{x^2 + d^2 + (H_E - h)^2}} \cdot \frac{d}{\sqrt{d^2 + (H_E - h)^2}}}{x^2 + d^2 + (H_E - h)^2} \, dx$$

Where:
I = current in the element
start and end = the distance of the ends of the element from the observer. The observer is located at zero.
d = the transverse (Y) distance between the observer and the circuit element
H_E = the height of the circuit element above ground
h = the height of the observer above ground
x = the integration variable along the X or longitudinal axis.
μ = the magnetic permeability of air or free space ($4\pi * 10^{-7}$)

The result is multiplied by 10^7 to convert from Teslas to milligauss.

$$\frac{\sqrt{d^2 + (H_E - h)^2}}{\sqrt{x^2 + d^2 + (H_E - h)^2}}$$

= the sine of the angle between the current and the observer. The sine is used for the cross product.

$$\frac{d}{\sqrt{d^2 + (H_E - h)^2}}$$

=the sine of the angle between the line of the current element and the observer, with 0 degrees parallel to the Z axis. This term provides the Z component of the cross product.

The Z component of the B- field generated by the current in the transverse elements going from the riser to the contact wire and from the feeder to the riser is calculated with the following integral:

$$B_{TrcurrZ}(I, start, end, x_{te}, T_E, h) = \frac{\mu \cdot I \cdot 10^7}{4 \cdot \pi} \cdot \int_{start}^{end} \frac{\frac{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}}{\sqrt{y^2 + \left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}} \cdot \frac{\frac{-x_{te}}{3.281}}{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}}}{\left[y^2 + \left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2\right]} dy$$

Where:
I = riser current
start = transverse distance from observer to start of the current element in meters
end = transverse distance from the observer to the start of the current element in meters
T_E = transverse element height above the ground plane in meters
x_{te} = longitudinal distance from observer to the riser in feet
h = height of the observer in meters

$$\frac{\frac{-x_{te}}{3.281}}{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}}$$

provides the Z component of the cross product

The Y components of the B field generated by longitudinal currents are calculated using the following function:

$$B_{HY}(I, start, end, h, H_E, d) = \int_{\frac{start}{3.281}}^{\frac{end}{3.281}} \frac{\mu \cdot 10^7}{4 \cdot \pi} \cdot \frac{I \cdot \frac{\sqrt{d^2 + (h - H_E)^2}}{\sqrt{x^2 + d^2 + (h - H_E)^2}} \cdot \frac{-(h - H_E)}{\sqrt{d^2 + (h - H_E)^2}}}{x^2 + d^2 + (h - H_E)^2} \, dx$$

Provides the Y component of the cross product so that By is positive when current goes to the right and the observer is below the element.

$$\frac{-(h - H_E)}{\sqrt{d^2 + (h - H_E)^2}}$$

$$B_{Yvertcurr}(I, bottom, top, x_{ve}, h, d) = \frac{\mu \cdot 10^7}{4 \cdot \pi} \cdot I \cdot \int_{bottom - h}^{top - h} \frac{\sqrt{\left(\frac{x_{ve}}{3.281}\right)^2 + d^2}}{\left[z^2 + \left(\frac{x_{ve}}{3.281}\right)^2 + d^2\right]^{\frac{3}{2}}} \cdot \frac{\frac{-x_{ve}}{3.281}}{\sqrt{\left(\frac{x_{ve}}{3.281}\right)^2 + d^2}} \, dz$$

The Y-axis field generated by vertical currents calculated using:

Where:
x_{ve} = the longitudinal distance of the vertical element from the observer in feet
d = the transverse distance from the observer to the vertical element
h = the height of the observer
bottom = the distance of the lower end of the vertical element above the ground in meters
top = the distance of the top end of the vertical element from the observer in meters
z = the integration variable

All other measurements are in meters.

$$\frac{\frac{-x_{ve}}{3.281}}{\sqrt{\left(\frac{x_{ve}}{3.281}\right)^2 + d^2}}$$ provides the Y component of the cross product.

The X-axis field components generated by the vertical currents are calculated using a very similar function:

$$B_{Xvertcurr}(I, bottom, top, x_{ve}, h, d) = \int_{bottom-h}^{top-h} \frac{\mu \cdot 10^7}{4 \cdot \pi} \cdot I \cdot \frac{\sqrt{\frac{\left(\frac{x_{ve}}{3.281}\right)^2 + d^2}{z^2 + \left(\frac{x_{ve}}{3.281}\right)^2 + d^2}}}{\left[z^2 + \left(\frac{x_{ve}}{3.281}\right)^2 + d^2\right]} \cdot \frac{-d}{\sqrt{\left(\frac{x_{ve}}{3.281}\right)^2 + d^2}} \, dz$$

The Bx component is positive when the observer is on the negative side of the tracks.

The X-axis field components produced by the transverse currents are calculated using the following function:

$$B_{Xtrcurr}(I, start, end, x_{te}, T_E, h) = \frac{\mu \cdot I \cdot 10^7}{4 \cdot \pi} \cdot \int_{start}^{end} \frac{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2} \cdot \frac{(T_E - h)}{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}}}{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2 + y^2}} \, dy$$

$$\frac{(T_E - h)}{\sqrt{\left(\frac{x_{te}}{3.281}\right)^2 + (T_E - h)^2}}$$

Provides the X component of the cross product.

Appendix 2: Additional Traction Power and Geomagnetic Field Plots

Below are sample plots of the X, Y, and Z-Axis Traction Power Fields.

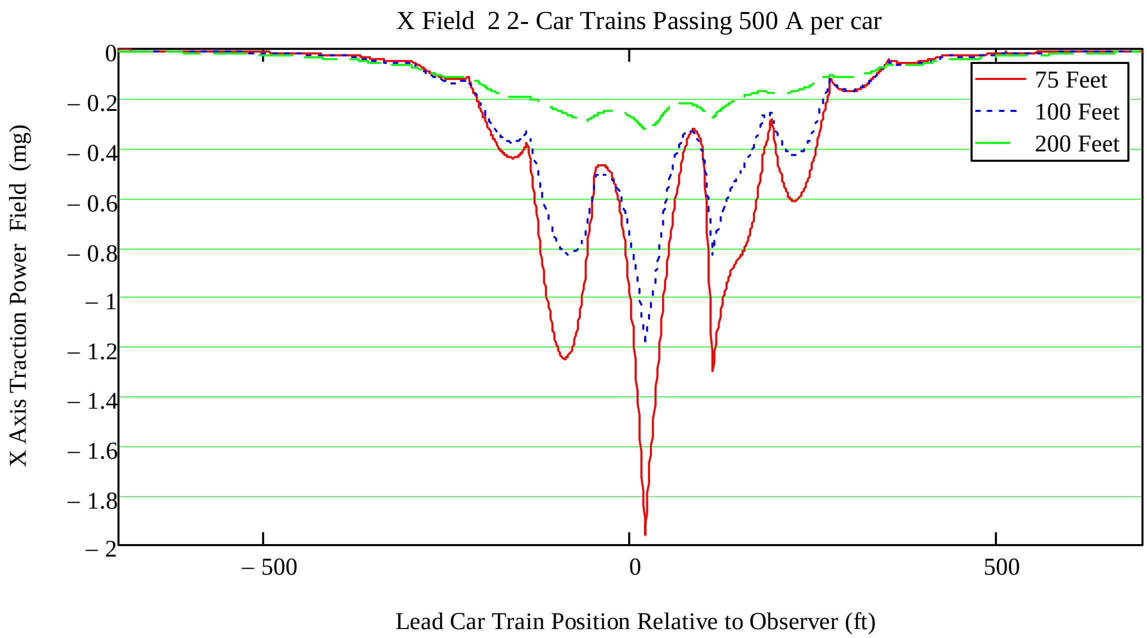


Figure 25: Sample X-Axis Traction Power Magnetic Field Plot

Figure 26: Sample Y-Axis Traction Power Magnetic Field Plot

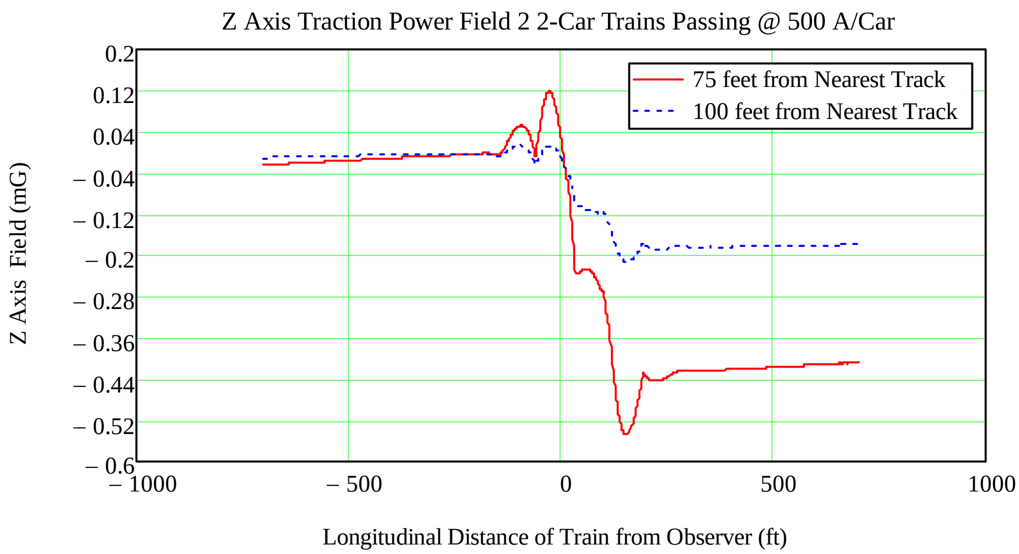


Figure 27: Sample Z-Axis Traction Power Magnetic Field Plot

23. Electromagnetic Emissions and Mitigation Measures

Electromagnetic Emissions and Mitigation Measures

February 16, 2010

Table of Contents

Introduction

The University of Maryland has understandable concerns about the potential adverse effects of a light rail transit (LRT) alignment through campus. These issues include pedestrian safety, traffic, visual and aesthetic effects, vibration, utilities, and electromagnetic interference (EMI). Many of these concerns are being addressed and can be resolved with additional analysis and a collaborative design process.

However, the university's major concern that must be resolved to establish the alignment through campus is the potential deleterious effect of light rail transit-generated electromagnetic interference on equipment and research activities being conducted on campus in proximity to the light rail. The MTA has identified a solution by using a combination of a double feeder power supply system at the transitway source, supplemented by active cancellation and/or shielding that would protect individual research equipment. The MTA is proposing to install the double feeder system as part of the project construction and could agree to install, as a project expense, active cancellation or passive shielding systems for existing equipment and future equipment within a certain distance of the LRT alignment, where needed. The MTA would work with the University to determine the appropriate distance.

Proposed Project on University of Maryland Campus

The University of Maryland is indirectly served by the Metrorail Green Line at the College Park/UM station, approximately one mile from campus. The proposed Purple Line would directly serve the campus with three stations and provide a direct connection to the Metrorail system. The project would also support the University's proposed large-scale development at East Campus, and the University's M^2 Research Park on River Road, currently under development.

The Locally Preferred Alternative (LPA) includes a surface alignment through the center of campus on Campus Drive, the principal route for shuttle and transit buses today; however, the Governor's LPA announcement did not specify an exact alignment through campus. The proposed Purple Line plans would restrict traffic on Campus Drive between Union Lane and Regents Drive to transit vehicles and University service vehicles. See Figure 1.

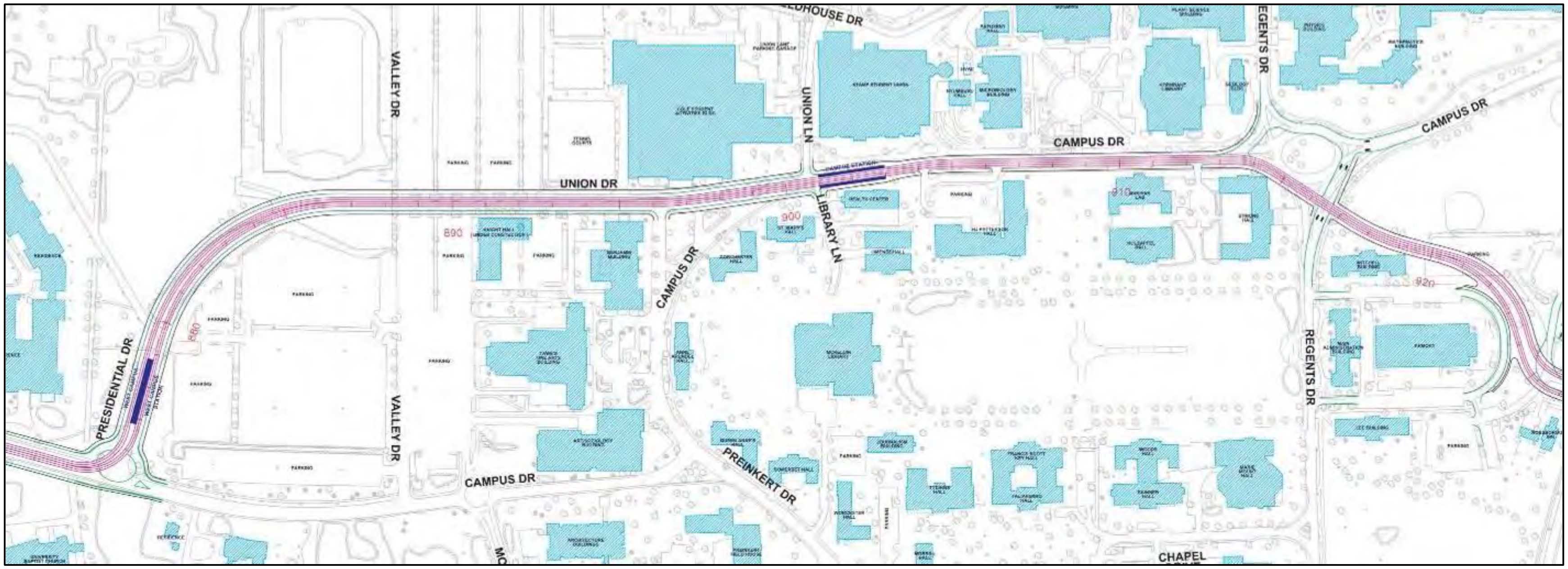
Light Rail Transit-Generated Electromagnetic Emissions

Light rail transit systems generate electromagnetic emissions in the form of magnetic field fluctuations from two sources, the propulsion system and perturbation.

The Propulsion System

Light rail vehicles have an electrical propulsion system. The propulsion system draws a large electric current from a wire that runs about 19 feet above the rails; this is referred to as the overhead catenary system. The current then returns to the electrical supply through the rails located at grade. The presence of the current in the overhead line and rails in turn

Figure 1: Proposed Campus Drive Alignment



generates a magnetic field. The magnitude of EMI is proportional to the power needs of the light rail trains as they operate both running and during acceleration.

Geomagnetic Perturbation

Light rail vehicles have steel trucks, a steel underframe, and a steel car body structure. The presence of a large mass of steel causes a distortion in the earth's naturally-occurring local magnetic field. EMI is generated by the ferrous metal (steel) mass of a moving light rail train disturbing the earth's naturally-occurring magnetic field. This is referred to as geomagnetic perturbation. An operating light rail train, therefore, is itself a source of electromagnetic interference which it has the potential to affect the instruments at the University.

Studies have been conducted on the University of Maryland campus to ascertain how much distortion there is in the local magnetic field due to the presence of large vehicles such as buses, garbage trucks, etc. Studies have also been conducted in other transit systems involving campus alignments (such as the University of Minnesota in Minneapolis-St. Paul) to measure how much distortion is caused by the passage of a light rail vehicle. The studies show that the disturbance to the local magnetic field caused by the light rail vehicle is approximately five times greater than that generated by other road vehicles, but that the effect of the distortion dies away very quickly as the distance from the rail increases. At a distance of 50 feet from the rails (which is approximately the distance to the outer walls of the closest building to the rails on the Minnesota campus), the distortion is the same as that generated by the passage of a bus next to the building.

Electromagnetic Interference (EMI) Sensitive Receptors on University of Maryland Campus

In common with many other universities, the University of Maryland has sensitive research instruments. Many of these instruments, such as electron microscopes, are very intolerant of fluctuations in the local magnetic field. Local fluctuations cause distortion in the images obtained.

Most of the potentially sensitive equipment at the University of Maryland is north of Campus Drive, and some equipment is located within several hundred feet of Campus Drive. The MTA will need a full inventory of the number, type, and locations of the sensitive equipment to fully complete its analysis of the impact and establish a budget for this mitigation. The University has specified an impact threshold standard of 0.1 mG (milligauss) that they do not wish the resultant EMI from the LRT to exceed. While existing background levels of EMI from other electrical sources on campus exceed the 0.1 mG level, it is the intermittent surge of the EMI levels caused by the LRT trains every 3-5 minutes which could adversely affect the use of certain research equipment.

Time duration for viewing specimens in an electron microscope is about a few seconds. This entails the selection of the desired lens for optimal resolution, focusing the magnetic lenses, and taking a snap-shot of the object. Recorded data is typically collected from a high resolution digital camera with a shutter time of less than one second, after which the image is deflected from the camera sensor magnetically. In rare cases where very high resolution is desired, photographic films are used to generate the image. With the rapid advance of the digital technology and high resolution sensors, photographic method will no longer be necessary. MTA is not aware of other tests that require a longer time for generation of the output data.

LRT-generated EMI on university research facilities has been or is being addressed on new LRT systems in St. Louis, Seattle, and Minneapolis. A number of older systems, particularly in Boston and Cambridge, have rail vehicles operating within close proximity to research facilities and equipment. Inquiries about these systems have informed the investigations and analyses of potential LRT-generated EMI effects and remedies. See the attached appendices for further discussion of other universities.

Mitigation

Interference can be mitigated in two manners: at the source of the EMI (the power system, the catenary system, the traction power substations, and the vehicles); and at the receptors (the research equipment).

Mitigation at the source

The magnitude of the generated magnetic field is directly proportional to the current being drawn by the vehicle systems. During the time that the vehicle is passing through the University campus, which has speed limits in effect, the speed of the vehicle will be limited to less than 20 mph, and will probably be less than 15 mph due to the high levels of pedestrian activity on campus. The speed of the vehicles could be deliberately limited to 15 mph to reduce EMI emissions. Operating at this limited speed while on campus will greatly reduce the amount of current drawn by the vehicle. As part of its operational information system, the light rail vehicles will be equipped with equipment that identifies the location of the LRT train along the alignment. This means that the vehicle will know when it is in an area where a reduction in line current is required, and the reduction in current through speed and acceleration control can be fully automatic, without requiring driver intervention.

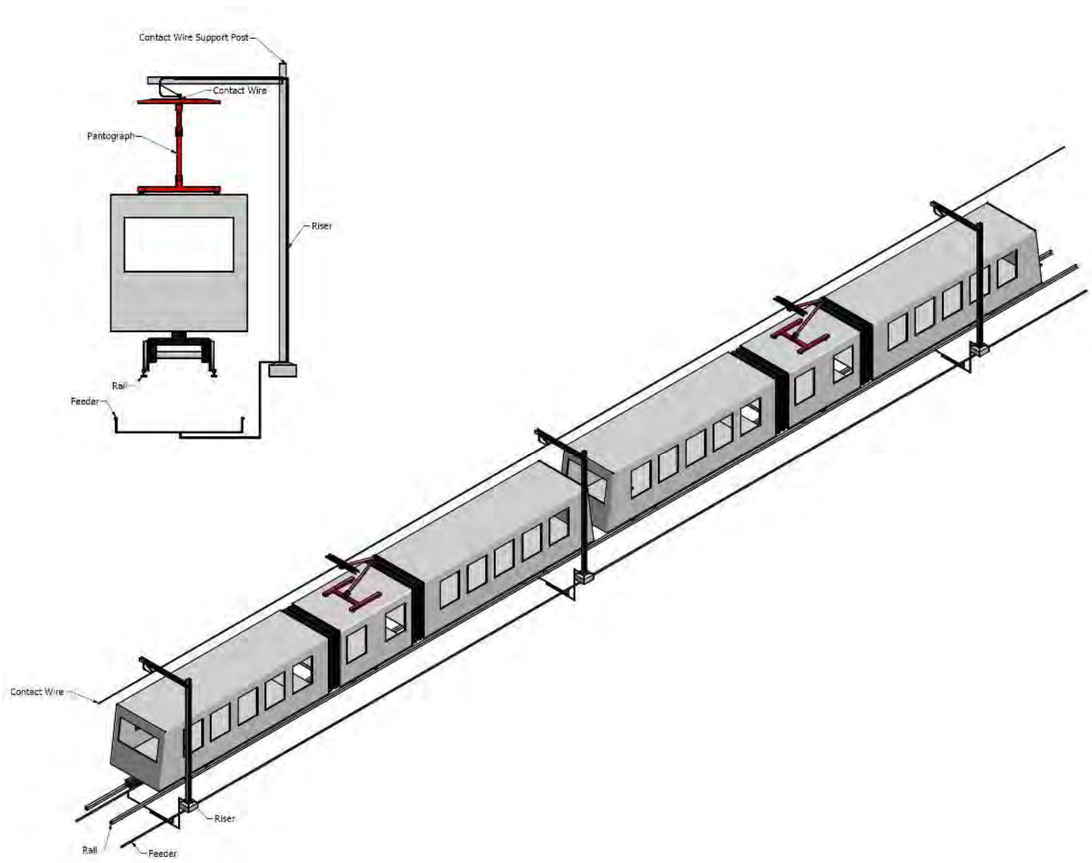
A second method to reduce EMI would be to use split wire “high-low” mitigation which reduces the effects of the EMI from the current in the catenary directly at the source.

Under split wire mitigation, the overhead wire is augmented with a feeder wire or conductor. A feeder wire is buried underground and connected to the overhead wire at predetermined intervals. This reduces the interference level by splitting the current demand between the contact wire and a feeder conductor. The magnitude of the interference can be reduced by judicial positioning of the feeder wire. This reduction is dependent on the current distribution between the contact wire and feeder conductors, the depth of burial, and the horizontal displacement of the feeder from the track. It is not desirable to locate the feeder conductor directly beneath the tracks for reasons such as maintenance and exposure to train loading. The feeder conductor is generally installed underground in a duct-bank near the running rails.

The split wire mitigation system can use either one feeder wire or a double wire. The double-feeder system uses two underground wires symmetrically located on either side of the rails. The double-wire technique provides a greater reduction in the electromagnetic emissions. The greater reduction increases proportionately with the distance from the source of EMI.

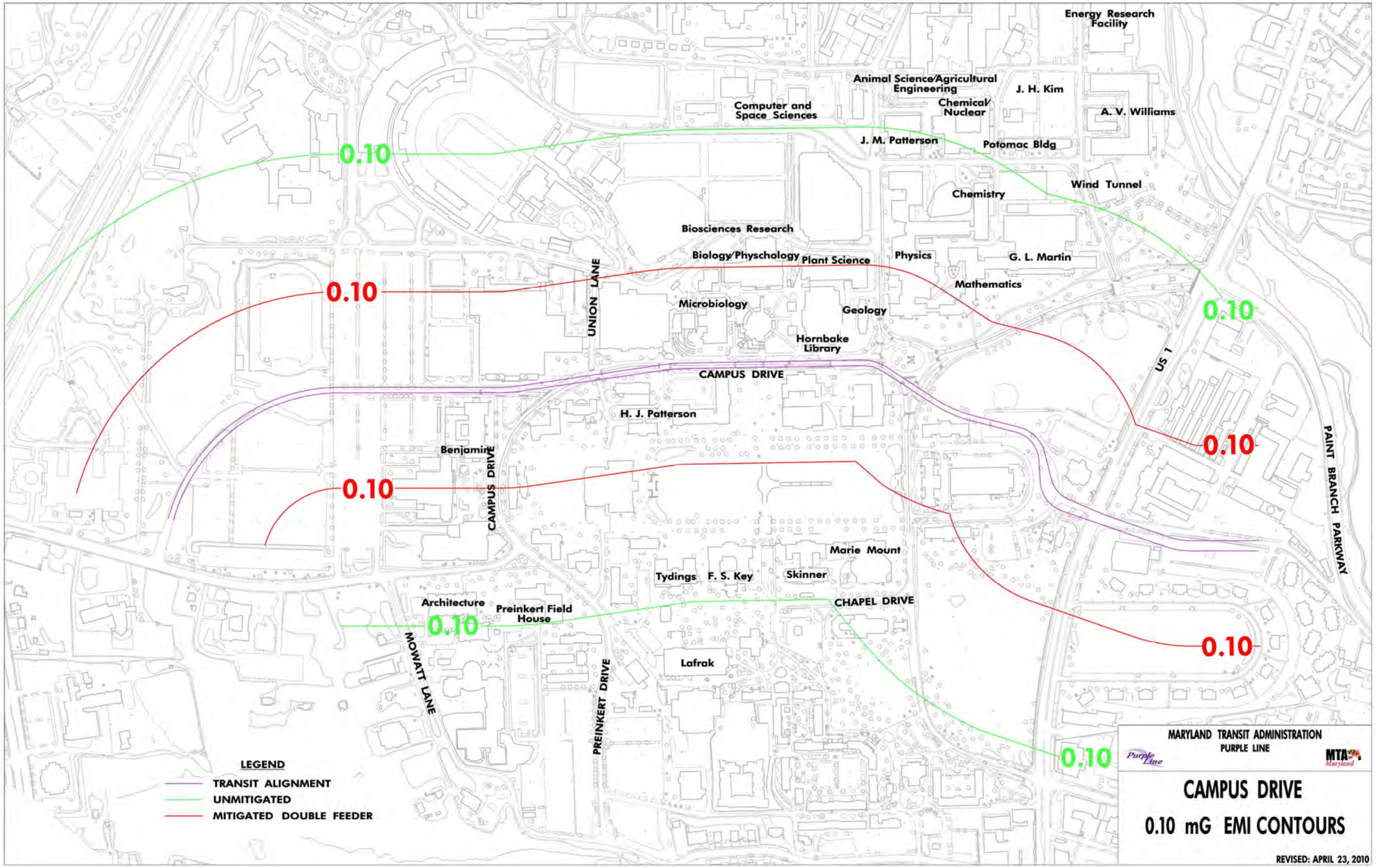
Washington University in St. Louis has used a single-feeder mitigation system that has proven to be very effective. The University of Minnesota is proposing to use a double-feeder system and the University of Washington in Seattle is proposing to use a single-feeder mitigation system to help reduce the EMI effects on the research facilities on campus.

Figure 2: Double Feeder System



Analyses and simulations were conducted to estimate the resultant levels of LRT-generated electromagnetic emissions and background conductions. The resulting estimated levels of emission relative to the distance from the proposed Campus Drive LRT alignment can be shown as "contours" on a campus map. Figure 3 shows the EMI

Figure 3: Campus Map showing EMI Contour Lines Unmitigated and with Double Feeder Source Mitigation



Note: the red lines indicate the centerlines of the tracks.

levels without mitigation and with double-feeder source mitigation in place; and indicates the buildings in which research equipment would likely need additional protection from electromagnetic emissions. The projections assume light rail operations are limited to 15 mph. Information will be needed on the specifications and locations of the research equipment.

Mitigation at the Receptor

If after mitigation is applied at the source of the EMI, there remains a need to mitigate further, there are several techniques for mitigation at the receptor, including active cancellation and passive shielding. Both techniques may be appropriate in this case.

Active cancellation equipment for sensitive measurement equipment has proven very effective. The active cancellation equipment operates in much the same manner as noise cancellation headphones in that they generate an equal but opposite field to the distortion, effectively cancelling the distortion. An example of this type of equipment is Magnetic Active Cancellation System, which can achieve a distortion attenuation of up to 30 dB. The effectiveness of the system can be seen in Figure 4 and Figure 5.

Figure 4: Unmitigated Local Magnetic Field

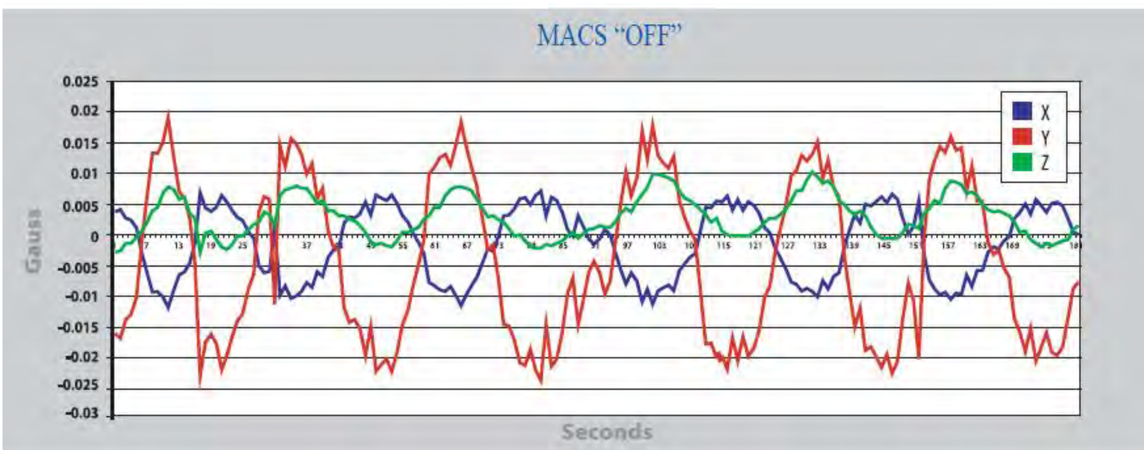
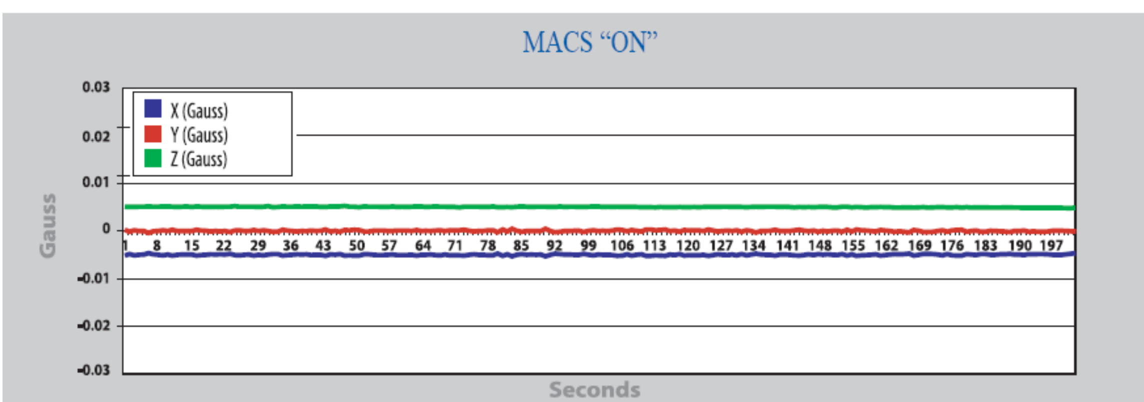


Figure 5: Local Magnetic Field with Magnetic Active Cancellation System (MACS) Switched On



If there are specific instances where the magnetic field fluctuations are high enough that the active cancellation system cannot reduce the impact to a level lower than the maximum specified by the manufacturer of the sensitive equipment, it is possible to fit passive shielding around the instrument. When properly executed passive shielding is a very effective method of reducing the effects of fluctuations in the ambient magnetic field at the instrument itself.

While further investigation is underway to gauge the effectiveness of the various passive shielding and active cancellation systems, the active cancellation devices appear to be an effective supplemental option for addressing the EMI issue at highly sensitive locations or the equipment closest to the proposed alignment. The cost per installation is approximately $40,000 for an existing piece of equipment. Subject to obtaining further information from the University on the nature and location of potentially sensitive equipment, we anticipate that the number required would be in range of one to two dozen. In the future, when purchasing new research equipment, the manufacturers may offer inclusion of active cancellation devices.

Proposed Remedy

The MTA proposes using a combination of automatic controls limiting the speed and acceleration rate of the light rail vehicles as they pass through the campus and a double feeder power supply system at the train source. If necessary this will be supplemented by active cancellation and/or passive shielding that would protect individual research equipment. The MTA is proposing to install the double feeder system as part of the project construction and would agree to install, as a project expense, effective mitigation systems (active cancellation and/or passive shielding) for existing equipment, and future equipment within a certain distance of the LRT alignment where needed. The MTA may need to establish an escrow fund for installing devices on future research equipment for some set period of time.

The MTA would also establish a monitoring program during project start-up and ongoing operations to measure the LRT-generated electromagnetic emissions and the effectiveness of the mitigation measures. As noted earlier, the exact location and specifications of the research equipment will be needed to identify the design needed to provide adequate mitigation.

Conclusion

It is believed that a combination of the mitigation remedies discussed will allow the light rail system to operate through the campus without causing undue problems due to electromagnetic interference for the sensitive instruments on the University campus.

Appendix 1: EMI Issues on other University Campuses due to Rail Operations

As part of the analysis of the potential impacts of EMI on research at the University of Maryland, the MTA has looked at other universities with similar sensitive research facilities in proximity to existing light rail lines. The following is a summary of the findings of that research.

Boston

MIT - Martinos Imaging Center

The Martinos Imaging Center at the Massachusetts Institute of Technology (MIT) houses two Magnetic Resonance Imaging (MRI) machines, and one electro-encephalograph (EEG) machine. They are currently in the process of procuring an additional MRI machine and a magneto-encephalograph (MEG) machine. The center is located approximately 150 feet from the Red Line rail system in Boston. The Red Line is a rapid transit rail line, with the traction current being drawn from a third rail.

It has been reported that the MRI machines are not affected by the operation of the rail vehicles. This is due to the fact that since the MRI machines are generators of large magnetic fields themselves, they are required to have an active cancellation system built in to prevent them from affecting other systems in the vicinity. A side effect of the active cancellation system is that it nulls local fluctuations in magnetic fields, as well as those generated by the MRI. EEG machines are also noted to be insensitive to low frequency variations in magnetic fields.

MEG machines are particularly sensitive to external magnetic fields. The new MEG machine at the Martinos Imaging Center requires an environment that has variations in the ambient magnetic field of less than 0.1 µG (0.0001 mG). This can only be achieved by placing the machine in a well shielded room, as active cancellation alone cannot achieve the required level of attenuation in the variations in the ambient field, even without taking account of the influence of the rail line. The new MEG will be housed in a room with three layers of Mu metal shielding and three layers of aluminum shielding plus active field cancellation. The new MIT MEG will be one of the most heavily shielded MEG installations in the world.

Martinos Center Charlestown Campus

The Martinos Center at the Charlestown Campus has a MEG machine which is also housed in a shielded room. In 2005, it was reported to be the fourth most heavily shielded room in the world.

Harvard - Center for Nanoscale Systems

The Center for Nanoscale Systems is located approximately 750 feet from the Red Line rail system in Boston. The Center uses several Scanning Electron Microscopes (SEM), Transmission Electron Microscopes (TEM), and Electron Beam Lithography machines.

It was reported that the Center has experienced some problems with stray field interference, but the stray field fluctuations do not exceed a few mG. It is not clear to what extent the field problems come from the Red Line which is quite far away and underground and to what extent they come from cars, buses, trucks, elevators and steel doors. Nevertheless the Center did have problems with stray fields and invested in active cancellation systems to protect the TEM, SEM, and Electron Beam Lithography machines.

The sensitivity of the equipment protected ranges from 3 mG to 0.1 mG. It was reported that the cancellation systems have worked superbly and that they should be used over passive shielding wherever possible. The active cancellation systems were supplied by Spicer Consulting. The systems control three Helmholtz coils located in the floor, ceiling, and walls to cancel the interfering fields. The Director for the Center reports that he has no problems even on equipment that has sensitivity to field fluctuations as small as 0.1 mG.

Northeastern University - Egan Engineering and Science Research Center

The Orange Line rail system (a rapid transit rail line, with the traction current being drawn from a third rail) runs adjacent to the Egan Engineering and Science Research Center. The Center houses three electron microscopes (two SEMs and one TEM), a Superconducting quantum interference device (Squid) Magnetometer, and Atomic Force Microscopes (AFM). The Center also has an electron beam diffraction system.

Magnetic field fluctuations in the building are as high as 100 mG peak to peak. The main sources of the magnetic fluctuation appear to be the buses and rail line, which pass about 40 feet from the building. The TEM machines and the AFM appear to not suffer from these fields; however, the SEM machines do suffer from the fluctuations. Active cancellation has been attempted, but the magnitude of the fluctuations is too high to be cancellable. These machines are therefore used mainly at night when the buses and rail systems are not operating. The Squid Magnetometer is equipped with its own cancellation system which makes it insensitive to external magnetic field fluctuations.

St. Louis

Washington University

Washington University in St. Louis houses several instruments sensitive to fluctuations in the ambient magnetic field. These include Nuclear Magnetic Resonance (NMR) and cyclotron machines. The Metrolink light rail system has a line that runs adjacent to the university campus, with rail vehicles drawing traction current from an overhead line. The electrical feed system in the vicinity of the university incorporates a double feeder power supply mitigation system. One of the sensitive instruments is housed approximately 150 feet from the alignment.

Prior to the construction of the line, calculations were made to estimate the likely effect of the vehicle on the ambient magnetic field. During the commissioning of the system, several measurements were made to measure fluctuations in the ambient magnetic field due to the passage of the light rail vehicle. It was found that the actual fluctuations were lower than calculated. It has been reported that the University was very satisfied with the mitigation measures taken, and that no reports of interference have been made to Metrolink since the start of operation. No additional shielding was required to provide further mitigation.

New York

Columbia University

Columbia University in New York houses TEM machines that are sensitive to fluctuations in the ambient magnetic field. The New York subway system has a line that runs adjacent to Columbia University Campus, with rail vehicles drawing traction current from a third rail.

Measurements were made in the vicinity of one of the TEM machines that are shielded by an active cancellation system. It could be seen that the attenuation afforded by the active cancellation system brought the fluctuations in the ambient magnetic field down from an unacceptably high level to a level acceptable for the use of the TEM machine.

New York University

New York University houses machines that are sensitive to fluctuations in the ambient magnetic field. Measurements were made in the vicinity of one of the machines that are shielded by an active cancellation system. It could be seen that the attenuation afforded by the active cancellation system brought the fluctuations in the ambient magnetic field down from an unacceptably high level to a level acceptable for the use of the machine.

Conclusions

Experience in St. Louis shows that a double feeder system is an effective means of mitigating the magnetic fields generated by the traction current drawn by a rail vehicle. Where separation between the rail line and instrumentation is such that the magnetic field due to the presence of rail vehicles causes fluctuations in the ambient magnetic field to be greater than that specified for an instrument sensitive to such fluctuations, there are two primary means of shielding the instrument. If the fluctuations are of the order of 10 mG or less, then active cancellation techniques have been shown to be very effective in reducing those fluctuations to an acceptable level. Where the fluctuations are greater than 10 mG, or the instrument is exceptionally sensitive (e.g. a MEG machine), then passive shielding has been shown to be the most effective method of attenuating those fluctuations to an acceptable level.

Appendix 2: Active and Passive Magnetic Compensation

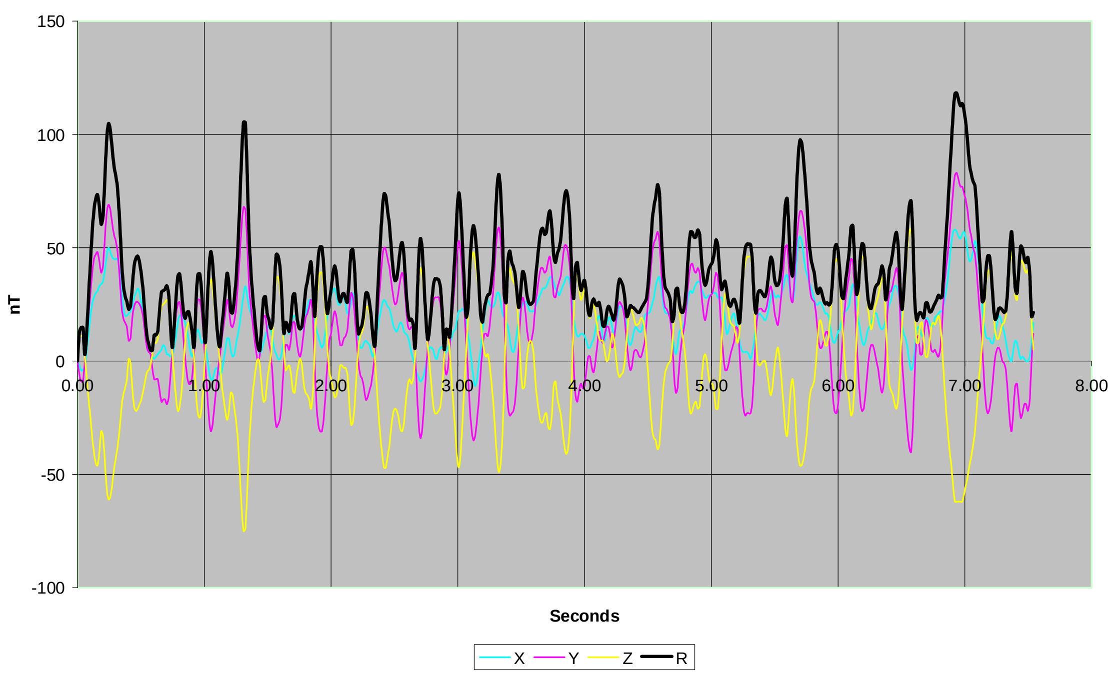
Tests were conducted at Columbia University Medical Center (CUMC) and New York University Medical Center (NYUMC) to compare the level of suppression provided by the active and passive shielding of electromagnetic fields in the low frequency range (below 10 Hz). Below is a summary of the findings:

Columbia University Medical Center

On 2010 January 21, a series of tests were conducted at the Columbia University Medical Center, where a transmission electron microscope (TEM) is housed in Room 501. This facility has two TEM units, both manufactured by FEI. One is the model Technai G20 and the other is the Technai F30. This type of microscope is chosen for the test, since it is most sensitive to deviations of ambient magnetic field. CUMC is located at 650 168th Street, New York, NY.

