MD 190 (RIVER ROAD) AT BRAEBURN PARKWAY
Project Impact Report – MDOT SHA

(March 2018) The Maryland Department of Transportation State Highway Administration (MDOT SHA) is dedicated to transparency by showing our data and work products. This cover page document is to provide proper context to the traffic study and the project impact report (PIR) generated. The defined full scope of PIR must be clearly understood to appreciate the information contained within the document as well as to help explain the roadway improvements since 2017 and our current path forward.

Following all fatal crashes on state roadways, the MDOT SHA conducts an internal review of the site. A traffic investigation was completed in response to a February 2016 fatal crash at the MD 190 at Braeburn Parkway intersection. From this assessment, five geometric alternatives were developed for potential enhancements for safe operations of MD 190 near of the intersection with Braeburn Parkway.

Following the initial investigation, MDOT SHA developed a solution to temporarily enhance safety at the existing intersection of MD 190 at Braeburn Parkway. This included increasing lighting at the crosswalk, video detection cameras to activate hazard identification beacons (HIB) for vehicles entering the existing intersection and installing flex posts in the S-shaped configuration. These improvements were constructed in the winter of 2016 and were put into full operation in April 2017. At the request of the Community Delegation, Alternative 5 was further evaluated for the sole purpose of identifying and quantifying project impacts and costs. The defined scope of **Alternative 5 (Figure *A5 & A6*): Relocate intersection to Pyle Road, close existing MD 190/Braeburn intersection, and dead end the west end of Braeburn Parkway, north end of MD 190,** was to relocate a new intersection to Pyle Road and close the existing MD 190/Braeburn intersection. The scope of the attached PIR was limited to this new intersection relocation alternative. No other alternatives were considered in this particular study, just options to the intersection relocation.

The decision-making process in any project effort is based on a combination of current existing conditions, the benefit any improvement would have for all transportation stakeholders, expected safety enhancements from an improvement, evaluating and discussing any unintended consequences to improvements, public feedback and value to the taxpayers of Maryland given needs throughout the state and limits of available resources.

An informational Public meeting is scheduled for Thursday, March 29, 2018 from 7:00pm to 9:00pm at Walt Whitman High School to share design options and obtain feedback from community members and stakeholders. All are encouraged to attend and voice your concerns to MDOT SHA representatives.

June 29, 2017

MEMORANDUM

TO: Ms. Anyesha Mookherjee
Assistant District Engineer – Traffic &

Ms. Erica Rigby
Assistant District Engineer – Project Development

FROM: Ms. Claudine Myers
Chief – Engineering Systems Team

BY: Ms. Makeda Drake
Project Manager – District 3 Engineering Systems Team

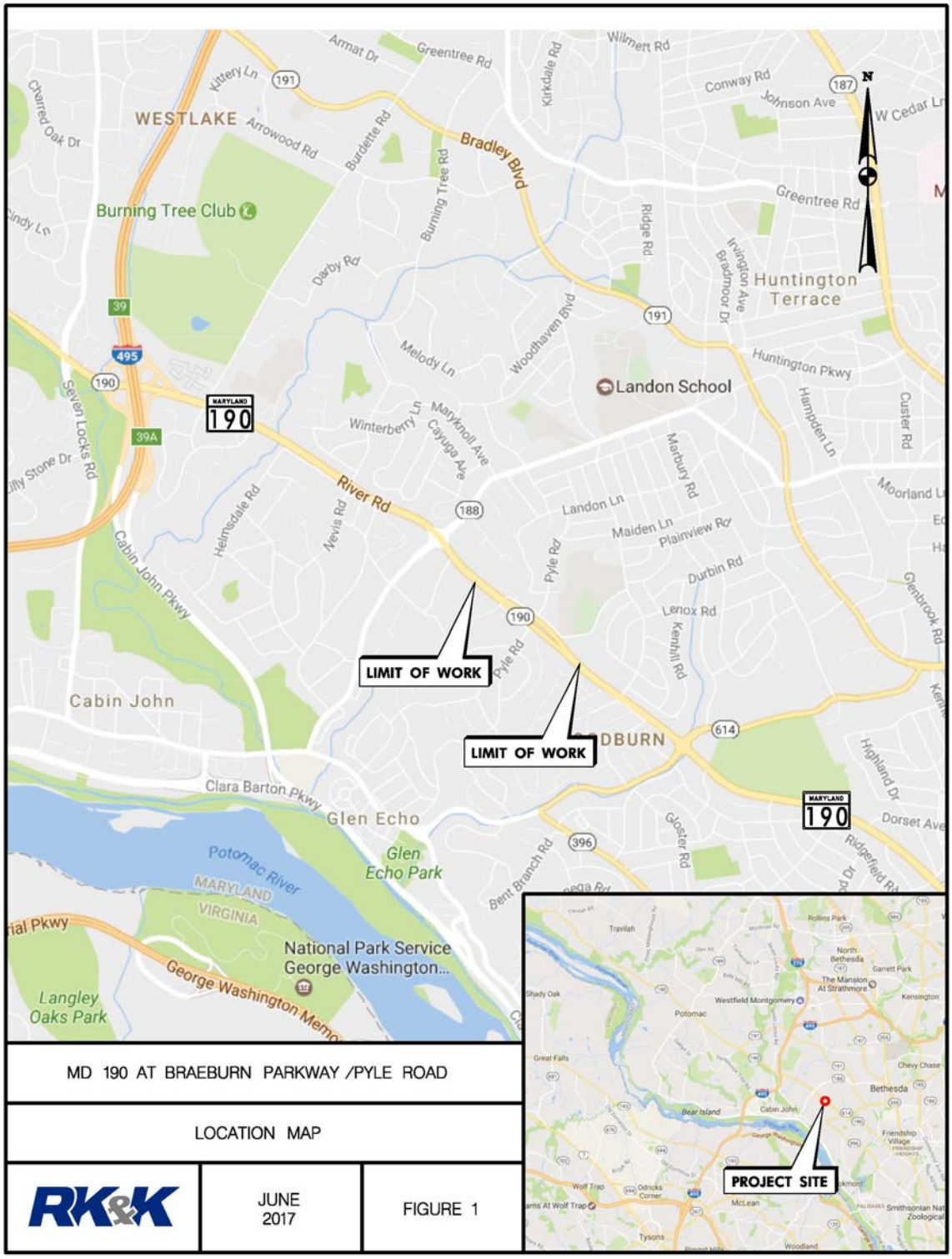
SUBJECT: PE FMIS No. MO981A21
Construction Contract No. MO9815176
Project: MD 190 (River Road) at Braeburn Parkway and Pyle Road Concepts

RE: Project Impact Review Report

PROJECT DESCRIPTION

The purpose of this study is to evaluate geometric alternatives for relocating the intersection of MD 190 (River Road) at Braeburn Parkway to Pyle Road in Montgomery County, MD *(see Figure 1 – Project Location Map)*. The alternatives studied in this Project Impact Review Report include closing the existing intersection at MD 190 at Braeburn Parkway and relocating the intersection 600 feet east at Pyle Road to improve safety for vehicles, cyclists and pedestrians. The new intersection would include a new traffic signal and have full deceleration lanes for left and right turn movements for traffic approaching Pyle Road from eastbound and westbound MD 190. Acceleration lanes will also be provided for right turn movements exiting Pyle Road. The proposed improvements will maintain and upgrade bicycle compatibility on River Road throughout the study limits. This project impact review report/geometric study accompanies the MD 190 (River Road) at Braeburn Parkway/Pyle Road Traffic and Safety Analysis Report (May 2017) located in *Appendix I*.

Improvements are currently being implemented by SHA to improve safety at the existing intersection of MD 190 (River Road) and Braeburn Parkway which include providing new street lighting, active hazard identification beacons, and video detection cameras. These improvements would be removed as a result of relocating the intersection to Pyle Road.


LIMIT OF WORK
LIMIT OF WORK
PROJECT SITE
WESTLAKE
Burning Tree Club
Bradley Blvd
Huntington Terrace
Landon School
River Rd
Cabin John
Glen Echo
Glen Echo Park
Potomac River
MARYLAND
VIRGINIA
National Park Service George Washington...
Langley Oaks Park
George Washington Memo
Clara Barton Pkwy
Cabin John Pkwy
Seven Locks Rd
Greentree Rd
Huntington Pkwy
Pyle Rd
Landon Ln
Maiden Ln
Durbin Rd
Lenox Rd
Plainview Rd
Marbury Rd
Woodhaven Blvd
Ridge Rd
Burning Tree Rd
Darby Rd
Melody Ln
Winterberry Ln
Maryknoll Ave
Cayuga Ave
Helmsdale Rd
Nevis Rd
Kenhill Rd
Glenbrook Rd
Hampden Ln
Custer Rd
Highland Dr
Dorset Ave
Ridgefield Rd
Gloster Rd
Bent Branch Rd
Irvington Ave
Bradmoor Dr
Conway Rd
Johnson Ave
W Cedar Ln
Moorland Ln
Kirkdale Rd
Wilmett Rd
Armat Dr
Kittery Ln
Arrowood Rd
Burdette Rd
Charred Oak Dr
Cindy Ln
Silly Stone Dr
MARYLAND 190
MARYLAND 190
N
MD 190 AT BRAEBURN PARKWAY /PYLE ROAD
LOCATION MAP
JUNE 2017
FIGURE 1

EXISTING CONDITIONS

MD 190 (River Road) is classified as secondary highway, urban other principal arterial with partial access controls and an approximate AADT of 44,600 *(2015 SHA Highway Location Reference – Montgomery County; and Title Sheet/Load Meter Data provided by SHA, December 31, 2015)*. Within the study area, MD 190 is a four lane, divided highway with a posted speed limit of 45 mph. The terrain is the area can be classified as "rolling."

Throughout the project limits, MD 190 consists of four 12-foot lanes, 10-foot outside shoulders with 5' striped bike lanes, 1' inside shoulders, and a variable width grass median. MD 190 eastbound approaching the Braeburn Parkway intersection has an existing 150-foot left and right turn lane. Departing the Braeburn Parkway intersection, MD 190 eastbound has an existing 200-foot acceleration lane. MD 190 westbound approaching the Braeburn Parkway intersection has an existing 100-foot left and right-turn lane. Departing the Braeburn Parkway intersection, MD 190 westbound has an existing 200-foot acceleration lane. The existing outside shoulder width varies with a 1' minimum width at the turn lanes and no bicycle pocket lanes exist.

East of the Braeburn Parkway intersection, the MD 190 eastbound and westbound roadways diverge to form a wide grass median with a maximum width of 120 feet. The grass median contains sidewalk, light poles, utilities, drainage inlets, drainage outfalls, trees and an existing TMDL facility. Approximately 600 feet east of the intersection at Pyle Road, there is an existing sidewalk in the median connecting two uncontrolled marked pedestrian crossings. Adjacent to each pedestrian crossing along eastbound and westbound MD 190, there is a WMATA stop with a 24x10 concrete sidewalk refuge area and a small, free-standing decorative wall. The eastbound and westbound lanes converge at the east end of the study limits, east of Pyle Road, and the median narrows to a 14-foot curbed grass landscaped median.

The pavement composition of MD 190 (River Road) based on as-built drawings is a 1.5-inch asphalt surface, 2-inch asphalt base, 9-inch reinforced Portland cement concrete, 4-inch CR-6 drainage layer and 6-inch cement modified base.

There is one volunteer hedgerow and one planted hedgerow within the MD 190 wide median, and several planted/volunteer hedgerows north and south of MD 190. No forest stands, waters of the U.S., or wetlands exist within the project study area.

Braeburn Parkway and Pyle Road north and south of MD 190 are two lane roads maintained by Montgomery County and categorized as Suburban Roadways *(Montgomery County Road Code Areas developed by the County Council)*. These roads do not have posted speeds; but the speed is assumed to be 25 MPH. Braeburn Parkway west of Pyle Road provides access to nine (9) single family homes and a small townhome community. East of Pyle Road and north of MD 190, Braeburn Parkway serves as a back entrance to Walt Whitman High School. Pyle Road on the north and south side of MD 190 provides access for many local communities.

There is an existing maintenance facility along the eastbound side of MD 190, just east of the uncontrolled marked pedestrian crossing at Pyle Road. The only access point for this facility is off MD 190 eastbound.

Several utilities are located throughout the study limits. These include, but are not limited to overhead electric, cable TV, telephone, utility poles; and underground water, storm sewer, gas, electric, cable TV, telephone, and an unknown utility line. Significant underground utilities include a 24-inch gas line and a 60-inch water line.

Intersection stopping sight distances were evaluated using the latest AASHTO criteria at the existing intersection of MD 190 at Braeburn Parkway. The minimum intersection stopping sight distance of 588 feet for a design speed of 50 MPH is exceeded in the eastbound and westbound directions. Stopping sight distances for the pedestrian crossing were also evaluated which indicated unobstructed view of at least 425 feet is provided meeting the requirements of a 50 MPH design speed. The pedestrian crossing at MD 190 westbound was measured to be 500 feet to the crest of the vertical curve which meets the stopping sight distance for a design speed of 55 MPH.

PREVIOUS AND OTHER CONCURRENT STUDIES

SHA conducted a preliminary intersection improvement study in April 2016 (by Mercado Consultants, Inc.). Five (5) alternates were presented to SHA for consideration:

- Alternate 1 (Figure *A1*): Install a Maryland T at existing MD 190/Braeburn Parkway intersection restricting turning movements.
- Alternate 2 (Figure *A2*): Close off median at existing MD 190/Braeburn Parkway intersection prohibiting all left turning and through movements.
- Alternate 3 (Figure *A3*): Install S-shaped raised monolithic median at existing MD 190/Braeburn Parkway intersection to channelize left turning movements and to prohibit through movements.
- Alternate 4 (Figure *A4*): Shift left turn lanes to channelize left turning movements and to improve sight distance.
- Alternate 5 (Figure *A5 & A6*): Relocate intersection to Pyle Road, close existing MD 190/Braeburn intersection, and dead end the west end of Braeburn Parkway, north end of MD 190.

Alternate concept plans are located in *Appendix A*.

SHA selected Alternate 5 to be further evaluated in this Project Impact Review Report.

SHA also developed a solution to enhance safety at the existing intersection of MD 190 at Braeburn Parkway which includes provided increased lighting at the intersection of Braeburn Parkway and at the existing uncontrolled marked pedestrian crosswalks approximately 600 feet east of the intersection at Pyle Road. Additional safety measures also include adding video detection cameras to activate hazard identification beacons (HIB) for vehicles entering the

existing intersection. The active identification beacons will begin to flash cautioning approaching traffic in the eastbound and westbound directions that a vehicle is in the intersection. Construction is currently underway for these improvements.

PROPOSED CONCEPTS

Two geometric alternatives are proposed based on the selected preliminary Alternate 5 to address the vehicular safety concern at the existing intersection of MD 190 and Braeburn Parkway. Both alternatives upgrade pedestrian safety at the uncontrolled marked pedestrian crossings and upgrade bicycle compatibility throughout the project limits.

Alternative 1 (*Figures B1 – B4*) shifts the eastbound and westbound alignments of MD 190 to bisect the midpoint of the grass median at Pyle Road, creating a new intersection. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walks, bus stops, median and single faced w-beam, sidewalk and curb & gutter are included. Existing pavement is utilized where feasible and storm water management is provided as required. Alternative 1 concept plans are located in *Appendix B*.

Alternative 2 (*Figures C1 – C3*) maintains westbound MD 190 through lanes, shifts the eastbound MD 190 alignment approximately 12 feet into the grass median, includes pavement box widening for the acceleration and deceleration lanes creating a new intersection at Pyle Road. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walk, bus stops, grass median, single face w-beam, sidewalk and curb & gutter are included. Existing pavement is utilized where feasible and storm water management is provided in the grass median as required. Alternative 2 concept plans are located in *Appendix C*.

Alternative 3 (Figures #1 - #4) maintains the westbound MD 190 through lanes, shifts the eastbound MD 190 alignment adjacent to the westbound alignment forming a new intersection with Pyle Road. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walk, bus stops, grass median, single face w-beam, sidewalk and curb & gutter are included. Existing pavement is utilized where feasible and storm water management is provided as required. Alternative 3 concept plans are located in *Appendix D*.

All three alternatives are described below in greater detail.

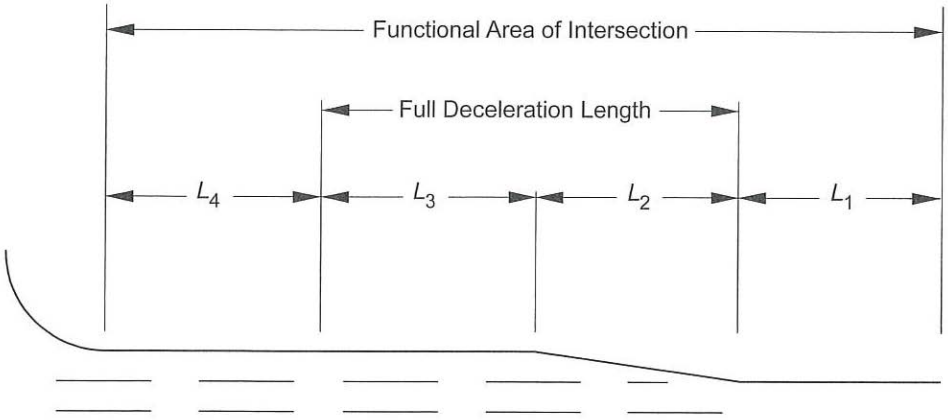
Alternative 1:

The proposed realignment of MD 190 for Alternative 1 begins approximately 600 feet west of the existing intersection with Braeburn Parkway. The existing radius of MD 190 is 1917.86 feet with an existing super elevation of 5.0%. Alternative 1 alignment uses an entry radius of 8,000 feet to shift the eastbound and westbound lanes into the median followed by a reversing curve having a radius of 5,180 feet requiring a super elevation of 2.2%. A new intersection is formed at the apex of the curve with Pyle Road. The 5,180-foot radius is followed by a tangent which

ultimately ties into an existing curve with a radius of 2,864.79 feet and with an existing super elevation rate of 4.0%, approximately 1,600 feet east of the existing intersection.

The proposed typical section east and west of the intersection includes 12-foot travel lanes, 10-foot outside shoulders with a 6-foot striped bike lane, and a 1-foot offset to the median curb. The proposed typical section of the new intersection with Pyle Road consists of 12-foot travel lanes, 12-foot acceleration and deceleration/turn lanes, 6-foot bicycle compatible shoulders, and 5-foot eastbound and westbound pocket bicycle lanes. The new alignment will replace the substandard existing intersection with a new intersection at Pyle Road that includes pocket bicycle lanes, additional storage for the left turn lanes, and a traffic signal. *Figure B5 through B8* located in *Appendix B* depicts the proposed profile for the new alignment. The vertical curve meets a design speed of 55 MPH with a high point at Sta. 122+17 closely matching the existing highpoint of the roadway.

The left and right turn lanes are designed per *AASHTO 2011, Figure 9-48* as shown in this report's *Figure 2.* AASHTO recommends utilizing desirable full deceleration lengths clear of through traffic on arterial roads and streets for left turn lanes where practical. Each lane is comprised of the recommended storage based on the traffic analysis and the full deceleration length which includes a 15:1 taper. The preliminary traffic analysis recommends 250 feet of storage for eastbound left turn lane, 150 feet of storage for westbound left turn lane, and no storage for the right turn lanes. Utilizing Table 9-22 in AASHTO, the desirable full deceleration length for a 50 MPH arterial is 425 feet. Using a 15:1 taper for a 12-foot turn lane, the AASHTO recommended lengths for the left and right turn lanes are shown in *Table 1*.



Notes: L_1 = Distance traveled during perception-reaction time
L_2 = Taper distance to begin deceleration and complete lateral movement
L_3 = Distance traveled to complete deceleration to a stop
L_4 = Storage length

Figure 2 – Components of Deceleration Lane Length
(AASHTO 2011 page 9-126, Figure 9-48)

Alternatives 1 & 2 Turn Lane Lengths			
MD 190 Pyle Rd	Recommended Storage Length (L4)	Full Decel = 425' (50 MPH)	
		Distance to end of Decel (L3)	Taper (15:1) (L2)
EB LT	250 ft.	245 ft.	180 ft.
EB RT	0 ft.	245 ft.	180 ft.
WB LT	150 ft.	245 ft.	180 ft.
WB RT	0 ft.	245 ft.	180 ft.

Table 1

Since MD 190 is categorized as a secondary highway by SHA *(2015 SHA Highway Location Reference – Montgomery County*), the acceleration lanes are designed following the *State Highway Access Manual Engineering Access Permits Division January 2004* manual. Table 13.4.2 Acceleration Lane Warrants for Street Connection Stop-Controlled Right Turn onto Highway on page 70 indicates that a partial acceleration lane is required if the total number of lots served is greater than 12. Pyle Road to the north and to the south of MD 190 serves more than 12 lots, therefore per Table 13.4.2.B on page 71, a minimum length for a partial acceleration lane for a highway at 50 MPH design speed is 360 feet including the taper. Using a 15:1 taper for a 12-foot turn lane, the partial acceleration lane calculations are shown in *Table 2*.

Alternatives 1 & 2 Acceleration Lengths		
MD 190 Accel Lane	Min Partial Accel = 360’	
	Distance to end of partial Accel	Taper
EB	200 ft. (match ex.)	180 ft.
WB	200 ft. (match ex.)	180 ft.

Table 2

Shifting the intersection to Pyle Road includes the closure of the existing intersection at Braeburn Parkway. The north leg of the existing intersection includes pavement removal along Braeburn Parkway and a turnaround area is following Montgomery County Standard No. MC-223.01 to form a dead end. The south leg of the existing intersection includes pavement removal at the existing tie-in of eastbound MD 190 and Braeburn Parkway, forming a ninety degree turn onto Pyle Road heading east towards the new intersection. Single faced w-beam is extended to close off the existing intersection.

Alternative 1 salvages existing pavement along MD 190 eastbound and westbound where possible. Due to the existing composite pavement composition, removing portions of the existing concrete pavement panels can lead to potential pavement failure; therefore, pavement reconstruction is assumed where proposed travel lanes and shoulders are overlapping with existing pavement and not matching the existing roadway configuration.

Intersection sight triangles were evaluated for the relocated intersection and are located in *Appendix E.* Case B1, left turn from a stop at a minor road does not meet AASHTO required sight distance for an unsignalized intersection when turning left from Pyle Road southbound to MD 190 eastbound. The red intersection stopping sight triangle shown on *Figure E1* indicates that 588 feet is required for minor-road left turning vehicle operators. The red vertical profile for the sight triangle for left turning vehicles crossing MD 190 westbound demonstrates that the high point in the roadway obstructs motorists' sight requiring a traffic signal to be installed for the intersection to operate safely. Case B2, right turns from a stop controlled minor road sight triangle is also shown. Per Table 9-8 in *AASHTO 2011*, an intersection sight distance of 480 feet is required for this movement. The blue vertical profile in *Figure E1* confirms right turn sight distance can be met and right turns on red are permissible.

Alternative 1 is anticipated to avoid impact to the 24-inch gas line, 60-inch waterline, and overhead electric and telephone lines. The clearance of the new intersection needs to be verified with the sag of the overhead electric and telephone lines to confirm there are no impacts. A new traffic signal will be required at the intersection of MD 190 and Pyle Road.

Alternative 2:

The proposed improvements of MD 190 for Alternative 2 are limited to pavement box widening off the existing alignments for eastbound and west bound MD 190 forming a new intersection with Pyle Road and slightly reducing the width of the grass median. Eastbound MD 190 utilizes reversing curves using a radius of 8,000 feet to limit the box widening into the median. MD 190 eastbound is higher than Pyle Road and MD 190 eastbound pavement widening towards the south will prohibit the necessary drainage ditch design between the two roadways.

The typical section for Alternative 2 is similar to Alternative 1, except Alternative 2 maintains the existing large grass median in lieu of utilizing a concrete monolithic median at the intersection. The new alignment will improve the existing substandard geometry of the intersection with Braeburn Parkway with a new intersection with Pyle Road that includes pocket bicycle lanes, additional storage for the left turn lanes, and a traffic signal. Alternative 2 follows the existing composite roadway pavement configuration of MD 190 eastbound and westbound. Utilizing the existing lane configuration of MD 190 will maintain the integrity of the roadway by not removing portions of the existing concrete panels. This approach will simplify maintenance of traffic (MOT) operations and reducing pavement reconstruction. However, the newly developed intersection forms short connections with Braeburn Parkway and Pyle Road minimizing storage and resulting in more difficult turning movements compared to Alternative 1. A comparison of Autoturn movements utilizing a school bus are shown in *Figure E2 & E3* located in *Appendix E*.

Similar to Alternative 1, shifting the intersection to Pyle Road includes the closure of the existing intersection at Braeburn Parkway. The north leg of the existing intersection includes pavement removal along Braeburn Parkway and a turnaround area is following Montgomery County Standard No. MC-223.01 to form a dead end. The south leg of the existing intersection includes pavement removal at the existing tie-in of eastbound MD 190 and Braeburn Parkway, forming a

ninety degree turn onto Pyle Road heading east towards the new intersection. Single faced w-beam is extended to close off the existing intersection.

Alternative 2 is anticipated to avoid impact to the 24-inch gas line, 60-inch waterline, and overhead electric and telephone lines. The clearance of the new intersection needs to be verified with the sag of the overhead electric and telephone lines to confirm there are no impacts. A new traffic signal will be required at the intersection of MD 190 and Pyle Road.

Alternative 3:

The proposed improvements of MD 190 for Alternative 3 are similar to Alternative 2 where the MD 190 westbound lanes are maintained on the existing alignment and the acceleration and deceleration lanes are formed by pavement box widening to the north. The MD 190 eastbound lanes are shifted into the median with a 3,020-foot radius, then follow the existing MD 190 westbound alignment with an 1,889.86-foot radius forming a new intersection with Pyle Road.

As with Alternative 1, the typical section for Alternative 3 will contain a concrete monolithic median separating the eastbound and westbound roadways. A new intersection is proposed at Pyle Road that will include pocket bicycle lanes, additional storage for the left turn lanes, and a traffic signal creating a more traditional intersection compared to the existing intersection at Braeburn Parkway. The proposed horizontal alignment of Alternative 3 will follow the existing westbound MD 190 alignment and allow the reuse of the existing pavement and lane configuration roadway. This alternative will maintain the integrity of the pavement for the westbound roadway by not removing portions of the existing concrete panels. Similar to Alternative 2, the newly developed intersection forms a short connection with Braeburn Parkway minimizing storage and resulting in more difficult turning movements compared to Alternative 1. A comparison of Autoturn movements utilizing a school bus are shown in *Figure E2* through *Figure E4* located in *Appendix E*.

Similar to Alternative 1 and 2, shifting the intersection to Pyle Road includes the closure of the existing intersection at Braeburn Parkway. The north leg of the existing intersection includes pavement removal along Braeburn Parkway and a turnaround area is following Montgomery County Standard No. MC-223.01 to form a dead end. The south leg of the existing intersection includes pavement removal at the existing tie-in of eastbound MD 190 and Braeburn Parkway, forming a ninety degree turn onto Pyle Road heading east towards the new intersection. Single faced w-beam is extended to close off the existing intersection.

Alternative 2 is anticipated to avoid impact to the 24-inch gas line, 60-inch waterline, and overhead electric and telephone lines. The clearance of the new intersection needs to be verified with the sag of the overhead electric and telephone lines to confirm there are no impacts. A new traffic signal will be required at the intersection of MD 190 and Pyle Road.

PROPOSED TYPICAL SECTIONS

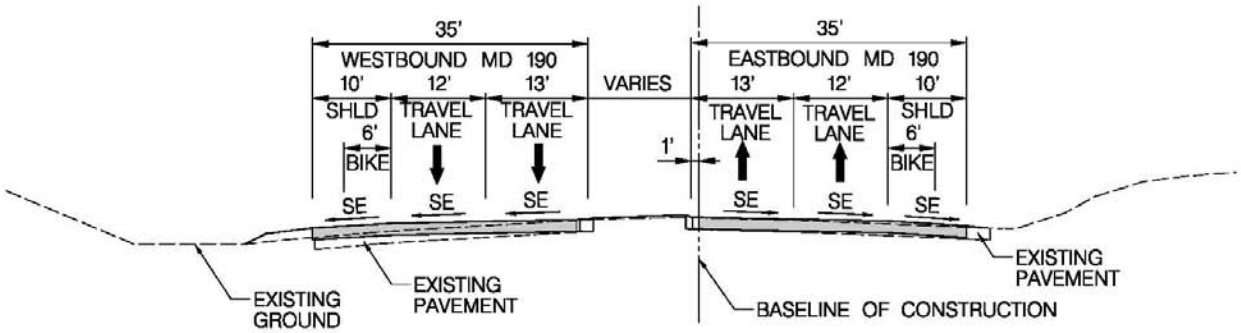


Figure 3: Alternative 1 – MD 190 East and West of Intersection with Pyle Road

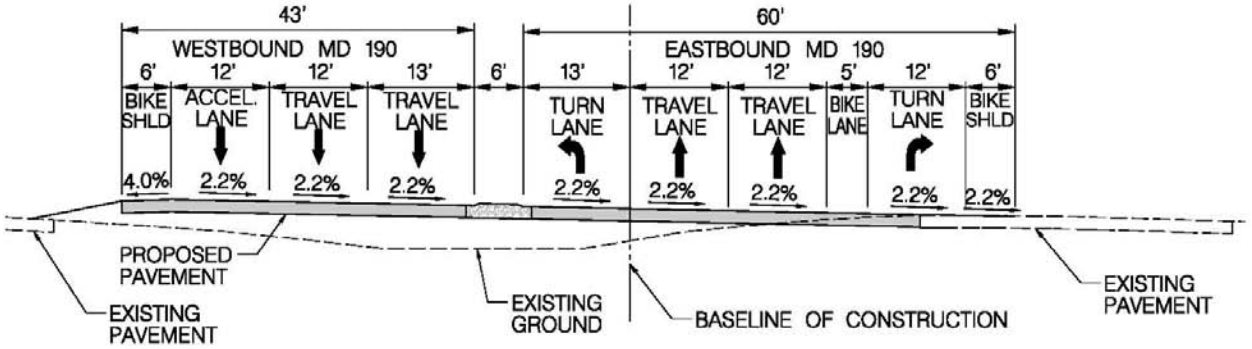


Figure 4: Alternative 1 - MD 190 Intersection West of Pyle Road

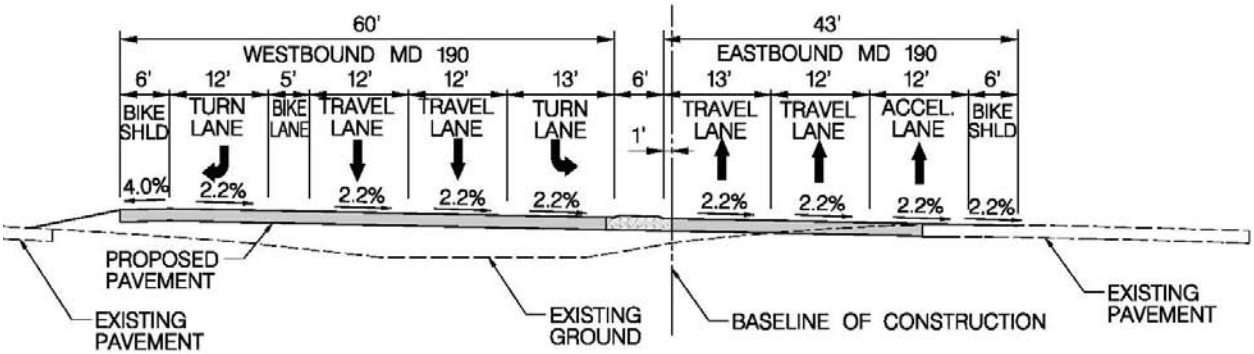


Figure 5: Alternative 1 - MD 190 Intersection East of Pyle Road

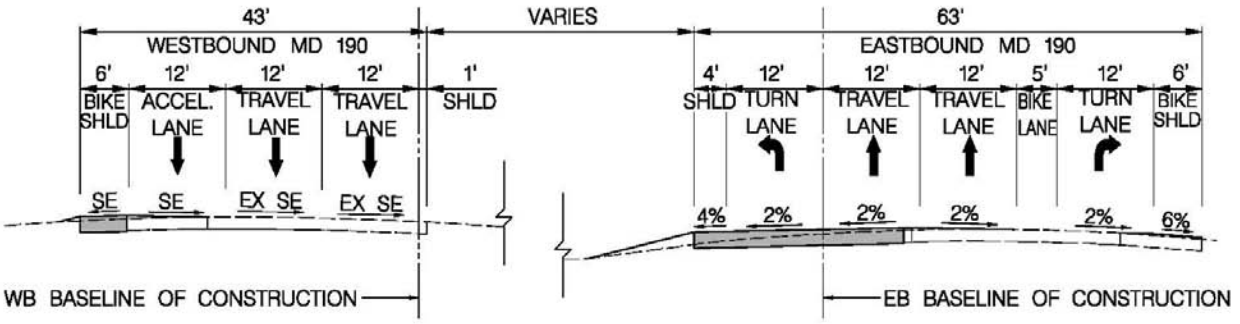


Figure 6: Alternative 2 - MD 190 Intersection West of Pyle Road

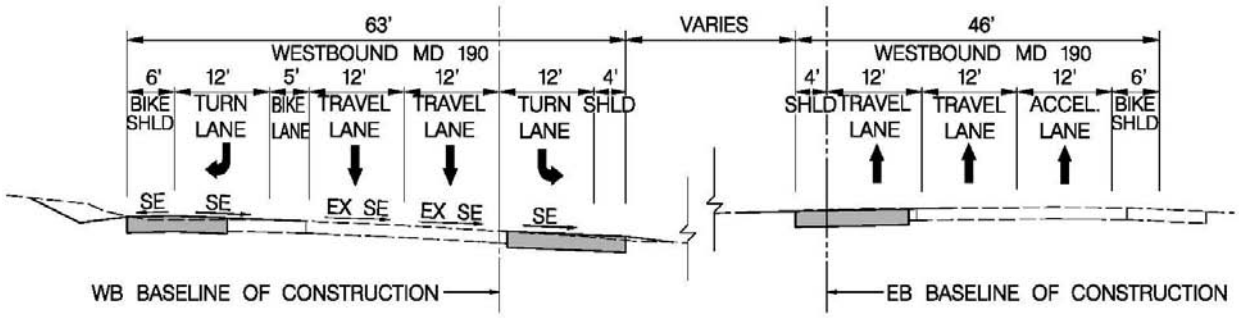


Figure 7: Alternative 2 - MD 190 Intersection East of Pyle Road

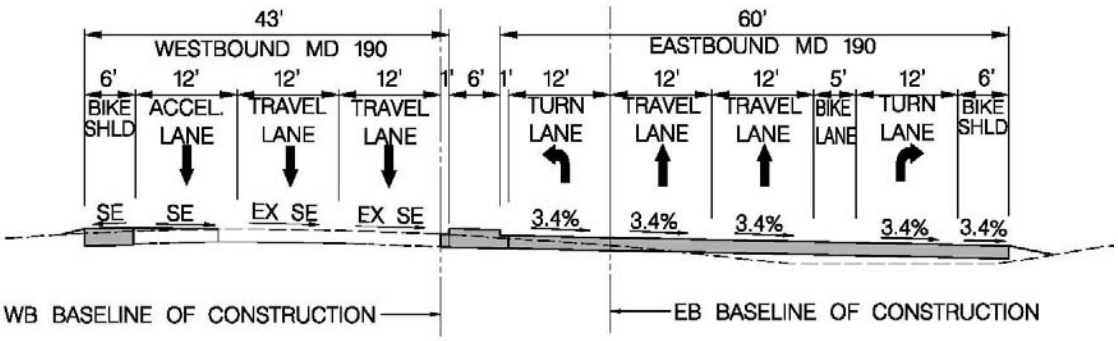


Figure 8: Alternative 3 - MD 190 Intersection West of Pyle Road

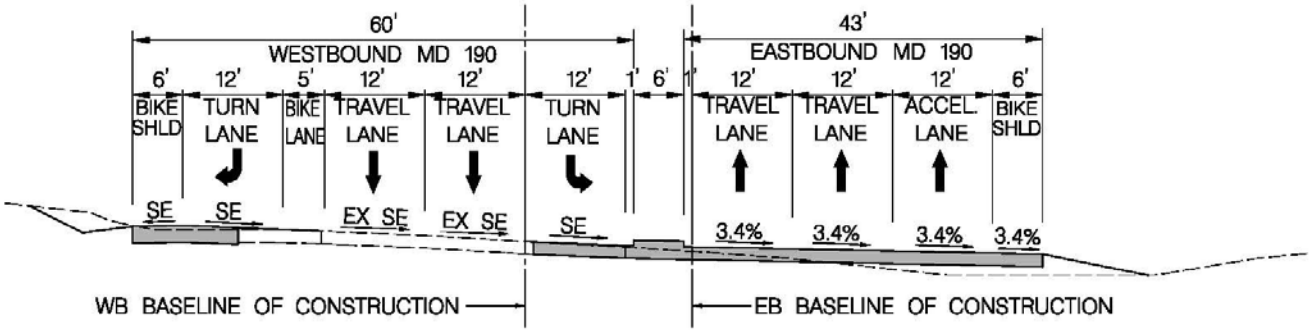


Figure 9: Alternative 3 - MD 190 Intersection East of Pyle Road

Posted Speed – 45 MPH
Design Speed – 50 MPH
Maximum Grades – up to 6% (Table 7-21 AASHTO 2011 - Rolling Arterial)
Maximum Superelevation – 6%
Lanes – 12-foot through lanes
12-foot left and right turn lanes
12-foot acceleration lane
5-foot (pocket) bike lanes along MD 190
Shoulders – 10' & 6' bicycle compatible shoulders (5' striped bicycle lane included in 10' shoulder)

PROGRAM DATA/FUNCTIONAL CLASIFICATION

The proposed MD 190 at Pyle Road intersection study is a Fund 76 (Safety/Spot Improvements) in Montgomery County. It is not on the NHS and does not appear in the draft 2015-2020 Consolidated Transportation Program. The project is currently funded for concept development only and is not Federally funded.

COST ESTIMATES

A preliminary major quantities estimate was prepared based on the proposed concept alternatives using the SHA Cost Estimating Manual. The estimated cost, including 35% contingency and 14.4% overhead, for each alternative is shown in *Table 3*. There are no estimated ROW and Construction Easement costs. A detailed cost estimate for each alternative is located in *Appendix H*.

Alternative	Construction Cost ($)
1	$8,900,000
2	$4,300,000
3	$7,800,000

Table 3

PROPOSED SCHEDULE

TBD

COMPLIANCE WITH AASHTO/SHA DESIGN GUIDELINES & POLICIES

The design criteria for this study is based on AASHTO's *Policy for Geometric Design of Highways and Streets – 2011*, using a design speed of 50 MPH (posted speed 45 MPH). The Roadway Classification for MD 190 is urban other principal arterial. A maximum superelevation of 6% is used and the terrain is considered rolling.

The proposed horizontal and vertical alignment meets a design speed of 50 MPH through the proposed limits of work. The intersection sight distance for left turns from Pyle Road to MD 190 eastbound does not meet AASHTO criteria if a signal is not installed.

Deceleration lanes meet AASHTO's *Policy for Geometric Design of Highways and Streets – 2011* and acceleration lanes meet *State Highway Access Manual Engineering Access Permits Division January 2004.*

The proposed constructed intersection utilizes Type C monolithic median and Type C curb based on the assumed design speed of 50 MPH. The existing curb throughout the study limits is Type A curb and does not conform to the recommended curb type as stated on SHA MD STD 620.02.

Practical Design considerations, based on *Maryland Department of Transportation Practical Design Policy Manual,* could include design speed reduction to 45 MPH matching the posted speed limit. Applying this design speed reduction would modify the following aspects of the project:

- Reduce clear zone to 20 feet. W beam requirements would remain unchanged.
- The total deceleration length for the proposed deceleration lanes could be reduced from 425 feet to 350 feet resulting in cost savings of full depth pavement and fewer project impacts.
- Type A curb could be used matching the existing condition.

PEDESTRIAN/ADA/BICYCLE ISSUES

This study proposes upgrades to the existing bicycle facilities by introducing 5-foot bicycle pocket lanes at right turn lanes, increasing the 5-foot bike lane to a 6-foot bike lane, and introduces 6-foot bicycle compatible shoulders adjacent to acceleration and deceleration lanes. Providing these features brings the proposed intersection into compliance with SHA's *Bicycle Policy and Design Guidelines (Revised January 2015).*

This study maintains pedestrian access and ADA compatibility by replacing existing ADA ramps and sidewalk connections from neighborhoods to the bus stops, across MD 190, and to Walt Whitman High School. Providing a traffic signal enhances pedestrian safety crossing MD 190.

TRAFFIC BARRIER

A clear zone of 22' for a roadway with a design speed of 50 MPH is assumed for this study based on *AASHTO Roadside Design Guide 4th Edition 2011*. Alternatives 1 and 3 of this study narrow the median and requires double face median barrier w-beam for the full length of the improvements.

There is a deep ditch with steep slopes located at the NW corner of the existing intersection at MD 190 at Braeburn Parkway. W-beam is required at this location for all the alternatives.

The double face median barrier w-beam ties into single face median barrier at the east end of the project which continues to the next intersection (Winston Drive). Per the *AASHTO Roadside Design Guide 4th Edition 2011*, this single face w-beam should be double face median barrier. The cost estimate for each alternative includes the upgrade to double face median barrier w-beam.

NEPA/ENVIRONMENTAL APPROVAL STATUS

Approval of an environmental document (type to be determined) will be necessary so that this project can progress beyond Preliminary Investigation.

PERMIT/APPROVALS

Required	Permit/Approval	Comments/Status
Y ☐ N ☒	Reforestation Law – Approval	
Y ☒ N ☐	Roadside Tree Permit	
Y ☐ N ☒	Forest Conservation Act Permit	
Y ☒ N ☐	SWM/E&S Control Permit	SHA-PRD approval will be required.
Y ☒ N ☐	NPDES General Permit for Construction activity	
Y ☐ N ☒	Joint Permit Application (JPA)	No potential wetlands or waterways within study area
Y ☐ N ☒	Individual Permit Application (IPA)	
Y ☐ N ☒	General Waterway Construction Permit (GWCP)	No waterway involvement.
Y ☐ N ☒	State Letter of Authorization (SLOA)	No flood plain or buffer impacts
Y ☐ N ☒	U.S. Coast Guard Permit (Bridge Hydraulic Div. would apply)	No waterway involvement.
Y ☐ N ☒	Change/alteration to easement; property permit	

HISTORIC AND CULTURAL RESOURCES

Not included in this study.

WETLAND AND STREAM IMPACTS

A desktop investigation of mapped wetlands, waterways, and floodplains was conducted prior to the preliminary field investigation. Several published reference maps were reviewed to determine the likelihood of federal or state jurisdictional wetlands or waters within the project study area, including the *National Wetlands Inventory*, *Maryland DNR Wetland Inventory*, *USDA Soil Survey*, *Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM)*, and the *USGS Topographic Survey*. No wetlands, waters of the U.S. or 100-Year FEMA floodplains were identified within the study area based on these sources. One hydric soil unit (6A: Baile silt loam) was identified within the study area, near the intersection of Braeburn Parkway and MD 190, according to the *USDA Soil Survey*.

A preliminary wetlands and waters field investigation was conducted on December 9, 2016 to approximate the limits of Waters of the U.S. and wetlands, within the project study area. No waters of the U.S. or wetlands were identified within the study area during the preliminary field investigation.

FOREST & ROADSIDE TREE IMPACTS

A preliminary walkthrough forest stand analysis was conducted on December 9, 2016 to characterize and approximate the limits of forest stands and hedgerows within the project study area. Five volunteer hedgerows and three planted hedgerows were identified within the project study area. No forest stands were identified within the project corridor.

One volunteer hedgerow (H3) and one planted (H8) were identified within the MD 190 median. Hedgerow 3 (H3) is a mid-successional volunteer hedgerow dominated by tulip poplar (*Liriodendron tulipifera*) and pin oak (*Quercus palustris*). The understory is dominated by multiflora rose (*rosa multiflora*) and bush honeysuckle (*Lonicera maackii*); and the herbaceous layer consists of Japanese honeysuckle (*Lonicera japonica*) and English ivy (*Hedera helix*). Trees between 12 and 20 inches in diameter at breast height (DBH) comprise the dominant size class, and overall the hedgerow is in poor condition due to extensive invasives in the understory and herbaceous layer. Hedgerow 8 (H8) is dominated by red maple (*Acer rubrum*), American holly (*Ilex opaca*), white pine (*Pinus strobus*), and willow oak (*Quercus phellos*) plantings. The majority of the trees within H8 are between 3 and 5 inches DBH and in good condition.

Six early-successional hedgerows (H1, H2, H4, H5, H6 & H7) were identified north and south of MD 190. These hedgerows have a dominant canopy size class of 6 to 11 inches DBH. H1, H2, H5, and H7 are volunteer hedgerows dominated by tulip polar, green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), and black locust (*Robinia pseudoacacia*). The understory in these hedgerows is dominated by bush honeysuckle, box elder (*Acer negundo*), and oriental bittersweet (*Celastrus orbiculatus*); and the herbaceous layer consists of English ivy and Japanese honeysuckle. These volunteer hedgerows are in poor condition due to extensive vines and invasives, and a lack of sapling regeneration in the understory. H4 and H6 are planted hedgerows with a dominant canopy size class of 6 to 11 inches. H4 is dominated by eastern red cedar (*Juniperus virginiana*), pin oak, Norway spruce (*Picea abies*), American holly and white pine; and H6 is dominated by white pine, willow oak, red maple, and American holly. H4 is in fair condition due to extensive English ivy in the herbaceous layer; and H6 is in good condition due to low invasive cover.

Regulated Resources Identified

- Roadside Trees

Impacts to Regulated Resources

- Alternatives 1, 2 & 3 would impact 14,918 square feet of volunteer hedgerow (H3) and 35,965 square feet of planted hedgerow (H8) within the MD 190 median.

Permitting Requirements for Impacts to Regulated Resources Listed Above

- Roadside Tree Permit: Roadside trees are present within the project corridor. Impacts to trees within the right-of-way are regulated under the Maryland Roadside Tree Law if forest impacts are less than 40,000 square feet. Mitigation will be required on a 1:1 ratio, based on either individual tree impacts or square footage of hedgerow impacts.

STORMWATER MANAGEMENT

The stormwater management quantity and quality control measures for this project will be designed in accordance with the MDE Stormwater Management Act of 2007 and will include implementation of Environmental Site Design (ESD) to the maximum extent practicable (MEP). An existing TMDL tree planting has been identified in the median of MD 190 that will be removed under the proposed conditions. A formal notification will be required to be sent to OED in order to update the TMDL program of the loss of the asset. Based on field observations and mapping provided by the district, it does not appear that any stormwater facilities exist in the project vicinity. A formal verification by Highway Hydraulics Division (HHD) will be required for any existing information.

The proposed alternatives involve relocating the existing MD 190 roadway as well as some widening to accommodate the lengthening of turn lanes and general safety upgrades. The proposed work results in an increase in impervious area project wide, as well as multiple areas of full-depth reconstruction; thus, the project will require stormwater management (SWM).

Alternative 1:

Stormwater management requirements have been developed based on the *Maryland Stormwater Design Manual, Volumes I & II (Effective October 2000, Revised May 2009).* These guidelines require that the site be separated into Points of Interest (POIs). These POIs are then defined as either New Development or Re-development, based on the existing percent impervious within the POI. For Re-development POIs, the existing percent impervious area must be >40%; any POI with less than 40% existing impervious area is defined as New Development. The site has been divided into 6 POIs, and the New/Re-development determination has been made for each POI. Percent impervious has been determined based on the Stormwater Study Area which has been defined as the approximated LOD. Detailed SWM/Drainage plans can be seen in *Figures E1-E4.*

The New/Re-development classification, as well as the Impervious Area Requiring Treatment (IART) and ESD volume required per each POI is summarized below in *Table 4*. Detailed calculations can be seen in *Appendix F*.

Alternative 1				
POI	Impervious (%)	Classification: New/ Redevelopment	ESDv Required (CF)	IART Required (acres)
1	0%	NEW	161	0.02
2	49%	RE-DEV	298	0.20
3	20%	RE-DEV	377	0.05
4	48%	RE-DEV	16100	1.81
5	47%	RE-DEV	1999	0.30
6	48%	RE-DEV	2231	0.38
Total:			***21165***	***2.76***

Table 4

The site has been analyzed and all available areas for SWM have been identified. SWM is supplied through the use of micro-bioretentions and bioswales. A total of 12 facilities are proposed; 5 bioswales and 6 micro-bioretentions. These combined facilities satisfy the ESDv requirements for POIs 2-4 and POI 6.

POI 1 and POI 5 are not able to meet the ESDv requirement due to the presence of steep slopes and utilities, which include a 60" water line, within each POI. The exact location of this utility is not known, so ESDv volumes may change once its exact location is determined. These POIs will need to pursue variances for the untreated ESDv in order to comply with SWM regulations.

Due to the steep slopes and utility conflicts mentioned above, IART requirement can also not be met in this alternative. The 0.03-acre deficit in IART provided, plus the 20% surcharge for Water Quality debit, will result in a debit of 0.04 acres to the Washington Metropolitan Watershed (02-14-02).

The treatment required/provided is summarized below in *Table 5*. Detailed calculations can be seen in *Appendix F*.

Alternative 1				
POI	ESDv Required (CF)	ESDv Provided (CF)	IART Required (acres)	IART Provided (acres)
1	161	0	0.02	0.00
2	298	677	0.20	0.10
3	377	2938	0.05	0.39
4	16100	16313	1.81	1.76
5	1999	836	0.30	0.09
6	2231	2439	0.38	0.38
Total:	***21165***	***23203***	***2.76***	***2.73***

Table 5

In several locations, multiple micro-bioretentions in series are being proposed in order to maximize treatment potential within the existing ROW where minimal environmental impacts exist. Bioswales were originally considered for these areas, but were abandoned due to their 8' width limit which would not allow for full treatment. Submerged gravel wetlands were also considered for these areas as they can treat a larger drainage area than micro-bioretentions; these were not used because they require poorly draining soils, which are not present in these areas based on Web Soil Survey. If soil borings obtained at a later phase show that these areas are poorly draining, the proposed micro-bioretentions could be combined into several submerged gravel wetlands.

Alternative 2:

Stormwater management was also analyzed for Alternative 2. This alternative includes less new pavement and redeveloped pavement as it more closely follows the existing roadway alignment. Due to this, there are no stormwater requirements for POIs 1, 2 and 6 in this alternative. The stormwater requirements for POIs 3, 4, and 5 are summarized below in *Table 6*.

Alternative 2				
POI	ESDv Required (CF)	ESDv Provided (CF)	IART Required (acres)	IART Provided (acres)
1	0	0	0	0.00
2	0	0	0	0.00
3	2187	2249	0.24	0.24
4	6037	6978	0.65	0.93
5	566	1254	0.06	0.13
6	0	0	0	0.00
Total:	***8790***	***10480***	***0.95***	***1.30***

Table 6

All POIs are able to meet the ESDv and IART requirements in this alternative, based on the existing highway design and the currently known utility locations. The IART requirements will be met and result in a net credit of 0.35 acres.

Alternative 3:

Stormwater management was also analyzed for Alternative 3. This alternative involves eliminating the large median area by moving the east-bound lanes further north, so they run parallel to the west-bound lanes. The work proposed will result in no stormwater requirements for POIs 1 and 6. The stormwater requirements for POIs 2-5 are summarized in *Table 7*:

Alternative 3				
POI	ESDv Required (CF)	ESDv Provided (CF)	IART Required (ac.)	IART Provided (ac.)
1	0	0	0.00	0.00
2	136	0	0.09	0.00
3	2254	1986	0.24	0.19
4	12331	12995	1.35	1.60
5	2577	2776	0.26	0.30
6	0	0	0.00	0.00
Total:	***17046***	***17757***	***1.93***	***2.09***

Table 7

ESDv requirements are met for POIs 4 and 5 in this alternative using 5 micro-bioretentions and 1 submerged gravel wetland. Due to various site constraints including utilities and steep slopes, ESDv requirements are not met for POI's 2 and 3. One bioswale is proposed in POI 3 and will treat a portion of the ESDv required. Variances will be sought for the unobtained ESDv of 136 CF and 268 CF in POIs 2 and 3, respectively. The overall IART requirement is satisfied for this alternative, generating a credit of 0.16 acres to the water quality bank.

EROSION & SEDIMENT CONTROL

Erosion and sediment perimeter controls for all three alternatives such as silt fence and diversion ditches, as well as inlet protection, dewatering devices, and same day stabilization will be used in order to provide erosion and sediment control during construction. Due to the maintenance of traffic requirements of the project, multiple erosion and sediment control phases will be necessary. Some existing ditch erosion (STA. 127+75-129+00 LT, STA 111+50 RT) will need to be stabilized in the proposed condition. See *Appendix G* for photos.

DRAINAGE DESIGN

The relocation of MD 190 in Alternative 1 will result in the removal/replacement of several existing stormdrain systems. Pipe systems at STA. 111+95 (I-1 and ES-3), STA. 118+90 (I-2 and I-3), and STA. 127+50 (I-4) are proposed in order to drain the westbound lanes of proposed MD 190; these proposed pipes will tie into existing drainage systems. The existing pipe/inlet systems at STA. 111+75 and 118+00 will be made obsolete by the proposed layout and will therefore be removed/abandoned. The existing stormdrain system at STA. 110+25 – 116+25 LT (MH-2 – MH-5) is proposed to be moved to the edge of the curb in order to accommodate proposed bioswale BIO 3-1. The downstream end of this system (MH-1, ES-1) is proposed to be adjusted in order to accommodate the widening of MD 190. At STA. 123+25 – 127+25, a pipe is proposed to connect the proposed manholes MH-6 and MH-7 in order to replace the existing ditch in this area. At STA. 111+50 RT, a COG inlet/pipe system (I-5) is proposed in order to intercept flow running along the curb proposed from STA 111+50-113+25 RT. This curb is

proposed in order to bypass excess flow from entering proposed MB 4-1. In the proposed condition, this ditch will be filled in. A culvert is also proposed at STA 117+50 LT to convey flow under the proposed entrance to Pyle Road (ES-4 to ES-2). All proposed drainage systems are approximate and will need to be adjusted once detailed survey data is obtained. Proposed pipe layout can be seen in *Figure F1-F4* in *Appendix F*.

The relocation of the intersection along MD 190 in Alternative 2 will result in minimal removal/replacement of existing stormdrain systems. Similar to Alternative 1, the existing storm drain system between stations 211+50-216+25 LT will need to be relocated in order to provide stormwater management. Additionally, the ditch in the median from STA. 223+50 – 227+50 will be converted to a pipe system to avoid erosion.

Alternative 3 requires the same drainage infrastructure as Alternative 1. Additionally, a cross culvert at STA. 317+00 is to facilitate flow to enter the proposed facilities. Open back inlets in the median and curb line will also be necessary to direct flow to the proposed facilities.

PAVEMENT/GEOTECHNICAL ISSUES

Based on the as-built plans provided by SHA, the existing pavement composition is 1.5-inch asphalt surface, 2-inch asphalt base, 9-inch reinforced Portland cement concrete, 4-inch CR-6 drainage layer and 6-inch cement modified base. It is not recommended to remove portions of the existing concrete pavement panels because it can lead to destabilization of the concrete pavement in these areas. To avoid future pavement failure, pavement reconstruction is assumed where proposed travel lanes merge into the existing roadway. This additional roadway reconstruction requires additional storm water management treatment; but may be scaled back during final design.

Alternative 2 and 3 maintains the existing MD 190 westbound alignment salvaging the existing pavement. Both alternatives also show pavement removal of existing turn lanes without adjacent full depth replacement because it is assumed that the turn lane concrete pavement slabs can be removed without damaging the through lane concrete pavement slabs. However, Alternative 3 will require new full depth pavement with the eastbound alignment shifted into the median following the westbound alignment.

SHA typically does not replace or widen roadways with a composite pavement section so a preliminary asphalt pavement design is assumed for estimating purposes based on the ADT of 44,622 for 2015, a truck percentage of 4%, and the SHA regional forecasting models showing 0.25% growth rate per year.

2-inch 12.5mm Asphalt Mix, Surface Course, PG64E-22
10-inch 19.0mm Asphalt Mix, Base, PG64S-22
12-inch Graded Aggregate Base
12-inch Geosynthetic Stabilized Subgrade using Graded Aggregate Base (GSSA)

GSSA is recommended where new pavement is located in the grass median or roadside ditch that collects surface drainage and saturated soils are anticipated.

EARTHWORK

It is estimated for Alternative 1 that this project will require approximately 21,500 cubic yards of Class I Excavation, 3,700 cubic yards of Class 1A Excavation, and 6,500 cubic yards of Common Borrow.

Alternative 1 Earthwork		
CLASS 1 EXCAVATION	CY	21,500
CLASS 1A EXCAVATION	CY	3,700
COMMON BORROW	CY	6,500

Table 8

It is estimated for Alternative 2 that this project will require approximately 10,400 cubic yards of Class I Excavation, 2,000 cubic yards of Class 1A Excavation, and 1,500 cubic yards of Common Borrow.

Alternative 2 Earthwork		
CLASS 1 EXCAVATION	CY	10,400
CLASS 1A EXCAVATION	CY	2,000
COMMON BORROW	CY	1,500

Table 9

It is estimated for Alternative 3 that this project will require approximately 14,000 cubic yards of Class I Excavation, 3,200 cubic yards of Class 1A Excavation, and 5,000 cubic yards of Common Borrow.

Alternative 3 Earthwork		
CLASS 1 EXCAVATION	CY	14,000
CLASS 1A EXCAVATION	CY	3,200
COMMON BORROW	CY	5,000

Table 10

For estimating purposes, it is assumed that no Class 1 Excavation can be used for embankment. Earthwork numbers are based on GIS vertical information; survey will be required to solidify earthwork quantities.

STRUCTURES

There are small existing decorative block walls at each of the WMATA bus stops along eastbound and westbound MD 190. It is anticipated that these walls would need to be reestablished at the new bus stops proposed in this study.

LANDSCAPE ARCHITECTURE

There are roadside trees within the project limits that will be impacted by the proposed improvements for all three alternatives. Impacts to trees within the right-of-way are regulated under the Maryland Roadside Tree Law if forest impacts are less than 40,000 square feet. A Roadside Tree Permit will need to be submitted to the Maryland Department of Natural Resources to obtain approval for impacting or removing roadside trees. Mitigation will be required for tree removals on a 1:1 ratio, based on either individual tree impacts or square footage of hedgerow impacts.

SIGNING & MARKING/LIGHTING/SIGNALIZATION

The existing intersection of MD 190 at Braeburn Parkway is unsignalized and has minimal pavement markings in the median delineating turning movements. Currently SHA is installing new light poles, active hazard identification beacons (HIB) for the existing intersection and, video detection cameras for the HIBs. The signalized intersection at MD 190/Pyle Road included in Alternatives 1, 2, and 3 will eliminate the need for the HIBs. New pavement markings will be required throughout the project limits.

MAINTENANCE OF TRAFFIC

It is anticipated that the Maintenance of Traffic (MOT) for Alternative 1 will be a three-phase approach. In phase one, the new intersection including curb & gutter, traffic barrier w-beam, and the proposed signal will be built in the median and traffic will be maintained on existing MD 190. In phase two, traffic will shift into the median, single lane closures and concrete barrier will be utilized to reconstruct the pavement at the tie ins. Portions of the existing roadway will be removed and SWM facilities will be installed. Phase three will include grinding and resurfacing followed by application of proposed pavement markings.

Alternative 2 MOT is expected to be a three-phase approach. Phase one will include right lane single lane closures to base widen pavement outside of the median; phase two will include left lane single lane closures to base widen pavement in the median and construct SWM facilities and the traffic signal. Phase three will include grinding and resurfacing followed by application of proposed pavement markings.

Alternative 3 MOT will be a three-phase approach. Phase one will include the construction of the new eastbound roadway in the median while maintaining traffic on its existing alignment. Phase two will shift the eastbound roadway onto its new alignment, using single lane closures as required to construct remaining pavement. Portions of the existing roadway will be removed and SWM facilities will be installed. Phase three will include grinding and resurfacing followed by applying final pavement markings.

Access to several residential properties on the north and south side of MD 190 will need to be maintained throughout all phases of construction.

Details for MOT will be developed during final design.

