

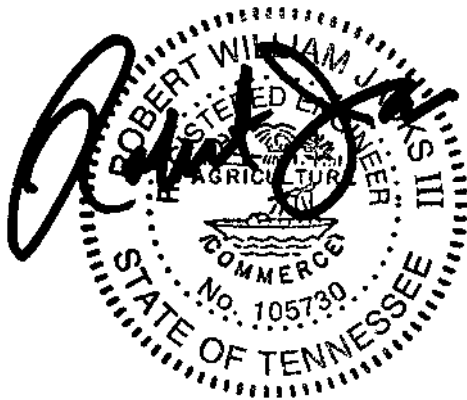


Transportation Impact Study Brakebill Road Subdivision Knox County, Tennessee



Revised August 2020

Prepared for:
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8/24/2020

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EXECUTIVE SUMMARY

Preface:

Maverick Development Group, LLC is proposing to construct a residential development adjacent to Brakebill Road and Hammer Road in East Knox County, TN. In this report, the name of this proposed residential development is referred to as “Brakebill Road Subdivision,” and this development will consist of 227 single-family detached houses and 95 single-family attached houses on 100.6± acres. This development is anticipated to be fully built-out and occupied by the year 2025. The primary purpose of this study is to determine and evaluate the potential impacts of the Brakebill Road Subdivision on the adjacent transportation system. The study includes a review of the primary access roads and the major surrounding intersections and is a Level 2 study as set forth by the Knoxville-Knox County Planning. Recommendations and mitigation measures will be offered where traffic operations have been projected to be below traffic engineering standards.

Study Results:

The findings of this study include the following:

- At full build-out and occupancy, the Brakebill Road Subdivision with 227 single-family detached houses and 95 single-family attached houses is expected to generate approximately 3,123 trips on an average weekday. Of these trips, 217 of these trips are estimated to occur during the AM peak hour and 298 trips in the PM peak hour at full build-out and occupancy in the year 2025.
- A total of three new unsignalized intersections will be created externally on existing roads by this new development. These intersections are projected to operate with minimal delays. Of the four existing intersections examined in the study, all of them are expected to need modifications to meet the projected traffic volumes in the year 2025.
- Based on the review of the vehicle crash history and the study observations on Brakebill Road, it was determined that the narrowness of Brakebill Road could be a contributing factor to vehicle crashes, and these crashes could be reduced with remediation strategies.

Recommendations:

An overview of the recommendations for the external roadways and intersections is provided in Figure 10 at the end of the report. A discussion of these recommendations is offered in the following based on the study analyses. The recommendations marked with an asterisk indicate an existing need and are not associated with the projected transportation impacts of the proposed subdivision.

- Minor traffic signal timing changes might be required in the projected conditions at the existing signalized intersection of Asheville Highway (US 25W/Hwy 11E) at Brakebill Road to optimize traffic flows and reduce vehicle queues.
- * • A 24" white stop bar needs to be installed on the eastbound approach of Hammer Road at Brakebill Road to improve visibility of the stop condition.
- The new Hammer Road at Road "B" intersection will require a white stop bar and Stop Sign (R1-1) on the Road "B" approach. Required sight distance at this proposed intersection needs to be verified by a licensed land surveyor and designed accordingly in the design plans. Larger curb radii should be considered to facilitate right-turns due to the narrowness of Hammer Road.
- The new Brakebill Road at Clubhouse Driveway intersection will require a 24" white stop bar and Stop Sign (R1-1) on the Clubhouse Driveway approach. Required sight distance at this proposed intersection needs to be verified by a licensed land surveyor and designed accordingly in the design plans. Larger curb radii should be considered to facilitate right-turns due to the narrowness of Brakebill Road.
- The new Brakebill Road at Road "A" intersection will require a separate northbound left-turn lane on Brakebill Road with a storage length of 75 feet. This lane should be constructed before the residential subdivision is opened to residents. The new intersection will require a 24" white stop bar and Stop Sign (R1-1) on the Road "A" approach. Required sight distance at this proposed intersection needs to be verified by a licensed land surveyor and designed accordingly in the design plans. Larger curb radii should be considered to facilitate right-turns due to the narrowness of Brakebill Road.
- Based on the projected traffic volumes in 2025, the existing turn lanes at the Strawberry Plains Pike and Interstate 40 On/Off-Ramps (north side) intersection will need to be modified. The projected results in the study show that an additional northbound left-turn lane will be required due to this traffic movement exceeding 300 vehicles per hour in the PM peak hour. Adding a second

northbound left-turn lane will require constructing a second lane on the westbound Interstate 40 On-Ramp and merging these lanes either before the entrance to westbound Interstate 40 or further downstream. The existing northbound left-turn lane has approximately 190 feet of storage. Based on the projected volumes, the second left-turn lane should also be constructed with 190 feet of storage. The projected 2025 volumes and calculations also indicate that the existing westbound Interstate 40 Off-Ramp double left-turn lanes will need to be lengthened by 25 feet to a total of 225 feet. Both modifications at this intersection are projected to be required due to overall traffic growth in the area and not directly due to the proposed residential subdivision.