A snapshot of the magnetic field with Active Magnetic Compensation (AMC) in service is shown in the graph below. The magnetic field at time zero was used as reference for all events.

Figure B-1: EMI Snapshot with Active Magnetic Compensation Engaged, at CUMC



Note: Sample time for the measurement of snapshot is 0.01439 second.

Sample time for the record 1 was 0.05747 second, and

Sample time for the longer period recordings was selected as 0.5 second.

Sample times of 0.01439 and 0.05747 are internally fixed with the FVM400 Vector Magnetometer test instrument.

The instrument and the orientation of the AMC are shown in Figure B-2. The AMC is manufactured by ETS Lindgren. It should be noted that direction of the Z axis on the FVM400 meter sensor is opposite to that of the ones noted for the TEM sensor.

Figure B-3 shows Record 1 at the Columbia University. It is at longer time intervals to graph a 30-second variation of the magnetic field with the AMC in the active state. All individual components of the magnetic field are within 100 nT (1 mG) limit, although the vectorial sum of all the three, X, Y, and Z field indicates excursions beyond the 125 nT (1.25 mG) limit recommended by the manufacturer.

Figure B-2: Instrument Orientation

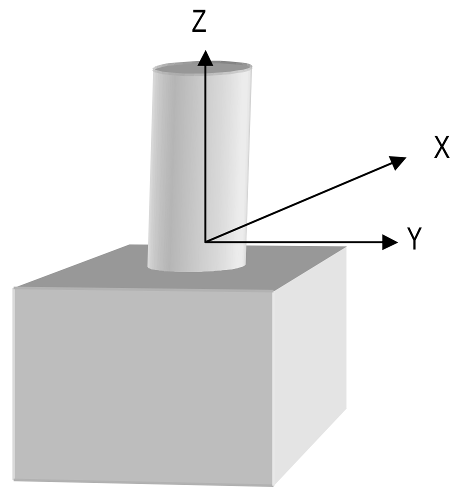
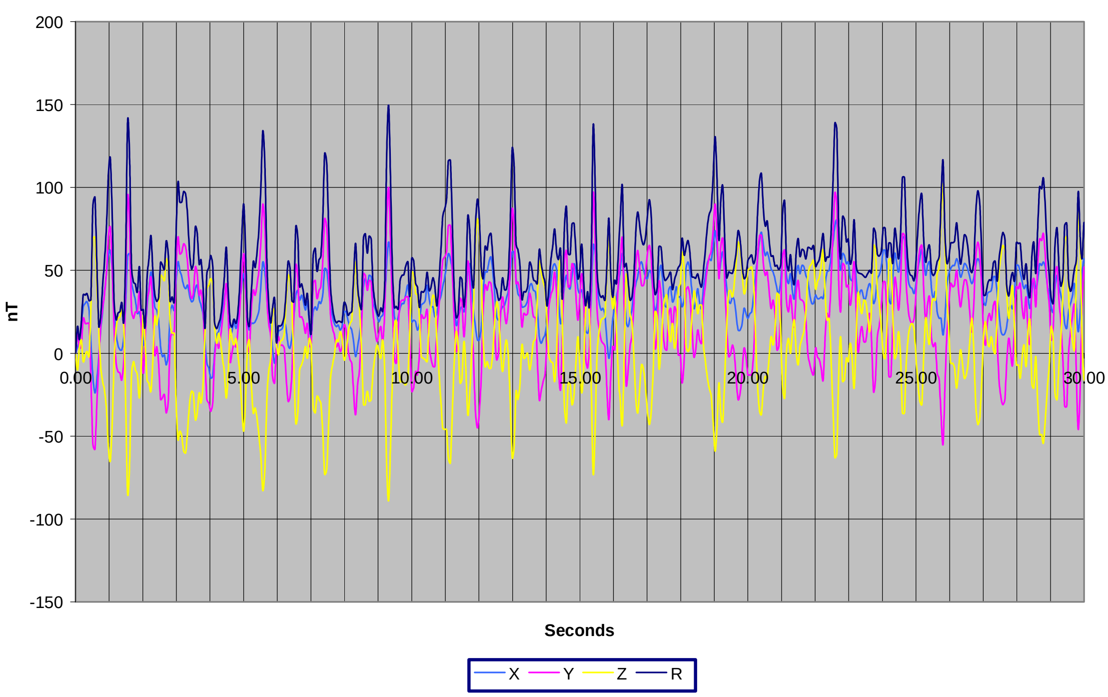
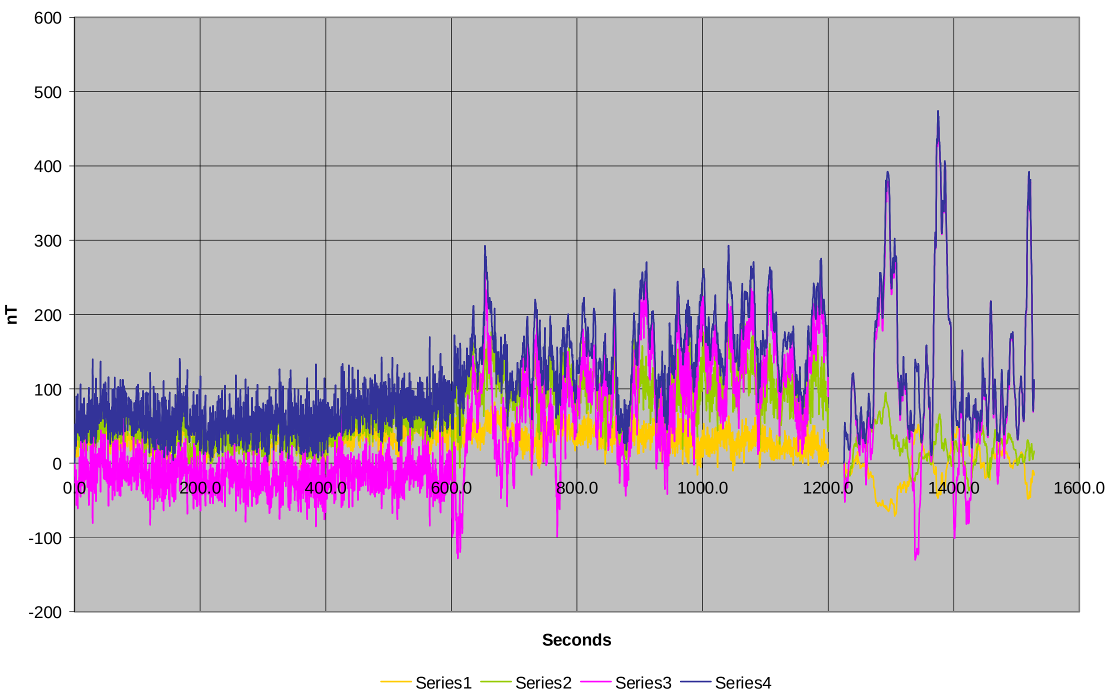


Figure B-3: Record 1, with Active Magnetic Cancellation Engaged, at CUMC



In order to make simple visual comparison of the field at the TEM, a composite graph was prepared that indicates the magnetic field with the AMC energized for a period of 600 seconds, then the AMC was de-energized for an additional 600 seconds, and finally the ambient field out side the shielded room was measured for 300 seconds. Start of time is normalized to zero for convenience. Also, start of time notation for the measurements outside the room is chosen as 1225 seconds from the start to allow better visual comparison of the composite graph.

Figure B-4: CUMC EMI Composite



New York University Medical Center

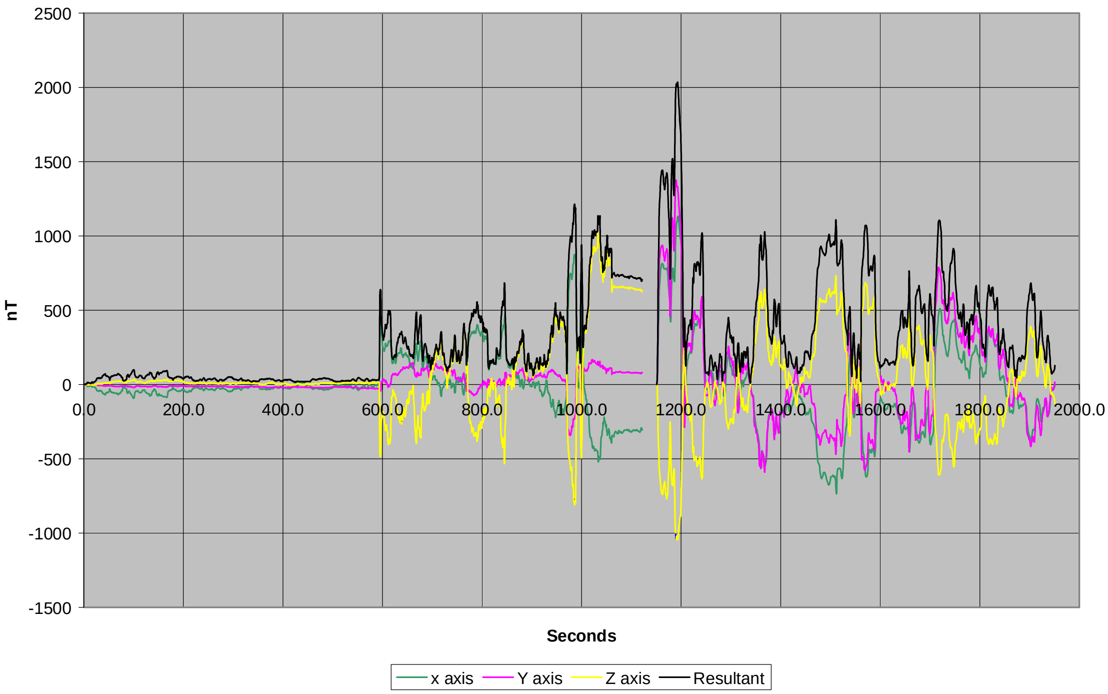
NYUMC is a good example of the EMI from transit systems. This facility, located at 540 1st Avenue in New York City, is in the vicinity of the Long Island Railroad (LIRR) and Amtrak lines that connect the Manhattan Island with the borough of Queens.

At New York University Medical Center (NYUMC) tests were made on the afternoon of 2010 January 08. Measurements were made in the room that houses the Philips CM200 Transmission Electron Microscope (TEM) (see Figure B-5).

Figure B-6 is a composite graph of the measurements that were made at the site for three conditions. The intent of the measurement was to identify the existing electromagnetic field and ascertain the efficacy of the two mitigation measures employed. In order to make this assessment, measurements started with the Active Magnetic Compensation (AMC) engaged for a period of about 10 minutes (0-594 seconds) and then the AMC was de-activated for nearly another ten minutes (from 594-1122), and finally the ambient field outside the room was measured for comparison (shown as time frame of 1151-1951).

Figure B-5: NYU Medical Center Philips CM200 Transmission Electron Microscope (TEM)

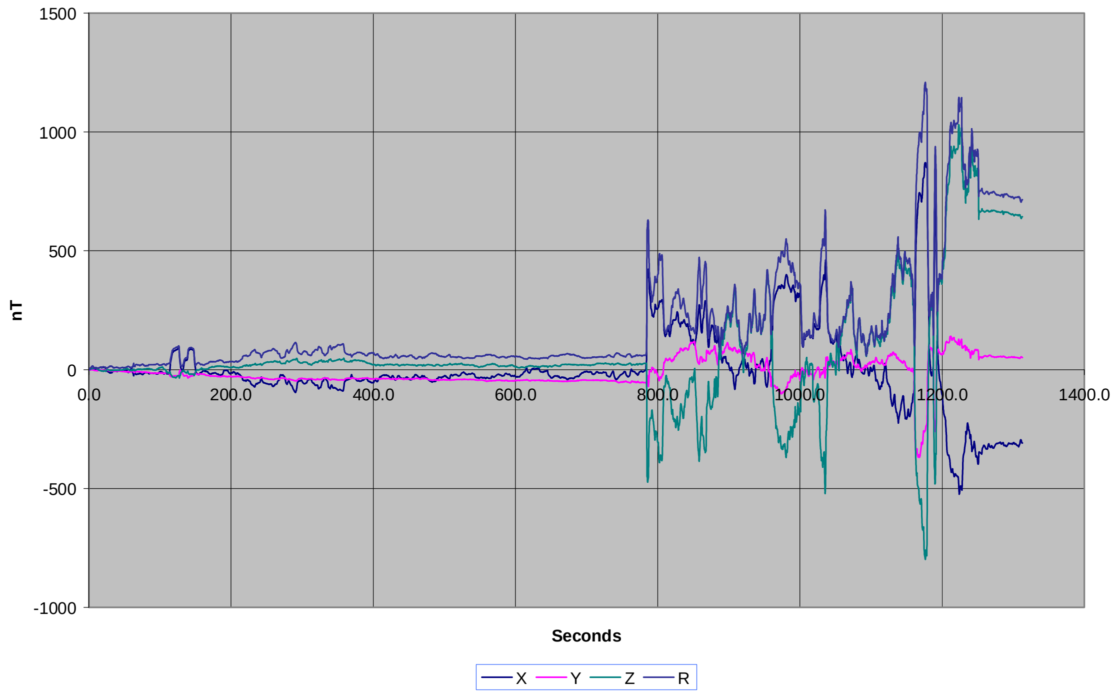
Figure B-6: NYUMC EMI Composite



The raw data for the resultant electromagnetic field indicates that the absolute magnetic field in the shielded room is about 38,615 nT (386 mG) with AMC disabled and 38,617 nT (386 mG) outside adjacent to the room. Typical magnetic field in the city of New York is about 55,000 nT (or 550 mG). This seems to suggest that there is some attenuation of the earth's magnetic field that may be attributed to the ferromagnetic material used in the building construction.

Figure B-7 below shows a plot of magnetic fields with the AMC on and off. This graph, as stated before, uses the magnetic field for each coordinate at the inception of the measurement as the point of reference, and all subsequent fields are compared to that instant.

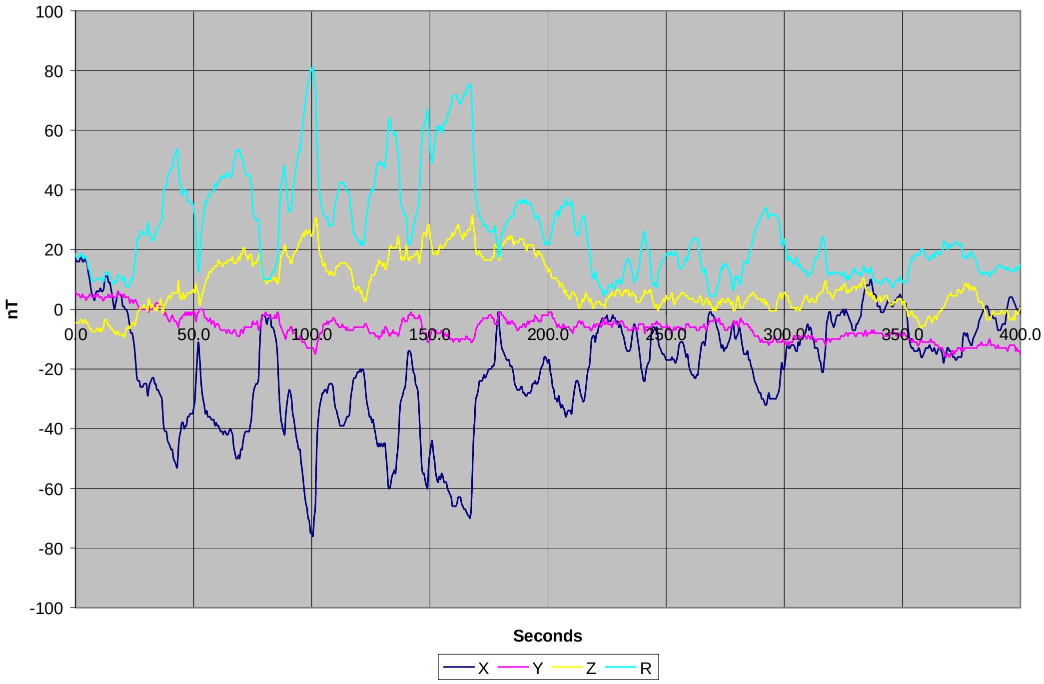
Figure B-7: NYUMC EMI



The time frame was chosen to be about ten minutes for each measurement to assure the presence of a moving train to be coincident with the measurements.

It is also possible to use an average field for the reference at the start of the measurements. This method avoids any skew of the results as shown in Figure B-8, and verifies the resultant field not to exceed 80 nT (0.8 mG), which is well within the manufacturer's recommended limits.

Figure B-8: NYUMC EMI Normalized



Conclusion

Based on the measurements and discussions with the members of these university medical facilities who use the TEMs, it is concluded that the AMC is a very effective method of mitigation for varying electromagnetic fields.

24. Alignments Dropped from Consideration for the Purple Line

Alignments Dropped From Consideration For The Purple Line

All alignments along Colesville Road from the Silver Spring Transit Center (SSTC)

Several alignments were presented at scoping that would follow Colesville Road from the SSTC. One alignment would follow Colesville Road north to University Boulevard in Four Corners, and turn south at the signalized intersection. Another alignment would follow Colesville Road north to East Franklin Avenue and travel east to Flower Avenue and then south to Piney Branch Road to University Boulevard, and a third alignment would follow Colesville Road to East Franklin Avenue to University Boulevard.

Colesville Road is six lanes wide with a reversible center lane. It is a heavily used major arterial. Surrounding land uses are generally single-family residential except in the Silver Spring CBD. The extremely heavy traffic on Colesville Road and constrained right-of-way would make it very difficult to implement dedicated or exclusive lanes for transit. In the 1990's the Montgomery County Department of Transportation conducted a feasibility study for a busway on US 29.[1] After this study, both the Montgomery County Council and Maryland-National Capital Park and Planning Commission (M-NCPPC) recommended that US 29 not be considered for either a busway or light rail. Because this alignment extends north above the Purple Line corridor and then comes south again before continuing east, it adds more than a mile of additional distance to the alignment. As a result, this alignment significantly lengthens the trip time, and increases the operational cost, both of which are counterproductive to the project goal of providing rapid transit service east-west in the corridor. These are the major reasons that this alignment is not being retained for detailed study.

[1] Montgomery County Department of Transportation, *US 29 Busway Feasibility Study*, 1996.

25. Riverdale Alternatives Analysis

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1.571.218.1000 Fax 1.571.218.1200

Memorandum

Date July 2, 2007

To Mike Madden, MTA

From Deirdre Smith, P.E. & Meghan Powell, P.E., Jacobs/ Jim Fritz, STV / Joe Romanowski, P.E., RK&K

Subject Purple Line – Riverdale Alternatives Analysis

INTRODUCTION

Prince George's County Council Member Eric Olson requested the Maryland Transit Administration (MTA) to study alignments in the Riverdale area that would provide LRT/BRT service to the community adjacent to the Riverdale MARC station. It was thought that by providing Purple Line service to this community the Purple Line may be a catalyst for economic development. In response to Mr. Olson's request, four alternatives were studied in an effort to provide a connection between the Purple Line and the existing Riverdale MARC station. The four alternatives were compared to two current Purple Line alternatives known in this memorandum as the Kenilworth Alignment and the Riverdale Tunnel Alignment.

The Purple Line Riverdale Alternatives Analysis begins near the College Park Metro Station located at the intersection of Paint Branch Parkway and River Road in College Park and terminates at the Riverdale Park Station on East-West Highway (MD 410), just east of Kenilworth Avenue.

This memorandum is divided into three sections:

1. A description of the alternatives studied including the advantages and disadvantages of each
2. A comparative running time analysis
3. The Purple Line ridership market potential of the Riverdale MARC Station

ALTERNATIVES STUDIED

The four alternatives evaluated were compared to the Kenilworth Alignment and the Riverdale Tunnel Alignment. The accompanying graphic illustrates the four alternatives, the Kenilworth Alignment, and the Riverdale Tunnel Alignment. The following is a brief description of the Kenilworth Alignment, the Riverdale Tunnel Alignment, and the four alternatives studied along with a summary of the advantages and disadvantages of each alternative.

Kenilworth Alignment

The Kenilworth Alignment is at-grade and begins near the College Park Metro Station in College Park, continues southeast along the west side of River Road, turning south onto Kenilworth Avenue, continues south on the west side of Kenilworth Avenue and then turns east onto East West Highway (MD 410) and terminates at the Riverdale Park Station. The Riverdale Park Station is located on East West Highway in the vicinity of the Kenilworth Avenue and East West Highway intersection.

Riverdale Tunnel Alignment

The Riverdale Tunnel Alignment begins at-grade from the College Park Metro along the west side of River Road past Rivertech Court. The 800’ long tunnel portal begins approximately 470’ before Haig Drive. The alignment then turns south onto the west side of Haig Drive and continues south under the Anacostia River Park. The alignment then turns eastward just north of East-West Highway and the 560’ long portal daylights within the median of East-West Highway approximately 700’ west of the Kenilworth Avenue intersection. The alignment crosses Kenilworth Avenue at-grade with the Riverdale Park Station just east of this intersection.

Elements Common to Alternatives A, B, C, and D

Alternatives A, B, C, and D share the following:

- Are at-grade and following the same general alignment from the College Park Metro Station to Lafayette Avenue via the west side of River Road to Rivertech Road, then south along the Rivertech Road right-of-way to Lafayette Avenue.

- Lafayette Avenue consists of a two way roadway, 20' in width.

- If additional right-of-way is required to widen Lafayette Avenue to accommodate the Purple Line, property must be acquired from the properties along the east side. CSX owns the property along the west side of Lafayette Avenue. Current CSX requirements will not allow the transitway to be constructed within 50' of the centerline of the CSX track nearest Lafayette Avenue without the construction of a crashwall. There is not sufficient space to accommodate the CSX requirements, therefore, CSX property cannot be considered for use to widen the roadway along Lafayette Avenue.

Alternative A

Alternative A veers east off of Lafayette Avenue at Sheridan Street and follows an existing concrete drainage ditch north of East West Highway. The alignment continues along an embankment, parallel to East West Highway, crosses the East West Highway and 49th Street intersection at-grade, and continues along the median of East West Highway until it reaches Kenilworth Avenue.

The station, to provide the connection to the Riverdale MARC station, would be located along Lafayette Avenue, at the intersection with Somerset Road, approximately 1200 linear feet north of the Riverdale MARC station.

Advantages/Disadvantages
Advantages

- Crosses the westbound lanes of East West Highway at the intersection with 49th Street.
- Shared operations along Lafayette Avenue will have minor impact to private property.
- Dedicated operations with one additional lane for one-way traffic will have less impact on private property than the Kenilworth Alternative currently being studied by MTA.

Disadvantages:

- Requires Lafayette Avenue to be a one-directional street between Tuckerman Street and Sheridan Street.
- Station would not be located adjacent to Riverdale MARC station. It would be approximately 1,200 linear feet north of the Riverdale MARC station.
- Requires some fill in the area of Ravenswood Road to allow the alignment to cross Ravenswood Road at-grade. *OR…* Requires a new structure on Ravenswood Road and Ravenswood Road to be raised, between 48th Avenue and Lafayette Avenue, to allow the track to pass underneath the road while it follows the existing concrete drainage ditch.
- Requires speed reduction to 15 mph to make the turn onto East West Highway.
- Requires a retaining wall along East West Highway, between 48th Street and 49th Street.
- Requires the taking of one residential structure.

<u>Alternative B</u>
Alternative B veers east off of Lafayette Avenue just after Ravenswood Road. The alignment continues along an embankment, parallel to East West Highway, crosses the East West Highway and 49th Street intersection at-grade, and continues along the median of East West Highway until it reaches Kenilworth Avenue.

The station, to provide the connection to the Riverdale MARC station, would be located along Lafayette Avenue, between Sheridan Street and Ravenswood Road.

Advantages/Disadvantages

Advantages:

- Crosses the westbound lanes of East West Highway at the intersection with 49th Street.
- Shared operations along Lafayette Avenue will have minor impact to private property.
- Dedicated operations with one additional lane for one-way traffic will have less impact on private property than the Kenilworth Alternative currently being studied by MTA.

Disadvantages:

- Requires Lafayette Avenue to be a one-directional street between Tuckerman Street and Ravenswood Road.
- Station would not be located adjacent to Riverdale MARC station. It would be approximately 650 linear feet north of the Riverdale MARC station.
- Requires speed reduction to 15 mph and a curve radius of 137 feet to make turn onto East West Highway.
- Requires a retaining wall along East West Highway, between Lafayette Avenue and 49th Street.

<u>Alternative C</u>

Alternative C continues on Lafayette Avenue, passing underneath East West Highway, leading to a turnback (the LRT vehicle pulls into the station then reverses direction to leave the station) at the proposed station, between Queensbury Road and Riverdale Road. The alignment then returns along Lafayette Avenue turning east prior to East West Highway. The alignment continues along an embankment, parallel to East West Highway, crosses East West Highway prior to 49th Street, and continues along the median of East West Highway until it reaches Kenilworth Avenue.

The station, to provide the connection to the Riverdale MARC station, would be located along Lafayette Avenue, between Queensbury Road and Riverdale Road.

Advantages/Disadvantages

Advantages:

- Provides access to a possible yard location further south along the CSX tracks.
- Station would be located just south of the Riverdale MARC Station.
- Provides a turnback location.
- Shared operations along Lafayette Avenue will have minor impact to private property.
- Dedicated operations with one additional lane for one-way traffic will have less impact on private property than the Kenilworth Alternative currently being studied by MTA.

Disadvantages:

- Requires Lafayette Avenue to be a one-directional street between Tuckerman Street and Queensbury Road.
- Requires the closure of Lafayette Avenue, between Queensbury Road and Riverdale Road, to provide room for the station and tracks.
- Cuts off existing access to a commercial building on Lafayette Avenue, between Queensbury Road and Riverdale Road. The commercial building has another access point from Riverdale Road.
- Requires speed reduction to 10 mph and a curve radius of 162 feet to make turn onto East West Highway.
- Crosses the eastbound lanes of East West Highway prior to the intersection with 49th Street, and then crosses 49th Street in the median of the intersection with East West Highway.

Alternative D

Alternative D continues on Lafayette Avenue, passing underneath East West Highway, and then it goes around a sharp curve to the east just prior to Queensbury Road. The alignment then passes through a residential neighborhood and continues along an embankment onto East West Highway. The alignment crosses East West Highway prior to 49th Street, and continues along the median of East West Highway until it reaches Kenilworth Avenue.

The station, to provide the connection to the Riverdale MARC station, would be located along Lafayette Avenue, between Queensbury Road and Riverdale Road.

Advantages/Disadvantages

Advantages:

- Station would be located just north of the Riverdale MARC Station.
- Shared operations along Lafayette Avenue will have minor impact to private property.
- Dedicated operations with one additional lane for one-way traffic will have less impact on private property than the Kenilworth Alternative currently being studied by MTA.

Disadvantages:

- Requires Lafayette Avenue to be a one-directional street between Tuckerman Street and Queensbury Road.
- Requires the closure of Lafayette Avenue, between Ravenswood Road and East West Highway, to provide room for the station and tracks.
- Requires the abutment of the East West Highway overpass, over Lafayette Avenue, to be shifted east to provide enough clearance under the overpass.

- Requires speed reduction to 10 mph and a curve radius of 100 feet to make turn onto East West Highway.
- Crosses the eastbound lanes of East West Highway prior to the intersection with 49th Street, and then crosses 49th Street in the median of the intersection with East West Highway.
- Requires the taking of three residential structures.

COMPARATIVE RUNNING TIME ANALYSIS

From the above four alternatives, the two most promising were selected for running-time comparison with the Kenilworth Alignment and the Riverdale Tunnel Alignment. The two Riverdale MARC station alternatives selected from the four above for comparison were Alternative C and Alternative D. These were compared on the basis of running time, the time it takes the LRT vehicle to travel, from College Park Metro station to the proposed Riverdale Park station on East-West Highway, east of Kenilworth Avenue. The two existing Purple Line alignments used for comparison were the Kenilworth Alignment and the Riverdale Tunnel Alignment.

For this analysis, light rail speeds ranging from 10 to 50 miles per hour were assumed. Average traffic signal delays of 30 seconds were assumed at all signalized intersections. The speed impact of curves includes the length of the curve itself plus a 200' assumed maximum train length. A "Schedule Adjustment Factor" of 20% was applied to all running times to allow for operator and vehicle vagaries as well as contingency in the absence of specific grade information. Table 1 contains the results of this analysis.

End-to-end running times in the analyzed segment range from 4.9 minutes for the Riverdale Tunnel Alignment to 13.0 minutes for Riverdale MARC station Alternative C. The existing Kenilworth Alignment, which may be considered a baseline alternative, requires 6.3 minutes. Both Riverdale MARC station alternatives require additional running time over the baseline, with Alternative C requiring 106% more running time than the base and Alternative D 63% more running time. Over the lowest possible running time, i.e. that of the Riverdale Tunnel Alignment, these alternatives require 165% and 110% more running time, respectively. While the five to eight minutes of additional running time required to serve the Riverdale MARC station may not seem like a long time, when multiplied by over a hundred and fifty trips per day, the cost in overall time delay becomes substantial. If 12 minute headways are operated from 6:00 A.M. until 6:00 P.M. each day and 20 minute headways from 6:00 P.M. until midnight, the total daily incremental delay attributable to Alternative C over Kenilworth Alignment would be 18 hours and 10 hours for Alternative D. Furthermore, all passengers who would ride east or west through Riverdale MARC station would necessarily endure this delay which detracts from the attractiveness of the service to these riders.

Table 1 - Running Times From/To Purple Line Stations

(All times in minutes)

	To	*Via Kenilworth Alignment*				*Via Riverdale Tunnel Alignment*			
		College Park	**River Road**	**Riverdale MARC**	**Riverdale Park**	**College Park**	**River Road**	**Riverdale MARC**	**Riverdale Park**
From									
College Park			1.8		6.3		1.8		4.9
River Road		1.8			4.5	1.8			3.1
Riverdale MARC									
Riverdale Park		6.3	4.5			4.9	3.1		

	To	*Via Alternative C*				*Via Alternative D*			
		College Park	**River Road**	**Riverdale MARC**	**Riverdale Park**	**College Park**	**River Road**	**Riverdale MARC**	**Riverdale Park**
From									
College Park			1.8	5.1	13.0		1.8	4.9	10.3
River Road		1.8		3.3	11.2	1.8		3.1	8.5
Riverdale MARC		5.1	3.3		7.9	4.9	3.1		5.4
Riverdale Park		13	11.2	7.9		9.7	7.8	4.8	

There are many ways to analyze delays and their impact on operations and passengers – operating cost, perceived and actual travel time, increased passenger dissatisfaction, vehicle requirement, loss of ridership, etc. But, in the case of Purple Line service to Riverdale MARC station, the fact that along Rivertech Court the service actually **reverses** direction probably has a more visceral and lasting impact on riders than the actual time lost, though, from the above analysis, it is evident that this reversal does indeed cost the rider time. Alternative C even reverses direction a second time at Riverdale Park MARC station but not before the operator has to stop the train, power down, collect his/her belongings, walk from one end of the train to the other, and power up the train while through passengers wait on board. Although passengers can be alighting and boarding during this time, which is here estimated to be two minutes overall; this is about 1.7 minutes more than would be required for a typical stop. Furthermore, the fact that the service encounters these delays mid-route with passengers on-board is especially egregious and should, in general, be avoided in planning rail service where large investments are made to reduce travel time in order to attract riders.

It has been suggested that the Riverdale MARC station could be the eastern terminus of the Purple Line. If this were to occur, the above discussion would be cast in a different light. But, as of the date of this report, this is not the case and, in fact, Prince George's County has urged the Purple Line planning team to consider the possibility of future extensions of the Purple Line even beyond New Carrollton.

It has also been suggested that there might be a possible yard and shop site south of the Riverdale MARC station along the MARC/CSX corridor. Again, selection of such a site for a storage yard and maintenance shop facility could change the current thinking about the Purple Line alignment in Riverdale Park. If this site is ultimately selected as the optimal site for a yard and shop, the Purple Line alignment through Riverdale Park would have to be reviewed and could have added advantage. However, it is premature and inappropriate to plan a routing around the supposition that the Purple Line, or a Minimum Operable Segment of that line, **might** end up terminating at the Riverdale Park MARC station or that such a routing would be consistent with a yard and shop site at a location still to be defined, examined, and selected.

PURPLE LINE MARKET POTENTIAL OF RIVERDALE MARC STATION

The Riverdale MARC Station is located on the MARC Camden Line between College Park and Washington Union Station. The station lies slightly over one mile south of the College Park Metro/MARC station and slightly over 1 ¼ miles east of Prince George's Plaza Metro station, which is the next Green Line Metro stop south of College Park. It is the first MARC station after leaving Washington Union Station. The stop is located in Riverdale Park between Queensbury Road to the south and East-West Highway to the north and Lafayette Street to the east and Rhode Island Avenue to the west. Twelve daily trains stop at the station on weekdays. There is no weekend service.

In addition to MARC, Riverdale Park is served by two bus routes, Route 14 of The Bus and Metrobus Route F4. Both transit routes connect Riverdale Park with Prince Georges Plaza, principally via Queensbury Road with about combined peak headways of approximately 11 minutes. Running time to Prince George's Plaza is approximately 7 minutes by way of Metrobus Route F4.

Initial ridership projections derived from the 2000 Capital Beltway Corridor Transportation Study suggest that nearly 70% of the expected riders of the Purple Line will be using the service to connect to the Metro. Assuming, this holds true for Riverdale Park, most passengers boarding the Purple Line at Riverdale Park would be destined for a Metro station and Washington.

Table 2 on the next page analyzes a typical trip for a person wishing to travel from Riverdale Park MARC station to the Metro inclusive of all times from arrival at the Riverdale MARC station to leaving the Prince George's Plaza station on the Metro, including all wait, travel, and dwell times for this trip. Two alternative routes are compared. One is a trip using light rail from Riverdale MARC station to College Park and transferring to the Metro. The other is a trip using either The Bus Route 14 or Metrobus Route F4 from the Riverdale MARC station to Prince George's Plaza and transferring to the Metro.

The result of this analysis is that the time required to make a typical trip to the Metro destined for Washington is identical whether a bus is taken to Prince George's Plaza with a transfer to the Metro or light rail is taken to College Park with a transfer to the Metro plus Metro travel time to Prince George's Plaza. There is no time advantage for a rider from the Riverdale MARC station area whether he travels to College Park via the Purple Line to board the Metro or makes the trip, as he would today, to Prince George's Plaza via bus. Based on this, the inclusion of a Riverdale MARC station stop on the Purple Line does not appear to strengthen the attractiveness of the Purple Line and, considering the added time required for such a stop, which has both a cost impact and a potentially deleterious ridership impact, a stop at Riverdale MARC station could not be justified at this time.

Similar analysis could be done for trips east from Riverdale MARC station. However, it should be noted that transit ridership east of College Park is generally lower than that west of College park and few riders would likely be attracted to destinations east of Riverdale MARC station. Clearly, if the destination is the Metro the nearest stop would be either College Park or Prince George's Plaza, not New Carrollton. It is therefore, unlikely that Riverdale Park riders would travel east to reach the Metro.

Table 2 - Analysis of Comparative Travel Times From Riverdale MARC Station to Leaving Prince Georges Plaza Via Metro

RIVERDALE MARC STATION VIA LRT/METRO TO LEAVE PRINCE GEORGES PLAZA VS. RIVERDALE MARC STATION VIA BUS/METRO TO LEAVE PRINCE GEORGES PLAZA					
	Wait for LRT	**Travel Time to College Park**	**Transfer to Metro**	**Travel Time to Leave Prince Georges Plaza via Metro**	**TOTAL**
Riverdale MARC to Leaving Prince Georges Plaza Via LRT/Metro	6	5	9	2	22
	Wait for Bus	**Travel Time to Prince Georges Plaza**	**Transfer to Metro**		
Riverdale MARC to Leaving Prince Georges Plaza Via Bus/Metro	6	7	9	0	22

Assumptions:

1. Bus service operates at 12 minute headways at Riverdale MARC Station (Combined AM Peak headways of The Bus Route 14 and Metrobus F4)
2. Metro service operates at 12 minute headways.
3. LRT service operates at 12 minute headways.
4. Transfer time = walk time (3 minutes) + wait time (6 minutes)
5. Wait time = 1/2 headway.
6. Travel Time to Prince Georges Plaza by bus = 7 minutes (estimation based on Metrobus F4 public timetable)
7. Metro travel time from College park to PG Plaza = 2 minutes.
8. All times in minutes.

Overall, Purple Line ridership market potential does not appear strong at Riverdale MARC station. It would strike most riders originating in Riverdale Park as inconvenient to travel north, then east, then north, then west, to reach a destination that is to the southwest. Locating a Purple Line stop at Riverdale MARC station would not have the advantage of connecting to MARC for that is already achieved at College Park. The addition of travel time required to reach the Riverdale MARC station would be nothing but a disincentive and nuisance for through riders.

Overall travel time savings of a proposed transportation project over existing means of travel is one of the key measures of its effectiveness. It is especially important in the Purple Line corridor, that every opportunity to reduce travel time is recognized and the benefit captured. Unlike many new transit corridors, much of the Purple Line does not traverse a “natural” right of way such as a railroad, utility corridor, highway median, or even principal roadway. Instead, it relies on a very complicated, interconnecting set of street segments for its routing. A diversion from principal arteries that require operation over small, neighborhood, residential streets does not support what needs to be rapid operation.

An individual’s choice of travel modes is a very complex decision. The time required for a trip is one very important component of that decision. It is key in planning transit projects to reduce travel time whenever and wherever possible. Providing direct service to the Riverdale MARC station increases overall Purple Line travel time for many passengers.

CONCLUSION

The above discussion highlights the idea that consideration of alternative alignments, which divert from long, regional transportation routes such as the Purple Line, requires that not only must local effects such as takings, street closings and traffic impacts be considered but also must corridor-wide impacts such as travel time, operations, and cost be understood. These impacts, large and small, must be weighed against the advantages of providing service to new markets and the size of the market that would be served. In the case of diverting Purple Line service from River Road to serve the Riverdale MARC station, a number of factors were considered. These led us to the recommendation that the proposal not be advanced for further consideration. Following is a summary of the points developed more fully above which led to this conclusion.

The disadvantages of the Riverdale MARC station alternative include, but are not limited to the following factors:

- Need to convert Lafayette Avenue to a one-directional residential street between Tuckerman Street and Queensbury Road
- Closure of sections of Lafayette Avenue to accommodate the station and tracks
- Required speed reductions in Purple Line service to turn onto East West Highway
- The necessity to cross the eastbound lanes of East West Highway prior to the intersection with 49th Avenue. This creates non-desirable grade crossing because the Purple Line crosses the vehicular traffic at an angle significantly less than 90° creating an extended grade crossing for just the eastbound lanes. The Purple Line then crosses 49th Avenue in the median of the intersection with East West Highway. This creates a second grade crossing for the Purple Line approximately 300 feet from the previous one creating an additional operational delay without an additional benefit.

- Elimination of existing access to a commercial building on Lafayette Avenue (Alternative C only)
- Need to reconstruct the East West Highway overpass abutment
- Taking of three residential structures (Alternative D only)
- Increase in overall Purple Line running times over Kenilworth Alignment and Riverdale Tunnel Alignment
- Low ridership potential based upon existing availability of equivalent bus service
- Service to MARC Camden Line station not unique; Purple Line already serves College Park MARC Camden Line station

We believe that these points support a decision to not consider Purple Line service to the Riverdale MARC station further.

RUNNING TIME FROM COLLEGE PARK METRO STATION TO RIVERDALE PARK STATION	
ALIGNMENT	MINUTES
KENILWORTH ALIGNMENT	6.3
RIVERDALE TUNNEL ALIGNMENT	4.9
PROPOSED AT-GRADE ALIGNMENT ALTERNATIVE C	13.0
PROPOSED AT-GRADE ALIGNMENT ALTERNATIVE D	9.7

MARYLAND DEPARTMENT OF TRANSPORTATION

MTA Maryland

JACOBS

LEGEND

KENILWORTH ALIGNMENT	RIVERDALE TUNNEL ALIGNMENT
PROPOSED AT-GRADE ALIGNMENT (ALTERNATIVES A, B, C & D)	PORTAL
ALTERNATIVE A	ALTERNATIVE B
ALTERNATIVE C	ALTERNATIVE D

Purple Line

PURPLE LINE

RIVERDALE ALIGNMENTS

DATE: JUNE 20, 2007 SCALE: 1:500

26. Bonifant Street Trackway Alignment

Memo to File
September 26, 2007

Downtown Silver Spring Alignments

At a meeting on August 29th 2007 Montgomery County agreed to the use of Bonifant Street, with an alignment through the Library site. Therefore the Ripley Street alignment is being dropped from consideration.