BUS/TRANSIT USE

There are two WMATA bus stops within the study limits; one in each direction on MD 190 adjacent to the uncontrolled marked pedestrian crosswalks. For each alternative, the bus stops would be placed in the acceleration lane to avoid conflict with vehicles turning onto Pyle Road from MD 190. It is anticipated that each proposed bus stop would include a free standing, decorative block wall to match the bus stops throughout the corridor.

RIGHT-OF-WAY

It is anticipated that acquisition of ROW will not be needed for any of the alternatives.

UTILITIES

There are several utilities present within the project study area, including both underground and overhead electric, cable TV, and telephone. Other utilities present include buried water, gas, sanitary and storm sewer. Significant utilities include a 60" waterline and a 24" gas transmission line.

Minimal impacts to utilities are anticipated for each alternative. Further investigation for roadway clearance under the overhead electric and telephone will be required at the newly located intersection.

Alternative 1 - Potential Utility Impacts
Overhead Electric & Telephone
HIB & video detection
Newly Installed lighting
Unknown underground line

Table 11

Alternative 2 - Potential Utility Impacts
HIB & video detection
Newly Installed lighting

Table 12

Alternative 3 - Potential Utility Impacts
Overhead Electric & Telephone
HIB & video detection
Newly Installed lighting

Table 13

Note: Utility impacts will need to be verified during final design following designation and are dependent on prior rights determination. Additional impacts may be required following further development of the storm drain design.

MAINTENANCE

No maintenance issues were observed or mentioned by SHA.

INTERSTATE ACCESS POINT APPROVAL

Interstate Access Point Approval is not required for this project.

MEMORANDUM OF UNDERSTANDING/AGREEMENTS

At the current stage of concept development, a Memorandum of Understanding or Agreement is not anticipated.

RAILROAD COORDINATION

There are no railroad facilities within, adjacent to, or impacted by this project.

SUMMARY

This report summarized the project impacts for three geometric configurations for closing the existing intersection at MD 190 (River Road) at Braeburn Parkway and relocating the intersection 600 feet to the east to Pyle Road where an existing marked pedestrian crosswalks exist to improve safety for vehicles, cyclists and pedestrians.

Alternative 1 shifts the eastbound and westbound alignments of MD 190 to bisect the midpoint of the grass median at Pyle Road, creating a new intersection. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walks, bus stops, median and single faced w-beam, sidewalk and curb & gutter are included in this concept. Pros and cons of Alternative 1 are listed below:

Pros:

- Typical intersection configuration
- Increases storage for left turns relative to existing
- Improves pedestrian safety
- Maximizes queuing capacity on Pyle Road
- Improves bicycle compatibility
- Accommodates larger vehicle turning templates better than Alternative 2 & 3
- Improves safety of left turning movements from MD 190

Cons:

- High construction cost

- Concerns with meeting SWM requirements
- Intersection under aerial utilities contingent upon adequate vertical clearance
- Complete removal of existing TMDL

Alternative 2 maintains westbound MD 190 through lanes, shifts the eastbound MD 190 alignment approximately 12 feet into the grass median, includes pavement box widening for the acceleration and deceleration lanes creating a new intersection at Pyle Road. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walk, bus stops, grass median, single face w-beam, sidewalk and curb & gutter are included in this concept. Pros and cons of Alternative 2 are listed below:

Pros:
- Increases storage for left turns relative to existing
- Improves bicycle compatibility
- Improves pedestrian safety
- Low construction cost
- Minimizes SWM requirements
- Improves safety of left turning movements from MD 190

Cons:
- Non-typical intersection configuration
- Complete removal of existing TMDL
- Queuing concerns on Pyle Road during peak periods
- More difficult turning movements compared to Alternative 1
- Complicated signal configuration

Alternative 3 maintains the westbound MD 190 through lanes, shifts the eastbound MD 190 alignment adjacent to the westbound alignment forming a new intersection with Pyle Road. Four through lanes, shoulders, acceleration lanes, deceleration lanes, bicycle lanes, pocket bicycle lanes at right turn lanes, cross walk, bus stops, grass median, single face w-beam, sidewalk and curb & gutter are included in this concept. Pros and cons of Alternative 3 are listed below:

Pros:
- Typical intersection configuration
- Increases storage for left turns relative to existing
- Improves bicycle compatibility
- Improves pedestrian safety
- Improves safety of left turning movements from MD 190

Cons:
- High construction cost
- Complete removal of existing TMDL
- Queuing concerns on Pyle Road during peak periods
- More difficult turning movements compared to Alternative 1

Alternative 1 would be preferred based on the projected traffic operations, typical intersection configuration, straight forward turning movements even though it carries the higher cost.

Alternative 2 would be expected to result in excessive queuing in the median connector road during peak periods, would require more complicated signal control for vehicles and pedestrians, and Alternative 2 & 3 provide challenging turning movements for school buses.

If you have any questions or comments, or corrections or additions to this report, please do not hesitate to contact Ms. Makeda Drake, Project Manager, at 410-512-4636 or via email at mdrake@sha.state.md.us.

Appendices: Appendix A – Preliminary Alternate Concept Plans (April 2016)
Appendix B – Alternative 1 Concept Plans
Appendix C – Alternative 2 Concept Plans
Appendix D – Alternative 3 Concept Plans
Appendix E – Intersection Sight Triangle Analysis & Autoturn Assessment
Appendix F – Stormwater Management Plans & Calculations
Appendix G – Site Photographs
Appendix H – Major Quantities Cost Estimates
Appendix I – MD 190 (River Road) at Braeburn Parkway/Pyle Road Traffic and Safety Analysis Report (February 2017)

GEOMETRIC DATA SHEET

Project Description: MD 190 (River Road) At Pyle Road

SHA Contract No. MO9815176

FAP No. N/A

☐ Expressway ☐ Rural Road
☒ Arterial ☒ Urban Road
☐ Collector

1. Design Data

DESIGN ELEMENTS	EXISTING CONDITION	PROPOSED CONDITION	MEETS SHA/AASHTO DESIGN STANDARDS
ADT	Source: SHA Title Sheet / Loadmeter Data; December 31, 2015 44,622	44,622	YES
% Trucks	Source: SHA Published Truck Volume Map for 2015 4%	4%	YES
Design Speed	50 mph	50 mph	YES
Posted Speed Limits	Source: Field Investigation 45 mph	45 mph	YES
Number of Lanes	4 Lanes	4 Lanes	YES
Through-Lane Width	Source: As-built/Field Investigation 12 ft.	Source: AASHTO Pg. 7-13 12 ft.	YES
Turn-Lane Width	Source: As-built/Field Investigation 12 ft.	12 ft.	YES
Shoulder Width	Source: As-built/Field Investigation 10 ft. outside (5' striped bike lane included) (no pocket lanes at right turn lanes) (no shoulder at accel or decel lanes) 1 ft. inside	Source: SHA *Bicycle Policy and Design Guide, Table 2.1* 10 ft. to 6 ft. outside (bike compatible) (pocket lanes included at right turn lanes) 1 ft. or 4 ft. inside	YES
Maximum Roadway Grade	Source: AASHTO pg. 7-4 & GIS surface 5%	5%	YES

DESIGN ELEMENTS	EXISTING CONDITION	PROPOSED CONDITION	MEETS SHA/AASHTO DESIGN STANDARDS
Turn Lane Length	Source: GIS/Aerial/Field Investigation MD190 EB RT – 150' MD190 EB LT – 150' MD190 EB Accel – 200' MD190 WB RT – 100' MD190 WB LT – 100' MD190 WB Accel – 200'	Source: AASHTO 2011 Pg. 9-126 & SHA Access Permit Manual pg. 69-71 MD190 EB RT – 245' MD190 EB LT – 445' MD190 EB Accel – 200' MD190 WB RT – 245' MD190 WB LT – 395' MD190 WB Accel – 200'	YES
Minimum Taper Length	Source: GIS/Aerial/Field Investigation 15:1 (180 ft.)	Source: AASHTO 2011 Pg. 9-127 & SHA Access Permit Manual pg. 69-71 15:1 (180 ft.)	YES
Stopping Sight Distance	Source: AASHTO 2011 425' for 50 MPH design speed	Source: AASHTO 2011 425' for 50 MPH design speed	YES

Appendix A
Preliminary Alternate Concept Plans (April 2016)

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R /W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILE1$

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT BRAEBURN PKWY
INTERSECTION SAFETY IMPROVEMENT

ALTERNATE 1 – MARYLAND T

SCALE 1" = 30' DATE APRIL 2016 CONTRACT NO. MO

DESIGNED BY CSF/ARJ
DRAWN BY ARJ
CHECKED BY CSF
F.A.P. NO. SEE TITLE SHEET

COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A1

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R / W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILE$

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT BRAEBURN PKWY
INTERSECTION SAFETY IMPROVEMENT

ALTERNATE 2 – CONTINUOUS MEDIAN

SCALE 1" = 30' DATE APRIL 2016 CONTRACT NO. MO

DESIGNED BY CSF/ARJ
DRAWN BY ARJ
CHECKED BY CSF
F.A.P. NO. SEE TITLE SHEET

COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A2

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R / W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILE$

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT BRAEBURN PKWY
INTERSECTION SAFETY IMPROVEMENT

ALTERNATE 3 – S–SHAPED MEDIAN

SCALE 1" = 30' DATE APRIL 2016 CONTRACT NO. MO

DESIGNED BY CSF/ARJ
DRAWN BY ARJ
CHECKED BY CSF
F.A.P. NO. SEE TITLE SHEET

COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A3

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R / W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILEL$

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STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

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INTERSECTION SAFETY IMPROVEMENT

ALTERNATE 4 – SHIFT LEFT TURN LANES

SCALE 1"=30' DATE APRIL 2016 CONTRACT NO. MO

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F.A.P. NO. SEE TITLE SHEET

COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A4

MATCHLINE, SEE SHEET PS-06

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R / W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILE$

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STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT BRAEBURN PKWY
INTERSECTION SAFETY IMPROVEMENT

ALTERNATE 5 – RELOCATE INTERSECTION

SCALE 1" = 30' DATE APRIL 2016 CONTRACT NO. MO

DESIGNED BY CSF/ARJ
DRAWN BY ARJ
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F.A.P. NO. SEE TITLE SHEET

COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A5

MATCHLINE, SEE SHEET PS-05

LEGEND

- NEW PAVEMENT
- NEW MEDIAN
- REMOVED PAVEMENT
- EXISTING TRAFFIC MOVEMENT
- PROPOSED TRAFFIC MOVEMENT
- EXISTING RIGHT OF WAY
- EXISTING TRAFFIC BARRIER

MERCADO CONSULTANTS, INC.

DATUM: NAD 8391 Horizontal
NAVD 88 Vertical

R / W PLAT NUMBER	REVISIONS

PLOTTED: $DATE$
FILE: $FILEL$

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ALTERNATE 5 – RELOCATE INTERSECTION

SCALE 1" = 30' DATE APRIL 2016 CONTRACT NO. MO

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DRAWN BY ARJ
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F.A.P. NO. SEE TITLE SHEET

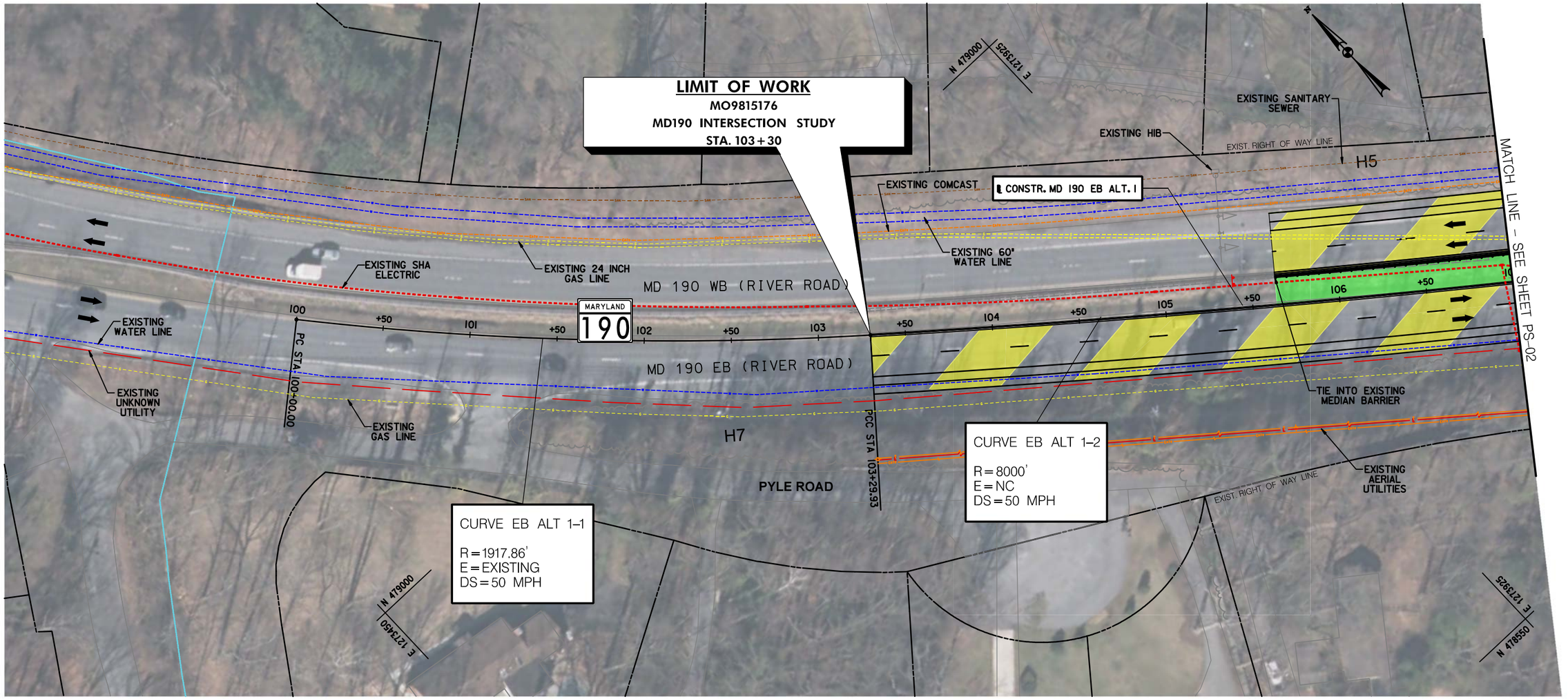
COUNTY MONTGOMERY
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

FIGURE A6

Appendix B
Alternative 1 Concept Plans

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 1

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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DRAWN BY AWG
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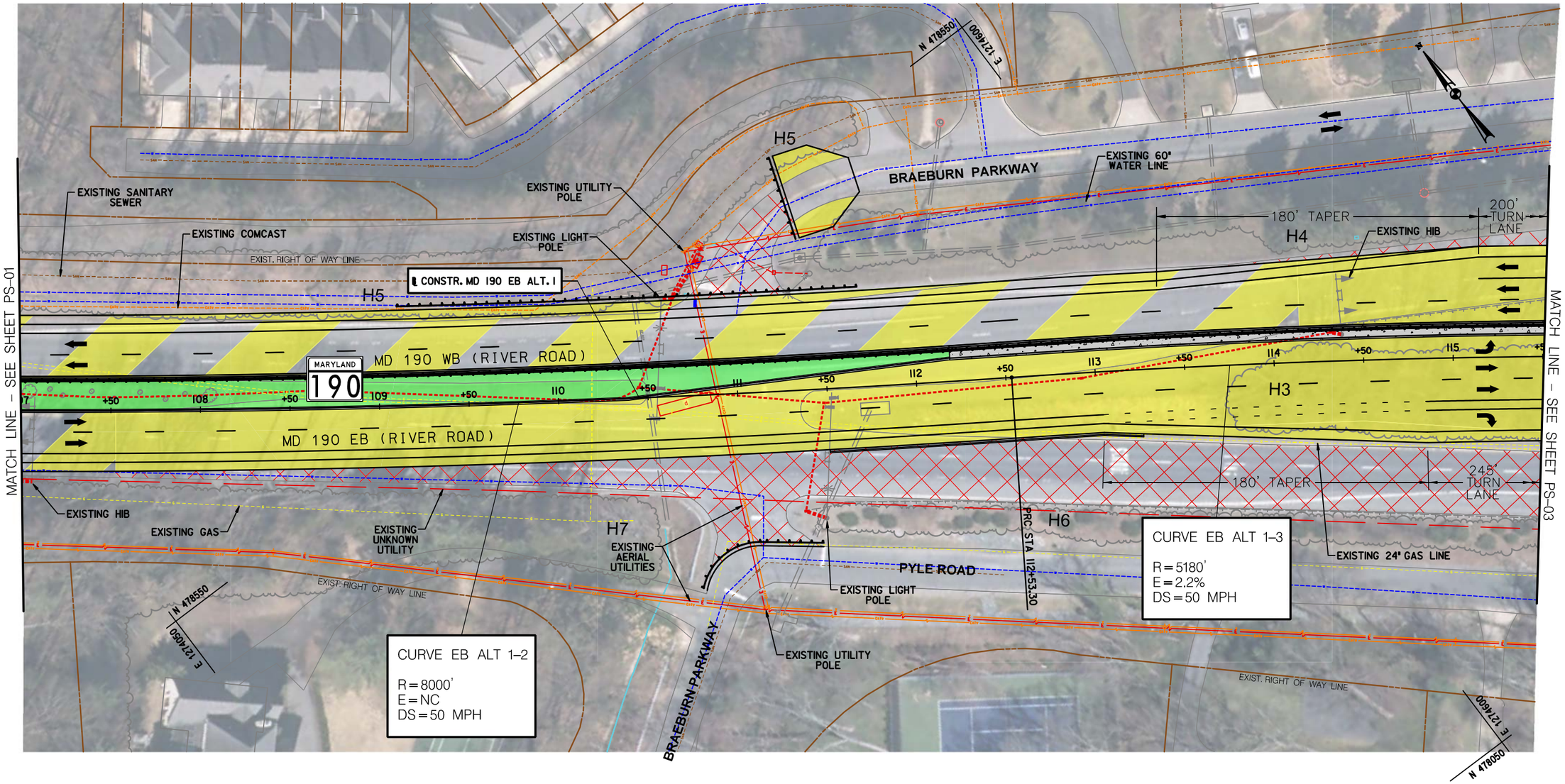
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

PLOTTED: Friday, March 10, 2017 AT 10:07 AM
FILE: \\baltenv04\v2013\2013\13103_d3_traffic\Task 23 – MI

FIGURE B1

TO MD 188

TO MD 614



CURVE EB ALT 1–2

R = 8000'
E = NC
DS = 50 MPH

CURVE EB ALT 1–3

R = 5180'
E = 2.2%
DS = 50 MPH

PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 1

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
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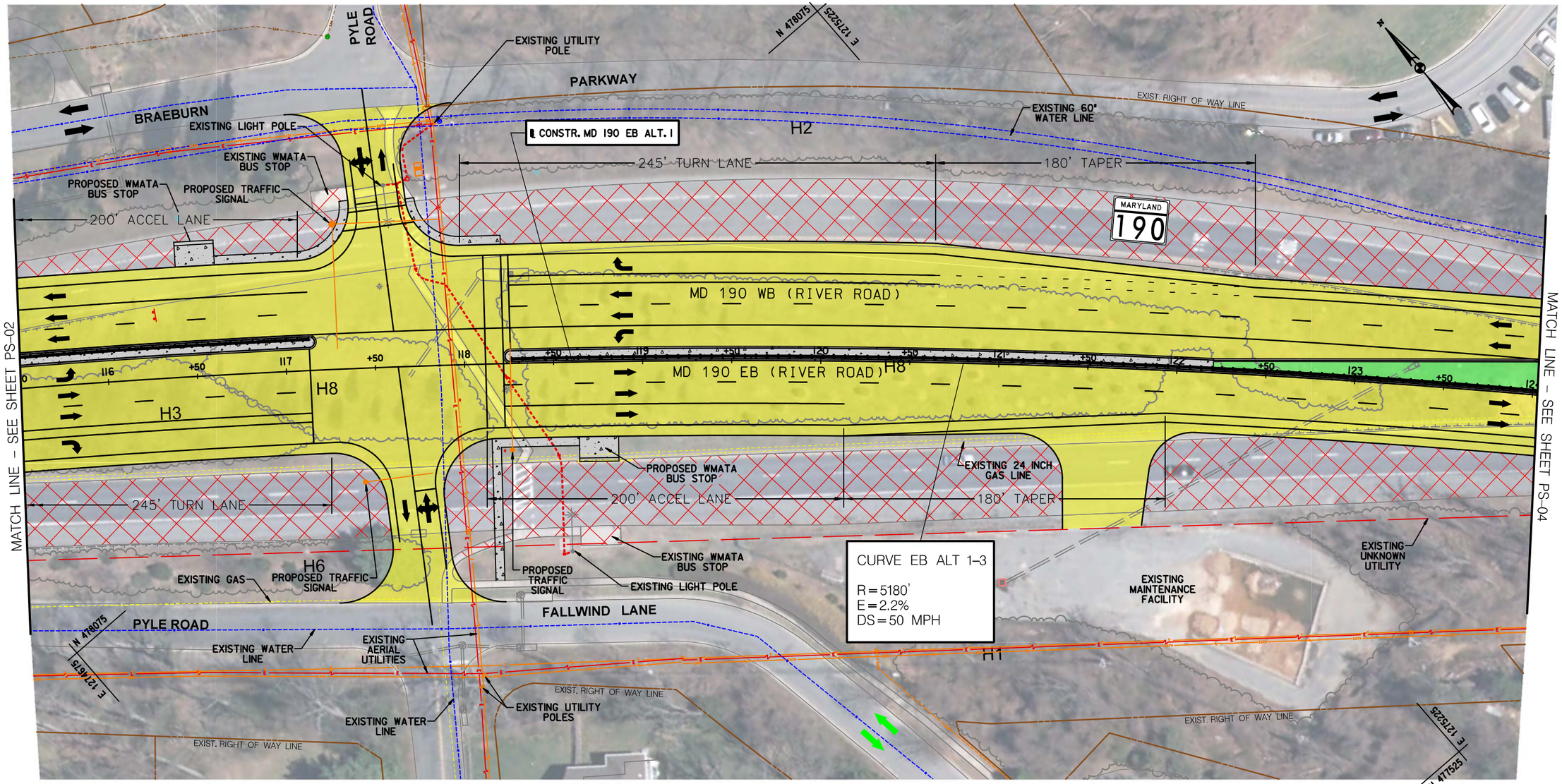
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE B2

PLOTTED: Friday, March 10, 2017 AT 10:07 AM
FILE: \\baltenv04\v2013\2013\13103_d3_traffic\Task 23 – Mi

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL-DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 1

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

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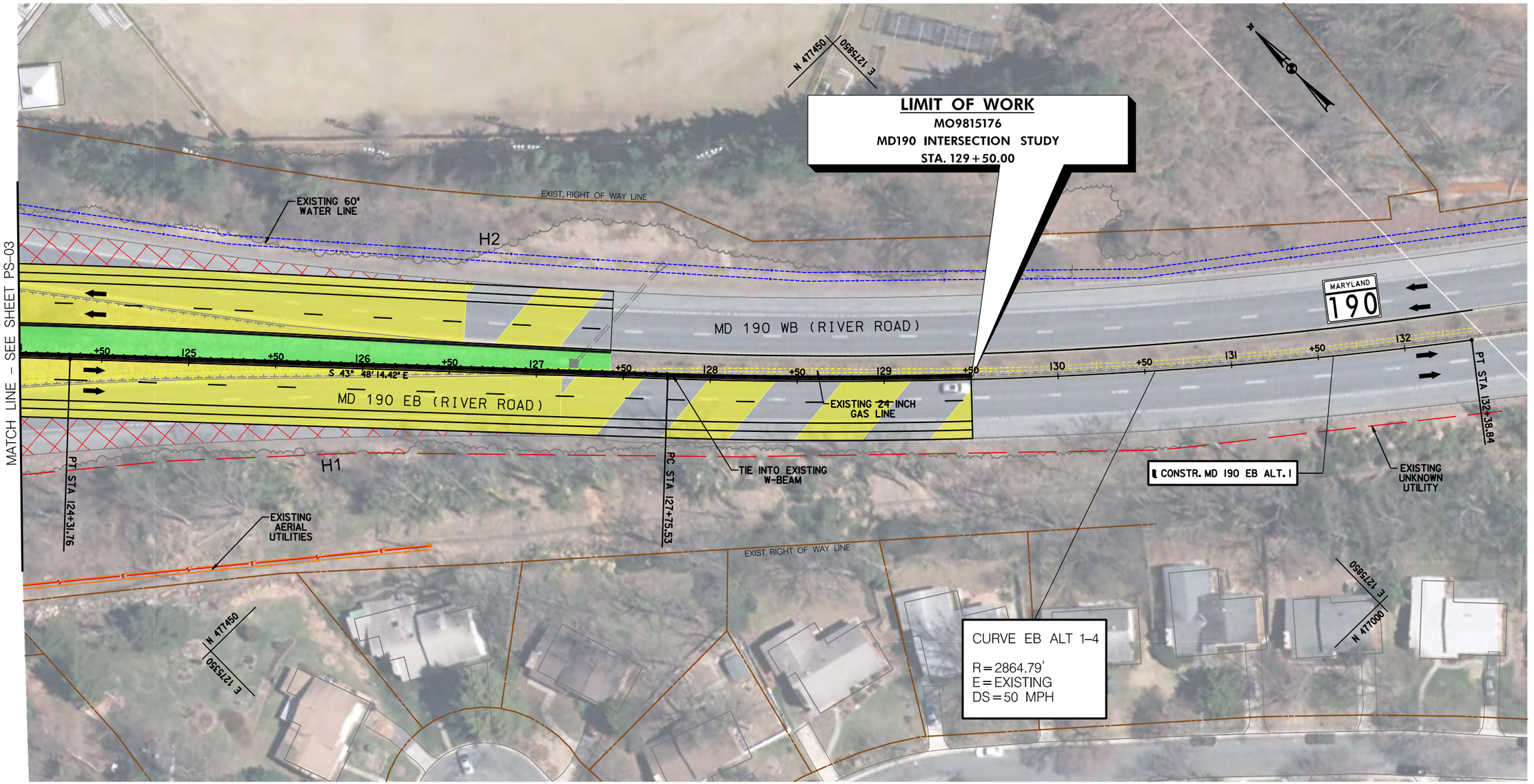
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - Mt

FIGURE B3

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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ALTERNATIVE 1

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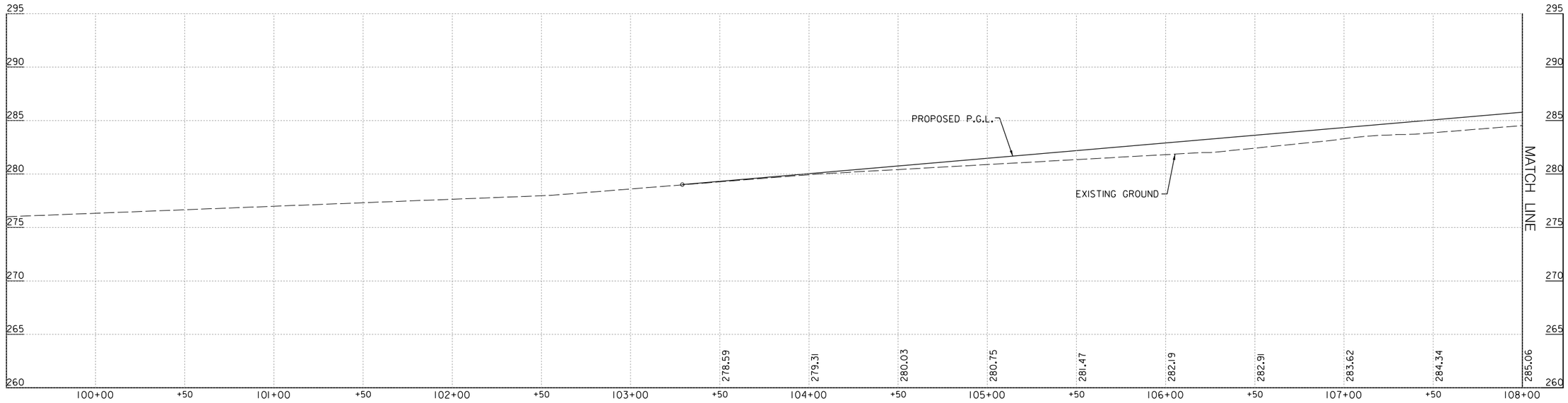
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE B4

PLOTTED: Friday, March 10, 2017 AT 10:21 AM
FILE: \\baltnvd41\v2013\13103\d3_traffic\Task 23 – Mi



MD 190 EB (RIVER ROAD)

SCALE: HORIZ. 1" = 30'
VERT. 1" = 5'

NOTE: EXISTING GROUND PROFILE BASED ON GIS 2-FOOT CONTOURS AND IS APPROXIMATE.

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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 1 PROFILE

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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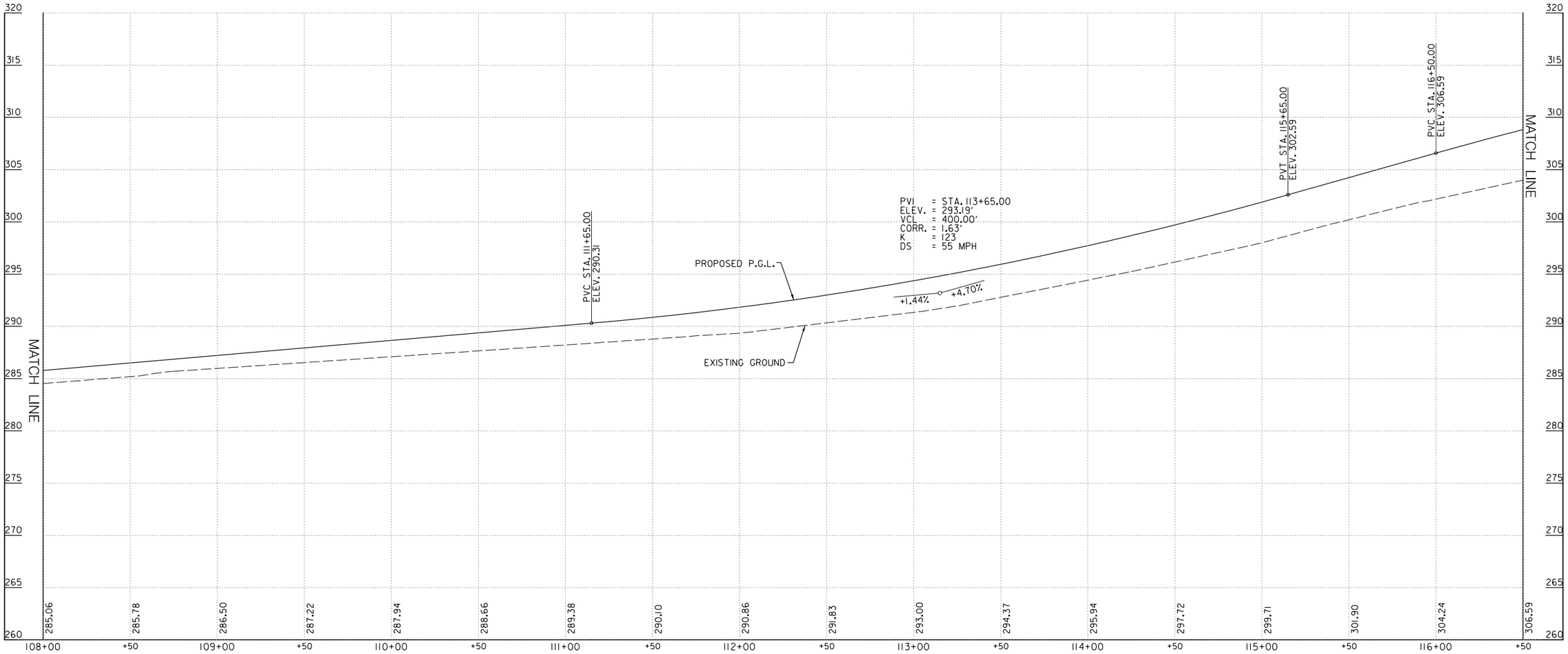
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE B5

PLOTTED: Friday, March 10, 2017 AT 03:07 PM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - M



MD 190 EB (RIVER ROAD)

SCALE: HORIZ. 1" = 30'
VERT. 1" = 5'

NOTE: EXISTING GROUND PROFILE BASED ON GIS 2-FOOT CONTOURS AND IS APPROXIMATE.

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INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 1 PROFILE

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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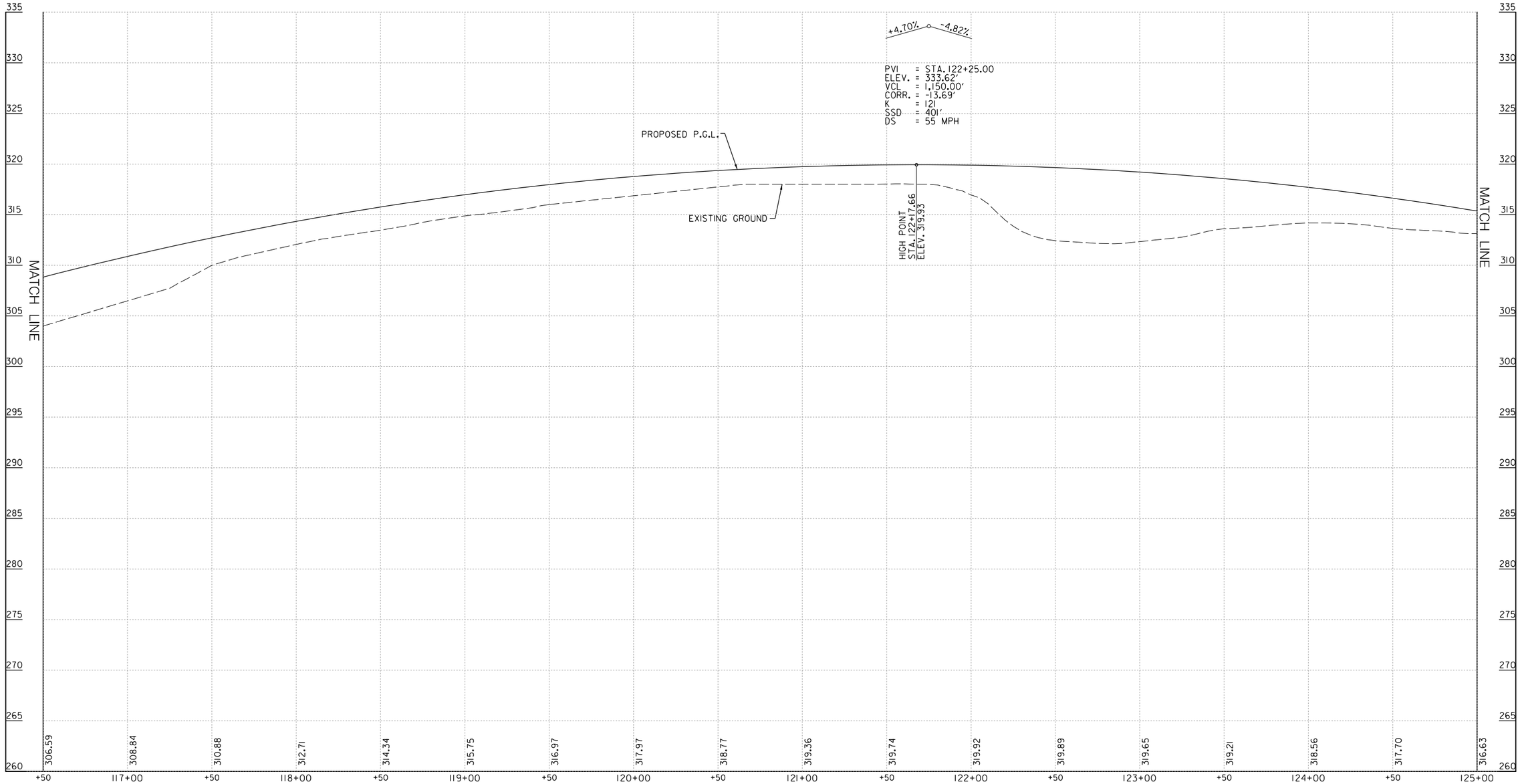
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE B6

PLOTTED: Friday, March 10, 2017 AT 03:07 PM
FILE: \\balsrv04\v2013\2013\13103_d3_traffic\Task 23 - MI



MD 190 EB (RIVER ROAD)

SCALE: HORIZ. 1" = 30'
VERT. 1" = 5'

NOTE: EXISTING GROUND PROFILE BASED ON GIS 2-FOOT CONTOURS AND IS APPROXIMATE.

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ALTERNATIVE 1 PROFILE

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
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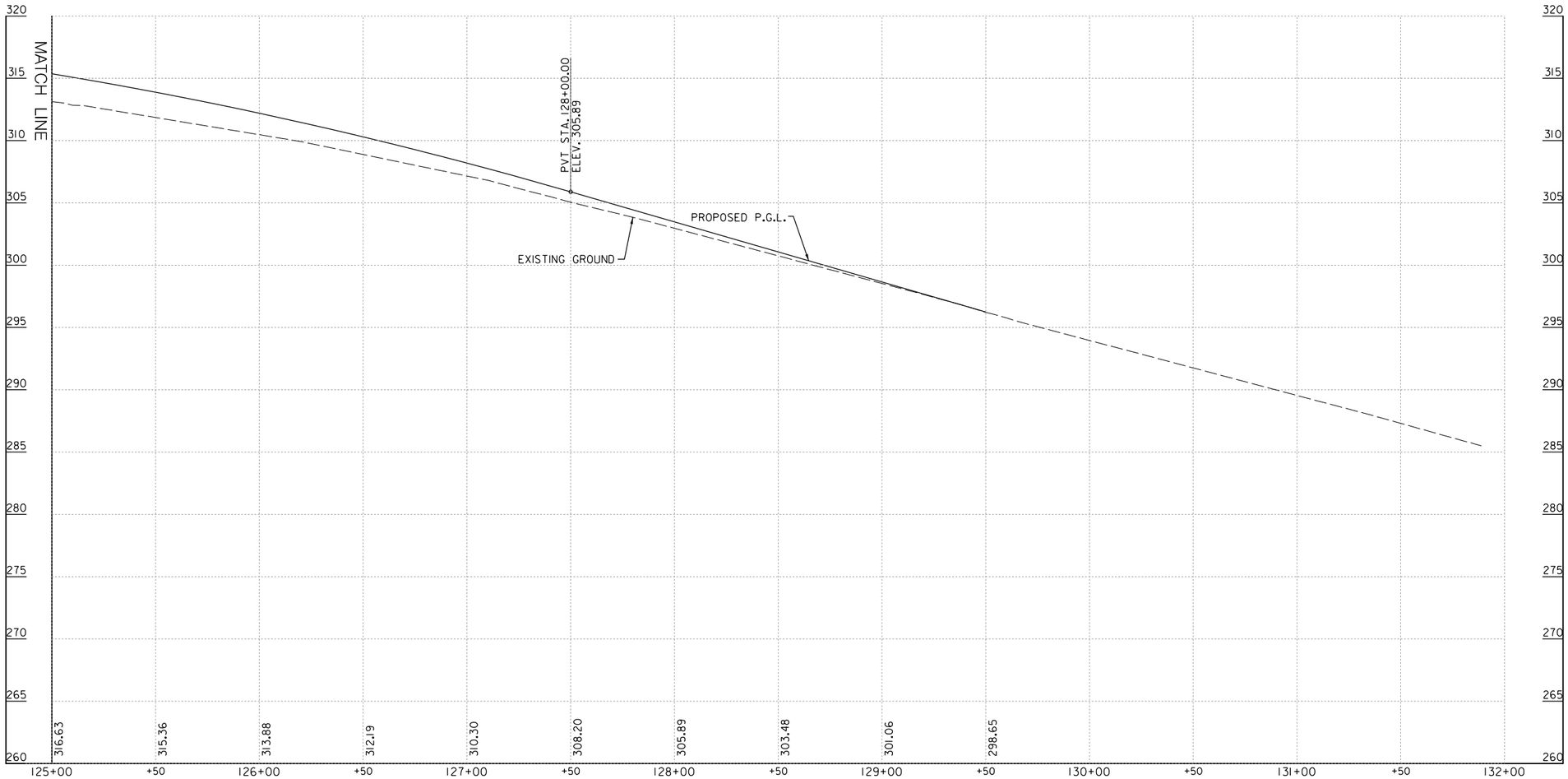
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE B7

PLOTTED: Friday, March 10, 2017 AT 02:42 PM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - M



MD 190 EB (RIVER ROAD)

SCALE: HORIZ. 1" = 30'
VERT. 1" = 5'

NOTE: EXISTING GROUND PROFILE BASED ON GIS 2-FOOT CONTOURS AND IS APPROXIMATE.

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ALTERNATIVE 1 PROFILE

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

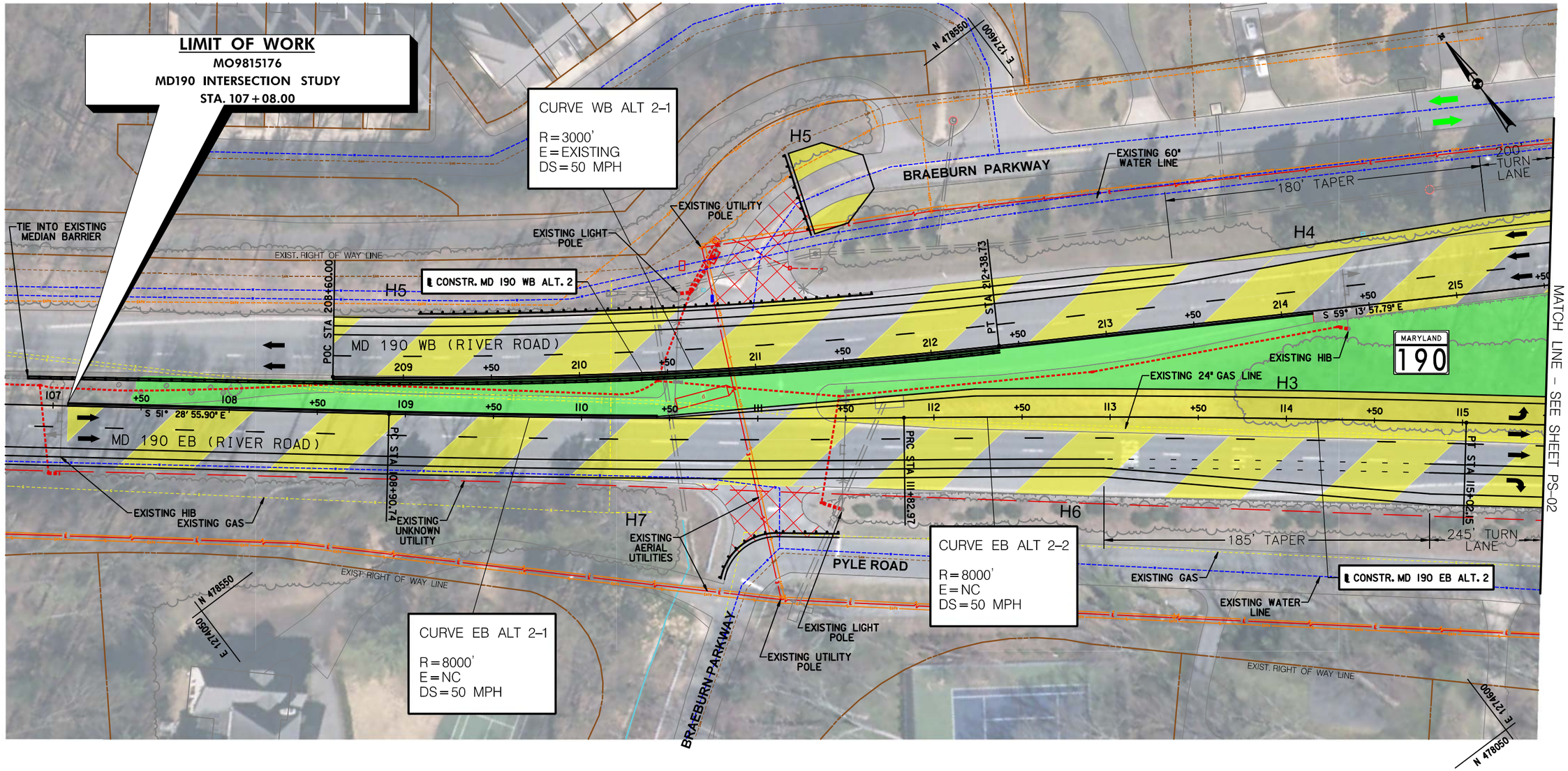
FIGURE B8

PLOTTED: Friday, March 10, 2017 AT 02:43 PM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - M

Appendix C
Alternative 2 Concept Plans

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL-DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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ALTERNATIVE 2

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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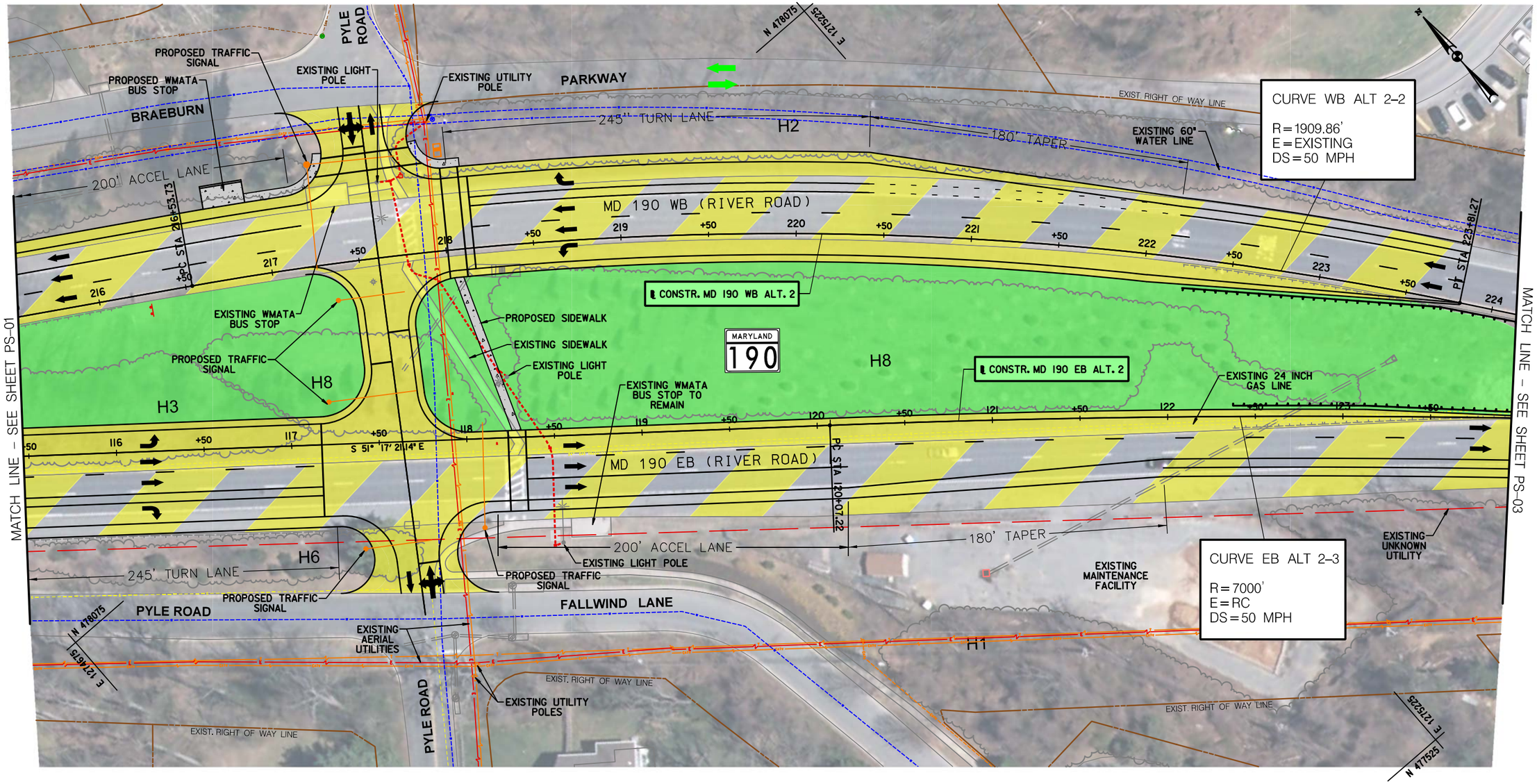
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

PLOTTED: Friday, March 10, 2017 AT 10:25 AM
FILE: \\baltnv04\v2013\2013\3303_s3_traffic\Task 23 - MI

FIGURE C1

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL-DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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ALTERNATIVE 2

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

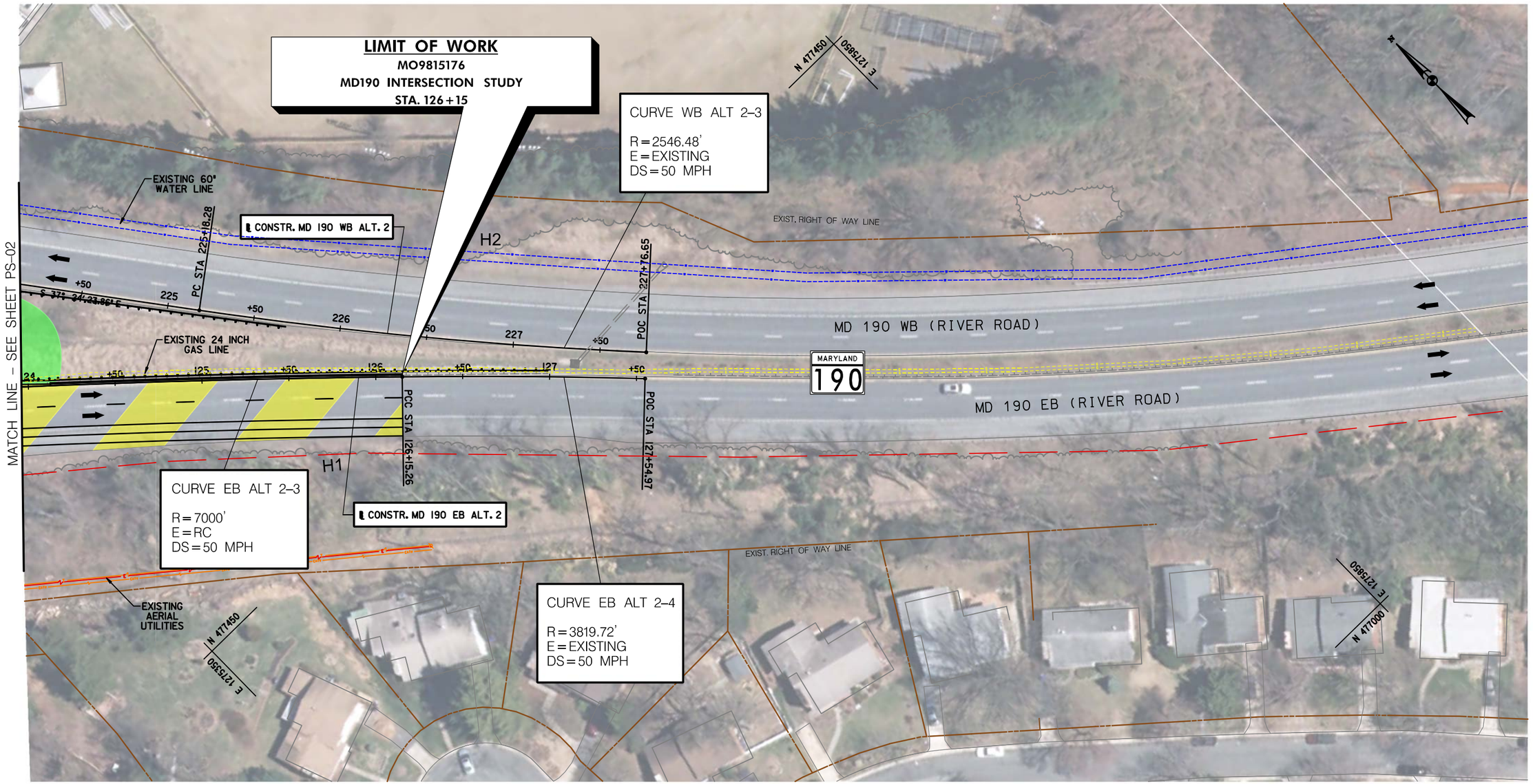
DESIGNED BY CJB COUNTY MONTGOMERY
DRAWN BY AWG LOGMILE _____
CHECKED BY MVS HORIZONTAL SCALE _____
F.A.P. NO. _____ VERTICAL SCALE _____

PLOTTED: Friday, March 10, 2017 AT 10:30 AM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - Mt

FIGURE C2

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL-DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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ALTERNATIVE 2

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

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COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

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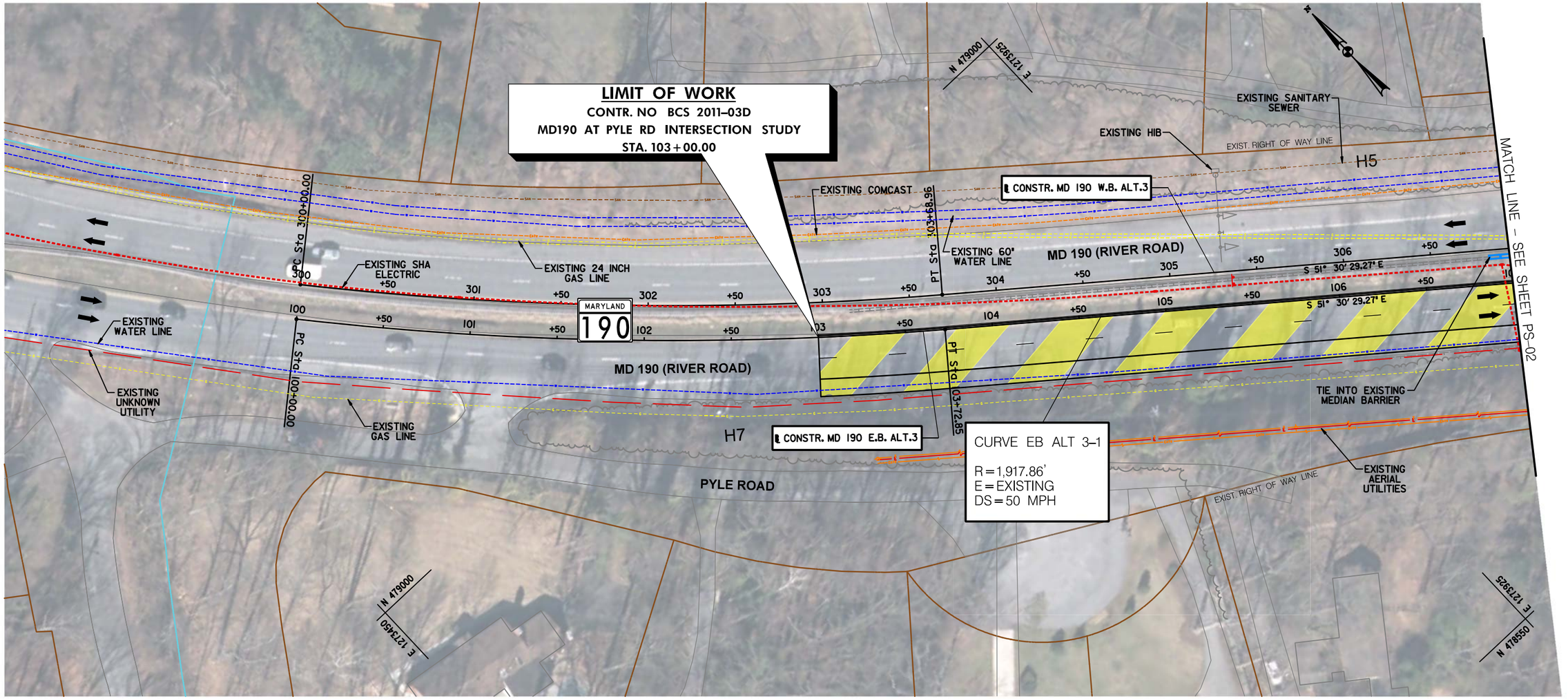
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - Mt

FIGURE C3

Appendix D
Alternative 3 Concept Plans

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 3

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
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CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

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FILE: \\baltorv04\v2013\2013\13103_d3_traffic\Task 23 – Mi

FIGURE D1

TO MD 188

TO MD 614

MATCH LINE – SEE SHEET PS-01

MATCH LINE – SEE SHEET PS-03

CURVE WB ALT 3–1

R = 3,000'
E = 3.4%
DS = 50 MPH

CURVE EB ALT 3–2

R = 3,020'
E = 3.4%
DS = 50 MPH

EXISTING SANITARY SEWER

EXISTING COMCAST

EXIST. RIGHT OF WAY LINE

EXISTING UTILITY POLE

EXISTING LIGHT POLE

℄ CONSTR. MD 190 W.B. ALT.3

℄ CONSTR. MD 190 E.B. ALT.3

BRAEBURN PARKWAY

EXISTING 60" WATER LINE

200' ACCEL LANE

180' TAPER

245' TURN LANE

EXISTING HIB

EXISTING GAS

EXISTING UNKNOWN UTILITY

EXISTING AERIAL UTILITIES

EXISTING 24" GAS LINE

PYLE ROAD

MD 190 (RIVER ROAD)

MARYLAND 190

PC Sta 308+30.70

PT Sta 312+35.15

PC Sta 108+34.58

PT Sta 112+41.74

S 59° 13' 57.79" E

N 478550 E 1274600

N 478550 E 1274060

N 478050 E 1274600

H3 H4 H5 H6 H7

PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 3

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

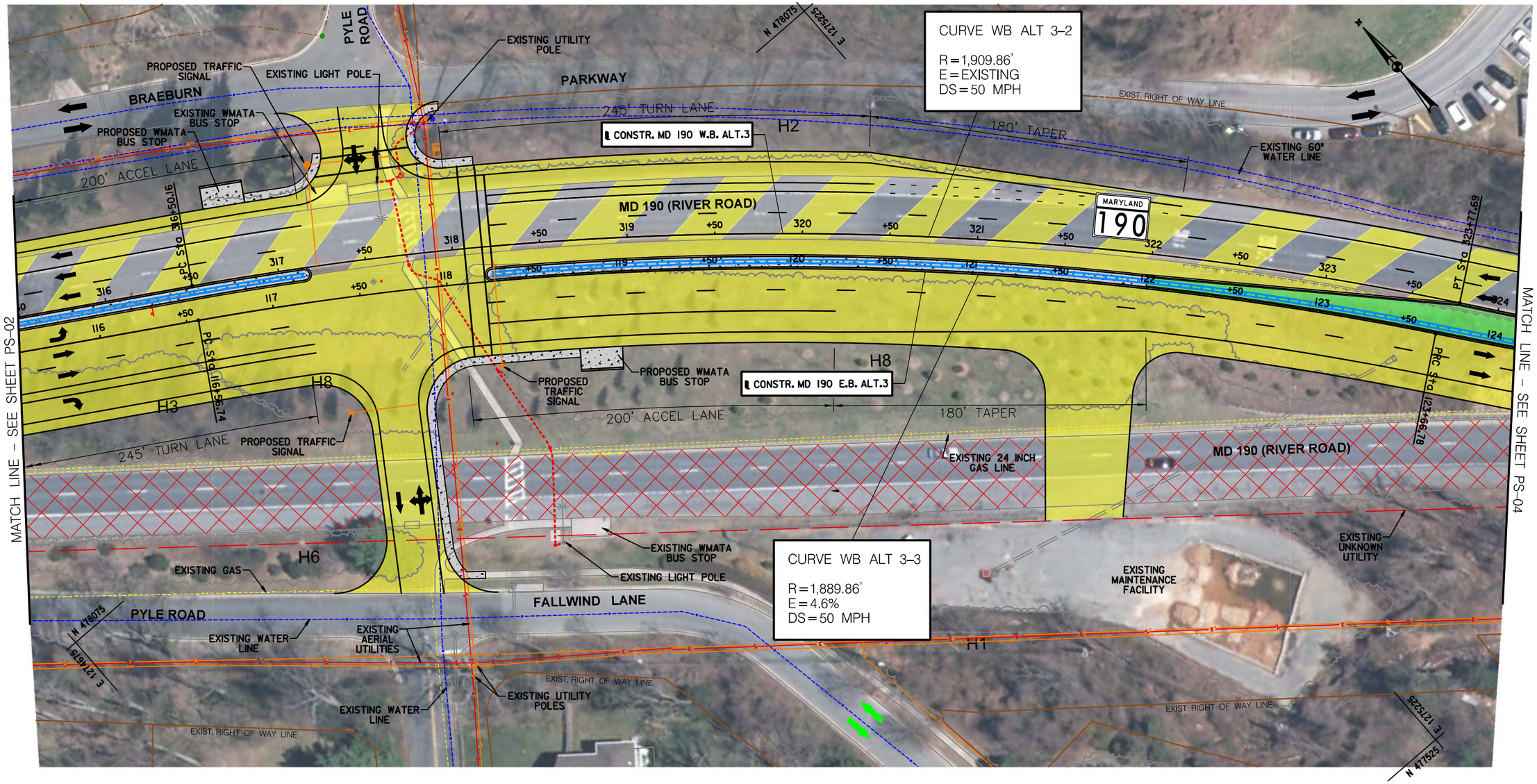
DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