27. River Road at Rivertech Court and at Haig Drive: Traffic Operations Analysis

River Road at Rivertech Court and at Haig Drive/University Research Court: Traffic Operations Analysis

June 2010

INTRODUCTION

The Maryland Transit Administration (MTA) is currently proceeding with the planning stages of the proposed 16-mile Purple Line transit corridor from Bethesda in Montgomery County to New Carrollton in Prince George's County. The Purple Line Alternatives Analysis / Draft Environmental Impact Statement (AA/DEIS) was published in November 2008 and a Locally Preferred Alternative (LPA) was announced by the Governor in August 2009.

The Locally Preferred Alternative (LPA) includes a surface alignment along the south side of River Road from Paint Branch Parkway to MD 201 (Kenilworth Avenue). The Rivertech Court and Haig Drive/University Research Court intersections with River Road currently operate with two-way STOP control. Since the side-running LRT is proposed to cross a public street at these locations, signalization should be considered for greatest safety and intersection operation.

This report evaluates various intersection traffic operations along River Road at Rivertech Court and Haig Drive/University Research Court with regard to the proposed Purple Line LPA.

TRAFFIC OPERATIONS ANALYSIS OF RIVER ROAD INTERSECTIONS

1. **<u>Development of Future Traffic Volume Forecasts</u>**: 2015 peak hour traffic volumes from the M Square Traffic Impact Analysis and Staging Analysis, dated April 6, 2007 were used for a 2015 analysis and are attached. It should be noted the turning movements into and out of the American Center for Physics driveway at River Road (Intersection 6) were rerouted to River Road at Rivertech Court due to the LPA's proposed closing of this driveway. An annual growth rate of 1% was applied to the 2015 River Road through volumes to derive and analyze 2030 conditions.

2. **<u>Traffic Analysis – Two-way STOP control</u>**: A Synchro network was created on River Road from Riverdale Court to Haig Drive/University Research Court. The intersections were modeled as STOP control to compare operations with both roundabout and signalization control. The 2015 STOP control analysis is summarized below.

Table 1 – 2015 Intersection Operation and Analysis – Unsignalized (SimTraffic)

Intersection Name	Movement	AM Peak Hour Delay (sec)[1]	AM Peak Hour LOS	AM Peak Hour Queue[2]	PM Peak Hour Delay (sec)[1]	PM Peak Hour LOS	PM Peak Hour Queue[2]
Rivertech Court	Northbound Left	249.8	F	983	820.8	F	983
	Northbound Thru	294.5	F		900.2	F	
	Northbound Right	206.5	F		807.1	F	
	Southbound Left	66.0	E	218	33.6	C	218
	Southbound Thru	23.8	C		41.1	D	
	Southbound Right	18.7	B		26.0	C	
Haig Drive / University Research Ct.	Northbound Left	-	-	-	-	-	28
	Northbound Thru	-	-		-	-	
	Northbound Right	4.8	A		8.5	A	
	Southbound Left	83.6	F	124	127.1	F	666
	Southbound Thru	50.8	D		122.8	F	
	Southbound Right	-	-		77.4	F	

1 – SimTraffic Delay
2 – SimTraffic 95th Percentile Queue

The 2015 SimTraffic Analysis indicates the northbound Rivertech Court and southbound University Research Court movements would have high delays and long queues even without considering the additional delay introduced by the LRT. The 2030 STOP control analysis is summarized below.

Table 2 – 2030 Intersection Operation and Analysis – Unsignalized (SimTraffic)

Intersection Name	Movement	AM Peak Hour Delay (sec)[1]	AM Peak Hour LOS	AM Peak Hour Queue[2]	PM Peak Hour Delay (sec)[1]	PM Peak Hour LOS	PM Peak Hour Queue[2]
Rivertech Court	Northbound Left	365.5	F	841	1353.3	F	964
	Northbound Thru	416.1	F		911.7	F	
	Northbound Right	369.7	F		1237.2	F	
	Southbound Left	88.1	F	51	53.3	D	157
	Southbound Thru	65.5	E		41.7	D	
	Southbound Right	18.4	B		55.1	E	
Haig Drive / University Research Ct.	Northbound Left	-	-	-	-	-	-
	Northbound Thru	-	-		-	-	
	Northbound Right	3.8	A		10.4	B	
	Southbound Left	556.5	F	475	413.6	F	413
	Southbound Thru	-	-		369.6	F	
	Southbound Right	-	-		214.3	F	

1 – SimTraffic Delay
2 – SimTraffic 95th Percentile Queue

The 2030 SimTraffic Analysis indicates that many side street movements would have high delays and long queues even without considering the additional delay introduced by the LRT. The stop control Synchro/SimTraffic reports are attached.

3. **Traffic Analysis – Roundabout**: The Haig Drive / University Research Court intersection was analyzed using SIDRA software to compare operations with unsignalized and signalized control. The 2015 roundabout analysis is summarized below.

Table 3 – 2015 Intersection Operation and Analysis - Roundabout

	AM Peak Hour			PM Peak Hour		
Intersection Name	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
Rivertech Court	-	-	-	-	-	-
Haig Dr/Univ. Research Ct.	5.8	A	182	10.3	B	213

[1] – SIDRA 95th Percentile Queue (Worst Lane)

The 2015 roundabout analysis indicates all movements operate at LOS C or better during the peak hours. The 2030 roundabout analysis is summarized below.

Table 4 – 2030 Intersection Operation and Analysis - Roundabout

	AM Peak Hour			PM Peak Hour		
Intersection Name	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
Rivertech Court	-	-	-	-	-	-
Haig Dr/Univ. Research Ct.	5.9	A	250	11.2	B	318

[1] – SIDRA 95th Percentile Queue (Worst Lane)

The 2030 roundabout analysis indicates all movements operate at LOS C or better during the peak hours. The roundabout SIDRA reports are attached.

4. **Traffic Analysis - Signal**: The intersections of River Road at Rivertech Court and at Haig Drive/University Research Court satisfy signal warrants during the 2015 PM peak hour using projected traffic volumes. The warrant analyses are attached. The 2015 signal analysis is summarized below.

Table 5 – 2015 Intersection Operation and Analysis – Signalized

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**10.1**	**B**	**-**	**33.7**	**C**	**-**
Eastbound Left	11.6	B	49	19.5	B	35
Eastbound Thru-Right	14.6	B	124	26.1	C	219
Westbound Left	3.3	A	216	13.2	B	140
Westbound Thru-Right	2.6	A	133	8.7	A	67
Northbound Left-Thru-Right	43.3	D	181	41.5	D	439
Southbound Left-Thru-Right	33.5	C	40	80.2	F	171
River Road at Haig Drive / University Research Court						
Overall Intersection	**6.1**	**A**	**-**	**13.4**	**B**	**-**
Eastbound Left	1.8	A	-	-	-	-
Eastbound Thru-Right	2.1	A	50	6.9	A	187
Westbound Left	1.7	A	-	8.6	A	-
Westbound Thru-Right	5.5	A	173	9.8	A	92
Northbound Left-Thru-Right	35.9	D	-	19.5	B	24
Southbound Left-Thru-Right	40.0	D	96	38.7	D	314

[1] – SimTraffic 95th Percentile Queue

The 2015 traffic analysis indicates the intersections and nearly all movements would operate at LOS D or better with minimal queuing during both peak hours. The 2030 signal analysis is summarized below.

Table 6 – 2030 Intersection Operation and Analysis – Signalized

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**10.1**	**A**	**-**	**33.5**	**C**	**-**
Eastbound Left	11.7	B	57	18.8	B	21
Eastbound Thru-Right	15.1	B	122	26.7	C	300
Westbound Left	3.8	A	234	16.3	B	273
Westbound Thru-Right	2.4	A	157	9.5	A	177
Northbound Left-Thru-Right	43.3	D	156	41.5	D	989
Southbound Left-Thru-Right	33.5	C	43	80.2	F	192
River Road at Haig Drive / University Research Court						
Overall Intersection	**7.3**	**A**	**-**	**13.7**	**B**	**-**
Eastbound Left	1.4	A	-	-	-	-
Eastbound Thru-Right	1.8	A	71	7.4	A	268
Westbound Left	1.7	A	-	8.3	A	-
Westbound Thru-Right	7.1	A	223	9.5	A	86
Northbound Left-Thru-Right	35.9	D	-	20.2	C	21
Southbound Left-Thru-Right	40.0	D	99	42.8	D	410

[1] – SimTraffic 95th Percentile Queue

The 2030 traffic analysis indicates the intersections would operate relatively the same as the 2015 condition. Nearly all movements would operate at LOS D or better with minimal queuing during both peak hours. The signal Synchro/SimTraffic reports are attached.

5. **<u>Traffic Analysis – Signal with LRT</u>**: To analyze the intersection operation with the Purple Line, a callable LRT phase was added to each intersection's signal timing to imitate the 10 assumed LRT vehicles in each direction per hour. Side street movements and mainline turns onto the south leg were prohibited during the LRT phase; however, east- and westbound River Road movements were permitted to run concurrently. In addition, east- and northbound right turns on red were prohibited. SimTraffic animations were run to evaluate the intersection operations and queues. The 2015 signal analysis with LRT is summarized below.

Table 7 – 2015 Intersection Operation and Analysis – Signalized with LRT

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**32.7**	**C**	**-**	**55.7**	**E**	**-**
Eastbound Left	36.7	D	37	34.0	C	-
Eastbound Thru-Right	37.2	D	149	30.3	C	257
Westbound Left	33.7	C	318	62.5	E	273
Westbound Thru-Right	6.4	A	772	6.5	A	161
Northbound Left-Thru-Right	86.7	F	233	101.3	F	1,017
Southbound Left-Thru-Right	44.3	D	40	60.9	E	194
River Road at Haig Drive / University Research Court						
Overall Intersection	**6.7**	**A**	**-**	**16.3**	**B**	**-**
Eastbound Left	2.5	A	-	-	-	-
Eastbound Thru-Right	3.3	A	44	5.7	A	234
Westbound Left	7.7	A	-	18.2	B	-
Westbound Thru-Right	5.0	A	162	11.7	B	76
Northbound Left-Thru-Right	49.5	D	-	27.1	C	24
Southbound Left-Thru-Right	55.8	E	93	53.2	D	360

1 – SimTraffic 95th Percentile Queue

The 2015 traffic analysis indicates River Road at Rivertech Court would operate at LOS E during the PM peak hour with the northbound approach operating at LOS F. River Road at Haig Drive / University Research Court and all intersection movements would continue to operate at LOS D or better.

Table 8 – 2030 Intersection Operation and Analysis – Signalized with LRT

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**31.2**	**C**	**-**	**54.6**	**D**	**-**
Eastbound Left	36.7	D	42	34.0	C	21
Eastbound Thru-Right	37.2	D	171	31.1	C	300
Westbound Left	31.5	C	324	71.1	E	273
Westbound Thru-Right	4.9	A	852	5.8	A	177
Northbound Left-Thru-Right	92.9	F	221	101.3	F	989
Southbound Left-Thru-Right	44.6	D	46	60.9	E	192
River Road at Haig Drive / University Research Court						
Overall Intersection	**6.7**	**A**	**-**	**16.6**	**B**	**-**
Eastbound Left	2.5	A	-	-	-	-
Eastbound Thru-Right	3.3	A	32	6.8	A	268
Westbound Left	7.7	A	-	17.7	B	-
Westbound Thru-Right	5.0	A	224	11.5	B	86
Northbound Left-Thru-Right	49.5	D	-	27.8	C	21
Southbound Left-Thru-Right	55.8	E	109	57.2	E	410

[1] – SimTraffic 95th Percentile Queue

The 2030 traffic analysis indicates the intersections would operate relatively the same as the 2015 condition. The LRT signal Synchro/SimTraffic reports are attached.

6. **Traffic Analysis – Signal with LRT (Two Northbound Lanes at Rivertech Court):** The south leg of River Rivertech Court is 45 feet wide and has adequate room to be striped with a shared northbound left-thru and separate right turn lane. The 2015 signal analysis with LRT and two northbound Rivertech Court lanes is summarized below.

Table 9 – 2015 Intersection Operation and Analysis – Signalized with LRT (2 NB Lanes)

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**28.2**	**C**	**-**	**35.4**	**D**	**-**
Eastbound Left	33.4	C	39	31.3	C	43
Eastbound Thru-Right	33.9	C	155	27.5	C	276
Westbound Left	34.2	C	325	44.6	D	225
Westbound Thru-Right	4.1	A	870	3.3	A	58
Northbound Left-Thru	53.0	D	116	31.1	C	278
Northbound Right	57.8	E	137	60.6	E	568
Southbound Left-Thru-Right	47.6	D	45	34.7	C	222

[1] – SimTraffic 95th Percentile Queue

The 2015 traffic analysis indicates the intersections and nearly all movements would operate at LOS D or better during both peak hours. The 2030 signal analysis with LRT is summarized below.

Table 10 – 2030 Intersection Operation and Analysis – Signalized with LRT (2 NB Lanes)

	AM Peak Hour			PM Peak Hour		
Movement	Delay (sec)	LOS	Queue[1]	Delay (sec)	LOS	Queue[1]
River Road at Rivertech Court						
Overall Intersection	**26.5**	**C**	**-**	**35.4**	**D**	**-**
Eastbound Left	33.6	C	41	30.5	C	42
Eastbound Thru-Right	34.1	C	162	27.5	C	283
Westbound Left	32.4	C	331	48.7	D	243
Westbound Thru-Right	3.2	A	834	2.3	A	175
Northbound Left-Thru	53.2	D	109	31.5	C	492
Northbound Right	58.3	E	156	63.1	E	679
Southbound Left-Thru-Right	47.7	D	51	35.3	D	209

[1] – SimTraffic 95th Percentile Queue

The 2030 traffic analysis indicates the intersections would operate relatively the same as the 2015 condition. Most movements would still operate at LOS D or better during both peak hours. The LRT signal with two northbound lanes Synchro/SimTraffic reports are attached.

7. **Traffic Analysis – Eastbound Right-Turn Lane Storage Requirements**: A traffic analysis was performed to determine the storage requirements of eastbound right-turn lanes along River Road at Rivertech Court and Haig Drive / University Research Court, also assuming the above referenced LRT phase and two northbound approach lanes. 2030 SimTraffic 95th percentile queue lengths were used for the analysis and are summarized below:

Table 11 – 2030 SimTraffic 95th Percentile Queues

	AM Peak	PM Peak
Movement	Queue	Queue
River Road at Rivertech Court		
Eastbound Thru	79	204
Eastbound Right	114	83
River Road at Haig Drive / University Research Court		
Eastbound Thru	36	340
Eastbound Right	-	-

The 2030 SimTraffic analysis indicates minor peak hour right-turn queuing at both intersections.

According to the SHA, the length of standard deceleration lanes is based on AASHTO design for speed change and transition tapers, plus any applicable queuing for right turns into the access point. State Highway Access Manual Table 13.3.3B for partial deceleration lanes was referenced to determine a minimum required storage length. The table is shown below:

Table 12 – SHA Access Manual Table 13.3.3B Length Required for Partial Deceleration Lanes

Posted Speed	30	35[1]	40	50	55
Total Length	150'	200'	250'	350'	400'
Min. Approach Lane Length	50'	**100'**	150'	250'	300'
Min. Approach Taper Length	100'	100'	100'	100'	100'

[1] – 35 mph lengths interpolated

Adding the queue lengths from Table 11 to the minimum deceleration lane lengths in Table 12 results in the following right turn storage requirements:

Eastbound Right Turn Lane at Rivertech Court: 114' + 100' = **214'**
Eastbound Right Turn Lane at Haig Drive / University Research Court: 0' + 100' = **100'**

The turn lane lengths listed above were input into the Synchro model and SimTraffic animations were run. The SimTraffic animations confirmed the storage lengths are adequate. The eastbound right turn lane SimTraffic reports are attached.

CONCLUSIONS AND RECOMMENDATIONS

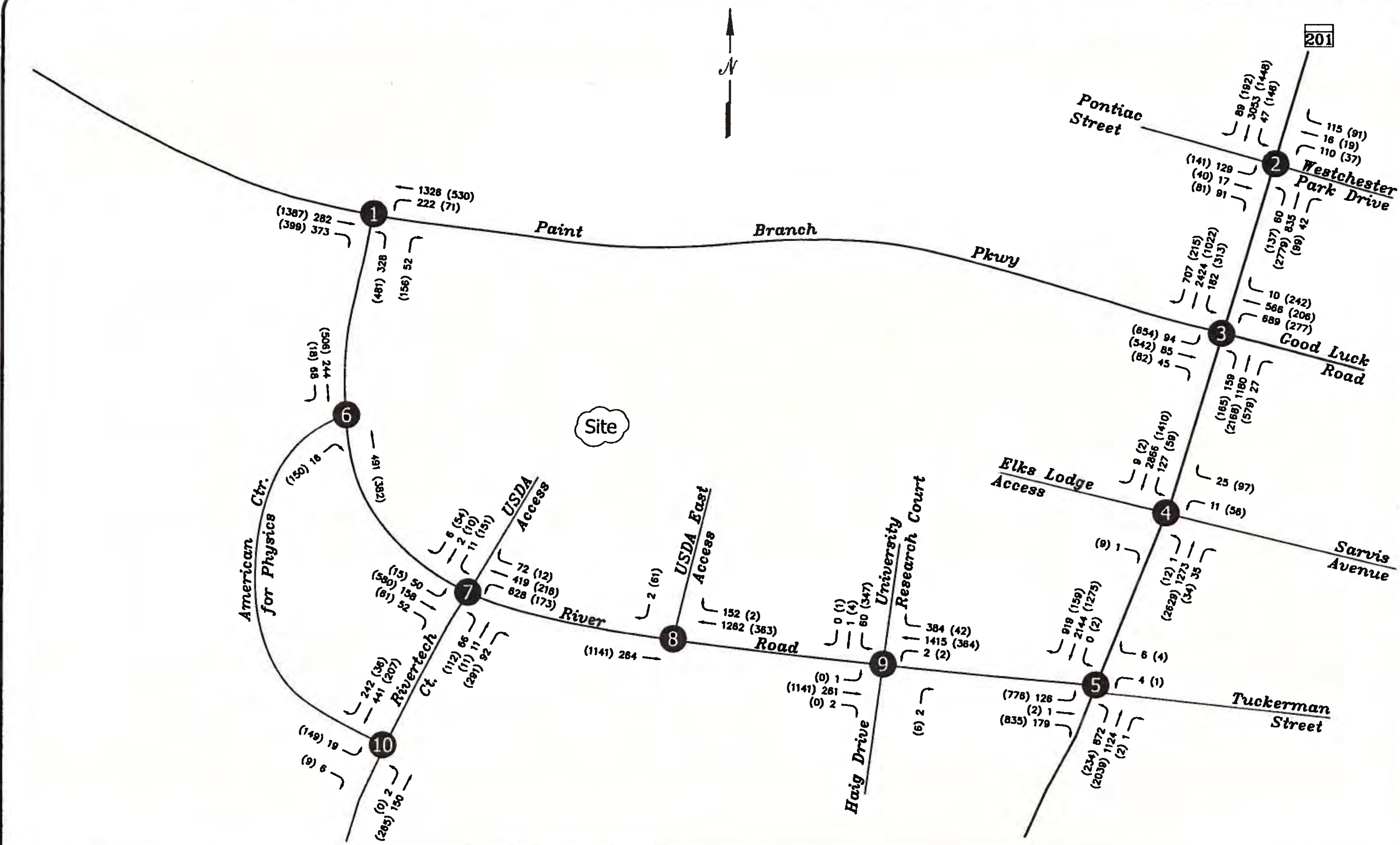
An analysis of stop controlled intersections indicated heavy side street delays and long queue lengths without considering the additional delays from the LRT interaction. The intersections of River Road at Rivertech Court and at Haig Drive/University Research Court satisfy signal warrants during the PM peak hour using projected traffic volumes. When signalized, each intersection would perform at an acceptable LOS and have acceptable queues. When adding the Purple Line and restriping Rivertech Court for a shared northbound left-thru and separate right turn lanes, each intersection would perform at an acceptable LOS. Therefore, signalization is recommended at the River Road intersections at Rivertech Court and at Haig Drive/University Research Court. The eastbound River Road right turn lane analysis indicated 215 and 100 feet are appropriate storage lengths at Rivertech Court and at Haig Drive / University Research Court, respectively.

Attachments:
Traffic Volumes
Signal Warrant Reports
Synchro / SimTraffic Reports – Stop Control
SIDRA Report
Synchro / SimTraffic Reports – Signal Control
Synchro / SimTraffic Reports – Signal Control with LRT
SimTraffic Reports – Signal Control with LRT and Eastbound Right Turn Lanes

Attachment

A

Traffic Volumes



NOT TO SCALE

00 – MORNING PEAK HOUR
(00) – EVENING PEAK HOUR

The Traffic Group

EXHIBIT 10E
2015 TOTAL PEAK
HOUR TRAFFIC VOLUMES
(PHASE V)

qt, 040621\0701\0129_07.dwg-tot5, 04/12/07

Attachment

B

Synchro/SimTraffic Reports – Stop Control

2: River Road & Rivertech Ct Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	0.1	0.0	1.6	0.4	0.0	4.3	0.9	6.3	0.2	0.0	0.0
Delay / Veh (s)	7.1	1.8	1.2	9.0	2.0	1.8	249.8	294.5	206.5	66.0	23.8	18.7
Total Stops	22	0	13	297	0	1	88	16	156	10	1	5
Travel Dist (mi)	11.7	38.2	29.5	134.5	123.4	15.4	9.4	1.8	16.7	1.4	0.1	0.6
Travel Time (hr)	0.4	1.0	0.9	5.5	3.5	0.5	4.7	1.0	7.0	0.2	0.0	0.1
Avg Speed (mph)	31	37	32	25	35	31	2	2	3	6	10	12
Fuel Used (gal)	0.3	1.1	0.7	3.1	4.6	0.5	1.3	0.3	2.0	0.1	0.0	0.0
HC Emissions (g)	2	11	8	28	67	10	2	0	13	0	0	0
CO Emissions (g)	65	534	271	688	2848	318	124	22	317	6	0	2
NOx Emissions (g)	10	45	31	100	231	31	10	1	27	1	0	0
Vehicles Entered	48	155	120	634	723	72	63	12	111	10	1	5
Vehicles Exited	47	154	120	635	723	73	61	11	107	10	1	5
Hourly Exit Rate	47	154	120	635	723	73	61	11	107	10	1	5
Input Volume	50	158	120	628	715	72	66	11	108	11	2	6
% of Volume	94	97	100	101	101	101	92	100	99	91	50	83
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0	0	0

2: River Road & Rivertech Ct Performance by movement

Movement	All
Total Delay (hr)	13.9
Delay / Veh (s)	25.6
Total Stops	609
Travel Dist (mi)	382.6
Travel Time (hr)	24.9
Avg Speed (mph)	16
Fuel Used (gal)	14.0
HC Emissions (g)	142
CO Emissions (g)	5195
NOx Emissions (g)	488
Vehicles Entered	1954
Vehicles Exited	1947
Hourly Exit Rate	1947
Input Volume	1947
% of Volume	100
Denied Entry Before	0
Denied Entry After	0

7: River Road & Haig Dr Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBL	SBT	All
Total Delay (hr)	0.0	0.0	0.0	0.0	1.5	0.5	0.0	1.4	0.0	3.5
Delay / Veh (s)		0.6	0.5	9.1	3.8	4.6	4.8	83.6	50.8	5.8
Total Stops	0	0	0	1	0	0	2	61	2	66
Travel Dist (mi)	0.0	55.7	0.6	0.6	387.7	104.2	0.2	7.4	0.2	556.7
Travel Time (hr)	0.0	1.6	0.0	0.0	11.5	3.6	0.0	1.7	0.0	18.5
Avg Speed (mph)	25	35	31	31	35	29	18	4	5	31
Fuel Used (gal)	0.0	2.2	0.0	0.0	11.2	2.5	0.0	0.6	0.0	16.5
HC Emissions (g)	0	31	0	0	134	26	0	4	0	196
CO Emissions (g)	0	1358	12	5	4279	790	0	107	1	6552
NOx Emissions (g)	0	113	1	0	505	90	0	10	0	719
Vehicles Entered	0	269	3	2	1430	385	2	61	2	2154
Vehicles Exited	0	269	3	2	1430	384	2	59	2	2151
Hourly Exit Rate	0	269	3	2	1430	384	2	59	2	2151
Input Volume	1	274	2	2	1415	384	2	60	1	2141
% of Volume	0	98	150	100	101	100	100	98	200	100
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	17.8
Delay / Veh (s)	26.8
Total Stops	675
Travel Dist (mi)	1346.8
Travel Time (hr)	57.1
Avg Speed (mph)	24
Fuel Used (gal)	45.4
HC Emissions (g)	512
CO Emissions (g)	17574
NOx Emissions (g)	1861
Vehicles Entered	2407
Vehicles Exited	2393
Hourly Exit Rate	2393
Input Volume	6175
% of Volume	39
Denied Entry Before	0
Denied Entry After	0

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	WB	WB	NB	SB
Directions Served	L	TR	L	TR	LTR	LTR
Maximum Queue (ft)	35	38	224	18	622	53
Average Queue (ft)	15	8	98	1	317	16
95th Queue (ft)	38	28	177	10	724	46
Link Distance (ft)		1299		1063	798	706
Upstream Blk Time (%)					8	
Queuing Penalty (veh)					0	
Storage Bay Dist (ft)	250		250			
Storage Blk Time (%)			0			
Queuing Penalty (veh)			0			

Intersection: 7: River Road & Haig Dr

Movement	EB	WB	WB	NB	SB
Directions Served	L	L	TR	LR	LTR
Maximum Queue (ft)	6	17	4	19	184
Average Queue (ft)	0	1	0	2	64
95th Queue (ft)	4	7	3	14	144
Link Distance (ft)			1430	592	644
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)	250	250			
Storage Blk Time (%)					
Queuing Penalty (veh)					

Network Summary

Network wide Queuing Penalty: 0

2: River Road & Rivertech Ct Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.0	0.3	0.0	0.3	0.0	0.0	18.7	2.3	70.2	1.4	0.1	0.4
Delay / Veh (s)	5.3	1.8	1.2	6.3	0.6	0.4	820.8	900.2	807.1	33.6	41.1	26.0
Total Stops	3	2	3	107	0	0	180	23	684	149	11	54
Travel Dist (mi)	3.6	142.4	18.0	34.5	44.0	2.3	12.5	1.5	47.2	19.8	1.4	7.2
Travel Time (hr)	0.1	3.9	0.6	1.3	1.1	0.1	19.2	2.3	72.2	2.2	0.2	0.7
Avg Speed (mph)	33	37	32	27	38	33	2	2	2	9	8	10
Fuel Used (gal)	0.1	4.2	0.5	0.8	1.3	0.1	4.7	0.6	17.6	0.9	0.1	0.3
HC Emissions (g)	0	59	5	8	15	0	5	0	54	5	0	2
CO Emissions (g)	17	1955	177	202	517	11	315	33	1613	170	10	61
NOx Emissions (g)	2	220	19	30	60	1	17	2	94	18	1	7
Vehicles Entered	15	578	73	171	220	11	85	10	322	149	11	54
Vehicles Exited	15	577	73	171	218	11	79	9	305	149	11	53
Hourly Exit Rate	15	577	73	171	218	11	79	9	305	149	11	53
Input Volume	15	580	79	173	216	12	112	11	441	151	10	54
% of Volume	100	99	92	99	101	92	71	82	69	99	110	98
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	25	4	130	0	0	0

2: River Road & Rivertech Ct Performance by movement

Movement	All
Total Delay (hr)	93.7
Delay / Veh (s)	200.2
Total Stops	1216
Travel Dist (mi)	334.3
Travel Time (hr)	104.0
Avg Speed (mph)	8
Fuel Used (gal)	31.0
HC Emissions (g)	154
CO Emissions (g)	5081
NOx Emissions (g)	471
Vehicles Entered	1699
Vehicles Exited	1671
Hourly Exit Rate	1671
Input Volume	1854
% of Volume	90
Denied Entry Before	0
Denied Entry After	159

7: River Road & Haig Dr Performance by movement

Movement	EBT	WBL	WBT	WBR	NBR	SBL	SBT	SBR	All
Total Delay (hr)	0.4	0.0	0.1	0.0	0.0	12.3	0.1	0.1	12.9
Delay / Veh (s)	1.5	8.8	0.6	0.5	8.5	127.1	122.8	77.4	26.0
Total Stops	1	1	0	0	6	406	4	3	421
Travel Dist (mi)	215.5	0.2	97.9	10.6	0.7	42.2	0.4	0.3	367.9
Travel Time (hr)	6.5	0.0	2.5	0.3	0.0	14.1	0.1	0.1	23.6
Avg Speed (mph)	33	27	39	34	16	3	4	4	17
Fuel Used (gal)	9.0	0.0	2.7	0.3	0.0	4.1	0.0	0.0	16.2
HC Emissions (g)	137	0	33	5	0	22	0	0	196
CO Emissions (g)	5705	1	1050	117	1	641	4	2	7522
NOx Emissions (g)	480	0	131	16	0	63	0	0	691
Vehicles Entered	1031	1	361	39	6	349	4	3	1794
Vehicles Exited	1031	1	361	39	6	344	3	3	1788
Hourly Exit Rate	1031	1	361	39	6	344	3	3	1788
Input Volume	1172	2	364	42	6	347	4	1	1938
% of Volume	88	50	99	93	100	99	75	300	92
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	5	0	0	5

Total Network Performance

Total Delay (hr)	107.2
Delay / Veh (s)	185.3
Total Stops	1638
Travel Dist (mi)	1226.9
Travel Time (hr)	143.0
Avg Speed (mph)	16
Fuel Used (gal)	65.0
HC Emissions (g)	586
CO Emissions (g)	20707
NOx Emissions (g)	2040
Vehicles Entered	2098
Vehicles Exited	2068
Hourly Exit Rate	2068
Input Volume	6016
% of Volume	34
Denied Entry Before	0
Denied Entry After	164

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	WB	NB	SB
Directions Served	L	TR	L	LTR	LTR
Maximum Queue (ft)	28	23	82	841	301
Average Queue (ft)	3	3	42	775	105
95th Queue (ft)	17	15	73	983	218
Link Distance (ft)		1299		798	703
Upstream Blk Time (%)				73	
Queuing Penalty (veh)				0	
Storage Bay Dist (ft)	250		250		
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	NB	SB
Directions Served	T	TR	L	LR	LTR
Maximum Queue (ft)	7	17	11	32	555
Average Queue (ft)	0	1	1	7	350
95th Queue (ft)	5	7	7	28	666
Link Distance (ft)	1064	1064		592	644
Upstream Blk Time (%)					12
Queuing Penalty (veh)					0
Storage Bay Dist (ft)			250		
Storage Blk Time (%)					
Queuing Penalty (veh)					

Network Summary

Network wide Queuing Penalty: 0

2: River Road & Rivertech Ct Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.1	0.1	0.0	1.8	0.6	0.0	5.6	1.3	10.6	0.2	0.0	0.0
Delay / Veh (s)	7.2	1.8	1.2	9.9	2.3	2.1	365.5	416.1	369.7	88.1	65.5	18.4
Total Stops	24	0	14	323	1	1	77	14	152	9	2	5
Travel Dist (mi)	12.6	41.6	28.8	140.0	154.1	16.1	8.4	1.7	15.7	1.2	0.3	0.7
Travel Time (hr)	0.5	1.1	0.9	5.9	4.5	0.5	5.9	1.3	11.3	0.3	0.0	0.1
Avg Speed (mph)	31	37	32	24	34	30	2	1	2	4	7	12
Fuel Used (gal)	0.3	1.2	0.7	3.3	6.0	0.5	1.6	0.3	2.9	0.1	0.0	0.0
HC Emissions (g)	2	18	11	29	88	6	2	0	10	0	0	0
CO Emissions (g)	67	673	327	762	3757	284	126	25	325	8	1	3
NOx Emissions (g)	11	63	38	104	304	22	8	1	23	1	0	0
Vehicles Entered	51	169	117	662	942	76	57	11	107	9	2	5
Vehicles Exited	51	169	117	662	943	76	53	10	100	8	2	5
Hourly Exit Rate	51	169	117	662	943	76	53	10	100	8	2	5
Input Volume	50	183	120	628	942	72	66	11	108	11	2	6
% of Volume	102	92	98	105	100	106	80	91	93	73	100	83
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	3	1	4	0	0	0

2: River Road & Rivertech Ct Performance by movement

Movement	All
Total Delay (hr)	20.4
Delay / Veh (s)	33.3
Total Stops	622
Travel Dist (mi)	421.2
Travel Time (hr)	32.3
Avg Speed (mph)	14
Fuel Used (gal)	17.1
HC Emissions (g)	167
CO Emissions (g)	6357
NOx Emissions (g)	576
Vehicles Entered	2208
Vehicles Exited	2196
Hourly Exit Rate	2196
Input Volume	2199
% of Volume	100
Denied Entry Before	0
Denied Entry After	8

7: River Road & Haig Dr Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBL	SBT	All
Total Delay (hr)	0.0	0.0	0.0	0.0	2.4	0.7	0.0	8.5	0.0	11.7
Delay / Veh (s)		0.6	0.4	8.2	5.2	6.2	3.8	556.5		17.5
Total Stops	0	0	0	2	1	0	2	59	1	65
Travel Dist (mi)	0.0	58.3	0.5	1.1	455.5	103.6	0.2	6.9	0.1	626.3
Travel Time (hr)	0.0	1.7	0.0	0.0	14.2	3.8	0.0	8.8	0.0	28.5
Avg Speed (mph)	21	35	31	31	33	28	18	1	2	22
Fuel Used (gal)	0.0	2.3	0.0	0.0	13.3	2.5	0.0	2.2	0.0	20.4
HC Emissions (g)	0	33	0	0	150	30	0	12	0	226
CO Emissions (g)	0	1364	12	6	4890	844	0	301	1	7419
NOx Emissions (g)	0	119	1	1	568	99	0	20	0	807
Vehicles Entered	0	278	3	4	1679	383	2	59	1	2409
Vehicles Exited	0	278	3	4	1680	382	2	51	0	2400
Hourly Exit Rate	0	278	3	4	1680	382	2	51	0	2400
Input Volume	1	303	2	2	1642	384	2	60	1	2397
% of Volume	0	92	150	200	102	99	100	85	0	100
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0	0

Total Network Performance

Total Delay (hr)	32.6
Delay / Veh (s)	44.2
Total Stops	687
Travel Dist (mi)	1477.3
Travel Time (hr)	75.2
Avg Speed (mph)	21
Fuel Used (gal)	53.2
HC Emissions (g)	583
CO Emissions (g)	19943
NOx Emissions (g)	2088
Vehicles Entered	2660
Vehicles Exited	2642
Hourly Exit Rate	2642
Input Volume	6792
% of Volume	39
Denied Entry Before	0
Denied Entry After	8

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	49	40	248	290	100	689	61
Average Queue (ft)	16	8	98	12	4	407	19
95th Queue (ft)	41	28	189	122	66	841	51
Link Distance (ft)		1299		1063	1063	798	706
Upstream Blk Time (%)						16	
Queuing Penalty (veh)						0	
Storage Bay Dist (ft)	250		250				
Storage Blk Time (%)			1				
Queuing Penalty (veh)			1				

Intersection: 7: River Road & Haig Dr

Movement	EB	WB	NB	SB
Directions Served	L	L	LR	LTR
Maximum Queue (ft)	6	23	25	398
Average Queue (ft)	0	2	2	234
95th Queue (ft)	4	12	13	475
Link Distance (ft)			592	644
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	250	250		
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 1

2: River Road & Rivertech Ct Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	0.0	0.3	0.0	0.3	0.0	0.0	26.3	1.5	92.1	2.3	0.2	0.9
Delay / Veh (s)	7.2	1.7	1.7	6.4	0.7	0.5	1353.3	911.7	1237.2	53.3	41.7	55.1
Total Stops	6	4	2	101	0	0	126	11	568	153	14	56
Travel Dist (mi)	3.2	162.3	18.3	32.1	52.4	1.4	10.5	0.8	40.3	20.3	1.9	7.5
Travel Time (hr)	0.1	4.4	0.6	1.2	1.4	0.0	26.8	1.6	93.9	3.1	0.2	1.2
Avg Speed (mph)	30	37	32	27	38	32	2	2	2	6	8	6
Fuel Used (gal)	0.1	4.7	0.5	0.8	1.5	0.0	6.4	0.4	22.3	1.2	0.1	0.4
HC Emissions (g)	0	65	11	7	22	0	8	0	93	7	0	3
CO Emissions (g)	14	2124	256	184	646	9	424	21	2284	226	14	97
NOx Emissions (g)	2	243	34	28	82	1	17	1	122	23	1	11
Vehicles Entered	13	658	74	153	252	7	71	5	275	152	14	57
Vehicles Exited	13	659	75	152	248	7	69	6	261	154	14	56
Hourly Exit Rate	13	659	75	152	248	7	69	6	261	154	14	56
Input Volume	15	673	79	173	251	12	112	11	441	151	10	54
% of Volume	87	98	95	88	99	58	62	55	59	102	140	104
Denied Entry Before	0	0	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	44	5	154	0	0	0

2: River Road & Rivertech Ct Performance by movement

Movement	All
Total Delay (hr)	123.9
Delay / Veh (s)	259.1
Total Stops	1041
Travel Dist (mi)	350.8
Travel Time (hr)	134.5
Avg Speed (mph)	8
Fuel Used (gal)	38.4
HC Emissions (g)	217
CO Emissions (g)	6299
NOx Emissions (g)	564
Vehicles Entered	1731
Vehicles Exited	1714
Hourly Exit Rate	1714
Input Volume	1982
% of Volume	86
Denied Entry Before	0
Denied Entry After	203

7: River Road & Haig Dr Performance by movement

Movement	EBT	WBL	WBT	WBR	NBR	SBL	SBT	SBR	All
Total Delay (hr)	0.5	0.0	0.1	0.0	0.0	35.3	0.3	0.1	36.2
Delay / Veh (s)	1.5	3.7	0.6	0.4	6.3	413.6	369.6	214.3	68.4
Total Stops	1	1	0	0	8	382	4	2	398
Travel Dist (mi)	234.7	0.5	109.8	10.8	0.9	37.3	0.4	0.1	394.6
Travel Time (hr)	6.9	0.0	2.8	0.3	0.1	36.9	0.3	0.1	47.4
Avg Speed (mph)	34	37	39	35	16	2	2	2	12
Fuel Used (gal)	9.5	0.0	3.1	0.3	0.0	9.3	0.1	0.0	22.3
HC Emissions (g)	158	0	36	4	0	33	0	0	231
CO Emissions (g)	6121	2	1073	99	2	999	5	1	8301
NOx Emissions (g)	541	0	147	14	0	74	0	0	777
Vehicles Entered	1139	2	407	40	8	316	3	1	1916
Vehicles Exited	1143	2	401	40	9	298	3	1	1897
Hourly Exit Rate	1143	2	401	40	9	298	3	1	1897
Input Volume	1325	2	424	42	6	347	4	1	2151
% of Volume	86	100	95	95	150	86	75	100	88
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	51	1	0	52

Total Network Performance

Total Delay (hr)	160.8
Delay / Veh (s)	269.3
Total Stops	1439
Travel Dist (mi)	1297.5
Travel Time (hr)	197.9
Avg Speed (mph)	14
Fuel Used (gal)	79.2
HC Emissions (g)	707
CO Emissions (g)	22995
NOx Emissions (g)	2294
Vehicles Entered	2171
Vehicles Exited	2128
Hourly Exit Rate	2128
Input Volume	6576
% of Volume	32
Denied Entry Before	0
Denied Entry After	255

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	WB	NB	SB
Directions Served	L	TR	L	LTR	LTR
Maximum Queue (ft)	29	30	73	850	304
Average Queue (ft)	6	4	41	813	139
95th Queue (ft)	24	18	64	852	263
Link Distance (ft)		1299		798	703
Upstream Blk Time (%)				83	
Queuing Penalty (veh)				0	
Storage Bay Dist (ft)	250		250		
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 7: River Road & Haig Dr

Movement	EB	WB	NB	SB
Directions Served	T	L	LR	LTR
Maximum Queue (ft)	37	26	31	696
Average Queue (ft)	2	1	8	571
95th Queue (ft)	17	8	31	791
Link Distance (ft)	1064		592	644
Upstream Blk Time (%)				57
Queuing Penalty (veh)				0
Storage Bay Dist (ft)		250		
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