PLOTTED: Friday, April 07, 2017 AT 07:28 AM
FILE: \\baltsrv04\v2013\13103_d3_traffic\Task 23 – MI

FIGURE D2

TO MD 188

TO MD 614



PAVEMENT LEGEND

- FULL-DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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MD 190 AT PYLE ROAD INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 3

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____

COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE D3

PLOTTED: Friday, April 07, 2017 AT 07:30 AM
FILE: \\baltenv04\v2013\2013\13103_d3_traffic\Task 23 - MI
BY: agrubb -

TO MD 188

TO MD 614

MATCH LINE – SEE SHEET PS-03

CURVE EB ALT 3–3

R = 2,546.28
E = EXISTING
DS = 50 MPH

N 477450
E 1275850

LIMIT OF WORK
MO9815176
MD190 INTERSECTION STUDY
STA. 129+50.00

EXISTING 60" WATER LINE

EXIST. RIGHT OF WAY LINE

H2

℄ CONSTR. MD 190 W.B. ALT.3

PC Sta 325+14.70

PT Sta 332+49.82

MARYLAND 190

MD 190 (RIVER ROAD)

PT Sta 132+50.54

℄ CONSTR. MD 190 E.B. ALT.3

EXISTING UNKNOWN UTILITY

PTC Sta 125+48.49

H1

EXISTING AERIAL UTILITIES

EXIST. RIGHT OF WAY LINE

N 477450
E 1275350

CURVE WB ALT 3–4

R = 2,826
E = EXISTING
DS = 50 MPH

N 477000
E 1275850

PAVEMENT LEGEND

- FULL–DEPTH ASPHALT PAVEMENT
- PAVEMENT RESURFACING
- PROPOSED SIDEWALK
- GRASS MEDIAN
- PAVEMENT REMOVAL

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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 3

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____

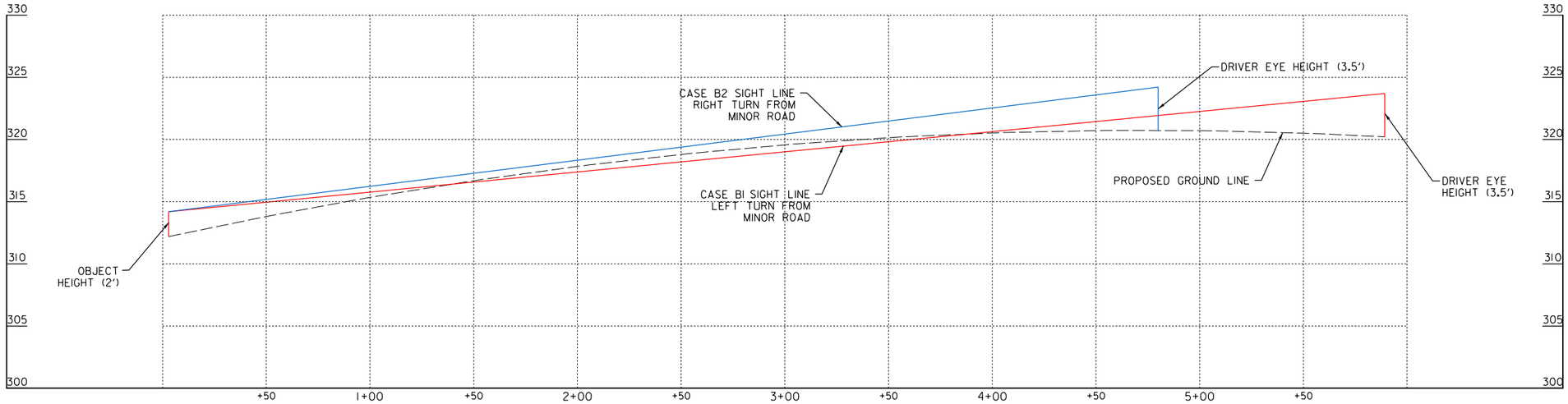
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE D4

PLOTTED: Friday, April 07, 2017 AT 07:49 AM
FILE: \\baltsrv04\vol2013\13103_d3_traffic\Task 23 – MI

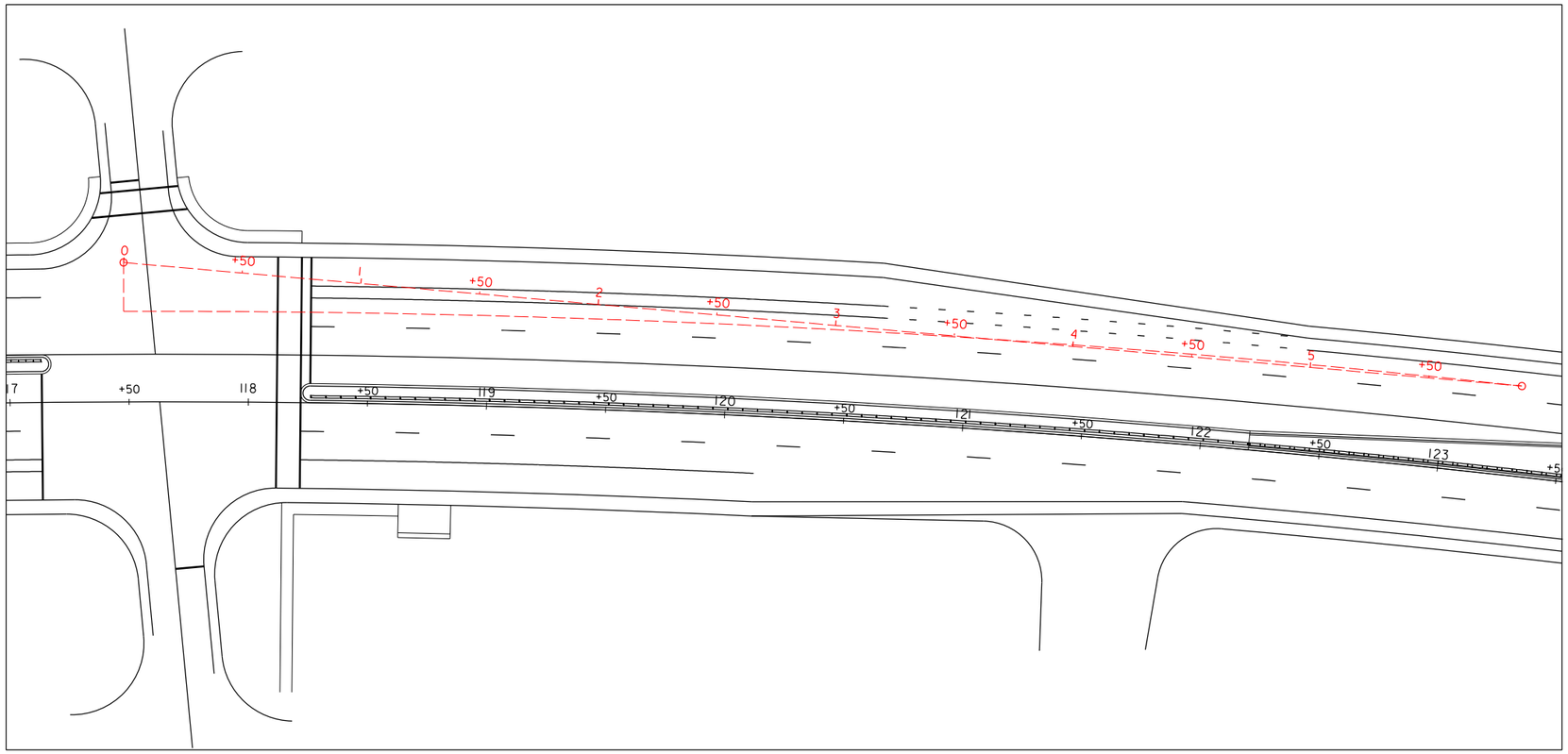
BY: agrubb –

Appendix E
Intersection Sight Triangle Analysis & Autoturn Assessment



MD 190 SIGHT TRIANGLE PROFILE

SCALE: HORIZ. 1" = 30'
VERT. 1" = 5'



MD 190 WB SIGHT TRIANGLE

SCALE: HORIZ. 1" = 30'

DRIVER EYE HEIGHT: 3.5'
OBJECT HEIGHT: 2.0'
PER AASHTO GREEN BOOK 2011
PG 3-14 & 3-15

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BY: cbauernfeind

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HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

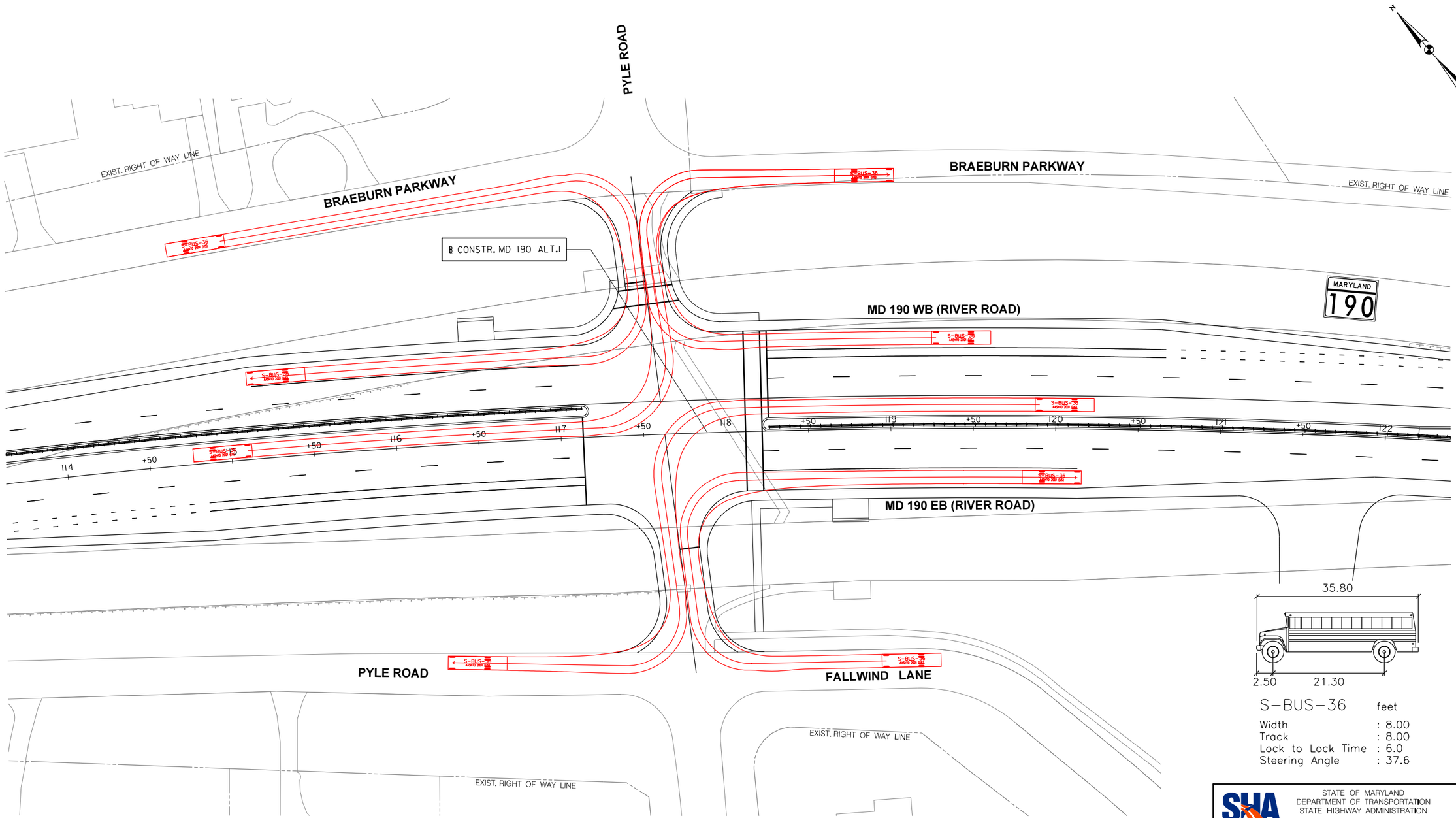
ALTERNATIVE 1 INTERSECTION SIGHT TRIANGLE

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE E1

PLOTTED: Tuesday, March 07, 2017 AT 09:21 AM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 - MI



S-BUS-36 feet

Width	: 8.00
Track	: 8.00
Lock to Lock Time	: 6.0
Steering Angle	: 37.6

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STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

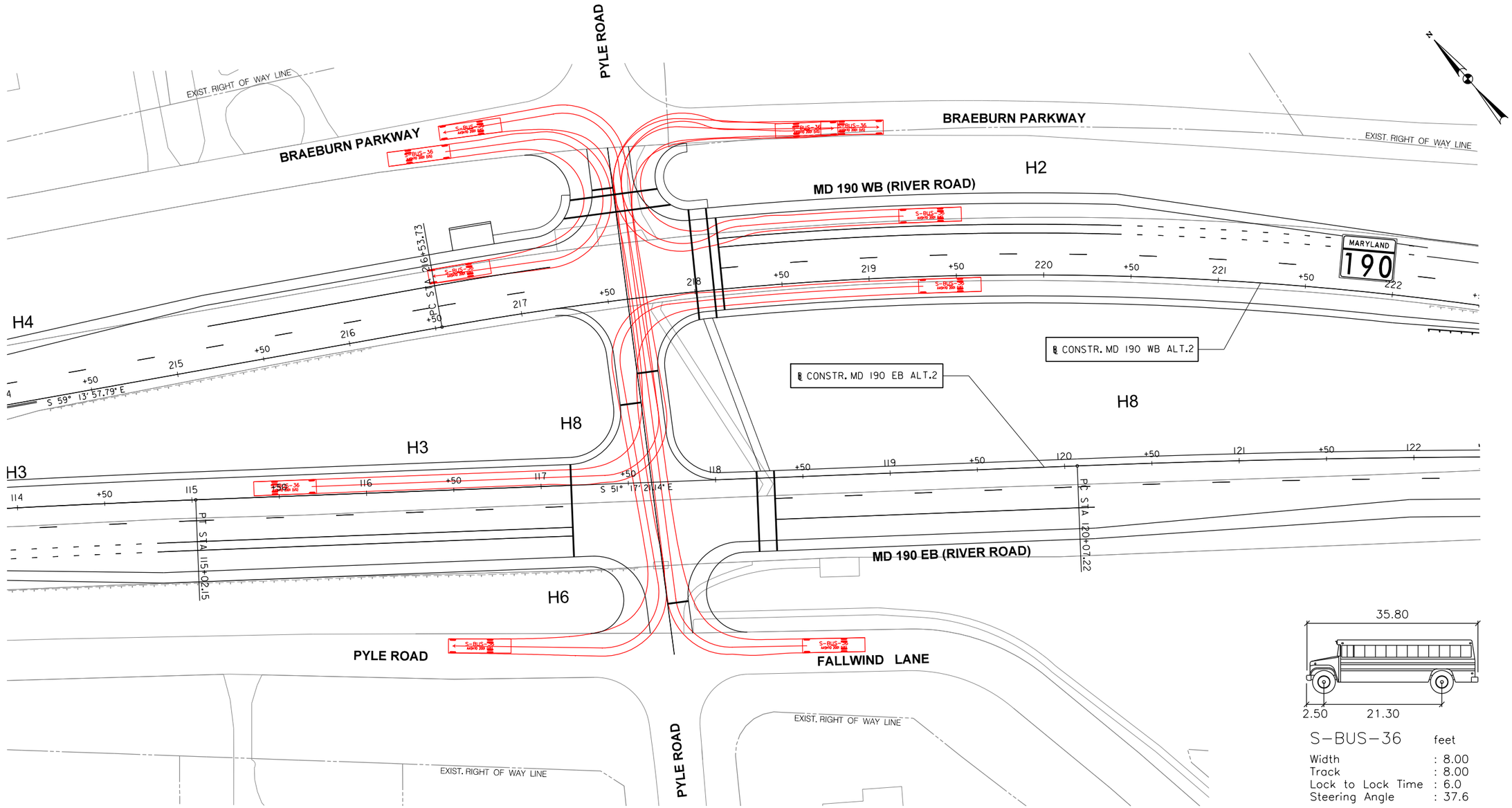
ALTERNATIVE 1 – AUTOTURN

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE E2

PLOTTED: Thursday, April 13, 2017 AT 02:40 PM
FILE: \\baltsvr04\vol2013\13103_s3_traffic\Task 23 – MI



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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

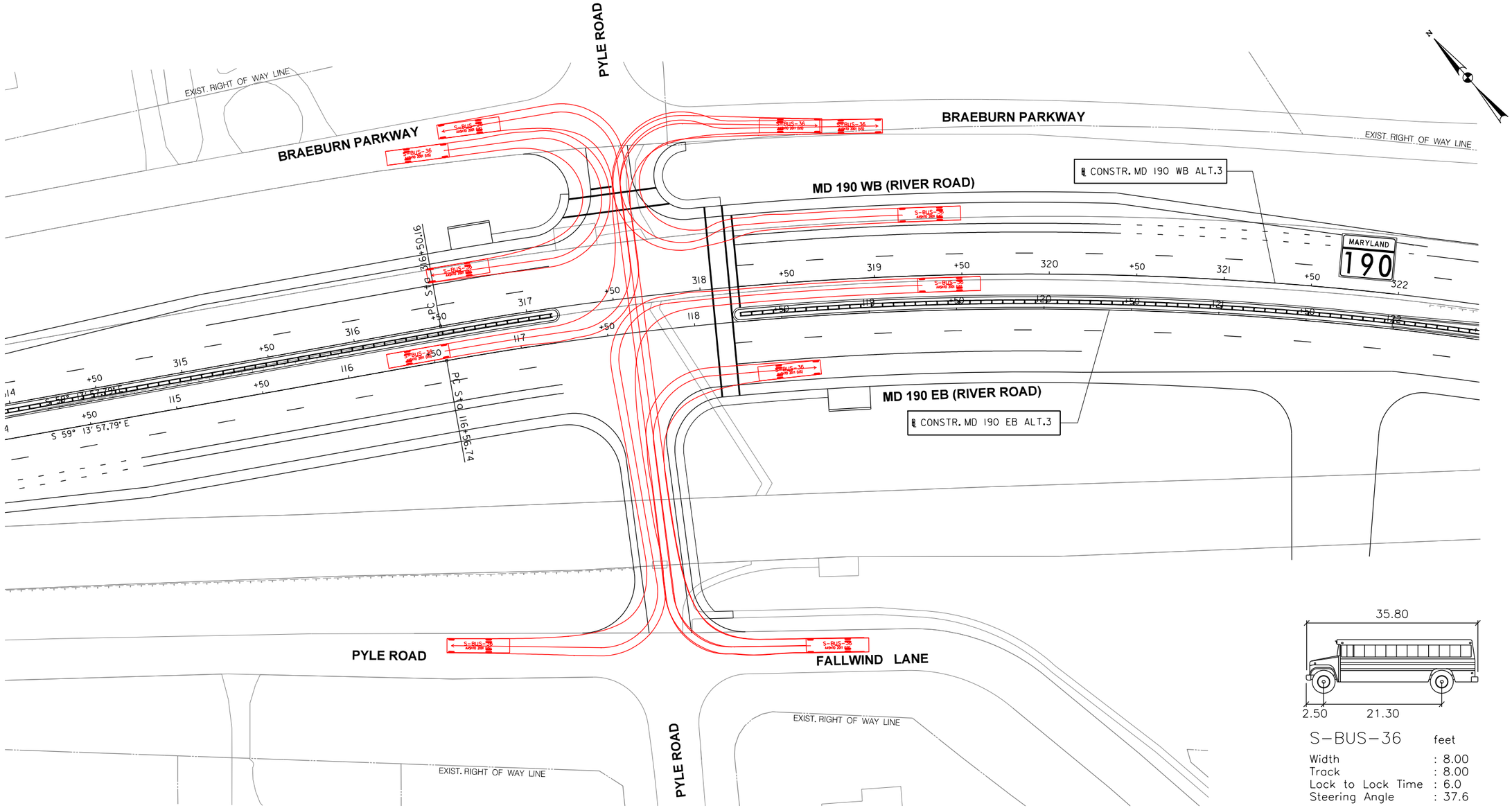
ALTERNATIVE 2 – AUTOTURN

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE E3

PLOTTED: Thursday, April 13, 2017 AT 02:38 PM
FILE: \\balbvs04\v2013\2013\13103_d3_traffic\Task 23 – ME



S-BUS-36 feet

Width	: 8.00
Track	: 8.00
Lock to Lock Time	: 6.0
Steering Angle	: 37.6

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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

ALTERNATIVE 3 – AUTOTURN

SCALE _____ ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY CJB
DRAWN BY AWG
CHECKED BY MVS
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

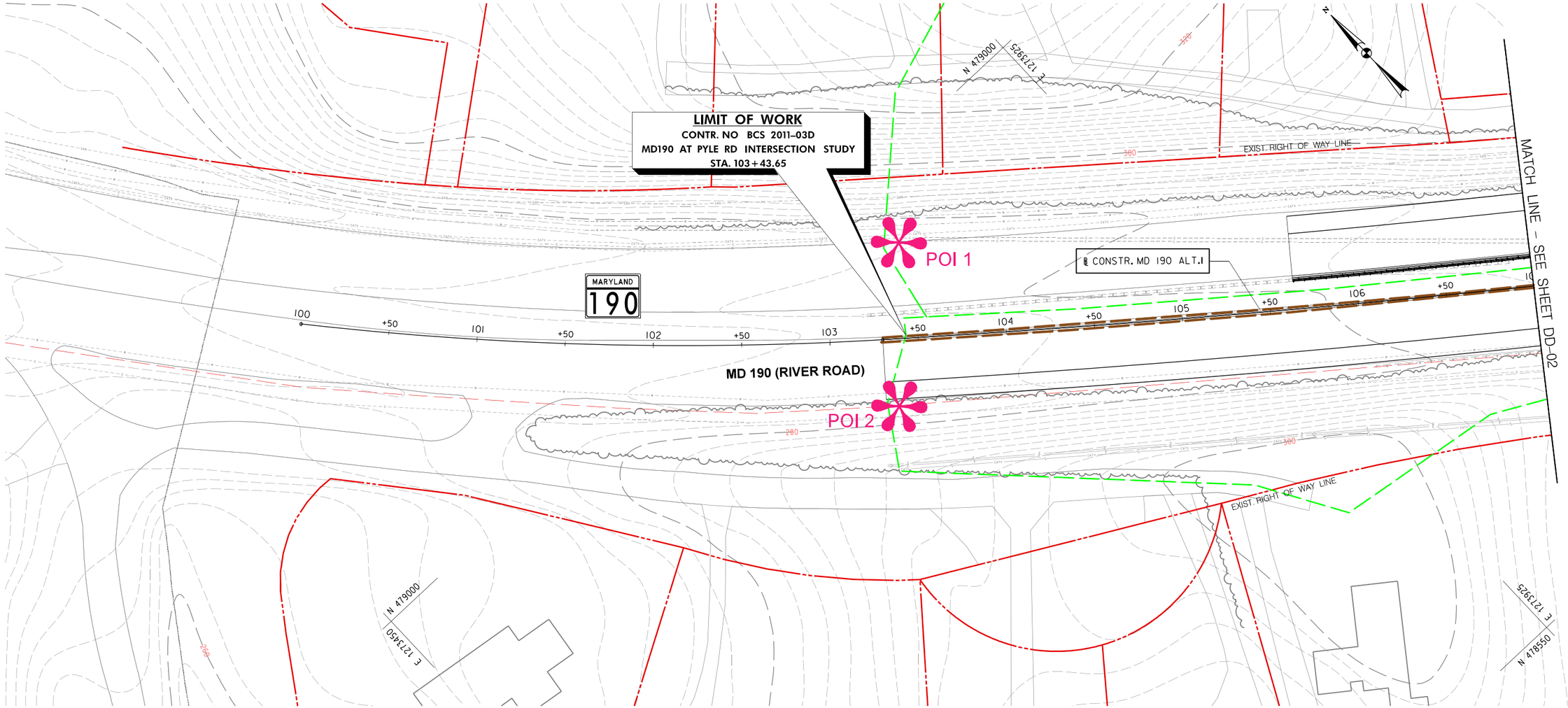
FIGURE E4

PLOTTED: Thursday, April 20, 2017 AT 10:02 AM
FILE: \\baltsv04\v2013\2013\13103_03_traffic\Task 23 – MI

Appendix F
Stormwater Management Plans & Calculations

TO MD 188

TO MD 614



LEGEND

- NEW IMPERVIOUS
- RECONSTRUCTED IMPERVIOUS
- REMOVED IMPERVIOUS
- DRAINAGE AREA TO FACILITY
- STORMWATER STUDY AREA LINE
- DRAINAGE AREA LINE
- PROPOSED STORMWATER FACILITY

NOTE: DRAINAGE AREAS BASED ON PROPOSED TYPICAL SECTIONS

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MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

DRAINAGE / SWM PLAN

SCALE 1" = 30' ADVERTISED DATE _____ CONTRACT NO. _____

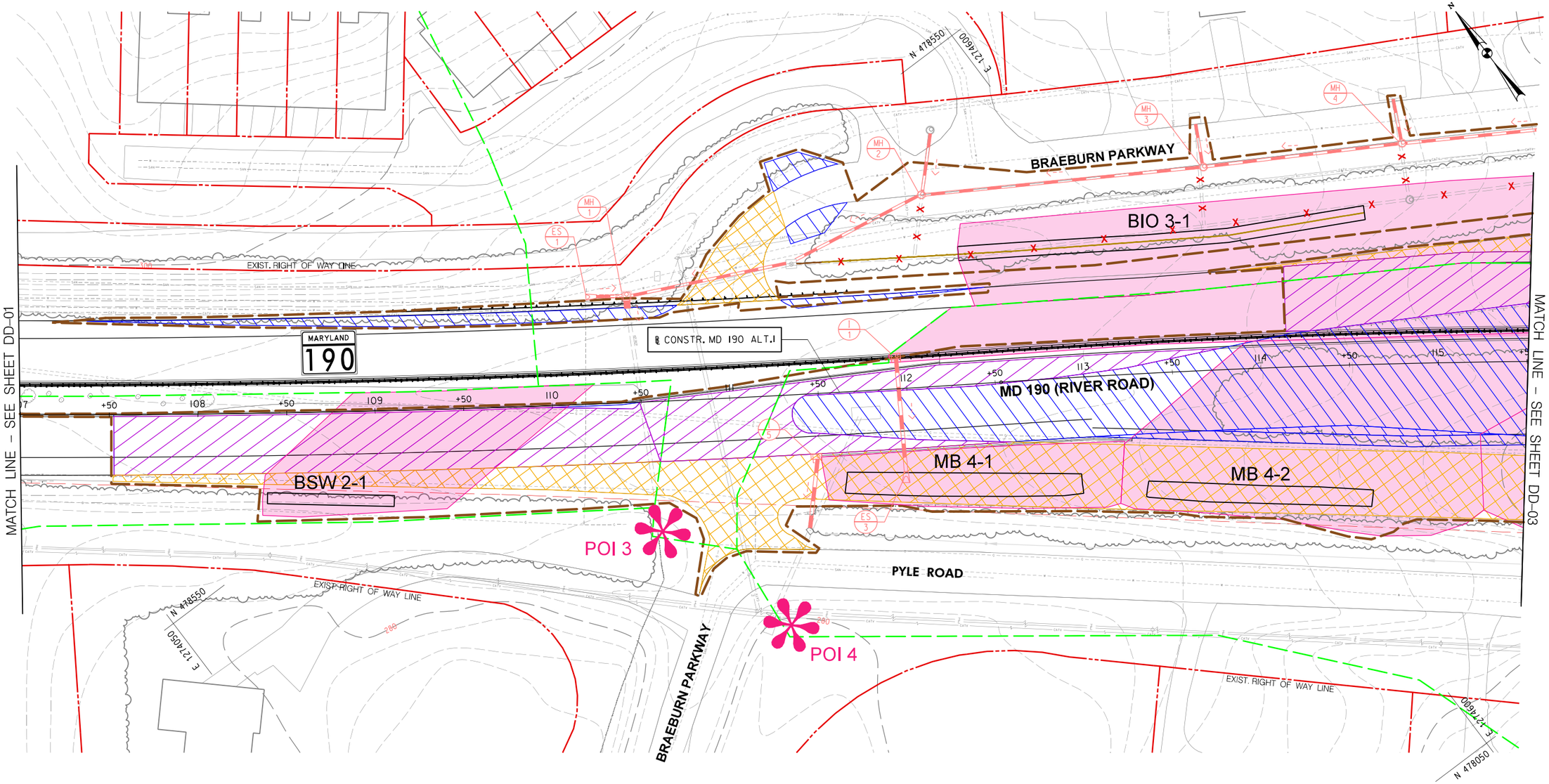
DESIGNED BY AGB / MEG
DRAWN BY DEA
CHECKED BY SBP
F.A.P. NO. _____
COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

PLOTTED: Tuesday, January 24, 2017 AT 05:30 PM
FILE: \\balbv04\v2013\2013\13103_d3_traffic\Task 23 – M

FIGURE F1

TO MD 188

TO MD 614



LEGEND

- NEW IMPERVIOUS
- RECONSTRUCTED IMPERVIOUS
- REMOVED IMPERVIOUS
- DRAINAGE AREA TO FACILITY
- STORMWATER STUDY AREA LINE
- DRAINAGE AREA LINE
- PROPOSED STORMWATER FACILITY

NOTE: DRAINAGE AREAS BASED ON PROPOSED TYPICAL SECTIONS

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

DRAINAGE / SWM PLAN

SCALE 1" = 30' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY AGB / MEG
DRAWN BY DEA
CHECKED BY SBP
F.A.P. NO. _____

COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE F2

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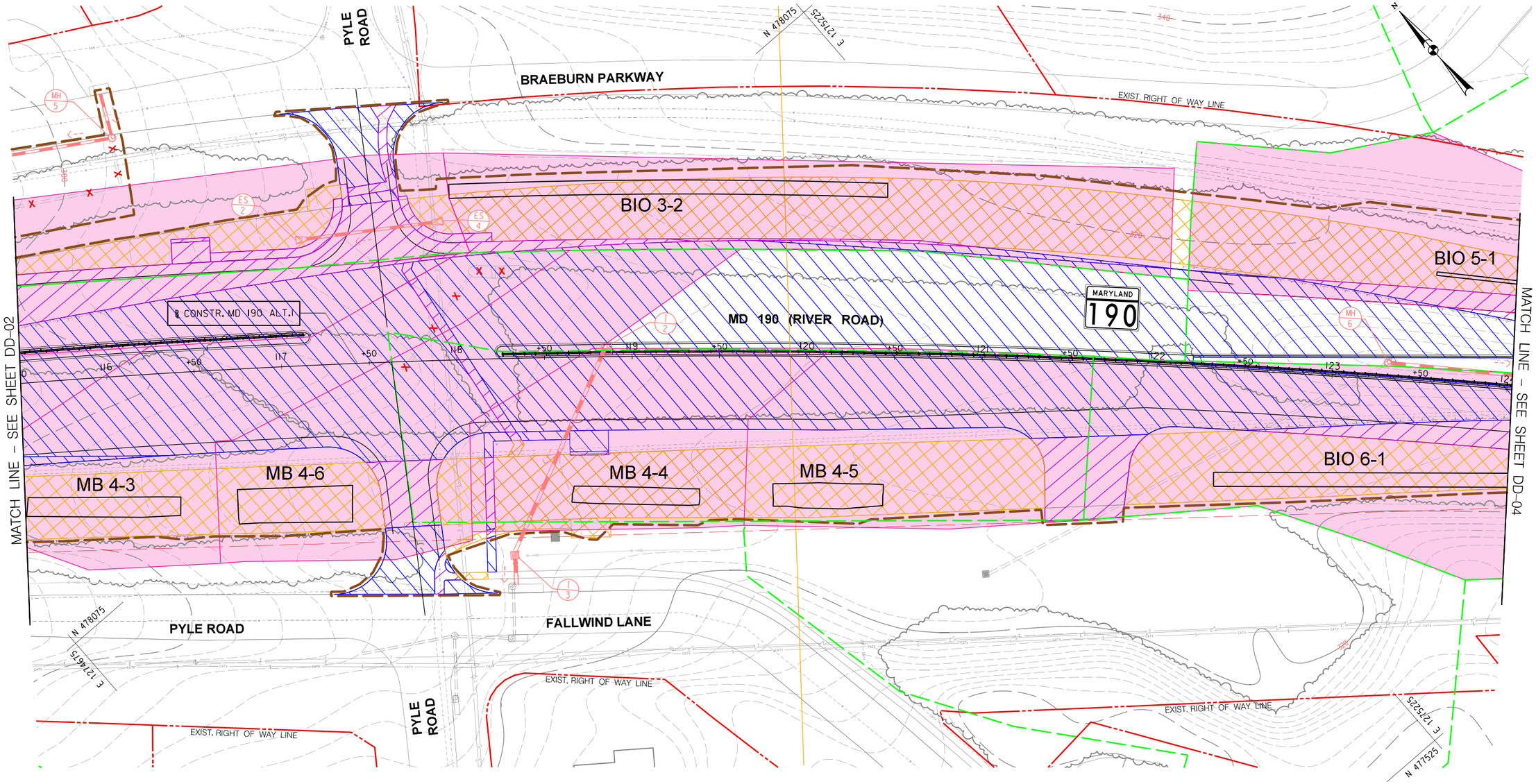
PLOTTED: Wednesday, January 25, 2017 AT 09:41 AM
FILE: \\baltsrv04\v2013\13103_d3_traffic\Task 23 – MI



LEGEND

- NEW IMPERVIOUS
- RECONSTRUCTED IMPERVIOUS
- REMOVED IMPERVIOUS
- DRAINAGE AREA TO FACILITY
- STORMWATER STUDY AREA LINE
- DRAINAGE AREA LINE
- PROPOSED STORMWATER FACILITY

NOTE: DRAINAGE AREAS BASED ON PROPOSED TYPICAL SECTIONS

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HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

DRAINAGE / SWM PLAN

SCALE 1" = 30' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY AGB / MEG
DRAWN BY DEA
CHECKED BY SBP
F.A.P. NO. _____

COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

PLOTTED: Tuesday, January 24, 2017 AT 05:56 PM
FILE: \\baltinv04\v2013\2013\13103_d3_traffic\Task 23 - MI

FIGURE F3

TO MD 188

TO MD 614

MATCH LINE – SEE SHEET DD-03

BIO 5-1

BIO 6-1

EXIST. RIGHT OF WAY LINE

℄ CONSTR. MD 190 ALT.1

MARYLAND 190

MD 190 (RIVER ROAD)

POI 5

POI 6

N 477430

E 1275840

N 477210

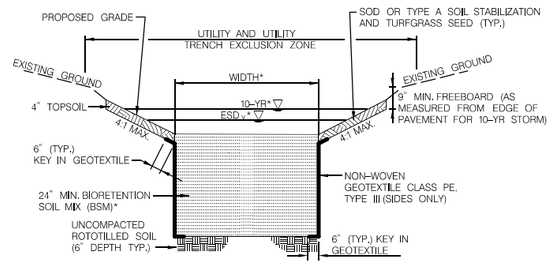
N 477430

E 1275300

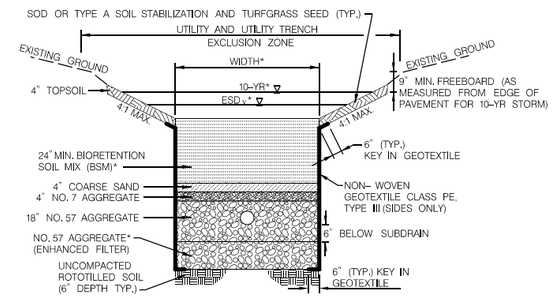
320

300

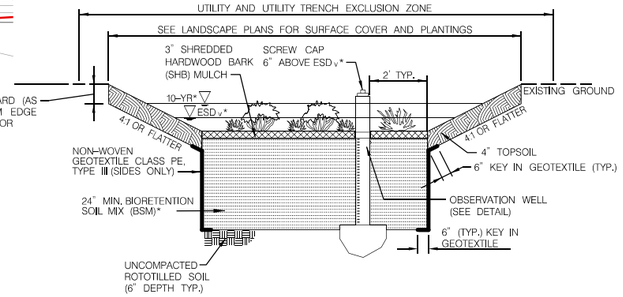
+50 125 +50 126 +50 127 +50 128 +50 129 +50 130



BIO-SWALE TYPICAL SECTION
FOR SOILS A OR B
NOT TO SCALE



BIO-SWALE TYPICAL SECTION
FOR SOILS C OR D
NOT TO SCALE



MICRO BIORETENTION
FOR SOILS A OR B
NOT TO SCALE

LEGEND

- NEW IMPERVIOUS
- RECONSTRUCTED IMPERVIOUS
- REMOVED IMPERVIOUS
- DRAINAGE AREA TO FACILITY
- STORMWATER STUDY AREA LINE
- DRAINAGE AREA LINE
- PROPOSED STORMWATER FACILITY

NOTE: DRAINAGE AREAS BASED ON PROPOSED TYPICAL SECTIONS

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HIGHWAY DESIGN DIVISION

MD 190 AT PYLE ROAD
INTERSECTION SAFETY IMPROVEMENTS

DRAINAGE / SWM PLAN

SCALE 1" = 30' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY AGB / MEG
DRAWN BY DEA
CHECKED BY SRP
F.A.P. NO. _____

COUNTY MONTGOMERY
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

FIGURE F4

PLOTTED: Tuesday, January 24, 2017 AT 05:57 PM
FILE: \\baltsrv04\v2013\2013\13103_d3_traffic\Task 23 – M

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**1**
Design Phase:	Preliminary	**Location:**	**Sta 103+50 LT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	0 ft²	= 0.00 acres
C soils	922 ft²	= 0.02 acres
D soils	0 ft²	= 0.00 acres
Total Site Area =	922 ft²	= 0.02 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	0 ft²	*B soils*	0 ft²	*B soils*	0 ft²
C soils	922 ft²	*C soils*	0 ft²	*C soils*	0 ft²
D soils	0 ft²	*D soils*	0 ft²	*D soils*	0 ft²

Existing Impervious Area =	*0 ft²*	= 0.00 acres
Proposed Impervious Area =	*922 ft²*	= 0.02 acres

POI CLASSIFICATION

% Impervious Area = $\frac{0\ ft^2}{922\ ft^2}$ = 0.00 %

NEW DEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel.})(Rv_{new\ devel.})(IA_{new})}{12} + \frac{(1")(Rv_{redevel.})(0.5*IA_{redevel.})}{12} - \frac{(1")(Rv_{redevel.})(0.5*IA_{removed})}{12}$$

$$PE_{new\ devel.} = \frac{\text{A Soil Area (2.6")} + \text{B Soil Area (2.6")} + \text{C Soil Area (2.2")} + \text{D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{new\ devel.}$ = 2.2000 --> 2.2

$$ESD_v = \frac{(2.2\ in)\ (0.95)\ (922 + 0\ SF) - (1\ in)\ (0.95)\ (0)}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

ESD_v = **161 CF**

IART = *922 ft²* **= 0.02 acres**

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**2**
Design Phase:	Preliminary	**Location:**	**Sta 103+50 RT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	0 ft²	= 0.00 acres
C soils	25,198 ft²	= 0.58 acres
D soils	871 ft²	= 0.02 acres
Total Site Area =	26,069 ft²	= 0.60 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	0 ft²	*B soils*	0 ft²	*B soils*	0 ft²
C soils	58 ft²	*C soils*	9,738 ft²	*C soils*	2,328 ft²
D soils	0 ft²	*D soils*	255 ft²	*D soils*	390 ft²

Existing Impervious Area =	*12,711 ft²*	= 0.29 acres
Proposed Impervious Area =	*10,051 ft²*	= 0.23 acres

POI CLASSIFICATION

$$\% \text{ Impervious Area} = \frac{12{,}711\ ft^2}{26{,}069\ ft^2} = 48.76\ \%$$

REDEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel.})(Rv_{new\ devel.})(IA_{new})}{12} + \frac{(1")(Rv_{redevel.})(0.5*IA_{redevel.})}{12} - \frac{(1")(Rv_{redevel.})(0.5*IA_{removed})}{12}$$

$$PE_{new\ devel.} = \frac{\text{A Soil Area (2.6")} + \text{B Soil Area (2.6")} + \text{C Soil Area (2.2")} + \text{D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{new\ devel.}$ = 2.1933 --> 2.19

$$ESD_v = \frac{(2.19\ in)(0.95)(58\ SF) + (1\ in)(0.95)(0.5 * 9992.8\ SF) - (1\ in)(0.95)(0.5 * 2718\ SF)}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

ESD_v = **298 CF**

IART = *8,692 ft²* **= 0.20 acres**

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/23/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**3**
Design Phase:	Preliminary	**Location:**	**Sta 110+50 RT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	50,498 ft²	= 1.16 acres
C soils	1,951 ft²	= 0.04 acres
D soils	16,162 ft²	= 0.37 acres
Total Site Area =	68,611 ft²	= 1.58 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	3,481 ft²	*B soils*	6,098 ft²	*B soils*	18,413 ft²
C soils	195 ft²	*C soils*	8 ft²	*C soils*	929 ft²
D soils	1,038 ft²	*D soils*	2,176 ft²	*D soils*	2,511 ft²

Existing Impervious Area =	*30,136 ft²*	= 0.69 acres
Proposed Impervious Area =	*12,996 ft²*	= 0.30 acres

POI CLASSIFICATION

$$\text{\% Impervious Area} = \frac{30{,}136\ ft^2}{68{,}611\ ft^2} = 43.92\ \%$$

REDEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel})(Rv_{new\ devel})(IA_{new})}{12} + \frac{(1")(Rv_{redevel})(0.5*IA_{redevel})}{12} - \frac{(1")(Rv_{redevel})(0.5*IA_{removed})}{12}$$

$$PE_{\text{new devel.}} = \frac{\text{A Soil Area (2.6")} + \text{B Soil Area (2.6")} + \text{C Soil Area (2.2")} + \text{D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{\text{new devel.}} =$ 2.4473 --> 2.45

$$ESD_v = \frac{(2.45\ in)(0.95)(4713.7937\ SF) + (1\ in)(0.95)(0.5 * 8282.6724\ SF) - (1\ in)(0.95)(0.5 * 21853.5299\ SF)}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

$ESD_v =$ **377 CF**

IART = *2,070 ft²* **= 0.05 acres**

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Location:**	**Sta 111+50 RT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	148,661 ft²	= 3.41 acres
C soils	0 ft²	= 0.00 acres
D soils	10,562 ft²	= 0.24 acres
Total Site Area =	159,223 ft²	= 3.66 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	82,199 ft²	*B soils*	10,995 ft²	*B soils*	34,265 ft²
C soils	0 ft²	*C soils*	0 ft²	*C soils*	0 ft²
D soils	1,918 ft²	*D soils*	2,233 ft²	*D soils*	2,913 ft²

Existing Impervious Area =	*73,217 ft²*	= 1.68 acres
Proposed Impervious Area =	*97,345 ft²*	= 2.23 acres

POI CLASSIFICATION

$$\% \text{ Impervious Area} = \frac{73{,}217\ ft^2}{159{,}223\ ft^2} = 45.98\ \%$$

REDEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel.})(Rv_{new\ devel.})(IA_{new})}{12} + \frac{(1")(Rv_{redevel.})(0.5*IA_{redevel.})}{12} - \frac{(1")(Rv_{redevel.})(0.5*IA_{removed})}{12}$$

$$PE_{new\ devel.} = \frac{\text{A Soil Area (2.6")} + \text{B Soil Area (2.6")} + \text{C Soil Area (2.2")} + \text{D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{new\ devel.}$ = 2.5602 --> 2.56

$$ESD_v = \frac{(2.56\ in)(0.95)(84117\ SF) + (1\ in)(0.95)(0.5 * 13228\ SF) - (1\ in)(0.95)(0.5 * 37178\ SF)}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

ESD_v = **16,100 CF**

IART = *78,756 ft²* **= 1.81 acres**

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/23/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**5**
Design Phase:	Preliminary	**Location:**	**Sta 129+50 LT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	33,998 ft²	= 0.78 acres
C soils	0 ft²	= 0.00 acres
D soils	0 ft²	= 0.00 acres
Total Site Area =	33,998 ft²	= 0.78 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	9,880 ft²	*B soils*	7,561 ft²	*B soils*	8,450 ft²
C soils	0 ft²	*C soils*	0 ft²	*C soils*	0 ft²
D soils	0 ft²	*D soils*	0 ft²	*D soils*	0 ft²

Existing Impervious Area =	*16,011 ft²*	= 0.37 acres
Proposed Impervious Area =	*17,441 ft²*	= 0.40 acres

POI CLASSIFICATION

$$\text{\% Impervious Area} = \frac{16{,}011\ ft^2}{33{,}998\ ft^2} = 47.09\ \%$$

REDEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel.})(Rv_{new\ devel.})(IA_{new})}{12} + \frac{(1")(Rv_{redevel.})(0.5*IA_{redevel.})}{12} - \frac{(1")(Rv_{redevel.})(0.5*IA_{removed})}{12}$$

$$PE_{new\ devel.} = \frac{\text{A Soil Area (2.6") + B Soil Area (2.6") + C Soil Area (2.2") + D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{new\ devel.}$ = 2.6000 --> 2.6

$$ESD_v = \frac{(2.6\text{ in})(0.95)(9880.3621\text{ SF}) + (1\text{ in})(0.95)(0.5 * 7561\text{ SF}) - (1\text{ in})(0.95)(0.5 * 8450.3256\text{ SF})}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

ESD_v = **1,999 CF**

IART = *13,216 ft²* **= 0.30 acres**

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/23/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**6**
Design Phase:	Preliminary	**Location:**	**Sta 128+00 RT**

Required Stormwater Management Calculations

STORMWATER SITE AREA CHARACTERISTICS

Input Cell

Site Area by Soil Type:

A soils	0 ft²	= 0.00 acres
B soils	36,235 ft²	= 0.83 acres
C soils	0 ft²	= 0.00 acres
D soils	0 ft²	= 0.00 acres
Total Site Area =	36,235 ft²	= 0.83 acres

New Impervious Area by Soil Type (IA_{new}):		*Redeveloped Imp Area by Soil Type ($IA_{redevel}$):*		*Removed Imp. Area by Soil Type ($IA_{removed}$):*	
A soils	0 ft²	*A soils*	0 ft²	*A soils*	0 ft²
B soils	10,725 ft²	*B soils*	10,718 ft²	*B soils*	10,131 ft²
C soils	0 ft²	*C soils*	0 ft²	*C soils*	0 ft²
D soils	0 ft²	*D soils*	0 ft²	*D soils*	0 ft²

Existing Impervious Area =	*20,849 ft²*	= 0.48 acres
Proposed Impervious Area =	*21,443 ft²*	= 0.49 acres

POI CLASSIFICATION

$$\text{\% Impervious Area} = \frac{20{,}849\ ft^2}{36{,}235\ ft^2} = 57.54\ \%$$

REDEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS

$$IART = 100\%(IA_{NEW}) + 100\%(IA_{REDEVEL}) - 50\%(IA_{REMOVED})$$

$$ESDv = \frac{(PE_{new\ devel.})(Rv_{new\ devel.})(IA_{new})}{12} + \frac{(1")(Rv_{redevel.})(0.5*IA_{redevel.})}{12} - \frac{(1")(Rv_{redevel.})(0.5*IA_{removed})}{12}$$

$$PE_{new\ devel.} = \frac{\text{A Soil Area (2.6") + B Soil Area (2.6") + C Soil Area (2.2") + D Soil Area (2.0")}}{\text{Total Area}}$$

$PE_{new\ devel.}$ = 2.6000 --> 2.6

$$ESD_v = \frac{(2.6\text{ in})(0.95)(10725\text{ SF}) + (1\text{ in})(0.95)(0.5 * 10718\text{ SF}) - (1\text{ in})(0.95)(0.5 * 10130.5845\text{ SF})}{12}$$

Note: For new development POIs, all disturbed impervious area must be treated at 100%.

ESD_v = **2,231 CF**

IART = *16,378 ft²* **= 0.38 acres**

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**2**
Design Phase:	Preliminary	**Facility No:**	**2-1**
		Location:	**Sta 108+40-109+10 RT**

M-8: Bio-swale Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target P_E (1.0 to 2.6 inches) ---> will be iterative based on site constraints	
Contributing Area (A) =	8651	sf.	---------->	0.20 ac.
Contributing Impervious Area (A_i) =	4560	sf.	---------->	0.10 ac.
Percent Impervious Area ($\%_{IMP}$) =	52.7	% → use	55%	
Volumetric Runoff Coefficient (R_v) =	0.524		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)	
ESDv Required (ESD_v) =	983	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)	

Step 2: Assume Bio-swale Dimensions:

Bioswale Length (L) =	72	ft.		
Bioswale Bottom Width (W) =	5	ft.		A_f/A =
Bioswale Surface Area (A_f) =	360	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	8%
Left Side Slope (S_{S1}) =	0.25	ft/ft	= 3:1 or flatter	
Right Side Slope (S_{S2}) =	0.25	ft/ft	= 3:1 or flatter	
Bioswale Slope (S_L) =	0.01	ft/ft	= 4% maximum longitudinal slope	

Step 3: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	55.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	7.9%		= filter bed area divided by impervious area (A_f/A_i)
ESD_v Required (ESD_v) =	983	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-S}$) =	52.1%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S) =	512	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**2**
Design Phase:	Preliminary	**Facility No:**	**2-1**
		Location:	**Sta 108+40-109+10 RT**

Step 4: Determine Surface Storage Provided by Bio-swale:

Check Dam Top Width (CD_W) =	1.00	ft.	
Check Dam Slope (S_{CD}) =	0.17	ft/ft	= max. slope 6:1 in clear zone and 3:1 outside the clear zone
Check Dam Height (CD_H) =	1.00	ft.	= max. 6" in the clear zone and 12" outside the clear zone
Maximal Length of Storage (L_{max}) =	100.00	ft.	= CD_H / S_L, If less than 50 ft. a minimum of 50 ft is used.
Length of Storage (L_S) =	50.00	ft.	= Length must be ≥ 50 ft and < L_{max}
Check Dam Length (CD_L) =	13.00	ft.	= $2 * CD_H / S_{CD} + CD_W$
Check Dam Spacing (CD_S) =	63.00	ft.	= $L_S + CD_L$
Number of cells (C) =	1.00		= L / CD_S
Minimal Storage Depth (d_{min}) =	0.50	ft.	= $S_L * (L_{max} - L_S)$

Surface Storage Per Cell (V_C) = $CD_H^3 / (6 * S_L * S_{S1}) + CD_H^3 / (6 * S_L * S_{S2}) + CD_H^2 * W / (2 * S_L)$
$- d_{min}^3 / (6 * S_L * S_{S1}) - d_{min}^3 / (6 * S_L * S_{S2}) - d_{min}^2 * W / (2 * S_L)$
= 304.17 cf.

Total Surface Storage Provided (V_T) = 347.63 cf. = $V_C * C + ((L - CD_S * C) * V_C / CD_S)$

Step 5: Determine Treatment Provided by the Bio-swale:

Min. Surface Storage Required (V_{S-R}) =	512	cf.	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Surface Storage Provided (V_{S-P}) =	347.6	cf.	= total volume from step 3
Percent Surface Storage Provided ($V_{\%-S}$) =	35%		= percent surface storage provided based on a Pe of 2.6 inches

Because the proposed facility does not provide enough surface storage to treat the target Pe, iterations will need to be done to determine the reduced

			Percent Storage		Actual >
From	P_E	ESD_v	Required	Actual	Required
	in.	cf.	%	%	Y/N
Table	1.70	643	50.53%	54.09%	Yes
Iteration	1.79	677	51.05%	51.35%	Yes
Table	1.80	680	51.11%	51.09%	No

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

The Pe credited is 1.79 in. and the ESDv credited is 677 cf.

Step 6: Determine the Impervious Area Treated by the Bio-swale:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.10	1.79	0.13

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 7: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media = C *underdrain is not required in A/B soils*

Underdrain is Required.

Project: MD 190 at Pyle Rd
County/Gr: Montgomery
Watershed:
SHA Project Number:
RKK Project Number: 13103-23
Design Phase: Preliminary

Designed By: MEG
Checked By: SBP
Approved By:
Date: 1/24/2017

POI: 3
Facility No: 3-1
Location: Sta 112+35 to 114+50 LT

M-8: Bio-swale Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target P_E (1.0 to 2.6 inches) ---> will be iterative based on site constraints	
Contributing Area (A) =	29570.4354	sf.	---------->	0.68 ac.
Contributing Impervious Area (A_i) =	6733.9777	sf.	---------->	0.15 ac.
Percent Impervious Area ($\%_{IMP}$) =	22.8	% → use	25%	
Volumetric Runoff Coefficient (R_v) =	0.255		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)	
ESDv Required (ESD_v) =	1633	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)	

Step 2: Assume Bio-swale Dimensions:

Bioswale Length (L) =	230	ft.		
Bioswale Bottom Width (W) =	8	ft.		A_f/A =
Bioswale Surface Area (A_f) =	1840	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	27%
Left Side Slope (S_{S1}) =	0.25	ft/ft	= 3:1 or flatter	
Right Side Slope (S_{S2}) =	0.25	ft/ft	= 3:1 or flatter	
Bioswale Slope (S_L) =	0.04	ft/ft	= 4% maximum longitudinal slope	

Step 3: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	25.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	27.3%		= filter bed area divided by impervious area (A_f/A_i)
ESD_v Required (ESD_v) =	1633	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-S}$) =	35.1%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S) =	573	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai 2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	MEG
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**3**
Design Phase:	Preliminary	**Facility No:**	**3-1**
		Location:	**Sta 112+35 to 114+50 LT**

Step 4: Determine Surface Storage Provided by Bio-swale:

Check Dam Top Width (CD_W) =	1.00	ft.	
Check Dam Slope (S_{CD}) =	0.17	ft/ft	= max. slope 6:1 in clear zone and 3:1 outside the clear zone
Check Dam Height (CD_H) =	1.00	ft.	= max. 6" in the clear zone and 12" outside the clear zone
Maximal Length of Storage (L_{max}) =	50.00	ft.	= CD_H / S_L, If less than 50 ft. a minimum of 50 ft is used.
Length of Storage (L_S) =	50.00	ft.	= Length must be ≥ 50 ft and < L_{max}
Check Dam Length (CD_L) =	13.00	ft.	= $2 * CD_H / S_{CD} + CD_W$
Check Dam Spacing (CD_S) =	63.00	ft.	= $L_S + CD_L$
Number of cells (C) =	3.00		= L / CD_S
Minimal Storage Depth (d_{min}) =	0.00	ft.	= $S_L * (L_{max} - L_S)$

Surface Storage Per Cell (V_C) = $CD_H^3 / (6 * S_L * S_{S1}) + CD_H^3 / (6 * S_L * S_{S2}) + CD_H^2 * W / (2 * S_L)$
$- d_{min}^3 / (6 * S_L * S_{S1}) - d_{min}^3 / (6 * S_L * S_{S2}) - d_{min}^2 * W / (2 * S_L)$

= 133.33 cf.

Total Surface Storage Provided (V_T) = 486.79 cf. = $V_C * C + ((L - CD_S * C) * V_C / CD_S)$

Step 5: Determine Treatment Provided by the Bio-swale:

Min. Surface Storage Required (V_{S-R}) =	573	cf.	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Surface Storage Provided (V_{S-P}) =	486.8	cf.	= total volume from step 3
Percent Surface Storage Provided ($V_{\%-S}$) =	30%		= percent surface storage provided based on a Pe of 2.6 inches

Because the proposed facility does not provide enough surface storage to treat the target Pe, iterations will need to be done to determine the reduced

			Percent Storage		Actual > Required
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.20	1382	35.07%	35.22%	Yes
Iteration	2.21	1388	35.07%	35.07%	Yes
Table	2.30	1445	35.07%	33.69%	No

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

The Pe credited is 2.21 in. and the ESDv credited is 1388 cf.

Step 6: Determine the Impervious Area Treated by the Bio-swale:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.15	2.21	0.20

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 7: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media = D *underdrain is not required in A/B soils*

Underdrain is Required.

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**3**
Design Phase:	Preliminary	**Facility No:**	**3-2**
		Location:	**Sta 118+00 to 120+50 LT**

M-8: Bio-swale Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target P_E (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	22119	sf.	---------->	0.51	ac.
Contributing Impervious Area (A_i) =	2303	sf.	---------->	0.05	ac.
Percent Impervious Area ($\%_{IMP}$) =	10.4	% → use	15%		
Volumetric Runoff Coefficient (R_v) =	0.144		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
ESDv Required (ESD_v) =	689	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Bio-swale Dimensions:

Bioswale Length (L) =	100	ft.		
Bioswale Bottom Width (W) =	8	ft.		A_f/A =
Bioswale Surface Area (A_f) =	800	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	35%
Left Side Slope (S_{S1}) =	0.25	ft/ft	= 3:1 or flatter	
Right Side Slope (S_{S2}) =	0.25	ft/ft	= 3:1 or flatter	
Bioswale Slope (S_L) =	0.04	ft/ft	= 4% maximum longitudinal slope	

Step 3: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	15.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	34.7%		= filter bed area divided by impervious area (A_f/A_i)
ESD_v Required (ESD_v) =	689	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-S}$) =	28.1%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S) =	194	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**3**
Design Phase:	Preliminary	**Facility No:**	**3-2**
		Location:	**Sta 118+00 to 120+50 LT**

Step 4: Determine Surface Storage Provided by Bio-swale:

Check Dam Top Width (CD_W) =	1.00	ft.	
Check Dam Slope (S_{CD}) =	0.17	ft/ft	= max. slope 6:1 in clear zone and 3:1 outside the clear zone
Check Dam Height (CD_H) =	1.00	ft.	= max. 6" in the clear zone and 12" outside the clear zone
Maximal Length of Storage (L_{max}) =	50.00	ft.	= CD_H / S_L, If less than 50 ft. a minimum of 50 ft is used.
Length of Storage (L_S) =	50.00	ft.	= Length must be ≥ 50 ft and < L_{max}
Check Dam Length (CD_L) =	13.00	ft.	= $2 * CD_H / S_{CD} + CD_W$
Check Dam Spacing (CD_S) =	63.00	ft.	= $L_S + CD_L$
Number of cells (C) =	1.00		= L / CD_S
Minimal Storage Depth (d_{min}) =	0.00	ft.	= $S_L * (L_{max} - L_S)$

Surface Storage Per Cell (V_C) = $CD_H^3 / (6 * S_L * S_{S1}) + CD_H^3 / (6 * S_L * S_{S2}) + CD_H^2 * W / (2 * S_L)$
$- d_{min}^3 / (6 * S_L * S_{S1}) - d_{min}^3 / (6 * S_L * S_{S2}) - d_{min}^2 * W / (2 * S_L)$
= 133.33 cf.

Total Surface Storage Provided (V_T) = 211.65 cf. = $V_C * C + ((L - CD_S * C) * V_C / CD_S)$

Step 5: Determine Treatment Provided by the Bio-swale:

Min. Surface Storage Required ($V_{S\text{-}R}$) =	194	cf.	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Surface Storage Provided ($V_{S\text{-}P}$) =	211.6	cf.	= total volume from step 3
Percent Surface Storage Provided ($V_{\%\text{-}S}$) =	31%		= percent surface storage provided based on a Pe of 2.6 inches

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		Actual > Required
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	689	28.11%	30.73%	Yes
Iteration	2.60	689	28.11%	30.72%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 689.

Step 6: Determine the Impervious Area Treated by the Bio-swale:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.05	2.60	0.07

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 7: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media = B *underdrain is not required in A/B soils*

Underdrain is not Required

Project: MD 190 at Pyle Rd
County/Gr: Montgomery
Watershed:
SHA Project Number:
RKK Project Number: 13103-23
Design Phase: Preliminary

Designed By: DES
Checked By: SBP
Approved By:
Date: 1/24/2017

POI: 5
Facility No: 5-1
Location: Sta 123+50 to 125+00 LT

M-8: Bio-swale Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target P_E (1.0 to 2.6 inches) ---> will be iterative based on site constraints	
Contributing Area (A) =	25093	sf.	---------->	0.58 ac.
Contributing Impervious Area (A_i) =	2891	sf.	---------->	0.07 ac.
Percent Impervious Area ($\%_{IMP}$) =	11.5	% → use	15%	
Volumetric Runoff Coefficient (R_v) =	0.154		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)	
ESDv Required (ESD_v) =	836	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)	

Step 2: Assume Bio-swale Dimensions:

Bioswale Length (L) =	150	ft.		
Bioswale Bottom Width (W) =	2	ft.		A_f/A =
Bioswale Surface Area (A_f) =	300	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	10%
Left Side Slope (S_{S1}) =	0.25	ft/ft	= 3:1 or flatter	
Right Side Slope (S_{S2}) =	0.25	ft/ft	= 3:1 or flatter	
Bioswale Slope (S_L) =	0.01	ft/ft	= 4% maximum longitudinal slope	

Step 3: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	15.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	10.4%		= filter bed area divided by impervious area (A_f/A_i)
ESD_v Required (ESD_v) =	836	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-S}$) =	42.7%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S) =	357	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai 2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**5**
Design Phase:	Preliminary	**Facility No:**	**5-1**
		Location:	**Sta 123+50 to 125+00 LT**

Step 4: Determine Surface Storage Provided by Bio-swale:

Check Dam Top Width (CD_W) =	1.00	ft.	
Check Dam Slope (S_{CD}) =	0.17	ft/ft	= max. slope 6:1 in clear zone and 3:1 outside the clear zone
Check Dam Height (CD_H) =	1.00	ft.	= max. 6" in the clear zone and 12" outside the clear zone
Maximal Length of Storage (L_{max}) =	100.00	ft.	= CD_H / S_L, If less than 50 ft. a minimum of 50 ft is used.
Length of Storage (L_S) =	50.00	ft.	= Length must be ≥ 50 ft and < L_{max}
Check Dam Length (CD_L) =	13.00	ft.	= $2 * CD_H / S_{CD} + CD_W$
Check Dam Spacing (CD_S) =	63.00	ft.	= $L_S + CD_L$
Number of cells (C) =	2.00		= L / CD_S
Minimal Storage Depth (d_{min}) =	0.50	ft.	= $S_L * (L_{max} - L_S)$

Surface Storage Per Cell (V_C) = $CD_H^3 / (6 * S_L * S_{S1}) + CD_H^3 / (6 * S_L * S_{S2}) + CD_H^2 * W / (2 * S_L)$
$- d_{min}^3 / (6 * S_L * S_{S1}) - d_{min}^3 / (6 * S_L * S_{S2}) - d_{min}^2 * W / (2 * S_L)$
= 191.67 cf.

Total Surface Storage Provided (V_T) = 456.37 cf. = $V_C * C + ((L - CD_S * C) * V_C / CD_S)$

Step 5: Determine Treatment Provided by the Bio-swale:

Min. Surface Storage Required (V_{S-R}) =	357	cf.	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Surface Storage Provided (V_{S-P}) =	456.4	cf.	= total volume from step 3
Percent Surface Storage Provided ($V_{\%-S}$) =	55%		= percent surface storage provided based on a Pe of 2.6 inches

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	836	42.70%	54.62%	Yes
Iteration	2.60	836	42.70%	54.59%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 836.

Step 6: Determine the Impervious Area Treated by the Bio-swale:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.07	2.60	0.09

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 7: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media = B *underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**6**
Design Phase:	Preliminary	**Facility No:**	**6-1**
		Location:	**Sta 122+50 to 124+75 RT**

M-8: Bio-swale Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target P_E (1.0 to 2.6 inches) ---> will be iterative based on site constraints	
Contributing Area (A) =	31238	sf.	---------->	0.72 ac.
Contributing Impervious Area (A_i) =	12345	sf.	---------->	0.28 ac.
Percent Impervious Area ($\%_{IMP}$) =	39.5	% → use	40%	
Volumetric Runoff Coefficient (R_v) =	0.406		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)	
ESDv Required (ESD_v) =	2746	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)	

Step 2: Assume Bio-swale Dimensions:

Bioswale Length (L) =	250	ft.		
Bioswale Bottom Width (W) =	8	ft.		A_f/A =
Bioswale Surface Area (A_f) =	2000	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	16%
Left Side Slope (S_{S1}) =	0.25	ft/ft	= 3:1 or flatter	
Right Side Slope (S_{S2}) =	0.25	ft/ft	= 3:1 or flatter	
Bioswale Slope (S_L) =	0.02	ft/ft	= 4% maximum longitudinal slope	

Step 3: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	40.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	16.2%		= filter bed area divided by impervious area (A_f/A_i)
ESD_v Required (ESD_v) =	2746	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-S}$) =	43.3%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S) =	1189	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**6**
Design Phase:	Preliminary	**Facility No:**	**6-1**
		Location:	**Sta 122+50 to 124+75 RT**

Step 4: Determine Surface Storage Provided by Bio-swale:

Check Dam Top Width (CD_W) =	1.00	ft.	
Check Dam Slope (S_{CD}) =	0.17	ft/ft	= max. slope 6:1 in clear zone and 3:1 outside the clear zone
Check Dam Height (CD_H) =	1.00	ft.	= max. 6" in the clear zone and 12" outside the clear zone
Maximal Length of Storage (L_{max}) =	50.00	ft.	= CD_H / S_L, If less than 50 ft. a minimum of 50 ft is used.
Length of Storage (L_S) =	50.00	ft.	= Length must be ≥ 50 ft and < L_{max}
Check Dam Length (CD_L) =	13.00	ft.	= $2 * CD_H / S_{CD} + CD_W$
Check Dam Spacing (CD_S) =	63.00	ft.	= $L_S + CD_L$
Number of cells (C) =	3.00		= L / CD_S
Minimal Storage Depth (d_{min}) =	0.00	ft.	= $S_L * (L_{max} - L_S)$

Surface Storage Per Cell (V_C) = $CD_H^3 / (6 * S_L * S_{S1}) + CD_H^3 / (6 * S_L * S_{S2}) + CD_H^2 * W / (2 * S_L)$
$- d_{min}^3 / (6 * S_L * S_{S1}) - d_{min}^3 / (6 * S_L * S_{S2}) - d_{min}^2 * W / (2 * S_L)$
= 266.67 cf.

Total Surface Storage Provided (V_T) = 1058.24 cf. = $V_C * C + ((L - CD_S * C) * V_C / CD_S)$

Step 5: Determine Treatment Provided by the Bio-swale:

Min. Surface Storage Required (V_{S-R}) =	1189	cf.	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Surface Storage Provided (V_{S-P}) =	1058.2	cf.	= total volume from step 3
Percent Surface Storage Provided ($V_{\%-S}$) =	39%		= percent surface storage provided based on a Pe of 2.6 inches

Because the proposed facility does not provide enough surface storage to treat the target Pe, iterations will need to be done to determine the reduced

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.30	2429	43.28%	43.57%	Yes
Iteration	2.31	2439	43.28%	43.39%	Yes
Table	2.40	2534	43.28%	41.75%	No

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

The Pe credited is 2.31 in. and the ESDv credited is 2439 cf.

Step 6: Determine the Impervious Area Treated by the Bio-swale:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.28	2.31	0.38

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 7: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media = B *underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-1**
		Location:	**Sta 112+25 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	24570	sf.	---------->	0.56	ac.
Contributing Impervious Area (A_i) =	19011	sf.	---------->	0.44	ac.
Percent Impervious Area ($\%_{IMP}$) =	77.4	% → use	80%		
Volumetric Runoff Coefficient (R_v) =	0.746		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	3973	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	1701	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	7%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	80.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	8.9%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	3973	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	51.1%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	2030	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-1**
		Location:	**Sta 112+25 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	1,701.00	0.0390				0.0000	0.00
288.00	2878.00	0.0661	1.0	0.0526	0.0526	0.0526	2,289.50

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	2030	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	2289.5	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	58%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	3973	51.05%	57.62%	Yes
Iteration	2.600	3973	51.05%	57.62%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 3973.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.44	2.60	0.61

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-2**
		Location:	**Sta 114+00 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	21670	sf.	---------->	0.50	ac.
Contributing Impervious Area (A_i) =	12732	sf.	---------->	0.29	ac.
Percent Impervious Area ($\%_{IMP}$) =	58.8	% → use	60%		
Volumetric Runoff Coefficient (R_v) =	0.579		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	2717	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	1160	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	5%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	60.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	9.1%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	2717	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	50.9%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	1383	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-2**
		Location:	**Sta 114+00 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	1,160.00	0.0266				0.0000	0.00
288.00	2296.00	0.0527	1.0	0.0397	0.0397	0.0397	1,728.00

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	1383	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	1728.0	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	64%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	2717	50.89%	63.59%	Yes
Iteration	2.600	2718	50.89%	63.59%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 2717.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.29	2.60	0.41

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-3**
		Location:	**Sta 116+00 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	21308	sf.	---------->	0.49	ac.
Contributing Impervious Area (A_i) =	12996	sf.	---------->	0.30	ac.
Percent Impervious Area ($\%_{IMP}$) =	61.0	% → use	65%		
Volumetric Runoff Coefficient (R_v) =	0.599		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	2765	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	1029	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	5%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	65.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	7.9%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	2765	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	52.1%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	1441	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-3**
		Location:	**Sta 116+00 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	1,029.00	0.0236				0.0000	0.00
288.00	1857.00	0.0426	1.0	0.0331	0.0331	0.0331	1,443.00

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	1441	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	1443.0	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	52%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	2765	52.08%	52.19%	Yes
Iteration	2.600	2765	52.08%	52.19%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 2765.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.30	2.60	0.42

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-4**
		Location:	**Sta 119+00 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	15790	sf.	---------->	0.36	ac.
Contributing Impervious Area (A_i) =	7752	sf.	---------->	0.18	ac.
Percent Impervious Area ($\%_{IMP}$) =	49.1	% → use	50%		
Volumetric Runoff Coefficient (R_v) =	0.492		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	1683	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	663	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	4%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	50.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	8.6%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	1683	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	50.4%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	848	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	AGB
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-4**
		Location:	**Sta 119+00 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	663.00	0.0152				0.0000	0.00
288.00	1200.00	0.0275	1.0	0.0214	0.0214	0.0214	931.50

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	848	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	931.5	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	55%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

			Percent Storage		*Actual > Required*
From	P_E	ESD_v	Required	Actual	
	in.	cf.	%	%	Y/N
Table	2.60	1683	50.45%	55.36%	Yes
Iteration	2.600	1683	50.45%	55.36%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 1683.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.18	2.60	0.25

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-5**
		Location:	**Sta 120+00 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	18865	sf.	---------->	0.43	ac.
Contributing Impervious Area (A_i) =	9287	sf.	---------->	0.21	ac.
Percent Impervious Area ($\%_{IMP}$) =	49.2	% → use	50%		
Volumetric Runoff Coefficient (R_v) =	0.493		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	2015	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	787	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	4%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	50.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	8.5%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	2015	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	50.5%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	1018	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-5**
		Location:	**Sta 120+00 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	787.00	0.0181				0.0000	0.00
288.00	1396.00	0.0320	1.0	0.0251	0.0251	0.0251	1,091.50

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	1018	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	1091.5	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	54%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

From	P_E	ESD_v	Percent Storage Required	Percent Storage Actual	*Actual > Required*
	in.	cf.	%	%	Y/N
Table	2.60	2015	50.53%	54.16%	Yes
Iteration	2.600	2015	50.53%	54.16%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 2015.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.21	2.60	0.30

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-6**
		Location:	**Sta 117+00 RT**

M-6: Micro-bioretention Design Calculations

Step 1: Determine Contributing Area Data:

Input Cell

ESD_v Target (P_E) =	2.6	in.	= Target Pe (1.0 to 2.6 inches) ---> will be iterative based on site constraints		
Contributing Area (A) =	21138	sf.	---------->	0.49	ac.
Contributing Impervious Area (A_i) =	15025	sf.	---------->	0.34	ac.
Percent Impervious Area ($\%_{IMP}$) =	71.1	% → use	75%		
Volumetric Runoff Coefficient (R_v) =	0.690		= 0.05 + 0.009 * ($\%_{IMP}$) (pg 5-18 of the MDE manual)		
$ESDv$ Required (ESD_v) =	3159	cf.	= (P_E * A * R_v) / 12 (pg 5-18 of the MDE manual)		

Step 2: Assume Micro-bioretention Dimensions:

Side Slope =	0.25	ft/ft	= 3:1 or flatter	A_f / A =
Filter Bed Area (A_f) =	1311	sf.	= Surface Area must be ≥ 2% of the contributing Area ---->	6%

The facility footprint is adequately sized.

Step 2: Determine Storage Requirements:

Percent Impervious Area ($\%_{IMP}$) =	75.0%		= impervious area divided by total contributing drainage area (A_i/A)
A_f/A_i =	8.7%		= filter bed area divided by impervious area (A_f/A_i)
$ESDv$ Required (ESD_v) =	3159	cf.	= (P_E * A * R_v) / 12
Percent Storage Required Above Surface ($V_{\%-R}$) =	51.3%	of ESD_v	= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i
Min. Surface Storage Required (V_S)=	1621	cf.	= $V_{\%-R}$ * ESD_v

Tables to be used with State Highway Administration (SHA) Bioretention Soil Mix (BSM)

Storage Volume (% of ESDv) required above surface for Pe = 2 - 2.6 inches

%Imp	Af/Ai										
	2%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
5%	46%	43%	39%	36%	32%	28%	26%	23%	21%	19%	18%
10%	50%	46%	41%	36%	32%	29%	27%	25%	23%	21%	20%
15%	53%	49%	43%	39%	35%	32%	30%	28%	26%	25%	24%
20%	55%	51%	45%	41%	38%	35%	33%	31%	29%	28%	26%
25%	55%	51%	46%	42%	39%	36%	34%	32%	30%	28%	27%
30%	56%	52%	46%	42%	39%	37%	35%	32%	31%	29%	28%
35%	56%	52%	47%	43%	40%	38%	35%	33%	31%	30%	28%
40%	57%	53%	48%	44%	41%	38%	36%	34%	32%	31%	29%
45%	58%	54%	48%	45%	42%	39%	37%	35%	33%	31%	30%
50%	58%	54%	49%	45%	42%	40%	38%	36%	34%	32%	30%
55%	59%	55%	50%	46%	43%	41%	38%	36%	34%	33%	31%
60%	59%	55%	50%	46%	44%	41%	39%	37%	35%	33%	31%
65%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
70%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
75%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
80%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
85%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
90%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
95%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%
100%	59%	55%	50%	46%	43%	41%	39%	37%	35%	33%	31%

Project:	MD 190 at Pyle Rd	Designed By:	DES
		Checked By:	SBP
County/Gr:	Montgomery	Approved By:	
Watershed:		Date:	1/24/2017
SHA Project Number:			
RKK Project Number:	13103-23	**POI:**	**4**
Design Phase:	Preliminary	**Facility No:**	**4-6**
		Location:	**Sta 117+00 RT**

Step 3: Determine Surface Storage Provided by Micro-bioretention:

Stage Storage Table

Elevation [ft.]	Area [ft²]	Area [acre]	Change in Elevation [ft]	Average Area [acre]	Incremental Volume [acre·ft]	Cumulative Volume [acre·ft]	Cumulative Volume [ft³]
287.00	1,311.00	0.0301				0.0000	0.00
288.00	2060.00	0.0473	1.0	0.0387	0.0387	0.0387	1,685.50

Step 4: Determine Treatment Provided by the Micro-bioretention:

Min. Surface Storage Required =	1621	*cf.*	*= Surface Storage tables based on P_E, $\%_{IMP}$, and A_f/A_i*
Surface Storage Provided =	1685.5	*cf.*	*= total volume from stage storage table*
Percent Surface Storage Provided=	53%		*= percent surface storage provided based on a Pe of 2.6 inches*

Because the proposed facility is providing more than enough surface storage, iterations will need to be done to determine the larger Pe treated.

From	P_E	ESD_v	Percent Storage Required	Percent Storage Actual	*Actual > Required*
	in.	cf.	%	%	Y/N
Table	2.60	3159	51.27%	53.36%	Yes
Iteration	2.600	3159	51.27%	53.36%	Yes
Table	0.00	0	0.00%	#DIV/0!	#DIV/0!

The PE treated is based on providing a surface storage volume that is a certain percent of the ESDv, but the ESDv changes depending on the Pe. Therefore, determing the Pe treated is an iterative process. The table shown demonstrates this process. The user should input the highest P_e value possible that still meets the required percent surface storage.

Because the proposed facility is providing a Pe greater than 2.6 in., the Pe credited is 2.6 in. and the ESDv credited is 3159.

Step 5: Determine the Impervious Area Treated by the Micro-bioretention:

Contributing Impervious Area	P_E treated	Impervious Acre Credit*
ac.	in.	ac.
0.34	2.60	0.48

** Impervious Acre Credit is based on Table 3 (page 12) of the MDE Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated from August 2014.*

Step 6: Determine if Underdrain is Required:

Primary HSG Soil Group under filter media =	B	*underdrain is not required in A/B soils*

Underdrain is not Required

Appendix G
Site Photographs

Existing outfall at STA. 123+30 in the median – 90% sedimented, will required pipe cleaning if option 2 is pursued.

Outlet at STA 127+75 LT (upstream of POI 5)– end of pipe is crushed and will need to be replaced in both options.

Ditch erosion from STA. 127+75 – 129+00 LT

Inlet at STA 111+50 RT (just upstream of POI 4) – grate missing, will need to be replaced in both options

Outfall at STA. 111+50 RT (POI 4)

POI 4, downstream view

Erosion at STA 111+50 RT – will need to be stabilized

Outfall at STA 110+50 RT (POI 3)

POI 3, downstream view

Existing junction box at STA 110+50 LT- will be replaced with MH-1 in option 1

Appendix H
Major Quantities Cost Estimates

Alternative 1: MD 190 Intersection at Pyle Road

State Highway Administration — Project Impact Report

Date: **6/29/2017** — RK&K, LLP

ITEM NUMBER	CAT. NUMBER	ITEM DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL ESTIMATE
	CAT 1					
1001	**100000**	MOT (50% of Categories 2, 4, 5 & 6)	1	LS	$1,240,000.00	$1,240,000.00
					Subtotal Category 1:	**$1,240,000.00**
	CAT 2					
2001	**210025**	Removal of Existing Pavement	5,600	CY	$25.00	$140,000.00
2002	**210026**	Removal of Existing Sidewalk	30	CY	$70.00	$2,100.00
2003	**202065**	Common Borrow	6,500	CY	$30.00	$195,000.00
2004	**201030**	Class 1 Excavation	5,500	CY	$25.00	$137,500.00
2005	**201031**	Class 1A Excavation	1,000	CY	$30.00	$30,000.00
2006	**201040**	GSSA	1,000	CY	$30.00	$30,000.00
					Subtotal Category 2:	**$534,600.00**
	CAT 3					
3001	**300000**	Drainage, SWM & E&S (40% of Categories 2, 4, 5 & 6)	1	LS	$987,000.00	$987,000.00
					Subtotal Category 3:	**$987,000.00**
	CAT 4					
4001	**400000**	Bus Stop Block Wall	2	EA	$9,000.00	$18,000.00
					Subtotal Category 4:	**$18,000.00**
	CAT 5					
5001	**504530**	12.5 MM Asphalt Mix For Surface, PG 64S-22, L2	2,850	TON	$100.00	$285,000.00
5002	**504560**	19.0 MM Asphalt Mix For Base, PG 64S-22, L2	11,000	TON	$75.00	$825,000.00
5003	**520113**	6 Inch Graded Aggregate Base Course	37,100	SY	$10.00	$371,000.00
5004	**530101**	Grinding Asphalt Pavement 0 Inch to 2 Inch	6,090	SY	$20.00	$121,800.00
5005	**500000**	Thermoplastic Pavement Markings	1	LS	$25,000.00	$25,000.00
					Subtotal Category 5:	**$1,627,800.00**
	CAT 6					
6001	**660482**	Traffic Barrier W-Beam Using 6 Foot Post	340	LF	$25.00	$8,500.00
6002	**660782**	Traffic Barrier W-Beam Median Barrier	4,950	LF	$30.00	$148,500.00
6003	**634331**	Standard Type C Combination Curb and Gutter	4,605	LF	$30.00	$138,150.00
6004	**648360**	Monolithic Concrete Median 6 Feet 0 Inch Wide Type C-1	900	LF	$100.00	$90,000.00
6005	**655105**	5 Inch Concrete Sidewalk	2,480	SF	$6.50	$16,120.00
6006	**661510**	Type C Traffic Barrier End Treatment	1	EA	$6,000.00	$6,000.00
6007	**661525**	Type F Traffic Barrier End Treatment	3	EA	$7,000.00	$21,000.00
6008	**661540**	Type K Traffic Barrier End Treatment	4	EA	$1,000.00	$4,000.00
					Subtotal Category 6:	**$432,270.00**
	CAT 7					
7001	**700000**	Landscaping (5% of Categories 2, 4, 5 and 6)	1	LS	$131,000.00	$131,000.00
					Subtotal Category 7:	**$131,000.00**
	CAT 8					
8001	**800000**	Traffic Signal, Lighting & Signing	1	LS	$275,000.00	$275,000.00
8002	**800000**	Contingent Utility Relocations	1	LS	$500,000.00	$500,000.00
					Subtotal Category 8:	**$775,000.00**
		NEAT CONSTRUCTION COST				**$5,745,670.00**
		CONTINGENCY (35%)				$2,011,000.00
		CONSTRUCTION OVERHEAD (14.4%)				$1,117,000.00
		TOTAL COST OF CONSTRUCTION				**$8,873,670.00**
					SAY	**$8,900,000.00**

Alternative 2: MD 190 Intersection at Pyle Road

State Highway Administration — Project Impact Report

Date: **6/29/2017** — RK&K, LLP

ITEM NUMBER	CAT. NUMBER	ITEM DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL ESTIMATE
	CAT 1					
1001	100000	MOT (50% of Categories 2, 4, 5 and 6)	1	LS	$616,722.50	$616,722.50
				Subtotal Category 1:		$616,722.50
	CAT 2					
2001	210025	Removal of Existing Pavement	1,250	CY	$25.00	$31,250.00
2002	210026	Removal of Existing Sidewalk	30	CY	$70.00	$2,100.00
2003	202065	Common Borrow	1,500	CY	$30.00	$45,000.00
2004	201030	Class 1 Excavation	4,000	CY	$25.00	$100,000.00
2005	201031	Class 1A Excavation	500	CY	$30.00	$15,000.00
2006	201040	GSSA	500	CY	$30.00	$15,000.00
				Subtotal Category 2:		$208,350.00
	CAT 3					
3001	300000	Drainage, SWM & E&S (40% of Categories 2, 4, 5 & 6)	1	LS	$494,000.00	$494,000.00
				Subtotal Category 3:		$494,000.00
	CAT 4					
4001	400000	Bus Stop Block Wall	1	EA	$9,000.00	$9,000.00
				Subtotal Category 4:		$9,000.00
	CAT 5					
5001	504534	12.5 MM Asphalt Mix For Surface, PG 64S-22, L2	2,100	TON	$100.00	$210,000.00
5002	504560	19.0 MM Asphalt Mix For Base, PG 64S-22, L2	3,100	TON	$75.00	$232,500.00
5003	520113	6 Inch Graded Aggregate Base Course	10,500	SY	$10.00	$105,000.00
5004	530101	Grinding Asphalt Pavement 0 Inch to 2 Inch	14,840	SY	$20.00	$296,800.00
5005	500000	Thermoplastic Pavement Markings	1	LS	$25,000.00	$25,000.00
				Subtotal Category 5:		$869,300.00
	CAT 6					
6001	660482	Traffic Barrier W-Beam Using 6 Foot Post	1,100	LF	$25.00	$27,500.00
6002	660782	Traffic Barrier W-Beam Median Barrier	1,300	LF	$30.00	$39,000.00
6003	634331	Standard Type C Combination Curb and Gutter	1,100	LF	$30.00	$33,000.00
6004	655105	5 Inch Concrete Sidewalk	1,430	SF	$6.50	$9,295.00
6005	661510	Type C Traffic Barrier End Treatment	3	EA	$6,000.00	$18,000.00
6006	661525	Type F Traffic Barrier End Treatment	2	EA	$7,000.00	$14,000.00
6007	661540	Type K Traffic Barrier End Treatment	6	EA	$1,000.00	$6,000.00
				Subtotal Category 6:		$146,795.00
	CAT 7					
7001	700000	Landscaping (5% of Categories 2, 4, 5 and 6)	1	LS	$62,000.00	$62,000.00
				Subtotal Category 7:		$62,000.00
	CAT 8					
8001	800000	Traffic Signal, Lighting & Signing	1	EA	$325,000.00	$325,000.00
				Subtotal Category 8:		$325,000.00
		NEAT CONSTRUCTION COST				**$2,731,167.50**
		CONTINGENCY (35%)				$956,000.00
		CONSTRUCTION OVERHEAD (14.4%)				$531,000.00
		TOTAL COST OF CONSTRUCTION				**$4,218,167.50**
					SAY	**$4,300,000.00**

Alternative 3: MD 190 Intersection at Pyle Road

State Highway Administration — Project Impact Report

Date: **6/29/2017** — RK&K, LLP

ITEM NUMBER	CAT. NUMBER	ITEM DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL ESTIMATE
	CAT 1					
1001	**100000**	MOT (50% of Categories 2, 4, 5 and 6)	1	LS	$1,219,000.00	$1,219,000.00
					Subtotal Category 1:	**$1,219,000.00**
	CAT 2					
2001	**210025**	Removal of Existing Pavement	4,000	CY	$25.00	$100,000.00
2002	**210026**	Removal of Existing Sidewalk	15	CY	$70.00	$1,050.00
2003	**202065**	Common Borrow	5,000	CY	$30.00	$150,000.00
2004	**201030**	Class 1 Excavation	14,000	CY	$25.00	$350,000.00
2005	**201031**	Class 1A Excavation	3,200	CY	$30.00	$96,000.00
2006	**201040**	GSSA	3,200	CY	$30.00	$96,000.00
					Subtotal Category 2:	**$793,050.00**
	CAT 3					
3001	**300000**	Drainage, SWM & E&S (40% of Categories 2, 4, 5 & 6)	1	LS	$976,000.00	$976,000.00
					Subtotal Category 3:	**$976,000.00**
	CAT 4					
4001	**400000**	Bus Stop Block Wall	1	EA	$9,000.00	$9,000.00
					Subtotal Category 4:	**$9,000.00**
	CAT 5					
5001	**504534**	12.5 MM Asphalt Mix For Surface, PG 64S-22, L2	2,760	TON	$100.00	$276,000.00
5002	**504560**	19.0 MM Asphalt Mix For Base, PG 64S-22, L2	7,940	TON	$75.00	$595,500.00
5003	**520113**	6 Inch Graded Aggregate Base Course	26,940	SY	$10.00	$269,400.00
5004	**530101**	Grinding Asphalt Pavement 0 Inch to 2 Inch	9,310	SY	$20.00	$186,200.00
5005	**500000**	Thermoplastic Pavement Markings	1	LS	$25,000.00	$25,000.00
					Subtotal Category 5:	**$1,352,100.00**
	CAT 6					
6001	**660482**	Traffic Barrier W-Beam Using 6 Foot Post	410	LF	$25.00	$10,250.00
6002	**660782**	Traffic Barrier W-Beam Median Barrier	2,270	LF	$30.00	$68,100.00
6003	**634331**	Standard Type C Combination Curb and Gutter	2,480	LF	$30.00	$74,400.00
6004	**648360**	Monolithic Concrete Median 6 Feet 0 Inch Wide Type C-1	920	LF	$100.00	$92,000.00
6005	**655105**	5 Inch Concrete Sidewalk	2,410	SF	$6.50	$15,665.00
6006	**661510**	Type C Traffic Barrier End Treatment	1	EA	$6,000.00	$6,000.00
6007	**661525**	Type F Traffic Barrier End Treatment	2	EA	$7,000.00	$14,000.00
6008	**661540**	Type K Traffic Barrier End Treatment	3	EA	$1,000.00	$3,000.00
					Subtotal Category 6:	**$283,415.00**
	CAT 7					
7001	**700000**	Landscaping (5% of Categories 2, 4, 5 and 6)	1	LS	$122,000.00	$122,000.00
					Subtotal Category 7:	**$122,000.00**
	CAT 8					
8001	**800000**	Traffic Signal, Lighting & Signing	1	EA	$275,000.00	$275,000.00
					Subtotal Category 8:	**$275,000.00**
		NEAT CONSTRUCTION COST				**$5,029,565.00**
		CONTINGENCY (35%)				$1,761,000.00
		CONSTRUCTION OVERHEAD (14.4%)				$977,900.00
		TOTAL COST OF CONSTRUCTION				**$7,768,465.00**
					SAY	**$7,800,000.00**

Appendix I

MD 190 (River Road) at Braeburn Parkway/Pyle Road Traffic and Safety Analysis Report (May 2017)

MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

MD 190 (River Road) at Braeburn Parkway/ Pyle Road

Traffic and Safety Analysis

May 2017

RK&K

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Appendices

I. Introduction

The Maryland Department of Transportation State Highway Administration (MDOT SHA) District Three Traffic Office requested a study of the proposed relocation of the intersection of MD 190 (River Road) at Braeburn Parkway, located in Bethesda, Montgomery County. MDOT SHA recently completed safety modifications to the MD 190 and Braeburn Parkway intersection (shown in **Figure 1**), which restricts access from Braeburn Parkway to right turns only onto MD 190 as a low-cost, near-term improvement. Under this modified condition, flashing beacons and improved roadway lighting were also be installed. The ultimate improvements proposed by this study would restore and relocate all movements to a new intersection approximately 600 feet to the east, at the alignment of Pyle Road, where an existing unsignalized pedestrian crosswalk is currently located. Under this scenario the existing intersection of Braeburn Parkway would be closed to all turning movements.

This study examined the proposed traffic control at the relocated intersection, analyzed existing and projected operating conditions for traffic, and evaluated the safety benefits from closing the existing Braeburn Parkway intersection and relocating the intersection to the alignment of Pyle Road. This traffic and safety analysis study was conducted in conjunction with a Project Impact Review to identify roadway and environmental impacts of the new intersection.

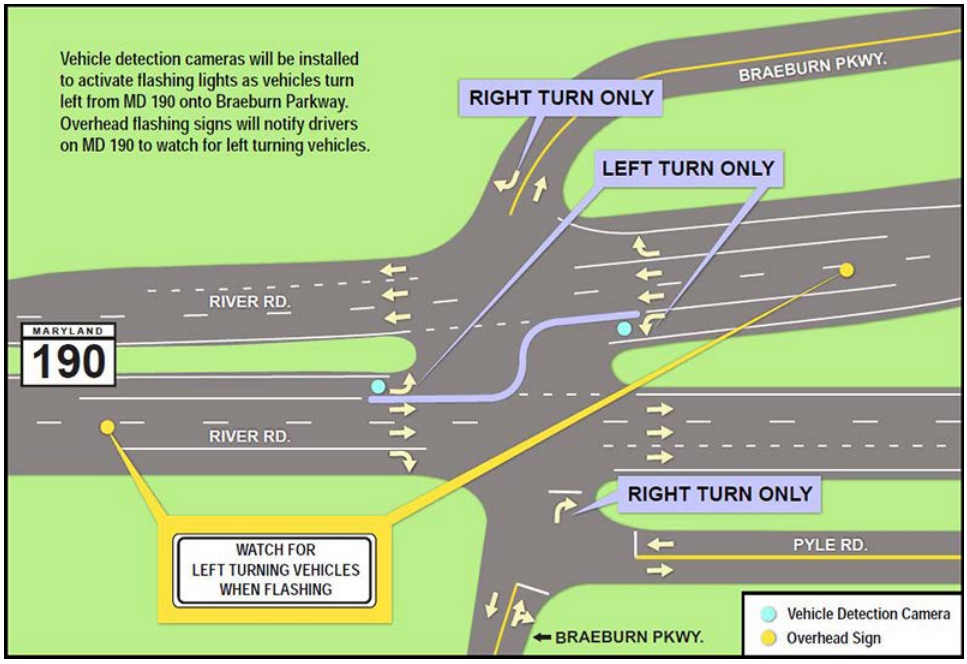
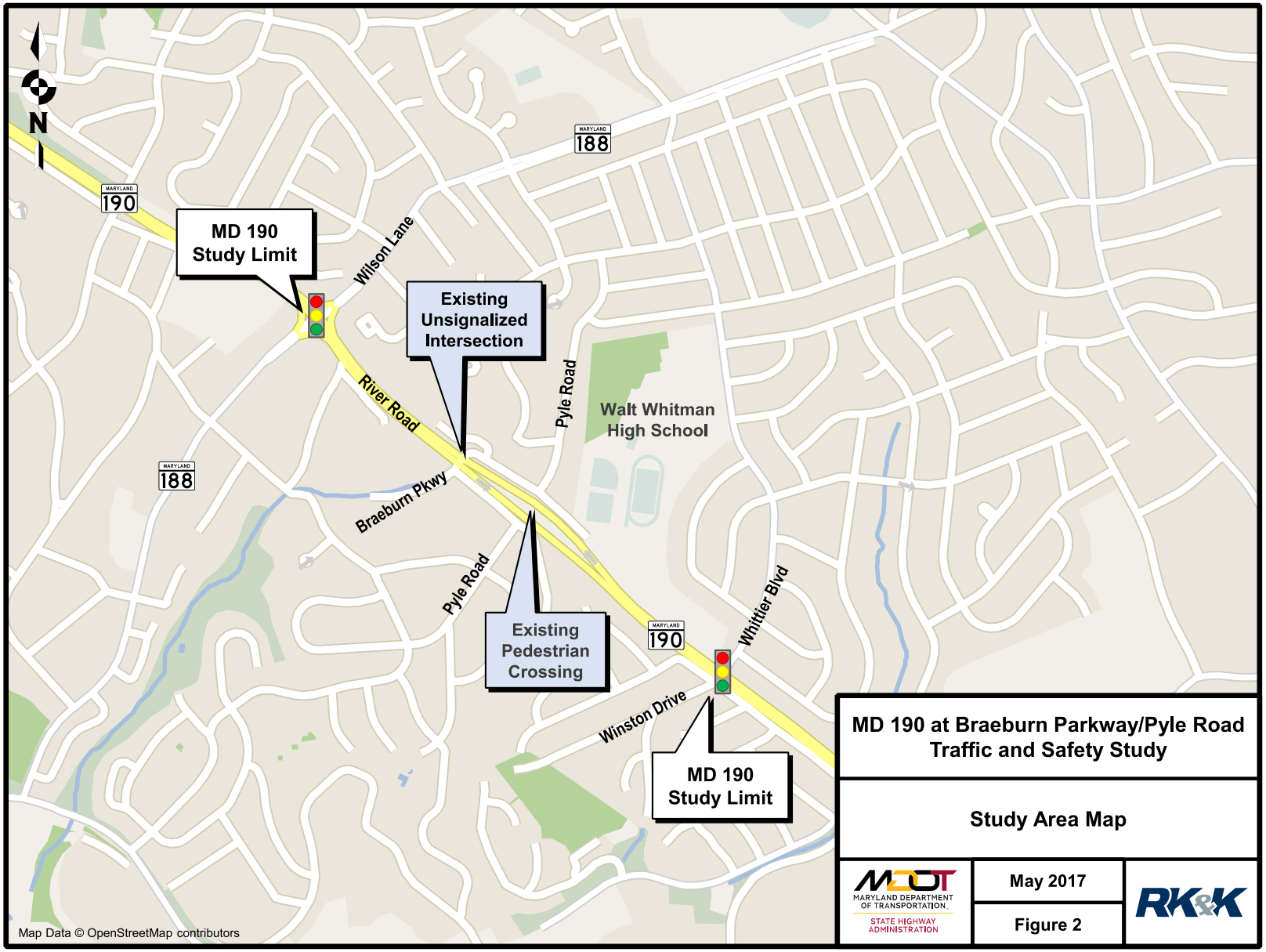


Figure 1: MDOT SHA Recently Constructed Braeburn Parkway Modifications (completed April 2017)

II. Existing Conditions

The study area includes approximately 4,400 feet along MD 190 including the signalized intersections of MD 188 (Wilson Lane) at the western end of the study area and Winston Drive/Whittier Boulevard at the eastern end of the study area. Within the study area, MD 190 travels east-west and includes two through lanes in each direction with a posted speed limit of 45 miles per hour. According to the 2015 Maryland Highway Location Reference, the roadway is classified as an Urban Other Principal Arterial, with an AADT of approximately 44,600 vehicles. The study area is shown in **Figure 2**.

The unsignalized intersection of Braeburn Parkway is located approximately 1,650 feet east of MD 188. Between Braeburn Parkway and Winston Drive, the median of MD 190 widens to over 100 feet wide, with trees and tall brush in the median. Within this segment, there is an unsignalized pedestrian crossing at the alignment of Pyle Road.


N
MARYLAND 190
MARYLAND 188
MD 190 Study Limit
Wilson Lane
Existing Unsignalized Intersection
River Road
Pyle Road
Walt Whitman High School
Braeburn Pkwy
Existing Pedestrian Crossing
Whittier Blvd
Winston Drive
MD 190 Study Limit
Map Data © OpenStreetMap contributors
MD 190 at Braeburn Parkway/Pyle Road Traffic and Safety Study
Study Area Map
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 2
RK&K

A. Peak Hour Traffic Volumes

Turning movement counts were obtained from the MDOT SHA Traffic Monitoring System (TMS) for the intersections within the study area. These counts were conducted in March 2016 at the intersections of MD 188, Braeburn Parkway and Winston Drive/Whittier Boulevard. Based on these counts, the peak periods for the corridor were determined to be from 7:30-8:30 AM and 5:30-6:30 PM. The raw counts are provided in **Attachment A**. The existing peak hour volumes were balanced along the corridor and are shown in **Figure 3**.

After the construction of the Braeburn Parkway modifications are complete, traffic volumes will change slightly within the study area as the through and left-turning movements from the minor approaches of Braeburn Parkway will be prohibited. Under this condition, these vehicles will turn right onto MD 190 and make a U-Turn at the next downstream traffic signal. These volumes are reported in **Figure 4**.

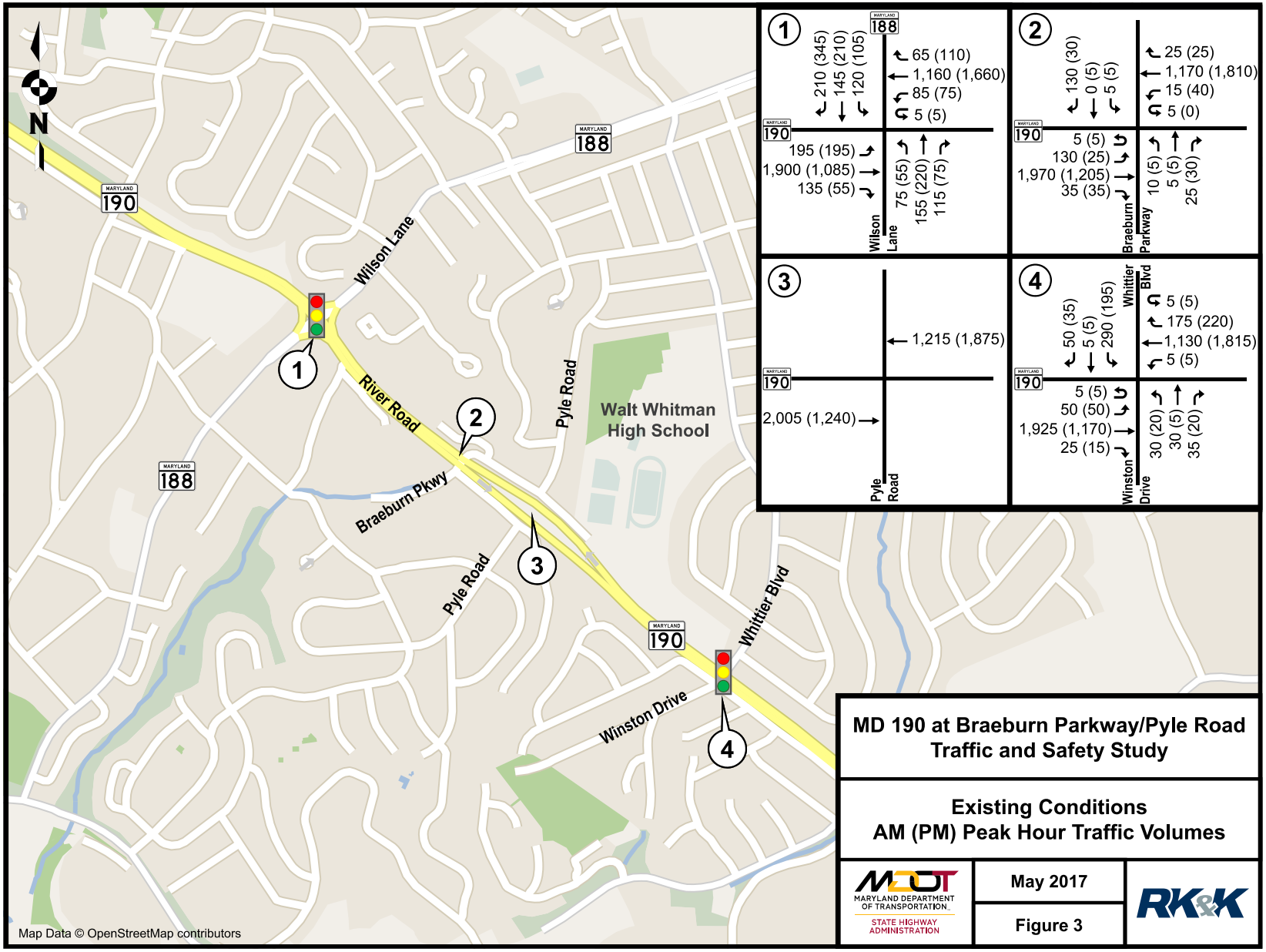
B. Field Observations

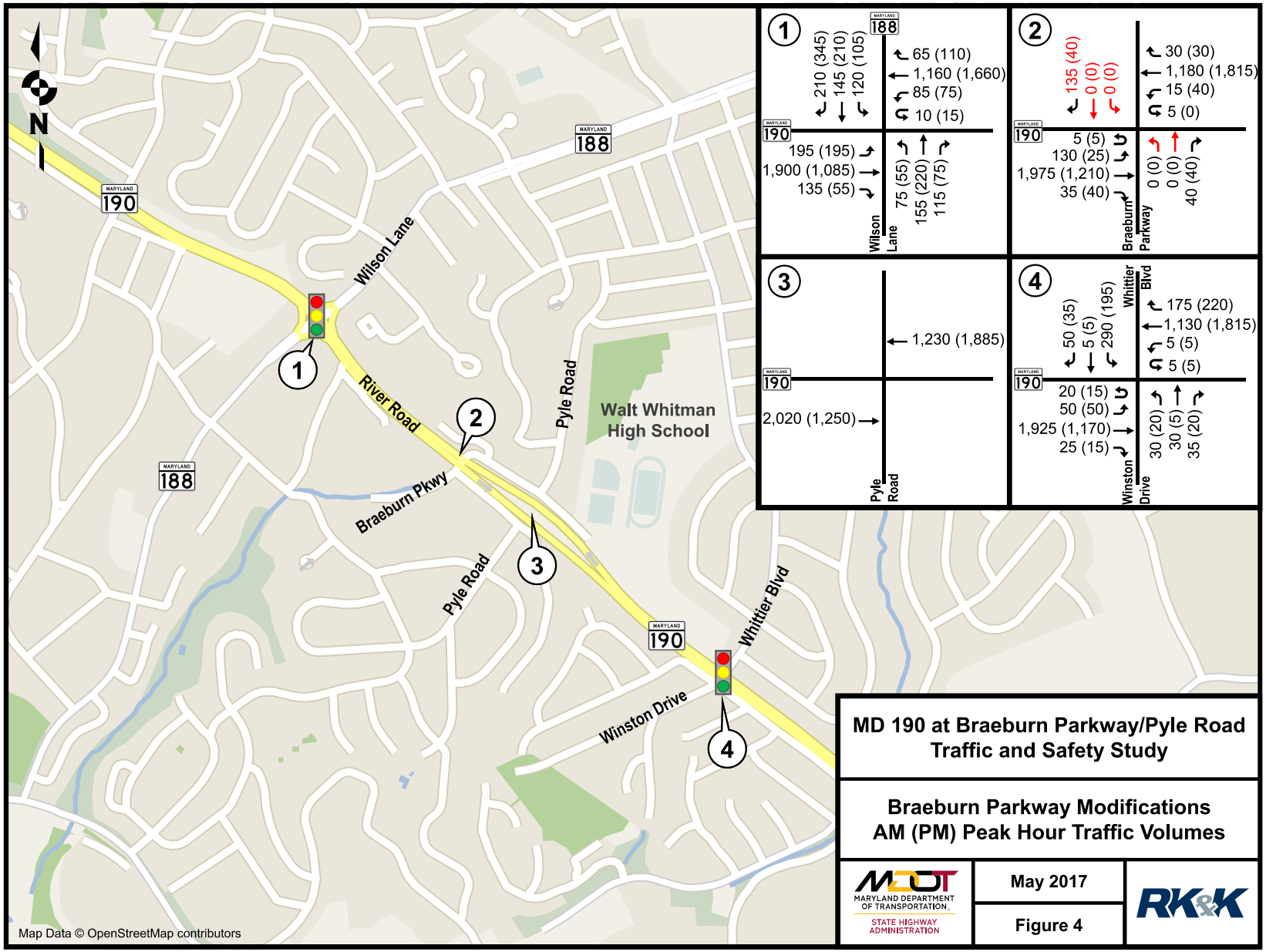
Field observations were performed along the study area on December 1, 2016. The roadway appeared to be recently paved with pavement markings in excellent condition. Bicycle lanes were installed on both directions of MD 190 in the study area. The MDOT SHA improvements at Braeburn Parkway were not implemented at the time of the field visit, but are expected to be installed by spring 2017. An inventory of warning and regulatory signs and special pavement markings was conducted and is included in **Figures 5 through 7**. Some highlights from the inventory include:

- At the intersection of Braeburn Parkway, pavement markings include a double white line and two through arrows directing motorists to make their turns on the right side of the opposing turning traffic. A photo of this behavior is shown in **Figure 8**.
- According to posted signs, left-turn and through movements from both approaches of Braeburn Parkway are prohibited from the hours of 7 to 9 AM and 2 to 3 PM. However, motorists were observed making these movements during the restricted period.
- There are transverse crosswalk lines at the unsignalized pedestrian crosswalk at Pyle Road as shown in **Figure 9**, but the crosswalk was not hatched with diagonal white lines as required by the Maryland MUTCD.
- WMATA bus stops are located just downstream of the Pyle Road crosswalk along both directions of MD 190. The bus stop along eastbound MD 190 is shown in **Figure 10**.

During the field observations, the sight distances at Braeburn Parkway and the Pyle Road crosswalk were also recorded. At both locations, the sight distance is adequate according to AASHTO guidelines and the posted speeds. The most constrained sight distance was found at the Pyle Road crosswalk at westbound MD 190, where the sight distance is constrained by the horizontal and vertical curvature of the roadway. However, at approximately 500 feet, the sight distance is still adequate for the posted speeds. Examples of the sight distance from the Pyle Road crosswalk at westbound MD 190 and eastbound MD 190 are shown in **Figures 11 and 12**.

The AM peak hour for vehicle traffic (7:30 to 8:30) along the corridor coincided with the morning bell time for nearby Walt Whitman High School (at 7:45 AM). At 7:30, the volume of left-turning traffic from eastbound MD 190 to Braeburn Parkway spiked significantly, including some bus traffic. While there were frequently adequate gaps created by upstream traffic signal at Winston Drive/Whittier Boulevard and the generally lower volume of westbound traffic, there were still queues that formed along the length of the eastbound left-turn bay at Braeburn Parkway during the peak 15-minute period at 7:30 to 7:45 AM before the morning bell time, as shown in **Figure 13**. Occasionally, eastbound left-turning drivers will accept a smaller than typical gap that will cause the approaching westbound MD 190 traffic to apply their brakes and slow down, as shown in **Figure 14**. It may be difficult to judge the oncoming speeds of westbound traffic as they are approaching on a downhill segment. During certain times of year, sun glare is also an issue for drivers along eastbound MD 190 during the AM peak period, which is evident in **Figure 13**.


N
MARYLAND 190
MARYLAND 188
Wilson Lane
River Road
Pyle Road
Braeburn Pkwy
Walt Whitman High School
Whittier Blvd
Winston Drive
1
2
3
4
1
210 (345)
145 (210)
120 (105)
65 (110)
1,160 (1,660)
85 (75)
5 (5)
195 (195)
1,900 (1,085)
135 (55)
75 (55)
155 (220)
115 (75)
Wilson Lane
2
130 (30)
0 (5)
5 (5)
25 (25)
1,170 (1,810)
15 (40)
5 (0)
5 (5)
130 (25)
1,970 (1,205)
35 (35)
10 (5)
5 (5)
25 (30)
Braeburn Parkway
3
1,215 (1,875)
2,005 (1,240)
Pyle Road
4
50 (35)
5 (5)
290 (195)
Whittier Blvd
5 (5)
175 (220)
1,130 (1,815)
5 (5)
5 (5)
50 (50)
1,925 (1,170)
25 (15)
30 (20)
30 (5)
35 (20)
Winston Drive
Map Data © OpenStreetMap contributors
MD 190 at Braeburn Parkway/Pyle Road
Traffic and Safety Study
Existing Conditions
AM (PM) Peak Hour Traffic Volumes
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 3
RK&K


N
MARYLAND 190
MARYLAND 188
Wilson Lane
River Road
Pyle Road
Walt Whitman High School
Braeburn Pkwy
Pyle Road
Whittier Blvd
Winston Drive
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2
3
4
1
210 (345)
145 (210)
120 (105)
65 (110)
1,160 (1,660)
85 (75)
10 (15)
195 (195)
1,900 (1,085)
135 (55)
75 (55)
155 (220)
115 (75)
Wilson Lane
2
135 (40)
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30 (30)
1,180 (1,815)
15 (40)
5 (0)
5 (5)
130 (25)
1,975 (1,210)
35 (40)
0 (0)
0 (0)
40 (40)
Braeburn Parkway
3
1,230 (1,885)
2,020 (1,250)
Pyle Road
4
50 (35)
5 (5)
290 (195)
Whittier Blvd
175 (220)
1,130 (1,815)
5 (5)
5 (5)
20 (15)
50 (50)
1,925 (1,170)
25 (15)
30 (20)
30 (5)
35 (20)
Winston Drive
Map Data © OpenStreetMap contributors
MD 190 at Braeburn Parkway/Pyle Road
Traffic and Safety Study
Braeburn Parkway Modifications
AM (PM) Peak Hour Traffic Volumes
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 4
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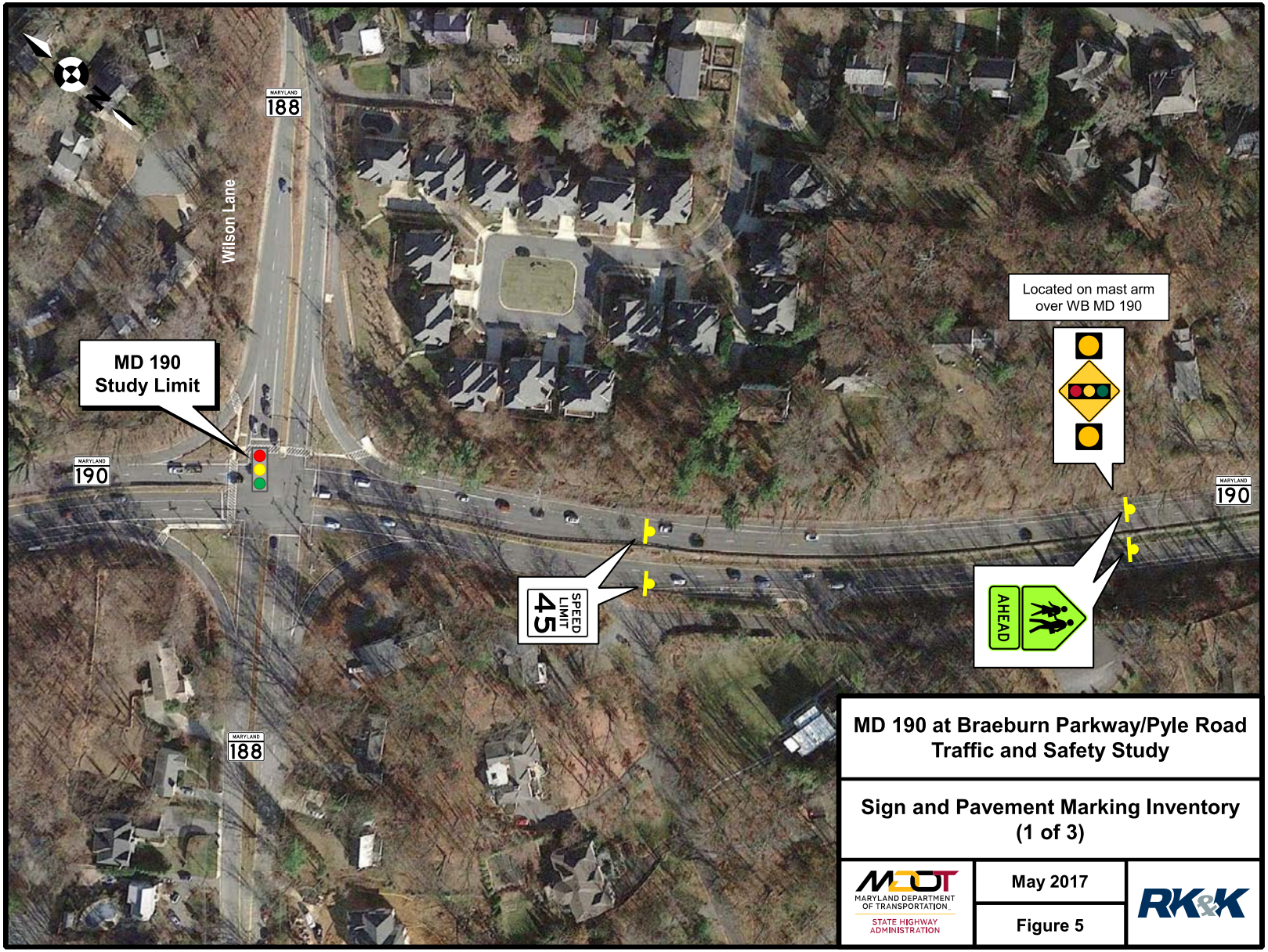
MARYLAND 188
Wilson Lane
MD 190 Study Limit
MARYLAND 190
Located on mast arm over WB MD 190
MARYLAND 190
SPEED LIMIT 45
AHEAD
MARYLAND 188
MD 190 at Braeburn Parkway/Pyle Road Traffic and Safety Study
Sign and Pavement Marking Inventory (1 of 3)
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 5
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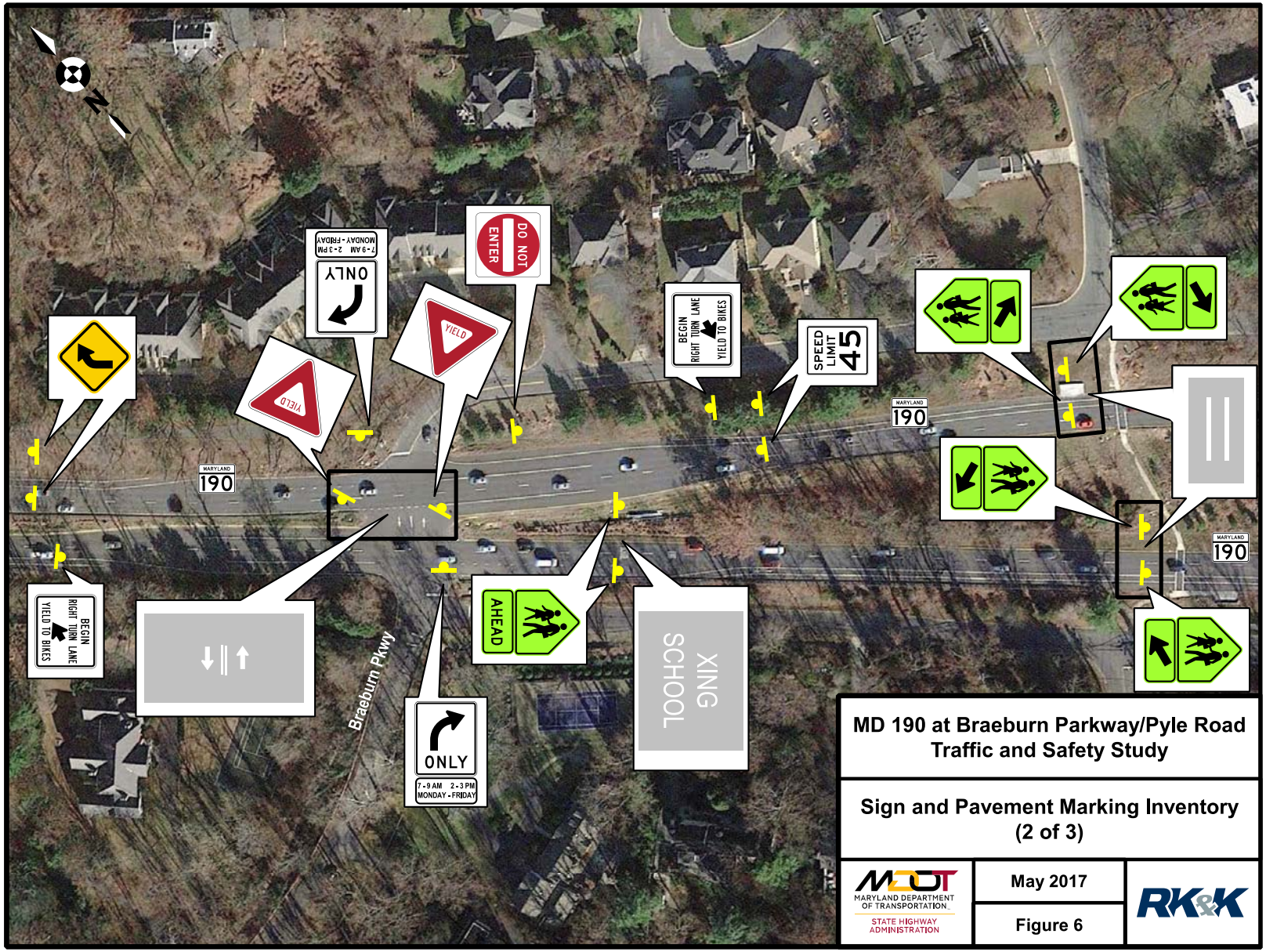

N
DO NOT ENTER
ONLY
7-9 AM 2-3 PM
MONDAY - FRIDAY
YIELD
YIELD
BEGIN RIGHT TURN LANE YIELD TO BIKES
SPEED LIMIT 45
MARYLAND 190
MARYLAND 190
MARYLAND 190
AHEAD
XING SCHOOL
BEGIN RIGHT TURN LANE YIELD TO BIKES
Braeburn Pkwy
ONLY
7-9 AM 2-3 PM
MONDAY - FRIDAY
MD 190 at Braeburn Parkway/Pyle Road
Traffic and Safety Study
Sign and Pavement Marking Inventory
(2 of 3)
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 6
RK&K

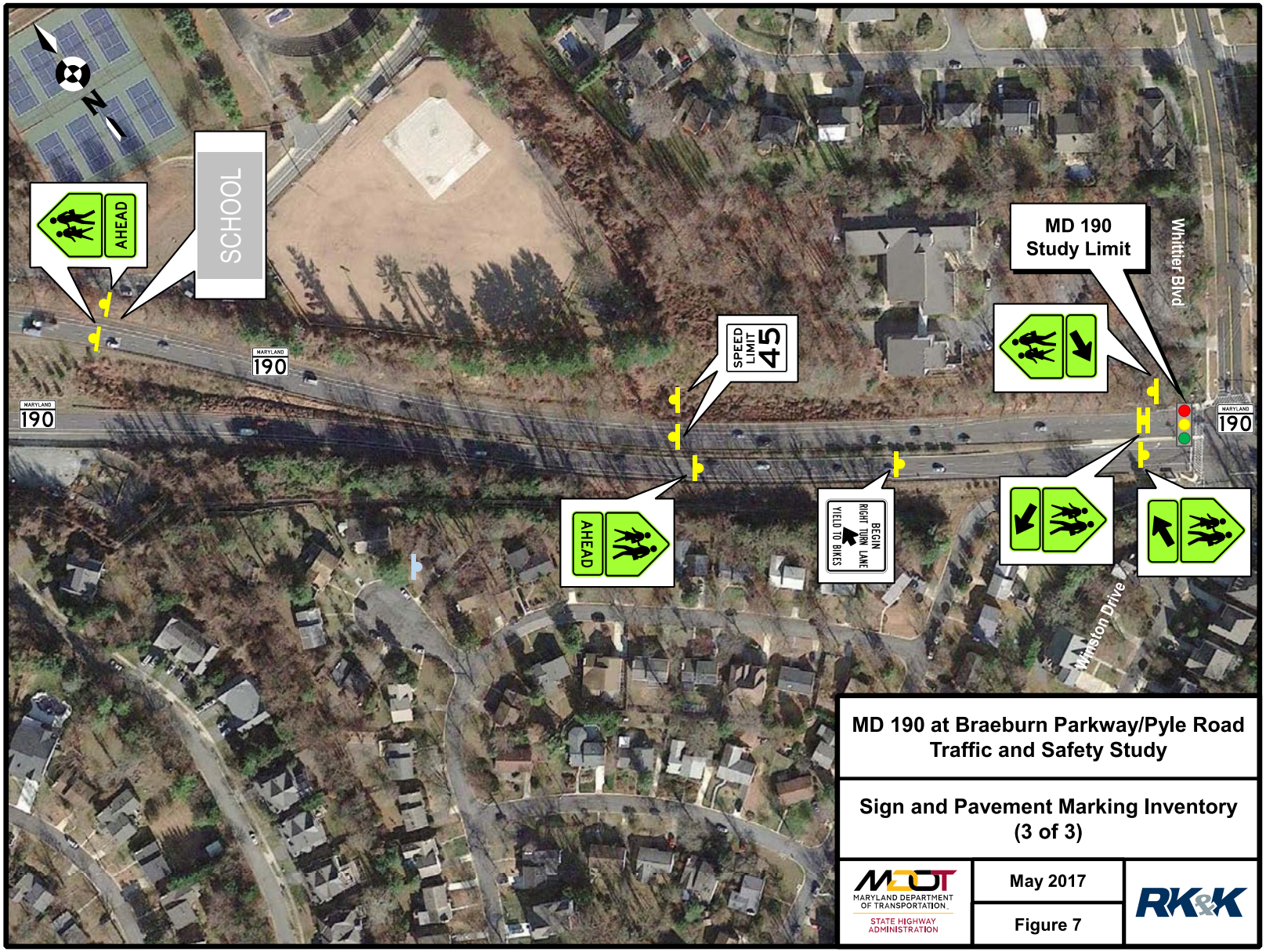

N
AHEAD
SCHOOL
MARYLAND 190
SPEED LIMIT 45
AHEAD
BEGIN RIGHT TURN LANE YIELD TO BIKES
MD 190 Study Limit
Whittier Blvd
Winston Drive
MD 190 at Braeburn Parkway/Pyle Road Traffic and Safety Study
Sign and Pavement Marking Inventory (3 of 3)
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 7
RK&K

Figure 8: Opposing left turn vehicles at Braeburn Parkway are directed to stay to the right

Figure 9: Pavement markings at the Pyle Road crosswalk are missing diagonal hatching

Figure 10: Bus stop located along eastbound MD 190 downstream of Pyle Road pedestrian crossing

Figure 11: Example of sight distance from Pyle Road crosswalk at westbound MD 190

Figure 12: Example of sight distance from Pyle Road crosswalk at eastbound MD 190

Figure 13: Eastbound left-turn queue at Braeburn Parkway during the peak 15-minute period

Figure 14: Westbound traffic braking as they approach a turning vehicle at Braeburn Parkway

At the Pyle Road pedestrian crossing during the AM peak period, school children were observed crossing MD 190 towards the high school. Pedestrians found adequate gaps along both directions of MD 190, and vehicles were observed yielding to pedestrians even before they committed to crossing the road, as shown in **Figure 15**.