Attachment

C

SIDRA Reports

INTERSECTION SUMMARY

Site: Year 2015_AM

River Road at Haig Dr/Univ. Research Ct.
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	2316 veh/h	2780 pers/h
Percent Heavy Vehicles	2.0 %	
Degree of Saturation	0.725	
Practical Spare Capacity	17.3 %	
Effective Intersection Capacity	3197 veh/h	
Control Delay (Total)	3.76 veh-h/h	4.51 pers-h/h
Control Delay (Average)	5.8 sec	5.8 sec
Control Delay (Worst Lane)	19.7 sec	
Control Delay (Worst Movement)	19.9 sec	19.9 sec
Level of Service (Aver. Int. Delay)	LOS A	
Level of Service (Worst Movement)	LOS B	
Level of Service (Worst Lane)	LOS B	
95% Back of Queue - Vehicles (Worst Lane)	7.2 veh	
95% Back of Queue - Distance (Worst Lane)	181.7 ft	
Total Effective Stops	1006 veh/h	1207 pers/h
Effective Stop Rate	0.43 per veh	0.43 per pers
Proportion Queued	0.10	0.10
Performance Index	37.0	37.0
Travel Distance (Total)	885.8 veh-mi/h	1063.0 pers-mi/h
Travel Distance (Average)	2019 ft	2019 ft
Travel Time (Total)	26.3 veh-h/h	31.5 pers-h/h
Travel Time (Average)	40.8 sec	40.8 sec
Travel Speed	33.7 mph	33.7 mph
Cost (Total)	437.15 $/h	437.15 $/h
Fuel Consumption (Total)	39.3 gal/h	
Carbon Dioxide (Total)	372.7 kg/h	
Hydrocarbons (Total)	0.587 kg/h	
Carbon Monoxide (Total)	26.41 kg/h	
NOx (Total)	0.879 kg/h	

LOS (Aver. Int. Delay) for Vehicles is based on average delay for all vehicle movements. LOS Method: Delay (HCM).
LOS Method for individual vehicle movements and lanes: Delay (HCM).
Roundabout LOS Method: Same as Signalised Intersections.
Roundabout Capacity Model: SIDRA Standard.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1,111,826 veh/y	1,334,191 pers/y
Delay	1,803 veh-h/y	2,163 pers-h/y
Effective Stops	482,849 veh/y	579,418 pers/y
Travel Distance	425,186 veh-mi/y	510,223 pers-mi/y
Travel Time	12,603 veh-h/y	15,123 pers-h/y
Cost	209,830 $/y	209,830 $/y
Fuel Consumption	18,888 gal/y	
Carbon Dioxide	178,886 kg/y	
Hydrocarbons	282 kg/y	
Carbon Monoxide	12,678 kg/y	
NOx	422 kg/y	

SIDRA INTERSECTION

INTERSECTION SUMMARY

Site: Year 2015_PM

River Road at Haig Dr/Univ. Research Ct.
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	2076 veh/h	2491 pers/h
Percent Heavy Vehicles	2.0 %	
Degree of Saturation	0.691	
Practical Spare Capacity	23.1 %	
Effective Intersection Capacity	3006 veh/h	
Control Delay (Total)	5.93 veh-h/h	7.12 pers-h/h
Control Delay (Average)	10.3 sec	10.3 sec
Control Delay (Worst Lane)	15.5 sec	
Control Delay (Worst Movement)	21.1 sec	21.1 sec
Level of Service (Aver. Int. Delay)	LOS B	
Level of Service (Worst Movement)	LOS C	
Level of Service (Worst Lane)	LOS B	
95% Back of Queue - Vehicles (Worst Lane)	8.4 veh	
95% Back of Queue - Distance (Worst Lane)	213.3 ft	
Total Effective Stops	1608 veh/h	1929 pers/h
Effective Stop Rate	0.77 per veh	0.77 per pers
Proportion Queued	0.60	0.60
Performance Index	42.3	42.3
Travel Distance (Total)	802.0 veh-mi/h	962.4 pers-mi/h
Travel Distance (Average)	2040 ft	2040 ft
Travel Time (Total)	26.1 veh-h/h	31.3 pers-h/h
Travel Time (Average)	45.2 sec	45.2 sec
Travel Speed	30.7 mph	30.7 mph
Cost (Total)	441.24 $/h	441.24 $/h
Fuel Consumption (Total)	40.2 gal/h	
Carbon Dioxide (Total)	380.7 kg/h	
Hydrocarbons (Total)	0.622 kg/h	
Carbon Monoxide (Total)	30.30 kg/h	
NOx (Total)	0.942 kg/h	

LOS (Aver. Int. Delay) for Vehicles is based on average delay for all vehicle movements. LOS Method: Delay (HCM).
LOS Method for individual vehicle movements and lanes: Delay (HCM).
Roundabout LOS Method: Same as Signalised Intersections.
Roundabout Capacity Model: SIDRA Standard.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	996,522 veh/y	1,195,826 pers/y
Delay	2,846 veh-h/y	3,415 pers-h/y
Effective Stops	771,668 veh/y	926,001 pers/y
Travel Distance	384,950 veh-mi/y	461,940 pers-mi/y
Travel Time	12,523 veh-h/y	15,027 pers-h/y
Cost	211,796 $/y	211,796 $/y
Fuel Consumption	19,293 gal/y	
Carbon Dioxide	182,723 kg/y	
Hydrocarbons	299 kg/y	
Carbon Monoxide	14,544 kg/y	
NOx	452 kg/y	

INTERSECTION SUMMARY

Site: Year 2030_AM

River Road at Haig Dr/Univ. Research Ct.
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	2610 veh/h	3132 pers/h
Percent Heavy Vehicles	2.0 %	
Degree of Saturation	0.725	
Practical Spare Capacity	17.3 %	
Effective Intersection Capacity	3602 veh/h	
Control Delay (Total)	4.30 veh-h/h	5.16 pers-h/h
Control Delay (Average)	5.9 sec	5.9 sec
Control Delay (Worst Lane)	22.0 sec	
Control Delay (Worst Movement)	22.2 sec	22.2 sec
Level of Service (Aver. Int. Delay)	LOS A	
Level of Service (Worst Movement)	LOS C	
Level of Service (Worst Lane)	LOS C	
95% Back of Queue - Vehicles (Worst Lane)	9.9 veh	
95% Back of Queue - Distance (Worst Lane)	250.3 ft	
Total Effective Stops	1163 veh/h	1396 pers/h
Effective Stop Rate	0.45 per veh	0.45 per pers
Proportion Queued	0.11	0.11
Performance Index	43.2	43.2
Travel Distance (Total)	995.6 veh-mi/h	1194.7 pers-mi/h
Travel Distance (Average)	2014 ft	2014 ft
Travel Time (Total)	29.5 veh-h/h	35.4 pers-h/h
Travel Time (Average)	40.7 sec	40.7 sec
Travel Speed	33.7 mph	33.7 mph
Cost (Total)	502.34 $/h	502.34 $/h
Fuel Consumption (Total)	45.9 gal/h	
Carbon Dioxide (Total)	435.0 kg/h	
Hydrocarbons (Total)	0.680 kg/h	
Carbon Monoxide (Total)	31.71 kg/h	
NOx (Total)	1.054 kg/h	

LOS (Aver. Int. Delay) for Vehicles is based on average delay for all vehicle movements. LOS Method: Delay (HCM).
LOS Method for individual vehicle movements and lanes: Delay (HCM).
Roundabout LOS Method: Same as Signalised Intersections.
Roundabout Capacity Model: SIDRA Standard.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	1,252,696 veh/y	1,503,235 pers/y
Delay	2,066 veh-h/y	2,479 pers-h/y
Effective Stops	558,278 veh/y	669,933 pers/y
Travel Distance	477,868 veh-mi/y	573,441 pers-mi/y
Travel Time	14,162 veh-h/y	16,994 pers-h/y
Cost	241,124 $/y	241,124 $/y
Fuel Consumption	22,045 gal/y	
Carbon Dioxide	208,794 kg/y	
Hydrocarbons	327 kg/y	
Carbon Monoxide	15,222 kg/y	
NOx	506 kg/y	

INTERSECTION SUMMARY

Site: Year 2030_PM

River Road at Haig Dr/Univ. Research Ct.
Roundabout

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	2754	veh/h	3305	pers/h
Percent Heavy Vehicles	2.0	%		
Degree of Saturation	1.087			
Practical Spare Capacity	-21.8	%		
Effective Intersection Capacity	2534	veh/h		
Control Delay (Total)	8.59	veh-h/h	10.31	pers-h/h
Control Delay (Average)	11.2	sec	11.2	sec
Control Delay (Worst Lane)	18.1	sec		
Control Delay (Worst Movement)	23.1	sec	23.1	sec
Level of Service (Aver. Int. Delay)	LOS B			
Level of Service (Worst Movement)	LOS C			
Level of Service (Worst Lane)	LOS B			
95% Back of Queue - Vehicles (Worst Lane)	12.5	veh		
95% Back of Queue - Distance (Worst Lane)	318.3	ft		
Total Effective Stops	2234	veh/h	2681	pers/h
Effective Stop Rate	0.81	per veh	0.81	per pers
Proportion Queued	0.59		0.59	
Performance Index	59.0		59.0	
Travel Distance (Total)	1059.1	veh-mi/h	1270.9	pers-mi/h
Travel Distance (Average)	2030	ft	2030	ft
Travel Time (Total)	35.1	veh-h/h	42.1	pers-h/h
Travel Time (Average)	45.8	sec	45.8	sec
Travel Speed	30.2	mph	30.2	mph
Cost (Total)	598.27	$/h	598.27	$/h
Fuel Consumption (Total)	54.6	gal/h		
Carbon Dioxide (Total)	517.5	kg/h		
Hydrocarbons (Total)	0.849	kg/h		
Carbon Monoxide (Total)	41.99	kg/h		
NOx (Total)	1.297	kg/h		

LOS (Aver. Int. Delay) for Vehicles is based on average delay for all vehicle movements. LOS Method: Delay (HCM).
LOS Method for individual vehicle movements and lanes: Delay (HCM).
Roundabout LOS Method: Same as Signalised Intersections.
Roundabout Capacity Model: SIDRA Standard.

Intersection Performance - Annual Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	1,322,087	veh/y	1,586,504	pers/y
Delay	4,124	veh-h/y	4,949	pers-h/y
Effective Stops	1,072,302	veh/y	1,286,763	pers/y
Travel Distance	508,362	veh-mi/y	610,035	pers-mi/y
Travel Time	16,834	veh-h/y	20,201	pers-h/y
Cost	287,171	$/y	287,171	$/y
Fuel Consumption	26,228	gal/y		
Carbon Dioxide	248,411	kg/y		
Hydrocarbons	407	kg/y		
Carbon Monoxide	20,157	kg/y		
NOx	623	kg/y		

SIDRA INTERSECTION

Attachment

D

Signal Warrant Reports

Analyst: SBS
Agency: STV Inc
Date: 3/11/2010
Project ID:
EW Street: River Rd

Intersection: River Rd and Haig Dr
Jurisdiction: PG County
Units: U.S. Customary
Analysis Year: 2015
NS Street: Haig Dr

General Information

Major St. Speed (mph): 35
Nearest Signal (ft): 0
Crashes per Yr: 0

Population: Not less than 10000
Coordinated Signal System: N

School Crossing

Students in Highest Hour: 0
Adequate Gaps in Period: 0
Minutes in Period: 0

Roadway Network

Two Major Routes: 0
Weekend Count: 0
5-yr Growth Factor: 0

Geometry and Traffic

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LaneUsage	L	LTR		L	TR			LTR			LTR	

Results

Warrant 1: Eight-Hour Vehicular Volume [ ]
1 A. Minimum Vehicular Volumes [ ]
1 B. Interruption of Continuous Traffic [ ]
1 80% Vehicular --and-- Interruption Volumes [ ]

Warrant 2: Four-Hour Vehicular Volume
2 A. Four-Hour Vehicular Volumes [ ]

Warrant 3: Peak Hour [X]
3 A. Peak-Hour Conditions [ ]
3 B. Peak-Hour Vehicular Volume Hours Met [X]

Warrant 4: Pedestrian Volume [ ]
4 A. Pedestrian Volumes [ ]
4 B. Gaps Same Period [ ]

Warrant 5: School Crossing [ ]
5 A. Student Volumes [ ]
5 B. Gaps Same Period [ ]

Warrant 6: Coordinated Signal System
6 Degree of Platooning [ ]

Warrant 7: Crash Experience [ ]
7 A. Adequate trials of alternatives [ ]

7 B. Reported crashes [ ]
7 80% Volumes for Warrants 1A, 1B --or-- 4 [ ]

Warrant 8: Roadway Network [ ]
8 A. Weekday Volume [ ]
8 B. Weekend Volume [ ]

Summary

Hours	Major Volume	Minor Volume	Total Volume	Delay (Veh-hr)	1A 100%	1A 80%	1B 100%	1B 80%	2 100%	3A 100%	3B 100%
07-08	2065	61	2128	0.0	No	No	No	Yes	No	No	No
08-09	0	0	0	0.0	No	No	No	No	No	No	No
09-10	0	0	0	0.0	No	No	No	No	No	No	No
10-11	0	0	0	0.0	No	No	No	No	No	No	No
11-12	0	0	0	0.0	No	No	No	No	No	No	No
12-13	0	0	0	0.0	No	No	No	No	No	No	No
13-14	0	0	0	0.0	No	No	No	No	No	No	No
14-15	0	0	0	0.0	No	No	No	No	No	No	No
15-16	0	0	0	0.0	No	No	No	No	No	No	No
16-17	1549	352	1907	0.0	Yes	Yes	Yes	Yes	Yes	No	Yes
17-18	0	0	0	0.0	No	No	No	No	No	No	No
18-19	0	0	0	0.0	No	No	No	No	No	No	No
Total	3614	413	4035		1	1	1	2	1	0	1

Traffic Volumes (vph)

Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
1	261	2	2	1415	384	0	0	2	60	1	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	1141	0	2	364	42	0	0	6	347	4	1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

Pedestrian Volumes and Gaps (Per Hour)

Volume	Gap	Volume	Gap	Volume	Gap	Volume	Gap
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Delay	sec/veh	veh-hrs	sec/veh	veh-hrs	sec/veh	veh-hrs	sec/veh	veh-hrs
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

HCS+: MUTCD Signal Warrants Release 5.21

Analyst: SBS
Agency: STV Inc
Date: 6/9/2010
Project ID:
EW Street: River Rd

Intersection: River Rd and Rivertech C
Jurisdiction: PG County
Units: U.S. Customary
Analysis Year: 2015
NS Street: Rivertech Ct

General Information

Major St. Speed (mph): 35
Nearest Signal (ft): 0
Crashes per Yr: 0

Population: Not less than 10000
Coordinated Signal System: N

School Crossing

Students in Highest Hour: 0
Adequate Gaps in Period: 0
Minutes in Period: 0

Roadway Network

Two Major Routes: 0
Weekend Count: 0
5-yr Growth Factor: 0

Geometry and Traffic

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LaneUsage	L	LTR		L	TR			LTR			LTR	

Results

Warrant 1: Eight-Hour Vehicular Volume	[ ]
1 A. Minimum Vehicular Volumes	[ ]
1 B. Interruption of Continuous Traffic	[ ]
1 80% Vehicular --and-- Interruption Volumes	[ ]
Warrant 2: Four-Hour Vehicular Volume	
2 A. Four-Hour Vehicular Volumes	[ ]
Warrant 3: Peak Hour	[X]
3 A. Peak-Hour Conditions	[ ]
3 B. Peak-Hour Vehicular Volume Hours Met	[X]
Warrant 4: Pedestrian Volume	[ ]
4 A. Pedestrian Volumes	[ ]
4 B. Gaps Same Period	[ ]
Warrant 5: School Crossing	[ ]
5 A. Student Volumes	[ ]
5 B. Gaps Same Period	[ ]
Warrant 6: Coordinated Signal System	
6 Degree of Platooning	[ ]
Warrant 7: Crash Experience	[ ]
7 A. Adequate trials of alternatives	[ ]

7 B. Reported crashes [ ]
7 80% Volumes for Warrants 1A, 1B --or-- 4 [ ]

Warrant 8: Roadway Network [ ]
8 A. Weekday Volume [ ]
8 B. Weekend Volume [ ]

Summary

Hours	Major Volume	Minor Volume	Total Volume	Delay (Veh-hr)	1A 100%	1A 80%	1B 100%	1B 80%	2 100%	3A 100%	3B 100%
07-08	1447	185	1651	0.0	Yes	Yes	Yes	Yes	Yes	No	Yes
08-09	0	0	0	0.0	No	No	No	No	No	No	No
09-10	0	0	0	0.0	No	No	No	No	No	No	No
10-11	0	0	0	0.0	No	No	No	No	No	No	No
11-12	0	0	0	0.0	No	No	No	No	No	No	No
12-13	0	0	0	0.0	No	No	No	No	No	No	No
13-14	0	0	0	0.0	No	No	No	No	No	No	No
14-15	0	0	0	0.0	No	No	No	No	No	No	No
15-16	0	0	0	0.0	No	No	No	No	No	No	No
16-17	1075	564	1854	0.0	Yes	Yes	Yes	Yes	Yes	No	Yes
17-18	0	0	0	0.0	No	No	No	No	No	No	No
18-19	0	0	0	0.0	No	No	No	No	No	No	No
Total	2522	749	3505		2	2	2	2	2	0	2

Traffic Volumes (vph)

Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
50	158	120	628	419	72	66	11	108	11	2	6
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
15	580	79	173	216	12	112	11	441	151	10	54
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

Pedestrian Volumes and Gaps (Per Hour)

Volume	Gap	Volume	Gap	Volume	Gap	Volume	Gap
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Delay	sec/veh	veh-hrs	sec/veh	veh-hrs	sec/veh	veh-hrs	sec/veh	veh-hrs
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Attachment

E

Synchro/SimTraffic Reports – Signal Control

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	158	120	628	419	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.94		1.00	0.98			0.92			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.97	
Satd. Flow (prot)	1770	3311		1770	3462			1686			1730	
Flt Permitted	0.45	1.00		0.52	1.00			0.87			0.76	
Satd. Flow (perm)	845	3311		963	3462			1498			1356	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	172	130	683	455	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	71	0	0	13	0	0	60	0	0	6	0
Lane Group Flow (vph)	54	231	0	683	520	0	0	141	0	0	15	0
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	45.3	41.0		67.0	58.7			13.0			13.0	
Effective Green, g (s)	45.3	41.0		67.0	58.7			13.0			13.0	
Actuated g/C Ratio	0.50	0.46		0.74	0.65			0.14			0.14	
Clearance Time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	470	1508		914	2258			216			196	
v/s Ratio Prot	0.01	0.07		c0.18	0.15							
v/s Ratio Perm	0.05			c0.37				c0.09			0.01	
v/c Ratio	0.11	0.15		0.75	0.23			0.65			0.08	
Uniform Delay, d1	11.4	14.3		5.0	6.4			36.4			33.3	
Progression Factor	1.00	1.00		0.19	0.38			1.00			1.00	
Incremental Delay, d2	0.1	0.2		2.4	0.2			6.9			0.2	
Delay (s)	11.6	14.6		3.3	2.6			43.3			33.5	
Level of Service	B	B		A	A			D			C	
Approach Delay (s)		14.1			3.0			43.3			33.5	
Approach LOS		B			A			D			C	

Intersection Summary			
HCM Average Control Delay	10.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	66.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	261	2	2	1415	384	0	0	2	60	1	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	1.00		1.00	0.97			0.86			1.00	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.95	
Satd. Flow (prot)	1770	3536		1770	3426			1611			1775	
Flt Permitted	0.08	1.00		0.58	1.00			1.00			0.73	
Satd. Flow (perm)	148	3536		1074	3426			1611			1357	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1	284	2	2	1538	417	0	0	2	65	1	0
RTOR Reduction (vph)	0	0	0	0	20	0	0	2	0	0	0	0
Lane Group Flow (vph)	1	286	0	2	1935	0	0	0	0	0	66	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	72.4	72.4		72.4	72.4			9.6			9.6	
Effective Green, g (s)	72.4	72.4		72.4	72.4			9.6			9.6	
Actuated g/C Ratio	0.80	0.80		0.80	0.80			0.11			0.11	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	119	2845		864	2756			172			145	
v/s Ratio Prot		0.08			c0.56			0.00				
v/s Ratio Perm	0.01			0.00							c0.05	
v/c Ratio	0.01	0.10		0.00	0.70			0.00			0.46	
Uniform Delay, d1	1.7	1.9		1.7	4.0			35.9			37.7	
Progression Factor	0.97	1.07		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.1	0.1		0.0	1.5			0.0			2.3	
Delay (s)	1.8	2.1		1.7	5.5			35.9			40.0	
Level of Service	A	A		A	A			D			D	
Approach Delay (s)		2.1			5.5			35.9			40.0	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	57	105	143	248	195	76	219	48
Average Queue (ft)	22	34	69	122	22	28	98	14
95th Queue (ft)	49	78	124	216	133	66	181	40
Link Distance (ft)		1299	1299		1065	1065	798	653
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	250			250				
Storage Blk Time (%)				1				
Queuing Penalty (veh)				1				

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LR	LTR
Maximum Queue (ft)	17	61	68	6	210	235	19	119
Average Queue (ft)	1	8	16	0	79	87	1	48
95th Queue (ft)	8	37	50	6	164	173	11	96
Link Distance (ft)		1065	1065		1430	1430	592	644
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	250			250				
Storage Blk Time (%)					0			
Queuing Penalty (veh)					0			

Network Summary

Network wide Queuing Penalty: 1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	15	580	79	173	216	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.98		1.00	0.99			0.89			0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.97	
Satd. Flow (prot)	1770	3475		1770	3511			1650			1738	
Flt Permitted	0.52	1.00		0.31	1.00			0.88			0.36	
Satd. Flow (perm)	968	3475		578	3511			1471			644	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	630	86	188	235	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	11	0	0	4	0	0	167	0	0	16	0
Lane Group Flow (vph)	16	705	0	188	244	0	0	446	0	0	218	0
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	31.3	31.3		44.7	43.7			31.5			31.5	
Effective Green, g (s)	31.3	31.3		44.7	43.7			31.5			31.5	
Actuated g/C Ratio	0.35	0.35		0.50	0.49			0.35			0.35	
Clearance Time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	344	1209		462	1705			515			225	
v/s Ratio Prot	0.00	c0.20		c0.06	0.07							
v/s Ratio Perm	0.02			0.14				0.30			c0.34	
v/c Ratio	0.05	0.58		0.41	0.14			0.87			0.97	
Uniform Delay, d1	19.4	24.0		19.7	12.8			27.3			28.8	
Progression Factor	1.00	1.00		0.64	0.66			1.00			1.00	
Incremental Delay, d2	0.1	2.1		0.6	0.2			14.2			51.5	
Delay (s)	19.5	26.1		13.2	8.7			41.5			80.2	
Level of Service	B	C		B	A			D			F	
Approach Delay (s)		25.9			10.6			41.5			80.2	
Approach LOS		C			B			D			F	

Intersection Summary			
HCM Average Control Delay	33.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1141	0	2	364	42	0	0	6	347	4	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor		0.95		1.00	0.95			1.00			1.00	
Frt		1.00		1.00	0.98			0.86			1.00	
Flt Protected		1.00		0.95	1.00			1.00			0.95	
Satd. Flow (prot)		3539		1770	3484			1611			1775	
Flt Permitted		1.00		0.15	1.00			1.00			0.72	
Satd. Flow (perm)		3539		272	3484			1611			1349	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	1240	0	2	396	46	0	0	7	377	4	1
RTOR Reduction (vph)	0	0	0	0	8	0	0	5	0	0	0	0
Lane Group Flow (vph)	0	1240	0	2	434	0	0	2	0	0	382	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		51.2		51.2	51.2			30.8			30.8	
Effective Green, g (s)		51.2		51.2	51.2			30.8			30.8	
Actuated g/C Ratio		0.57		0.57	0.57			0.34			0.34	
Clearance Time (s)		4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)		2013		155	1982			551			462	
v/s Ratio Prot		c0.35			0.12			0.00				
v/s Ratio Perm				0.01							c0.28	
v/c Ratio		0.62		0.01	0.22			0.00			0.83	
Uniform Delay, d1		12.9		8.4	9.6			19.5			27.2	
Progression Factor		0.45		1.00	1.00			1.00			1.00	
Incremental Delay, d2		1.1		0.2	0.3			0.0			11.5	
Delay (s)		6.9		8.6	9.8			19.5			38.7	
Level of Service		A		A	A			B			D	
Approach Delay (s)		6.9			9.8			19.5			38.7	
Approach LOS		A			A			B			D	

Intersection Summary			
HCM Average Control Delay	13.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	47	240	250	164	70	78	494	217
Average Queue (ft)	11	118	136	81	20	32	255	98
95th Queue (ft)	35	200	219	140	52	67	439	171
Link Distance (ft)		1299	1299		1065	1065	798	653
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	250			250				
Storage Blk Time (%)		0						
Queuing Penalty (veh)		0						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB
Directions Served	T	TR	L	T	TR	LR	LTR
Maximum Queue (ft)	183	211	23	108	102	31	369
Average Queue (ft)	73	97	1	44	43	5	196
95th Queue (ft)	157	187	11	92	84	24	314
Link Distance (ft)	1065	1065		1430	1430	592	644
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)			250				
Storage Blk Time (%)							
Queuing Penalty (veh)							

Network Summary

Network wide Queuing Penalty: 0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	183	120	628	486	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.94		1.00	0.98			0.92			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.97	
Satd. Flow (prot)	1770	3329		1770	3471			1686			1730	
Flt Permitted	0.42	1.00		0.50	1.00			0.87			0.76	
Satd. Flow (perm)	787	3329		930	3471			1498			1356	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	199	130	683	528	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	72	0	0	11	0	0	60	0	0	6	0
Lane Group Flow (vph)	54	257	0	683	595	0	0	141	0	0	15	0
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	45.0	40.3		67.0	58.3			13.0			13.0	
Effective Green, g (s)	45.0	40.3		67.0	58.3			13.0			13.0	
Actuated g/C Ratio	0.50	0.45		0.74	0.65			0.14			0.14	
Clearance Time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	445	1491		904	2248			216			196	
v/s Ratio Prot	0.01	0.08		c0.19	0.17							
v/s Ratio Perm	0.05			c0.37				c0.09			0.01	
v/c Ratio	0.12	0.17		0.76	0.26			0.65			0.08	
Uniform Delay, d1	11.6	14.9		5.1	6.7			36.4			33.3	
Progression Factor	1.00	1.00		0.31	0.34			1.00			1.00	
Incremental Delay, d2	0.1	0.3		2.2	0.2			6.9			0.2	
Delay (s)	11.7	15.1		3.8	2.4			43.3			33.5	
Level of Service	B	B		A	A			D			C	
Approach Delay (s)		14.6			3.1			43.3			33.5	
Approach LOS		B			A			D			C	

Intersection Summary			
HCM Average Control Delay	10.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	303	2	2	1643	384	0	0	2	60	1	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	1.00		1.00	0.97			0.86			1.00	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.95	
Satd. Flow (prot)	1770	3536		1770	3439			1611			1775	
Flt Permitted	0.06	1.00		0.55	1.00			1.00			0.73	
Satd. Flow (perm)	103	3536		1028	3439			1611			1357	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1	329	2	2	1786	417	0	0	2	65	1	0
RTOR Reduction (vph)	0	0	0	0	16	0	0	2	0	0	0	0
Lane Group Flow (vph)	1	331	0	2	2187	0	0	0	0	0	66	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	72.4	72.4		72.4	72.4			9.6			9.6	
Effective Green, g (s)	72.4	72.4		72.4	72.4			9.6			9.6	
Actuated g/C Ratio	0.80	0.80		0.80	0.80			0.11			0.11	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	83	2845		827	2766			172			145	
v/s Ratio Prot		0.09			c0.64			0.00				
v/s Ratio Perm	0.01			0.00							c0.05	
v/c Ratio	0.01	0.12		0.00	0.79			0.00			0.46	
Uniform Delay, d1	1.7	1.9		1.7	4.7			35.9			37.7	
Progression Factor	0.68	0.91		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.3	0.1		0.0	2.4			0.0			2.3	
Delay (s)	1.4	1.8		1.7	7.1			35.9			40.0	
Level of Service	A	A		A	A			D			D	
Approach Delay (s)		1.8			7.1			35.9			40.0	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	72	73	137	274	325	114	224	51
Average Queue (ft)	27	32	59	121	28	23	85	17
95th Queue (ft)	57	74	122	234	157	64	156	43
Link Distance (ft)		1299	1299		1065	1065	798	653
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	250			250				
Storage Blk Time (%)				1				
Queuing Penalty (veh)				1				

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	SB
Directions Served	T	TR	L	T	TR	LTR
Maximum Queue (ft)	53	120	29	292	295	119
Average Queue (ft)	8	24	3	95	116	52
95th Queue (ft)	34	71	17	204	223	99
Link Distance (ft)	1065	1065		1430	1430	644
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)			250			
Storage Blk Time (%)				0		
Queuing Penalty (veh)				0		

Network Summary

Network wide Queuing Penalty: 1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	15	673	79	173	251	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.98		1.00	0.99			0.89			0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.97	
Satd. Flow (prot)	1770	3483		1770	3515			1650			1738	
Flt Permitted	0.50	1.00		0.26	1.00			0.88			0.36	
Satd. Flow (perm)	937	3483		475	3515			1471			644	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	732	86	188	273	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	9	0	0	3	0	0	167	0	0	16	0
Lane Group Flow (vph)	16	809	0	188	283	0	0	446	0	0	218	0
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	32.3	32.3		44.7	43.7			31.5			31.5	
Effective Green, g (s)	32.3	32.3		44.7	43.7			31.5			31.5	
Actuated g/C Ratio	0.36	0.36		0.50	0.49			0.35			0.35	
Clearance Time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	344	1250		411	1707			515			225	
v/s Ratio Prot	0.00	c0.23		c0.06	0.08							
v/s Ratio Perm	0.02			0.16				0.30			c0.34	
v/c Ratio	0.05	0.65		0.46	0.17			0.87			0.97	
Uniform Delay, d1	18.8	24.1		22.6	13.0			27.3			28.8	
Progression Factor	1.00	1.00		0.69	0.72			1.00			1.00	
Incremental Delay, d2	0.1	2.6		0.8	0.2			14.2			51.5	
Delay (s)	18.8	26.7		16.3	9.5			41.5			80.2	
Level of Service	B	C		B	A			D			F	
Approach Delay (s)		26.5			12.2			41.5			80.2	
Approach LOS		C			B			D			F	

Intersection Summary

HCM Average Control Delay	33.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1325	0	2	423	42	0	0	6	347	4	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor		0.95		1.00	0.95			1.00			1.00	
Frt		1.00		1.00	0.99			0.86			1.00	
Flt Protected		1.00		0.95	1.00			1.00			0.95	
Satd. Flow (prot)		3539		1770	3491			1611			1775	
Flt Permitted		1.00		0.10	1.00			1.00			0.72	
Satd. Flow (perm)		3539		189	3491			1611			1349	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	1440	0	2	460	46	0	0	7	377	4	1
RTOR Reduction (vph)	0	0	0	0	8	0	0	5	0	0	0	0
Lane Group Flow (vph)	0	1440	0	2	498	0	0	2	0	0	382	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		52.2		52.2	52.2			29.8			29.8	
Effective Green, g (s)		52.2		52.2	52.2			29.8			29.8	
Actuated g/C Ratio		0.58		0.58	0.58			0.33			0.33	
Clearance Time (s)		4.0		4.0	4.0			4.0			4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)		2053		110	2025			533			447	
v/s Ratio Prot		c0.41			0.14			0.00				
v/s Ratio Perm				0.01							c0.28	
v/c Ratio		0.70		0.02	0.25			0.00			0.85	
Uniform Delay, d1		13.4		8.0	9.3			20.2			28.1	
Progression Factor		0.44		1.00	1.00			1.00			1.00	
Incremental Delay, d2		1.5		0.3	0.3			0.0			14.7	
Delay (s)		7.4		8.3	9.5			20.2			42.8	
Level of Service		A		A	A			C			D	
Approach Delay (s)		7.4			9.5			20.2			42.8	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	35	234	261	188	66	85	507	240
Average Queue (ft)	6	136	155	83	25	40	248	101
95th Queue (ft)	26	221	245	150	58	75	439	187
Link Distance (ft)		1299	1299		1065	1065	798	653
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	250			250				
Storage Blk Time (%)		0						
Queuing Penalty (veh)		0						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB
Directions Served	T	TR	L	T	TR	LR	LTR
Maximum Queue (ft)	214	262	27	142	136	31	342
Average Queue (ft)	85	111	2	56	48	3	195
95th Queue (ft)	179	215	13	119	103	20	306
Link Distance (ft)	1065	1065		1430	1430	592	644
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)			250				
Storage Blk Time (%)	0						
Queuing Penalty (veh)	0						

Network Summary

Network wide Queuing Penalty: 0

Attachment

F

Synchro/SimTraffic Reports – Signal Control with LRT

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	50	158	120	628	419	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.94		1.00	0.98			0.92			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.97	
Satd. Flow (prot)	1770	3311		1770	3462			1686			1730	
Flt Permitted	0.45	1.00		0.95	1.00			0.87			0.76	
Satd. Flow (perm)	845	3311		1770	3462			1498			1360	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	172	130	683	455	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	0	0	0	12	0	0	0	0	0	6	0
Lane Group Flow (vph)	54	302	0	683	521	0	0	201	0	0	15	0
Turn Type	pm+pt			Prot			Perm			Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8			4		
Actuated Green, G (s)	34.8	30.2		53.1	78.7			17.7			17.7	
Effective Green, g (s)	29.8	30.2		53.1	78.7			17.7			17.7	
Actuated g/C Ratio	0.25	0.25		0.44	0.66			0.15			0.15	
Clearance Time (s)	4.0			4.0				5.0			5.0	
Vehicle Extension (s)	3.0			3.0				3.0			3.0	
Lane Grp Cap (vph)	245	833		783	2270			221			201	
v/s Ratio Prot	0.01	c0.09		c0.39	0.15							
v/s Ratio Perm	0.05							c0.13			0.01	
v/c Ratio	0.22	0.36		0.87	0.23			0.91			0.07	
Uniform Delay, d1	36.2	37.0		30.4	8.4			50.4			44.1	
Progression Factor	1.00	1.00		0.85	0.75			1.00			1.00	
Incremental Delay, d2	0.5	0.3		7.8	0.0			36.3			0.2	
Delay (s)	36.7	37.2		33.7	6.4			86.7			44.3	
Level of Service	D	D		C	A			F			D	
Approach Delay (s)		37.2			21.7			86.7			44.3	
Approach LOS		D			C			F			D	

Intersection Summary

HCM Average Control Delay	32.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	79.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBT	NBR	SBL2	SBT	NWL2	NER2
Lane Configurations												
Volume (vph)	1	261	2	2	1415	384	0	2	60	1	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0			5.0	5.0	5.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00			1.00	1.00	1.00
Frt	1.00	1.00		1.00	0.97		0.86			1.00	1.00	0.86
Flt Protected	0.95	1.00		0.95	1.00		1.00			0.95	0.95	1.00
Satd. Flow (prot)	1770	3536		1770	3426		1611			1775	1770	1611
Flt Permitted	0.08	1.00		0.05	1.00		1.00			0.73	0.95	1.00
Satd. Flow (perm)	155	3536		93	3426		1611			1357	1770	1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1	284	2	2	1538	417	0	2	65	1	11	11
RTOR Reduction (vph)	0	0	0	0	17	0	0	0	0	0	0	0
Lane Group Flow (vph)	1	286	0	2	1938	0	2	0	0	66	11	11
Turn Type	Perm			custom					Perm		Prot	custom
Protected Phases		2 9 10			6 9 10		8			4	10	9
Permitted Phases	2 9 10			6					4			
Actuated Green, G (s)	98.9	98.9		80.1	98.9		11.1			11.1	4.4	4.4
Effective Green, g (s)	98.9	98.9		80.1	98.9		11.1			11.1	4.4	4.4
Actuated g/C Ratio	0.82	0.82		0.67	0.82		0.09			0.09	0.04	0.04
Clearance Time (s)				5.0			5.0			5.0	5.0	5.0
Vehicle Extension (s)				3.0			3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	128	2914		62	2824		149			126	65	59
v/s Ratio Prot		0.08			c0.57		0.00				0.01	0.01
v/s Ratio Perm	0.01			0.02						c0.05		
v/c Ratio	0.01	0.10		0.03	0.69		0.01			0.52	0.17	0.19
Uniform Delay, d1	1.9	2.0		6.8	4.3		49.5			51.9	56.0	56.1
Progression Factor	1.31	1.63		1.00	1.00		1.00			1.00	1.00	1.00
Incremental Delay, d2	0.0	0.0		1.0	0.7		0.0			3.9	1.2	1.5
Delay (s)	2.5	3.3		7.7	5.0		49.5			55.8	57.3	57.6
Level of Service	A	A		A	A		D			E	E	E
Approach Delay (s)		3.3			5.0		49.5			55.8		
Approach LOS		A			A		D			E		

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LTR	<LTR>	<	>
Maximum Queue (ft)	52	136	169	275	829	660	267	48	53	31
Average Queue (ft)	12	40	92	262	379	86	137	12	8	4
95th Queue (ft)	37	97	149	318	772	386	233	40	32	16
Link Distance (ft)		1252	1252		983	983	798	653	243	276
Upstream Blk Time (%)					0					
Queuing Penalty (veh)					2					
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)				21						
Queuing Penalty (veh)				43						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	4	53	78	6	216	206	28	108	48	33
Average Queue (ft)	0	3	9	0	64	66	1	48	11	5
95th Queue (ft)	2	25	44	4	157	162	11	93	35	21
Link Distance (ft)		983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)					0					
Queuing Penalty (veh)					0					

Network Summary

Network wide Queuing Penalty: 45

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	15	580	79	173	216	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.98		1.00	0.99			0.89			0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.97	
Satd. Flow (prot)	1770	3475		1770	3511			1650			1738	
Flt Permitted	0.52	1.00		0.95	1.00			0.88			0.37	
Satd. Flow (perm)	969	3475		1770	3511			1468			668	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	630	86	188	235	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	10	0
Lane Group Flow (vph)	16	716	0	188	245	0	0	613	0	0	224	0
Turn Type	pm+pt			Prot			Perm			Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8			4		
Actuated Green, G (s)	39.7	44.7		15.3	52.9			46.0			46.0	
Effective Green, g (s)	34.7	44.7		15.3	52.9			46.0			46.0	
Actuated g/C Ratio	0.29	0.37		0.13	0.44			0.38			0.38	
Clearance Time (s)	4.0			4.0				5.0			5.0	
Vehicle Extension (s)	3.0			3.0				3.0			3.0	
Lane Grp Cap (vph)	294	1294		226	1548			563			256	
v/s Ratio Prot	0.00	c0.21		c0.11	0.07							
v/s Ratio Perm	0.01							c0.42			0.34	
v/c Ratio	0.05	0.55		0.83	0.16			1.09			0.88	
Uniform Delay, d1	33.9	29.8		51.1	20.2			37.0			34.3	
Progression Factor	1.00	1.00		0.79	0.32			1.00			1.00	
Incremental Delay, d2	0.1	0.5		22.0	0.0			64.3			26.6	
Delay (s)	34.0	30.3		62.5	6.5			101.3			60.9	
Level of Service	C	C		E	A			F			E	
Approach Delay (s)		30.4			30.6			101.3			60.9	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	55.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Movement	EBL	EBT	WBL2	WBT	WBR	NBT	NBR	SBL2	SBT	SBR	NWL2	NER2
Lane Configurations												
Volume (vph)	0	1141	2	364	42	0	6	347	4	1	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0		5.0			5.0		5.0	5.0
Lane Util. Factor		0.95	1.00	0.95		1.00			1.00		1.00	1.00
Frt		1.00	1.00	0.98		0.86			1.00		1.00	0.86
Flt Protected		1.00	0.95	1.00		1.00			0.95		0.95	1.00
Satd. Flow (prot)		3539	1770	3484		1611			1775		1770	1611
Flt Permitted		1.00	0.07	1.00		1.00			0.72		0.95	1.00
Satd. Flow (perm)		3539	133	3484		1611			1349		1770	1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	1240	2	396	46	0	7	377	4	1	11	11
RTOR Reduction (vph)	0	0	0	6	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1240	2	436	0	7	0	0	382	0	11	11
Turn Type	Perm		custom					Perm			Prot	custom
Protected Phases		2 9 10		6 9 10		8			4		10	9
Permitted Phases	2 9 10		6					4				
Actuated Green, G (s)		70.5	56.1	70.5		39.5			39.5		2.2	2.2
Effective Green, g (s)		70.5	56.1	70.5		39.5			39.5		2.2	2.2
Actuated g/C Ratio		0.59	0.47	0.59		0.33			0.33		0.02	0.02
Clearance Time (s)			5.0			5.0			5.0		5.0	5.0
Vehicle Extension (s)			3.0			3.0			3.0		3.0	3.0
Lane Grp Cap (vph)		2079	62	2047		530			444		32	30
v/s Ratio Prot		c0.35		0.13		0.00					0.01	0.01
v/s Ratio Perm			0.02						c0.28			
v/c Ratio		0.60	0.03	0.21		0.01			0.86		0.34	0.37
Uniform Delay, d1		15.7	17.3	11.7		27.1			37.7		58.2	58.2
Progression Factor		0.34	1.00	1.00		1.00			1.00		1.00	1.00
Incremental Delay, d2		0.3	1.0	0.1		0.0			15.5		6.3	7.4
Delay (s)		5.7	18.2	11.7		27.1			53.2		64.5	65.7
Level of Service		A	B	B		C			D		E	E
Approach Delay (s)		5.7		11.8		27.1			53.2			
Approach LOS		A		B		C			D			

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LTR	<LTR>	<	>
Maximum Queue (ft)	23	280	283	266	245	78	823	234	36	47
Average Queue (ft)	3	143	165	163	31	20	725	109	6	10
95th Queue (ft)	14	242	257	273	161	57	1017	194	24	37
Link Distance (ft)		1252	1252		983	983	798	653	243	276
Upstream Blk Time (%)							49			
Queuing Penalty (veh)							0			
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)		0		7						
Queuing Penalty (veh)		0		7						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	TR	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	277	286	15	91	92	37	404	37	33
Average Queue (ft)	92	110	1	31	25	5	244	9	6
95th Queue (ft)	216	234	6	76	68	24	360	30	21
Link Distance (ft)	983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			250						
Storage Blk Time (%)	1								
Queuing Penalty (veh)	0								

Network Summary

Network wide Queuing Penalty: 7

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	50	183	120	628	486	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.94		1.00	0.98			0.92			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.97	
Satd. Flow (prot)	1770	3329		1770	3471			1686			1730	
Flt Permitted	0.42	1.00		0.95	1.00			0.87			0.76	
Satd. Flow (perm)	787	3329		1770	3471			1498			1344	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	199	130	683	528	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	0	0	0	10	0	0	0	0	0	6	0
Lane Group Flow (vph)	54	329	0	683	596	0	0	201	0	0	15	0
Turn Type	pm+pt			Prot			Perm			Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8			4		
Actuated Green, G (s)	35.1	30.6		53.1	79.2			17.3			17.3	
Effective Green, g (s)	30.1	30.6		53.1	79.2			17.3			17.3	
Actuated g/C Ratio	0.25	0.26		0.44	0.66			0.14			0.14	
Clearance Time (s)	4.0			4.0				5.0			5.0	
Vehicle Extension (s)	3.0			3.0				3.0			3.0	
Lane Grp Cap (vph)	234	849		783	2291			216			194	
v/s Ratio Prot	0.01	c0.10		c0.39	0.17							
v/s Ratio Perm	0.05							c0.13			0.01	
v/c Ratio	0.23	0.39		0.87	0.26			0.93			0.08	
Uniform Delay, d1	36.2	37.0		30.4	8.4			50.8			44.4	
Progression Factor	1.00	1.00		0.81	0.58			1.00			1.00	
Incremental Delay, d2	0.5	0.3		6.8	0.0			42.2			0.2	
Delay (s)	36.7	37.2		31.5	4.9			92.9			44.6	
Level of Service	D	D		C	A			F			D	
Approach Delay (s)		37.2			19.0			92.9			44.6	
Approach LOS		D			B			F			D	

Intersection Summary			
HCM Average Control Delay	31.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBT	NBR	SBL2	SBT	NWL2	NER2
Lane Configurations												
Volume (vph)	1	303	2	2	1643	384	0	2	60	1	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0			5.0	5.0	5.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00			1.00	1.00	1.00
Frt	1.00	1.00		1.00	0.97		0.86			1.00	1.00	0.86
Flt Protected	0.95	1.00		0.95	1.00		1.00			0.95	0.95	1.00
Satd. Flow (prot)	1770	3536		1770	3439		1611			1775	1770	1611
Flt Permitted	0.06	1.00		0.05	1.00		1.00			0.73	0.95	1.00
Satd. Flow (perm)	104	3536		93	3439		1611			1357	1770	1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1	329	2	2	1786	417	0	2	65	1	11	11
RTOR Reduction (vph)	0	0	0	0	14	0	0	0	0	0	0	0
Lane Group Flow (vph)	1	331	0	2	2189	0	2	0	0	66	11	11
Turn Type	Perm			custom					Perm		Prot	custom
Protected Phases		2 9 10			6 9 10		8			4	10	9
Permitted Phases	2 9 10			6					4			
Actuated Green, G (s)	98.9	98.9		80.1	98.9		11.1			11.1	4.4	4.4
Effective Green, g (s)	98.9	98.9		80.1	98.9		11.1			11.1	4.4	4.4
Actuated g/C Ratio	0.82	0.82		0.67	0.82		0.09			0.09	0.04	0.04
Clearance Time (s)				5.0			5.0			5.0	5.0	5.0
Vehicle Extension (s)				3.0			3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	86	2914		62	2834		149			126	65	59
v/s Ratio Prot		0.09			c0.64		0.00				0.01	0.01
v/s Ratio Perm	0.01			0.02						c0.05		
v/c Ratio	0.01	0.11		0.03	0.77		0.01			0.52	0.17	0.19
Uniform Delay, d1	1.9	2.0		6.8	5.1		49.5			51.9	56.0	56.1
Progression Factor	1.14	1.89		1.00	1.00		1.00			1.00	1.00	1.00
Incremental Delay, d2	0.0	0.0		1.0	1.4		0.0			3.9	1.2	1.5
Delay (s)	2.2	3.9		7.7	6.5		49.5			55.8	57.3	57.6
Level of Service	A	A		A	A		D			E	E	E
Approach Delay (s)		3.9			6.5		49.5			55.8		
Approach LOS		A			A		D			E		

Intersection Summary

HCM Average Control Delay	7.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LTR	<LTR>	<	>
Maximum Queue (ft)	65	165	198	275	857	732	258	57	41	26
Average Queue (ft)	14	50	97	258	433	140	128	16	9	3
95th Queue (ft)	42	111	171	324	852	515	221	46	32	14
Link Distance (ft)		1252	1252		983	983	798	653	243	276
Upstream Blk Time (%)					1	0				
Queuing Penalty (veh)					7	0				
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)				22						
Queuing Penalty (veh)				54						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	4	41	65	3	316	291	28	140	35	42
Average Queue (ft)	0	3	7	0	93	89	2	56	7	5
95th Queue (ft)	2	21	32	2	224	220	14	109	26	25
Link Distance (ft)		983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)					1					
Queuing Penalty (veh)					0					

Network Summary

Network wide Queuing Penalty: 61

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	15	673	79	173	250	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frt	1.00	0.98		1.00	0.99			0.89			0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.97	
Satd. Flow (prot)	1770	3483		1770	3515			1650			1738	
Flt Permitted	0.49	1.00		0.95	1.00			0.88			0.37	
Satd. Flow (perm)	911	3483		1770	3515			1468			668	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	732	86	188	272	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	10	0
Lane Group Flow (vph)	16	818	0	188	282	0	0	613	0	0	224	0
Turn Type	pm+pt			Prot			Perm			Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8			4		
Actuated Green, G (s)	40.5	45.5		14.5	52.9			46.0			46.0	
Effective Green, g (s)	35.5	45.5		14.5	52.9			46.0			46.0	
Actuated g/C Ratio	0.30	0.38		0.12	0.44			0.38			0.38	
Clearance Time (s)	4.0			4.0				5.0			5.0	
Vehicle Extension (s)	3.0			3.0				3.0			3.0	
Lane Grp Cap (vph)	285	1321		214	1550			563			256	
v/s Ratio Prot	0.00	c0.23		c0.11	0.08							
v/s Ratio Perm	0.02							c0.42			0.34	
v/c Ratio	0.06	0.62		0.88	0.18			1.09			0.88	
Uniform Delay, d1	34.0	30.2		51.9	20.4			37.0			34.3	
Progression Factor	1.00	1.00		0.78	0.28			1.00			1.00	
Incremental Delay, d2	0.1	0.9		30.4	0.1			64.3			26.6	
Delay (s)	34.0	31.1		71.1	5.8			101.3			60.9	
Level of Service	C	C		E	A			F			E	
Approach Delay (s)		31.2			31.8			101.3			60.9	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	54.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	90.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Movement	EBL	EBT	WBL2	WBT	WBR	NBT	NBR	SBL2	SBT	SBR	NWL2	NER2
Lane Configurations												
Volume (vph)	0	1324	2	423	42	0	6	347	4	1	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0		5.0			5.0		5.0	5.0
Lane Util. Factor		0.95	1.00	0.95		1.00			1.00		1.00	1.00
Frt		1.00	1.00	0.99		0.86			1.00		1.00	0.86
Flt Protected		1.00	0.95	1.00		1.00			0.95		0.95	1.00
Satd. Flow (prot)		3539	1770	3491		1611			1775		1770	1611
Flt Permitted		1.00	0.07	1.00		1.00			0.72		0.95	1.00
Satd. Flow (perm)		3539	130	3491		1611			1349		1770	1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	1439	2	460	46	0	7	377	4	1	11	11
RTOR Reduction (vph)	0	0	0	6	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	1439	2	500	0	7	0	0	382	0	11	11
Turn Type	Perm		custom					Perm			Prot	custom
Protected Phases		2 9 10		6 9 10		8			4		10	9
Permitted Phases	2 9 10		6					4				
Actuated Green, G (s)		71.5	57.1	71.5		38.5			38.5		2.2	2.2
Effective Green, g (s)		71.5	57.1	71.5		38.5			38.5		2.2	2.2
Actuated g/C Ratio		0.60	0.48	0.60		0.32			0.32		0.02	0.02
Clearance Time (s)			5.0			5.0			5.0		5.0	5.0
Vehicle Extension (s)			3.0			3.0			3.0		3.0	3.0
Lane Grp Cap (vph)		2109	62	2080		517			433		32	30
v/s Ratio Prot		c0.41		0.14		0.00					0.01	0.01
v/s Ratio Perm			0.02						c0.28			
v/c Ratio		0.68	0.03	0.24		0.01			0.88		0.34	0.37
Uniform Delay, d1		16.5	16.7	11.4		27.8			38.6		58.2	58.2
Progression Factor		0.38	1.00	1.00		1.00			1.00		1.00	1.00
Incremental Delay, d2		0.6	1.0	0.1		0.0			18.6		6.3	7.4
Delay (s)		6.8	17.7	11.5		27.8			57.2		64.5	65.7
Level of Service		A	B	B		C			E		E	E
Approach Delay (s)		6.8		11.5		27.8			57.2			
Approach LOS		A		B		C			E			

Intersection Summary			
HCM Average Control Delay	16.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	84.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LTR	<LTR>	<	>
Maximum Queue (ft)	43	281	317	264	133	142	824	221	41	85
Average Queue (ft)	4	174	201	152	33	24	660	110	8	25
95th Queue (ft)	21	262	300	273	177	112	989	192	29	79
Link Distance (ft)		1252	1252		983	983	798	653	243	276
Upstream Blk Time (%)							22			
Queuing Penalty (veh)							0			
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)		0		7						
Queuing Penalty (veh)		0		9						

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	TR	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	289	307	15	121	125	30	494	43	41
Average Queue (ft)	106	126	1	34	31	5	256	9	7
95th Queue (ft)	241	268	6	86	85	21	410	31	27
Link Distance (ft)	983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)							0		
Queuing Penalty (veh)							0		
Storage Bay Dist (ft)			250						
Storage Blk Time (%)	1								
Queuing Penalty (veh)	0								

Network Summary

Network wide Queuing Penalty: 9

Attachment

G

Synchro/SimTraffic Reports – Signal Control with LRT
Two Northbound Rivertech Court Lanes

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	50	158	120	628	419	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frt	1.00	0.94		1.00	0.98			1.00	0.85		0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1770	3311		1770	3462			1786	1583		1730	
Flt Permitted	0.45	1.00		0.95	1.00			0.74	1.00		0.83	
Satd. Flow (perm)	845	3311		1770	3462			1381	1583		1483	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	172	130	683	455	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	0	0	0	11	0	0	0	0	0	6	0
Lane Group Flow (vph)	54	302	0	683	522	0	0	84	117	0	15	0
Turn Type	pm+pt			Prot			Perm		Perm	Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8		8	4		
Actuated Green, G (s)	38.8	34.3		52.8	82.6			13.9	13.9		13.9	
Effective Green, g (s)	33.8	34.3		52.8	82.6			13.9	13.9		13.9	
Actuated g/C Ratio	0.28	0.29		0.44	0.69			0.12	0.12		0.12	
Clearance Time (s)	4.0			4.0				5.0	5.0		5.0	
Vehicle Extension (s)	3.0			3.0				3.0	3.0		3.0	
Lane Grp Cap (vph)	273	946		779	2383			160	183		172	
v/s Ratio Prot	0.01	c0.09		c0.39	0.15							
v/s Ratio Perm	0.05							0.06	c0.07		0.01	
v/c Ratio	0.20	0.32		0.88	0.22			0.52	0.64		0.09	
Uniform Delay, d1	33.1	33.7		30.6	6.9			49.9	50.7		47.4	
Progression Factor	1.00	1.00		0.85	0.59			1.00	1.00		1.00	
Incremental Delay, d2	0.4	0.2		8.1	0.0			3.1	7.1		0.2	
Delay (s)	33.4	33.9		34.2	4.1			53.0	57.8		47.6	
Level of Service	C	C		C	A			D	E		D	
Approach Delay (s)		33.8			21.0			55.8			47.6	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM Average Control Delay	28.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	75.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Queuing and Blocking Report
Signal with LRT and 2 NB Lanes

6/10/2010

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	56	122	185	275	921	678	131	150	60	44	35
Average Queue (ft)	13	43	90	249	401	115	59	77	14	10	4
95th Queue (ft)	39	92	155	325	870	444	116	137	45	34	19
Link Distance (ft)		1252	1252		983	983	788	788	653	250	276
Upstream Blk Time (%)					0						
Queuing Penalty (veh)					3						
Storage Bay Dist (ft)	250			250							
Storage Blk Time (%)				24							
Queuing Penalty (veh)				49							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	4	41	70	9	199	218	29	119	44	33
Average Queue (ft)	0	7	15	1	62	66	1	52	9	5
95th Queue (ft)	3	28	49	5	148	163	11	97	32	19
Link Distance (ft)		983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)					0					
Queuing Penalty (veh)					0					

Network Summary

Network wide Queuing Penalty: 52

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	15	580	79	173	216	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.99			1.00	0.85		0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1770	3475		1770	3511			1782	1583		1738	
Flt Permitted	0.53	1.00		0.95	1.00			0.63	1.00		0.68	
Satd. Flow (perm)	990	3475		1770	3511			1166	1583		1228	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	630	86	188	235	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	11	0
Lane Group Flow (vph)	16	716	0	188	245	0	0	134	479	0	223	0
Turn Type	pm+pt			Prot			Perm		Perm	Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8		8	4		
Actuated Green, G (s)	43.0	48.0		18.6	59.5			39.4	39.4		39.4	
Effective Green, g (s)	38.0	48.0		18.6	59.5			39.4	39.4		39.4	
Actuated g/C Ratio	0.32	0.40		0.16	0.50			0.33	0.33		0.33	
Clearance Time (s)	4.0			4.0				5.0	5.0		5.0	
Vehicle Extension (s)	3.0			3.0				3.0	3.0		3.0	
Lane Grp Cap (vph)	327	1390		274	1741			383	520		403	
v/s Ratio Prot	0.00	c0.21		c0.11	0.07							
v/s Ratio Perm	0.01							0.11	c0.30		0.18	
v/c Ratio	0.05	0.52		0.69	0.14			0.35	0.92		0.55	
Uniform Delay, d1	31.3	27.2		47.9	16.4			30.6	38.8		33.1	
Progression Factor	1.00	1.00		0.79	0.20			1.00	1.00		1.00	
Incremental Delay, d2	0.1	0.3		6.9	0.0			0.6	21.8		1.7	
Delay (s)	31.3	27.5		44.6	3.3			31.1	60.6		34.7	
Level of Service	C	C		D	A			C	E		C	
Approach Delay (s)		27.6			21.1			54.2			34.7	
Approach LOS		C			C			D			C	

Intersection Summary

HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	83.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	74	280	307	245	106	73	449	606	253	53	51
Average Queue (ft)	5	152	177	128	9	14	99	352	127	8	10
95th Queue (ft)	43	246	276	225	58	49	278	568	222	33	35
Link Distance (ft)		1252	1252		983	983	788	788	653	250	276
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	250			250							
Storage Blk Time (%)		0		1							
Queuing Penalty (veh)		0		1							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	TR	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	292	336	16	132	95	34	448	53	40
Average Queue (ft)	59	81	1	38	26	5	248	10	5
95th Queue (ft)	168	203	8	97	68	23	377	34	21
Link Distance (ft)	983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			250						
Storage Blk Time (%)	0								
Queuing Penalty (veh)	0								

Network Summary

Network wide Queuing Penalty: 2

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	50	183	120	628	486	72	66	11	108	11	2	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frt	1.00	0.94		1.00	0.98			1.00	0.85		0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1770	3329		1770	3471			1786	1583		1730	
Flt Permitted	0.42	1.00		0.95	1.00			0.74	1.00		0.83	
Satd. Flow (perm)	787	3329		1770	3471			1381	1583		1482	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	199	130	683	528	78	72	12	117	12	2	7
RTOR Reduction (vph)	0	0	0	0	9	0	0	0	0	0	6	0
Lane Group Flow (vph)	54	329	0	683	597	0	0	84	117	0	15	0
Turn Type	pm+pt			Prot			Perm		Perm	Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8		8	4		
Actuated Green, G (s)	38.9	34.4		52.8	82.7			13.8	13.8		13.8	
Effective Green, g (s)	33.9	34.4		52.8	82.7			13.8	13.8		13.8	
Actuated g/C Ratio	0.28	0.29		0.44	0.69			0.12	0.12		0.12	
Clearance Time (s)	4.0			4.0				5.0	5.0		5.0	
Vehicle Extension (s)	3.0			3.0				3.0	3.0		3.0	
Lane Grp Cap (vph)	259	954		779	2392			159	182		170	
v/s Ratio Prot	0.01	c0.10		c0.39	0.17							
v/s Ratio Perm	0.05							0.06	c0.07		0.01	
v/c Ratio	0.21	0.34		0.88	0.25			0.53	0.64		0.09	
Uniform Delay, d1	33.2	33.9		30.6	7.0			50.0	50.7		47.5	
Progression Factor	1.00	1.00		0.83	0.46			1.00	1.00		1.00	
Incremental Delay, d2	0.4	0.2		7.0	0.0			3.1	7.5		0.2	
Delay (s)	33.6	34.1		32.4	3.2			53.2	58.3		47.7	
Level of Service	C	C		C	A			D	E		D	
Approach Delay (s)		34.0			18.7			56.2			47.7	
Approach LOS		C			B			E			D	

Intersection Summary			
HCM Average Control Delay	26.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	64	143	189	275	924	695	138	182	78	40	12
Average Queue (ft)	15	48	99	241	347	108	55	89	17	9	2
95th Queue (ft)	41	106	162	331	834	439	109	156	51	31	8
Link Distance (ft)		1252	1252		983	983	788	788	653	250	276
Upstream Blk Time (%)					0						
Queuing Penalty (veh)					3						
Storage Bay Dist (ft)	250			250							
Storage Blk Time (%)				18							
Queuing Penalty (veh)				45							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	4	52	78	13	262	255	34	130	40	33
Average Queue (ft)	0	5	13	1	79	90	2	52	10	4
95th Queue (ft)	2	24	46	6	179	202	17	99	33	18
Link Distance (ft)		983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250						
Storage Blk Time (%)					0					
Queuing Penalty (veh)					0					

Network Summary

Network wide Queuing Penalty: 48

HCM Signalized Intersection Capacity Analysis
2: River Road & Rivertech Ct 6/10/2010

Movement	EBL	EBT	EBR2	WBL2	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR2
Lane Configurations												
Volume (vph)	15	673	79	173	250	12	112	11	441	151	10	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.99			1.00	0.85		0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1770	3483		1770	3515			1782	1583		1738	
Flt Permitted	0.51	1.00		0.95	1.00			0.63	1.00		0.68	
Satd. Flow (perm)	947	3483		1770	3515			1167	1583		1226	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	16	732	86	188	272	13	122	12	479	164	11	59
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	10	0
Lane Group Flow (vph)	16	818	0	188	282	0	0	134	479	0	224	0
Turn Type	pm+pt			Prot			Perm		Perm	Perm		
Protected Phases	5	2 9 10		1	6 9 10			8			4	
Permitted Phases	2 9 10						8		8	4		
Actuated Green, G (s)	44.6	49.6		17.4	59.9			39.0	39.0		39.0	
Effective Green, g (s)	39.6	49.6		17.4	59.9			39.0	39.0		39.0	
Actuated g/C Ratio	0.33	0.41		0.14	0.50			0.32	0.32		0.32	
Clearance Time (s)	4.0			4.0				5.0	5.0		5.0	
Vehicle Extension (s)	3.0			3.0				3.0	3.0		3.0	
Lane Grp Cap (vph)	327	1440		257	1755			379	514		398	
v/s Ratio Prot	0.00	c0.23		c0.11	0.08							
v/s Ratio Perm	0.02							0.11	c0.30		0.18	
v/c Ratio	0.05	0.57		0.73	0.16			0.35	0.93		0.56	
Uniform Delay, d1	30.5	27.0		49.1	16.4			30.9	39.2		33.5	
Progression Factor	1.00	1.00		0.79	0.14			1.00	1.00		1.00	
Incremental Delay, d2	0.1	0.5		10.1	0.0			0.6	23.9		1.8	
Delay (s)	30.5	27.5		48.7	2.3			31.5	63.1		35.3	
Level of Service	C	C		D	A			C	E		D	
Approach Delay (s)		27.6			20.7			56.2			35.3	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	NWL2	NER2
Lane Configurations		
Volume (vph)	10	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	5.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.86
Flt Protected	0.95	1.00
Satd. Flow (prot)	1770	1611
Flt Permitted	0.95	1.00
Satd. Flow (perm)	1770	1611
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	11	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	11	11
Turn Type	Prot	custom
Protected Phases	10	9
Permitted Phases		
Actuated Green, G (s)	2.2	2.2
Effective Green, g (s)	2.2	2.2
Actuated g/C Ratio	0.02	0.02
Clearance Time (s)	5.0	5.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	32	30
v/s Ratio Prot	0.01	0.01
v/s Ratio Perm		
v/c Ratio	0.34	0.37
Uniform Delay, d1	58.2	58.2
Progression Factor	1.00	1.00
Incremental Delay, d2	6.3	7.4
Delay (s)	64.5	65.7
Level of Service	E	E
Approach Delay (s)		
Approach LOS		

Intersection Summary

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	TR>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	67	292	307	239	148	141	406	618	238	54	44
Average Queue (ft)	4	171	191	137	31	18	142	381	119	10	14
95th Queue (ft)	42	268	283	243	175	75	492	679	209	35	47
Link Distance (ft)		1252	1252		983	983	788	788	653	250	276
Upstream Blk Time (%)							1	4			
Queuing Penalty (veh)							0	0			
Storage Bay Dist (ft)	250			250							
Storage Blk Time (%)		1		5							
Queuing Penalty (veh)		0		6							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	TR	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	301	330	6	144	104	35	481	44	62
Average Queue (ft)	91	113	0	41	30	6	251	11	9
95th Queue (ft)	222	246	4	102	80	25	398	36	37
Link Distance (ft)	983	983		1400	1400	586	644	248	219
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			250						
Storage Blk Time (%)	1								
Queuing Penalty (veh)	0								

Network Summary

Network wide Queuing Penalty: 6

Attachment

H

SimTraffic Reports – Signal Control with LRT and Eastbound Right Turn Lanes

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	T	>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	35	66	93	150	274	924	703	131	183	60	40	39
Average Queue (ft)	6	16	39	53	255	371	119	56	81	15	7	5
95th Queue (ft)	23	47	79	114	321	840	469	107	148	45	27	23
Link Distance (ft)		1237	1237	1237		953	953	787	787	653	222	257
Upstream Blk Time (%)						1						
Queuing Penalty (veh)						5						
Storage Bay Dist (ft)	250				250							
Storage Blk Time (%)					20							
Queuing Penalty (veh)					49							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	T	>	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	40	60	4	3	356	331	16	124	48	42
Average Queue (ft)	3	8	0	0	91	99	1	55	10	6
95th Queue (ft)	20	36	3	2	236	238	9	106	33	24
Link Distance (ft)	953	953	953		1400	1400	579	644	248	201
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)				250						
Storage Blk Time (%)					1					
Queuing Penalty (veh)					0					

Network Summary

Network wide Queuing Penalty: 54

Intersection: 2: River Road & Rivertech Ct

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	SB	NW	NE
Directions Served	L	T	T	>	<	T	TR	LT	R	<LTR>	<	>
Maximum Queue (ft)	7	206	223	107	223	78	84	277	583	255	45	21
Average Queue (ft)	0	105	134	38	114	18	24	83	323	108	8	3
95th Queue (ft)	5	179	204	83	200	58	67	234	549	205	31	15
Link Distance (ft)		1237	1237	1237		953	953	787	787	653	222	257
Upstream Blk Time (%)									0			
Queuing Penalty (veh)									0			
Storage Bay Dist (ft)	250				250							
Storage Blk Time (%)		0			0							
Queuing Penalty (veh)		0			0							

Intersection: 7: River Road & Haig Dr

Movement	EB	EB	WB	WB	WB	NB	SB	NW	NE
Directions Served	T	T	<	T	TR	LR	<LTR	<	>
Maximum Queue (ft)	330	478	12	131	121	26	450	48	24
Average Queue (ft)	121	148	1	44	34	3	252	10	4
95th Queue (ft)	261	340	5	101	88	16	392	35	17
Link Distance (ft)	953	953		1400	1400	579	644	248	201
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			250						
Storage Blk Time (%)	1								
Queuing Penalty (veh)	0								

Network Summary

Network wide Queuing Penalty: 0

28. MD 410 at MD 201 and at Riverdale Road Traffic Operations Analysis

MD 410 (East-West Highway) at MD 201 (Kenilworth Avenue) and at Riverdale Road/58th Street: Traffic Operations Analysis

May 2010

MD 410 (East-West Highway) at MD 201 (Kenilworth Avenue)
and at Riverdale Road / 58th Street:
Traffic Operations Analysis

INTRODUCTION

The Maryland Transit Administration (MTA) is currently proceeding with the planning stages of the proposed 16-mile Purple Line transit corridor from Bethesda in Montgomery County to New Carrollton in Prince George's County. The Purple Line Alternatives Analysis / Draft Environmental Impact Statement (AA/DEIS) was published in November 2008 and a Locally Preferred Alternative (LPA) was announced by the Governor in August 2009.

The Locally Preferred Alternative (LPA) includes a surface alignment along the west side of MD 201 from River Road to MD 410. A proposed aerial structure will carry the alignment over the west and south legs of the MD 201 and MD 410 intersection and will return to surface alignment along the median of MD 410 east of Riverdale Road. MD 410 at MD 201 is currently signalized with channelized right-turn islands in all four quadrants. The aerial structure may have impacts to the channelized right-turn islands and associated right-turn acceleration lanes in the northwest and southeast corners. The southbound right-turn currently has a 500-foot acceleration lane along westbound MD 410, and the northbound right-turn currently has a 2,000-foot acceleration lane along eastbound MD 410. The eastbound acceleration lane also provides access to business driveways along the south side of MD 410 between MD 201 and Riverdale Road. The Purple Line LPA plan in the vicinity of the study intersections is attached.

The south side of MD 410 east of Riverdale Road will be impacted due to the proposed LPA surface alignment, either in the median of MD 410 or along the south side of the roadway. This will impact the properties along the south side of MD 410 including a church in the southeast quadrant of MD 410 and Riverdale Road / 58th Street intersection. MD 410 and Riverdale Road / 58th Street currently operates as an unsignalized intersection with particularly heavy northbound right-turn and westbound left-turn traffic volumes. These heavy turning volumes exist because Riverdale Road functions as a cut-through route for westbound MD 410 left-turning vehicles and northbound MD 201 right-turning vehicles. The northbound right-turn from Riverdale Road onto MD 410 currently uses the remaining 1,300-feet of the 2,000 foot acceleration lane that begins at the MD 410 and MD 201 intersection. Existing peak hour intersection observations indicate long gaps in eastbound MD 410 traffic that allow northbound right- and westbound left-turning vehicles to perform their respective movements. The northbound right-turning vehicles were observed only using the acceleration lane for no more than a few hundred feet before merging, or pulling directly into the eastbound lanes.

This report evaluates the following possible alternatives at the study intersections due to the Purple Line LPA impacts.

MD 410 at MD 201

- 2030 Base
- 2030 Alternative 1 - Remove the south- and northbound right-turn acceleration lanes
- 2030 Alternative 2 – Alternative 1 and remove the channelized islands

MD 410 at Riverdale Road

- 2030 Base
- 2030 Alternative 1 – Remove the northbound right-turn acceleration lane
- 2030 Alternative 2 – Signalize the intersection
- 2030 Alternative 3 – Alternative 1 and Alternative 2

TRAFFIC OPERATIONS ANALYSIS OF MD 410 AT MD 201

Development of Future Traffic Volume Forecasts: 2030 Synchro model volumes and a 2008 turning movement count were provided by RK&K. The 2030 volumes were generally higher than the 2008 volumes, with the exception of the southbound right-turn volume during both peak hours. A one (1) percent annual growth rate was applied to the 2008 southbound right-turn volumes to provide a more conservative right-turn lane analysis. The 2030 southbound right-turn volume was increased from 335 to 498 during the AM peak hour and from 190 to 285 vehicles during the PM peak hour. The 2030 traffic volumes are attached.

Traffic Analysis – MD 410 at MD 201: The 2030 Synchro model was updated to reflect the adjusted traffic volumes noted above, and SimTraffic animations were run.

The 2030 Base Condition Synchro analysis is summarized below in Table 1.

Table 1 – 2030 Base Condition Analysis – MD 410 at MD 201

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	1.40	163.8	F	-	1.51	227.0	F	-
Eastbound Left	0.98	110.6	F	425	1.63	349.5	F	486
Eastbound Thru	0.77	48.0	D	542	1.52	282.2	F	541
Eastbound Right	0.45	39.4	D	309	0.76	46.3	D	520
Westbound Left	0.83	132.5	F	164	0.80	75.7	E	381
Westbound Thru	1.69	370.3	F	1,597	1.61	321.3	F	1,528
Westbound Right	0.38	0.7	A	1,613	0.21	0.3	A	1,588
Northbound Left	1.37	273.3	F	297	1.58	357.7	F	305
Northbound Thru	0.71	33.2	C	527	1.35	190.7	F	553
Northbound Right	***0.03***	***0.0***	***A***	***19***	***0.04***	***0.0***	***A***	***31***
Southbound Left	0.67	76.7	E	238	1.59	338.8	F	276
Southbound Thru	1.36	213.8	F	510	1.20	140.2	F	572
Southbound Right	***0.34***	***0.6***	***A***	***58***	***0.20***	***0.3***	***A***	***121***

[1] – SimTraffic 95th Percentile Queue

The 2030 Base Synchro analysis indicates the intersection will be well over capacity in year 2030; however, the north- and southbound right-turn delays are negligible. Access to the northbound channelized right-turn is often blocked by northbound through vehicles, however the right-turn peak hour volume is relatively low (40 AM / 55 PM). Intersection observations indicate these few turning vehicles utilize the eastbound acceleration lane to access the businesses along the south side of MD 410.

Alternative 1 evaluates the intersection if the north- and southbound right-turn acceleration lanes were removed. The 2030 Alternative 1 analysis are summarized below in Table 2.

Table 2 – 2030 Alternative 1 Analysis – MD 410 at MD 201

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	1.40	166.8	F	-	1.51	228.1	F	-
Northbound Right	0.06	18.4	B	49	0.12	21.2	C	57
Southbound Right	0.69	46.0	D	362	0.34	32.6	C	294

[1] – SimTraffic 95th Percentile Queue

The 2030 Alternative 1 Synchro analysis indicates that removing the south- and northbound right-turn acceleration lanes increase the right-turn delays, however, the movements remain at an acceptable LOS and the effect on the overall intersection operation is negligible.

2030 Alternative 2 evaluates the intersection if the channelized right-turn islands were removed in addition to the north- and southbound right-turn acceleration lanes. The 2030 Alternative 2 analysis is summarized below in Table 3.

Table 3 – 2030 Alternative 2 Analysis – MD 410 at MD 201

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	1.40	166.8	F	-	1.51	228.1	F	-
Northbound Right	0.06	18.4	B	49	0.12	21.2	C	61
Southbound Right	0.69	46.0	D	409	0.34	32.6	C	290

[1] – SimTraffic 95th Percentile Queue

The 2030 Alternative 2 Synchro Analysis indicates that removing the channelized right-turn islands had essentially no operational impact compared with Alternative 1. The lack of operational change is mainly due to the heavy westbound MD 410 movements that make it difficult for southbound right-turns to turn on red whether the turn is yield controlled or not. The removal of the islands would however, increase pedestrian crossing time and eliminate the refuge areas within the channelized areas. The MD 410 at MD 201 Synchro and SimTraffic outputs are attached.

Purple Line

TRAFFIC OPERATIONS ANALYSIS OF MD 410 AT RIVERDALE ROAD / 58TH STREET

Development of Future Traffic Volume Forecasts: A 2008 turning movement count at MD 410 and Riverdale Road / 58th Street was provided by RK&K. A one (1) percent annual growth rate was applied to the 2008 volumes to derive 2030 volumes at this intersection since the provided Synchro model did not include MD 410 at Riverdale Road / 58th Street. The 2030 MD 410 at Riverdale Road / 58th Street volumes were then balanced with the other 2030 Synchro volumes. The traffic volumes are attached.

Traffic Analysis – MD 410 at Riverdale Road / 58th Street: The MD 410 at Riverdale Road intersection and Riverdale Road connection between MD 410 and MD 201 were added to the Synchro model and SimTraffic animations were run.

The 2030 Base Condition Synchro Analysis is summarized below in Table 4.

Table 4 – 2030 Base Condition Analysis – MD 410 at Riverdale Road / 58th Street

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	0.73[2]	3.7	D[2]	-	0.98[2]	25.8	F[2]	-
Eastbound Left	0.05	23.5	C	29	0.09	21.0	C	41
Eastbound Thru	0.26	-	-	111	0.48	-	-	90
Westbound Left	0.63	14.5	B	292	1.36	204.6	F	288
Westbound Thru	0.56	-	-	1,945[3]	0.50	-	-	1,988[3]
Northbound Right	***0.58***	***15.2***	***C***	***345***	***0.96***	***47.4***	***E***	***796***
Southbound Right	0.11	17.0	C	405	0.16	16.5	C	422

1 – SimTraffic 95th Percentile Queue
2 – Intersection Capacity Utilization (ICU)
3 – Combination of westbound left-turn queues spilling into through lanes and westbound MD 410 at MD 201 queues extending beyond this intersection.

The 2030 Base Synchro analysis indicates that during the PM peak hour the northbound right-turn will operate over capacity and have queues spilling onto northbound MD 201. The westbound left-turn storage capacity is insufficient in both peaks resulting in queues spilling into the westbound through lanes. It should be noted that MD 410 at MD 201 will be operating well over capacity and the westbound queues will have significant impacts to the MD 410 and Riverdale Road / 58th Street operation.

Alternative 1 evaluates the intersection if the right-most eastbound lane, which also serves as the northbound right-turn acceleration lane, were removed. The 2030 Alternative 1 analysis is summarized below in Table 5.

Table 5 – 2030 Alterative 1 Analysis – MD 410 at Riverdale Road / 58th Street

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	0.83[2]	6.1	E[2]	-	1.15[2]	86.7	F[2]	-
Eastbound Left	0.05	23.5	C	40	0.09	21.0	C	45
Eastbound Thru	0.43	-	-	245	0.81	-	-	233
Westbound Left	0.85	30.9	D	290	2.28	620.7	F	282
Westbound Thru	0.56	-	-	1,980[3]	0.50	-	-	1,933[3]
Northbound Right	***0.61***	***16.6***	***C***	***369***	***1.40***	***213.3***	***F***	***851***
Southbound Right	0.11	17.0	C	398	0.16	16.5	C	424

[1] – SimTraffic 95th Percentile Queue
[2] – Intersection Capacity Utilization (ICU)
[3] – Combination of westbound left-turn queues spilling into through lanes and westbound MD 410 at MD 201 queues extending beyond this intersection.

The 2030 Alternative 1 Synchro analysis indicates that removing the right-most eastbound lane would have consequences to the overall intersection, the westbound left-turn, and the northbound right-turn operation. However, the SimTraffic analysis does not indicate there would be significant delay or queue length increases to the northbound right-turn operation compared to the 2030 Base condition.

Alternative 2 evaluates the intersection with signal control including an exclusive westbound left-turn phase and northbound right-turn overlap phase. The 2030 Alternative 2 Synchro analysis is summarized below in Table 6.

Table 6 – 2030 Alterative 2 Analysis – MD 410 at Riverdale Road / 58th Street

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	0.62	8.2	A	-	0.94	14.7	B	-
Eastbound Left	0.08	6.8	A	23	0.14	10.7	B	26
Eastbound Thru	0.60	10.8	B	217	0.92	17.0	B	189
Westbound Left	0.63	24.1	C	260	0.60	22.2	C	303
Westbound Thru	0.51	0.9	A	1,974[2]	0.48	1.9	A	1,850[2]
Northbound Right	***0.52***	***8.2***	***A***	***164***	***0.96***	***36.2***	***D***	***316***
Southbound Right	0.13	75.8	E	340[3]	0.26	60.4	E	96

[1] – SimTraffic 95th Percentile Queue
[2] – Combination of westbound left-turn queues spilling into through lanes and westbound MD 410 at MD 201 queues extending beyond this intersection.
[3] – Westbound MD 410 at MD 201 queues blocking southbound right turns.

The 2030 Alternative 2 Synchro analysis indicates that installing a traffic signal at MD 410 and Riverdale Road would significantly improve northbound right-turn and westbound left-turn operations, resulting in improved overall intersection operations. The northbound right-turn queue lengths would decrease significantly and would no longer spill into northbound MD 201. It should be noted, however, that the MD 201 at MD 410 westbound left-turn will be operating well over capacity and the westbound queues will have significant impacts to the MD 410 and Riverdale Road / 58th Street westbound left-turn operation.

Alternative 3 evaluates the intersection with signal control and the removal of the northbound right-turn acceleration lane. The 2030 Alternative 3 Synchro analysis is summarized below in Table 7.

Table 7 – 2030 Alterative 3 Analysis – MD 410 at Riverdale Road / 58th Street

	AM Peak Hour				PM Peak Hour			
Movement	v/c	Delay (sec)	LOS	Queue[1]	v/c	Delay (sec)	LOS	Queue[1]
Overall	0.73	9.4	A	-	1.13	53.1	D	-
Eastbound Left	0.09	5.3	A	25	0.16	12.7	B	59
Eastbound Thru	0.74	9.0	A	234	1.15	97.5	F	357
Westbound Left	0.72	33.9	C	288	0.69	31.0	C	306
Westbound Thru	0.61	1.4	A	1,852[2]	0.47	1.7	A	2,017[2]
Northbound Right	***0.57***	***12.8***	***B***	***197***	***1.11***	***90.2***	***F***	***375***
Southbound Right	0.10	76.1	E	396[3]	0.30	62.1	E	418[3]

1 – SimTraffic 95th Percentile Queue

2 – Combination of westbound left-turn queues spilling into through lanes and westbound MD 410 at MD 201 queues extending beyond this intersection.

3 – Westbound MD 410 at MD 201 queues blocking southbound right turns.

The 2030 Alternative 3 Synchro analysis indicates that removing the right-most eastbound lane would have consequences to the overall intersection, eastbound through, and northbound right-turn operations. However, the SimTraffic analysis does not indicate significant operational consequences to the northbound right-turn nor the eastbound through-right operations. This is because SimTraffic can better capture that the eastbound through volume is often metered at the MD 410 and MD 201 intersection, while Synchro does not. This metering provides gaps for northbound right-turns on red in addition to the right-turn overlap phase. The MD 410 at Riverdale Road / 58th Street Synchro and SimTraffic outputs are attached.