During off-peak periods, speed study data was collected for traffic along both directions of MD 190 near the Pyle Road crosswalk. Only free-flow vehicles were counted. The posted speed along MD 190 is 45 miles per hour. For eastbound MD 190, the data indicated the 85th percentile speed was 51 miles per hour. For westbound MD 190, the observed 85th percentile speed was 54 miles per hour.

Observations were also conducted at the Pyle Road pedestrian crossing during the afternoon school bell time at 2:30 PM. There were adequate gaps for groups of students to cross MD 190, as shown in **Figure 16**. There were no significant issues at the intersection of MD 190 at Braeburn Parkway.

During the PM peak period, congestion and queues formed along westbound MD 190, extending from MD 188 through the intersection at Braeburn Parkway, to the Pyle Road crosswalk, as shown in **Figure 17**. The queues continued from 4:45 to approximately 6:30 PM. During this congested period, queued vehicles along westbound MD 190 often stopped and yielded to turning vehicles at the Braeburn Parkway intersection and to pedestrians at the Pyle Road pedestrian crossing.

C. Crash History

The data shown below in **Table 1** portrays the crashes that have occurred along MD 190 by year, severity, collision type, and rate of crashes per 100 million vehicle miles of travel and compares this data to the weighted statewide average crash rate. Those values that are indicated with an asterisk (*) are significantly higher than the statewide average. The detailed crash data report is provided in **Attachment B**.

Within the corridor, there were 47 total police-reported crashes that happened within a nearly four-year period (January 2013 - October 2016). The majority of these crashes occurred at one of the signalized intersections, either MD 188 (Wilson Lane) or Whittier Boulevard/Winston Drive. The crash data shows that 20 crashes were related to the MD 188 intersection, 13 crashes were related to the Whittier Boulevard/Winston Drive intersection, and only three crashes were related to the Braeburn Parkway intersection.

From the crash data, there was one reported fatal crash, which occurred in 2016 at the intersection of MD 190 and Braeburn Parkway. There were three fatalities as a result of this crash, due to a vehicle traveling along westbound MD 190 at a high rate of speed and colliding into an eastbound left-turning vehicle. In total, more than 40 percent of all crashes in the study area resulted in injuries.

Figure 15: During AM peak, pedestrians crossing westbound MD 190 after vehicles stopped

Figure 16: After the afternoon bell, pedestrians crossing westbound MD 190 under adequate gap

Figure 17: Queues along westbound MD 190 during the PM peak period

Table 1: MD 190 Crash Data from Wilson Lane to Winston Drive							
	Year				Total	Average Rate	
	2013	2014	2015	2016		Study	Statewide
Fatal	0	0	0	1	1	1.9	1.0
Injury	4	4	5	6	19	36.9	52.6
Property Damage	5	10	7	5	27	52.4	72.4
Total Crashes	9	14	12	12	47	91.2	125.9
Rear End	6	10	5	7	28	54.3	54.6
Sideswipe	1	2	2	0	5	9.7	13.8
Left Turn	2	2	0	2	6	11.6	9.4
Angle	0	0	2	1	3	5.8	17.8
Fixed Object	0	0	2	0	2	3.9	17.5
Other	0	0	1	2	3	5.8*	1.9
Night Time	3	2	3	1	9	19%	31%
Wet Surface	0	2	2	2	6	13%	21%
Alcohol	0	0	0	0	0	0%	8%

Note: 2016 crash data reported from January 2016 to October 2016.
* Significantly higher than the statewide average rate for similar roadways.

The most prevalent type of collision was rear end collisions with 28 occurrences (60%). Other types of collisions that were reported along MD 190 include left turn (13%), sideswipe (11%), angle (6%), fixed object (4%), and those of an unknown/other category (6%). Crashes that fall into the unknown/other category occurred more frequently along this segment of MD 190 than in the statewide average. Of the 49 crashes, nine (9) occurred at nighttime (19%), six (6) occurred along a wet surface (13%), and no crashes were reported to be alcohol-related.

The crash history along the study corridor does not indicate a significant pattern of crashes. The number of rear end crashes appear to be comparable to a typical signalized corridor. While there were relatively few reported crashes at the Braeburn Parkway intersection, the most serious crash occurred at the unsignalized intersection. Additionally, local media reported a multiple-vehicle collision occurred at the intersection in November 2016 when a driver was blinded by sun glare and rear-ended other vehicles waiting to turn from the eastbound left turn lane. The fatal crash was also covered by the media and the local community has expressed concern about the safety of this intersection.

D. Capacity Analysis

Synchro and SimTraffic (Version 9) models were created for Existing conditions and the modified Braeburn Parkway intersection, which is currently under construction. The turning movements, signal timings, and lane geometry were input into the Synchro models to analyze traffic operations. The results from the Synchro models were used to report Level of Service (LOS) and delay per vehicle at each intersection using Highway Capacity Manual (HCM) guidelines. The results from the SimTraffic model were used to report queue lengths for the Existing and Modified conditions. The capacity analysis results are summarized in **Table 2**. Detailed reports are included in this report in **Attachment C**.

At the signalized intersections of MD 190 at MD 188 and Winston Drive/Whittier Boulevard, the LOS remains unchanged between Existing and Modified conditions with operations of LOS D or better for the overall intersection during both peak periods.

Under existing conditions at the intersection of MD 190 at Braeburn Parkway, both stop-controlled approaches are reported to operate at LOS F during both peak hours with a reported delay of more than 300 seconds per vehicle. However, the Synchro model may not accurately reflect the two-stage crossing that was observed in the field where many vehicles stopped in the median. The Synchro/HCM results may also overestimate the time left-turning and through vehicles spent waiting for a gap. Especially during the AM peak hour, when these movements are prohibited during the peak school periods, drivers making illegal left-turn and through movements from the minor street are typically

opportunistic drivers that make the illegal movements under an available gap or a smaller than typical gap in traffic along MD 190.

Under the Modified conditions scenario, the northbound approach at Braeburn Parkway is projected to operate at LOS D during the AM peak and LOS B during the PM peak. The southbound approach is projected to operate at LOS C during both peak periods. Therefore, significant improvements in LOS and delay are projected at the intersection by constructing a physical barrier to restrict through and left-turn movements from both approaches of Braeburn Parkway.

Although reported queue lengths by the SimTraffic do not appear to be a problem within the study area for both Existing and Modified conditions, it was noted during field observations that there was queue spillback during the PM peak period along westbound MD 190 through Braeburn Parkway. The study area and Synchro/SimTraffic models do not include the downstream intersections and interchange at I-495, where recurring congestion may cause queuing not explicitly shown in the SimTraffic results.

Table 2: MD 190 Existing and Modified Synchro Results

#	Intersection	Approach/ Movement	Existing – AM (PM)		Modified – AM (PM)	
			LOS	Delay per Vehicle (sec)	LOS	Delay per Vehicle (sec)
1	MD 190 at MD 188	**Overall**	**D (D)**	**44.0 (44.7)**	**D (D)**	**44.6 (45.4)**
		EB	D (C)	35.3 (27.3)	D (C)	35.9 (27.3)
		WB	D (D)	35.8 (38.1)	D (D)	36.4 (39.7)
		NB	E (E)	79.7 (77.2)	E (E)	79.7 (77.2)
		SB	F (F)	82.3 (81.1)	F (F)	82.3 (81.1)
2	MD 190 at Braeburn Parkway	NB	F (F)	>300 (>300)	D (B)	31.6 (14.7)
		SB	F (F)	>300 (>300)	C (C)	21.4 (22.1)
		EBL	C (C)	16.4 (18.6)	C (C)	16.7 (18.8)
		WBL	D (B)	25.2 (12.6)	D (B)	25.3 (12.7)
3	MD 190 at Pyle Road	N/A	No intersection		No intersection	
4	MD 190 at Winston Drive/ Whittier Boulevard	**Overall**	**D (C)**	**53.9 (23.2)**	**D (C)**	**53.8 (23.7)**
		EB	A (B)	9.4 (10.1)	A (B)	9.5 (10.2)
		WB	B (C)	12.3 (26.4)	B (C)	12.5 (27.2)
		NB	E (D)	70.9 (40.3)	E (D)	70.9 (40.3)
		SB	F (E)	>300 (61.1)	F (E)	>300 (61.1)

Table 3: MD 190 at Braeburn Parkway SimTraffic Queuing Results

Approach	Movement	Existing – AM (PM)	Modified – AM (PM)
		95th Percentile Queue (ft)	95th Percentile Queue (ft)
EB	UL	130 (55)	140 (55)
	R	5 (5)	N/A (5)
WB	UL	40 (45)	45 (40)
	R	5 (5)	15 (5)
NB	LTR	100 (65)	60 (50)
SB	LTR	160 (80)	115 (60)

III. Proposed Relocated Intersection

A. Peak Hour Traffic Volumes

Under the proposed condition, Braeburn Parkway will be closed off to MD 190, and all turning traffic will use a new intersection located at Pyle Road. For the capacity analysis, turning movement volumes that were recorded at Braeburn Parkway were transferred to the new Pyle Road intersection. Volumes at the surrounding intersections are not expected to change. These volumes are shown in **Figure 18**.

B. Recommended Proposed Traffic Control

The proposed relocated intersection was originally designed as an unsignalized intersection. Signal warrant analyses were performed based on the procedures in the Maryland Manual on Uniform Traffic Control Devices (MUTCD). The 13-hour traffic data from the Braeburn Parkway intersection was assumed to be relocated to the new intersection at Pyle Road. When performing the signal warrant analysis, engineering judgment was applied when considering right-turn traffic from the minor street. According to the MUTCD, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. At the existing Braeburn Parkway intersection, non-right-turning traffic is prohibited during school peak hours. Right-turning traffic would then be able to enter the major street with minimal conflict. Therefore, when right-turn traffic volumes from the minor street are not included in the analysis, no signal warrants are met. However, when right-turn traffic volumes from the minor street are included in the analysis, Warrants #2 (Four-Hour Vehicular Volume) and #3 (Peak Hour Volume) are met. The signal warrant analysis was also performed using the higher of the major-street left-turn volumes as the “minor-street” volume and the corresponding single direction of opposing traffic on the major street as the “major-street” volume”. Under these conditions, Warrant #3 (Peak Hour Volume) was met. The detailed signal warrant analysis is included in this report in **Attachment D**.

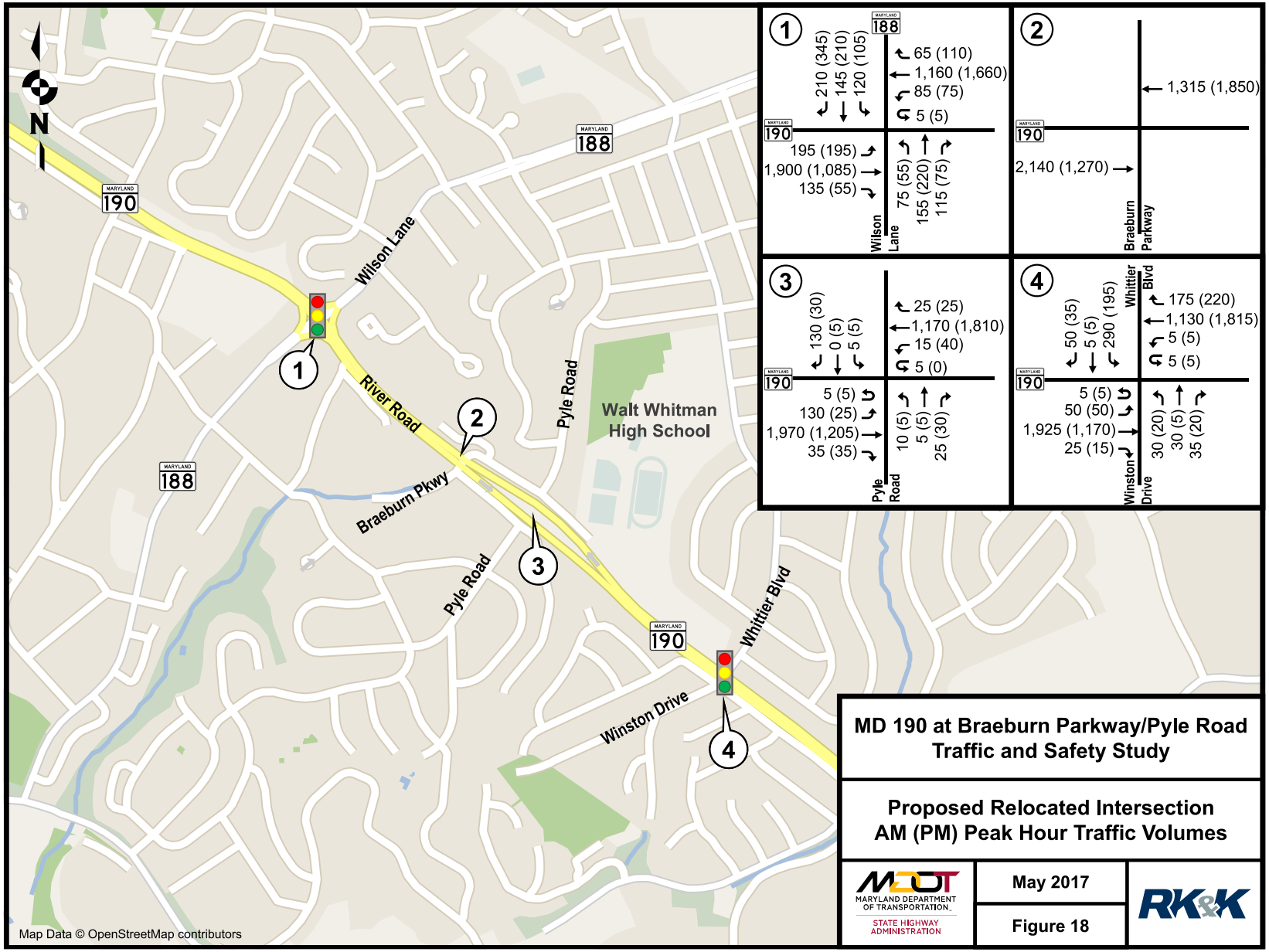
There are other considerations beyond the MUTCD traffic signal warrants. The new intersection will combine the relocated vehicle turning movements with an existing school pedestrian crossing. The Pyle Road pedestrian crossing under the existing conditions is split into two 40-foot crossings with a 120-foot refuge median. The pedestrian crossing under the new configuration will be nearly 100 feet with a smaller median refuge area. Pedestrians and schoolchildren will need to watch for conflicting traffic from multiple approaches including turning vehicles. Additionally, the sight distance for minor street crossing maneuvers at the new intersection may be limited looking at the westbound approach. As noted in the Project Impact Review Report, while the stopping sight distance for the existing Pyle Road pedestrian crossing is adequate, the intersection sight distance for an unsignalized left turn from southbound Pyle Road to eastbound MD 190 does not meet AAHSTO guidelines.

Based on these factors, the recommended traffic control for the proposed relocated intersection is full signalized control. A signalized intersection would alternate right-of-way for vehicles and pedestrians and allow pedestrian signals to be installed. It is also expected to mitigate the impact of the restricted sight distance for minor street traffic and the oncoming traffic from the westbound approach. After reviewing MDOT SHA’s Left Turn Phasing guidelines and initial capacity analysis results, and noting the lack of a significant pattern of left-turn crashes at the existing intersection, the recommended left turn phasing for eastbound MD 190 is a protected-permissive left-turn phase, and permissive left turns for westbound MD 190.

C. Intersection Design Concepts

Two alternatives were initially developed for the geometric design of the relocated intersection at MD 190 and Pyle Road. Under Alternative 1, shown in **Figure 19**, the alignment of MD 190 will be shifted into the existing median at Pyle Road, so that all movements can be controlled by one signal. Alternative 2, shown in **Figure 20**, will retain the existing alignment of MD 190 and connect Pyle Road through the wide median with an approximately 100-foot roadway, with separate signals controlling westbound MD 190 and eastbound MD 190.

Based on design aspects, there are several advantages and disadvantages for each option, which are discussed in detail in the Project Impact Review Report. Operationally, Alternative 1 would be simpler than Alternative 2, which would operate using two separate signals. Left turns and traffic from Pyle Road would be required to travel through separate signals along both directions of MD 190. The timing


N
MARYLAND 190
MARYLAND 188
Wilson Lane
River Road
Braeburn Pkwy
Pyle Road
Walt Whitman High School
Whittier Blvd
Winston Drive
1
2
3
4
1
210 (345)
145 (210)
120 (105)
65 (110)
1,160 (1,660)
85 (75)
5 (5)
195 (195)
1,900 (1,085)
135 (55)
75 (55)
155 (220)
115 (75)
Wilson Lane
2
1,315 (1,850)
2,140 (1,270)
Braeburn Parkway
3
130 (30)
0 (5)
5 (5)
25 (25)
1,170 (1,810)
15 (40)
5 (0)
5 (5)
130 (25)
1,970 (1,205)
35 (35)
10 (5)
5 (5)
25 (30)
Pyle Road
4
50 (35)
5 (5)
290 (195)
Whittier Blvd
175 (220)
1,130 (1,815)
5 (5)
5 (5)
5 (5)
50 (50)
1,925 (1,170)
25 (15)
30 (20)
30 (5)
35 (20)
Winston Drive
Map Data © OpenStreetMap contributors
MD 190 at Braeburn Parkway/Pyle Road
Traffic and Safety Study
Proposed Relocated Intersection
AM (PM) Peak Hour Traffic Volumes
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
May 2017
Figure 18
RK&K

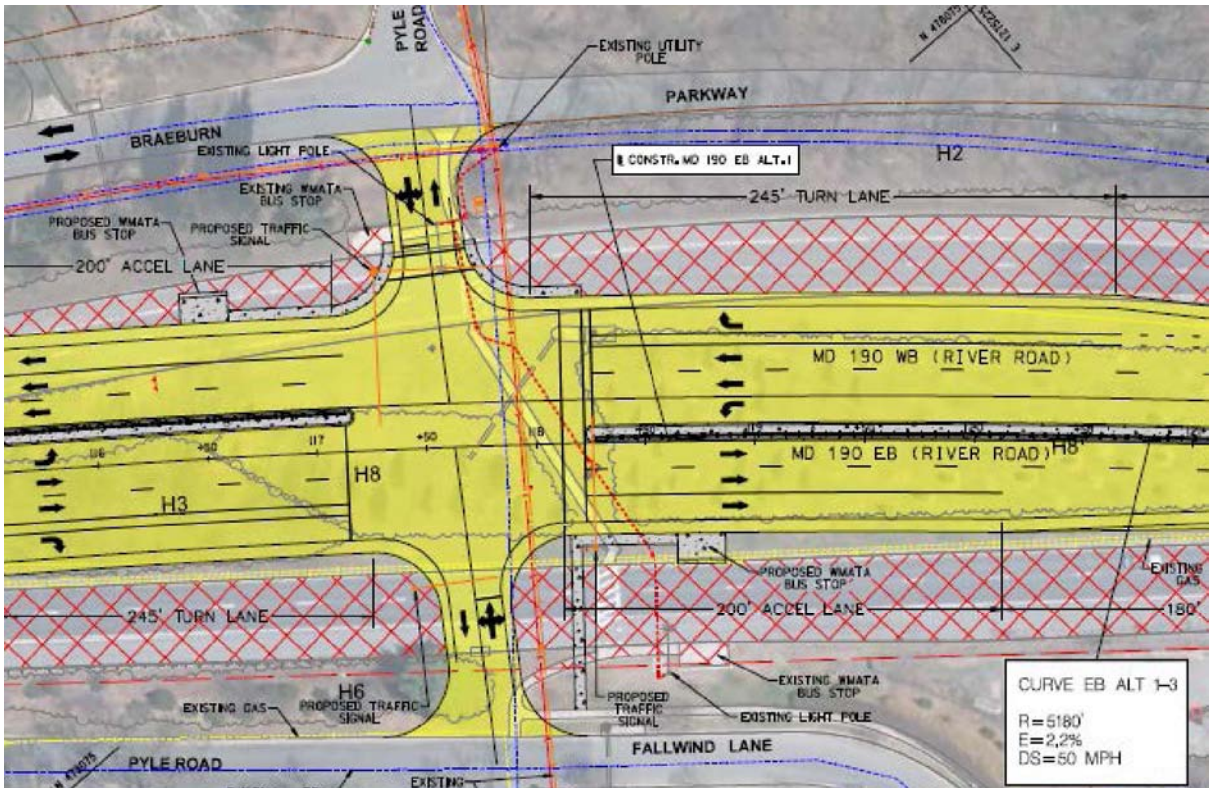


Figure 19: Alternative 1 Concept Plan

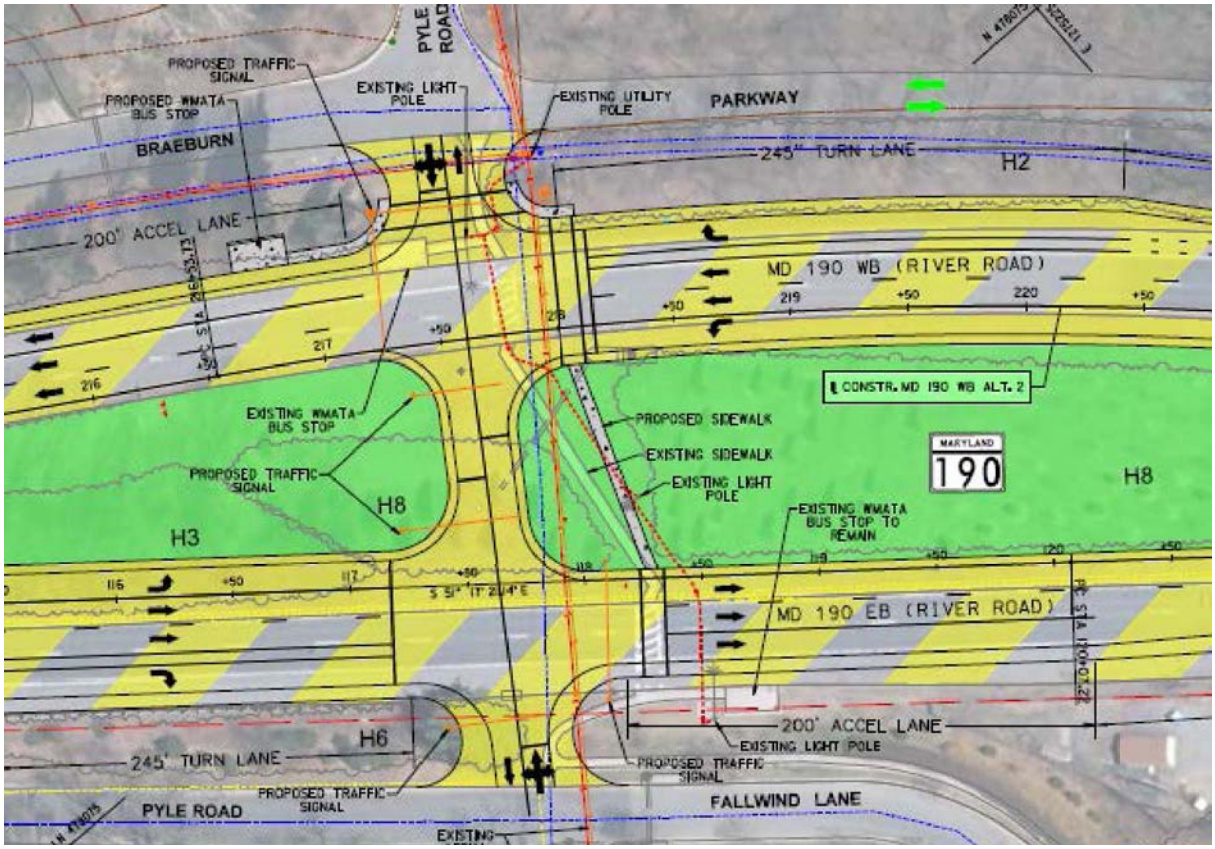


Figure 20: Alternative 2 Concept Plan

of the two signals would be coordinated to minimize stopping and queuing within the median roadway. Alternative 1 also allows longer queue storage for the approaches of Pyle Road between MD 190 and the adjacent parallel service roads. Under Alternative 2, the short distance between MD 190 and the parallel service road may result in more potential conflicts at these unsignalized intersections than under Alternative 1.

After an initial review, a third alternative was developed that would maintain the westbound MD 190 alignment and shift the eastbound MD 190 alignment adjacent to the westbound alignment, forming a single intersection at Pyle Road. Under Alternative 3, as shown in **Figure 21**, the proposed signal would operate the same as Alternative 1, while the segment between MD 190 and the parallel service road to the north would be similar to the proposed conditions under Alternative 2.

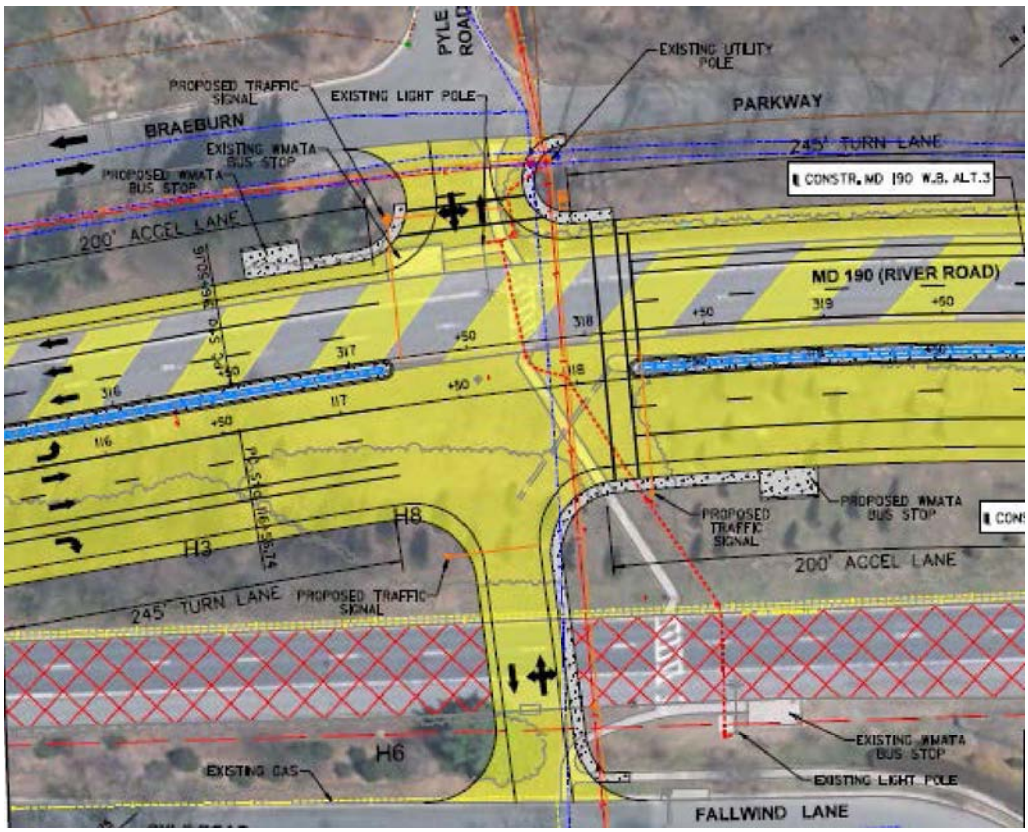


Figure 21: Alternative 3 Concept Plan

D. Capacity Analysis

Synchro/SimTraffic models were prepared for both options using the proposed relocated intersection volumes. The unsignalized intersections at the parallel service roads were not modeled. Capacity analysis results for both options are summarized in **Table 4**. Queuing results for the relocated intersection(s) of MD 190 at Pyle Road are summarized in **Table 5**. Detailed reports are included in this report in **Attachment E**.

Under all alternatives, the LOS at the intersections of MD 190 at MD 188 and Winston Drive/Whittier Boulevard remain unchanged from the Existing/Modified conditions.

For Alternative 1 and 3, at the new relocated intersection at Pyle Road, operations are projected to be LOS B or better during both peak periods. Under Alternative 1 and 3, the projected queues at the new relocated intersection at Pyle Road are less than 150 feet for all turn movements. The proposed storage lengths are all adequate and do not fill up to their capacity.

For Alternative 2, the two new signalized intersections at Pyle Road and eastbound and westbound MD 190 are projected to operate at LOS B or better during both peak periods. However, under Alternative

Table 4: MD 190 Relocated Synchro Results						
#	Intersection	Approach	Relocated Alternative 1/3 AM (PM)		Relocated Alternative 2 AM (PM)	
			LOS	Delay per Vehicle (sec)	LOS	Delay per Vehicle (sec)
1	MD 190 at MD 188	**Overall**	**D (D)**	**42.5 (40.4)**	**D (D)**	**41.9 (41.9)**
		EB	D (C)	35.3 (27.3)	D (C)	35.3 (27.3)
		WB	C (C)	30.6 (28.5)	C (C)	28.7 (31.8)
		NB	E (E)	79.7 (77.2)	E (E)	79.7 (77.2)
		SB	F (F)	82.3 (81.1)	F (F)	82.3 (81.1)
2	MD 190 at Braeburn Parkway	N/A	No intersection		No intersection	
3	MD 190 at Pyle Road	**Overall**	**A (B)**	**8.7 (12.3)**	N/A	
		EB	A (A)	3.8 (3.7)		
		WB	A (B)	9.3 (15.9)		
		NB	E (E)	63.2 (63.5)		
		SB	E (E)	63.6 (63.5)		
3a	Eastbound MD 190 at Pyle Road	**Overall**	N/A		**B (A)**	**11.2 (6.8)**
		EB			A (A)	9.6 (2.3)
		NB			E (E)	63.1 (68.6)
		SB			E (E)	62.1 (71.7)
3b	Westbound MD 190 at Pyle Road	**Overall**	N/A		**B (A)**	**17.2 (9.1)**
		WB			A (A)	7.9 (6.2)
		NB			D (F)	52.1 (80.6)
		SB			E (E)	61.8 (72.6)
4	MD 190 at Winston Drive/ Whittier Boulevard	**Overall**	**D (C)**	**53.0 (23.2)**	**D (C)**	**50.3 (23.2)**
		EB	A (B)	7.7 (10.1)	A (B)	2.8 (10.1)
		WB	B (C)	12.3 (26.4)	B (C)	12.3 (26.4)
		NB	E (D)	70.9 (40.3)	E (D)	70.9 (40.3)
		SB	F (E)	>300 (61.1)	F (E)	>300 (61.1)

Table 5: MD 190 at Relocated Pyle Road SimTraffic Queuing Results				
Approach	Movement	Relocated Alternative 1/3 AM (PM)	Relocated Alternative 2 EB MD 190 – AM (PM)	Relocated Alternative 2 WB MD 190 – AM (PM)
		95th Percentile Queue (ft)	95th Percentile Queue (ft)	95th Percentile Queue (ft)
EB	U & L	125 (55)	155 (20)	N/A
	Through	305 (130)	465 (105)	
	R	25 (15)	70 (15)	
WB	U & L	65 (55)	N/A	30 (25)
	Through	220 (420)		240 (275)
	R	25 (70)		20 (65)
NB	LTR	70 (65)	85 (60)	120* (85)
SB	LTR	140 (70)	50 (90)	110 (80)

* Exceeds storage length between WB MD 190 and EB MD 190. Actual queue may be longer.

2, the northbound queues within the median roadway are projected to exceed the length of the roadway during the AM peak period and traffic turning left from eastbound MD 190 traveling to Pyle Road north of the intersection is expected to spill over into the intersection. This queuing behavior is expected to occur during the peak of the peak hour, before the morning school bell time.

E. Expected Safety Benefits

AASHTO's *Highway Safety Manual* (HSM) is a resource used to quantify and predict the safety performance of an intersection or roadway based on various elements such as roadway planning, design, maintenance, etc. The HSM includes a catalog of crash modification factors (CMF), factors developed based on a scientific process that estimate the potential change in crash frequency or crash severity due to installing a particular treatment. The CMFs in the HSM have been developed using reliable before/after studies that account for natural variation in crash data.

According to the HSM, reliable CMFs for the conversion of an urban intersection with minor-road stop control to signal control (Table 14-7 of the HSM) include the following:

For crashes of all types and all severities:

- CMF for conversion of intersection with minor-road stop control to signal control (from Table 14-7 of HSM) = 0.95 (standard error, SE, of 0.09),
- CMF 95% Confidence Interval = $CMF \pm 2{\times}SE$ = $0.95 \pm 2{\times}0.09$ = 0.77 to 1.13,
- Reduction in crashes as a result of conversion to signalized control = $1 - CMF$= -0.13 to 0.23, or 23% reduction to 13% increase in number of crashes of all types and severities as a result of installing a traffic signal.

For right-angle crashes of all severities:

- CMF for conversion of intersection with minor-road stop control to signal control (from Table 14-7 of HSM) = 0.33 (standard error, SE, of 0.06),
- CMF 95% Confidence Interval = $CMF \pm 2{\times}SE$ = $0.33 \pm 2{\times}0.06$ = 0.21 to 0.45,

Reduction in crashes as a result of conversion to signalized control = $1 - CMF$= 0.55 to 0.79, or 55% to 79% reduction in number of right-angle crashes of all severities as a result of installing a traffic signal. The HSM also reports a less reliable CMF for rear-end crashes of all severities (CMF = 2.43; standard error, SE, of 0.40) which indicates the number of rear-end crashes at the intersection would be expected to increase significantly. A CMF could not be obtained for the conversion of an existing unsignalized marked pedestrian crossing into a signalized intersection with pedestrian signals.

According to the CMFs in the HSM, the proposed traffic signal at the Pyle Road should reduce the number of right-angle crashes but may increase or decrease the total number of crashes at the intersection. It should be noted that the existing unsignalized intersection of MD 190 at Braeburn Parkway did not exhibit a pattern of crashes during the over three-year period between January 2013 and October 2016. A traffic signal also would not have been expected to eliminate the risk for the high-profile fatal crash that occurred in February 2016 where a driver was reportedly traveling along MD 190 at extremely high speeds.

IV. Summary and Conclusions

This report summarizes the results of a traffic and safety analysis conducted by RK&K for District 3 at the intersection of MD 190 and Braeburn Parkway/Pyle Road. Three intersection concepts were analyzed to close the existing unsignalized intersection at Braeburn Parkway and relocate those turning movements to a new signalized intersection at the alignment of Pyle Road, where an existing pedestrian crosswalk is located. The Alternative 1 concept would re-align both directions of MD 190 to the existing median and allow all movements to travel through a single intersection. Under Alternative 2, the alignment of MD 190 would remain unchanged from existing conditions, and a new connector would be constructed in the existing wide median, essentially creating two intersections with one-way traffic along MD 190 at each intersection. Finally, the Alternative 3 concept would maintain the alignment of westbound MD 190 and shift the eastbound lanes adjacent to the existing westbound lanes, creating a single intersection that would operate the same as Alternative 1 conditions.

Full signalized control is recommended for the relocated intersection due to conflicts between turning vehicles and pedestrians and potential sight distance issues for the minor street crossing maneuvers. From

an operational perspective, Alternative 1 or 3 would be preferred because it is projected to operate at LOS B or better with minimal queuing, while Alternative 2 would be expected to result in queue spillback during the AM peak period and would require more complicated signal control. From a safety perspective, all alternatives would be expected to significantly reduce the risk for right-angle crashes, but could increase the overall number of crashes.

APPENDIX A

March 2016 Raw Counts

Maryland Department of Transportation
State Highway Administration Data Services Engineering Division
Turning Movement Count Study - Field Sheet

Station ID: S1999150153 **County:** Montgomery **Comments:**

Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

Hour Begin	Braeburn Pkwy From North					Braeburn Pkwy From South					MD 190 From East					MD 190 From West					Grand Total
	U.Tur	Left	Through	Right	TOTAL	U.Turn	Left	Throug	Right	TOTAL	U.Turn	Left	Throug	RIGHT	TOTAL	U.Turn	Left	Through	Right	TOTAL	
6:00	0	0	0	0	0	0	1	0	0	1	0	0	54	1	55	0	4	216	1	221	277
6:15	0	1	0	0	1	0	1	0	0	1	0	1	81	0	82	0	4	265	0	269	353
6:30	0	1	0	3	4	0	0	0	1	1	0	3	83	1	87	0	6	321	3	330	422
6:45	0	3	0	7	10	0	1	1	2	4	0	1	111	0	112	0	11	407	1	419	545
7:00	0	3	0	9	12	0	1	0	1	2	0	1	151	1	153	1	15	496	5	516	683
7:15	0	0	0	26	26	0	0	1	3	4	0	2	235	18	255	0	54	469	3	526	811
7:30	**0**	**0**	**0**	**75**	**75**	**0**	**0**	**0**	**13**	**13**	**1**	**3**	**331**	**16**	**350**	**2**	**116**	**497**	**6**	**619**	**1057**
7:45	**0**	**1**	**0**	**40**	**41**	**0**	**3**	**0**	**5**	**8**	**0**	**1**	**292**	**0**	**293**	**0**	**9**	**486**	**10**	**505**	**847**
8:00	**0**	**0**	**0**	**13**	**13**	**0**	**4**	**1**	**3**	**8**	**1**	**6**	**252**	**2**	**260**	**0**	**3**	**520**	**13**	**536**	**817**
8:15	**0**	**0**	**0**	**11**	**11**	**0**	**3**	**0**	**4**	**7**	**1**	**3**	**305**	**2**	**310**	**1**	**15**	**485**	**17**	**517**	**845**
8:30	0	0	0	12	12	0	2	0	3	5	0	5	290	0	295	2	11	497	11	519	831
8:45	0	0	1	6	7	0	2	1	4	7	1	1	301	0	302	0	5	443	13	461	777
9:00	0	1	0	3	4	0	5	0	6	11	1	1	283	0	284	1	5	444	14	463	762
9:15	0	1	1	5	7	0	3	1	4	8	0	1	252	2	255	2	7	466	15	488	758
9:30	0	2	0	6	8	0	6	0	2	8	0	3	216	4	223	1	8	475	4	487	726
9:45	0	4	0	3	7	0	5	0	4	9	0	1	213	1	215	0	3	484	3	490	721
10:00	0	4	0	1	5	0	4	0	6	10	1	1	231	1	233	0	5	385	3	393	641
10:15	0	5	0	9	14	0	4	0	5	9	1	1	227	0	228	1	0	319	1	320	571
10:30	0	2	0	5	7	0	1	0	4	5	1	5	234	4	243	1	2	261	7	270	525
10:45	0	0	0	1	1	0	1	0	6	7	0	0	229	1	230	1	5	311	1	317	555

Station ID: S1999150153 **County:** Montgomery **Comments:**

Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

11:00	0	2	0	3	5	0	4	0	5	9	0	3	249	2	254	1	4	274	8	286	554
11:15	0	4	1	3	8	0	3	0	5	8	1	7	262	2	271	1	2	308	1	311	598
11:30	0	1	0	3	4	0	1	1	3	5	0	3	294	5	302	2	1	301	2	304	615
11:45	0	0	0	3	3	0	3	0	6	9	1	4	307	2	313	2	3	252	6	261	586
12:00	0	4	0	9	13	0	3	2	3	8	0	3	309	3	315	1	6	266	6	278	614
12:15	0	1	0	9	10	0	3	0	1	4	0	3	283	5	291	2	5	264	4	273	578
12:30	0	2	0	2	4	0	3	0	6	9	0	6	273	1	280	1	4	264	2	270	563
12:45	0	2	0	5	7	0	3	0	6	9	1	5	319	4	328	1	5	270	9	284	628
13:00	0	3	0	8	11	0	5	0	1	6	0	4	303	3	310	1	6	236	1	243	570
13:15	0	1	0	4	5	1	1	0	3	4	0	2	319	1	322	0	2	253	1	256	587
13:30	0	1	0	11	12	1	4	1	4	9	1	3	288	2	293	1	4	276	8	288	602
13:45	0	1	1	16	18	0	6	0	2	8	1	4	293	3	300	0	5	259	7	271	597
14:00	0	2	0	3	5	0	4	0	3	7	0	3	339	1	343	2	12	274	5	291	646
14:15	0	0	0	8	8	0	1	2	4	7	0	8	389	7	404	1	16	282	2	300	719
14:30	0	4	0	60	64	0	2	0	5	7	1	3	400	5	408	0	9	302	4	315	794
14:45	0	1	1	27	29	0	4	1	4	9	0	4	398	1	403	1	17	268	6	291	732
15:00	0	1	2	27	30	1	7	1	2	10	0	3	473	3	479	0	6	298	5	309	828
15:15	0	1	0	24	25	2	3	0	6	9	2	4	433	6	443	2	8	304	11	323	800
15:30	0	3	1	19	23	0	1	0	3	4	0	5	419	3	427	0	11	281	5	297	751
15:45	0	1	0	19	20	0	5	0	6	11	1	2	450	7	459	0	5	316	2	323	813
16:00	0	1	0	12	13	2	1	0	8	9	0	1	434	3	438	1	7	256	8	271	731
16:15	0	0	0	8	8	0	4	0	5	9	0	2	458	4	464	1	6	270	8	284	765
16:30	0	1	0	9	10	0	0	1	2	3	0	5	383	2	390	0	4	276	5	285	688
16:45	0	0	3	6	9	0	3	1	6	10	0	2	427	1	430	0	1	243	6	250	699
17:00	0	1	0	9	10	0	5	2	7	14	0	4	455	1	460	0	5	231	1	237	721
17:15	0	0	0	7	7	0	3	0	2	5	0	7	501	1	509	0	4	280	6	290	811

Station ID: S1999150153 **County:** Montgomery **Comments:**

Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

17:30	0	2	1	6	9	0	1	0	4	5	0	2	446	2	450	1	3	307	4	314	778
17:45	0	0	1	1	2	0	3	0	5	8	0	12	449	1	462	1	5	277	11	293	765
18:00	0	1	0	10	11	0	1	2	12	15	0	6	467	4	477	3	12	298	13	323	826
18:15	0	3	1	25	29	0	2	0	8	10	0	5	460	8	473	0	8	322	11	341	853
18:30	0	1	4	9	14	0	2	0	6	8	0	10	411	6	427	1	10	293	9	312	761
18:45	0	2	0	7	9	0	4	1	3	8	0	5	360	5	370	1	9	241	8	258	645
TOTAL:	0	75	18	607	700	7	142	20	222	384	17	180	16422	158	16760	41	493	17089	316	17898	35742
AM Peak:	0	1	0	139	140	0	10	1	25	36	3	13	1180	20	1213	3	143	1988	46	2177	3566
PM Peak:	0	6	3	42	51	0	7	2	29	38	0	25	1822	15	1862	5	28	1204	39	1271	3222

Station ID: S1999150153 **County:** Montgomery **Comments:**

Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

	Braeburn Pkwy North Leg			Braeburn Pkwy South Leg			MD 190 East Leg			MD 190 West Leg		
Hour Ending	School Children	Pedestrians	Bicycles	School Children	Pedestrains	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles
6:00	0	0	0	0	0	0	0	0	0	0	0	0
6:15	0	0	0	0	0	0	0	0	0	0	0	0
6:30	0	0	0	0	0	0	0	0	0	0	0	0
6:45	0	0	0	0	0	0	0	0	0	0	0	0
7:00	0	0	0	0	0	0	0	0	0	0	0	0
7:15	0	0	0	0	0	0	0	0	0	0	0	0
7:30	0	0	0	0	1	0	0	0	0	0	0	0
7:45	0	0	0	0	0	0	0	0	0	0	0	0
8:00	0	0	0	0	0	0	0	0	0	0	0	0
8:15	0	0	0	0	0	0	0	0	0	0	0	0
8:30	0	0	0	0	0	0	0	0	0	0	0	0
8:45	0	0	0	0	0	0	0	0	0	0	0	0
9:00	0	0	0	0	0	0	0	0	0	0	0	0
9:15	0	0	0	0	0	0	0	0	0	0	0	0
9:30	0	0	0	0	0	0	0	0	0	0	0	0
9:45	0	0	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	1	0	0	0	0	0	0	0
10:15	0	0	0	0	0	0	0	0	0	0	1	0
10:30	0	0	0	0	0	0	0	0	0	0	0	0
10:45	0	1	0	0	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	0	0	0	0	0
11:15	0	0	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	0	0	0	0	0
12:00	0	0	0	0	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0	0	0	0	0	0	0
12:30	0	0	0	0	0	0	0	0	0	0	0	0
12:45	0	0	0	0	0	0	0	0	0	0	0	0

Station ID: S1999150153 **County:** Montgomery **Comments:**

Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

13:00	0	0	0	0	0	0	0	0	0	0	0	0	
13:15	0	0	0	0	0	0	0	0	0	0	0	0	
13:30	0	0	0	0	0	0	0	0	0	0	0	0	
13:45	0	0	0	0	0	0	0	0	0	0	0	0	
14:00	0	0	0	0	0	0	0	0	0	0	0	0	
14:15	0	0	0	0	0	0	0	0	0	0	0	0	
14:30	0	0	0	0	0	0	0	0	0	0	0	0	
14:45	0	0	0	0	0	0	0	0	0	0	0	0	
15:00	0	0	0	0	0	0	0	0	0	0	0	0	
15:15	0	0	0	0	0	0	0	0	0	0	0	0	
15:30	0	0	0	0	0	0	0	0	0	0	0	0	
15:45	0	0	0	0	0	0	0	1	0	0	0	0	
16:00	0	0	0	0	0	0	0	0	0	0	0	0	
16:15	0	0	0	0	0	0	0	0	0	0	0	0	
16:30	0	0	0	0	0	0	0	0	0	0	0	0	
16:45	0	0	0	0	0	0	0	0	0	0	0	0	
17:00	0	0	0	0	0	0	0	0	0	0	0	0	
17:15	0	0	0	0	0	0	0	0	0	0	0	0	
17:30	0	0	0	0	0	0	0	0	0	0	0	0	
17:45	0	0	0	0	0	0	0	0	0	0	0	0	
18:00	0	0	0	0	0	0	0	0	0	0	0	0	
18:15	0	0	0	0	0	0	0	0	0	0	0	0	
18:30	0	0	0	0	0	0	0	0	0	0	0	0	
18:45	0	0	0	0	0	0	0	0	0	0	0	0	
Total:	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	
AM Peak:	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
PM Peak:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

Station ID: S1999150153 **County:** Montgomery **Comments:**

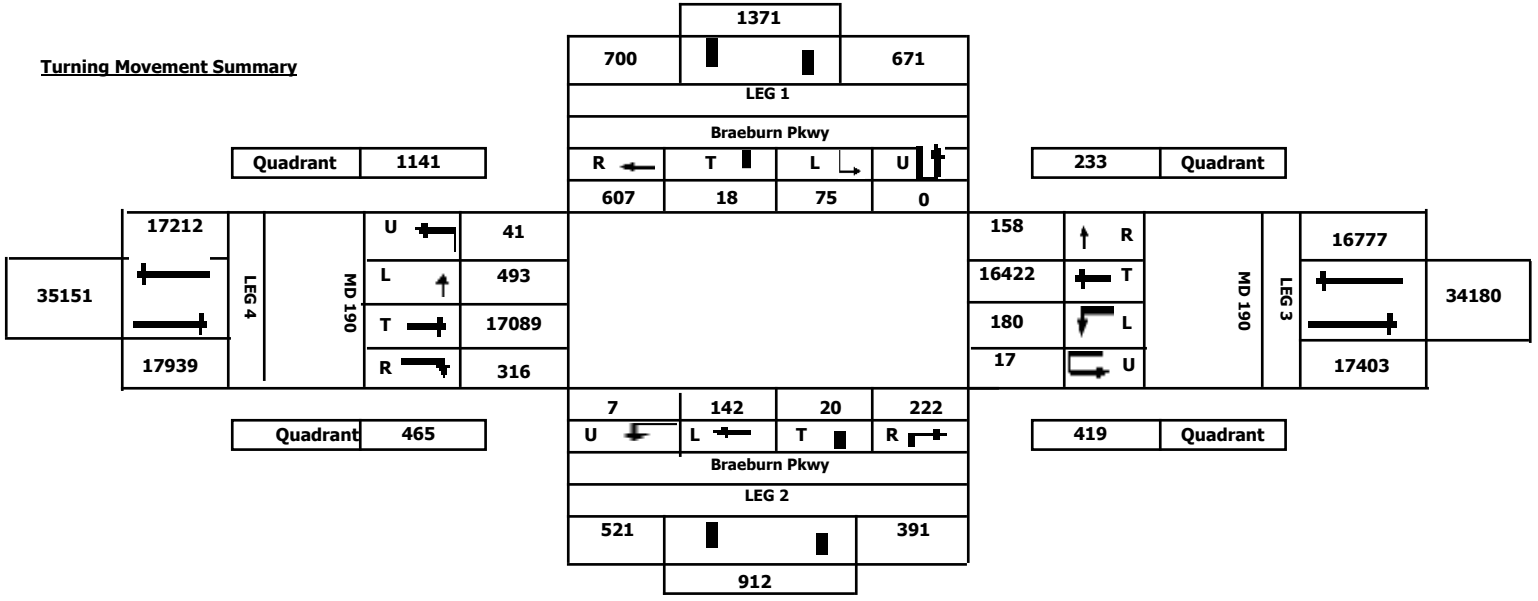
Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

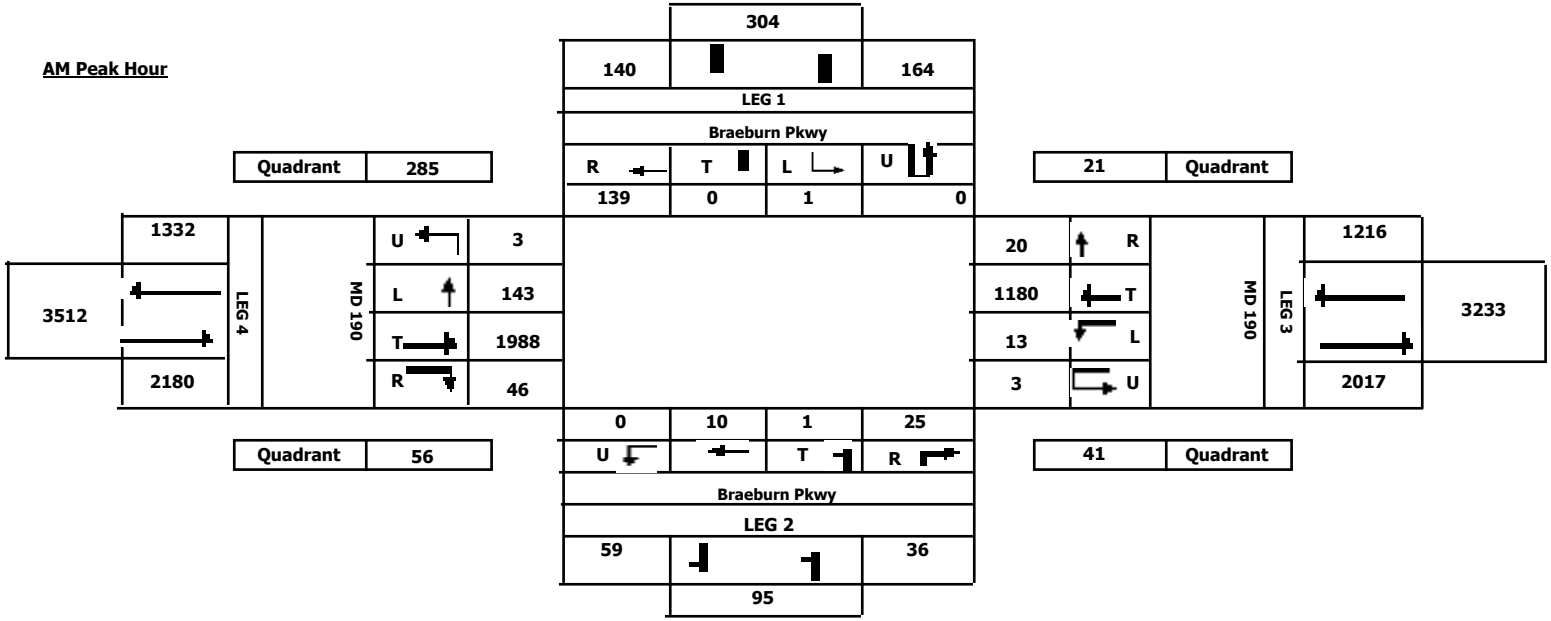
Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

Turning Movement Summary



AM Peak Hour



Station ID: S1999150153 **County:** Montgomery **Comments:**

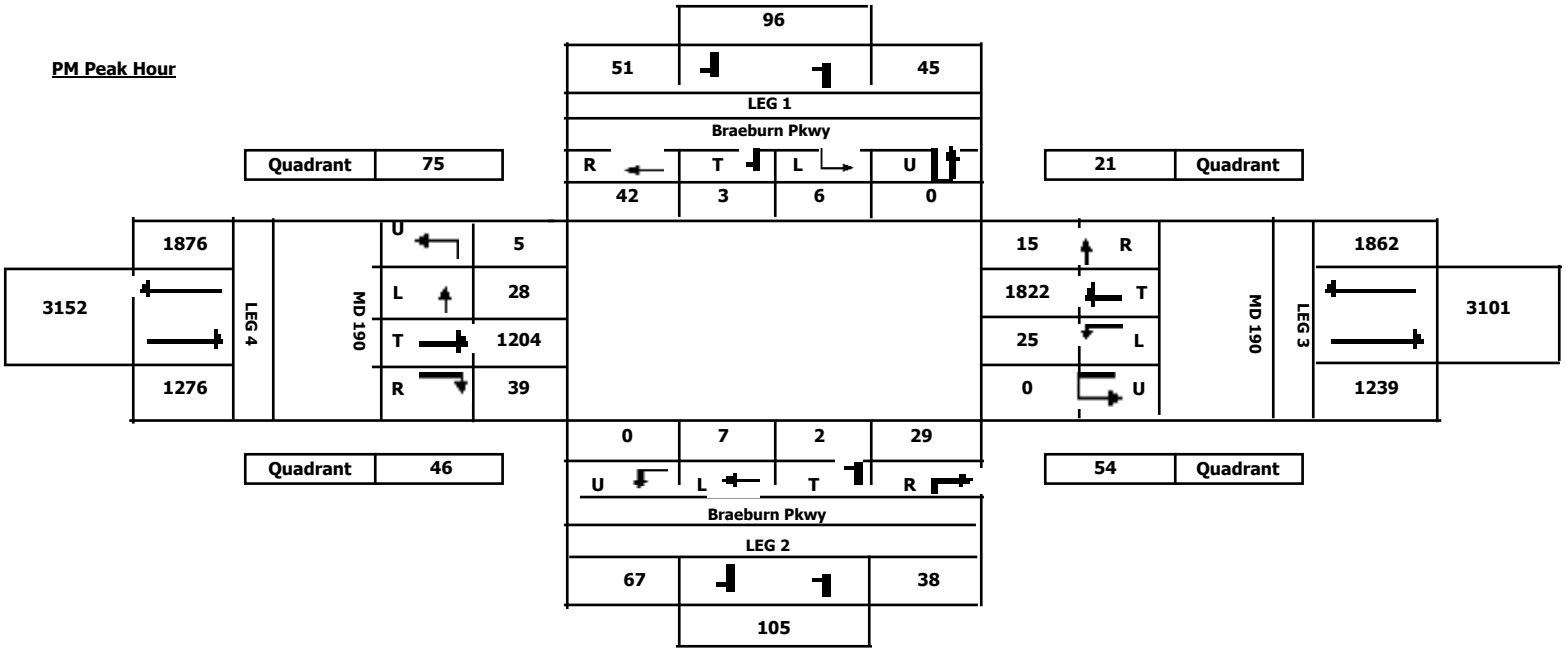
Date: Tuesday 03/08/2016 **Town:** none

Location: MD 190 at Braeburn Pkwy **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:30	08:30	3566	C	0.79		17:30	18:30	3222	B	0.68

PM Peak Hour



Maryland Department of Transportation
State Highway Administration Data Services Engineering Division
Turning Movement Count Study - Field Sheet