RESULTS AND CONCLUSIONS

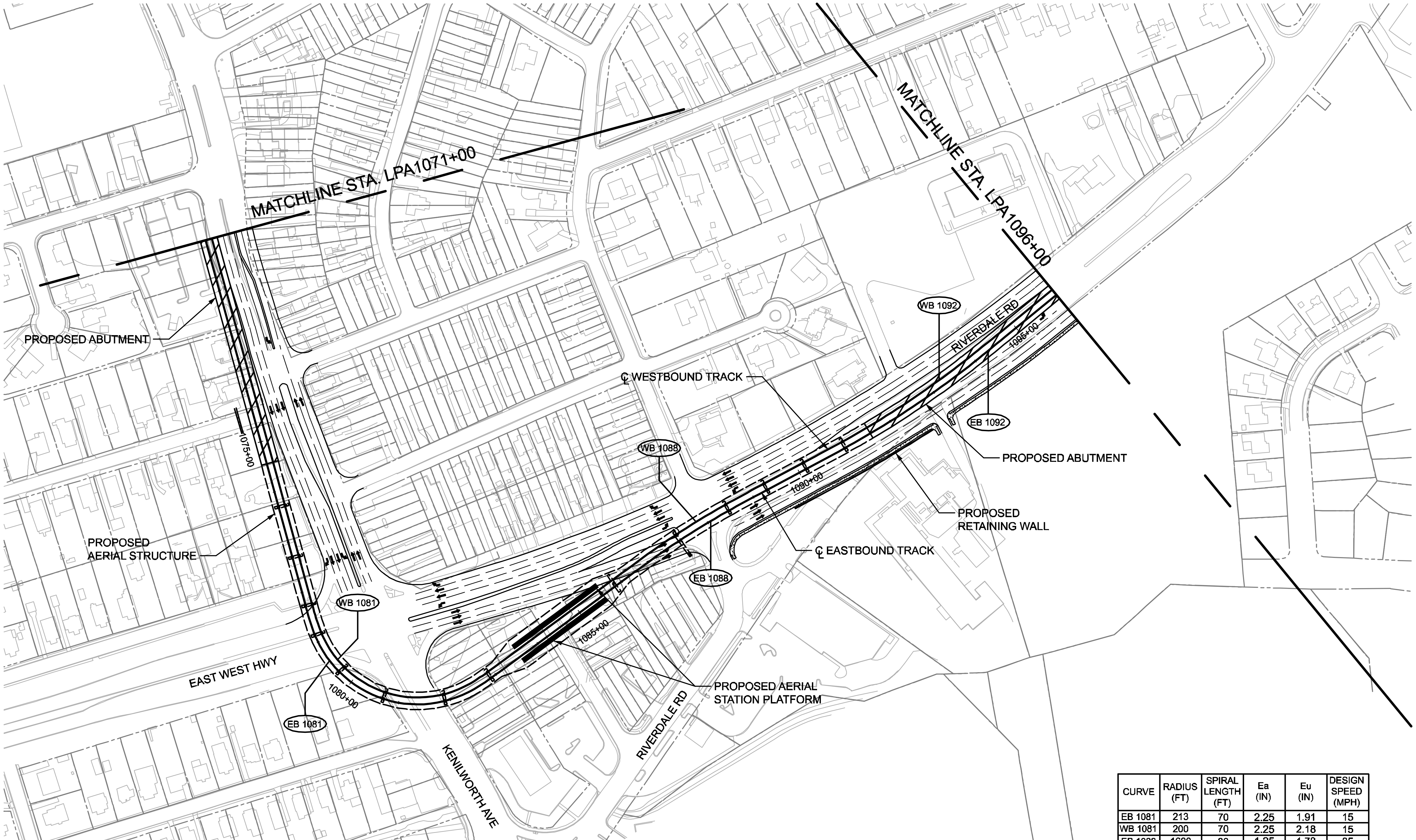
The 2030 analysis of MD 410 at MD 201 indicates that the intersection will operate over capacity; however, the north- and southbound right-turn delays are negligible in the Base condition. Alternative 1 evaluated changing the north- and southbound right-turn control from “free” to “yield”, removing the east- and westbound acceleration lanes. Alternative 2 evaluated changing the north- and southbound right-turns from “yield” to “signal” control, removing the acceleration lanes and the channelized islands. Both right turn lanes would continue to operate at an acceptable LOS under both alternatives. It should be noted that northbound right-turn peak hour volume is relatively low (40 AM / 55 PM) due to the cut-through from MD 201 to MD 410 via Riverdale Road. As long as this cut-through remains after redevelopment of this triangular site, the results are as shown above. Therefore, removing the south- and northbound right-turn acceleration lanes (with the channelized islands remaining) would have relatively minor effects on intersection operation.

Existing intersection peak hour observations indicate that northbound right-turning vehicles do not typically use the entire acceleration lane, if at all. The 2030 analysis of MD 410 at Riverdale Road / 58th Street indicates that the intersection will operate over capacity during the PM peak hour with the northbound right-turn operating at LOS E. The northbound right-turn queues will extend beyond the available storage along Riverdale Road. Alterative 1 evaluated removing the right-most eastbound lane resulting in the northbound right-turn operating at LOS F and increased queue lengths. Alternative 2 evaluated signalizing the intersection without removing the right-most eastbound lane. This resulted in the overall intersection and all major movements operating at an acceptable LOS. The Alternative 2 northbound right-turn queue significantly decreased compared to the Base condition. Alternative 3 evaluated the signalized intersection without the right-most eastbound lane which resulted in moderate delay increases; however, SimTraffic indicated only minor northbound right-turn queue increases compared with Alternative 2. Therefore, removing the right-most eastbound lane in conjunction with a traffic signal would improve intersection operations compared with the 2030 Base condition. It should be noted, however, that the effectiveness of the overall intersection operation is limited by the westbound delays and queues extending from the MD 201 at MD 410 intersection.

Attachment

A

Purple Line LPA Plan



CURVE	RADIUS (FT)	SPIRAL LENGTH (FT)	Ea (IN)	Eu (IN)	DESIGN SPEED (MPH)
EB 1081	213	70	2.25	1.91	15
WB 1081	200	70	2.25	2.18	15
EB 1088	1600	80	1.25	1.78	35
WB 1088	1613	80	1.25	1.75	35
EB 1092	1793	90	1.75	1.78	40
WB 1092	1780	90	1.75	1.81	40

DRAFT WORK-IN-PROGRESS

The Purple Line Transit Study information shown shall be used for general planning/information only. The locations of the proposed transit facilities and/or proposed roadway reconstruction/relocation are approximate and subject to change during subsequent stages of project development.

PLOTTED: 8/12/2009
FILE: C:\WORKING\CIVIL\DMS44418\LPA-29.DGN

MARYLAND DEPARTMENT OF TRANSPORTATION
MTA Maryland

STV Incorporated
engineers / architects / planners / construction managers
2125 Ambassador Road Baltimore, MD 21244 2322 (410) 944 9812

JE JACOBS

Purple Line

100' 0 100' 200'
SCALE: 1"=200'

PURPLE LINE

LOCALLY PREFERRED ALTERNATIVE LRT - PLAN
STA. LPA1071+00 TO STA. LPA1096+00

DATE: AUGUST 2009 SCALE: AS SHOWN

CONTRACT NO.

DRAWING NO.
LPA - 29

SHEET NO.
31 OF 75

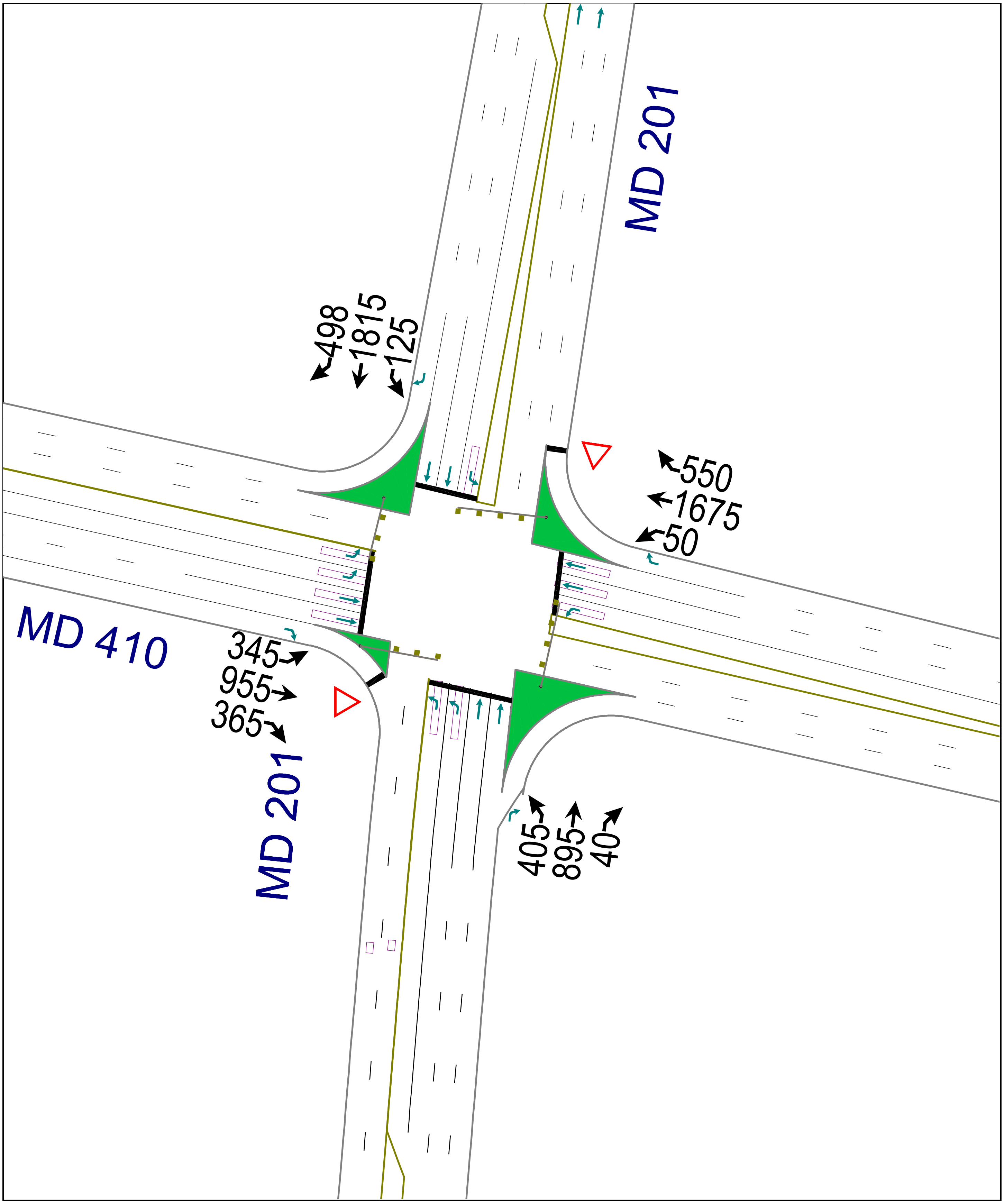
Attachment

B

Traffic Volumes – MD 410 at MD 201

MD 410 at MD 201
Volumes

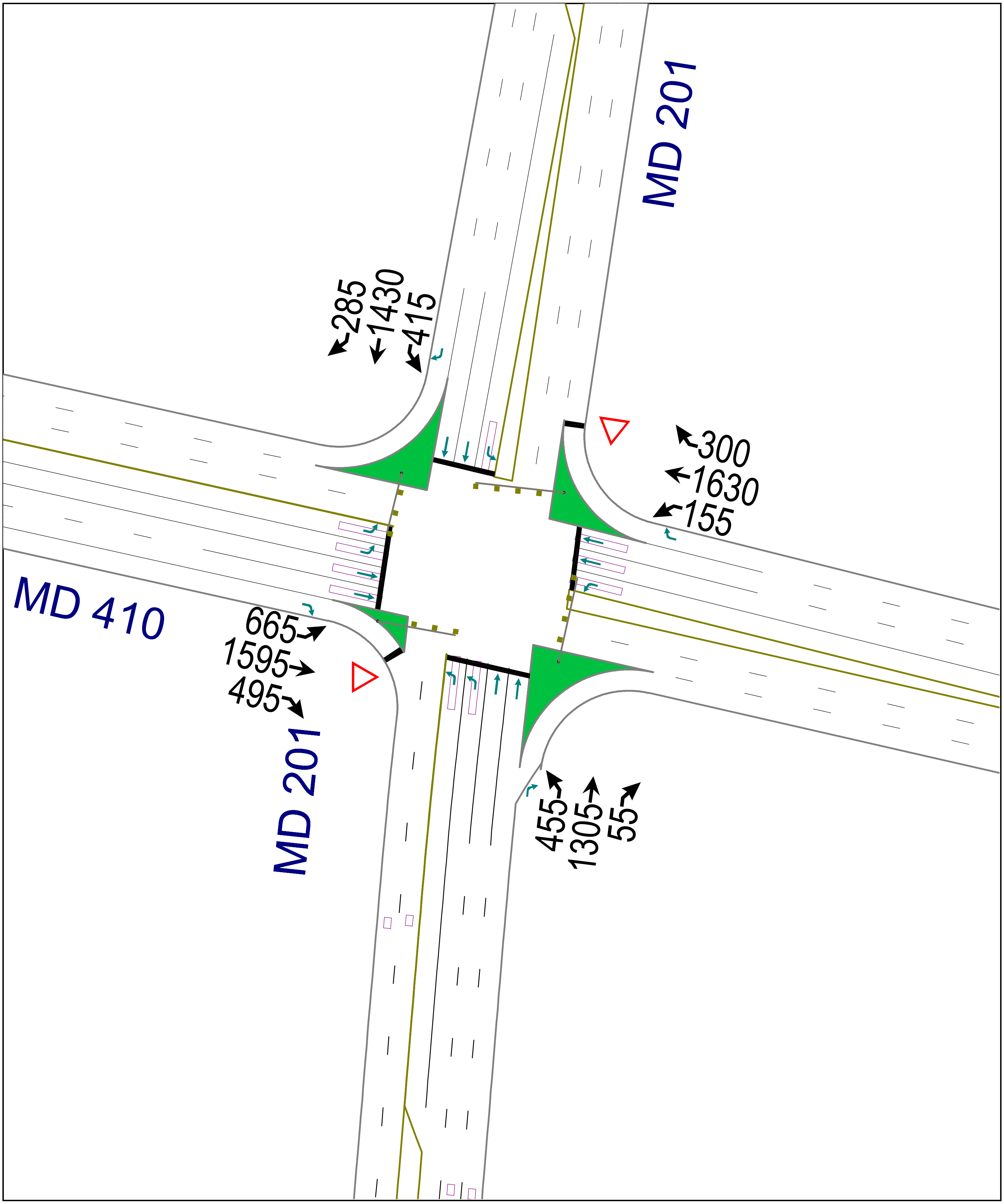
5/21/2010



2030 Base AM
STV Incorporated

MD 410 at MD 201
Volumes

5/21/2010



2030 Base PM
STV Incorporated

Attachment

C

Synchro/SimTraffic Reports – MD 410 at MD 201

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	345	955	365	50	1675	550	405	895	40	125	1815	498
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	363	1005	384	53	1763	579	426	942	42	132	1911	524
RTOR Reduction (vph)	0	0	124	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	363	1005	260	53	1763	579	426	942	42	132	1911	524
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Prot		Perm	Prot		Free	Prot		Free	Prot		Free
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			Free			Free
Actuated Green, G (s)	16.0	58.0	58.0	4.0	46.0	160.0	13.0	59.6	160.0	16.4	63.0	160.0
Effective Green, g (s)	18.0	61.0	61.0	6.0	49.0	160.0	15.0	62.6	160.0	18.4	66.0	160.0
Actuated g/C Ratio	0.11	0.38	0.38	0.04	0.31	1.00	0.09	0.39	1.00	0.12	0.41	1.00
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0		5.0	6.0	
Vehicle Extension (s)	3.0	5.0	5.0	3.0	5.0		3.0	5.0		3.0	5.0	
Lane Grp Cap (vph)	372	1299	581	64	1043	1524	310	1333	1524	196	1405	1524
v/s Ratio Prot	c0.11	0.30		0.03	c0.52		c0.13	0.28		c0.08	c0.56	
v/s Ratio Perm			0.17			0.38			0.03			0.34
v/c Ratio	0.98	0.77	0.45	0.83	1.69	0.38	1.37	0.71	0.03	0.67	1.36	0.34
Uniform Delay, d1	70.8	43.4	36.9	76.5	55.5	0.0	72.5	41.0	0.0	67.9	47.0	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.21	0.74	1.00	1.00	1.00	1.00
Incremental Delay, d2	39.9	4.5	2.5	56.0	314.8	0.7	185.9	2.9	0.0	8.8	166.8	0.6
Delay (s)	110.6	48.0	39.4	132.5	370.3	0.7	273.3	33.2	0.0	76.7	213.8	0.6
Level of Service	F	D	D	F	F	A	F	C	A	E	F	A
Approach Delay (s)		59.1			275.7			104.8			163.2	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM Average Control Delay	163.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.40		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	131.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	14.9	12.0	1.4	13.1	468.4	133.8	25.4	6.4	0.2	2.8	27.5	0.3
Delay / Veh (s)	159.8	45.6	13.3	1969.5	1905.5	1610.6	319.1	31.2	19.3	120.0	75.4	2.6

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	706.2
Delay / Veh (s)	446.4

35: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	14.3	8.8	8.4	14.4	6.4	2.2	8.0	118.5	22.4	0.3	6.5	0.2
Delay / Veh (s)	2239.1	1169.6	1115.8	242.6	224.9	155.6	525.7	439.4	455.2	24.1	13.8	12.3

35: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	210.3
Delay / Veh (s)	219.3

Total Network Performance

Total Delay (hr)	1261.9
Delay / Veh (s)	705.1

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	357	424	637	605	411	39	9	234	1492	1489	1482	277
Average Queue (ft)	254	278	358	364	158	2	0	47	1443	1441	1421	262
95th Queue (ft)	393	425	542	519	309	35	7	164	1597	1593	1613	297
Link Distance (ft)			670	670		722	722		1448	1448	1448	
Upstream Blk Time (%)			0	0					65	59	29	
Queuing Penalty (veh)			0	0					0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	1	3	2	0	0			0	72			59
Queuing Penalty (veh)	6	16	8	1	0			0	36			119

Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	457	461	472	46	274	520	526	82	674	682	672
Average Queue (ft)	424	250	238	2	116	493	494	3	645	645	575
95th Queue (ft)	527	474	431	19	238	510	510	58	703	698	780
Link Distance (ft)	441	441	441			421	421	421	634	634	634
Upstream Blk Time (%)	66	2	1			55	56	0	49	49	12
Queuing Penalty (veh)	293	9	3			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	76		48	0	0	56					
Queuing Penalty (veh)	154		19	0	3	70					

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	665	1595	495	155	1630	300	455	1305	55	415	1430	285
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	700	1679	521	163	1716	316	479	1374	58	437	1505	300
RTOR Reduction (vph)	0	0	145	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	700	1679	376	163	1716	316	479	1374	58	437	1505	300
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Prot		Perm	Prot		Free	Prot		Free	Prot		Free
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			Free			Free
Actuated Green, G (s)	15.0	39.4	39.4	13.6	38.0	130.0	10.0	36.0	130.0	19.0	45.0	130.0
Effective Green, g (s)	17.0	42.4	42.4	15.6	41.0	130.0	12.0	39.0	130.0	21.0	48.0	130.0
Actuated g/C Ratio	0.13	0.33	0.33	0.12	0.32	1.00	0.09	0.30	1.00	0.16	0.37	1.00
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0		5.0	6.0	
Vehicle Extension (s)	3.0	3.5	3.5	3.0	3.5		3.0	5.0		3.0	5.0	
Lane Grp Cap (vph)	430	1105	494	203	1069	1516	303	1016	1516	274	1251	1516
v/s Ratio Prot	c0.21	0.50		0.10	c0.51		0.15	c0.41		c0.26	0.44	
v/s Ratio Perm			0.25			c0.21			0.04			0.20
v/c Ratio	1.63	1.52	0.76	0.80	1.61	0.21	1.58	1.35	0.04	1.59	1.20	0.20
Uniform Delay, d1	56.5	43.8	39.3	55.7	44.5	0.0	59.0	45.5	0.0	54.5	41.0	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.46	0.61	1.00	1.00	1.00	1.00
Incremental Delay, d2	293.0	238.4	7.0	20.0	276.8	0.3	271.5	162.9	0.0	284.3	99.2	0.3
Delay (s)	349.5	282.2	46.3	75.7	321.3	0.3	357.7	190.7	0.0	338.8	140.2	0.3
Level of Service	F	F	D	E	F	A	F	F	A	F	F	A
Approach Delay (s)		256.1			256.8			226.8			160.2	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	227.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.51		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	136.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	24.9	21.2	1.5	40.0	432.2	67.9	24.2	13.5	0.4	16.5	18.0	0.1
Delay / Veh (s)	214.7	71.6	15.7	1486.2	1664.0	1388.1	308.1	57.4	38.0	231.8	69.4	2.2

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	660.4
Delay / Veh (s)	426.3

6: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	24.1	45.5	21.0	26.1	14.3	12.0	11.8	287.6	65.5	0.8	6.3	0.2
Delay / Veh (s)	1522.1	1212.2	1144.9	545.7	515.6	458.6	907.4	1006.3	1122.4	38.0	17.9	13.9

6: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	515.2
Delay / Veh (s)	560.0

Total Network Performance

Total Delay (hr)	2031.2
Delay / Veh (s)	1145.0

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	404	413	514	517	414	1010	1010	323	1488	1493	1482	275
Average Queue (ft)	346	382	493	487	262	980	982	125	1457	1455	1419	265
95th Queue (ft)	461	486	502	541	520	1072	1055	281	1528	1528	1588	305
Link Distance (ft)			421	421		972	972		1448	1448	1448	
Upstream Blk Time (%)	0	27	50	30	1	39	34		61	53	20	
Queuing Penalty (veh)	0	0	0	0	0	0	0		0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	7	36	21	30	1			0	66			48
Queuing Penalty (veh)	57	286	142	147	5			0	102			108

Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	462	494	484	44	275	511	510	319	677	680	677
Average Queue (ft)	414	381	370	5	274	493	470	11	637	620	465
95th Queue (ft)	529	553	530	31	276	502	572	121	754	782	913
Link Distance (ft)	441	441	441			421	421	421	634	634	634
Upstream Blk Time (%)	39	10	7			79	31	0	61	25	6
Queuing Penalty (veh)	233	59	43			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	75		66	0	76	11					
Queuing Penalty (veh)	170		37	0	546	47					

HCM Signalized Intersection Capacity Analysis
5: MD 410 & MD 201

3/17/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	345	955	365	50	1675	550	405	895	40	125	1815	498
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	3.0	3.0	5.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	363	1005	384	53	1763	579	426	942	42	132	1911	524
RTOR Reduction (vph)	0	0	124	0	0	0	0	0	6	0	0	104
Lane Group Flow (vph)	363	1005	260	53	1763	579	426	942	36	132	1911	420
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Prot		Perm	Prot		Free	Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			2			6
Actuated Green, G (s)	16.0	58.0	58.0	4.0	46.0	160.0	13.0	59.6	59.6	16.4	63.0	63.0
Effective Green, g (s)	18.0	61.0	61.0	6.0	49.0	160.0	15.0	62.6	60.6	18.4	66.0	64.0
Actuated g/C Ratio	0.11	0.38	0.38	0.04	0.31	1.00	0.09	0.39	0.38	0.12	0.41	0.40
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0	6.0	5.0	6.0	6.0
Vehicle Extension (s)	3.0	5.0	5.0	3.0	5.0		3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	372	1299	581	64	1043	1524	310	1333	577	196	1405	610
v/s Ratio Prot	c0.11	0.30		0.03	c0.52		c0.13	0.28		c0.08	c0.56	
v/s Ratio Perm			0.17			0.38			0.02			0.28
v/c Ratio	0.98	0.77	0.45	0.83	1.69	0.38	1.37	0.71	0.06	0.67	1.36	0.69
Uniform Delay, d1	70.8	43.4	36.9	76.5	55.5	0.0	72.5	41.0	31.6	67.9	47.0	39.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.21	0.74	0.57	1.00	1.00	1.00
Incremental Delay, d2	39.9	4.5	2.5	56.0	314.8	0.7	185.9	2.9	0.2	8.8	166.8	6.2
Delay (s)	110.6	48.0	39.4	132.5	370.3	0.7	273.3	33.2	18.4	76.7	213.8	46.0
Level of Service	F	D	D	F	F	A	F	C	B	E	F	D
Approach Delay (s)		59.1			275.7			105.3			172.5	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM Average Control Delay	166.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.40		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	131.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	13.7	12.7	1.5	11.9	390.2	111.4	26.0	6.5	0.2	3.0	27.5	2.0
Delay / Veh (s)	145.5	47.6	14.4	1471.3	1400.6	1119.8	329.2	32.4	23.2	121.2	74.7	19.8

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	606.3
Delay / Veh (s)	372.3

35: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	18.0	9.6	8.8	17.3	7.5	2.4	9.1	142.2	27.4	0.3	6.7	0.2
Delay / Veh (s)	3604.1	1826.9	1985.2	289.8	268.5	206.1	563.2	541.0	570.4	28.2	14.2	10.0

35: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	249.5
Delay / Veh (s)	264.6

Total Network Performance

Total Delay (hr)	1224.0
Delay / Veh (s)	670.3

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	379	424	648	638	446	51	54	278	1494	1497	1483	275
Average Queue (ft)	246	275	360	379	169	3	3	55	1444	1446	1407	261
95th Queue (ft)	385	425	564	566	354	40	34	169	1588	1589	1692	305
Link Distance (ft)			670	670		722	722		1448	1448	1448	
Upstream Blk Time (%)			1	0					59	58	29	
Queuing Penalty (veh)			0	0					0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	1	2	3	2	0				70			62
Queuing Penalty (veh)	3	8	12	6	0				35			126

Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	455	460	454	70	274	524	520	402	672	667	660
Average Queue (ft)	429	257	233	10	123	492	492	200	643	640	556
95th Queue (ft)	526	482	417	49	248	518	507	362	710	710	793
Link Distance (ft)	441	441	441			421	421	421	634	634	634
Upstream Blk Time (%)	68	2	0			55	56	0	49	48	13
Queuing Penalty (veh)	305	9	1			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	78		49	0	1	55					
Queuing Penalty (veh)	157		19	0	8	69					

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	665	1595	495	155	1630	300	455	1305	55	415	1430	285
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	3.0	3.0	5.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	700	1679	521	163	1716	316	479	1374	58	437	1505	300
RTOR Reduction (vph)	0	0	145	0	0	0	0	0	6	0	0	116
Lane Group Flow (vph)	700	1679	376	163	1716	316	479	1374	52	437	1505	184
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Prot		Perm	Prot		Free	Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			2			6
Actuated Green, G (s)	15.0	39.4	39.4	13.6	38.0	130.0	10.0	36.0	36.0	19.0	45.0	45.0
Effective Green, g (s)	17.0	42.4	42.4	15.6	41.0	130.0	12.0	39.0	37.0	21.0	48.0	46.0
Actuated g/C Ratio	0.13	0.33	0.33	0.12	0.32	1.00	0.09	0.30	0.28	0.16	0.37	0.35
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0	6.0	5.0	6.0	6.0
Vehicle Extension (s)	3.0	3.5	3.5	3.0	3.5		3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	430	1105	494	203	1069	1516	303	1016	431	274	1251	536
v/s Ratio Prot	c0.21	0.50		0.10	c0.51		0.15	c0.41		c0.26	0.44	
v/s Ratio Perm			0.25			c0.21			0.03			0.12
v/c Ratio	1.63	1.52	0.76	0.80	1.61	0.21	1.58	1.35	0.12	1.59	1.20	0.34
Uniform Delay, d1	56.5	43.8	39.3	55.7	44.5	0.0	59.0	45.5	34.4	54.5	41.0	30.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.46	0.61	0.60	1.00	1.00	1.00
Incremental Delay, d2	293.0	238.4	7.0	20.0	276.8	0.3	271.5	162.9	0.4	284.3	99.2	1.7
Delay (s)	349.5	282.2	46.3	75.7	321.3	0.3	357.7	190.7	21.2	338.8	140.2	32.6
Level of Service	F	F	D	E	F	A	F	F	C	F	F	C
Approach Delay (s)		256.1			256.8			227.4			164.5	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	228.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.51		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	136.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	23.8	22.0	1.5	34.5	365.8	57.9	25.4	13.1	0.4	16.2	17.8	0.4
Delay / Veh (s)	207.8	74.2	16.4	1231.2	1315.6	1068.5	333.0	55.3	37.8	221.1	67.5	8.4
Total Stops	892	1047	148	386	3755	350	754	817	35	515	865	75

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	578.9
Delay / Veh (s)	367.4
Total Stops	9639

6: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	24.7	47.7	22.5	25.5	14.9	13.2	13.3	310.2	69.2	0.9	6.2	0.2
Delay / Veh (s)	1585.7	1291.7	1288.3	537.5	530.1	457.9	1084.8	1103.5	1169.7	36.5	17.5	13.4
Total Stops	129	273	123	365	200	136	129	3140	799	91	376	15

6: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	548.5
Delay / Veh (s)	596.9
Total Stops	5776

Total Network Performance

Total Delay (hr)	1969.9
Delay / Veh (s)	1096.6
Total Stops	20103

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	403	413	521	516	413	1017	1014	325	1491	1484	1484	275
Average Queue (ft)	343	377	493	484	248	979	981	145	1449	1444	1408	267
95th Queue (ft)	470	494	508	559	523	1079	1067	318	1568	1571	1578	298
Link Distance (ft)			421	421		972	972		1448	1448	1448	
Upstream Blk Time (%)	1	20	47	34	1	39	35		57	49	15	
Queuing Penalty (veh)	0	0	0	0	0	0	0		0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	6	27	26	34	1			0	65			52
Queuing Penalty (veh)	46	218	174	167	5			0	101			119

Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	446	475	492	72	275	517	505	362	674	670	663
Average Queue (ft)	412	382	359	13	274	495	468	88	638	616	464
95th Queue (ft)	516	525	526	55	276	507	582	249	740	790	903
Link Distance (ft)	430	430	430			422	422	422	634	634	634
Upstream Blk Time (%)	52	8	5			78	32	0	61	22	6
Queuing Penalty (veh)	315	46	29			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	74		66	0	73	12					
Queuing Penalty (veh)	169		37	1	524	51					

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	345	955	365	50	1675	550	405	895	40	125	1815	498
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	3.0	3.0	5.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3303	3406	1524	1703	3406	1524	3303	3406	1524	1703	3406	1524
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	363	1005	384	53	1763	579	426	942	42	132	1911	524
RTOR Reduction (vph)	0	0	124	0	0	0	0	0	6	0	0	104
Lane Group Flow (vph)	363	1005	260	53	1763	579	426	942	36	132	1911	420
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Prot		Perm	Prot		Free	Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			2			6
Actuated Green, G (s)	16.0	58.0	58.0	4.0	46.0	160.0	13.0	59.6	59.6	16.4	63.0	63.0
Effective Green, g (s)	18.0	61.0	61.0	6.0	49.0	160.0	15.0	62.6	60.6	18.4	66.0	64.0
Actuated g/C Ratio	0.11	0.38	0.38	0.04	0.31	1.00	0.09	0.39	0.38	0.12	0.41	0.40
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0	6.0	5.0	6.0	6.0
Vehicle Extension (s)	3.0	5.0	5.0	3.0	5.0		3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	372	1299	581	64	1043	1524	310	1333	577	196	1405	610
v/s Ratio Prot	c0.11	0.30		0.03	c0.52		c0.13	0.28		c0.08	c0.56	
v/s Ratio Perm			0.17			0.38			0.02			0.28
v/c Ratio	0.98	0.77	0.45	0.83	1.69	0.38	1.37	0.71	0.06	0.67	1.36	0.69
Uniform Delay, d1	70.8	43.4	36.9	76.5	55.5	0.0	72.5	41.0	31.6	67.9	47.0	39.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.21	0.74	0.57	1.00	1.00	1.00
Incremental Delay, d2	39.9	4.5	2.5	56.0	314.8	0.7	185.9	2.9	0.2	8.8	166.8	6.2
Delay (s)	110.6	48.0	39.4	132.5	370.3	0.7	273.3	33.2	18.4	76.7	213.8	46.0
Level of Service	F	D	D	F	F	A	F	C	B	E	F	D
Approach Delay (s)		59.1			275.7			105.3			172.5	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM Average Control Delay	166.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.40		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	131.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	16.6	12.4	1.5	10.9	366.2	101.7	24.8	6.6	0.2	2.9	27.3	4.1
Delay / Veh (s)	178.0	47.7	14.3	1221.7	1290.0	1043.4	307.2	32.1	24.3	117.3	74.6	41.3

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	575.3
Delay / Veh (s)	352.7

35: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	14.0	8.5	7.5	20.2	9.1	3.2	6.9	104.8	19.1	0.3	6.5	0.1
Delay / Veh (s)	1680.8	1051.5	875.2	336.3	355.1	253.6	457.1	387.0	351.1	28.3	13.5	10.1

35: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	200.1
Delay / Veh (s)	206.9

Total Network Performance

Total Delay (hr)	1143.2
Delay / Veh (s)	620.8

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	378	424	627	627	469	150	151	239	1476	1473	1468	275
Average Queue (ft)	266	285	389	388	164	42	41	55	1423	1421	1392	262
95th Queue (ft)	435	467	646	608	362	297	294	175	1599	1599	1718	302
Link Distance (ft)			658	658		722	722		1435	1435	1435	
Upstream Blk Time (%)			5	1		1	0		55	54	28	
Queuing Penalty (veh)			0	0		0	0		0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	1	11	1	1	0				68			60
Queuing Penalty (veh)	5	52	5	4	0				34			120

Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	455	454	452	67	274	519	509	474	675	673	663
Average Queue (ft)	420	242	232	12	122	493	492	250	641	641	563
95th Queue (ft)	529	447	408	49	240	508	509	409	719	719	790
Link Distance (ft)	441	441	441			421	421	421	634	634	634
Upstream Blk Time (%)	62	1	0			54	56	2	50	50	9
Queuing Penalty (veh)	277	5	2			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	75		49	1	0	55					
Queuing Penalty (veh)	152		20	5	0	69					

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	665	1595	495	155	1630	300	455	1305	55	415	1430	285
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	3.0	3.0	5.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3286	3388	1516	1694	3388	1516	3286	3388	1516	1694	3388	1516
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	700	1679	521	163	1716	316	479	1374	58	437	1505	300
RTOR Reduction (vph)	0	0	145	0	0	0	0	0	6	0	0	116
Lane Group Flow (vph)	700	1679	376	163	1716	316	479	1374	52	437	1505	184
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Prot		Perm	Prot		Free	Prot		Perm	Prot		Perm
Protected Phases	3	8		7	4		5	2		1	6	
Permitted Phases			8			Free			2			6
Actuated Green, G (s)	15.0	39.4	39.4	13.6	38.0	130.0	10.0	36.0	36.0	19.0	45.0	45.0
Effective Green, g (s)	17.0	42.4	42.4	15.6	41.0	130.0	12.0	39.0	37.0	21.0	48.0	46.0
Actuated g/C Ratio	0.13	0.33	0.33	0.12	0.32	1.00	0.09	0.30	0.28	0.16	0.37	0.35
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	6.0	6.0	5.0	6.0	6.0
Vehicle Extension (s)	3.0	3.5	3.5	3.0	3.5		3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	430	1105	494	203	1069	1516	303	1016	431	274	1251	536
v/s Ratio Prot	c0.21	0.50		0.10	c0.51		0.15	c0.41		c0.26	0.44	
v/s Ratio Perm			0.25			c0.21			0.03			0.12
v/c Ratio	1.63	1.52	0.76	0.80	1.61	0.21	1.58	1.35	0.12	1.59	1.20	0.34
Uniform Delay, d1	56.5	43.8	39.3	55.7	44.5	0.0	59.0	45.5	34.4	54.5	41.0	30.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.46	0.61	0.60	1.00	1.00	1.00
Incremental Delay, d2	293.0	238.4	7.0	20.0	276.8	0.3	271.5	162.9	0.4	284.3	99.2	1.7
Delay (s)	349.5	282.2	46.3	75.7	321.3	0.3	357.7	190.7	21.2	338.8	140.2	32.6
Level of Service	F	F	D	E	F	A	F	F	C	F	F	C
Approach Delay (s)		256.1			256.8			227.4			164.5	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	228.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.51		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	136.4%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

5: MD 410 & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	21.5	22.6	1.5	33.2	375.8	55.5	23.7	14.7	0.4	16.6	16.4	1.4
Delay / Veh (s)	187.5	75.4	16.1	1258.2	1339.6	1110.0	291.7	59.6	41.5	229.5	65.8	28.2

5: MD 410 & MD 201 Performance by movement

Movement	All
Total Delay (hr)	583.3
Delay / Veh (s)	370.7

6: Riverdale Rd. & MD 201 Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay (hr)	23.3	46.2	20.8	31.4	19.1	17.6	13.0	275.5	65.1	0.8	6.0	0.2
Delay / Veh (s)	1313.0	1221.8	1190.7	791.5	731.3	654.6	879.7	934.8	1010.0	35.0	17.5	13.6

6: Riverdale Rd. & MD 201 Performance by movement

Movement	All
Total Delay (hr)	519.0
Delay / Veh (s)	566.5

Total Network Performance

Total Delay (hr)	1997.8
Delay / Veh (s)	1115.0

Intersection: 5: MD 410 & MD 201

Movement	EB	EB	EB	EB	EB	B52	B52	WB	WB	WB	WB	NB
Directions Served	L	L	T	T	R	T	T	L	T	T	R	L
Maximum Queue (ft)	393	404	514	497	404	1018	1017	324	1476	1478	1461	275
Average Queue (ft)	319	361	485	479	269	988	985	134	1440	1437	1401	254
95th Queue (ft)	452	479	497	534	533	1015	1009	312	1554	1558	1577	319
Link Distance (ft)			412	412		972	972		1439	1439	1439	
Upstream Blk Time (%)	0	18	48	36	1	38	34		59	53	17	
Queuing Penalty (veh)	0	0	0	0	0	0	0		0	0	0	
Storage Bay Dist (ft)	400	400			500			300				250
Storage Blk Time (%)	1	22	29	36	1			0	65			40
Queuing Penalty (veh)	5	173	194	177	11			0	101			92

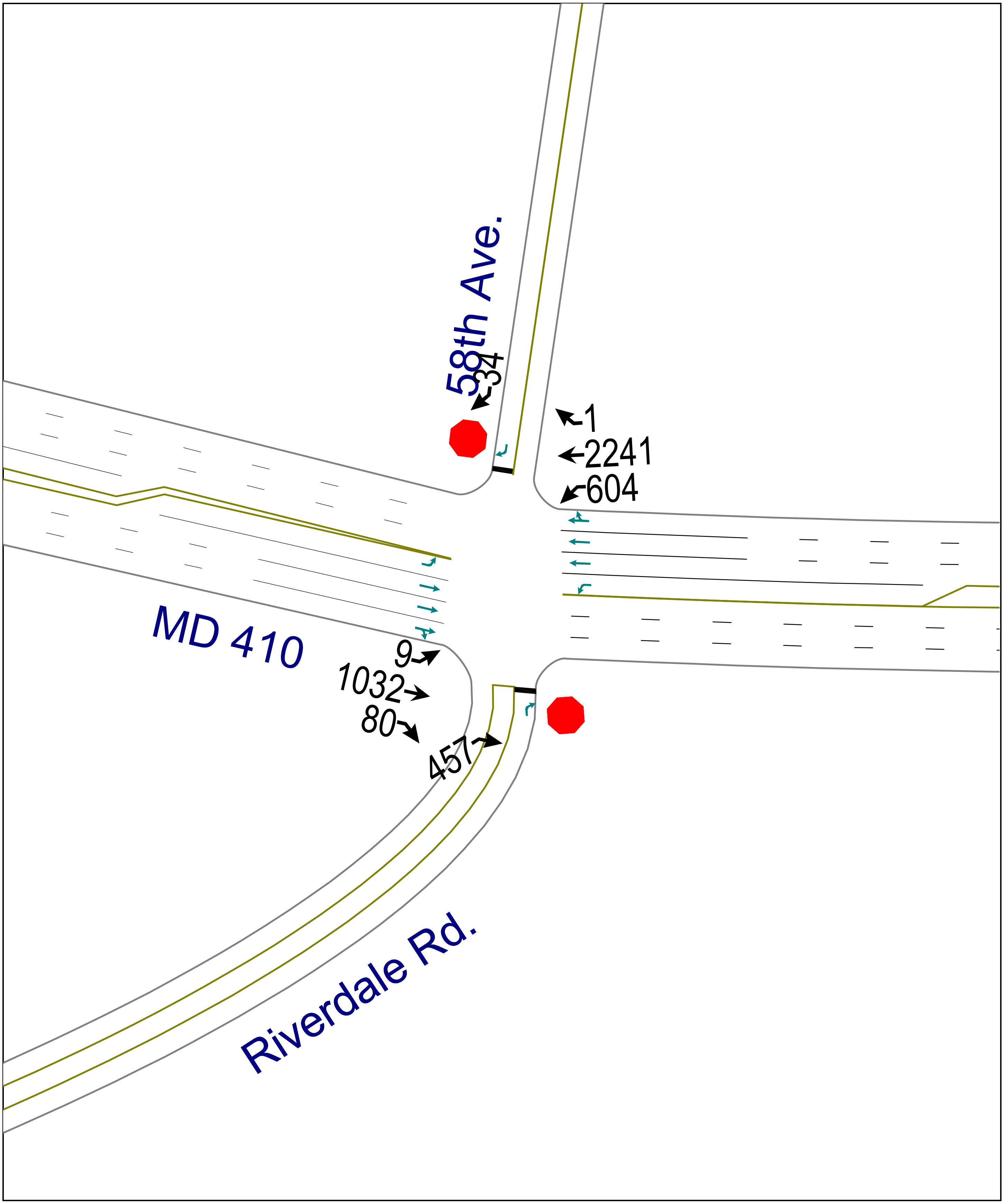
Intersection: 5: MD 410 & MD 201

Movement	NB	NB	NB	NB	SB	SB	SB	SB	B49	B49	B49
Directions Served	L	T	T	R	L	T	T	R	T	T	T
Maximum Queue (ft)	448	450	501	74	275	512	516	467	680	681	662
Average Queue (ft)	381	390	378	18	274	495	454	141	638	600	406
95th Queue (ft)	536	519	513	64	275	507	605	314	748	840	880
Link Distance (ft)	430	430	430			422	422	422	634	634	634
Upstream Blk Time (%)	39	8	6			80	29	0	64	19	7
Queuing Penalty (veh)	238	49	33			0	0	0	0	0	0
Storage Bay Dist (ft)				50	250						
Storage Blk Time (%)	63		68	0	76	13					
Queuing Penalty (veh)	142		38	2	541	53					

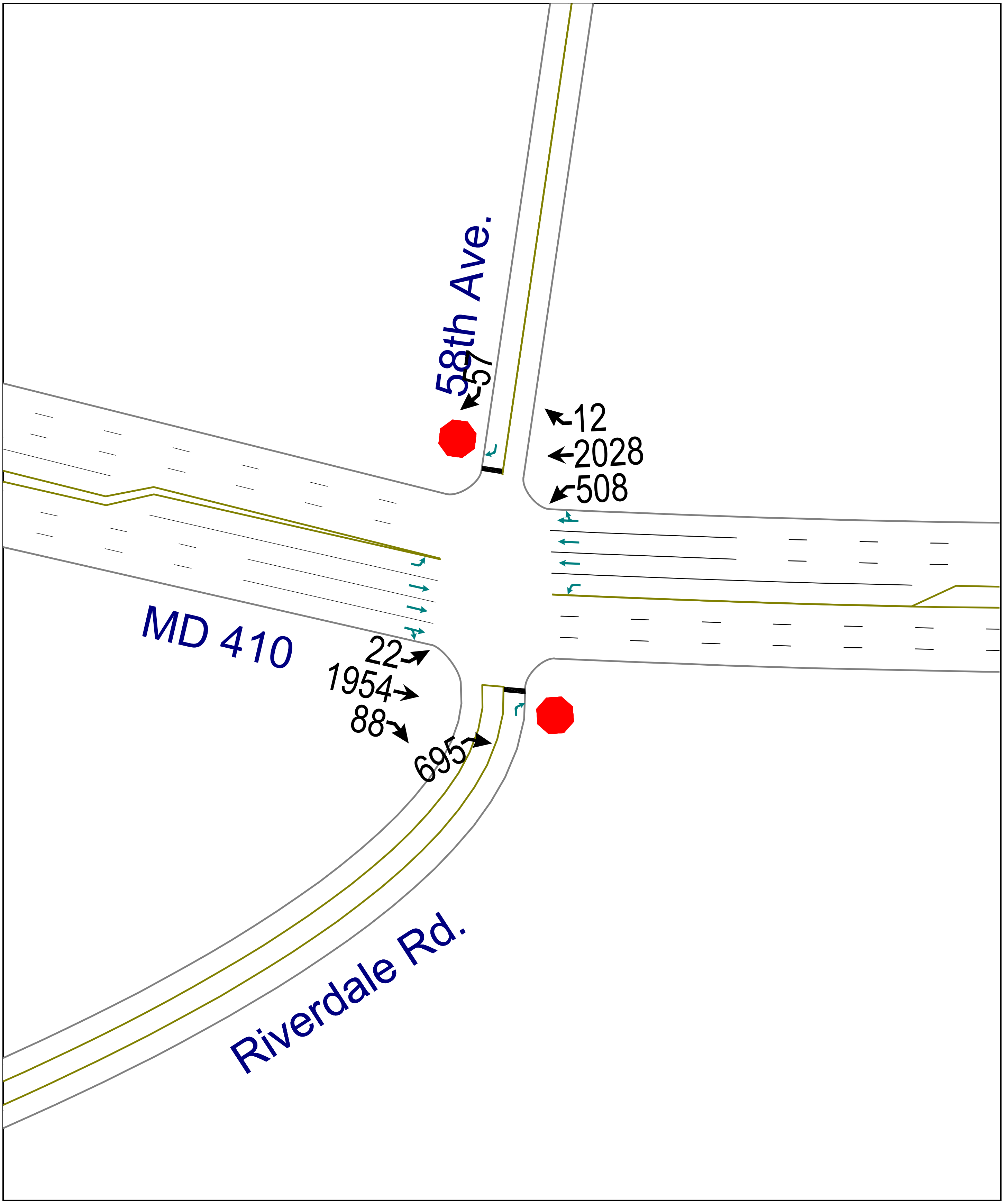
Attachment

D

Traffic Volumes – MD 410 at Riverdale Road / 58th Street


58th Ave.
34
1
2241
604
MD 410
9
1032
80
457
Riverdale Rd.

MD 410 at Riverdale Road / 58th Street
Volumes 5/21/2010



2030 Base PM
STV Incorporated

Attachment

E

Synchro/SimTraffic Reports – MD 410 at Riverdale Road / 58th Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	1032	80	604	2241	1	0	0	457	0	0	34
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	9	1086	84	636	2359	1	0	0	481	0	0	36
Pedestrians					19			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					4.0			4.0				
Percent Blockage					2			1				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		577										
pX, platoon unblocked				0.78			0.78	0.78	0.78	0.78	0.78	
vC, conflicting volume	2360			1183			3253	4791	435	4512	4833	787
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2360			266			2908	4871	0	4516	4924	787
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			37			100	100	42	100	100	89
cM capacity (veh/h)	204			1005			2	0	828	0	0	335

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	9	435	435	301	636	944	944	473	481	36
Volume Left	9	0	0	0	636	0	0	0	0	0
Volume Right	0	0	0	84	0	0	0	1	481	36
cSH	204	1700	1700	1700	1005	1700	1700	1700	828	335
Volume to Capacity	0.05	0.26	0.26	0.18	0.63	0.56	0.56	0.28	0.58	0.11
Queue Length 95th (ft)	4	0	0	0	117	0	0	0	96	9
Control Delay (s)	23.5	0.0	0.0	0.0	14.5	0.0	0.0	0.0	15.2	17.0
Lane LOS	C				B				C	C
Approach Delay (s)	0.2				3.1				15.2	17.0
Approach LOS									C	C

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	73.3%	ICU Level of Service	D
Analysis Period (min)	15		

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBR	All
Total Delay (hr)	0.1	2.5	0.2	17.4	61.5	0.0	0.0	3.0	12.9	97.5
Delay / Veh (s)	45.8	8.6	8.3	183.3	174.9		6.3	32.0	2575.3	113.3
Total Stops	7	56	11	838	2424	1	0	344	21	3702
Travel Dist (mi)	1.0	114.7	8.6	65.7	243.0	0.0	0.1	46.4	1.1	480.5
Travel Time (hr)	0.1	5.2	0.5	19.3	67.8	0.0	0.0	4.8	12.9	110.6
Avg Speed (mph)	7	22	19	3	4	3	15	10	0	4
Vehicles Entered	9	1056	78	350	1284	0	1	337	25	3140
Vehicles Exited	9	1050	77	334	1246	0	1	332	12	3061
Hourly Exit Rate	9	1050	77	334	1246	0	1	332	12	3061
Input Volume	9	1076	80	604	2241	1	1	457	34	4503
% of Volume	100	98	96	55	56	0	100	73	35	68
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	10	10

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	T	TR	L	T	T	TR	T	T	R	LR
Maximum Queue (ft)	41	109	166	192	225	1050	1036	996	624	623	437	337
Average Queue (ft)	6	6	15	24	187	1013	983	869	558	554	157	226
95th Queue (ft)	29	59	84	111	292	1172	1156	1145	789	793	345	405
Link Distance (ft)		486	486	486		960	960	960	581	581	651	317
Upstream Blk Time (%)						58	30	6	45	40		41
Queuing Penalty (veh)						0	0	0	0	0		0
Storage Bay Dist (ft)	160				200							
Storage Blk Time (%)		0			12	55						
Queuing Penalty (veh)		0			89	332						

HCM Unsignalized Intersection Capacity Analysis
1: MD 410 & 58th Ave.

5/18/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	22	1954	88	508	2028	12	0	0	695	0	0	57
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	23	2057	93	535	2135	13	0	0	732	0	0	60
Pedestrians					19			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					4.0			4.0				
Percent Blockage					2			1				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		577										
pX, platoon unblocked				0.72			0.72	0.72	0.72	0.72	0.72	
vC, conflicting volume	2147			2161			4003	5378	763	4693	5418	718
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2147			1249			3808	5721	0	4768	5777	718
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	91			0			0	0	4	0	0	84
cM capacity (veh/h)	248			394			0	0	760	0	0	372

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	23	823	823	504	535	854	854	440	732	60
Volume Left	23	0	0	0	535	0	0	0	0	0
Volume Right	0	0	0	93	0	0	0	13	732	60
cSH	248	1700	1700	1700	394	1700	1700	1700	760	372
Volume to Capacity	0.09	0.48	0.48	0.30	1.36	0.50	0.50	0.26	0.96	0.16
Queue Length 95th (ft)	8	0	0	0	637	0	0	0	372	14
Control Delay (s)	21.0	0.0	0.0	0.0	204.6	0.0	0.0	0.0	47.4	16.5
Lane LOS	C				F				E	C
Approach Delay (s)	0.2				40.8				47.4	16.5
Approach LOS									E	C

Intersection Summary			
Average Delay	25.8		
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBR	All
Total Delay (hr)	0.2	2.9	0.1	16.9	58.9	0.2	14.1	19.7	112.9
Delay / Veh (s)	69.8	8.4	6.8	182.1	161.9	106.3	131.7	3076.8	121.8
Total Stops	10	60	5	954	2950	11	556	28	4574
Travel Dist (mi)	1.3	136.4	5.5	64.2	253.3	1.4	54.0	1.4	517.6
Travel Time (hr)	0.3	6.1	0.3	18.7	65.4	0.3	16.2	19.7	127.0
Avg Speed (mph)	5	22	20	3	4	6	3	0	4
Vehicles Entered	12	1211	49	338	1329	7	391	30	3367
Vehicles Exited	12	1225	49	331	1289	7	381	16	3310
Hourly Exit Rate	12	1225	49	331	1289	7	381	16	3310
Input Volume	22	1975	88	508	2028	12	695	57	5385
% of Volume	55	62	56	65	64	58	55	28	61
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	28	28

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	T	TR	L	T	T	TR	T	T	R	LR
Maximum Queue (ft)	59	102	162	169	225	1056	1051	986	617	628	669	344
Average Queue (ft)	11	6	16	17	194	1011	972	856	557	555	456	267
95th Queue (ft)	41	49	85	90	288	1184	1188	1119	793	800	796	422
Link Distance (ft)		486	486	486		960	960	960	581	581	651	317
Upstream Blk Time (%)						58	27	1	46	36	16	64
Queuing Penalty (veh)						0	0	0	0	0	113	0
Storage Bay Dist (ft)	160				200							
Storage Blk Time (%)		0			16	49						
Queuing Penalty (veh)		0			105	250						

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	1032	80	604	2241	1	0	0	457	0	0	34
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	9	1086	84	636	2359	1	0	0	481	0	0	36
Pedestrians					19			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					4.0			4.0				
Percent Blockage					2			1				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		577										
pX, platoon unblocked				0.74			0.74	0.74	0.74	0.74	0.74	
vC, conflicting volume	2360			1183			3253	4791	616	4693	4833	787
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2360			549			3341	5415	0	5283	5471	787
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			15			100	100	39	100	100	89
cM capacity (veh/h)	204			746			1	0	784	0	0	335

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	9	724	446	636	944	944	473	481	36
Volume Left	9	0	0	636	0	0	0	0	0
Volume Right	0	0	84	0	0	0	1	481	36
cSH	204	1700	1700	746	1700	1700	1700	784	335
Volume to Capacity	0.05	0.43	0.26	0.85	0.56	0.56	0.28	0.61	0.11
Queue Length 95th (ft)	4	0	0	250	0	0	0	107	9
Control Delay (s)	23.5	0.0	0.0	30.9	0.0	0.0	0.0	16.6	17.0
Lane LOS	C			D				C	C
Approach Delay (s)	0.2			6.6				16.6	17.0
Approach LOS								C	C

Intersection Summary			
Average Delay	6.1		
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBR	All
Total Delay (hr)	0.1	2.3	0.2	16.1	63.0	0.0	0.0	3.5	10.6	95.9
Delay / Veh (s)	52.2	8.1	8.7	171.5	183.5		4.1	37.2	1906.0	112.8
Total Stops	8	82	14	772	2479	1	0	350	24	3730
Travel Dist (mi)	1.0	111.7	8.7	64.7	237.9	0.1	0.0	48.0	1.3	473.5
Travel Time (hr)	0.2	4.9	0.5	18.0	69.2	0.0	0.0	5.5	10.6	108.9
Avg Speed (mph)	6	23	19	4	3	7	15	9	0	4
Vehicles Entered	9	1036	78	346	1261	0	1	342	27	3100
Vehicles Exited	9	1035	78	330	1214	0	1	341	14	3022
Hourly Exit Rate	9	1035	78	330	1214	0	1	341	14	3022
Input Volume	9	1076	80	604	2241	1	1	457	34	4503
% of Volume	100	96	98	55	54	0	100	75	41	67
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	6	6

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	TR	L	T	T	TR	T	T	R	LR
Maximum Queue (ft)	75	288	478	224	1052	1036	1019	618	620	454	314
Average Queue (ft)	8	35	56	180	1011	981	877	557	554	174	218
95th Queue (ft)	40	182	245	290	1194	1183	1125	786	786	369	398
Link Distance (ft)		486	486		962	962	962	581	581	663	317
Upstream Blk Time (%)		0	0		58	32	4	44	40	0	31
Queuing Penalty (veh)		1	1		0	0	0	0	0	0	0
Storage Bay Dist (ft)	160			200							
Storage Blk Time (%)		1		8	57						
Queuing Penalty (veh)		0		59	346						

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	22	1954	88	508	2028	12	0	0	695	0	0	57
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	23	2057	93	535	2135	13	0	0	732	0	0	60
Pedestrians					19			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					4.0			4.0				
Percent Blockage					2			1				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		577										
pX, platoon unblocked				0.68			0.68	0.68	0.68	0.68	0.68	
vC, conflicting volume	2147			2161			4003	5378	1106	5036	5418	718
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2147			1768			4473	6495	216	5992	6554	718
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	91			0			0	0	0	0	0	84
cM capacity (veh/h)	248			235			0	0	523	0	0	372

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	23	1371	778	535	854	854	440	732	60
Volume Left	23	0	0	535	0	0	0	0	0
Volume Right	0	0	93	0	0	0	13	732	60
cSH	248	1700	1700	235	1700	1700	1700	523	372
Volume to Capacity	0.09	0.81	0.46	2.28	0.50	0.50	0.26	1.40	0.16
Queue Length 95th (ft)	8	0	0	1056	0	0	0	854	14
Control Delay (s)	21.0	0.0	0.0	620.7	0.0	0.0	0.0	213.3	16.5
Lane LOS	C			F				F	C
Approach Delay (s)	0.2			123.8				213.3	16.5
Approach LOS								F	C

Intersection Summary			
Average Delay	86.7		
Intersection Capacity Utilization	115.3%	ICU Level of Service	H
Analysis Period (min)	15		

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBR	All
Total Delay (hr)	0.3	2.7	0.1	15.9	62.4	0.2	18.4	18.1	118.0
Delay / Veh (s)	64.3	7.4	6.6	177.5	172.0	75.4	175.4	2332.4	124.3
Total Stops	12	93	10	854	3038	14	630	32	4683
Travel Dist (mi)	1.6	144.7	7.4	61.8	252.6	2.0	53.9	1.7	525.8
Travel Time (hr)	0.3	6.1	0.4	17.6	68.9	0.3	20.5	18.2	132.3
Avg Speed (mph)	5	24	20	4	4	7	3	0	4
Vehicles Entered	14	1286	66	327	1325	11	385	36	3450
Vehicles Exited	14	1302	66	316	1287	10	371	22	3388
Hourly Exit Rate	14	1302	66	316	1287	10	371	22	3388
Input Volume	22	1975	88	508	2028	12	695	57	5385
% of Volume	64	66	75	62	63	83	53	39	63
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	20	20

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	TR	L	T	T	TR	T	T	R	LR
Maximum Queue (ft)	60	278	378	225	1060	1050	993	626	621	645	332
Average Queue (ft)	13	33	51	199	1019	1007	880	569	563	546	244
95th Queue (ft)	45	163	233	282	1149	1154	1117	779	779	851	424
Link Distance (ft)		486	486		962	962	962	581	581	663	317
Upstream Blk Time (%)		0	0		59	33	4	45	38	32	57
Queuing Penalty (veh)		1	1		0	0	0	0	0	219	0
Storage Bay Dist (ft)	160			200							
Storage Blk Time (%)		1		13	51						
Queuing Penalty (veh)		0		86	258						

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	1032	80	604	2241	1	0	0	457	0	0	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Lane Util. Factor	1.00	0.91		1.00	0.91				1.00			1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Frt	1.00	0.99		1.00	1.00				0.86			0.86
Flt Protected	0.95	1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)	1770	5018		1770	5085				1611			1611
Flt Permitted	0.07	1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)	121	5018		1770	5085				1611			1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	9	1086	84	636	2359	1	0	0	481	0	0	36
RTOR Reduction (vph)	0	6	0	0	0	0	0	0	8	0	0	29
Lane Group Flow (vph)	9	1164	0	636	2360	0	0	0	473	0	0	7
Confl. Peds. (#/hr)	4		3	3		4			8			
Turn Type	pm+pt			Prot					Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases	2											
Actuated Green, G (s)	67.0	61.4		90.6	146.4				90.6			5.6
Effective Green, g (s)	67.0	61.4		90.6	146.4				90.6			5.6
Actuated g/C Ratio	0.42	0.38		0.57	0.92				0.57			0.03
Clearance Time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0				3.0			3.0
Lane Grp Cap (vph)	108	1926		1002	4653				912			56
v/s Ratio Prot	0.00	c0.23		c0.36	0.46				0.29			0.00
v/s Ratio Perm	0.03											
v/c Ratio	0.08	0.60		0.63	0.51				0.52			0.13
Uniform Delay, d1	27.4	39.6		23.5	1.1				21.3			74.8
Progression Factor	0.20	0.25		1.00	1.00				0.38			1.00
Incremental Delay, d2	0.2	1.0		1.3	0.4				0.4			1.0
Delay (s)	5.7	10.8		24.8	1.5				8.4			75.8
Level of Service	A	B		C	A				A			E
Approach Delay (s)		10.7			6.4			8.4			75.8	
Approach LOS		B			A			A			E	

Intersection Summary			
HCM Average Control Delay	8.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	61.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBR	All
Total Delay (hr)	0.2	5.0	0.4	26.4	52.6	0.0	0.0	0.7	6.2	91.5
Delay / Veh (s)	78.9	17.4	19.9	264.3	148.3		1.2	7.4	1183.4	106.3
Total Stops	5	244	30	952	2391	0	0	117	21	3760
Travel Dist (mi)	0.8	111.6	8.6	68.7	247.9	0.0	0.1	45.6	1.1	484.4
Travel Time (hr)	0.2	7.6	0.7	28.4	59.0	0.0	0.0	2.5	6.3	104.7
Avg Speed (mph)	4	15	12	2	4	4	22	18	0	5
Vehicles Entered	7	1030	79	359	1310	0	1	330	25	3141
Vehicles Exited	7	1022	79	362	1244	0	1	331	13	3059
Hourly Exit Rate	7	1022	79	362	1244	0	1	331	13	3059
Input Volume	9	1076	80	604	2241	1	1	457	34	4503
% of Volume	78	95	99	60	56	0	100	72	38	68
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	5	5

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	T	TR	L	T	T	TR	T	T	R	R
Maximum Queue (ft)	33	221	255	257	225	1062	1048	1008	619	613	216	283
Average Queue (ft)	6	36	79	92	218	1032	959	845	584	576	69	136
95th Queue (ft)	23	133	197	217	260	1062	1244	1243	710	730	164	340
Link Distance (ft)		486	486	486		960	960	960	581	581	651	317
Upstream Blk Time (%)						65	23	7	48	40		18
Queuing Penalty (veh)						0	0	0	0	0		0
Storage Bay Dist (ft)	160				200							
Storage Blk Time (%)		0			45	38						
Queuing Penalty (veh)		0			336	230						

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	22	1954	88	508	2028	12	0	0	695	0	0	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Lane Util. Factor	1.00	0.91		1.00	0.91				1.00			1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Frt	1.00	0.99		1.00	1.00				0.86			0.86
Flt Protected	0.95	1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)	1770	5045		1770	5080				1611			1611
Flt Permitted	0.08	1.00		0.08	1.00				1.00			1.00
Satd. Flow (perm)	150	5045		140	5080				1611			1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	23	2057	93	535	2135	13	0	0	732	0	0	60
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	1	0	0	37
Lane Group Flow (vph)	23	2146	0	535	2148	0	0	0	731	0	0	23
Confl. Peds. (#/hr)	4		3	3		4			8			
Turn Type	pm+pt			pm+pt					Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases	2			6								
Actuated Green, G (s)	60.4	60.4		114.8	114.8				61.6			7.2
Effective Green, g (s)	60.4	60.4		114.8	114.8				61.6			7.2
Actuated g/C Ratio	0.46	0.46		0.88	0.88				0.47			0.06
Clearance Time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0				3.0			3.0
Lane Grp Cap (vph)	159	2344		896	4486				763			89
v/s Ratio Prot	0.01	c0.43		0.28	0.42				c0.45			0.01
v/s Ratio Perm	0.06			0.24								
v/c Ratio	0.14	0.92		0.60	0.48				0.96			0.26
Uniform Delay, d1	22.0	32.4		21.1	1.5				33.0			58.8
Progression Factor	0.49	0.50		1.00	1.00				0.72			1.00
Incremental Delay, d2	0.0	0.7		1.1	0.4				12.6			1.6
Delay (s)	10.7	17.0		22.2	1.9				36.2			60.4
Level of Service	B	B		C	A				D			E
Approach Delay (s)		16.9			5.9			36.2			60.4	
Approach LOS		B			A			D			E	

Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBR	All
Total Delay (hr)	0.1	5.2	0.2	13.7	67.3	0.3	2.1	0.6	89.5
Delay / Veh (s)	26.5	15.4	13.9	169.9	199.5	101.0	17.5	41.5	98.5
Total Stops	9	329	20	669	3110	14	354	43	4548
Travel Dist (mi)	1.5	135.8	6.2	55.8	234.7	1.7	59.0	3.3	498.0
Travel Time (hr)	0.1	8.4	0.4	15.3	73.4	0.3	4.4	0.8	103.2
Avg Speed (mph)	10	16	15	4	3	6	13	4	5
Vehicles Entered	13	1206	54	295	1232	9	420	56	3285
Vehicles Exited	14	1218	55	285	1198	9	422	56	3257
Hourly Exit Rate	14	1218	55	285	1198	9	422	56	3257
Input Volume	22	1975	88	508	2028	12	695	57	5385
% of Volume	64	62	62	56	59	75	61	98	60
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	T	TR	L	T	T	TR	T	T	R	R
Maximum Queue (ft)	29	171	186	207	225	1067	1042	996	628	619	406	129
Average Queue (ft)	8	67	102	106	156	1029	1012	898	579	574	164	43
95th Queue (ft)	26	146	181	189	303	1080	1094	1042	756	752	316	96
Link Distance (ft)		486	486	486		960	960	960	581	581	651	317
Upstream Blk Time (%)						61	36	2	49	40		
Queuing Penalty (veh)						0	0	0	0	0		
Storage Bay Dist (ft)	160				200							
Storage Blk Time (%)		0			2	58						
Queuing Penalty (veh)		0			15	292						

HCM Signalized Intersection Capacity Analysis
1: MD 410 & 58th Ave.

5/19/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	1032	80	604	2241	1	0	0	457	0	0	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Lane Util. Factor	1.00	0.95		1.00	0.91				1.00			1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Frt	1.00	0.99		1.00	1.00				0.86			0.86
Flt Protected	0.95	1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)	1770	3492		1770	5085				1611			1611
Flt Permitted	0.06	1.00		0.95	1.00				1.00			1.00
Satd. Flow (perm)	106	3492		1770	5085				1611			1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	9	1086	84	636	2359	1	0	0	481	0	0	36
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	19	0	0	31
Lane Group Flow (vph)	9	1167	0	636	2360	0	0	0	462	0	0	5
Confl. Peds. (#/hr)	4		3	3		4			8			
Turn Type	pm+pt			Prot					Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases	2											
Actuated Green, G (s)	77.0	71.9		80.1	146.9				80.1			5.1
Effective Green, g (s)	77.0	71.9		80.1	146.9				80.1			5.1
Actuated g/C Ratio	0.48	0.45		0.50	0.92				0.50			0.03
Clearance Time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0				3.0			3.0
Lane Grp Cap (vph)	104	1569		886	4669				807			51
v/s Ratio Prot	0.00	c0.33		c0.36	0.46				0.29			0.00
v/s Ratio Perm	0.04											
v/c Ratio	0.09	0.74		0.72	0.51				0.57			0.10
Uniform Delay, d1	21.9	36.4		31.1	1.0				28.0			75.2
Progression Factor	0.23	0.19		1.00	1.00				0.43			1.00
Incremental Delay, d2	0.2	2.2		2.8	0.4				0.8			0.8
Delay (s)	5.3	9.0		33.9	1.4				12.8			76.1
Level of Service	A	A		C	A				B			E
Approach Delay (s)		8.9			8.3			12.8			76.1	
Approach LOS		A			A			B			E	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	71.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBR	All
Total Delay (hr)	0.1	3.2	0.3	17.8	65.1	0.0	0.0	1.0	11.3	98.9
Delay / Veh (s)	67.4	11.2	13.0	191.0	188.9		0.7	11.2	2715.0	117.8
Total Stops	5	113	17	770	2517	0	0	143	20	3585
Travel Dist (mi)	1.0	110.8	8.8	64.6	238.9	0.0	0.1	45.3	0.9	470.4
Travel Time (hr)	0.2	5.8	0.6	19.7	71.3	0.0	0.0	2.8	11.4	111.7
Avg Speed (mph)	5	19	15	3	3	7	21	16	0	4
Vehicles Entered	9	1014	79	336	1249	0	1	322	21	3031
Vehicles Exited	8	1022	80	337	1233	0	1	324	8	3013
Hourly Exit Rate	8	1022	80	337	1233	0	1	324	8	3013
Input Volume	9	1076	80	604	2241	1	1	457	34	4503
% of Volume	89	95	100	56	55	0	100	71	24	67
Denied Entry Before	0	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	11	11

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	TR	L	T	T	TR	T	T	R	R
Maximum Queue (ft)	42	283	341	225	1052	1037	1015	614	612	251	313
Average Queue (ft)	6	51	72	191	1026	1005	906	579	578	90	201
95th Queue (ft)	25	173	234	288	1117	1114	1116	727	735	197	396
Link Distance (ft)		486	486		962	962	962	581	581	663	317
Upstream Blk Time (%)		0	0		58	35	7	46	42		38
Queuing Penalty (veh)		0	1		0	0	0	0	0		0
Storage Bay Dist (ft)	160			200							
Storage Blk Time (%)		0		13	54						
Queuing Penalty (veh)		0		98	325						

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	22	1954	88	508	2028	12	0	0	695	0	0	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Lane Util. Factor	1.00	0.95		1.00	0.91				1.00			1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00				1.00			1.00
Frt	1.00	0.99		1.00	1.00				0.86			0.86
Flt Protected	0.95	1.00		0.95	1.00				1.00			1.00
Satd. Flow (prot)	1770	3511		1770	5080				1611			1611
Flt Permitted	0.07	1.00		0.06	1.00				1.00			1.00
Satd. Flow (perm)	124	3511		118	5080				1611			1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Growth Factor (vph)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Adj. Flow (vph)	23	2057	93	535	2135	13	0	0	732	0	0	60
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	3	0	0	37
Lane Group Flow (vph)	23	2148	0	535	2148	0	0	0	729	0	0	23
Confl. Peds. (#/hr)	4		3	3		4			8			
Turn Type	pm+pt			pm+pt					Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases	2			6								
Actuated Green, G (s)	69.2	69.2		115.9	115.9				52.8			6.1
Effective Green, g (s)	69.2	69.2		115.9	115.9				52.8			6.1
Actuated g/C Ratio	0.53	0.53		0.89	0.89				0.41			0.05
Clearance Time (s)	4.0	4.0		4.0	4.0				4.0			4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0				3.0			3.0
Lane Grp Cap (vph)	143	1869		776	4529				654			76
v/s Ratio Prot	0.01	c0.61		0.28	0.42				c0.45			0.01
v/s Ratio Perm	0.08			0.33								
v/c Ratio	0.16	1.15		0.69	0.47				1.11			0.30
Uniform Delay, d1	14.9	30.4		28.4	1.3				38.6			59.9
Progression Factor	0.85	0.98		1.00	1.00				0.75			1.00
Incremental Delay, d2	0.0	67.8		2.6	0.4				61.2			2.2
Delay (s)	12.7	97.5		31.0	1.7				90.2			62.1
Level of Service	B	F		C	A				F			E
Approach Delay (s)		96.6			7.5			90.2			62.1	
Approach LOS		F			A			F			E	

Intersection Summary			
HCM Average Control Delay	53.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.13		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

1: MD 410 & 58th Ave. Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBR	All
Total Delay (hr)	0.2	9.1	0.4	14.5	61.4	0.3	2.4	29.0	117.3
Delay / Veh (s)	50.3	25.7	27.3	149.8	164.9	111.6	20.6	9478.8	121.6
Total Stops	10	457	28	643	2885	16	293	16	4348
Travel Dist (mi)	1.4	143.2	6.3	67.3	259.6	1.8	58.8	0.7	539.2
Travel Time (hr)	0.2	12.5	0.6	16.4	68.1	0.3	4.7	29.0	132.0
Avg Speed (mph)	6	11	10	4	4	6	13	0	5
Vehicles Entered	13	1279	56	353	1361	10	412	18	3502
Vehicles Exited	13	1285	55	345	1322	9	413	4	3446
Hourly Exit Rate	13	1285	55	345	1322	9	413	4	3446
Input Volume	22	1975	88	508	2028	12	695	57	5385
% of Volume	59	65	62	68	65	75	59	7	64
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	43	43

Intersection: 1: MD 410 & 58th Ave.

Movement	EB	EB	EB	WB	WB	WB	WB	B43	B43	NB	SB
Directions Served	L	T	TR	L	T	T	TR	T	T	R	R
Maximum Queue (ft)	134	404	440	225	1048	1045	1010	626	624	460	332
Average Queue (ft)	12	194	200	140	1002	988	883	549	551	195	286
95th Queue (ft)	59	341	357	306	1201	1203	1132	814	806	375	418
Link Distance (ft)		486	486		962	962	962	581	581	663	317
Upstream Blk Time (%)		2	1		53	30	3	42	33		78
Queuing Penalty (veh)		19	14		0	0	0	0	0		0
Storage Bay Dist (ft)	160			200							
Storage Blk Time (%)		23		9	50						
Queuing Penalty (veh)		5		61	252						

29. Lyttonsville Yard Location and Configuration

Lyttonsville Yard & Shop Site Evaluation

August 16, 2013

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Appendix A

1 Introduction

The Purple Line is a proposed 16-mile light rail line extending from Bethesda in Montgomery County to New Carrollton in Prince George's County. It would provide a direct connection to the Metrorail Red, Green, and Orange Lines; at Bethesda, Silver Spring, College Park, and New Carrollton. The Purple Line would also connect to MARC, AMTRAK, and local bus services. Two storage and maintenance yards are proposed; one in Montgomery County and one in Prince George's County. A location was needed for the storage and maintenance facility that would be close to the mainline tracks and within or adjacent to a compatible land use area large enough to provide a workable switching yard. Lyttonsville offered the only area adjacent to comparable land uses, large enough to support the yard in Montgomery County. The majority of other adjacent lands to the proposed track alignment are densely populated residential areas, businesses, or parkland and unable to support a usable switching yard. The area chosen for the yard in Montgomery County is to be located northwest of Silver Spring, Maryland, near the intersection of Lyttonsville Place and Brookville Road. This facility is referred to as the Lyttonsville Yard and Shop.

The purpose of the Lyttonsville Yard and Shop is to store, service, maintain, and dispatch light rail vehicles. Services to be provided at the yard and shop include the following:

- Pre-trip, weekly and periodic safety inspections
- Daily and heavy interior cleaning
- Vehicle sanding
- Vehicle exterior washing
- Major and minor vehicle repairs
- Wheel truing
- Scheduled maintenance and change outs
- Vehicle painting
- Vehicle storage and dispatch

The general location chosen for the Lyttonsville Yard and Shop is adjacent to the abandoned Georgetown Branch and is bordered by the CSX Metropolitan Branch Subdivision to the east, Rock Creek Park to the west, residential areas and Washington Suburban Sanitary Commission (WSSC) yard to the south, and an industrial area to the north, which includes the Montgomery County Department of Transportation (DOT) maintenance and bus facility. Lyttonsville Place bridge, which crosses over the existing Georgetown Branch trail, would be replaced with a larger structure as part of the Purple Line project. A large industrial area lies to the north of Brookville Road and east of the Montgomery County maintenance facility. The WSSC facility lies immediately south of the Georgetown Branch and west of Lyttonsville Place. Existing parking lots for the Montgomery County DOT facility lie north of the Georgetown Branch and west of Lyttonsville Place. This existing parking for the County will need to be replaced as a result of most of the yard option locations. There are several residential communities to the south and west of the proposed yard. These communities have been actively involved throughout this design process.

Throughout the design and evaluation process the following factors were considered:

- Yard operations and connections with the mainline tracks;
- Maintaining businesses along Brookville Road;
- Potential impacts to the existing communities and businesses;
- Coordination with the trail and station location;
- Right-of-way (ROW) costs;
- Construction costs;
- Access from existing roadways and relocated traffic patterns;
- Physical constraints;
- Storm water management;
- Parking for the MTA facility and the displaced Montgomery County parking.

Due to limited space, parking has been a major concern. Montgomery County employees, who work at the maintenance yard/bus facility, are currently parking on Parcel P070 located just south of Brookville Road adjacent to the maintenance and bus facility. The proposed construction of the shop and maintenance facility for the light rail would eliminate that parking and require that an alternate parking area be provided for them. The existing lot handles about 185 cars and some storage. MTA has been asked to provide parking for 200 cars for Montgomery County personnel. The site also needs to provide an additional 200 spaces for the Purple Line light rail facility. Parking garages, surface lots and a parking deck over the tracks have been considered.

In order to evaluate costs for each option, ROW costs were estimated for each option to include property acquisitions and relocation costs and comparable construction costs were developed. The comparable construction costs only looked at items of work that changed from option to option so as to get a cost difference between each option rather than a total cost for the facility. The construction costs were generally cost neutral making the ROW cost the differentiator.

The following is a list of location options considered for the MTA Lyttonsville Yard and Shop:

- Locally Preferred Alternative (LPA)
- Design Option of LPA with Parking Options
- West of Lyttonsville Place Option
- WSSC Option
- North of Brookville Road Option

2 Lyttonsville Yard & Shop Alternatives Considered

The Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS) presented the need for maintenance and storage facilities and identified sites on Brookville Road in Lyttonsville in Montgomery County and along Veterans Parkway at the site of the Northern Area Maintenance Office (Glenridge) in Prince George's County. The AA/DEIS also presented information on other sites and why they were dropped from further consideration. The Lyttonsville and Glenridge sites were identified as the most promising at the time of the AA/DEIS.

At the Public Hearings in support of the AA/DEIS, the Lyttonsville facility was shown bounded by Brookville Road on the north, the Purple Line on the south, from the existing Montgomery County maintenance facility on the west to a point east of Lyttonsville Place near the intersection of Garfield Avenue.

Since that time, the site was developed in more detail and presented to the public a number of times in differing levels of detail. Several factors have influenced the design since the publication of the AA/DEIS including:

- Updated ridership and transit travel time estimates have increased the total projected fleet size resulting in an increase in the maintenance and storage needs.
- More detailed design for each yard has refined the layout of each facility.

The maintenance and storage facilities were refined based on the factors listed above as well as input from the community and stakeholders. Due to the increased fleet size and resulting additional site requirements, the yards were trending larger than anticipated in the AA/DEIS. More detailed mapping, refined design criteria, more detailed yard operational analyses, and stormwater management requirements resulted in changes to the yards not anticipated in the AA/DEIS. Therefore, the Lyttonsville site included in the Locally Preferred Alternative (LPA) would have extended further east of Lyttonsville Place, closer to the residential community and would have resulted in additional potential business displacements. This shift towards a larger yard was met with much community concern and comments. These concerns were a major factor in MTA's decision to evaluate the location options and refinements recommended as part of the Preferred Alternative.

2.1 Locally Preferred Alternative (LPA)

The LPA consists of a storage yard and maintenance facility south of Brookville Road. Refer to Appendix Figure A1. The yard would have five stub-end storage tracks located to the east of Lyttonsville Place Bridge and a four bay maintenance facility with eight work positions located to the west of the Bridge. The mainline alignment of the Purple Line would be located to the south of the Yard and Shop, primarily along the Georgetown Branch right-of-way, and would allow access to the Yard and Shop via two lead tracks, one each from the east and the west. The lead tracks travel in an east-west direction with the west lead beginning approximately 500 feet east of Rock Creek Park and the east lead meeting the mainline approximately 450’ west of Stewart Avenue. Access to the stub ended storage tracks would only be feasible from the west end of the Yard. The Lyttonsville Place Bridge would have to be reconstructed over the new yard and the Lyttonsville Station would be located approximately 300’ east of Lyttonsville Place, south of Brookville Road and south of the yard and shop.

2.1.1 Operations

From an operations standpoint, this option is the least desirable option due to the stub-ended yard tracks and the many required reverse moves. Rail vehicles enter and exit the yard and shop from two points off the mainline as described above. Vehicles entering from the west end choose to enter either the yard or the shop. Vehicles entering from the east end can directly enter the shop; however one reverse move is required to enter the yard. Vehicles are able to travel from any track in the storage yard (from the west end only) to any track in the shop or vice versa by traveling through the western ladders (a series of switches between the parallel tracks) and reversing directions to their destination. Vehicles leaving the yard can leave the storage yard from the yard’s west end and then proceed either east or west on to the appropriate lead to the mainline tracks. If trains leave in an easterly direction one reverse move would be required. Allowances were not made for 600’ of tangent test track nor a wash track. Access to the shop for deliveries would be from relocated Stewart Avenue with one at grade crossing over the runaround/open track.

2.1.2 Parking

Parking options were not designed for this option and, therefore, are not evaluated; however it is assumed the parking options available would be similar to those evaluated for the Design Option as described below in section **2.2.2**.

2.1.3 Right-of-Way Impacts

There would be 18 total property acquisitions and 6 partial property acquisitions. This would result in a facility of approximately 12.9 acres. These properties include all of the businesses fronting Brookville Road on the south side, from Lyttonsville Place to Stewart Avenue and the properties between Brookville Road and WSSC, where Montgomery County currently supplies parking for their maintenance and bus facility. Additional properties were not taken into account for parking.

2.1.4 ROW Costs

This option was not developed for cost due the operational deficiencies associated with the stub end track layout and required reverse moves.

2.1.5 Community Outreach

The LPA raised concerns in regards to disturbance to surrounding communities and lost redevelopment potential along the south side of Brookville Road east of Lyttonsville Place. Since this option utilizes the property along the south side of Brookville Road, it would not allow for any redevelopment in that area. The community expressed concern that the expansion of the facility from what was shown in the AA/DEIS resulted in it being closer to the surrounding residential areas. The station and trail would remain south of the yard making them convenient for the communities to access.

2.2 Design Option of LPA

The purpose of this design option was to address the operational deficiencies associated with the stub end tracks included in the LPA Option. Refer to Appendix Figures A2 and A3. It features the storage tracks to the west of Lyttonsville Place and the maintenance building to the east of Lyttonsville Place.

The Design Option consists of a storage yard and maintenance facility south of Brookville Road in a similar location to option **2.1** above. The yard has six double-ended storage tracks and one stub-end storage tracks located to the west of Lyttonsville Place Bridge; one wash track and a four bay maintenance facility, with eight work positions, located to the east of the Lyttonsville Place Bridge. The mainline alignment of the Purple Line is located to the north of the yard and shop, adjacent to the south side of Brookville Road and allows access to the yard and shop from both the east and west ends. The lead tracks travel in an east-west direction with the west lead beginning approximately 500 feet east of Rock Creek Park and the east lead meeting the mainline under the relocated Stephen Sitter/Stewart Avenue. Lyttonsville Place Bridge and Stephen Sitter/Stewart Avenue would be reconstructed over the new yard and the Lyttonsville Station would be located approximately 200’ east of Lyttonsville Place south of Brookville Road and north of the yard and shop.

2.2.1 Operations

Rail vehicles enter and exit the yard and shop from two points off the mainline as described above. Vehicles entering from either end can choose to enter either the yard, shop or wash track. If the vehicle enters the wash track, it may then proceed through the ladder on either end, reverse direction and enter the yard or shop. Vehicles can travel from any track in the storage yard to any track in the shop or vice versa by traveling through either ladder, reversing directions, then proceeding to the desired location. Vehicles leaving the yard can leave the storage yard or shop from either end and proceed either east or west on the appropriate lead to the main tracks. There would be room on the open/runaround track for 600’ of tangent test track. Access to the shop for deliveries would be off relocated Stephen Sitter/Stewart Avenue at the east end of the shop building.