Station ID: S2002150138 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

Hour Begin	MD 188 From North					MD 188 From South					MD 190 From East					MD 190 From West					Grand Total
	U.Tur	Left	Through	Right	TOTAL	U.Turn	Left	Throug	Right	TOTAL	U.Turn	Left	Throug	RIGHT	TOTAL	U.Turn	Left	Through	Right	TOTAL	
6:00	0	4	3	13	20	0	1	5	1	7	0	0	53	1	54	0	16	210	5	231	312
6:15	0	2	8	15	25	0	4	4	2	10	0	1	69	2	72	0	17	258	6	281	388
6:30	0	5	12	16	33	0	5	7	2	14	0	1	80	1	82	0	33	321	21	375	504
6:45	0	6	33	39	78	0	10	15	3	28	0	1	107	5	113	0	24	401	31	456	675
7:00	0	14	21	39	74	0	7	14	9	30	1	3	149	9	161	0	31	475	16	522	787
7:15	**0**	**16**	**38**	**49**	**103**	**0**	**13**	**65**	**38**	**116**	**0**	**10**	**229**	**9**	**248**	**0**	**33**	**476**	**34**	**543**	**1010**
7:30	**0**	**27**	**46**	**51**	**124**	**1**	**22**	**30**	**47**	**99**	**1**	**26**	**332**	**9**	**367**	**0**	**43**	**492**	**38**	**573**	**1163**
7:45	**0**	**21**	**33**	**51**	**105**	**0**	**18**	**46**	**20**	**84**	**0**	**26**	**310**	**23**	**359**	**0**	**45**	**448**	**39**	**532**	**1080**
8:00	**0**	**37**	**39**	**57**	**133**	**0**	**22**	**54**	**17**	**93**	**0**	**12**	**235**	**10**	**257**	**0**	**52**	**465**	**28**	**545**	**1028**
8:15	0	24	29	50	103	0	13	25	17	55	0	5	281	6	292	0	53	465	31	549	999
8:30	0	12	24	43	79	0	16	54	12	82	1	7	295	5	307	0	53	471	28	552	1020
8:45	0	24	30	64	118	0	14	35	12	61	1	3	267	13	283	0	62	419	53	534	996
9:00	0	19	35	54	108	0	16	55	9	80	0	9	280	12	301	0	58	426	39	523	1012
9:15	0	26	33	67	126	0	26	51	17	94	0	4	224	13	241	0	80	424	28	532	993
9:30	0	16	24	73	113	0	17	38	12	67	1	7	212	8	227	0	51	442	20	513	920
9:45	0	10	17	46	73	0	19	29	12	60	0	6	203	7	216	0	47	474	14	535	884
10:00	0	15	16	37	68	0	17	27	10	54	0	2	208	9	219	0	50	363	15	428	769
10:15	0	13	20	31	64	0	16	22	4	42	0	8	215	8	231	0	32	301	11	344	681
10:30	0	6	18	35	59	0	11	15	5	31	1	6	191	8	205	0	45	255	10	310	605
10:45	0	5	14	59	78	0	10	15	4	29	0	6	222	14	242	0	38	299	10	347	696

Station ID: S2002150138 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

11:00	0	13	18	47	78	0	13	17	10	40	2	7	211	10	228	0	29	261	6	296	642
11:15	0	5	20	49	74	0	11	18	8	37	0	7	261	6	274	0	31	287	9	327	712
11:30	0	11	11	40	62	0	7	24	4	35	0	2	252	16	270	0	42	273	9	324	691
11:45	0	6	28	42	76	0	8	17	4	29	0	8	280	10	298	0	40	245	2	287	690
12:00	0	16	15	54	85	0	8	14	11	33	0	7	262	14	283	0	40	242	5	287	688
12:15	1	13	11	44	68	0	16	13	7	36	0	7	283	14	304	0	37	243	7	287	695
12:30	0	12	24	57	93	0	14	16	6	36	0	6	262	9	277	0	38	246	8	292	698
12:45	0	14	15	41	70	0	11	8	5	24	1	2	283	13	298	0	39	251	13	303	695
13:00	0	14	17	53	84	0	20	21	10	51	1	10	302	10	322	0	41	218	6	265	722
13:15	0	12	21	38	71	0	13	20	7	40	1	6	280	12	298	0	32	231	5	268	677
13:30	0	23	19	37	79	0	8	25	7	40	0	4	262	13	279	0	36	245	12	293	691
13:45	0	11	11	45	67	0	13	23	6	42	0	8	270	7	285	0	48	248	8	304	698
14:00	0	13	9	54	76	0	7	23	6	36	1	3	321	16	340	0	42	260	10	312	764
14:15	0	10	14	67	91	0	12	25	11	48	0	3	365	12	380	1	37	271	15	323	842
14:30	0	15	13	74	102	0	13	21	12	46	2	19	389	29	437	2	40	287	11	338	923
14:45	0	17	23	73	113	0	27	32	11	70	0	10	363	18	391	0	48	252	12	312	886
15:00	0	20	32	83	135	0	19	30	12	61	0	18	438	27	483	0	39	263	12	314	993
15:15	0	14	35	98	147	0	11	48	11	70	0	7	413	23	443	0	33	282	17	332	992
15:30	0	11	37	65	113	1	15	49	15	79	1	17	414	19	450	0	50	265	23	338	980
15:45	0	12	50	79	141	0	24	45	17	86	0	11	380	21	412	0	51	293	9	353	992
16:00	0	22	60	86	168	0	29	45	11	85	1	10	390	21	421	1	37	235	19	291	965
16:15	0	29	62	100	191	0	29	56	16	101	1	5	409	25	439	1	48	222	8	278	1009
16:30	0	23	56	79	158	0	17	51	15	83	0	8	392	19	419	0	41	243	7	291	951
16:45	0	15	48	75	138	1	23	53	19	95	1	6	401	18	425	0	47	213	4	264	922
17:00	0	13	49	82	144	0	23	57	31	111	0	10	427	22	459	1	26	189	9	224	938
17:15	0	29	54	92	175	0	18	58	17	93	1	7	445	15	467	0	30	246	12	288	1023

Station ID: S2002150138 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

17:30	0	24	53	81	158	0	20	41	22	83	1	17	418	21	456	0	42	270	10	322	1019
17:45	0	36	60	69	165	0	11	57	12	80	1	10	423	19	452	0	55	245	11	311	1008
18:00	0	25	49	99	173	0	15	74	22	111	1	8	429	20	457	0	45	269	14	328	1069
18:15	0	17	46	97	160	0	11	50	17	78	1	15	382	29	426	0	55	302	18	375	1039
18:30	0	26	45	84	155	0	9	53	30	92	0	10	402	16	428	0	39	248	11	298	973
18:45	0	14	24	60	98	0	17	37	23	77	0	9	309	26	344	0	43	231	17	291	810
TOTAL:	1	837	1522	3033	5392	3	769	1727	668	3164	23	420	15280	722	16422	6	2164	15961	816	18941	43919
AM Peak:	0	101	156	208	465	1	75	195	122	392	1	74	1106	51	1231	0	173	1881	139	2193	4281
PM Peak:	0	102	208	346	656	0	57	222	73	352	4	50	1652	89	1791	0	197	1086	53	1336	4135

Station ID: S2002150138 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

	MD 188 North Leg			MD 188 South Leg			MD 190 East Leg			MD 190 West Leg		
Hour Ending	School Children	Pedestrians	Bicycles	School Children	Pedestrains	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles
6:00	0	0	0	0	0	0	0	0	0	0	0	0
6:15	0	0	0	0	0	0	0	0	0	0	0	0
6:30	0	0	0	0	0	0	0	0	0	0	0	0
6:45	0	0	0	0	0	0	0	0	0	0	0	0
7:00	0	0	0	0	0	0	0	0	0	0	0	0
7:15	0	0	1	0	0	0	0	0	0	0	0	0
7:30	0	0	1	0	0	0	0	0	0	0	0	0
7:45	0	0	0	0	0	0	0	0	0	0	1	0
8:00	0	2	0	0	0	0	0	1	0	0	2	0
8:15	0	0	0	0	0	0	0	0	0	0	0	0
8:30	0	0	0	0	0	0	0	0	0	0	0	0
8:45	0	0	0	0	0	0	0	0	0	0	1	0
9:00	0	0	0	0	0	0	0	0	0	0	0	0
9:15	0	0	0	0	0	0	0	0	0	0	0	0
9:30	0	1	0	0	0	0	0	0	0	0	1	0
9:45	0	0	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	0	0	0	0	0	0	0	0
10:15	0	0	0	0	0	0	0	0	0	0	0	0
10:30	0	1	0	0	0	0	0	0	0	0	1	0
10:45	0	0	0	0	0	0	0	0	0	0	1	0
11:00	0	0	0	0	0	0	0	0	0	0	0	0
11:15	0	0	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	0	0	0	1	0
12:00	0	0	0	0	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0	0	0	0	0	1	0
12:30	0	0	0	0	0	0	0	0	0	0	0	0
12:45	0	0	0	0	0	0	0	0	0	0	0	0

Station ID: S2002150138 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

13:00	0	0	0	0	0	0	0	0	0	0	0	0
13:15	0	1	0	0	0	0	0	0	0	0	1	0
13:30	0	0	0	0	0	0	0	0	0	0	0	0
13:45	0	0	0	0	0	0	0	0	0	0	0	0
14:00	0	0	0	0	0	0	0	0	0	0	1	0
14:15	0	0	0	0	0	0	0	0	0	0	1	0
14:30	0	0	0	0	0	0	0	0	0	0	0	0
14:45	0	0	0	0	0	0	0	0	0	0	0	0
15:00	0	0	1	0	0	0	0	0	0	0	1	1
15:15	0	0	0	0	0	0	0	0	0	0	3	0
15:30	1	2	0	0	0	0	0	0	0	0	0	0
15:45	0	0	0	0	0	0	0	0	0	0	0	0
16:00	0	0	0	0	0	0	0	0	0	0	0	0
16:15	0	0	0	0	0	0	0	0	0	0	1	0
16:30	1	1	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	2	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	0	0	0	0	0	0	0
18:30	0	0	0	0	0	0	0	0	0	0	0	0
18:45	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**2**	**10**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**17**	**1**
AM Peak:	**0**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**3**	**0**
PM Peak:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Station ID: S2002150138 **County:** Montgomery **Comments:**

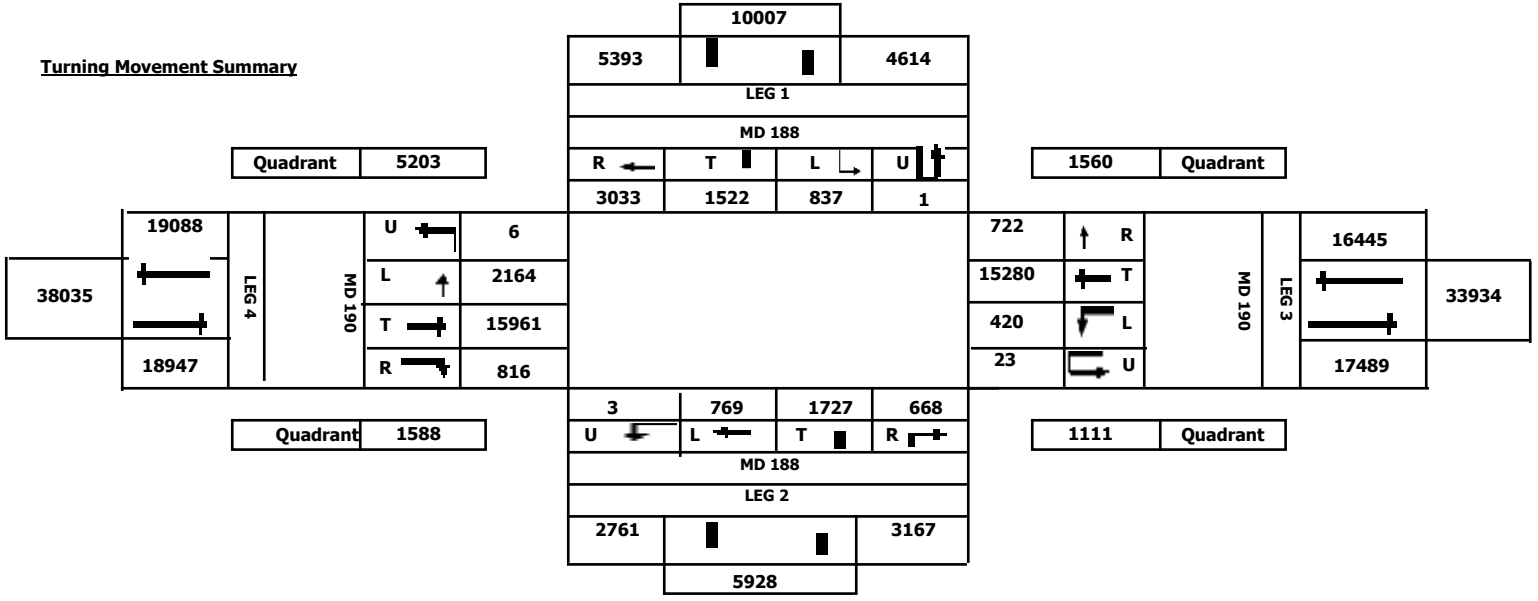
Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

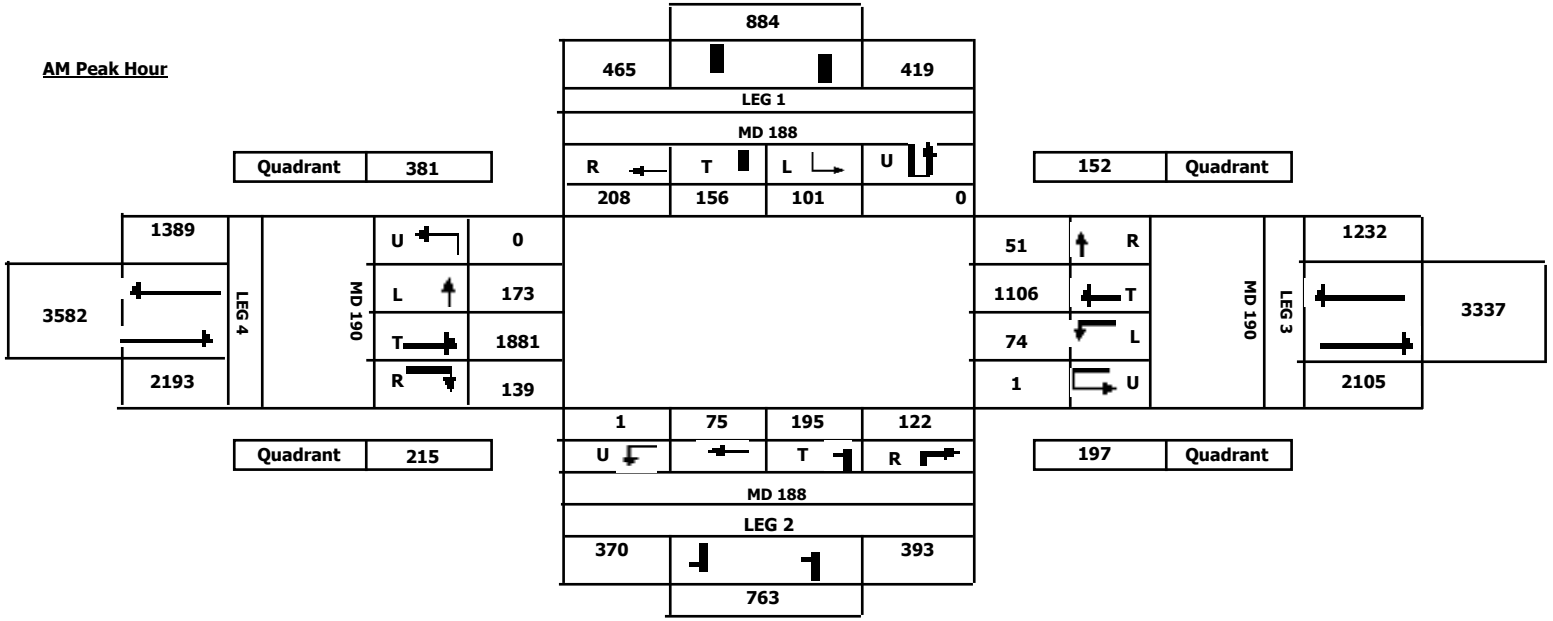
Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

Turning Movement Summary



AM Peak Hour



Station ID: S2002150138 **County:** Montgomery **Comments:**

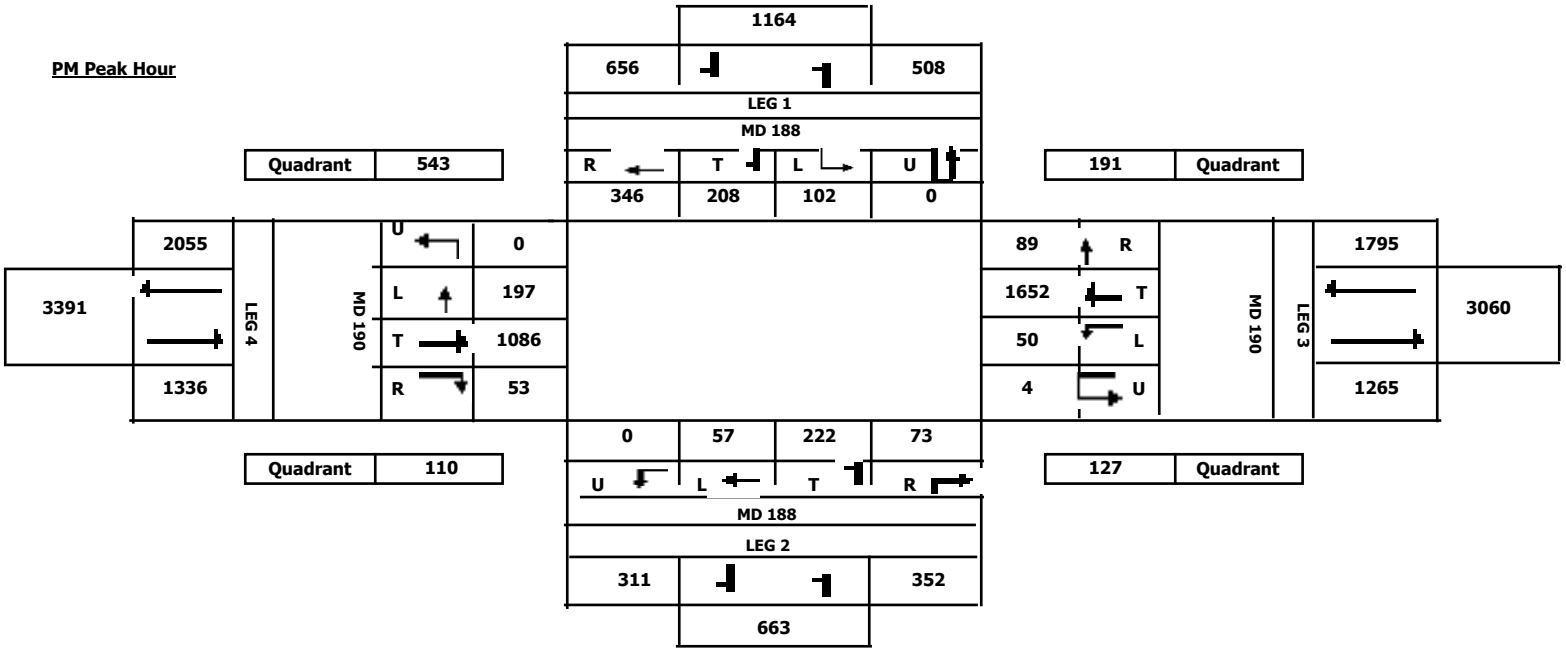
Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at MD 188 **Weather:** Sunny/Cloudy

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	4281	D	0.87		17:30	18:30	4135	E	0.92

PM Peak Hour



Maryland Department of Transportation
State Highway Administration Data Services Engineering Division
Turning Movement Count Study - Field Sheet

Station ID: S2002150139 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

Hour Begin	Whittier Blvd From North					Winston Dr From South					MD 190 From East					MD 190 From West					Grand Total
	U.Tur	Left	Through	Right	TOTAL	U.Turn	Left	Throug	Right	TOTAL	U.Turn	Left	Throug	RIGHT	TOTAL	U.Turn	Left	Through	Right	TOTAL	
6:00	0	3	0	0	3	0	1	1	0	2	0	0	60	4	64	0	1	194	0	195	264
6:15	0	9	0	4	13	0	3	0	1	4	0	2	72	3	77	0	4	266	1	271	365
6:30	0	7	0	3	10	0	2	0	1	3	0	0	80	7	87	0	3	308	3	314	414
6:45	0	11	0	6	17	0	3	1	2	6	0	0	108	9	117	0	8	400	3	411	551
7:00	0	25	1	5	31	0	3	3	5	11	0	2	143	28	173	0	12	467	6	485	700
7:15	**0**	**56**	**0**	**12**	**68**	**0**	**6**	**11**	**1**	**18**	**0**	**0**	**243**	**86**	**329**	**0**	**19**	**468**	**1**	**488**	**903**
7:30	**0**	**73**	**1**	**26**	**100**	**0**	**10**	**17**	**13**	**40**	**1**	**0**	**322**	**91**	**413**	**1**	**15**	**468**	**0**	**483**	**1036**
7:45	**0**	**90**	**0**	**12**	**102**	**0**	**12**	**4**	**10**	**26**	**2**	**1**	**264**	**28**	**293**	**0**	**5**	**499**	**2**	**506**	**927**
8:00	**0**	**66**	**0**	**5**	**71**	**0**	**5**	**2**	**7**	**14**	**2**	**0**	**245**	**30**	**275**	**0**	**5**	**479**	**0**	**484**	**844**
8:15	0	60	1	7	68	0	2	5	7	14	0	1	299	28	328	0	6	465	4	475	885
8:30	0	51	1	12	64	0	8	2	8	18	0	0	275	34	309	1	8	495	4	507	898
8:45	0	53	0	15	68	0	5	4	7	16	0	0	275	29	304	1	3	454	3	460	848
9:00	0	44	0	12	56	0	5	2	3	10	0	2	262	36	300	1	11	450	2	463	829
9:15	0	36	0	15	51	0	3	1	7	11	2	0	234	43	277	0	14	468	4	486	825
9:30	0	24	0	5	29	0	0	2	3	5	0	1	231	25	257	0	14	486	4	504	795
9:45	0	38	1	8	47	0	7	3	8	18	0	1	187	30	218	0	11	454	8	473	756
10:00	0	27	0	11	38	0	6	1	2	9	0	2	213	17	232	0	19	390	4	413	692
10:15	0	26	0	9	35	0	7	1	1	9	0	0	213	20	233	2	7	319	2	328	605
10:30	1	11	1	11	23	0	7	4	3	14	0	0	224	24	248	1	3	268	3	274	559
10:45	0	22	0	1	23	0	1	1	5	7	1	2	243	15	260	0	7	335	4	346	636

Station ID: S2002150139 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

11:00	0	23	0	9	32	0	4	1	2	7	1	1	226	21	248	0	10	255	9	274	561
11:15	0	21	0	13	34	0	2	1	5	8	1	3	263	20	286	0	7	289	4	300	628
11:30	0	25	1	12	38	0	9	1	7	17	0	3	270	22	295	0	8	272	4	284	634
11:45	0	24	0	12	36	0	6	1	6	13	1	4	300	36	340	0	9	249	1	259	648
12:00	0	56	0	22	78	0	7	2	3	12	1	0	272	26	298	0	13	269	4	286	674
12:15	0	28	0	9	37	0	5	1	4	10	0	2	285	30	317	0	7	252	1	260	624
12:30	0	20	1	8	29	0	2	0	5	7	1	0	254	43	297	1	13	237	9	259	592
12:45	0	23	1	14	38	0	3	1	6	10	1	4	330	28	362	0	9	268	3	280	690
13:00	0	28	0	8	36	0	6	0	3	9	1	0	277	26	303	0	10	225	2	237	585
13:15	0	18	0	11	29	0	4	0	8	12	2	1	320	23	344	0	9	252	4	265	650
13:30	0	20	0	13	33	0	0	0	1	1	0	1	259	21	281	1	11	263	8	282	597
13:45	0	29	0	13	42	0	3	1	6	10	1	2	297	17	316	1	10	240	4	254	622
14:00	0	14	0	14	28	0	6	3	5	14	1	0	328	32	360	0	16	268	3	287	689
14:15	0	26	1	10	37	0	5	2	2	9	1	1	378	39	418	0	20	262	1	283	747
14:30	0	88	0	28	116	0	5	2	5	12	0	0	350	43	393	0	16	267	4	287	808
14:45	0	39	0	11	50	0	2	2	7	11	0	1	399	45	445	0	13	277	4	294	800
15:00	0	31	1	16	48	0	4	0	7	11	2	1	457	40	498	0	12	280	2	294	851
15:15	0	42	0	17	59	0	5	5	6	16	1	2	419	56	477	0	11	297	6	314	866
15:30	0	34	1	12	47	0	3	2	2	7	2	2	403	34	439	1	15	266	4	285	778
15:45	0	27	1	13	41	0	6	1	9	16	1	2	448	37	487	1	7	309	0	316	860
16:00	0	32	0	11	43	0	3	7	6	16	2	1	413	54	468	0	12	248	7	267	794
16:15	0	44	2	12	58	0	8	3	4	15	3	2	432	44	478	2	7	265	10	282	833
16:30	0	44	0	14	58	0	4	2	5	11	3	2	372	56	430	0	9	265	4	278	777
16:45	0	32	1	7	40	0	4	3	2	9	0	1	414	49	464	0	8	249	5	262	775
17:00	0	35	0	7	42	0	2	1	3	6	2	6	453	41	500	0	6	229	3	238	786
17:15	0	47	1	10	58	0	3	2	7	12	1	0	493	41	534	0	6	252	3	261	865

Station ID: S2002150139 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

17:30	0	40	0	6	46	0	2	1	5	8	2	4	439	49	492	1	12	291	7	310	856
17:45	0	49	0	8	57	0	6	1	7	14	0	0	453	40	493	1	10	273	2	285	849
18:00	0	44	1	5	50	0	3	1	8	12	0	0	460	64	524	0	15	294	3	312	898
18:15	0	60	1	14	75	0	9	2	2	13	4	2	463	68	533	0	12	314	7	333	954
18:30	0	62	1	13	76	0	3	0	10	13	0	5	394	55	454	1	15	270	6	291	834
18:45	0	42	1	4	47	0	4	1	7	12	0	7	357	43	407	0	9	242	4	255	721
TOTAL:	1	1879	21	555	2455	0	234	115	259	608	43	74	15871	1830	17775	17	522	16622	196	17340	38178
AM Peak:	0	285	1	55	341	0	33	34	31	98	5	1	1074	235	1310	1	44	1914	3	1961	3710
PM Peak:	0	193	2	33	228	0	20	5	22	47	6	6	1815	221	2042	2	49	1172	19	1240	3557

Station ID: S2002150139 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

Hour Ending	Whittier Blvd North Leg			Winston Dr South Leg			MD 190 East Leg			MD 190 West Leg		
	School Children	Pedestrians	Bicycles	School Children	Pedestrains	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles
6:00	0	0	0	0	0	0	0	0	0	0	0	0
6:15	0	1	0	0	1	0	0	0	0	0	1	0
6:30	0	0	0	0	0	0	0	0	1	0	0	0
6:45	0	0	0	0	1	0	0	0	0	0	0	0
7:00	0	1	0	0	0	0	0	0	0	0	3	0
7:15	0	1	0	0	0	1	0	0	0	0	3	1
7:30	0	0	0	0	1	0	0	0	0	0	1	1
7:45	0	0	0	0	0	0	0	0	0	0	2	0
8:00	0	1	0	0	1	0	0	0	0	0	1	0
8:15	0	0	0	0	1	0	0	0	0	0	1	0
8:30	0	0	0	0	0	0	0	0	0	0	1	0
8:45	0	2	0	0	1	0	0	0	0	0	1	0
9:00	0	0	0	0	2	0	0	0	0	0	2	0
9:15	0	0	0	0	1	0	0	0	0	0	0	0
9:30	0	0	0	0	2	0	0	0	0	0	2	0
9:45	0	0	0	0	1	0	0	0	0	0	1	0
10:00	0	0	0	0	0	0	0	0	0	0	0	1
10:15	0	0	0	0	0	0	0	0	0	0	0	0
10:30	0	0	0	0	0	0	0	0	0	0	0	0
10:45	0	1	0	0	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	1	0	0	0	0
11:15	0	0	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	0	0	0	1	0
12:00	0	0	0	0	0	0	0	0	0	0	1	0
12:15	0	0	0	0	0	0	0	0	0	0	0	0
12:30	0	1	0	0	0	0	0	0	0	0	2	0
12:45	0	0	0	0	0	0	0	0	0	0	0	0

Station ID: S2002150139 **County:** Montgomery **Comments:**

Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

13:00	0	0	0	0	0	0	0	0	0	0	0	0	
13:15	0	0	0	0	1	0	0	0	0	0	3	0	
13:30	0	0	0	0	0	0	0	0	0	0	0	0	
13:45	0	0	0	0	0	0	0	0	0	0	1	0	
14:00	0	0	0	0	0	0	0	0	0	0	1	0	
14:15	0	0	0	0	0	0	0	0	0	0	1	0	
14:30	0	0	0	0	1	0	0	0	0	0	4	1	
14:45	0	0	0	0	2	0	0	0	0	0	4	0	
15:00	0	0	0	0	0	1	0	0	0	0	1	1	
15:15	0	0	0	0	0	0	0	0	0	0	4	0	
15:30	0	0	0	0	1	0	0	0	0	0	2	0	
15:45	0	0	0	0	1	0	0	0	0	0	2	0	
16:00	0	3	0	0	0	0	0	0	0	0	5	0	
16:15	0	3	0	0	3	0	0	0	0	1	8	0	
16:30	0	0	0	0	2	0	0	0	0	0	6	0	
16:45	0	0	0	0	1	0	0	0	0	0	6	2	
17:00	0	1	0	0	0	0	0	0	0	0	3	0	
17:15	0	0	0	0	0	0	0	0	0	0	5	0	
17:30	0	0	0	0	0	1	0	0	0	0	1	0	
17:45	0	0	0	0	0	0	0	0	0	0	1	0	
18:00	0	0	0	0	0	0	0	0	0	0	4	0	
18:15	0	0	0	0	1	0	0	0	0	0	1	2	
18:30	0	0	0	0	0	0	0	0	0	0	2	1	
18:45	0	0	0	0	0	0	0	0	0	0	2	0	
Total:	**0**	**15**	**0**	**0**	**25**	**3**	**0**	**1**	**1**	**1**	**90**	**10**	
AM Peak:	**0**	**2**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**7**	**2**	
PM Peak:	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**7**	**2**	

Station ID: S2002150139 **County:** Montgomery **Comments:**

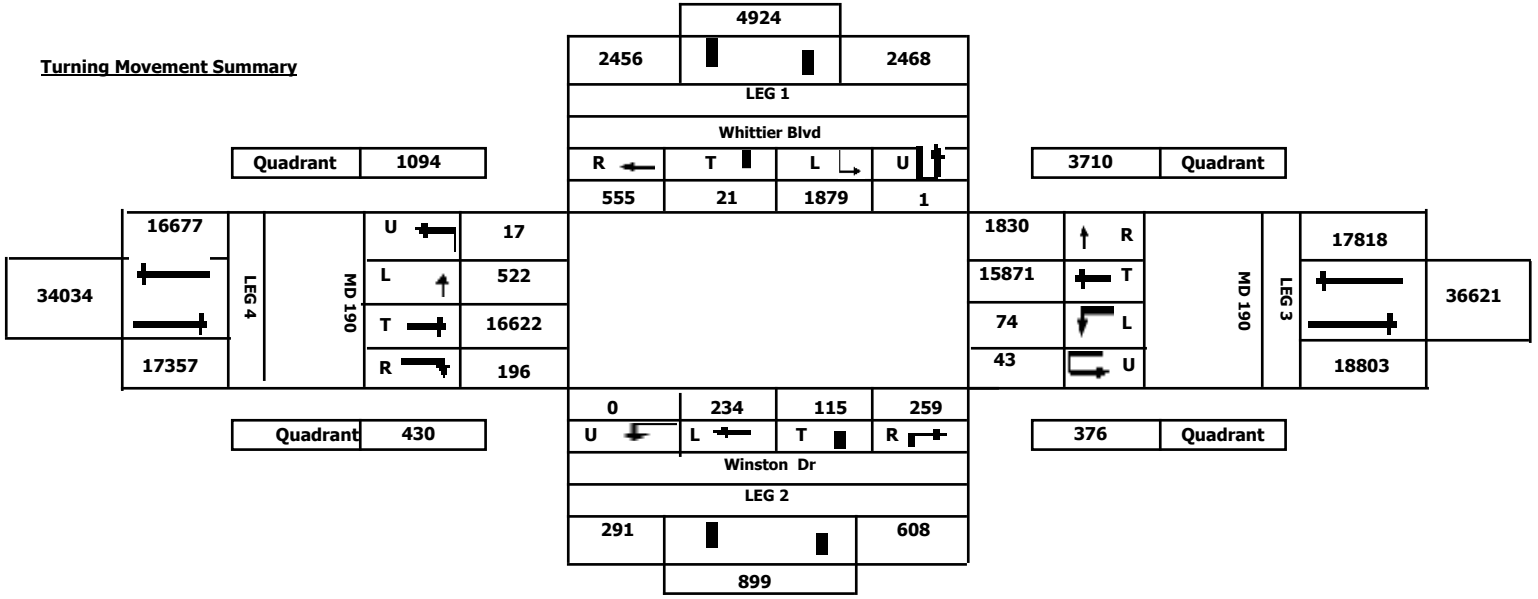
Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

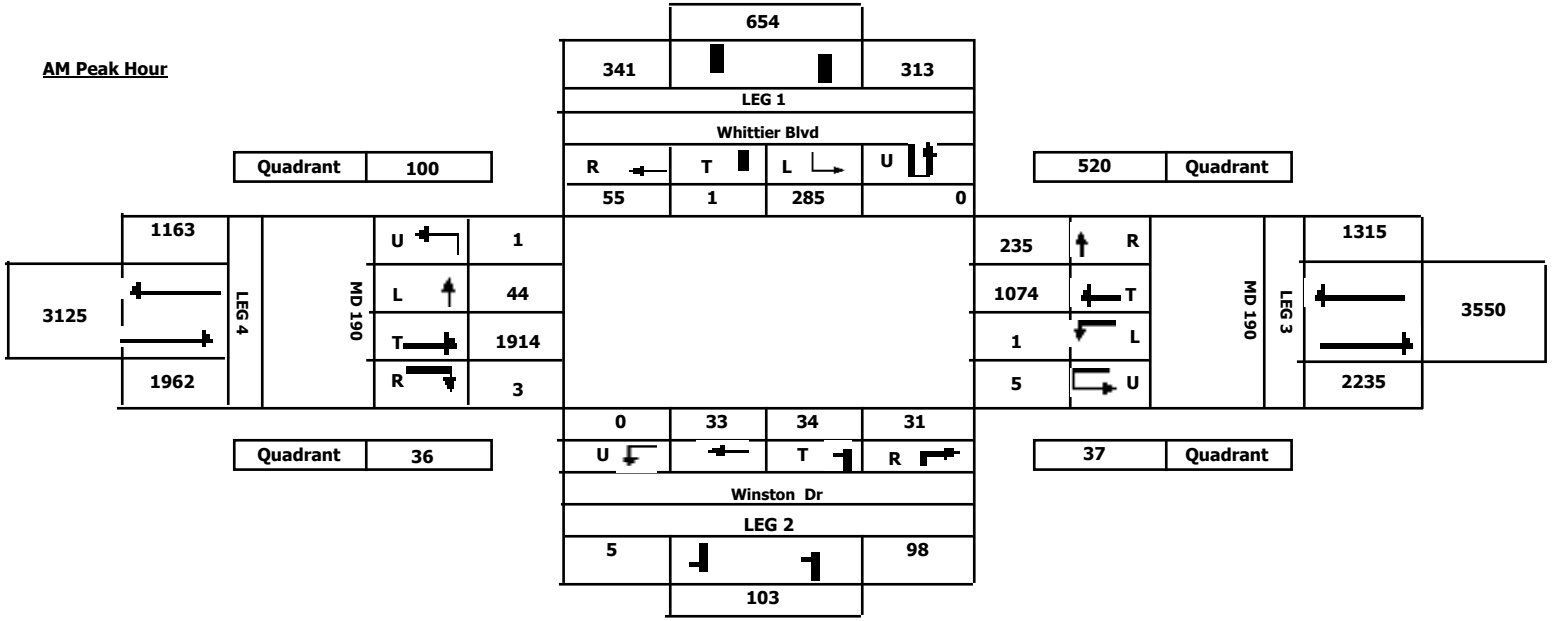
Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

Turning Movement Summary



AM Peak Hour



Station ID: S2002150139 **County:** Montgomery **Comments:**

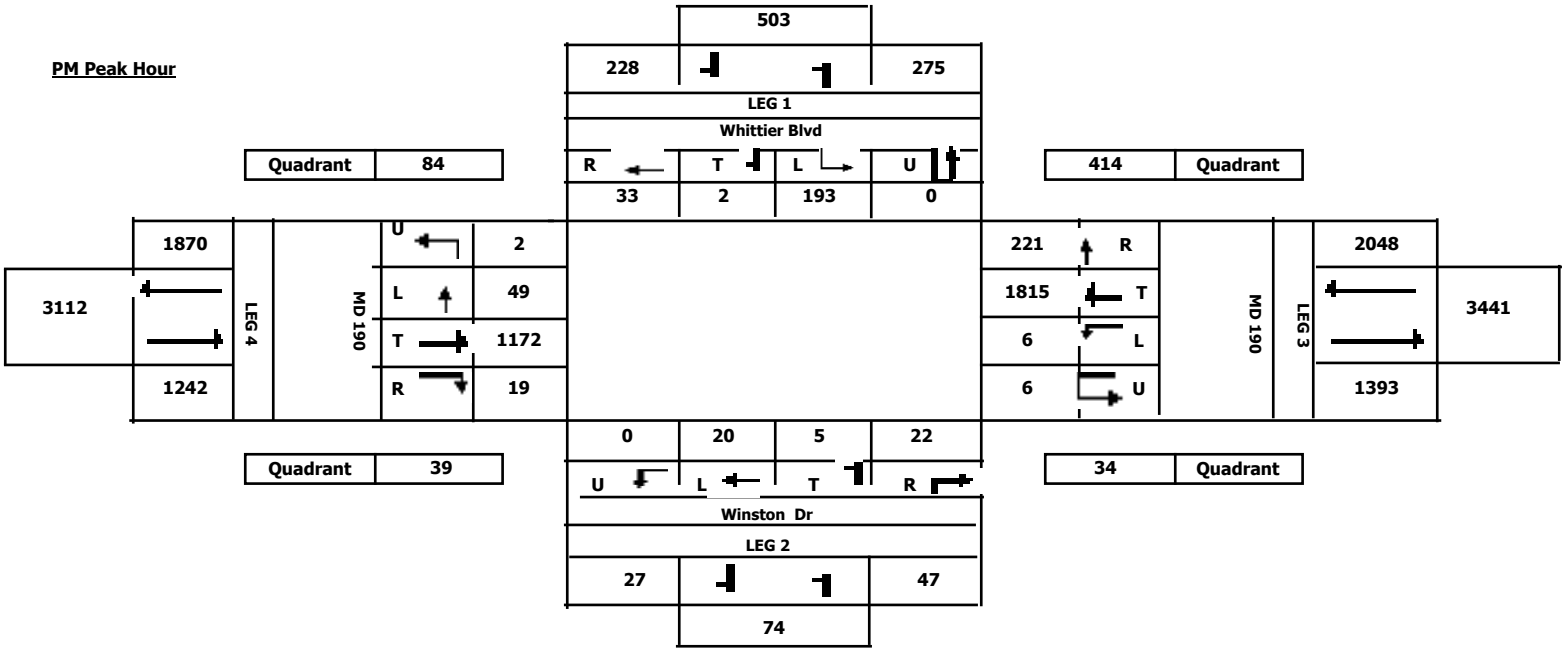
Date: Wednesday 03/09/2016 **Town:** none

Location: MD 190 at WHITTIER BLVD/WINST **Weather:** Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	3710	C	0.72		17:30	18:30	3557	B	0.69

PM Peak Hour



APPENDIX B

Crash Data

Maryland State Highway Administration

Office of Traffic and Safety - Traffic Development and Support Division

SHA 52.1 ADC Study Worksheet Output rev. 04/2016-1

Name: William MacLeod

Date: 12/10/2016

Location: MD 190 from Wilson Lane To Winston Drive

Logmiles: From 12.71 To 13.55 Length: 0.84

County: Montgomery, D3 Period: January 01, 2013 To October 24, 2016

Note: 2016 data is preliminary

Type Controls: 3U-100%

*** Significantly Higher than Statewide**

YEAR >>	2013	2014	2015	2016	Total	Study	StateWd
Fatal	0	0	0	1	1	1.9	1.0
No. Killed	0	0	0	3	3		
Injury	4	4	5	6	19	36.9	52.6
No. Injured	5	4	8	9	26		
Prop. Damage	5	10	7	5	27	52.4	72.4
Total Crashes	9	14	12	12	47	91.2	125.9
Severity Index	20	27	19	43	Avg 27		
RATE	67.3	105.0	87.7	107.4			
WAADT	43620	43490	44621	44621			
VMT millions	13.4	13.3	13.7	11.2	51.6		
Opposite Dir.	0	0	0	0	0	0.0	1.9
Rear End	6	10	5	7	28	54.3	54.6
Sideswipe	1	2	2	0	5	9.7	13.8
Left Turn	2	2	0	2	6	11.6	9.4
Angle	0	0	2	1	3	5.8	17.8
Pedestrian	0	0	0	0	0	0.0	1.9
Parked Veh.	0	0	0	0	0	0.0	0.5
Fixed Object	0	0	2	0	2	3.9	17.5
Other	0	0	1	2	3	5.8 *	1.9
U-Turn	0	0	0	0	0		
Backing	0	0	1	0	1		
Animal	0	0	0	1	1		
Railroad	0	0	0	0	0		
Fire / Expl.	0	0	0	0	0		
Overturn	0	0	0	0	0		
Truck Related	2	4	2	0	8	15.5 *	8.0
Night Time	3	2	3	1	9	19 %	31 %
Wet Surface	0	2	2	2	6	13 %	21 %
Alcohol	0	0	0	0	0	0 %	8 %
Intersection	7	12	9	8	36		
Total Vehicles	19	32	22	25	98		
Total Trucks	2	4	2	0	8		
Truck %	10.5	12.5	9.1	0.0	8.2		

Comments:

Maryland State Highway Administration

Office of Traffic and Safety - Traffic Development and Support Division

SHA 52.1 ADC Summary Output rev. 04/2016-1

Name: William MacLeod

Date: 12/10/2016

Location: MD 190 from Wilson Lane To Winston Drive

Logmiles: From 12.71 To 13.55 Length: 0.84

County: Montgomery, D3

Period: January 1, 2013 To October 24, 2016

Note: 2016 data is preliminary

SEVERITY	FATAL	INJURY	P-DAMAGE	TOTAL
Accidents	1	19	27	47
Veh Occ	3	26		
Pedestrian				

AVG Severity Index: 27

DAY OF THE WEEK

SUN	MON	TUE	WED	THU	FRI	SAT	UNK
2	5	9	11	4	3	13	

MONTH OF THE YEAR

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	UNK
2	6	2	3	5	3	3	4	6	7	1	5	

CONDITION	DRIVER	PED
Normal:	85	
Alcohol:		
Other:	12	

TIME	12	01	02	03	04	05	06	07	08	09	10	11	UNK
AM:		1		1			1	1	4	4	2	8	
PM:	6	2	5	2	2	1	5		1	1			

VEHICLES INVOLVED PER ACCIDENT

1	2	3	4	5	6+	UNK	TOTAL
3	38	5	1				98

VEHICLE TYPE

	Motorcycle/Moped	1	Tractor Trailer
64	Passenger Vehicle	1	Passenger Bus
13	Sport Utility Veh		School Bus
3	Pick-Up Truck	1	Emergency Veh
7	Trucks (2+3 axles)	11	Other Types

SURFACE

6	Wet
41	Dry
	Sno/Ice
	Mud
	Other

MOVEMENTS

NORTH			SOUTH			EAST			WEST		
LF	ST	RT	LF	ST	RT	LF	ST	RT	LF	ST	RT
	2			7		6	30	1		43	

OTHER MOVEMENTS 9

PROBABLE CAUSES

	Influence of Drugs	2	Improper Lane Change
	Influence of Alcohol		Improper Backing
	Influence of Medication		Improper Passing
	Influence of Combined Subst.		Improper Signal
	Physical/Mental Difficulty		Improper Parking
	Fell Asleep/Fainted, etc.		Passenger Interfere/Obstruct.
16	Fail to give full Attention		Illegally in Roadway
	Lic. Restr. Non-compliance		Bicycle Violation
2	Fail to Drive in Single Lane		Clothing Not Visible
	Improper Right Turn on Red		Sleet, Hail, Freezing Rain
5	Fail to Yield Right-of-way		Severe Crosswinds
	Fail to Obey Stop Sign		Rain, Snow
1	Fail to Obey Traffic Signal		Animal
1	Fail to Obey Other Control		Vision Obstruction
	Fail to Keep Right of Center		Vehicle Defect
	Fail to Stop for School Bus		Wet
	Wrong Way on One Way		Icy or Snow Covered
	Exceeded Speed Limit		Debris or Obstruction
	Operator Using Cell Phone		Ruts, Holes or Bumps
1	Stopping in Lane Roadway		Road Under Construction
1	Too Fast for Conditions		Traffic Control Device Inop.
3	Followed too Closely		Shoulders Low, Soft or High
1	Improper Turn	14	Other or Unknown

COLLISION TYPES		FATAL	INJURY	PROP	TOTAL
Opposite Dir	Related:				
	UnRelated:				
Rear End	Related:		7	12	19
	UnRelated:		5	4	9
Sideswipe	Related:			5	5
	UnRelated:				
Left Turn	Related:	1	3	2	6
	UnRelated:				
Angle	Related:		2	1	3
	UnRelated:				
Pedestrian	Related:				
	UnRelated:				
Parked Vehicle	Related:				
	UnRelated:				
Other Collision	Related:			2	2
	UnRelated:			1	1

F	Bridge	01			
I	Building	02			
X	Culvert/Ditch	03			
E	Curb	04		1	1
D	Guardrail/Barrier	05		1	1
	Embankment	06			
O	Fence	07			
B	Light Pole	08			
J	Sign Pole	09			
E	Other Pole	10			
C	Tree/Shrubbery	11			
T	Contr. Barrier	12			
S	Crash Attenuator	13			
	Other Fixed Object				

WEATHER

42	Clear / Cloudy
	Foggy
4	Raining
1	Snow / Sleet
	Other

ILLUMINATION

36	Day
2	Dawn/Dusk
8	Dark - Lights On
1	Dark - No Lights
	Other

TOTALS

13-16	47

Maryland State Highway Administration

Office of Traffic and Safety - Traffic Development and Support Division

SHA 52.1 ADC History Output rev. 05/2016-1 - Combined Year Listing

Name: William MacLeod

Date: 12/10/2016

Location: MD 190 from Wilson Lane To Winston Drive

Logmiles: From 12.71 To 13.55 Length: 0.84

County: Montgomery, D3 Period: January 01, 2013 To October 24, 2016

Note: 2016 data is preliminary

MilePt	Int Rel	Date	Severity	Time	Light	Surface	Alc Rel	FixObj	Collision	Movement V1	Movement V2	Probable Cause
MD190												
12.710	✓	02072013	Property	12P	Day	Dry			RREND	ES	ES	Fail to give full attention
12.710	✓	04032013	1 Injured	06P	Night	Dry			RREND	ES	ES	Fail to give full attention
12.710	✓	09172013	1 Injured	11A	Day	Dry			RREND	WS	WS	Followed too closely
12.710	✓	09172013	Property	12P	Day	Dry			SDSWP	ES	uS	Improper turn
12.710	✓	06042014	Property	10A	Day	Dry			RREND	WS	WS	Other or Unknown
12.710	✓	07232014	1 Injured	06P	Day	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	08202014	1 Injured	12P	Day	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	09152014	1 Injured	09A	Day	Dry			RREND	ES	ES	Too fast for conditions
12.710	✓	09202014	Property	02P	Day	Dry			SDSWP	WS	WS	Fail to drive in single lane
12.710	✓	12132014	Property	06P	Night	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	02192015	Property	08P	Night	Dry			ANGLE	SS	ES	Fail to yield right-of-way
12.710	✓	08232015	2 Injured	03A	Night	Dry			RREND	WS	WS	Other or Unknown
12.710	✓	10202015	1 Injured	11A	Day	Dry			ANGLE	WS	SS	Other or Unknown
12.710	✓	10312015	Property	10A	Day	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	10312015	Property	01P	Day	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	12052015	Property	09A	Day	Dry			SDSWP	WS	WS	Other or Unknown
12.710	✓	12112015	Property	02P	Day	Dry			OTHER	Wu	WS	Other or Unknown
12.710	✓	04232016	Property	12P	Day	Dry			RREND	WS	WS	Fail to give full attention
12.710	✓	05172016	Property	09A	Day	Wet			RREND	WS	WS	Fail to give full attention
12.720	✓	06092013	Property	11A	Day	Dry			RREND	NS	NS	Fail to give full attention
12.730		12222014	Property	06P	Night	Wet			RREND	ES	ES	Other or Unknown
12.750		09022015	1 Injured	01P	Day	Dry			RREND	WS	WS	Fail to give full attention
12.800		05032016	1 Injured	03P	Day	Dry			RREND	ES	ES	Fail to give full attention
12.950	✓	05252016	Property	11A	Day	Dry			RREND	ES	ES	Fail to give full attention
12.990		09162015	Property	12P	Day	Dry			RREND	WS	WS	Other or Unknown
13.030	✓	12302013	Property	05P	Night	Dry			LFTRN	EL	WS	Fail to yield right-of-way
13.030		02182016	Property	06A	Day	Dry			OTHER	ES	--	Other or Unknown
13.030	✓	02272016	3 K, 2 I	06P	Night	Dry			LFTRN	EL	WS	Other or Unknown
13.070		10242014	Property	08A	Day	Dry			RREND	ES	ES	Improper lane change
13.470		10132016	1 Injured	08A	Day	Dry			RREND	ES	ES	Fail to give full attention
13.490		08032016	1 Injured	04P	Day	Dry			RREND	ES	ES	Other or Unknown
13.530	✓	05272014	Property	04P	Day	Dry			RREND	SS	SS	Fail to give full attention
13.540		08102013	Property	09A	Day	Dry			RREND	ES	ES	Fail to give full attention
13.540	✓	03102015	Property	08A	Day	Dry			SDSWP	ES	ES	Improper lane change
13.550	✓	02132013	2 Injured	02P	Day	Dry			LFTRN	EL	WS	Fail to yield right-of-way
13.550		06052013	1 Injured	09P	Night	Dry			RREND	WS	WS	Fail to obey traffic signal

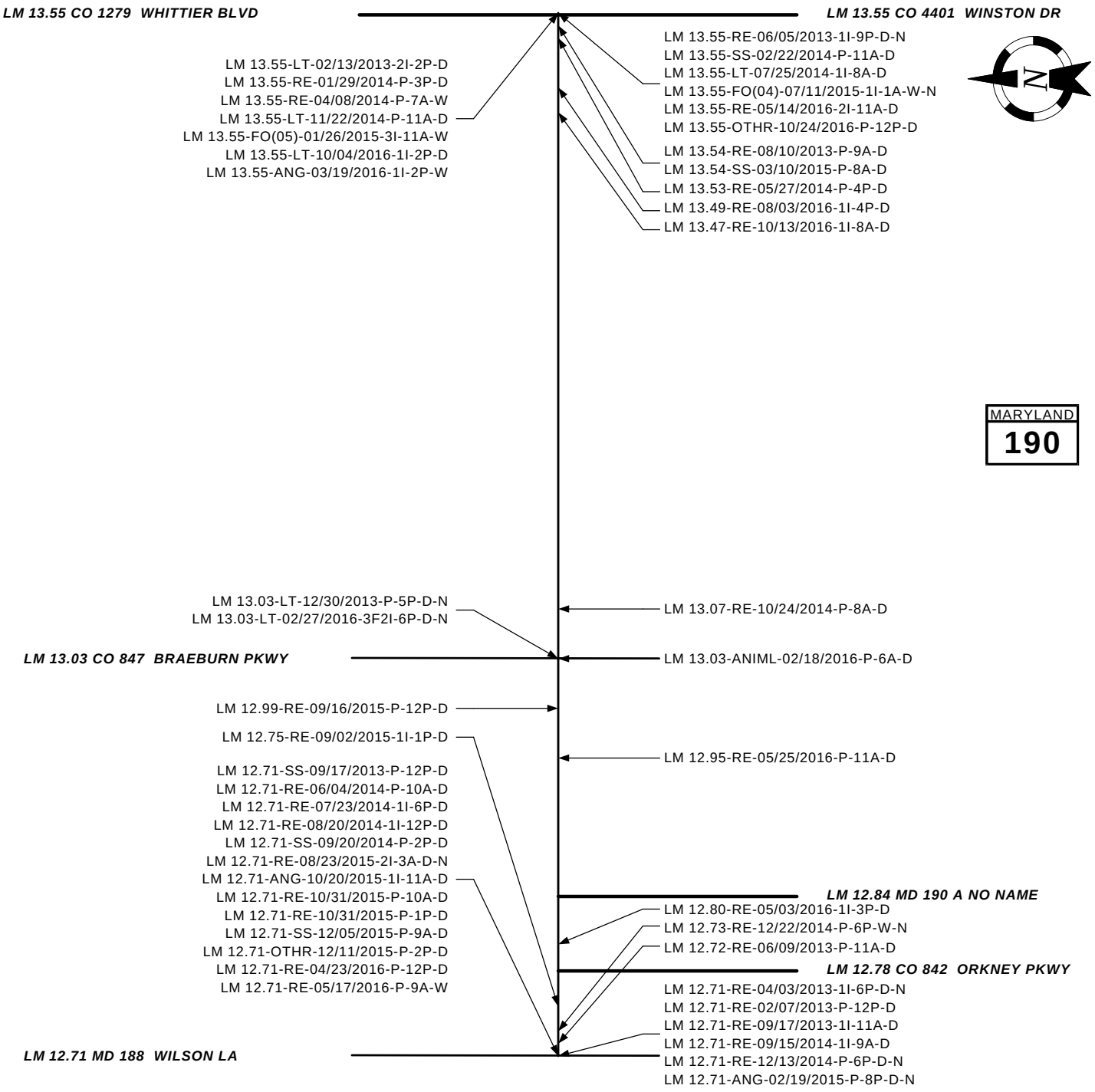
Fixed Object: 01 = Bridge 02 = Building 03 = Culvert/Ditch 04 = Curb 05 = Guardrail/Barrier 06 = Embankment 07 = Fence
08 = Light Pole 09 = Sign Post 10 = Other Pole 11 = Tree/Shrubbery 12 = Construction Barrier 13 = Crash Attenuator

MilePt	Int Rel	Date	Severity	Time	Light	Surface	Alc Rel	FixObj	Collision	Movement V1	Movement V2	Probable Cause
13.550	✓	01292014	Property	03P	Day	Dry			RREND	WS	WS	Followed too closely
13.550	✓	02222014	Property	11A	Day	Dry			SDSWP	ES	ES	Fail to drive in single lane
13.550	✓	04082014	Property	07A	Day	Wet			RREND	WS	WS	Stopping in lane roadway
13.550	✓	07252014	1 Injured	08A	Day	Dry			LFTRN	EL	WS	Fail to yield right-of-way
13.550	✓	11222014	Property	11A	Day	Dry			LFTRN	EL	WS	Fail to yield right-of-way
13.550	✓	01262015	3 Injured	11A	Day	Wet		05	FXOBJ	SS	--	Other or Unknown
13.550		07112015	1 Injured	01A	Night	Wet		04	FXOBJ	ES	--	Other or Unknown
13.550	✓	03192016	1 Injured	02P	Day	Wet			ANGLE	WS	SS	Other or Unknown
13.550	✓	05142016	2 Injured	11A	Day	Dry			RREND	ES	ES	Followed too closely
13.550	✓	10042016	1 Injured	02P	Day	Dry			LFTRN	EL	WS	Other or Unknown
13.550	✓	10242016	Property	12P	Day	Dry			OTHER	ER	SS	Fail to obey other control

Fixed Object: 01 = Bridge 02 = Building 03 = Culvert/Ditch 04 = Curb 05 = Guardrail/Barrier 06 = Embankment 07 = Fence
08 = Light Pole 09 = Sign Post 10 = Other Pole 11 = Tree/Shrubbery 12 = Construction Barrier 13 = Crash Attenuator

Office of Traffic & Safety
Traffic Development & Support Division
Crash Analysis Safety Team

Location: MD 190 frrom 12.71 to 13.55
County: MONTGOMERY
Study Period: 01/01/2013 to 10/24/2016
Analyst: WMACLEOD Date: 12/10/2016



KEY:LogMile-CollisionType (FixedObjectStruck) -Date-Severity-Time-Surface-Illumination-Alcohol

template 06-27-06

F - Fatalities	SS - Sideswipe	FO - Fixed Object	OFFRD - Off Road	00 - Not Applicable	08 - Light Support Pole	N - Night
I - Injury	PARKD - Parked Vehicle	OOBJ - Other Object	RUNWY - Downhill Runaway	01 - Bridge or Overpass	09 - Sign Support Pole	X - Alcohol
P - Property Damage	PED - Pedestrian	OT - Overturn	FIRE - Explosion Fire	02 - Building	10 - Other Pole	D - Dry Surface
OD - Opposite Direction	BIKE - Bicycle	SPILL - Spilled Cargo	BCKNG - Backing	03 - Culvert or Ditch	11 - Tree Shrubbery	W - Wet Surface
LT - Left Turn	PEDAL - Other Pedalcycle	JCKKNF - Jackknife	UTURN - U-Turn	04 - Curb	12 - Construction Barrier	I - Icy Surface
RE - Rear End	CONVY - Other Conveyance	SPRTD - Units Separated	OTHR - Other	05 - Guardrail or Barrier	13 - Crash Attenuater	S - Snowy Surface
ANG - Angle	ANIML - Animal	NCOLL - Other Non Collision	UNK - Unknown	06 - Embankment	88 - Other	
				07 - Fence	99 - Unknown	

APPENDIX C

Synchro / SimTraffic Results Worksheets

(Existing and Modified)

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Future Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.58	1.00	1.00	0.51	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	1063	3505	1568	945	3505
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)	212	2065	147	5	92	1261	71	82	168	125	130	158
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	115	0	0
Lane Group Flow (vph)	212	2065	147	0	97	1261	71	82	168	10	130	158
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Effective Green, g (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Actuated g/C Ratio	0.15	0.66	1.00		0.08	0.59	1.00	0.13	0.08	0.08	0.14	0.08
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	263	2297	1568		146	2062	1568	176	272	121	172	280
v/s Ratio Prot	c0.12	c0.59			0.06	0.36		0.02	0.05		c0.04	0.05
v/s Ratio Perm			c0.09				0.05	0.04		0.01	c0.06	
v/c Ratio	0.81	0.90	0.09		0.66	0.61	0.05	0.47	0.62	0.08	0.76	0.56
Uniform Delay, d1	73.9	26.0	0.0		80.1	23.8	0.0	71.3	80.4	77.0	73.4	79.8
Progression Factor	1.00	1.00	1.00		0.89	1.38	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.3	6.1	0.1		10.1	1.3	0.1	1.9	4.1	0.3	17.1	2.6
Delay (s)	90.2	32.1	0.1		81.4	34.3	0.1	73.2	84.5	77.3	90.5	82.4
Level of Service	F	C	A		F	C	A	E	F	E	F	F
Approach Delay (s)		35.3				35.8			79.7			82.3
Approach LOS		D				D			E			F

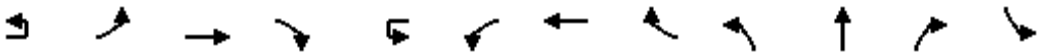
Intersection Summary			
HCM 2000 Control Delay	44.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	210
Future Volume (vph)	210
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.92
Adj. Flow (vph)	228
RTOR Reduction (vph)	210
Lane Group Flow (vph)	18
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.4
Effective Green, g (s)	14.4
Actuated g/C Ratio	0.08
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	125
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.15
Uniform Delay, d1	77.1
Progression Factor	1.00
Incremental Delay, d2	0.5
Delay (s)	77.6
Level of Service	E
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (veh/h)	5	130	1970	35	5	15	1170	25	10	5	25	5
Future Volume (Veh/h)	5	130	1970	35	5	15	1170	25	10	5	25	5
Sign Control			Free				Free			Stop		
Grade			0%				0%			0%		
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	0	155	2345	42	0	18	1393	30	12	6	30	6
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type			None				None					
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked	0.00				0.00							
vC, conflicting volume	0	1423			0	2387			3542	4114	1172	2944
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0	1423			0	2387			3542	4114	1172	2944
tC, single (s)	0.0	4.2			0.0	4.2			7.6	6.6	7.0	7.6
tC, 2 stage (s)												
tF (s)	0.0	2.2			0.0	2.2			3.5	4.0	3.3	3.5
p0 queue free %	0	67			0	91			0	0	84	0
cM capacity (veh/h)	0	469			0	196			1	1	184	0

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	155	1172	1172	42	18	696	696	30	48	161
Volume Left	155	0	0	0	18	0	0	0	12	6
Volume Right	0	0	0	42	0	0	0	30	30	155
cSH	469	1700	1700	1700	196	1700	1700	1700	3	0
Volume to Capacity	0.33	0.69	0.69	0.02	0.09	0.41	0.41	0.02	17.98	Err
Queue Length 95th (ft)	36	0	0	0	7	0	0	0	Err	Err
Control Delay (s)	16.4	0.0	0.0	0.0	25.2	0.0	0.0	0.0	Err	Err
Lane LOS	C				D				F	F
Approach Delay (s)	1.0				0.3				Err	Err
Approach LOS									F	F

Intersection Summary				
Average Delay	Err			
Intersection Capacity Utilization	76.4%	ICU Level of Service	D	
Analysis Period (min)	15			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (veh/h)	0	130
Future Volume (Veh/h)	0	130
Sign Control	Stop	
Grade	0%	
Peak Hour Factor	0.84	0.84
Hourly flow rate (vph)	0	155
Pedestrians		
Lane Width (ft)		
Walking Speed (ft/s)		
Percent Blockage		
Right turn flare (veh)		
Median type		
Median storage veh)		
Upstream signal (ft)		
pX, platoon unblocked		
vC, conflicting volume	4126	696
vC1, stage 1 conf vol		
vC2, stage 2 conf vol		
vCu, unblocked vol	4126	696
tC, single (s)	6.6	7.0
tC, 2 stage (s)		
tF (s)	4.0	3.3
p0 queue free %	100	59
cM capacity (veh/h)	1	381

Direction, Lane #

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Future Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.95		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1725		1752
Flt Permitted		0.17	1.00	1.00		0.06	1.00	1.00		0.88		0.60
Satd. Flow (perm)		318	3505	1568		105	3505	1568		1541		1104
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	6	56	2139	28	6	6	1256	194	33	33	39	322
RTOR Reduction (vph)	0	0	0	5	0	0	0	39	0	12	0	0
Lane Group Flow (vph)	0	62	2139	23	0	12	1256	155	0	93	0	322
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Effective Green, g (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Actuated g/C Ratio		0.78	0.78	0.78		0.71	0.71	0.71		0.15		0.15
Clearance Time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		302	2726	1219		74	2474	1107		226		162
v/s Ratio Prot		0.01	c0.61				0.36					
v/s Ratio Perm		0.15		0.01		0.11		0.10		0.06		c0.29
v/c Ratio		0.21	0.78	0.02		0.16	0.51	0.14		0.41		1.99
Uniform Delay, d1		7.5	11.4	4.5		8.8	12.1	8.6		69.7		76.8
Progression Factor		1.13	0.70	1.45		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		0.2	1.4	0.0		4.7	0.7	0.3		1.2		465.8
Delay (s)		8.7	9.4	6.5		13.4	12.9	8.9		70.9		542.5
Level of Service		A	A	A		B	B	A		E		F
Approach Delay (s)			9.4				12.3			70.9		
Approach LOS			A				B			E		

Intersection Summary			
HCM 2000 Control Delay	53.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	50
Future Volume (vph)	5	50
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.86	
Flt Protected	1.00	
Satd. Flow (prot)	1595	
Flt Permitted	1.00	
Satd. Flow (perm)	1595	
Peak-hour factor, PHF	0.90	0.90
Adj. Flow (vph)	6	56
RTOR Reduction (vph)	48	0
Lane Group Flow (vph)	14	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	26.5	
Effective Green, g (s)	26.5	
Actuated g/C Ratio	0.15	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	234	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.06	
Uniform Delay, d1	66.0	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	66.2	
Level of Service	E	
Approach Delay (s)	465.6	
Approach LOS	F	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	UL	T	T	R	L	T	T	R
Maximum Queue (ft)	838	879	790	350	350	542	538	180	126	209	166	109
Average Queue (ft)	218	493	439	91	119	319	330	18	63	123	71	4
95th Queue (ft)	471	828	749	343	286	512	514	163	111	189	160	46
Link Distance (ft)	852	852	852			1567	1567			444	444	444
Upstream Blk Time (%)	0	1	0									
Queuing Penalty (veh)	0	0	0									
Storage Bay Dist (ft)				300	250			350	250			
Storage Blk Time (%)			16		0	17	9					
Queuing Penalty (veh)			21		0	15	6					

Intersection: 1: MD 188 & MD 190

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	238	262	206	96
Average Queue (ft)	113	117	71	6
95th Queue (ft)	195	213	171	53
Link Distance (ft)		411	411	411
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	200			
Storage Blk Time (%)	1	2		
Queuing Penalty (veh)	1	2		

Intersection: 2: Braeburn Pkwy & MD 190

Movement	EB	EB	EB	WB	WB	WB	WB	B5	NB	SB
Directions Served	UL	T	R	UL	T	T	R	T	LTR	LTR
Maximum Queue (ft)	161	291	13	48	3	7	16	6	126	213
Average Queue (ft)	65	10	0	12	0	0	1	0	42	71
95th Queue (ft)	128	205	5	36	2	4	6	4	96	160
Link Distance (ft)		1567			313	313		1672	473	451
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	200		170	170			200			
Storage Blk Time (%)	0									
Queuing Penalty (veh)	0									

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	B5	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	T	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	249	429	433	246	11	45	260	238	55	170	541	508
Average Queue (ft)	44	250	281	27	0	8	129	100	17	75	509	223
95th Queue (ft)	148	475	465	160	7	31	259	216	45	148	530	600
Link Distance (ft)		1672	1672		251		1275	1275		471	492	492
Upstream Blk Time (%)											97	13
Queuing Penalty (veh)											0	0
Storage Bay Dist (ft)	150			200		150			150			
Storage Blk Time (%)		12	12				5	3				
Queuing Penalty (veh)		7	3				0	5				

Network Summary

Network wide Queuing Penalty: 60

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Future Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.53	1.00	1.00	0.39	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	983	3505	1568	710	3505
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	201	1119	57	5	77	1711	113	57	227	77	108	216
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	69	0	0
Lane Group Flow (vph)	201	1119	57	0	82	1711	113	57	227	8	108	216
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Effective Green, g (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Actuated g/C Ratio	0.14	0.66	1.00		0.06	0.57	1.00	0.15	0.10	0.10	0.17	0.12
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	243	2297	1568		101	2013	1568	177	362	162	179	405
v/s Ratio Prot	c0.11	0.32			0.05	c0.49		0.01	0.06		c0.03	0.06
v/s Ratio Perm			0.04				c0.07	0.03		0.01	0.07	
v/c Ratio	0.83	0.49	0.04		0.81	0.85	0.07	0.32	0.63	0.05	0.60	0.53
Uniform Delay, d1	75.4	15.7	0.0		83.8	31.8	0.0	67.8	77.4	72.7	66.1	75.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.1	0.7	0.0		37.2	4.7	0.1	1.1	3.4	0.1	5.6	1.4
Delay (s)	95.5	16.4	0.0		121.0	36.6	0.1	68.8	80.8	72.9	71.7	76.4
Level of Service	F	B	A		F	D	A	E	F	E	E	E
Approach Delay (s)		27.3				38.1			77.2			81.1
Approach LOS		C				D			E			F

Intersection Summary			
HCM 2000 Control Delay	44.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.97
Adj. Flow (vph)	356
RTOR Reduction (vph)	232
Lane Group Flow (vph)	124
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	20.8
Effective Green, g (s)	20.8
Actuated g/C Ratio	0.12
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	181
v/s Ratio Prot	
v/s Ratio Perm	c0.08
v/c Ratio	0.69
Uniform Delay, d1	76.5
Progression Factor	1.00
Incremental Delay, d2	10.3
Delay (s)	86.8
Level of Service	F
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Movement	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (veh/h)	5	25	1205	35	40	1810	25	5	5	30	5	5
Future Volume (Veh/h)	5	25	1205	35	40	1810	25	5	5	30	5	5
Sign Control			Free			Free			Stop			Stop
Grade			0%			0%			0%			0%
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	27	1282	37	43	1926	27	5	5	32	5	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type			None			None						
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked	0.00											
vC, conflicting volume	0	1953			1319			2420	3375	641	2742	3385
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0	1953			1319			2420	3375	641	2742	3385
tC, single (s)	0.0	4.2			4.2			7.6	6.6	7.0	7.6	6.6
tC, 2 stage (s)												
tF (s)	0.0	2.2			2.2			3.5	4.0	3.3	3.5	4.0
p0 queue free %	0	91			92			0	18	92	0	17
cM capacity (veh/h)	0	291			515			4	6	415	2	6

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	27	641	641	37	43	963	963	27	42	42
Volume Left	27	0	0	0	43	0	0	0	5	5
Volume Right	0	0	0	37	0	0	0	27	32	32
cSH	291	1700	1700	1700	515	1700	1700	1700	19	14
Volume to Capacity	0.09	0.38	0.38	0.02	0.08	0.57	0.57	0.02	2.15	3.00
Queue Length 95th (ft)	8	0	0	0	7	0	0	0	140	152
Control Delay (s)	18.6	0.0	0.0	0.0	12.6	0.0	0.0	0.0	945.7	1450.8
Lane LOS	C				B				F	F
Approach Delay (s)	0.4				0.3				945.7	1450.8
Approach LOS									F	F

Intersection Summary				
Average Delay	29.7			
Intersection Capacity Utilization	60.0%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	SBR
Lane Configurations	
Traffic Volume (veh/h)	30
Future Volume (Veh/h)	30
Sign Control	
Grade	
Peak Hour Factor	0.94
Hourly flow rate (vph)	32
Pedestrians	
Lane Width (ft)	
Walking Speed (ft/s)	
Percent Blockage	
Right turn flare (veh)	
Median type	
Median storage veh)	
Upstream signal (ft)	
pX, platoon unblocked	
vC, conflicting volume	963
vC1, stage 1 conf vol	
vC2, stage 2 conf vol	
vCu, unblocked vol	963
tC, single (s)	7.0
tC, 2 stage (s)	
tF (s)	3.3
p0 queue free %	87
cM capacity (veh/h)	254
Direction, Lane #	

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Future Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.94		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1695		1752
Flt Permitted		0.05	1.00	1.00		0.21	1.00	1.00		0.87		0.73
Satd. Flow (perm)		95	3505	1568		388	3505	1568		1507		1337
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	5	54	1258	16	5	5	1952	237	22	5	22	210
RTOR Reduction (vph)	0	0	0	5	0	0	0	37	0	18	0	0
Lane Group Flow (vph)	0	59	1258	11	0	10	1952	200	0	31	0	210
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Effective Green, g (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Actuated g/C Ratio		0.70	0.70	0.70		0.61	0.61	0.61		0.19		0.19
Clearance Time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		143	2441	1092		236	2132	953		287		255
v/s Ratio Prot		0.02	c0.36				c0.56					
v/s Ratio Perm		0.27		0.01		0.03		0.13		0.02		c0.16
v/c Ratio		0.41	0.52	0.01		0.04	0.92	0.21		0.11		0.82
Uniform Delay, d1		23.4	8.6	5.6		9.4	20.8	10.6		40.1		46.6
Progression Factor		1.00	1.00	1.00		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		1.9	0.8	0.0		0.3	7.6	0.5		0.2		18.9
Delay (s)		25.4	9.4	5.6		9.8	28.4	11.1		40.3		65.5
Level of Service		C	A	A		A	C	B		D		E
Approach Delay (s)			10.1				26.4			40.3		
Approach LOS			B				C			D		

Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	35
Future Volume (vph)	5	35
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.87	
Flt Protected	1.00	
Satd. Flow (prot)	1600	
Flt Permitted	1.00	
Satd. Flow (perm)	1600	
Peak-hour factor, PHF	0.93	0.93
Adj. Flow (vph)	5	38
RTOR Reduction (vph)	31	0
Lane Group Flow (vph)	12	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	22.9	
Effective Green, g (s)	22.9	
Actuated g/C Ratio	0.19	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	305	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.04	
Uniform Delay, d1	39.6	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	39.6	
Level of Service	D	
Approach Delay (s)	61.1	
Approach LOS	E	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	UL	T	T	R	L	T	T	L	T
Maximum Queue (ft)	344	366	330	350	709	736	450	132	246	230	219	251
Average Queue (ft)	188	171	134	157	440	457	125	50	163	122	108	151
95th Queue (ft)	295	325	279	341	658	677	458	102	229	215	197	238
Link Distance (ft)	852	852	852		1567	1567			444	444		411
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)				250			350	250			200	
Storage Blk Time (%)			0	0	23	18			0		1	4
Queuing Penalty (veh)			0	4	19	20			0		1	4

Intersection: 1: MD 188 & MD 190

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	213	388
Average Queue (ft)	110	178
95th Queue (ft)	209	366
Link Distance (ft)	411	411
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 2: Braeburn Pkwy & MD 190

Movement	EB	EB	WB	WB	B3	B5	NB	SB
Directions Served	UL	R	UL	R	T	T	LTR	LTR
Maximum Queue (ft)	78	9	48	4	5	7	79	96
Average Queue (ft)	20	0	17	0	0	0	25	35
95th Queue (ft)	55	4	42	3	4	5	64	77
Link Distance (ft)					251	1672	473	451
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	200	170	170	200				
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	148	294	266	31	32	491	514	250	102	288	87
Average Queue (ft)	43	107	115	5	8	282	270	89	24	142	22
95th Queue (ft)	105	230	238	23	28	459	468	252	64	243	58
Link Distance (ft)		1672	1672			1275	1275		471	492	492
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)		3	2			17	13				
Queuing Penalty (veh)		2	0			2	29				

Network Summary

Network wide Queuing Penalty: 81

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1900	135	10	85	1160	65	75	155	115	120	145
Future Volume (vph)	195	1900	135	10	85	1160	65	75	155	115	120	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.58	1.00	1.00	0.51	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	1063	3505	1568	945	3505
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)	212	2065	147	11	92	1261	71	82	168	125	130	158
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	115	0	0
Lane Group Flow (vph)	212	2065	147	0	103	1261	71	82	168	10	130	158
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	27.1	117.4	180.0		15.6	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Effective Green, g (s)	27.1	117.4	180.0		15.6	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Actuated g/C Ratio	0.15	0.65	1.00		0.09	0.59	1.00	0.13	0.08	0.08	0.14	0.08
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	263	2286	1568		151	2062	1568	176	272	121	172	280
v/s Ratio Prot	c0.12	c0.59			0.06	0.36		0.02	0.05		c0.04	0.05
v/s Ratio Perm			c0.09				0.05	0.04		0.01	c0.06	
v/c Ratio	0.81	0.90	0.09		0.68	0.61	0.05	0.47	0.62	0.08	0.76	0.56
Uniform Delay, d1	73.9	26.5	0.0		79.8	23.8	0.0	71.3	80.4	77.0	73.4	79.8
Progression Factor	1.00	1.00	1.00		0.89	1.40	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.3	6.4	0.1		11.2	1.3	0.1	1.9	4.1	0.3	17.1	2.6
Delay (s)	90.2	32.9	0.1		82.1	34.7	0.1	73.2	84.5	77.3	90.5	82.4
Level of Service	F	C	A		F	C	A	E	F	E	F	F
Approach Delay (s)		35.9				36.4			79.7			82.3
Approach LOS		D				D			E			F

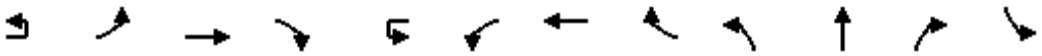
Intersection Summary			
HCM 2000 Control Delay	44.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	90.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	210
Future Volume (vph)	210
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.92
Adj. Flow (vph)	228
RTOR Reduction (vph)	210
Lane Group Flow (vph)	18
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.4
Effective Green, g (s)	14.4
Actuated g/C Ratio	0.08
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	125
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.15
Uniform Delay, d1	77.1
Progression Factor	1.00
Incremental Delay, d2	0.5
Delay (s)	77.6
Level of Service	E
Approach Delay (s)	
Approach LOS	

Intersection Summary

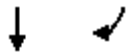
HCM 2010 cannot analyze U-Turning movements.



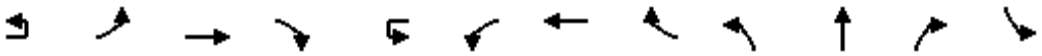
Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (veh/h)	5	130	1975	35	5	15	1180	30	0	0	40	0
Future Volume (Veh/h)	5	130	1975	35	5	15	1180	30	0	0	40	0
Sign Control			Free				Free			Stop		
Grade			0%				0%			0%		
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	0	155	2351	42	0	18	1405	36	0	0	48	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type			None				None					
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked	0.00				0.00							
vC, conflicting volume	0	1441			0	2393			3560	4138	1176	2974
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0	1441			0	2393			3560	4138	1176	2974
tC, single (s)	0.0	4.2			0.0	4.2			7.6	6.6	7.0	7.6
tC, 2 stage (s)												
tF (s)	0.0	2.2			0.0	2.2			3.5	4.0	3.3	3.5
p0 queue free %	0	66			0	91			100	100	74	100
cM capacity (veh/h)	0	462			0	195			1	1	183	3

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	155	1176	1176	42	18	702	702	36	48	161
Volume Left	155	0	0	0	18	0	0	0	0	0
Volume Right	0	0	0	42	0	0	0	36	48	161
cSH	462	1700	1700	1700	195	1700	1700	1700	183	378
Volume to Capacity	0.34	0.69	0.69	0.02	0.09	0.41	0.41	0.02	0.26	0.43
Queue Length 95th (ft)	37	0	0	0	8	0	0	0	25	52
Control Delay (s)	16.7	0.0	0.0	0.0	25.3	0.0	0.0	0.0	31.6	21.4
Lane LOS	C				D				D	C
Approach Delay (s)	1.0				0.3				31.6	21.4
Approach LOS									D	C

Intersection Summary				
Average Delay	1.9			
Intersection Capacity Utilization	71.3%	ICU Level of Service	C	
Analysis Period (min)	15			



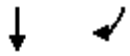
Movement	SBT	SBR
Lane Configurations		
Traffic Volume (veh/h)	0	135
Future Volume (Veh/h)	0	135
Sign Control	Stop	
Grade	0%	
Peak Hour Factor	0.84	0.84
Hourly flow rate (vph)	0	161
Pedestrians		
Lane Width (ft)		
Walking Speed (ft/s)		
Percent Blockage		
Right turn flare (veh)		
Median type		
Median storage veh)		
Upstream signal (ft)		
pX, platoon unblocked		
vC, conflicting volume	4144	702
vC1, stage 1 conf vol		
vC2, stage 2 conf vol		
vCu, unblocked vol	4144	702
tC, single (s)	6.6	7.0
tC, 2 stage (s)		
tF (s)	4.0	3.3
p0 queue free %	100	57
cM capacity (veh/h)	1	378
Direction, Lane #		



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	20	50	1925	25	5	5	1130	175	30	30	35	290
Future Volume (vph)	20	50	1925	25	5	5	1130	175	30	30	35	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.95		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1725		1752
Flt Permitted		0.17	1.00	1.00		0.06	1.00	1.00		0.88		0.60
Satd. Flow (perm)		317	3505	1568		105	3505	1568		1541		1104
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	22	56	2139	28	6	6	1256	194	33	33	39	322
RTOR Reduction (vph)	0	0	0	5	0	0	0	39	0	12	0	0
Lane Group Flow (vph)	0	78	2139	23	0	12	1256	155	0	93	0	322
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		140.0	140.0	140.0		126.7	126.7	126.7		26.5		26.5
Effective Green, g (s)		140.0	140.0	140.0		126.7	126.7	126.7		26.5		26.5
Actuated g/C Ratio		0.78	0.78	0.78		0.70	0.70	0.70		0.15		0.15
Clearance Time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		304	2726	1219		73	2467	1103		226		162
v/s Ratio Prot		0.01	c0.61				0.36					
v/s Ratio Perm		0.19		0.01		0.11		0.10		0.06		c0.29
v/c Ratio		0.26	0.78	0.02		0.16	0.51	0.14		0.41		1.99
Uniform Delay, d1		7.7	11.4	4.5		8.9	12.3	8.8		69.7		76.8
Progression Factor		1.14	0.71	1.48		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		0.3	1.5	0.0		4.8	0.8	0.3		1.2		465.8
Delay (s)		9.1	9.6	6.7		13.7	13.1	9.0		70.9		542.5
Level of Service		A	A	A		B	B	A		E		F
Approach Delay (s)			9.5				12.5			70.9		
Approach LOS			A				B			E		

Intersection Summary			
HCM 2000 Control Delay	53.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	92.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	50
Future Volume (vph)	5	50
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.86	
Flt Protected	1.00	
Satd. Flow (prot)	1595	
Flt Permitted	1.00	
Satd. Flow (perm)	1595	
Peak-hour factor, PHF	0.90	0.90
Adj. Flow (vph)	6	56
RTOR Reduction (vph)	48	0
Lane Group Flow (vph)	14	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	26.5	
Effective Green, g (s)	26.5	
Actuated g/C Ratio	0.15	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	234	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.06	
Uniform Delay, d1	66.0	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	66.2	
Level of Service	E	
Approach Delay (s)	465.6	
Approach LOS	F	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	UL	T	T	R	L	T	T	R
Maximum Queue (ft)	865	872	821	350	350	546	560	450	176	184	164	117
Average Queue (ft)	255	501	438	109	147	347	360	48	72	110	60	5
95th Queue (ft)	584	859	765	377	328	538	551	276	138	176	148	57
Link Distance (ft)	852	852	852			1567	1567			444	444	444
Upstream Blk Time (%)	1	3	0									
Queuing Penalty (veh)	0	0	0									
Storage Bay Dist (ft)				300	250			350	250			
Storage Blk Time (%)			15		0	20	12					
Queuing Penalty (veh)			21		0	19	8					

Intersection: 1: MD 188 & MD 190

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	238	252	186	169
Average Queue (ft)	106	110	58	14
95th Queue (ft)	191	191	148	86
Link Distance (ft)		411	411	411
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	200			
Storage Blk Time (%)	1	1		
Queuing Penalty (veh)	1	1		

Intersection: 2: Braeburn Pkwy & MD 190

Movement	EB	EB	WB	WB	WB	NB	SB
Directions Served	UL	T	UL	T	R	R	R
Maximum Queue (ft)	189	314	60	4	24	85	158
Average Queue (ft)	65	10	15	0	2	24	54
95th Queue (ft)	138	221	42	3	12	57	114
Link Distance (ft)		1567		313		473	451
Upstream Blk Time (%)		0					
Queuing Penalty (veh)		0					
Storage Bay Dist (ft)	200		170		200		
Storage Blk Time (%)	0						
Queuing Penalty (veh)	1						

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	228	432	434	246	44	314	286	173	184	544	512
Average Queue (ft)	45	254	307	18	10	153	125	24	83	505	203
95th Queue (ft)	127	475	467	122	33	296	257	85	161	546	571
Link Distance (ft)		1672	1672			1275	1275		471	492	492
Upstream Blk Time (%)										95	14
Queuing Penalty (veh)										0	0
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)	0	12	12			8	4				
Queuing Penalty (veh)	0	9	3			1	7				

Network Summary

Network wide Queuing Penalty: 71

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1085	55	15	75	1660	110	55	220	75	105	210
Future Volume (vph)	195	1085	55	15	75	1660	110	55	220	75	105	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.53	1.00	1.00	0.39	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	983	3505	1568	710	3505
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	201	1119	57	15	77	1711	113	57	227	77	108	216
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	69	0	0
Lane Group Flow (vph)	201	1119	57	0	92	1711	113	57	227	8	108	216
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Effective Green, g (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Actuated g/C Ratio	0.14	0.66	1.00		0.06	0.57	1.00	0.15	0.10	0.10	0.17	0.12
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	243	2297	1568		101	2013	1568	177	362	162	179	405
v/s Ratio Prot	c0.11	0.32			0.05	c0.49		0.01	0.06		c0.03	0.06
v/s Ratio Perm			0.04				c0.07	0.03		0.01	0.07	
v/c Ratio	0.83	0.49	0.04		0.91	0.85	0.07	0.32	0.63	0.05	0.60	0.53
Uniform Delay, d1	75.4	15.7	0.0		84.3	31.8	0.0	67.8	77.4	72.7	66.1	75.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.1	0.7	0.0		61.5	4.7	0.1	1.1	3.4	0.1	5.6	1.4
Delay (s)	95.5	16.4	0.0		145.9	36.6	0.1	68.8	80.8	72.9	71.7	76.4
Level of Service	F	B	A		F	D	A	E	F	E	E	E
Approach Delay (s)		27.3				39.7			77.2			81.1
Approach LOS		C				D			E			F

Intersection Summary			
HCM 2000 Control Delay	45.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.97
Adj. Flow (vph)	356
RTOR Reduction (vph)	232
Lane Group Flow (vph)	124
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	20.8
Effective Green, g (s)	20.8
Actuated g/C Ratio	0.12
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	181
v/s Ratio Prot	
v/s Ratio Perm	c0.08
v/c Ratio	0.69
Uniform Delay, d1	76.5
Progression Factor	1.00
Incremental Delay, d2	10.3
Delay (s)	86.8
Level of Service	F
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Movement	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (veh/h)	5	25	1210	40	40	1815	30	0	0	40	0	0
Future Volume (Veh/h)	5	25	1210	40	40	1815	30	0	0	40	0	0
Sign Control			Free			Free			Stop			Stop
Grade			0%			0%			0%			0%
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	27	1287	43	43	1931	32	0	0	43	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type			None			None						
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked	0.00											
vC, conflicting volume	0	1963			1330			2436	3390	644	2758	3401
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	0	1963			1330			2436	3390	644	2758	3401
tC, single (s)	0.0	4.2			4.2			7.6	6.6	7.0	7.6	6.6
tC, 2 stage (s)												
tF (s)	0.0	2.2			2.2			3.5	4.0	3.3	3.5	4.0
p0 queue free %	0	91			92			100	100	90	100	100
cM capacity (veh/h)	0	289			510			12	6	413	7	6

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1
Volume Total	27	644	644	43	43	966	966	32	43	43
Volume Left	27	0	0	0	43	0	0	0	0	0
Volume Right	0	0	0	43	0	0	0	32	43	43
cSH	289	1700	1700	1700	510	1700	1700	1700	413	253
Volume to Capacity	0.09	0.38	0.38	0.03	0.08	0.57	0.57	0.02	0.10	0.17
Queue Length 95th (ft)	8	0	0	0	7	0	0	0	9	15
Control Delay (s)	18.8	0.0	0.0	0.0	12.7	0.0	0.0	0.0	14.7	22.1
Lane LOS	C				B				B	C
Approach Delay (s)	0.4				0.3				14.7	22.1
Approach LOS									B	C

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	60.2%	ICU Level of Service		B
Analysis Period (min)	15			

Movement	SBR
Lane Configurations	
Traffic Volume (veh/h)	40
Future Volume (Veh/h)	40
Sign Control	
Grade	
Peak Hour Factor	0.94
Hourly flow rate (vph)	43
Pedestrians	
Lane Width (ft)	
Walking Speed (ft/s)	
Percent Blockage	
Right turn flare (veh)	
Median type	
Median storage veh)	
Upstream signal (ft)	
pX, platoon unblocked	
vC, conflicting volume	966
vC1, stage 1 conf vol	
vC2, stage 2 conf vol	
vCu, unblocked vol	966
tC, single (s)	7.0
tC, 2 stage (s)	
tF (s)	3.3
p0 queue free %	83
cM capacity (veh/h)	253
Direction, Lane #	

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	15	50	1170	15	5	5	1815	220	20	5	20	195
Future Volume (vph)	15	50	1170	15	5	5	1815	220	20	5	20	195
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.94		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1695		1752
Flt Permitted		0.05	1.00	1.00		0.21	1.00	1.00		0.87		0.73
Satd. Flow (perm)		95	3505	1568		391	3505	1568		1507		1337
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	16	54	1258	16	5	5	1952	237	22	5	22	210
RTOR Reduction (vph)	0	0	0	5	0	0	0	37	0	18	0	0
Lane Group Flow (vph)	0	70	1258	11	0	10	1952	200	0	31	0	210
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		83.6	83.6	83.6		72.6	72.6	72.6		22.9		22.9
Effective Green, g (s)		83.6	83.6	83.6		72.6	72.6	72.6		22.9		22.9
Actuated g/C Ratio		0.70	0.70	0.70		0.60	0.60	0.60		0.19		0.19
Clearance Time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		149	2441	1092		236	2120	948		287		255
v/s Ratio Prot		0.02	c0.36				c0.56					
v/s Ratio Perm		0.30		0.01		0.03		0.13		0.02		c0.16
v/c Ratio		0.47	0.52	0.01		0.04	0.92	0.21		0.11		0.82
Uniform Delay, d1		24.2	8.6	5.6		9.6	21.1	10.7		40.1		46.6
Progression Factor		1.00	1.00	1.00		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		2.3	0.8	0.0		0.3	8.0	0.5		0.2		18.9
Delay (s)		26.5	9.4	5.6		9.9	29.2	11.2		40.3		65.5
Level of Service		C	A	A		A	C	B		D		E
Approach Delay (s)			10.2				27.2			40.3		
Approach LOS			B				C			D		

Intersection Summary			
HCM 2000 Control Delay	23.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	35
Future Volume (vph)	5	35
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.87	
Flt Protected	1.00	
Satd. Flow (prot)	1600	
Flt Permitted	1.00	
Satd. Flow (perm)	1600	
Peak-hour factor, PHF	0.93	0.93
Adj. Flow (vph)	5	38
RTOR Reduction (vph)	31	0
Lane Group Flow (vph)	12	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	22.9	
Effective Green, g (s)	22.9	
Actuated g/C Ratio	0.19	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	305	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.04	
Uniform Delay, d1	39.6	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	39.6	
Level of Service	D	
Approach Delay (s)	61.1	
Approach LOS	E	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	UL	T	T	R	L	T	T	L	T
Maximum Queue (ft)	308	337	313	350	670	693	450	126	239	222	247	289
Average Queue (ft)	173	180	145	177	419	427	96	50	157	118	105	160
95th Queue (ft)	275	327	293	349	621	624	400	104	226	211	201	257
Link Distance (ft)	852	852	852		1567	1567			444	444		411
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)				250			350	250			200	
Storage Blk Time (%)			0	4	23	16			0		0	5
Queuing Penalty (veh)			0	29	20	18			0		0	6

Intersection: 1: MD 188 & MD 190

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	250	421
Average Queue (ft)	117	153
95th Queue (ft)	230	359
Link Distance (ft)	411	411
Upstream Blk Time (%)		1
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 2: Braeburn Pkwy & MD 190

Movement	EB	EB	WB	WB	B14	NB	SB
Directions Served	UL	R	UL	R	T	R	R
Maximum Queue (ft)	64	4	39	8	7	64	71
Average Queue (ft)	20	0	14	0	0	22	25
95th Queue (ft)	52	3	36	4	5	49	56
Link Distance (ft)					266	473	451
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	200	170	170	200			
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	132	278	289	30	160	521	496	250	71	281	65
Average Queue (ft)	45	104	112	3	17	270	263	84	24	145	20
95th Queue (ft)	93	236	236	17	97	476	466	246	59	243	51
Link Distance (ft)		1672	1672			1275	1275		471	492	492
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)		3	2			16	13				
Queuing Penalty (veh)		2	0			2	29				

Network Summary

Network wide Queuing Penalty: 107

APPENDIX D

Signal Warrant Analysis

Summary of Traffic Signal Warrant Analysis

Intersection: **MD 190 (River Rd) at Pyle Rd (Relocated Braeburn Pkwy)**
Location: **Montgomery County**
Study Date: **1/13/2017**

Warrant Analysis:

SHA is mandated to follow the nationally accepted *Manual on Uniform Traffic Control Devices* (MUTCD) as the guideline for the installation of the Traffic Signal. In a signal warrant analysis, numerous factors are evaluated including traffic volumes, delay, accident history, and pedestrian volumes. A signal warrant analysis was conducted on January 13, 2017 based on a March 8, 2016 traffic count to evaluate if a traffic signal is warranted at the intersection of MD 190 (River Road) at Pyle Road (Relocated Braeburn Parkway). It was assumed that all turning movements from Braeburn Parkway would be relocated to Pyle Road and would be combined with the existing school crossing. At the existing intersection, non-right-turning movements from the minor street were prohibited during peak periods. Therefore, right-turning vehicles from the minor street were able to enter the roadway with little to no conflicts and thus were not included for the signal warrant evaluation. After review, no warrants were met.

☐ 1	Eight-Hour vehicular volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 2	Four-Hour vehicular volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 3	Peak Hour	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 4	Pedestrian Volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 5	School Crossing	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 6	Coordinated Signal System	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 7	Crash Experience	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 8	Roadway Network	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 9	Intersection Near a Grade Crossing	☐ **YES**	☐ **NO**	☒ **N/A**

☐ **Location warrants signalization.**

☒ Location does not warrant signalization.

Traffic Signal Warrant Analysis

Source: Maryland Manual on Uniform Traffic Control Devices, 2011.

YEAR ANALYZED 2016

Does the 85th percentile speed of the major street traffic exceed 40 mph? yes ☒ no ☐

Does the intersection lie within the built-up area of an isolated community having a population of less than 10,000? yes ☐ no ☒

Major Street: **MD 190 (River Road)**
Number of lanes of moving traffic on each major street approach: 2+
Minor Street**: Pyle Road (Relocated Braeburn Parkway)**
Number of lanes of moving traffic on each minor street approach: 1
Posted speed limit along MD 190: **45 mph**

Warrants for Traffic Signal Installation

Traffic control signal may be justified at an intersection, driveway or mid block pedestrian crossing, if one or more of the following warrants are satisfied:

Warrant1, Eight-Hour Vehicular Volume **WARRANT SATISFIED:** **yes** ☐ **no** ☒

This warrant is satisfied when one of the following apply:

Condition satisfied:

A. **<u>Minimum Vehicular Volume</u>** yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **420 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **105 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**5**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**5**	yes ☐	no ☒
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**13**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**20**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**10**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**12**	yes ☐	no ☒
12:00 AM – 01:00 PM	MD 190	**2319**	Braeburn Parkway	**14**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**14**	yes ☐	no ☒
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**17**	yes ☐	no ☒
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**10**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**14**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**12**	yes ☐	no ☒

Condition satisfied:

B. The Interruption of Continuous Traffic yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **630 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **53 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**5**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**5**	yes ☐	no ☒
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**13**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**20**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**10**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**12**	yes ☐	no ☒
12:00 AM – 01:00 AM	MD 190	**2319**	Braeburn Parkway	**14**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**14**	yes ☐	no ☒
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**17**	yes ☐	no ☒
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**10**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**14**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**12**	yes ☐	no ☒

Warrant 1 is not satisfied.

Warrant 2, Four-Hour Vehicular Volume **WARRANT SATISFIED:** **yes ☐ no ☒**

The Four-Hour Volume Warrant is satisfied when for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major-street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor-street (one direction only) all fall above the curve in Figure B. **The lower threshold volume for Minor Street is 60 vph (70% Factor Applies)**.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**5**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**5**	yes ☐	no ☒
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**13**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**20**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**10**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**12**	yes ☐	no ☒
12:00 AM – 01:00 AM	MD 190	**2319**	Braeburn Parkway	**14**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**14**	yes ☐	no ☒
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**17**	yes ☐	no ☒
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**10**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**14**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**12**	yes ☐	no ☒

Warrant 2 is not satisfied.

Warrant 3, Peak Hour	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when either of the following two categories apply:

		Condition satisfied:
A.	If all of the following conditions exist for the same 1 hour of an average day:	yes ☐ no ☒
1.	The total delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceeds: four vehicle-hours for one lane approach; and five vehicle-hours for two-lane approach, and	yes ☐ no ☒
2.	The volume on the same minor-street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes of traffic, and	yes ☐ no ☒
3.	The total entering volume serviced during the hour equals or exceeds 650 vph for intersections with three approaches or 800 vph for intersections with four or more approaches.	yes ☒ no ☐
B.	The plot of vehicles per hour on the major street and the corresponding vehicles per hour on the higher-volume minor-street approach for 1 hour of average day falls above the applicable curve in Figure D for the combination of approach lanes.	yes ☐ no ☒

Warrant 3 is not satisfied.

Warrant 4, Pedestrian Volume	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when the following apply:

		Condition satisfied:
A.	Pedestrian volume crossing the major-street during an average day Is 75 or more for each of any four (4) hours or 93 during any one (1) hour and	yes ☐ no ☒
B.	Fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied.	yes ☐ no ☒

Warrant 4 is not satisfied.

Warrant 5, School Crossing	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when the study of the frequency and adequacy of gaps in vehicular traffic stream as related to number and size of groups of school children at an established school crossing across a major street shows that the number of adequate gaps in the traffic stream during the period when children are using the crossing is less than the number of minutes in the same period and that there are a minimum of twenty (20) students during the highest crossing hour.

Warrant 5 is not satisfied.

Warrant 6, Coordinated Signal System	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when one of the following applies.

A. On a one way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning or

B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of vehicular platooning and the proposed and adjacent traffic control signal will collectively provide a progressive operation.

Warrant 6 is not satisfied.

Warrant 7, Crash Experience	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when all of the following apply:

Review of three year accident report shows a total of five reported collisions at this intersection.

		Condition satisfied:	
1.	Adequate trial of alternatives, with satisfactory observance and enforcement has failed to reduce the crash frequency and	yes ☐	no ☒
2.	Five or more reported crashes, of types susceptible to correction by traffic control signal; have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for reportable crashes and	yes ☐	no ☒
3.	There exists a volume of vehicle and pedestrian traffic not less than 80% Of the requirements specified in Warrant 1, or Warrant 5.	yes ☒	no ☐

Warrant 7 is not satisfied.

Warrant 8, Roadway Network	WARRANT SATISFIED:	yes ☐	NA ☒

This warrant is satisfied when the common intersection of two or more major routes meet either criterion A or B.

Warrant 8 is not satisfied. The intersection does not include two or more major routes.

Warrant 9, Intersection Near a Grade Crossing	WARRANT SATISFIED:	yes ☐	NA ☒

Warrant 9 is not satisfied. The intersection is not near a grade crossing.

Figure A. Warrant 2 Four-Hour Vehicular Volume

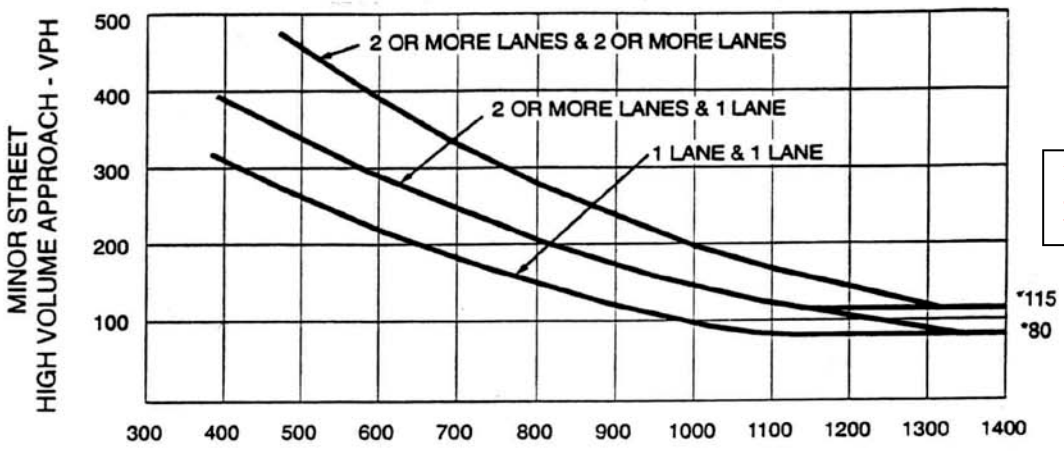
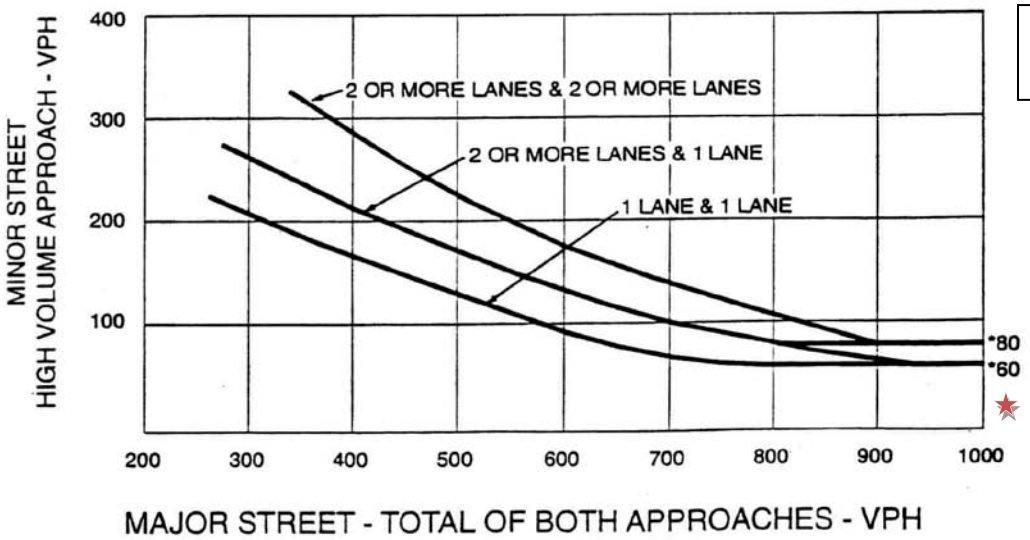


Figure B is applicable for this intersection

*Note: 115 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure B. Warrant 2 Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



All points are below the curve and off the chart.

*Note: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure C. Warrant 3 Peak Hour

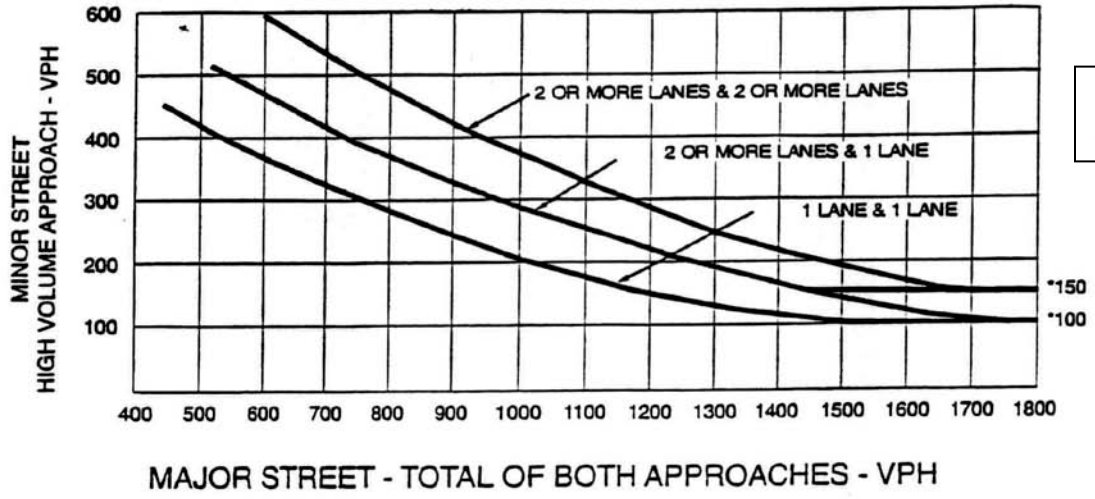
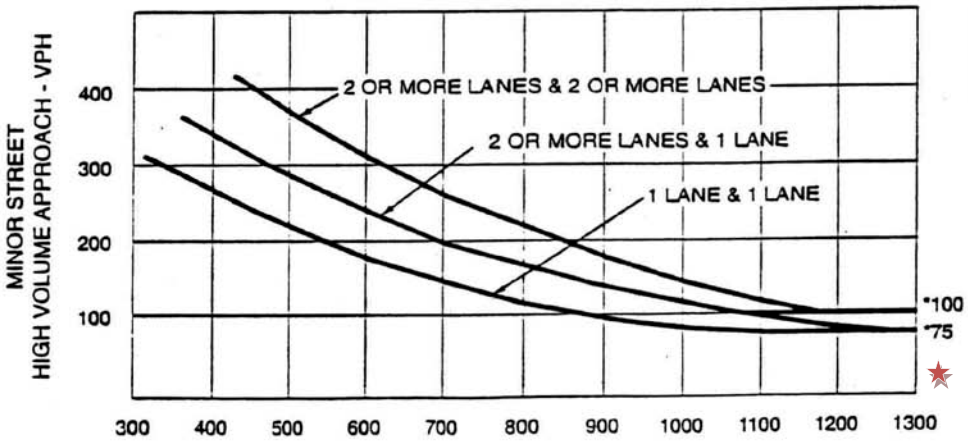


Figure D is applicable for this intersection

*Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure D. Warrant 3 Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



All points are below the curve and off the chart

*Note: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor street approach with one lane.

Summary of Traffic Signal Warrant Analysis

Intersection: **MD 190 (River Road) at Braeburn Parkway**
Location: **Montgomery County**
Study Date: **1/12/2017**

Warrant Analysis:

SHA is mandated to follow the nationally accepted *Manual on Uniform Traffic Control Devices* (MUTCD) as the guideline for the installation of the Traffic Signal. In a signal warrant analysis, numerous factors are evaluated including traffic volumes, delay, accident history, and pedestrian volumes. A signal warrant analysis was conducted on January 12, 2017 based on a March 8, 2016 traffic count to evaluate if a traffic signal is warranted at the intersection of MD 190 (River Road) at Braeburn Parkway. After the Four-Hour vehicular volume and the Peak Hour warrants are satisfied.

☐ 1	Eight-Hour vehicular volume	☐ **YES**	☒ **NO**	☐ **N/A**
☒ 2	Four-Hour vehicular volume	☒ **YES**	☐ **NO**	☐ **N/A**
☒ 3	Peak Hour	☒ **YES**	☐ **NO**	☐ **N/A**
☐ 4	Pedestrian Volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 5	School Crossing	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 6	Coordinated Signal System	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 7	Crash Experience	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 8	Roadway Network	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 9	Intersection Near a Grade Crossing	☐ **YES**	☐ **NO**	☒ **N/A**

☒ **Location warrants signalization.**

☐ Location does not warrant signalization.

Traffic Signal Warrant Analysis

Source: Maryland Manual on Uniform Traffic Control Devices, 2011.

YEAR ANALYZED 2015

Does the 85th percentile speed of the major street traffic exceed 40 mph? yes ☒ no ☐

Does the intersection lie within the built-up area of an isolated community having a population of less than 10,000? yes ☐ no ☒

Major Street: **MD 190 (River Road)**
Number of lanes of moving traffic on each major street approach: 2+
Minor Street**: Pyle Road (Relocated Braeburn Parkway)**
Number of lanes of moving traffic on each minor street approach: 1
Posted speed limit along MD 190: **45 mph**

Warrants for Traffic Signal Installation

Traffic control signal may be justified at an intersection, driveway or mid block pedestrian crossing, if one or more of the following warrants are satisfied:

Warrant1, Eight-Hour Vehicular Volume **WARRANT SATISFIED:** **yes** ☐ **no** ☒

This warrant is satisfied when one of the following apply:

Condition satisfied:

A. **Minimum Vehicular Volume** yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **420 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **105 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**15**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**154**	yes ☒	no ☐
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**43**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**36**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**31**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**31**	yes ☐	no ☒
12:00 AM – 01:00 PM	MD 190	**2319**	Braeburn Parkway	**34**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**46**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**106**	yes ☒	no ☐
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**98**	yes ☐	no ☒
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**40**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**32**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**63**	yes ☐	no ☒

Condition satisfied:

B. The Interruption of Continuous Traffic yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **630 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **53 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**15**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**154**	yes ☒	no ☐
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**43**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**36**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**31**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**31**	yes ☐	no ☒
12:00 AM – 01:00 AM	MD 190	**2319**	Braeburn Parkway	**34**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**46**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**106**	yes ☒	no ☐
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**98**	yes ☒	no ☐
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**40**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**32**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**63**	yes ☒	no ☐

Warrant 1 is not satisfied.

Warrant 2, Four-Hour Vehicular Volume **WARRANT SATISFIED:** **yes ☒ no ☐**

The Four-Hour Volume Warrant is satisfied when for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major-street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor-street (one direction only) all fall above the curve in Figure B. **The lower threshold volume for Minor Street is 60 vph (70% Factor Applies)**.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	MD 190	**1575**	Braeburn Parkway	**15**	yes ☐	no ☒
07:00 AM – 08:00 AM	MD 190	**3217**	Braeburn Parkway	**154**	yes ☒	no ☐
08:00 AM – 09:00 AM	MD 190	**3200**	Braeburn Parkway	**43**	yes ☐	no ☒
09:00 AM – 10:00 AM	MD 190	**2905**	Braeburn Parkway	**36**	yes ☐	no ☒
10:00 AM – 11:00 AM	MD 190	**2234**	Braeburn Parkway	**31**	yes ☐	no ☒
11:00 AM – 12:00 AM	MD 190	**2302**	Braeburn Parkway	**31**	yes ☐	no ☒
12:00 AM – 01:00 AM	MD 190	**2319**	Braeburn Parkway	**34**	yes ☐	no ☒
01:00 PM – 02:00 PM	MD 190	**2283**	Braeburn Parkway	**46**	yes ☐	no ☒
02:00 PM – 03:00 PM	MD 190	**2755**	Braeburn Parkway	**106**	yes ☒	no ☐
03:00 PM – 04:00 PM	MD 190	**3060**	Braeburn Parkway	**98**	yes ☒	no ☐
04:00 PM – 05:00 PM	MD 190	**2812**	Braeburn Parkway	**40**	yes ☐	no ☒
05:00 PM – 06:00 PM	MD 190	**3015**	Braeburn Parkway	**32**	yes ☐	no ☒
06:00 PM – 07:00 PM	MD 190	**2981**	Braeburn Parkway	**63**	yes ☒	no ☐

Warrant 2 is satisfied.

Warrant 3, Peak Hour	WARRANT SATISFIED:	yes ☒	no ☐

This warrant is satisfied when either of the following two categories apply:

		Condition satisfied:
A.	If all of the following conditions exist for the same 1 hour of an average day:	yes ☐ no ☒
1.	The total delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceeds: four vehicle-hours for one lane approach; and five vehicle –hours for two--lane approach, and	yes ☐ no ☒
2.	The volume on the same minor-street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes of traffic, and	yes ☒ no ☐
3.	The total entering volume serviced during the hour equals or exceeds 650 vph for intersections with three approaches or 800 vph for intersections with four or more approaches.	yes ☒ no ☐
B.	The plot of vehicles per hour on the major street and the corresponding vehicles per hour on the higher-volume minor-street approach for 1 hour of average day falls above the applicable curve in Figure D for the combination of approach lanes.	yes ☒ no ☐

Warrant 3 is satisfied.

Warrant 4, Pedestrian Volume	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when the following apply:

		Condition satisfied:
A.	Pedestrian volume crossing the major-street during an average day Is 75 or more for each of any four (4) hours or 93 during any one (1) hour and	yes ☐ no ☒
B.	Fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied.	yes ☐ no ☒

Warrant 4 is not satisfied.

Warrant 5, School Crossing	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when the study of the frequency and adequacy of gaps in vehicular traffic stream as related to number and size of groups of school children at an established school crossing across a major street shows that the number of adequate gaps in the traffic stream during the period when children are using the crossing is less than the number of minutes in the same period and that there are a minimum of twenty (20) students during the highest crossing hour.

Warrant 5 is not satisfied.

Warrant 6, Coordinated Signal System	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when one of the following applies.

A. On a one way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning or

B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of vehicular platooning and the proposed and adjacent traffic control signal will collectively provide a progressive operation.

Warrant 6 is not satisfied.

Warrant 7, Crash Experience	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when all of the following apply:

Review of three year accident report shows a total of five reported collisions at this intersection.

		Condition satisfied:	
1.	Adequate trial of alternatives, with satisfactory observance and enforcement has failed to reduce the crash frequency and	yes ☐	no ☒
2.	Five or more reported crashes, of types susceptible to correction by traffic control signal; have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for reportable crashes and	yes ☐	no ☒
3.	There exists a volume of vehicle and pedestrian traffic not less than 80% Of the requirements specified in Warrant 1, or Warrant 5.	yes ☒	no ☐

Warrant 7 is not satisfied.

Warrant 8, Roadway Network	WARRANT SATISFIED:	yes ☐	NA ☒

This warrant is satisfied when the common intersection of two or more major routes meet either criterion A or B.

Warrant 8 is not satisfied. The intersection does not include two or more major routes.

Warrant 9, Intersection Near a Grade Crossing	WARRANT SATISFIED:	yes ☐	NA ☒

Warrant 9 is not satisfied. The intersection is not near a grade crossing.

Figure A. Warrant 2 Four-Hour Vehicular Volume

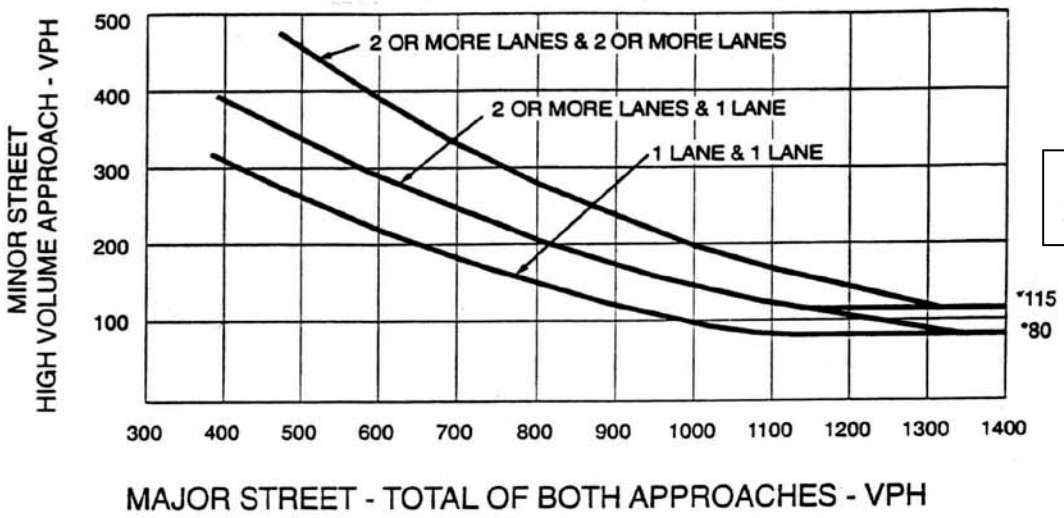
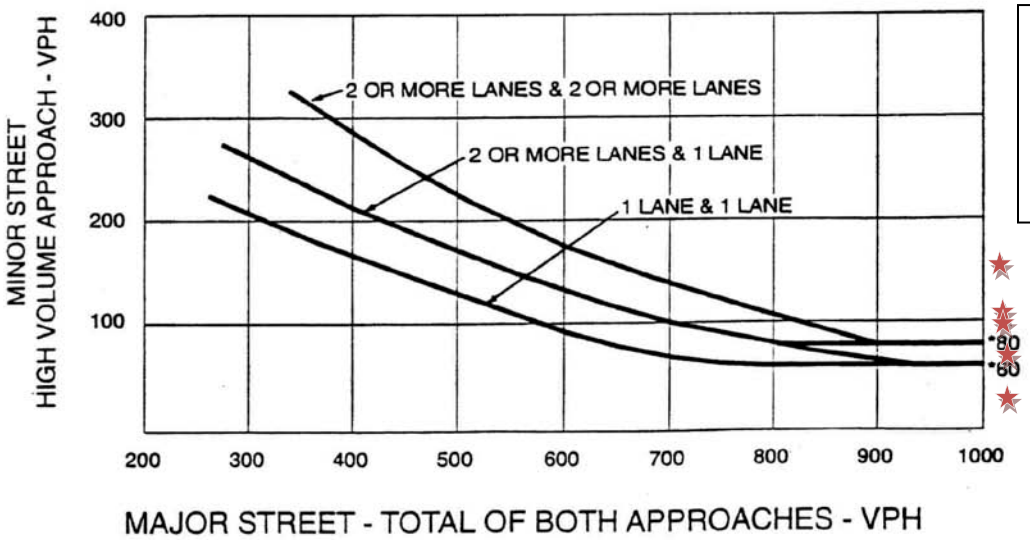


Figure B is applicable for this intersection

*Note: 115 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure B. Warrant 2 Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



The 7 AM, 2 PM, 3 PM, and 6 PM points fall above the curve. All other points are below the curve off the chart.

*Note: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure C. Warrant 3 Peak Hour

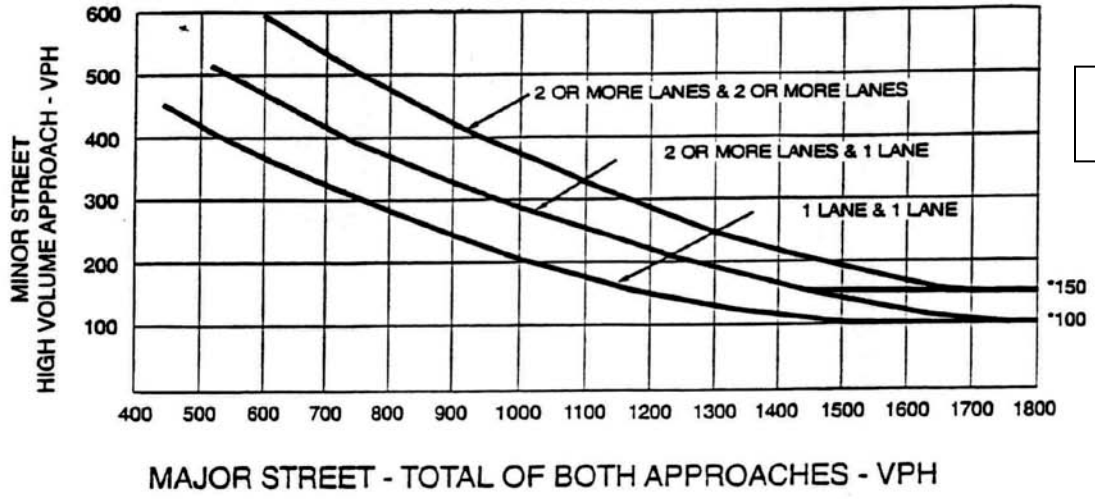
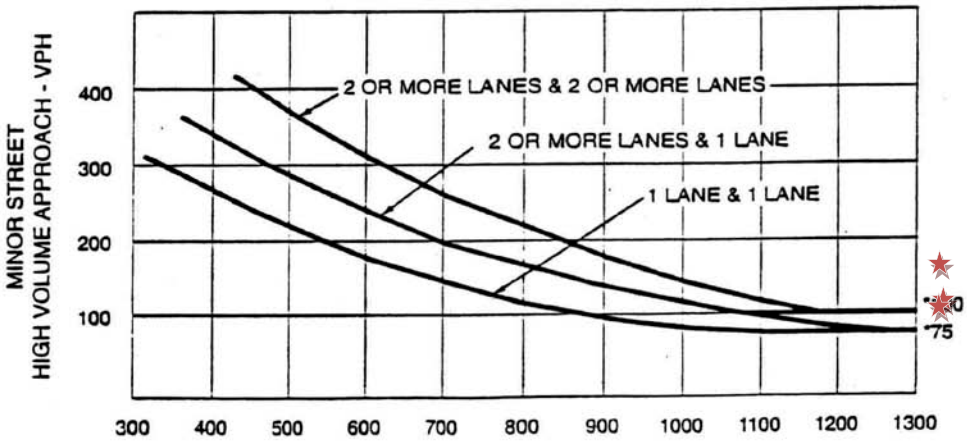


Figure D is applicable for this intersection

*Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure D. Warrant 3 Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



The 7 AM, 2 PM and 3 PM hour satisfy this warrant.

*Note: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor street approach with one lane.