2.2.2 Parking

Two parking options for this layout were considered due to cost, right-of-way, and community constraints. However, alternate parking options could be developed.

2.2.2.1 Parking Garage Option

The parking structure would be located south of the maintenance facility and would occupy one additional property, as compared to the LPA. It would have a 200 space capacity. An additional parking structure would need to be built on Montgomery County’s DPW site due to the acquisition of their existing parking lot. That structure would provide cover for at least 100 buses and parking for 200 automobiles.

2.2.2.2 Parking Canopy Option

The parking canopy would be located over the yard tracks to the west of Lyttonsville Place Bridge. It would be built to handle 400 spaces, which would provide enough parking for Purple Line employees and Montgomery County employees. Spaces on the parking structure for Montgomery County employees are necessary due to the acquisition of their existing parking lot. The canopy would double as cover for the yard area.

2.2.3 Right-of-Way Impacts

The LPA Design Option would require 18 total property acquisitions and 15 partial property acquisitions. This would result in a facility of approximately 13 acres. These properties include all of the businesses fronting Brookville Road on the south side from the Lyttonsville Place to Stewart Avenue.

2.2.4 ROW Costs

Total property acquisition and relocation costs = $38,000,000.

2.2.5 Community Outreach

This Design Option raised concerns regarding disturbance to surrounding communities and lost redevelopment potential along the south side of Brookville Road east of Lyttonsville Place, similar to the Locally Preferred Alternative Option above. Additionally, the maintenance shop is located relatively close to the residential community. The station and trail would remain north of the yard making them less convenient for the adjacent residential communities. The parking garage option raised additional community concern, as it placed the parking garage closer to the residential community.

2.3 West of Lyttonsville Place Option

This option was developed in order to address community concerns and to minimize impacts to properties along Brookville Road east of Lyttonsville Place. Refer to Appendix Figure A4. The West of Lyttonsville Place Option consists of a storage yard and maintenance facility situated between relocated Brookville Road to the north, WSSC to the south, Lyttonsville Place to the east and Montgomery County's DPW site to the west. The yard has five double-ended storage tracks, one open track, one wash track and a four bay maintenance facility with eight work positions located to the west of Lyttonsville Place Bridge. The maintenance facility is furthest north in the yard, followed to the south by the storage tracks, the open track, and the wash track, respectively. The mainline alignment of the Purple Line is located to the south of the yard and shop, primarily along the Georgetown Branch right-of-way, and allows access to the yard and shop via lead tracks from the east and the west. The lead tracks travel in an east-west direction, with the west lead beginning approximately 300 feet east of Rock Creek Park and the east lead meeting the mainline approximately 450' west of Stewart Avenue. This layout requires the realignment and reconstruction of Brookville Road (approximately 900' in length) from Lyttonsville Place to the west. The realignment of the road results in additional property acquisitions on the north side of the existing Brookville Road. Lyttonsville Place Bridge would be reconstructed over the new yard. The station would be located between the eastbound and westbound main tracks approximately 200' east of Lyttonsville Place and south of the yard and shop.

2.3.1 Operations

Rail vehicles enter and exit the yard and shop from two points off the main, as described above. Vehicles entering from either end choose to enter the yard, shop or wash track. If the vehicle enters the wash track, it would then proceed through the ladder on either end, reverse direction and then enter the yard or shop. Vehicles can travel from any track in the storage yard to any track in the shop or vice versa by moving through either ladder and reversing directions. Vehicles leaving the yard may leave the storage yard or shop from either end and proceed east or west on the appropriate lead to the mains. There would be room on the open/runaround track for 600' of tangent test track. Access to the shop for deliveries would be off relocated Brookville Road at the west end of the shop building.

2.3.2 Parking

This option included a parking canopy located over the yard tracks to the west of Lyttonsville Place Bridge and south of the shop. It is designed to handle 400 spaces, which would provide enough parking for Purple Line/MTA employees and Montgomery County employees. Spaces on the parking structure for Montgomery County employees are necessary due to the acquisition of their existing parking lot. The canopy doubles as cover for the yard area.

Alternate parking options could be developed for this option.

2.3.3 Right-of-Way Impacts
The West of Lyttonsville Place Option would require 7 total property acquisitions and 13 partial property acquisitions. This would result in a facility of approximately 12.8 acres. Unlike the LPA Design Option, there would only be 1 total and 1 partial acquisition on the south side of Brookville Road between Lyttonsville Place and Stewart Avenue. This will allow for redevelopment along the south side of Brookville Road to the east of Lyttonsville Place.

2.3.4 ROW Costs
Total property acquisition and relocation costs = $33,725,000.

2.3.5 Community Outreach
The West of Lyttonsville Place Option would keep the yard and shop mostly west of Lyttonsville Place minimizing impact to the east, while maintaining the WSSC property as a buffer to the south. The yard and shop will remain south of relocated Brookville Road and west of Lyttonsville Place. The station and trail will remain south of the yard locating them adjacent to the residential community. Redevelopment along the south side of Brookville Road to the east of Lyttonsville Place will be possible.

2.4 WSSC Option
At the request of the community, another option was developed using a portion of the Washington Suburban Sanitary Commission (WSSC) property south of Brookville Road. Refer to figure A5 in the Appendix. The WSSC Option consists of a storage yard and maintenance facility situated between Brookville Road to the north, a remaining portion of the existing WSSC property to the south, Lyttonsville Place to the east and Montgomery County's DPW site to the west. Approximately half of the yard would be situated on WSSC property. The yard would have five double-ended storage tracks, one open track, one wash track and a four bay maintenance facility, with eight work positions located to the west of Lyttonsville Place Bridge. The storage tracks are furthest north in the yard, followed to the south by the open track, the wash track and the maintenance facility, respectively. The mainline alignment of the Purple Line is located to the north of the yard and shop adjacent to the south side of Brookville Road and allows access to the yard and shop from both ends. The lead tracks travel in an east-west direction, with the west lead beginning approximately 300 feet east of Rock Creek Park and the east lead meeting the mainline approximately 450' west of Stewart Avenue. Lyttonsville Place Bridge is scheduled to be reconstructed over the new yard. The station is located between the eastbound and westbound main tracks approximately 200' east of Lyttonsville Place and northeast of the yard and shop.

2.4.1 Operations
Rail vehicles enter and exit the yard and shop from two points off the main as described above. Vehicles entering from either end could choose to enter the yard, shop or wash track. If the vehicle enters the wash track, it would then proceed through the ladder on either end, reverse direction and then enter the yard or shop. Vehicles could travel from any track in the storage yard to any track in the shop or vice versa by traveling through either ladder and reversing directions. Vehicles would exit the storage yard from either end and would proceed east or west on the appropriate lead to the mains. There would be room on the open/runaround track for 600' of tangent test track. Access to the shop for deliveries would be through the WSSC property off Brookville Road from the south side.

2.4.2 Parking
A parking canopy is located over the yard tracks to the west of Lyttonsville Place Bridge and north of the shop. It is designed to handle 400 spaces, which would provide enough parking for Purple Line

employees and Montgomery County employees. Spaces on the parking structure for Montgomery County employees are necessary due to the acquisition of their existing parking lot. The canopy doubles as cover for the yard area.

Alternate parking options could be developed for this option.

2.4.3 Right-of-Way Impacts

The WSSC Option would require 8 total property acquisitions and 9 partial property acquisitions. This would result in a facility of approximately 13.3 acres. This option will require the relocation of the WSSC yard. Since this location of the WSSC yard is central to their service area, and there are few available sites of this size in the vicinity, relocating this site would hinder WSSC's ability to serve their customers. Unlike the LPA Design Option, there would only be 2 total acquisitions on the south side of Brookville Road, between Lyttonsville Place and Stewart Avenue. This would allow for redevelopment along the south side of Brookville Road.

2.4.4 ROW Costs

Total property acquisition and relocation costs = $38,500,000.

2.4.5 Community Outreach

The WSSC Option would keep the Purple Line yard and shop west of Lyttonsville Place satisfying the community to the east, however it would be closer to the community to the south, as the WSSC property as a buffer would be reduced. The station and trail would stay north of the yard making them less convenient for the residential community. Redevelopment along the south side of Brookville Road to the east of Lyttonsville Place would be possible.

2.5 North of Brookville Road Option

This option was developed to investigate the possibility of moving the storage and maintenance facility further from the residential areas and into the industrial park north of Brookville Road. Refer to figure A6 in the Appendix. The North of Brookville Road Option would consist of a storage yard and maintenance facility north of Brookville Road and east of the Montgomery County maintenance/bus facility. Several options were reviewed and eventually dropped in this area including an option within the Montgomery County facility and an option with the yard tracks running parallel to Brookville Road. The option chosen to be considered has the two lead tracks turning north and perpendicular to the main tracks under a new bridge over Brookville Road to the yard, which employs a loop track. This option would require a large property acquisition within the industrial area including removal/relocation of three large radio towers. Despite the large property acquisitions, there are several benefits to this option due to the expanded area to work with. The disruption to the Brookville Road retail businesses are minimal, Lyttonsville Place Bridge may not need to be replaced (additional engineering required) and only a portion of the existing parking currently used by Montgomery County would need to be replaced. The yard would have nine double-ended storage tracks on the east side of the loop, one open loop track, one wash track and a four bay maintenance facility, with eight work positions located to the west side of the loop. The open track loops to both the storage tracks on the east and the maintenance tracks/wash track on the west. The mainline alignment of the Purple Line runs primarily along the Georgetown Branch right-of-way and allows access to the yard and shop from the east at Lyttonsville Place Bridge or from the west, approximately 500' east of Rock Creek.

2.5.1 Operations

This is the best option from an operations standpoint, as it is the only option with a loop track. Rail vehicles enter and exit the yard from two points off the main, as described above. The two leads curve north and continue under a proposed structure at Brookville Road. A double crossover between the two leads allows rail vehicles from either direction to enter the storage yard to the east or the wash track and maintenance shop to the west. If the vehicle enters the wash track, it may then proceed around the loop to the storage yard on the east side without reversing directions. Vehicles may travel from any track in the storage yard to any track in the shop without changing directions. Vehicles would exit the storage yard from either end and proceed east or west on the appropriate lead to the mains. There would be room on the open/runaround track for 600' of tangent test track. Access to the shop for deliveries would be off the access road used by Montgomery County at the west end of Brookville Road.

2.5.2 Parking

Parking is provided with a canopy over the storage yard and access is off Brookville Road. Workers and visitors will be able to access the shop/offices via stairs and/or elevators from the canopy. The canopy is designed to handle 300 spaces, which will provide enough parking for Purple Line employees and a portion of the Montgomery County employees. Spaces on the parking canopy for Montgomery County employees are necessary due to the acquisition of half of their existing parking lot.

Alternate parking options could be developed for this option.

2.5.3 Right-of-Way Impacts

As a result of the North of Brookville layout, there will be 7 total property acquisitions and 17 partial property acquisitions. These acquisitions would significantly reduce the available light industrial property in the area. The County was opposed to this impact to the light industrial property. This would result in a facility of approximately 28.6 acres, predominantly north of Brookville Road, in the industrial area. There are three large radio towers in this area that will need to be removed or relocated. There would not be any acquisitions on the south side of Brookville Road, between Lyttonsville Place and Stewart Avenue. This would allow for redevelopment along the south side of Brookville Road.

2.5.4 ROW Costs

Total property acquisition and relocation costs = $89,000,000.

2.5.5 Community Outreach

The North of Brookville Option keeps the Yard and Shop north of Brookville Road reducing impacts to the communities, however there would be a large impact to the commercial and light industrial industry in that area, as well as the removal/relocation of the large radio towers. The station and trail will remain south of the yard making them convenient to the communities. Redevelopment along the majority of Brookville Road will be possible.

3 Community Outreach

There has been extensive community outreach and input into the design of the Lyttonsville Yard. This location was shown on the mapping provided at the public hearings on the AA/DEIS. In addition, the locations have been shown on project mapping, on the project website, and presented at public meetings since that time. Detailed information on the exact yard layout or the specific activities to be performed at each yard was not available at the time of the AA/DEIS. The types of activities typically performed at light rail yards were described, and conceptual layouts were shown, as appropriate. As layouts were developed in more detail, materials were presented at public meetings for review and comment.

The displays at the public hearings in November 2008 showed the outline of the Lyttonsville yard bounded by Brookville Road and the Purple Line from the county maintenance facility to east of Lyttonsville Place. This is approximately the same size and location of the yard included in the Preferred Alternative. Notices for the hearings were sent to the project mailing list of over 60,000 names, and advertisements were published in local newspapers. Materials from the hearings, including the mapping showing the yard, were posted on the project website.

Since the public hearings, there has been extensive outreach in the Lyttonsville area. The proposed yard is adjacent to the Lyttonsville station, and there is an active community and Neighborhood Work Group. MTA presented information on the alignment, station, and proposed yard and shop at a community meeting in February 2009. At that time, data showed the need to expand the yard, and future storage tracks were shown extending further east of Lyttonsville Place. This expansion would have resulted in an increase in potential business displacements as compared to the AA/DEIS. Similar mapping was shown at a Community Focus Group meeting in October 2009. The Locally Preferred Alternative included a yard at Lyttonsville, and mapping of the LPA showed the expanded yard east of Lyttonsville Place. In order to address the increased fleet size, updated design criteria, and operational issues within the yard, a design option was developed. The LPA and design option were presented to the community at a Neighborhood Work Group Meeting in September 2011. The community was concerned with the expanded size of the yard, the increase in potential business displacements, and the encroachment into the residential areas. In order to provide an additional opportunity for review and comment, an additional Neighborhood Work Group meeting was held in October of 2011. MTA recorded the community's concerns and committed to looking at options that would reduce impacts and push the bulk of the yard west of Lyttonsville Place similar to the configuration shown in the AA/DEIS. At the invitation of the community, members of MTA's Purple Line team toured Lyttonsville with community representatives in December 2011 to further understand the history of the community and their concerns.

MTA developed a refined configuration in response to community concerns and presented it at a Neighborhood Work Group meeting in March 2012. The refined configuration encroached on the WSSC property and required a shift in the end of Brookville Road. This, as well as the need for parking, resulted in potential business displacements on the north side of Brookville Road. However, the yard did not extend further east of Lyttonsville Place than what was shown in the AA/DEIS, it did not encroach into the residential area, it reduced the number of potential business displacements, and it preserved the land along Brookville Road for future redevelopment. The refinement received overwhelming community support and residents were pleased that MTA responded to their concerns. The MTA also committed to continue to look for opportunities to further reduce impacts.

4 Site Evaluation

4.1.1 Considerations

<u>Items considered</u>: The major items considered to determine the preferred track design and site layout for the Lyttonsville Yard and Shop were the operational functionality of the yard, parking, ROW costs and community concerns as described above. Other items considered were storage capacity, amount of earthwork, environmental impacts, station and trail location, traffic, and storm water management.

4.1.2 West of Lyttonsville Place Option – Summary and Cost Analysis

Criteria	Alternatives				
	LPA Design Option - Parking Garage	LPA Design Option - Parking Canopy	West of Lyttonsville Place	WSSC	North of Brookville Rd
OPERATIONS					
LRV Storage Capacity	Met	Met	Met	Met	Met
Operating Efficiency	Better	Better	Good	Good	Best
Surface Vehicle Accessibility	Met	Met	Met	Met	Met
PARKING					
Passenger Vehicle Storage Capacity	Met	Met	Met	Met	Met
Parking Cost	Average	Average	Average	Average	Low
Parking Structure Covers Yard	No	Yes	No	Yes	Yes
ROW IMPACTS					
Total Site Acreage	13.1	13.1	12.8	13.3	28.6
Number of properties affected	33	33	20	17	24
ROW Cost					
ROW Cost	$38,000,000	$38,000,000	$33,725,000	$38,500,000	$89,000,000
Community					
Redevelopment Potential Along Brookville Road	Northside only	Northside only	Partial Northside, Partial Southside	Northside, Partial Southside	Partial Northside, Partial Southside
Adjacent to residential	Yes	Yes	Partially	Partially	No

5 Lyttonsville Yard & Shop Recommendations

5.1 West of Lyttonsville Place Option

5.1.1 Investigation

The West of Lyttonsville Option was retained for consideration because the operational functionality was adequate, the ROW costs were low, the construction costs were low and the community accepted this option with open arms. This option turned out to be the least expensive option overall and satisfied the community's concerns. The only option with better operational functionality was North of Brookville which was the considered undesirable due to the extremely high ROW costs, high construction costs and relatively high loss of industrial land in Montgomery County.

The West of Lyttonsville Place option was retained for consideration for many key reasons. From an operational standpoint, the yard met all the necessary components for functionality. Additionally, it maintained the smallest footprint. A number of essential community concerns were also addressed. The shop was moved from the east side of Lyttonsville Place to the west side, as the name suggests. This quelled the community's concern about the shop building's proximity to the adjacent neighborhoods. This also addressed Montgomery County's request to redevelop businesses on the south side of Brookville Road to the east of Lyttonsville Place, which was not a possibility when the LPA Design Option was originally presented. Moving the shop to the west also allowed it to be flanked by industrial and commercial properties, which was a more appropriate setting for such a building from the community's perspective.

The other 3 options could not be retained due to critical flaws. Although the LPA Design option met all of the basic needs for a yard and shop, the issue of redevelopment on the south side of Brookville Road and the proximity of the primary shop building to the neighboring communities were unappealing to Montgomery County. The WSSC option also met the primary needs for a yard and shop; however, the prospect of displacing a facility that is the backbone for county-wide maintenance operations was too risky and expensive. Additionally, while the North of Brookville Road option exceeded the requirements for yard and shop function, the ROW impacts, commercial and industrial business displacements, large footprint and cost made it an undesirable option.

The West of Lyttonsville Place option addressed all of the critical flaws above and, in many cases, enhanced the relationship between the yard and shop facility, Montgomery County and the surrounding community regarding these issues.

6 Further Refinements

At the time of the AA/DEIS and in the early evaluation of the Lyttonsville options, it was envisioned that approximately half the fleet would be stored in each of the two locations (Lyttonsville and Glenridge), and the maintenance and operations activities would be split. However, this arrangement resulted in some redundant activities as certain functions (car wash, interior cleaning, daily servicing, etc.) would have to be located at each site. Maintenance buildings were required at each location with associated materials storage, locker rooms, training/break rooms, and other employee services. A more detailed assessment of the overall storage and maintenance functions has resulted in a proposed re-programming of the two sites. The locations remain the same; however, the current proposal redistributes the functions to allow for better efficiencies, less redundancies, and reduced impacts. This re-programming results in the Lyttonsville site being used primarily for storage, daily cleaning/servicing, and the operations center. The Glenridge site would be used primarily for maintenance activities.

The current option is a modified version of the West of Lyttonsville Place option without the shop. By eliminating the shop from the Lyttonsville Yard, the LRV capacity was able to be increased to 55 100' long spaces and was redesigned to fit in a smaller area. In the West of Lyttonsville Place" option Brookville Road was to be relocated approximately 125' north, however under the current option Brookville Road predominantly remains where it is now with some improvements. The current option eliminates any property acquisition north of Brookville Road. The current design includes the wash track, wash building and a track reserved for MOW equipment. There is also adequate space for vehicles to be tested within the yard.

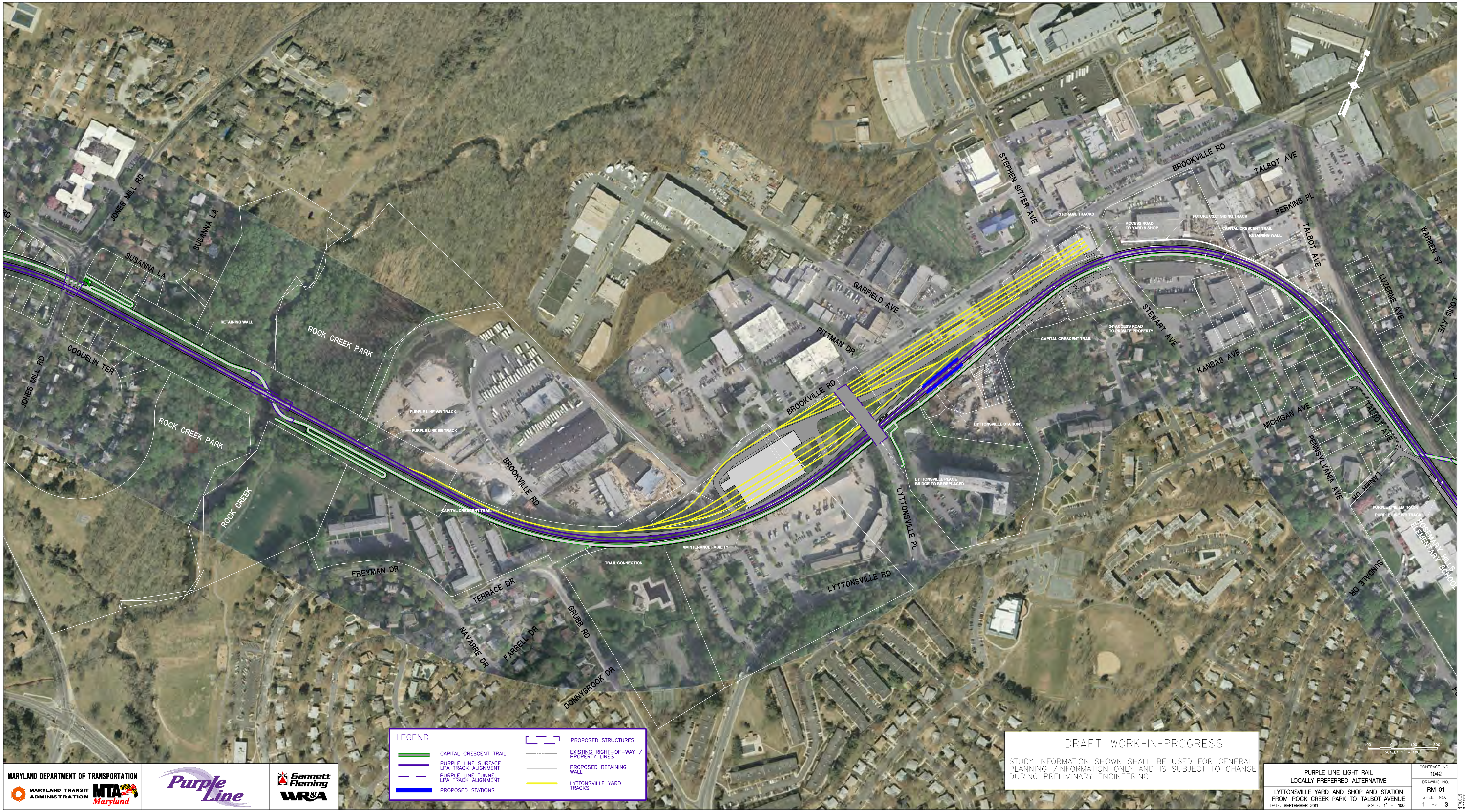
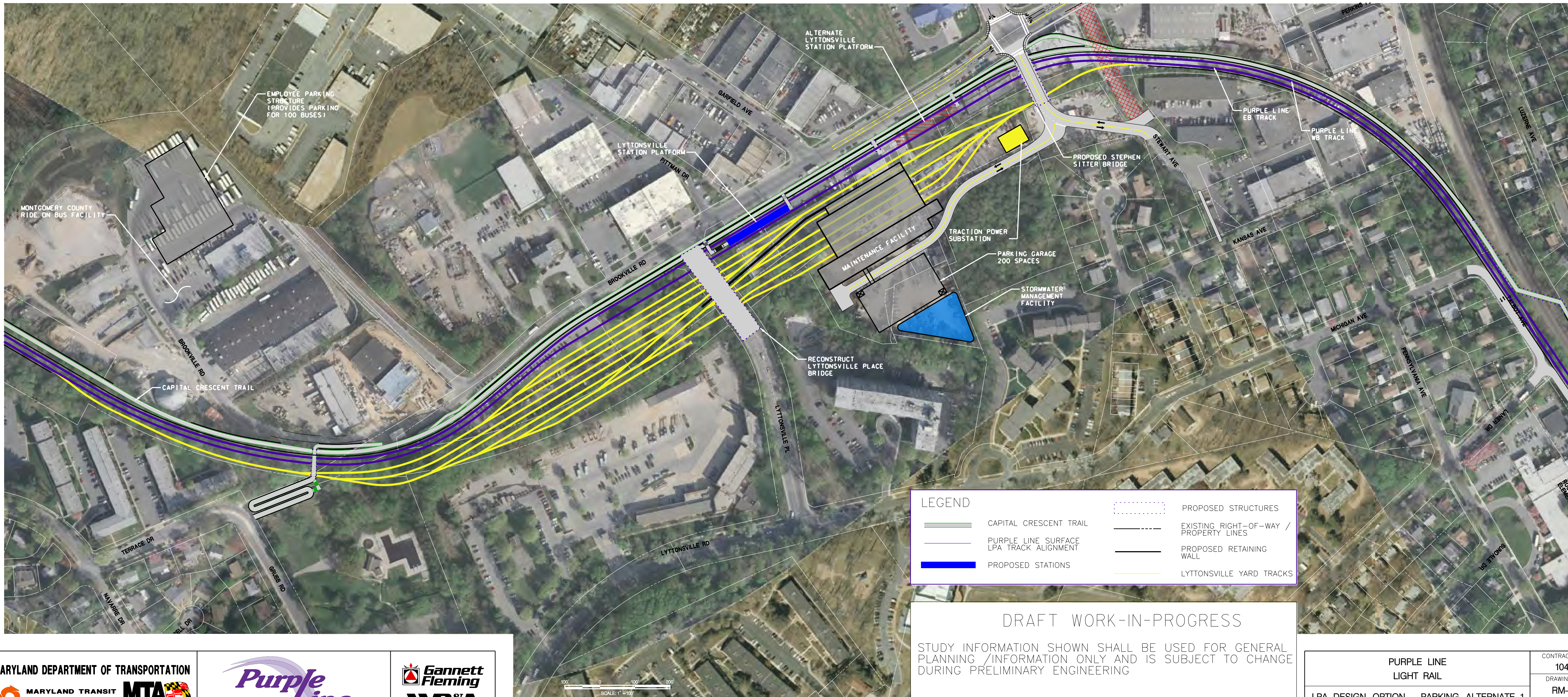

JONES MILL RD
SUSANNA LA
RETAINING WALL
ROCK CREEK PARK
COQUELIN TER
ROCK CREEK
PURPLE LINE WB TRACK
PURPLE LINE EB TRACK
BROOKVILLE RD
CAPITAL CRESCENT TRAIL
FREYMAN DR
TERRACE DR
NAVARRE DR
FARRELL DR
GRUBB RD
DONNYBROOK DR
TRAIL CONNECTION
MAINTENANCE FACILITY
LYTTONSVILLE RD
LYTTONSVILLE PL
LYTTONSVILLE STATION
GARFIELD AVE
PITTMAN DR
STEPHEN SITTER AVE
STORAGE TRACKS
ACCESS ROAD TO YARD & SHOP
STEWART AVE
KANSAS AVE
MICHIGAN AVE
PENNSYLVANIA AVE
BROOKVILLE RD
TALBOT AVE
PERKINS PL
WARREN ST
LUZERNE AVE
LANIER DR
SUNDALE DR
LEGEND
CAPITAL CRESCENT TRAIL
PURPLE LINE SURFACE LPA TRACK ALIGNMENT
PURPLE LINE TUNNEL LPA TRACK ALIGNMENT
PROPOSED STATIONS
PROPOSED STRUCTURES
EXISTING RIGHT-OF-WAY / PROPERTY LINES
PROPOSED RETAINING WALL
LYTTONSVILLE YARD TRACKS
DRAFT WORK-IN-PROGRESS
STUDY INFORMATION SHOWN SHALL BE USED FOR GENERAL PLANNING /INFORMATION ONLY AND IS SUBJECT TO CHANGE DURING PRELIMINARY ENGINEERING
SCALE: 1" = 100'
MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION
MTA Maryland
Purple Line
Gannett Fleming
WR&A
PURPLE LINE LIGHT RAIL
LOCALLY PREFERRED ALTERNATIVE
LYTTONSVILLE YARD AND SHOP AND STATION FROM ROCK CREEK PARK TO TALBOT AVENUE
DATE: SEPTEMBER 2011
SCALE: 1" = 100'
CONTRACT NO. 1042
DRAWING NO. RM-01
SHEET NO. 1 OF 3

Figure A1



LEGEND

CAPITAL CRESCENT TRAIL	PROPOSED STRUCTURES
PURPLE LINE SURFACE LPA TRACK ALIGNMENT	EXISTING RIGHT-OF-WAY / PROPERTY LINES
PROPOSED STATIONS	PROPOSED RETAINING WALL
	LYTTONSVILLE YARD TRACKS

DRAFT WORK-IN-PROGRESS

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MARYLAND TRANSIT ADMINISTRATION — MTA Maryland

Purple Line

Gannett Fleming — WR&A

PURPLE LINE
LIGHT RAIL

LPA DESIGN OPTION – PARKING ALTERNATE 1

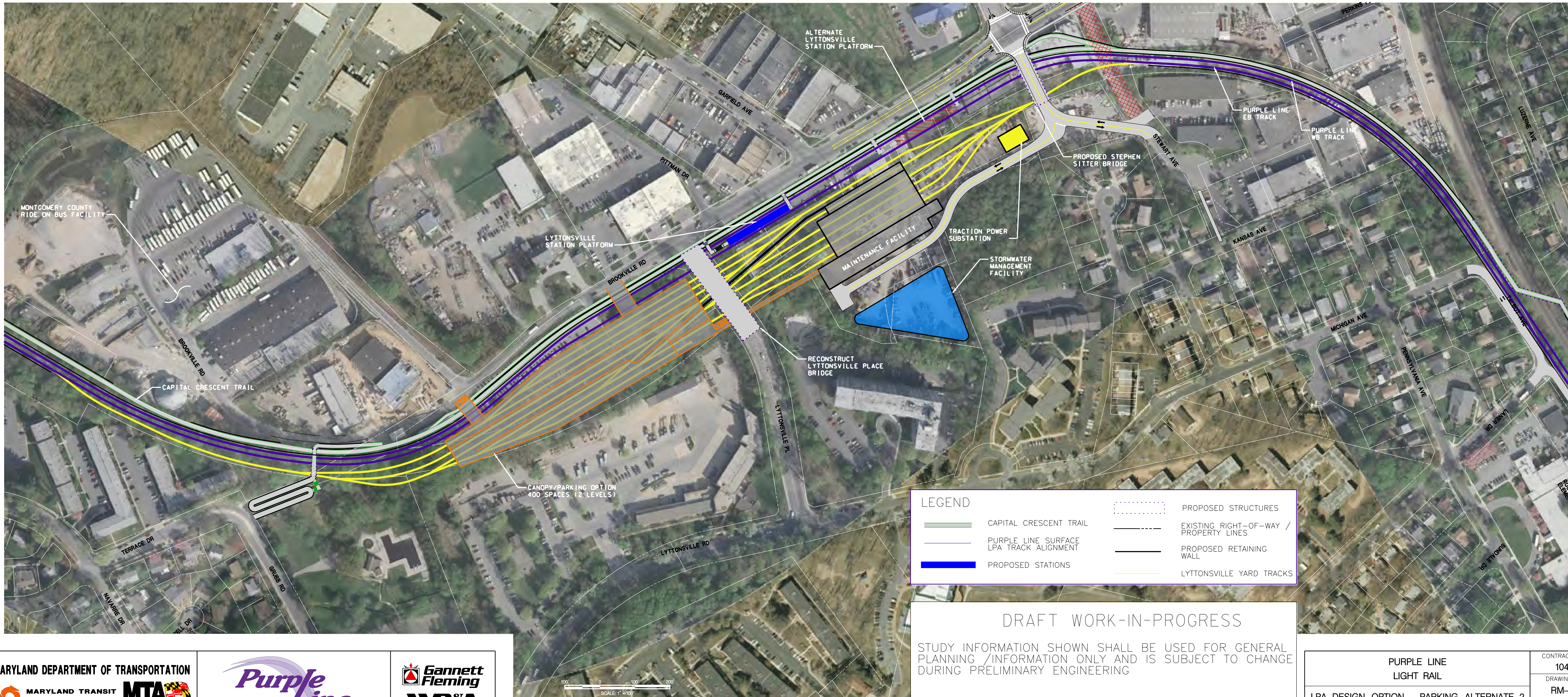
DATE: JANUARY 2012 | SCALE: AS SHOWN

CONTRACT NO. 1042

DRAWING NO. RM-01

SHEET NO. 1 OF 6

Figure A2



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Purple Line

Gannett Fleming WR&A

PURPLE LINE LIGHT RAIL	CONTRACT NO. 1042
LPA DESIGN OPTION – PARKING ALTERNATE 2	DRAWING NO. RM-02
DATE: JANUARY 2012 SCALE: AS SHOWN	SHEET NO. 2 OF 6

Figure A3

LEGEND

	CAPITAL CRESCENT TRAIL		PROPOSED STRUCTURES
	PURPLE LINE SURFACE LPA TRACK ALIGNMENT		EXISTING RIGHT-OF-WAY / PROPERTY LINES
	PROPOSED STATIONS		PROPOSED RETAINING WALL
			LYTTONSVILLE YARD TRACKS

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MTA Maryland

Purple Line

Gannett Fleming
WR&A

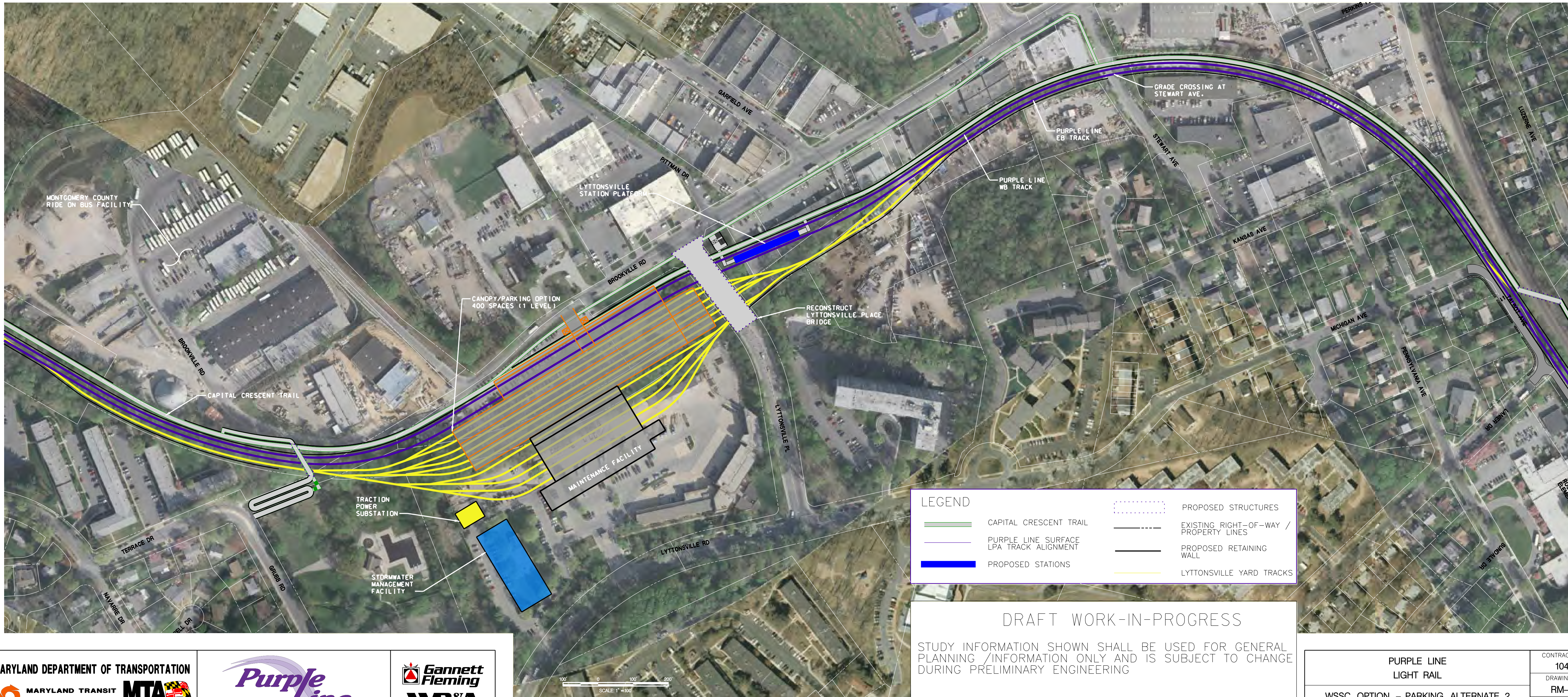
PURPLE LINE
LIGHT RAIL

WEST OF LYTTONSVILLE PLACE

DATE: JANUARY 2012 SCALE: AS SHOWN

CONTRACT NO. 1042
DRAWING NO. RM-06
SHEET NO. 6 OF 6

Figure A4



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WR&A

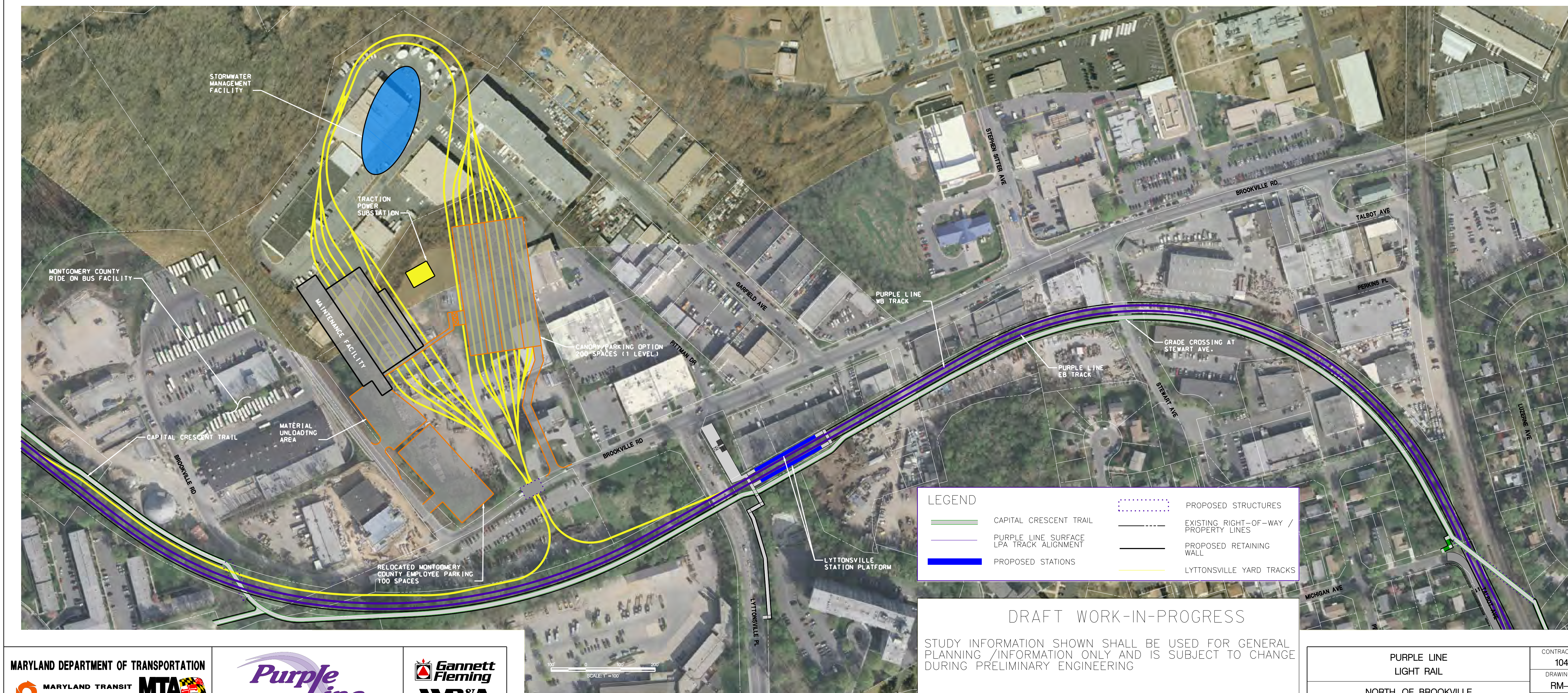
PURPLE LINE
LIGHT RAIL

WSSC OPTION – PARKING ALTERNATE 2

DATE: JANUARY 2012
SCALE: AS SHOWN

CONTRACT NO. 1042
DRAWING NO. RM-04
SHEET NO. 4 OF 6

Figure A5



DRAFT WORK-IN-PROGRESS

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MTA Maryland

Purple Line

Gannett Fleming

WR&A

PURPLE LINE
LIGHT RAIL

NORTH OF BROOKVILLE

DATE: JANUARY 2012 SCALE: AS SHOWN

CONTRACT NO.	1042
DRAWING NO.	RM-05
SHEET NO.	5 OF 6

Figure A6