Summary of Traffic Signal Warrant Analysis

Intersection: **MD 190 (River Road) at Braeburn Parkway**
Location: **Montgomery County**
Study Date: **3/31/2017**

Warrant Analysis:

SHA is mandated to follow the nationally accepted *Manual on Uniform Traffic Control Devices* (MUTCD) as the guideline for the installation of the Traffic Signal. In a signal warrant analysis, numerous factors are evaluated including traffic volumes, delay, accident history, and pedestrian volumes. A signal warrant analysis was conducted on March 31, 2017 based on a March 8, 2016 traffic count to evaluate if a traffic signal is warranted at the intersection of MD 190 (River Road) at Braeburn Parkway. Because this intersection has a high volume of left-turn traffic from the major street, the signal warrant analysis was performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume. The Peak Hour warrant is satisfied.

☐ 1	Eight-Hour vehicular volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 2	Four-Hour vehicular volume	☐ **YES**	☒ **NO**	☐ **N/A**
☒ 3	Peak Hour	☒ **YES**	☐ **NO**	☐ **N/A**
☐ 4	Pedestrian Volume	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 5	School Crossing	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 6	Coordinated Signal System	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 7	Crash Experience	☐ **YES**	☒ **NO**	☐ **N/A**
☐ 8	Roadway Network	☐ **YES**	☐ **NO**	☒ **N/A**
☐ 9	Intersection Near a Grade Crossing	☐ **YES**	☐ **NO**	☒ **N/A**

☒ **Location warrants signalization.**

☐ Location does not warrant signalization.

Traffic Signal Warrant Analysis

Source: Maryland Manual on Uniform Traffic Control Devices, 2011.

YEAR ANALYZED 2016

Does the 85th percentile speed of the major street traffic exceed 40 mph? yes ☒ no ☐

Does the intersection lie within the built-up area of an isolated community having a population of less than 10,000? yes ☐ no ☒

Major Street: **WB/EB MD 190 (River Road)**
Number of lanes of moving traffic on each major street approach: 2+
Minor Street**: WB/EB MD 190 (River Road) Left Turn**
Number of lanes of moving traffic on each minor street approach: 1
Posted speed limit along MD 190: **45 mph**

Warrants for Traffic Signal Installation

Traffic control signal may be justified at an intersection, driveway or mid block pedestrian crossing, if one or more of the following warrants are satisfied:

Warrant1, Eight-Hour Vehicular Volume **WARRANT SATISFIED:** **yes** ☐ **no** ☒

This warrant is satisfied when one of the following apply:

Condition satisfied:

A. **Minimum Vehicular Volume** yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **420 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **105 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	WB MD 190	**329**	EB MD 190 Left Turn	**25**	yes ☐	no ☒
07:00 AM – 08:00 AM	WB MD 190	**1009**	EB MD 190 Left Turn	**194**	yes ☒	no ☐
08:00 AM – 09:00 AM	WB MD 190	**1148**	EB MD 190 Left Turn	**34**	yes ☐	no ☒
09:00 AM – 10:00 AM	WB MD 190	**964**	EB MD 190 Left Turn	**23**	yes ☐	no ☒
10:00 AM – 11:00 AM	WB MD 190	**921**	EB MD 190 Left Turn	**12**	yes ☐	no ☒
11:00 AM – 12:00 AM	EB MD 190	**1135**	WB MD 190 Left Turn	**17**	yes ☐	no ☒
12:00 AM – 01:00 PM	WB MD 190	**1184**	EB MD 190 Left Turn	**20**	yes ☐	no ☒
01:00 PM – 02:00 PM	WB MD 190	**1203**	EB MD 190 Left Turn	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	WB MD 190	**1526**	EB MD 190 Left Turn	**54**	yes ☐	no ☒
03:00 PM – 04:00 PM	WB MD 190	**1775**	EB MD 190 Left Turn	**30**	yes ☐	no ☒
04:00 PM – 05:00 PM	WB MD 190	**1702**	EB MD 190 Left Turn	**18**	yes ☐	no ☒
05:00 PM – 06:00 PM	EB MD 190	**1095**	WB MD 190 Left Turn	**25**	yes ☐	no ☒
06:00 PM – 07:00 PM	WB MD 190	**1698**	EB MD 190 Left Turn	**39**	yes ☐	no ☒

Condition satisfied:

B. The Interruption of Continuous Traffic yes ☐ no ☒

For each of any 8 hours of an average day, the vehicles per hour on the major street and on the higher-volume minor street or driveway approach to the intersection equal or exceed the following:

Major Street: **630 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Minor Street: **53 vph** (MUTCD Table 4C-1 70% column for speeds above 40 MPH) for 2+ lanes for major street approach and 1 lane for minor street approach.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	WB MD 190	**329**	EB MD 190 Left Turn	**25**	yes ☐	no ☒
07:00 AM – 08:00 AM	WB MD 190	**1009**	EB MD 190 Left Turn	**194**	yes ☒	no ☐
08:00 AM – 09:00 AM	WB MD 190	**1148**	EB MD 190 Left Turn	**34**	yes ☐	no ☒
09:00 AM – 10:00 AM	WB MD 190	**964**	EB MD 190 Left Turn	**23**	yes ☐	no ☒
10:00 AM – 11:00 AM	WB MD 190	**921**	EB MD 190 Left Turn	**12**	yes ☐	no ☒
11:00 AM – 12:00 AM	EB MD 190	**1135**	WB MD 190 Left Turn	**17**	yes ☐	no ☒
12:00 AM – 01:00 AM	WB MD 190	**1184**	EB MD 190 Left Turn	**20**	yes ☐	no ☒
01:00 PM – 02:00 PM	WB MD 190	**1203**	EB MD 190 Left Turn	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	WB MD 190	**1526**	EB MD 190 Left Turn	**54**	yes ☒	no ☐
03:00 PM – 04:00 PM	WB MD 190	**1775**	EB MD 190 Left Turn	**30**	yes ☐	no ☒
04:00 PM – 05:00 PM	WB MD 190	**1702**	EB MD 190 Left Turn	**18**	yes ☐	no ☒
05:00 PM – 06:00 PM	EB MD 190	**1095**	WB MD 190 Left Turn	**25**	yes ☐	no ☒
06:00 PM – 07:00 PM	WB MD 190	**1698**	EB MD 190 Left Turn	**39**	yes ☐	no ☒

Warrant 1 is not satisfied.

Warrant 2, Four-Hour Vehicular Volume **WARRANT SATISFIED:** **yes ☐ no ☒**

The Four-Hour Volume Warrant is satisfied when for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major-street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor-street (one direction only) all fall above the curve in Figure B. **The lower threshold volume for Minor Street is 60 vph (70% Factor Applies)**.

Time	Major Street	Volume	Minor Street	Volume	Requirement Satisfied	
06:00 AM – 07:00 AM	WB MD 190	**329**	EB MD 190 Left Turn	**25**	yes ☐	no ☒
07:00 AM – 08:00 AM	WB MD 190	**1009**	EB MD 190 Left Turn	**194**	yes ☒	no ☐
08:00 AM – 09:00 AM	WB MD 190	**1148**	EB MD 190 Left Turn	**34**	yes ☐	no ☒
09:00 AM – 10:00 AM	WB MD 190	**964**	EB MD 190 Left Turn	**23**	yes ☐	no ☒
10:00 AM – 11:00 AM	WB MD 190	**921**	EB MD 190 Left Turn	**12**	yes ☐	no ☒
11:00 AM – 12:00 AM	EB MD 190	**1135**	WB MD 190 Left Turn	**17**	yes ☐	no ☒
12:00 AM – 01:00 AM	WB MD 190	**1184**	EB MD 190 Left Turn	**20**	yes ☐	no ☒
01:00 PM – 02:00 PM	WB MD 190	**1203**	EB MD 190 Left Turn	**17**	yes ☐	no ☒
02:00 PM – 03:00 PM	WB MD 190	**1526**	EB MD 190 Left Turn	**54**	yes ☐	no ☒
03:00 PM – 04:00 PM	WB MD 190	**1775**	EB MD 190 Left Turn	**30**	yes ☐	no ☒
04:00 PM – 05:00 PM	WB MD 190	**1702**	EB MD 190 Left Turn	**18**	yes ☐	no ☒
05:00 PM – 06:00 PM	EB MD 190	**1095**	WB MD 190 Left Turn	**25**	yes ☐	no ☒
06:00 PM – 07:00 PM	WB MD 190	**1698**	EB MD 190 Left Turn	**39**	yes ☐	no ☒

Warrant 2 is not satisfied.

Warrant 3, Peak Hour	**WARRANT SATISFIED:**	**yes** ☒	**no** ☐

This warrant is satisfied when either of the following two categories apply:

		Condition satisfied:	
A.	If all of the following conditions exist for the same 1 hour of an average day:	yes ☐	no ☒
1.	The total delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceeds: four vehicle-hours for one lane approach; and five vehicle –hours for two--lane approach, and	yes ☐	no ☒
2.	The volume on the same minor-street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes of traffic, and	yes ☒	no ☐
3.	The total entering volume serviced during the hour equals or exceeds 650 vph for intersections with three approaches or 800 vph for intersections with four or more approaches.	yes ☒	no ☐
B.	The plot of vehicles per hour on the major street and the corresponding vehicles per hour on the higher-volume minor-street approach for 1 hour of average day falls above the applicable curve in Figure D for the combination of approach lanes.	yes ☒	no ☐

Warrant 3 is satisfied.

Warrant 4, Pedestrian Volume	**WARRANT SATISFIED:**	**yes** ☐	**no** ☒

This warrant is satisfied when the following apply:

		Condition satisfied:	
A.	Pedestrian volume crossing the major-street during an average day Is 75 or more for each of any four (4) hours or 93 during any one (1) hour and	yes ☐	no ☒
B.	Fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied.	yes ☐	no ☒

Warrant 4 is not satisfied.

Warrant 5, School Crossing	**WARRANT SATISFIED:**	**yes** ☐	**NA** ☒

This warrant is satisfied when the study of the frequency and adequacy of gaps in vehicular traffic stream as related to number and size of groups of school children at an established school crossing across a major street shows that the number of adequate gaps in the traffic stream during the period when children are using the crossing is less than the number of minutes in the same period and that there are a minimum of twenty (20) students during the highest crossing hour.

Warrant 5 is not applicable. An established school crossing is not present at this intersection.

Warrant 6, Coordinated Signal System	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when one of the following applies.

A. On a one way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning or

B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of vehicular platooning and the proposed and adjacent traffic control signal will collectively provide a progressive operation.

Warrant 6 is not satisfied.

Warrant 7, Crash Experience	WARRANT SATISFIED:	yes ☐	no ☒

This warrant is satisfied when all of the following apply:

Review of three year accident report shows a total of five reported collisions at this intersection.

		Condition satisfied:	
1.	Adequate trial of alternatives, with satisfactory observance and enforcement has failed to reduce the crash frequency and	yes ☐	no ☒
2.	Five or more reported crashes, of types susceptible to correction by traffic control signal; have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for reportable crashes and	yes ☐	no ☒
3.	There exists a volume of vehicle and pedestrian traffic not less than 80% Of the requirements specified in Warrant 1, or Warrant 5.	yes ☒	no ☐

Warrant 7 is not satisfied.

Warrant 8, Roadway Network	WARRANT SATISFIED:	yes ☐	NA ☒

This warrant is satisfied when the common intersection of two or more major routes meet either criterion A or B.

Warrant 8 is not satisfied. The intersection does not include two or more major routes.

Warrant 9, Intersection Near a Grade Crossing	WARRANT SATISFIED:	yes ☐	NA ☒

Warrant 9 is not satisfied. The intersection is not near a grade crossing.

Figure A. Warrant 2 Four-Hour Vehicular Volume

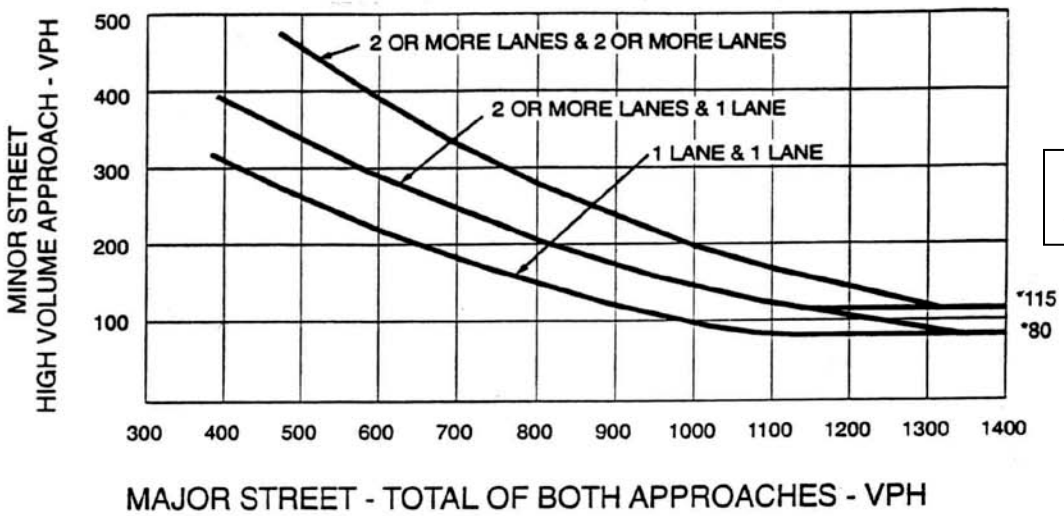
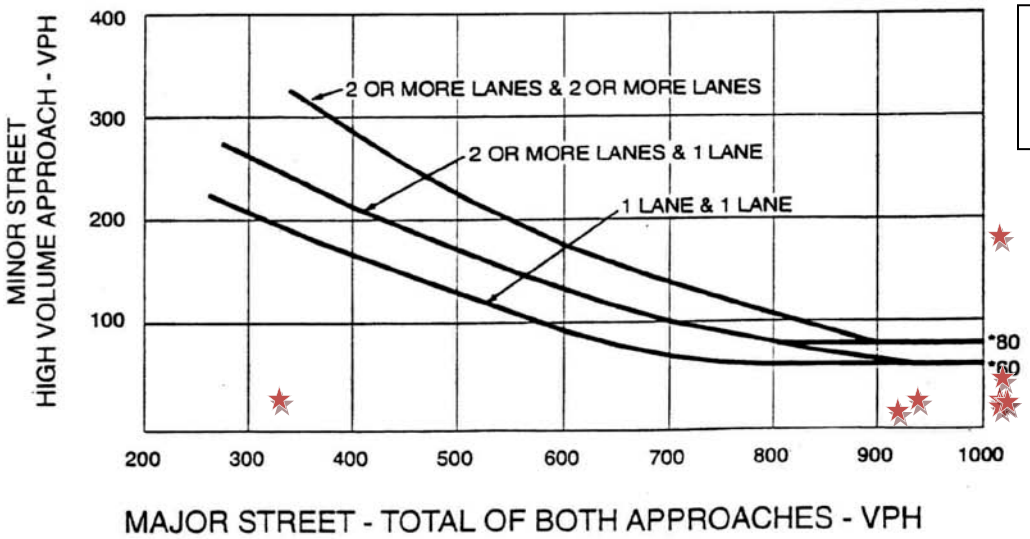


Figure B is applicable for this intersection

*Note: 115 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure B. Warrant 2 Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



The 7 AM data point falls above the curve. All other points are below the curve.

*Note: 80 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure C. Warrant 3 Peak Hour

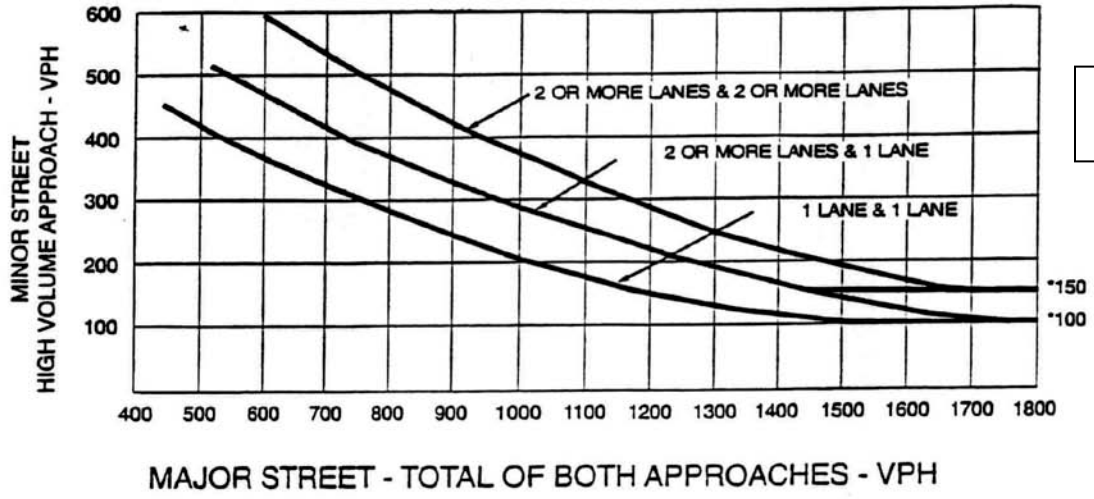
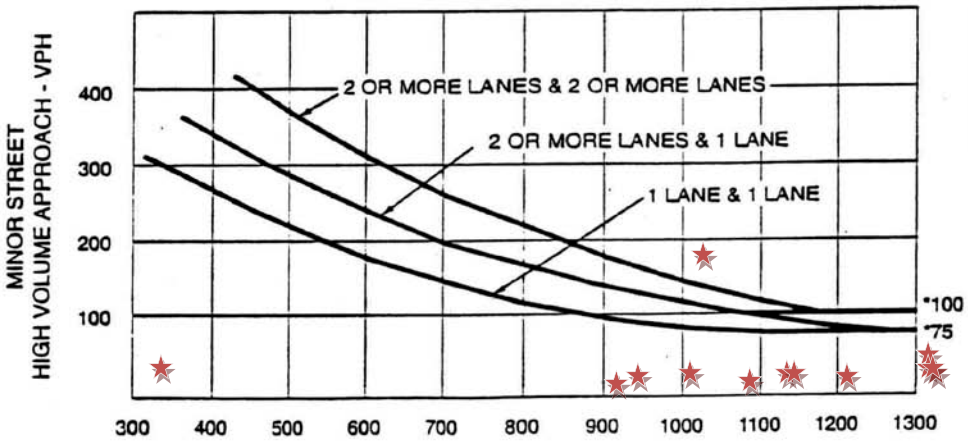


Figure D is applicable for this intersection

*Note: 150 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor street approach with one lane.

Figure D. Warrant 3 Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h (40 mph) ON MAJOR STREET)



The 7 AM hour satisfies this warrant. All other hours are below the curve.

*Note: 100 vph applies as the lower threshold volume for a minor street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor street approach with one lane.

APPENDIX E

Synchro / SimTraffic Results Worksheets

(Relocated – Alternative 1/3 and Alternative 2)

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Future Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.58	1.00	1.00	0.51	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	1063	3505	1568	945	3505
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)	212	2065	147	5	92	1261	71	82	168	125	130	158
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	115	0	0
Lane Group Flow (vph)	212	2065	147	0	97	1261	71	82	168	10	130	158
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Effective Green, g (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Actuated g/C Ratio	0.15	0.66	1.00		0.08	0.59	1.00	0.13	0.08	0.08	0.14	0.08
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	263	2297	1568		146	2062	1568	176	272	121	172	280
v/s Ratio Prot	c0.12	c0.59			0.06	0.36		0.02	0.05		c0.04	0.05
v/s Ratio Perm			c0.09				0.05	0.04		0.01	c0.06	
v/c Ratio	0.81	0.90	0.09		0.66	0.61	0.05	0.47	0.62	0.08	0.76	0.56
Uniform Delay, d1	73.9	26.0	0.0		80.1	23.8	0.0	71.3	80.4	77.0	73.4	79.8
Progression Factor	1.00	1.00	1.00		0.80	1.17	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.3	6.1	0.1		9.6	1.2	0.0	1.9	4.1	0.3	17.1	2.6
Delay (s)	90.2	32.1	0.1		73.4	29.0	0.0	73.2	84.5	77.3	90.5	82.4
Level of Service	F	C	A		E	C	A	E	F	E	F	F
Approach Delay (s)		35.3				30.6			79.7			82.3
Approach LOS		D				C			E			F

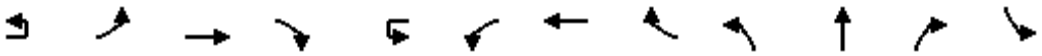
Intersection Summary			
HCM 2000 Control Delay	42.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	210
Future Volume (vph)	210
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.92
Adj. Flow (vph)	228
RTOR Reduction (vph)	210
Lane Group Flow (vph)	18
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.4
Effective Green, g (s)	14.4
Actuated g/C Ratio	0.08
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	125
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.15
Uniform Delay, d1	77.1
Progression Factor	1.00
Incremental Delay, d2	0.5
Delay (s)	77.6
Level of Service	E
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	130	1970	35	5	15	1170	25	10	5	25	5
Future Volume (vph)	5	130	1970	35	5	15	1170	25	10	5	25	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	4.0	4.0		4.0	4.0	4.0		6.0		
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.92		
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.99		
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1667		
Flt Permitted		0.16	1.00	1.00		0.05	1.00	1.00		0.92		
Satd. Flow (perm)		298	3505	1568		99	3505	1568		1560		
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)	5	141	2141	38	5	16	1272	27	11	5	27	5
RTOR Reduction (vph)	0	0	0	7	0	0	0	8	0	21	0	0
Lane Group Flow (vph)	0	146	2141	31	0	21	1272	19	0	22	0	0
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	5	5	2				6			4		
Permitted Phases	2	2		2	6	6		6	4			8
Actuated Green, G (s)		139.0	139.0	139.0		124.7	124.7	124.7		31.0		
Effective Green, g (s)		139.0	139.0	139.0		124.7	124.7	124.7		31.0		
Actuated g/C Ratio		0.77	0.77	0.77		0.69	0.69	0.69		0.17		
Clearance Time (s)		5.0	4.0	4.0		4.0	4.0	4.0		6.0		
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		
Lane Grp Cap (vph)		305	2706	1210		68	2428	1086		268		
v/s Ratio Prot		0.02	c0.61				0.36					
v/s Ratio Perm		0.34		0.02		0.21		0.01		0.01		
v/c Ratio		0.48	0.79	0.03		0.31	0.52	0.02		0.08		
Uniform Delay, d1		10.1	12.0	4.8		10.8	13.3	8.6		62.6		
Progression Factor		0.67	0.20	0.05		0.67	0.65	0.26		1.00		
Incremental Delay, d2		0.6	1.2	0.0		10.1	0.7	0.0		0.6		
Delay (s)		7.3	3.6	0.3		17.4	9.4	2.2		63.2		
Level of Service		A	A	A		B	A	A		E		
Approach Delay (s)			3.8				9.3			63.2		
Approach LOS			A				A			E		

Intersection Summary			
HCM 2000 Control Delay	8.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	0	130
Future Volume (vph)	0	130
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.0	
Lane Util. Factor	1.00	
Frt	0.87	
Flt Protected	1.00	
Satd. Flow (prot)	1601	
Flt Permitted	0.99	
Satd. Flow (perm)	1592	
Peak-hour factor, PHF	0.92	0.92
Adj. Flow (vph)	0	141
RTOR Reduction (vph)	117	0
Lane Group Flow (vph)	29	0
Turn Type	NA	
Protected Phases	8	
Permitted Phases		
Actuated Green, G (s)	31.0	
Effective Green, g (s)	31.0	
Actuated g/C Ratio	0.17	
Clearance Time (s)	6.0	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	274	
v/s Ratio Prot		
v/s Ratio Perm	c0.02	
v/c Ratio	0.11	
Uniform Delay, d1	62.8	
Progression Factor	1.00	
Incremental Delay, d2	0.8	
Delay (s)	63.6	
Level of Service	E	
Approach Delay (s)	63.6	
Approach LOS	E	

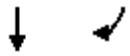
Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Future Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.95		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1725		1752
Flt Permitted		0.17	1.00	1.00		0.06	1.00	1.00		0.88		0.60
Satd. Flow (perm)		318	3505	1568		105	3505	1568		1541		1104
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	6	56	2139	28	6	6	1256	194	33	33	39	322
RTOR Reduction (vph)	0	0	0	5	0	0	0	39	0	12	0	0
Lane Group Flow (vph)	0	62	2139	23	0	12	1256	155	0	93	0	322
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Effective Green, g (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Actuated g/C Ratio		0.78	0.78	0.78		0.71	0.71	0.71		0.15		0.15
Clearance Time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		302	2726	1219		74	2474	1107		226		162
v/s Ratio Prot		0.01	c0.61				0.36					
v/s Ratio Perm		0.15		0.01		0.11		0.10		0.06		c0.29
v/c Ratio		0.21	0.78	0.02		0.16	0.51	0.14		0.41		1.99
Uniform Delay, d1		7.5	11.4	4.5		8.8	12.1	8.6		69.7		76.8
Progression Factor		1.09	0.55	1.39		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		0.2	1.5	0.0		4.7	0.7	0.3		1.2		465.8
Delay (s)		8.4	7.7	6.3		13.4	12.9	8.9		70.9		542.5
Level of Service		A	A	A		B	B	A		E		F
Approach Delay (s)			7.7				12.3			70.9		
Approach LOS			A				B			E		

Intersection Summary			
HCM 2000 Control Delay	53.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	50
Future Volume (vph)	5	50
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.86	
Flt Protected	1.00	
Satd. Flow (prot)	1595	
Flt Permitted	1.00	
Satd. Flow (perm)	1595	
Peak-hour factor, PHF	0.90	0.90
Adj. Flow (vph)	6	56
RTOR Reduction (vph)	48	0
Lane Group Flow (vph)	14	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	26.5	
Effective Green, g (s)	26.5	
Actuated g/C Ratio	0.15	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	234	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.06	
Uniform Delay, d1	66.0	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	66.2	
Level of Service	E	
Approach Delay (s)	465.6	
Approach LOS	F	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	UL	T	T	R	L	T	T	R
Maximum Queue (ft)	658	872	823	350	349	548	552	180	192	206	189	122
Average Queue (ft)	238	502	437	74	121	309	321	6	71	119	71	4
95th Queue (ft)	512	856	766	310	282	487	498	91	148	191	162	52
Link Distance (ft)	852	852	852			1567	1567			444	444	444
Upstream Blk Time (%)	1	2	0									
Queuing Penalty (veh)	0	0	0									
Storage Bay Dist (ft)				300	250			350	250			
Storage Blk Time (%)			16		0	18	8		0	0		
Queuing Penalty (veh)			21		3	16	5		0	0		

Intersection: 1: MD 188 & MD 190

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	223	213	179	132
Average Queue (ft)	120	110	55	7
95th Queue (ft)	208	190	140	62
Link Distance (ft)		411	411	411
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	200			
Storage Blk Time (%)	4	1		
Queuing Penalty (veh)	3	1		

Intersection: 3: Pyle Road & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	LTR
Maximum Queue (ft)	157	287	307	36	78	236	234	34	84	207
Average Queue (ft)	67	115	128	5	26	120	123	5	30	62
95th Queue (ft)	124	278	301	23	62	216	218	23	70	136
Link Distance (ft)		644	644			1985	1985		329	304
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	495			245	395			245		
Storage Blk Time (%)			2				0			
Queuing Penalty (veh)			1				0			

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	217	347	345	93	45	281	283	181	194	533	509
Average Queue (ft)	41	191	221	8	11	136	110	26	88	507	205
95th Queue (ft)	138	403	404	53	37	274	240	94	157	526	581
Link Distance (ft)		1985	1985			1275	1275		471	492	492
Upstream Blk Time (%)										97	10
Queuing Penalty (veh)										0	0
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)		12	11			6	3				
Queuing Penalty (veh)		7	3			1	5				

Network Summary

Network wide Queuing Penalty: 64

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Future Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.53	1.00	1.00	0.39	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	983	3505	1568	710	3505
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	201	1119	57	5	77	1711	113	57	227	77	108	216
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	69	0	0
Lane Group Flow (vph)	201	1119	57	0	82	1711	113	57	227	8	108	216
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Effective Green, g (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Actuated g/C Ratio	0.14	0.66	1.00		0.06	0.57	1.00	0.15	0.10	0.10	0.17	0.12
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	243	2297	1568		101	2013	1568	177	362	162	179	405
v/s Ratio Prot	c0.11	0.32			0.05	c0.49		0.01	0.06		c0.03	0.06
v/s Ratio Perm			0.04				c0.07	0.03		0.01	0.07	
v/c Ratio	0.83	0.49	0.04		0.81	0.85	0.07	0.32	0.63	0.05	0.60	0.53
Uniform Delay, d1	75.4	15.7	0.0		83.8	31.8	0.0	67.8	77.4	72.7	66.1	75.0
Progression Factor	1.00	1.00	1.00		0.84	0.75	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.1	0.7	0.0		27.7	3.3	0.1	1.1	3.4	0.1	5.6	1.4
Delay (s)	95.5	16.4	0.0		97.7	27.1	0.1	68.8	80.8	72.9	71.7	76.4
Level of Service	F	B	A		F	C	A	E	F	E	E	E
Approach Delay (s)		27.3				28.5			77.2			81.1
Approach LOS		C				C			E			F

Intersection Summary			
HCM 2000 Control Delay	40.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.97
Adj. Flow (vph)	356
RTOR Reduction (vph)	232
Lane Group Flow (vph)	124
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	20.8
Effective Green, g (s)	20.8
Actuated g/C Ratio	0.12
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	181
v/s Ratio Prot	
v/s Ratio Perm	c0.08
v/c Ratio	0.69
Uniform Delay, d1	76.5
Progression Factor	1.00
Incremental Delay, d2	10.3
Delay (s)	86.8
Level of Service	F
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

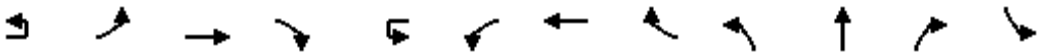
Movement	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	5	25	1205	35	40	1810	25	5	5	30	5	5
Future Volume (vph)	5	25	1205	35	40	1810	25	5	5	30	5	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	4.0	4.0	4.0	4.0	4.0		6.0			6.0
Lane Util. Factor		1.00	0.95	1.00	1.00	0.95	1.00		1.00			1.00
Frt		1.00	1.00	0.85	1.00	1.00	0.85		0.90			0.90
Flt Protected		0.95	1.00	1.00	0.95	1.00	1.00		0.99			0.99
Satd. Flow (prot)		1752	3505	1568	1752	3505	1568		1646			1646
Flt Permitted		0.07	1.00	1.00	0.21	1.00	1.00		0.97			0.97
Satd. Flow (perm)		123	3505	1568	384	3505	1568		1614			1614
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	5	26	1242	36	41	1866	26	5	5	31	5	5
RTOR Reduction (vph)	0	0	0	8	0	0	7	0	26	0	0	26
Lane Group Flow (vph)	0	31	1242	28	41	1866	19	0	15	0	0	15
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA		Perm	NA
Protected Phases	5	5	2			6			4			8
Permitted Phases	2	2		2	6		6	4			8	
Actuated Green, G (s)		140.0	140.0	140.0	131.0	131.0	131.0		30.0			30.0
Effective Green, g (s)		140.0	140.0	140.0	131.0	131.0	131.0		30.0			30.0
Actuated g/C Ratio		0.78	0.78	0.78	0.73	0.73	0.73		0.17			0.17
Clearance Time (s)		5.0	4.0	4.0	4.0	4.0	4.0		6.0			6.0
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0		3.0			3.0
Lane Grp Cap (vph)		131	2726	1219	279	2550	1141		269			269
v/s Ratio Prot		0.01	c0.35			c0.53						
v/s Ratio Perm		0.18		0.02	0.11		0.01		c0.01			0.01
v/c Ratio		0.24	0.46	0.02	0.15	0.73	0.02		0.06			0.06
Uniform Delay, d1		16.1	6.9	4.5	7.5	14.3	6.8		63.1			63.1
Progression Factor		0.75	0.45	0.20	1.00	1.00	1.00		1.00			1.00
Incremental Delay, d2		0.8	0.5	0.0	1.1	1.9	0.0		0.4			0.4
Delay (s)		12.9	3.6	0.9	8.6	16.2	6.8		63.5			63.5
Level of Service		B	A	A	A	B	A		E			E
Approach Delay (s)			3.7			15.9			63.5			63.5
Approach LOS			A			B			E			E

Intersection Summary			
HCM 2000 Control Delay	12.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	30
Future Volume (vph)	30
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.97
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

HCM 2010 cannot analyze U-Turning movements.



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Future Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.94		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1695		1752
Flt Permitted		0.05	1.00	1.00		0.21	1.00	1.00		0.87		0.73
Satd. Flow (perm)		95	3505	1568		388	3505	1568		1507		1337
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	5	54	1258	16	5	5	1952	237	22	5	22	210
RTOR Reduction (vph)	0	0	0	5	0	0	0	37	0	18	0	0
Lane Group Flow (vph)	0	59	1258	11	0	10	1952	200	0	31	0	210
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Effective Green, g (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Actuated g/C Ratio		0.70	0.70	0.70		0.61	0.61	0.61		0.19		0.19
Clearance Time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		143	2441	1092		236	2132	953		287		255
v/s Ratio Prot		0.02	c0.36				c0.56					
v/s Ratio Perm		0.27		0.01		0.03		0.13		0.02		c0.16
v/c Ratio		0.41	0.52	0.01		0.04	0.92	0.21		0.11		0.82
Uniform Delay, d1		23.4	8.6	5.6		9.4	20.8	10.6		40.1		46.6
Progression Factor		1.00	1.00	1.00		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		1.9	0.8	0.0		0.3	7.6	0.5		0.2		18.9
Delay (s)		25.4	9.4	5.6		9.8	28.4	11.1		40.3		65.5
Level of Service		C	A	A		A	C	B		D		E
Approach Delay (s)			10.1				26.4			40.3		
Approach LOS			B				C			D		

Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	35
Future Volume (vph)	5	35
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.87	
Flt Protected	1.00	
Satd. Flow (prot)	1600	
Flt Permitted	1.00	
Satd. Flow (perm)	1600	
Peak-hour factor, PHF	0.93	0.93
Adj. Flow (vph)	5	38
RTOR Reduction (vph)	31	0
Lane Group Flow (vph)	12	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	22.9	
Effective Green, g (s)	22.9	
Actuated g/C Ratio	0.19	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	305	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.04	
Uniform Delay, d1	39.6	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	39.6	
Level of Service	D	
Approach Delay (s)	61.1	
Approach LOS	E	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	UL	T	T	R	L	T	T	L	T
Maximum Queue (ft)	324	339	280	350	708	693	450	145	247	207	230	273
Average Queue (ft)	184	175	138	177	496	504	129	50	157	111	101	161
95th Queue (ft)	291	324	285	348	688	689	464	104	226	207	195	247
Link Distance (ft)	852	852	852		1567	1567			444	444		411
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)				250			350	250			200	
Storage Blk Time (%)			0	4	30	25		0	0		0	5
Queuing Penalty (veh)			0	34	24	27		0	0		0	6

Intersection: 1: MD 188 & MD 190

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	222	400
Average Queue (ft)	116	177
95th Queue (ft)	216	373
Link Distance (ft)	411	411
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 3: Pyle Road & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB
Directions Served	UL	T	T	R	L	T	T	R	LTR	LTR
Maximum Queue (ft)	72	134	137	25	65	418	434	125	83	87
Average Queue (ft)	19	46	52	3	22	204	217	8	22	29
95th Queue (ft)	52	112	127	15	52	401	416	68	62	69
Link Distance (ft)		642	642			1981	1981		502	399
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	495			245	395			245		
Storage Blk Time (%)						0	7			
Queuing Penalty (veh)						0	2			

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	167	298	286	33	86	423	406	250	65	236	70
Average Queue (ft)	41	94	102	2	10	225	206	55	22	125	21
95th Queue (ft)	102	228	233	16	49	376	366	185	51	204	53
Link Distance (ft)		1981	1981			1275	1275		474	493	493
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)	0	3	2			13	10				
Queuing Penalty (veh)	0	1	0			1	22				

Network Summary

Network wide Queuing Penalty: 118

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Future Volume (vph)	195	1900	135	5	85	1160	65	75	155	115	120	145
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.58	1.00	1.00	0.51	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	1063	3505	1568	945	3505
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)	212	2065	147	5	92	1261	71	82	168	125	130	158
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	115	0	0
Lane Group Flow (vph)	212	2065	147	0	97	1261	71	82	168	10	130	158
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Effective Green, g (s)	27.1	118.0	180.0		15.0	105.9	180.0	23.6	14.0	14.0	24.4	14.4
Actuated g/C Ratio	0.15	0.66	1.00		0.08	0.59	1.00	0.13	0.08	0.08	0.14	0.08
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	263	2297	1568		146	2062	1568	176	272	121	172	280
v/s Ratio Prot	c0.12	c0.59			0.06	0.36		0.02	0.05		c0.04	0.05
v/s Ratio Perm			c0.09				0.05	0.04		0.01	c0.06	
v/c Ratio	0.81	0.90	0.09		0.66	0.61	0.05	0.47	0.62	0.08	0.76	0.56
Uniform Delay, d1	73.9	26.0	0.0		80.1	23.8	0.0	71.3	80.4	77.0	73.4	79.8
Progression Factor	1.00	1.00	1.00		0.87	1.06	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.3	6.1	0.1		9.8	1.2	0.0	1.9	4.1	0.3	17.1	2.6
Delay (s)	90.2	32.1	0.1		79.3	26.5	0.0	73.2	84.5	77.3	90.5	82.4
Level of Service	F	C	A		E	C	A	E	F	E	F	F
Approach Delay (s)		35.3				28.7			79.7			82.3
Approach LOS		D				C			E			F

Intersection Summary			
HCM 2000 Control Delay	41.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	90.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	210
Future Volume (vph)	210
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.92
Adj. Flow (vph)	228
RTOR Reduction (vph)	210
Lane Group Flow (vph)	18
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.4
Effective Green, g (s)	14.4
Actuated g/C Ratio	0.08
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	125
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.15
Uniform Delay, d1	77.1
Progression Factor	1.00
Incremental Delay, d2	0.5
Delay (s)	77.6
Level of Service	E
Approach Delay (s)	
Approach LOS	

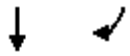
Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Future Volume (vph)	5	50	1925	25	5	5	1130	175	30	30	35	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.95		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1725		1752
Flt Permitted		0.17	1.00	1.00		0.06	1.00	1.00		0.88		0.60
Satd. Flow (perm)		318	3505	1568		105	3505	1568		1541		1104
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	6	56	2139	28	6	6	1256	194	33	33	39	322
RTOR Reduction (vph)	0	0	0	5	0	0	0	39	0	12	0	0
Lane Group Flow (vph)	0	62	2139	23	0	12	1256	155	0	93	0	322
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Effective Green, g (s)		140.0	140.0	140.0		127.1	127.1	127.1		26.5		26.5
Actuated g/C Ratio		0.78	0.78	0.78		0.71	0.71	0.71		0.15		0.15
Clearance Time (s)		6.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		302	2726	1219		74	2474	1107		226		162
v/s Ratio Prot		0.01	c0.61				0.36					
v/s Ratio Perm		0.15		0.01		0.11		0.10		0.06		c0.29
v/c Ratio		0.21	0.78	0.02		0.16	0.51	0.14		0.41		1.99
Uniform Delay, d1		7.5	11.4	4.5		8.8	12.1	8.6		69.7		76.8
Progression Factor		0.11	0.12	0.00		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		0.2	1.5	0.0		4.7	0.7	0.3		1.2		465.8
Delay (s)		1.1	2.9	0.0		13.4	12.9	8.9		70.9		542.5
Level of Service		A	A	A		B	B	A		E		F
Approach Delay (s)			2.8				12.3			70.9		
Approach LOS			A				B			E		

Intersection Summary			
HCM 2000 Control Delay	50.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

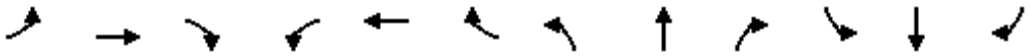
c Critical Lane Group



Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	50
Future Volume (vph)	5	50
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.86	
Flt Protected	1.00	
Satd. Flow (prot)	1595	
Flt Permitted	1.00	
Satd. Flow (perm)	1595	
Peak-hour factor, PHF	0.90	0.90
Adj. Flow (vph)	6	56
RTOR Reduction (vph)	48	0
Lane Group Flow (vph)	14	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	26.5	
Effective Green, g (s)	26.5	
Actuated g/C Ratio	0.15	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	234	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.06	
Uniform Delay, d1	66.0	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	66.2	
Level of Service	E	
Approach Delay (s)	465.6	
Approach LOS	F	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

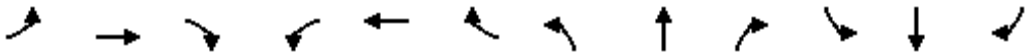


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	1970	35	0	0	0	0	15	25	10	15	0
Future Volume (vph)	135	1970	35	0	0	0	0	15	25	10	15	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0					6.0		6.0	6.0	
Lane Util. Factor	1.00	0.95	1.00					1.00		1.00	1.00	
Frt	1.00	1.00	0.85					0.92		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1752	3505	1568					1688		1752	1845	
Flt Permitted	0.95	1.00	1.00					1.00		0.73	1.00	
Satd. Flow (perm)	1752	3505	1568					1688		1345	1845	
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)	147	2141	38	0	0	0	0	16	27	11	16	0
RTOR Reduction (vph)	0	0	9	0	0	0	0	14	0	0	0	0
Lane Group Flow (vph)	147	2141	29	0	0	0	0	29	0	11	16	0
Turn Type	Perm	NA	Perm					NA		Perm	NA	
Protected Phases		1 2						5 6			5 6	
Permitted Phases	1 2		1 2							5 6		
Actuated Green, G (s)	137.2	137.2	137.2					30.8		30.8	30.8	
Effective Green, g (s)	137.2	137.2	137.2					30.8		30.8	30.8	
Actuated g/C Ratio	0.76	0.76	0.76					0.17		0.17	0.17	
Clearance Time (s)												
Vehicle Extension (s)												
Lane Grp Cap (vph)	1335	2671	1195					288		230	315	
v/s Ratio Prot		c0.61						c0.02			0.01	
v/s Ratio Perm	0.08		0.02							0.01		
v/c Ratio	0.11	0.80	0.02					0.10		0.05	0.05	
Uniform Delay, d1	5.6	13.1	5.2					62.9		62.3	62.4	
Progression Factor	1.11	0.68	2.54					1.00		1.00	0.99	
Incremental Delay, d2	0.0	0.9	0.0					0.2		0.1	0.1	
Delay (s)	6.2	9.8	13.2					63.1		62.7	61.7	
Level of Service	A	A	B					E		E	E	
Approach Delay (s)		9.6			0.0			63.1			62.1	
Approach LOS		A			A			E			E	

Intersection Summary			
HCM 2000 Control Delay	11.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	113.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	20	1170	25	15	135	0	0	5	130
Future Volume (vph)	0	0	0	20	1170	25	15	135	0	0	5	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor				1.00	0.95	1.00	1.00	1.00			1.00	
Frt				1.00	1.00	0.85	1.00	1.00			0.87	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	3505	1568	1752	1845			1604	
Flt Permitted				0.95	1.00	1.00	0.53	1.00			1.00	
Satd. Flow (perm)				1752	3505	1568	980	1845			1604	
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	0	0	22	1272	27	16	147	0	0	5	141
RTOR Reduction (vph)	0	0	0	0	0	7	0	0	0	0	81	0
Lane Group Flow (vph)	0	0	0	22	1272	20	16	147	0	0	65	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					2 5			1 6			1 6	
Permitted Phases				2 5		2 5	1 6					
Actuated Green, G (s)				133.7	133.7	133.7	34.3	34.3			34.3	
Effective Green, g (s)				133.7	133.7	133.7	34.3	34.3			34.3	
Actuated g/C Ratio				0.74	0.74	0.74	0.19	0.19			0.19	
Clearance Time (s)												
Vehicle Extension (s)												
Lane Grp Cap (vph)				1301	2603	1164	186	351			305	
v/s Ratio Prot					c0.36			c0.08			0.04	
v/s Ratio Perm				0.01		0.01	0.02					
v/c Ratio				0.02	0.49	0.02	0.09	0.42			0.21	
Uniform Delay, d1				6.0	9.3	6.0	60.0	64.1			61.5	
Progression Factor				0.98	0.85	0.00	0.81	0.81			1.00	
Incremental Delay, d2				0.0	0.1	0.0	0.2	0.8			0.4	
Delay (s)				5.9	8.1	0.0	48.9	52.5			61.8	
Level of Service				A	A	A	D	D			E	
Approach Delay (s)		0.0			7.9			52.1			61.8	
Approach LOS		A			A			D			E	

Intersection Summary			
HCM 2000 Control Delay	17.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	113.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	UL	T	T	R	L	T	T	R
Maximum Queue (ft)	541	817	775	350	323	491	481	180	184	235	184	119
Average Queue (ft)	191	460	413	65	109	265	272	9	70	112	59	6
95th Queue (ft)	360	782	721	289	232	437	439	113	141	194	151	60
Link Distance (ft)	852	852	852			1498	1498			444	444	444
Upstream Blk Time (%)	0	1	0									
Queuing Penalty (veh)	0	0	0									
Storage Bay Dist (ft)				300	250			350	250			
Storage Blk Time (%)			13	0	0	15	5		0	0		
Queuing Penalty (veh)			18	0	0	13	3		0	0		

Intersection: 1: MD 188 & MD 190

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	224	243	176	119
Average Queue (ft)	113	103	48	9
95th Queue (ft)	196	187	129	74
Link Distance (ft)		411	411	411
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	200			
Storage Blk Time (%)	1	1		
Queuing Penalty (veh)	1	1		

Intersection: 2: EB MD 190 & MD 190/WB MD 190

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	72	129	134	16	46	277	272	184	164	538	505
Average Queue (ft)	28	20	28	1	7	120	99	28	82	508	197
95th Queue (ft)	62	74	85	8	29	260	234	110	146	527	555
Link Distance (ft)		952	952			1275	1275		475	493	493
Upstream Blk Time (%)										97	12
Queuing Penalty (veh)										0	0
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)		0				5	3				
Queuing Penalty (veh)		0				0	4				

Intersection: 5: EB MD 190/MD 190 & WB MD 190

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 30: Pyle Road & EB MD 190

Movement	EB	EB	EB	EB	NB	SB	SB
Directions Served	L	T	T	R	TR	L	T
Maximum Queue (ft)	197	508	511	111	125	48	52
Average Queue (ft)	64	264	281	9	30	9	15
95th Queue (ft)	151	449	465	68	84	32	46
Link Distance (ft)		714	714		331		88
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	495			245		25	
Storage Blk Time (%)		0	12			15	17
Queuing Penalty (veh)		1	4			2	2

Intersection: 31: Pyle Road & WB MD 190

Movement	WB	WB	WB	WB	NB	NB	SB
Directions Served	L	T	T	R	L	T	TR
Maximum Queue (ft)	49	270	271	34	49	99	156
Average Queue (ft)	6	101	110	4	8	76	53
95th Queue (ft)	27	224	240	19	34	116	110
Link Distance (ft)		1010	1010			88	272
Upstream Blk Time (%)						20	
Queuing Penalty (veh)						31	
Storage Bay Dist (ft)	395			245	25		
Storage Blk Time (%)			0		7	53	
Queuing Penalty (veh)			0		10	8	

Network Summary

Network wide Queuing Penalty: 98

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Future Volume (vph)	195	1085	55	5	75	1660	110	55	220	75	105	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	7.0	4.0		5.0	7.0	4.0	5.0	6.0	6.0	5.0	6.0
Lane Util. Factor	1.00	0.95	1.00		1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1752	3505	1568		1752	3505	1568	1752	3505	1568	1752	3505
Flt Permitted	0.95	1.00	1.00		0.95	1.00	1.00	0.53	1.00	1.00	0.39	1.00
Satd. Flow (perm)	1752	3505	1568		1752	3505	1568	983	3505	1568	710	3505
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	201	1119	57	5	77	1711	113	57	227	77	108	216
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	69	0	0
Lane Group Flow (vph)	201	1119	57	0	82	1711	113	57	227	8	108	216
Turn Type	Prot	NA	Free	Prot	Prot	NA	Free	pm+pt	NA	Perm	pm+pt	NA
Protected Phases	1	6		5	5	2		3	8		7	4
Permitted Phases			Free				Free	8		8	4	
Actuated Green, G (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Effective Green, g (s)	25.0	118.0	180.0		10.4	103.4	180.0	26.4	18.6	18.6	30.8	20.8
Actuated g/C Ratio	0.14	0.66	1.00		0.06	0.57	1.00	0.15	0.10	0.10	0.17	0.12
Clearance Time (s)	5.0	7.0			5.0	7.0		5.0	6.0	6.0	5.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	243	2297	1568		101	2013	1568	177	362	162	179	405
v/s Ratio Prot	c0.11	0.32			0.05	c0.49		0.01	0.06		c0.03	0.06
v/s Ratio Perm			0.04				c0.07	0.03		0.01	0.07	
v/c Ratio	0.83	0.49	0.04		0.81	0.85	0.07	0.32	0.63	0.05	0.60	0.53
Uniform Delay, d1	75.4	15.7	0.0		83.8	31.8	0.0	67.8	77.4	72.7	66.1	75.0
Progression Factor	1.00	1.00	1.00		0.93	0.83	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.1	0.7	0.0		30.6	3.7	0.1	1.1	3.4	0.1	5.6	1.4
Delay (s)	95.5	16.4	0.0		108.8	30.2	0.1	68.8	80.8	72.9	71.7	76.4
Level of Service	F	B	A		F	C	A	E	F	E	E	E
Approach Delay (s)		27.3				31.8			77.2			81.1
Approach LOS		C				C			E			F

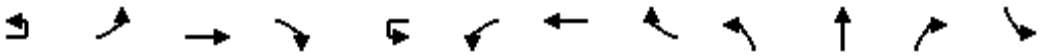
Intersection Summary			
HCM 2000 Control Delay	41.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	6.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1568
Flt Permitted	1.00
Satd. Flow (perm)	1568
Peak-hour factor, PHF	0.97
Adj. Flow (vph)	356
RTOR Reduction (vph)	232
Lane Group Flow (vph)	124
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	20.8
Effective Green, g (s)	20.8
Actuated g/C Ratio	0.12
Clearance Time (s)	6.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	181
v/s Ratio Prot	
v/s Ratio Perm	c0.08
v/c Ratio	0.69
Uniform Delay, d1	76.5
Progression Factor	1.00
Incremental Delay, d2	10.3
Delay (s)	86.8
Level of Service	F
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Future Volume (vph)	5	50	1170	15	5	5	1815	220	20	5	20	195
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Lane Util. Factor		1.00	0.95	1.00		1.00	0.95	1.00		1.00		1.00
Frt		1.00	1.00	0.85		1.00	1.00	0.85		0.94		1.00
Flt Protected		0.95	1.00	1.00		0.95	1.00	1.00		0.98		0.95
Satd. Flow (prot)		1752	3505	1568		1752	3505	1568		1695		1752
Flt Permitted		0.05	1.00	1.00		0.21	1.00	1.00		0.87		0.73
Satd. Flow (perm)		95	3505	1568		388	3505	1568		1507		1337
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	5	54	1258	16	5	5	1952	237	22	5	22	210
RTOR Reduction (vph)	0	0	0	5	0	0	0	37	0	18	0	0
Lane Group Flow (vph)	0	59	1258	11	0	10	1952	200	0	31	0	210
Turn Type	pm+pt	pm+pt	NA	Perm	Perm	Perm	NA	Perm	Perm	NA		Perm
Protected Phases	1	1	6				2			8		
Permitted Phases	6	6		6	2	2		2	8			4
Actuated Green, G (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Effective Green, g (s)		83.6	83.6	83.6		73.0	73.0	73.0		22.9		22.9
Actuated g/C Ratio		0.70	0.70	0.70		0.61	0.61	0.61		0.19		0.19
Clearance Time (s)		5.0	7.0	7.0		7.0	7.0	7.0		6.5		6.5
Vehicle Extension (s)		3.0	3.0	3.0		3.0	3.0	3.0		3.0		3.0
Lane Grp Cap (vph)		143	2441	1092		236	2132	953		287		255
v/s Ratio Prot		0.02	c0.36				c0.56					
v/s Ratio Perm		0.27		0.01		0.03		0.13		0.02		c0.16
v/c Ratio		0.41	0.52	0.01		0.04	0.92	0.21		0.11		0.82
Uniform Delay, d1		23.4	8.6	5.6		9.4	20.8	10.6		40.1		46.6
Progression Factor		1.00	1.00	1.00		1.00	1.00	1.00		1.00		1.00
Incremental Delay, d2		1.9	0.8	0.0		0.3	7.6	0.5		0.2		18.9
Delay (s)		25.4	9.4	5.6		9.8	28.4	11.1		40.3		65.5
Level of Service		C	A	A		A	C	B		D		E
Approach Delay (s)			10.1				26.4			40.3		
Approach LOS			B				C			D		

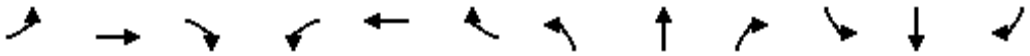
Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	5	35
Future Volume (vph)	5	35
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.87	
Flt Protected	1.00	
Satd. Flow (prot)	1600	
Flt Permitted	1.00	
Satd. Flow (perm)	1600	
Peak-hour factor, PHF	0.93	0.93
Adj. Flow (vph)	5	38
RTOR Reduction (vph)	31	0
Lane Group Flow (vph)	12	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	22.9	
Effective Green, g (s)	22.9	
Actuated g/C Ratio	0.19	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	305	
v/s Ratio Prot	0.01	
v/s Ratio Perm		
v/c Ratio	0.04	
Uniform Delay, d1	39.6	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	39.6	
Level of Service	D	
Approach Delay (s)	61.1	
Approach LOS	E	

Intersection Summary

HCM 2010 cannot analyze U-Turning movements.

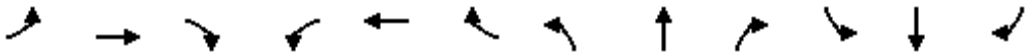


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	1205	35	0	0	0	0	10	30	5	45	0
Future Volume (vph)	30	1205	35	0	0	0	0	10	30	5	45	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0					6.0		6.0	6.0	
Lane Util. Factor	1.00	0.95	1.00					1.00		1.00	1.00	
Frt	1.00	1.00	0.85					0.90		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1752	3505	1568					1656		1752	1845	
Flt Permitted	0.95	1.00	1.00					1.00		0.73	1.00	
Satd. Flow (perm)	1752	3505	1568					1656		1347	1845	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	31	1242	36	0	0	0	0	10	31	5	46	0
RTOR Reduction (vph)	0	0	7	0	0	0	0	27	0	0	0	0
Lane Group Flow (vph)	31	1242	29	0	0	0	0	14	0	5	46	0
Turn Type	Perm	NA	Perm					NA		Perm	NA	
Protected Phases		1 2						5 6			5 6	
Permitted Phases	1 2		1 2							5 6		
Actuated Green, G (s)	144.3	144.3	144.3					23.7		23.7	23.7	
Effective Green, g (s)	144.3	144.3	144.3					23.7		23.7	23.7	
Actuated g/C Ratio	0.80	0.80	0.80					0.13		0.13	0.13	
Clearance Time (s)												
Vehicle Extension (s)												
Lane Grp Cap (vph)	1404	2809	1257					218		177	242	
v/s Ratio Prot		c0.35						0.01			c0.02	
v/s Ratio Perm	0.02		0.02							0.00		
v/c Ratio	0.02	0.44	0.02					0.06		0.03	0.19	
Uniform Delay, d1	3.6	5.5	3.6					68.4		68.1	69.6	
Progression Factor	0.52	0.41	0.07					1.00		1.05	1.02	
Incremental Delay, d2	0.0	0.1	0.0					0.1		0.1	0.4	
Delay (s)	1.9	2.4	0.3					68.6		71.3	71.7	
Level of Service	A	A	A					E		E	E	
Approach Delay (s)		2.3			0.0			68.6			71.7	
Approach LOS		A			A			E			E	

Intersection Summary			
HCM 2000 Control Delay	6.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	40	1810	25	10	30	0	0	10	30
Future Volume (vph)	0	0	0	40	1810	25	10	30	0	0	10	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor				1.00	0.95	1.00	1.00	1.00			1.00	
Frt				1.00	1.00	0.85	1.00	1.00			0.90	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1752	3505	1568	1752	1845			1656	
Flt Permitted				0.95	1.00	1.00	0.73	1.00			1.00	
Satd. Flow (perm)				1752	3505	1568	1347	1845			1656	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	0	0	0	41	1866	26	10	31	0	0	10	31
RTOR Reduction (vph)	0	0	0	0	0	5	0	0	0	0	27	0
Lane Group Flow (vph)	0	0	0	41	1866	21	10	31	0	0	14	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					2 5			1 6			1 6	
Permitted Phases				2 5		2 5	1 6					
Actuated Green, G (s)				148.7	148.7	148.7	19.3	19.3			19.3	
Effective Green, g (s)				148.7	148.7	148.7	19.3	19.3			19.3	
Actuated g/C Ratio				0.83	0.83	0.83	0.11	0.11			0.11	
Clearance Time (s)												
Vehicle Extension (s)												
Lane Grp Cap (vph)				1447	2895	1295	144	197			177	
v/s Ratio Prot					c0.53			c0.02			0.01	
v/s Ratio Perm				0.02		0.01	0.01					
v/c Ratio				0.03	0.64	0.02	0.07	0.16			0.08	
Uniform Delay, d1				2.8	5.8	2.8	72.3	73.0			72.4	
Progression Factor				1.00	1.00	1.00	1.11	1.10			1.00	
Incremental Delay, d2				0.0	0.5	0.0	0.2	0.4			0.2	
Delay (s)				2.8	6.3	2.8	80.8	80.6			72.6	
Level of Service				A	A	A	F	F			E	
Approach Delay (s)		0.0			6.2			80.6			72.6	
Approach LOS		A			A			F			E	

Intersection Summary			
HCM 2000 Control Delay	9.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

Intersection: 1: MD 188 & MD 190

Movement	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	UL	T	T	R	L	T	T	L	T
Maximum Queue (ft)	355	358	325	349	777	774	450	166	230	202	247	287
Average Queue (ft)	192	175	144	156	490	492	99	50	146	109	107	152
95th Queue (ft)	313	325	296	335	733	747	406	112	214	197	206	245
Link Distance (ft)	852	852	852		1544	1544			444	444		411
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)				250			350	250			200	
Storage Blk Time (%)			0	0	26	19			0		1	4
Queuing Penalty (veh)			0	0	21	21			0		1	5

Intersection: 1: MD 188 & MD 190

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	228	336
Average Queue (ft)	102	143
95th Queue (ft)	211	326
Link Distance (ft)	411	411
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 2: EB MD 190 & MD 190/WB MD 190

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: Winston Dr/Whittier Blvd & MD 190

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB	SB
Directions Served	UL	T	T	R	UL	T	T	R	LTR	L	TR
Maximum Queue (ft)	201	278	293	30	161	538	535	250	64	279	61
Average Queue (ft)	44	108	122	4	13	275	260	71	24	141	18
95th Queue (ft)	110	248	262	19	80	476	465	217	54	247	46
Link Distance (ft)		963	963			1275	1275		472	492	492
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	150			200	150			150			
Storage Blk Time (%)	0	4	3			15	13				
Queuing Penalty (veh)	0	2	0			1	28				

Intersection: 5: EB MD 190/MD 190 & WB MD 190

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 30: Pyle Road & EB MD 190

Movement	EB	EB	EB	EB	NB	SB	SB
Directions Served	L	T	T	R	TR	L	T
Maximum Queue (ft)	36	113	119	29	82	49	109
Average Queue (ft)	4	37	40	2	22	3	41
95th Queue (ft)	19	99	103	14	56	20	86
Link Distance (ft)		708	708		507		105
Upstream Blk Time (%)							1
Queuing Penalty (veh)							1
Storage Bay Dist (ft)	495			245		25	
Storage Blk Time (%)						6	45
Queuing Penalty (veh)						3	2

Intersection: 31: Pyle Road & WB MD 190

Movement	WB	WB	WB	WB	NB	NB	SB
Directions Served	L	T	T	R	L	T	TR
Maximum Queue (ft)	36	415	424	100	49	97	103
Average Queue (ft)	5	84	90	5	11	34	32
95th Queue (ft)	22	257	272	62	37	81	79
Link Distance (ft)		985	985			105	449
Upstream Blk Time (%)						0	
Queuing Penalty (veh)						0	
Storage Bay Dist (ft)	395			245	25		
Storage Blk Time (%)		0	1		17	31	
Queuing Penalty (veh)		0	0		5	3	

Network Summary

Network wide Queuing Penalty: 94