- * • The existing Strawberry Plains Pike at Brakebill Road intersection currently meets warrants for traffic signalization based on the existing traffic counts and during an analysis by the Tennessee Department of Transportation in 2010. This intersection is presently operating with a reduced level of service and has high vehicle delays for eastbound left-turns. It is recommended that this intersection have a traffic signal installed and coordinated with the existing traffic signal to the south at the Strawberry Plains Pike and Interstate 40 On/Off-Ramps (north side) intersection. Based on the projected volumes in 2025 and a preliminary traffic signal design, the existing northbound left-turn lane at the Strawberry Plains Pike at Brakebill Road will need to be increased by 50 feet in length to a minimum of 200 feet. This traffic signal should be constructed before the residential subdivision is opened to residents. As part of this work, some items such as pavement markings, vegetation removal, and retroreflective bi-directional raised pavement markings need to be refreshed and re-installed as first identified in the TDOT Road Safety Audit Review (RSAR).
- * • Based on the narrowness of Brakebill Road and the recent past crash history, it is recommended that remediation strategies be employed to attempt to reduce future vehicle crashes. While this road was evaluated and deemed not to meet the benchmark for TDOT safety funding, Brakebill Road crash history indicates that a substantial amount of crashes involved opposite direction sideswipe and road departure crashes. The recommended strategies include identifying and removing/re-locating roadside hazards, installing advance warning signage on two existing horizontal curves, replacing and correcting existing warning road signage, replacing pavement markings, and installing rumble strips on the centerline and the edge line of Brakebill Road. Eventually, Brakebill Road will

need to be widened and upgraded since it is a major collector and is an important link between Asheville Highway (US 25W/Hwy 11E) and Strawberry Plains Pike at Interstate 40. The current pavement width of Brakebill Road adjacent to the development site is approximately 18.5 feet, and it would be beneficial to widen and upgrade the road to facilitate travel in between Strawberry Plains Pike and Asheville Highway (US 25W/Hwy 11E).

- * • Pavement markings on Brakebill Road, especially within the Knoxville City limits, is recommended to be reapplied.
- It is recommended that 25-mph speed limit signs be posted on Road “A” and Road “B” for vehicles traveling into the new residential subdivision.
- Stop Signs (R1-1) and 24” white stop bars should be installed internally on the new streets, as shown in the report.
- Sight distance at the new intersections in the Brakebill Road Subdivision must not be impacted by new signage or future landscaping. For a posted speed limit of 25-mph, the intersection sight distance requirement is 250 feet. The stopping sight distance required is 155 feet for a level road grade. The road layout designer should ensure that these sight distance lengths are met, and they should be labeled on the plans.
- All drainage grates and covers for the residential development need to be pedestrian and bicycle safe.
- The internal sidewalks that are proposed for the development should have appropriate ADA compliant curbed ramps at intersection corners, and the sidewalks are recommended to be 5 feet minimum in width.
- The United States Postal Service (USPS) has recently implemented changes to its guidelines for delivery in new residential subdivisions. If directed by the local post office, the designer should include an area within the development with a parking area for a centralized mail delivery center.
- Traffic calming measures might be needed for this development. Sections of the horizontal alignment for proposed Road “A”, “C”, and “D” within the development have long and straight road segments. The possible need for traffic calming measures inside the development will need to be coordinated with Knox County Engineering and Public Works during the detailed design phase.
- All road grade and intersection elements internally and externally should be designed to AASHTO, TDOT, and Knox County specifications and guidelines to ensure proper operation.

DESCRIPTION OF EXISTING CONDITIONS

■ STUDY AREA:

The proposed location of this new development is shown on a map in Figure 1. The proposed development is to be located adjacent to Brakebill Road and Hammer Road in East Knox County, TN. The development site is located to the south of Asheville Highway (US 25W/Hwy 11E), west of Strawberry Plains Pike, and north of Interstate 40. The proposed development is to be comprised of six internal paved roads and will contain 227 single-family detached houses and 95 single-family attached houses encompassing approximately 100.6 acres. Transportation impacts associated with the proposed development were analyzed at the following existing roadways and intersections, where the most significant impact is expected and as requested by Knoxville-Knox County Planning:

- o Asheville Highway (US 25W/Hwy 11E) at Brakebill Road
- o Hammer Road at Brakebill Road
- o Strawberry Plains Pike at Brakebill Road
- o Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side)

In addition to these existing intersections, the study also includes the review of three new proposed intersections that will be constructed by the development. The subdivision will have two entrances, one will be located on Hammer Road on the north side, and one will be located on Brakebill Road on the east side of the development. The other proposed intersection will be for a subdivision clubhouse driveway on Brakebill Road.

The proposed development property is located within Knox County. However, all the existing study intersections, except for the Hammer Road at Brakebill Road intersection, are located within the City of Knoxville limits. Near this development, there are several residential areas, unused/woodland properties, farm properties, commercial developments, and a temple. The proposed development site property currently consists almost entirely of undeveloped woodlands.

The development property is bounded by Hammer Road to the north, Brakebill Road to the east, undeveloped property and a handful of individual residences to the west, and undeveloped property to the south.

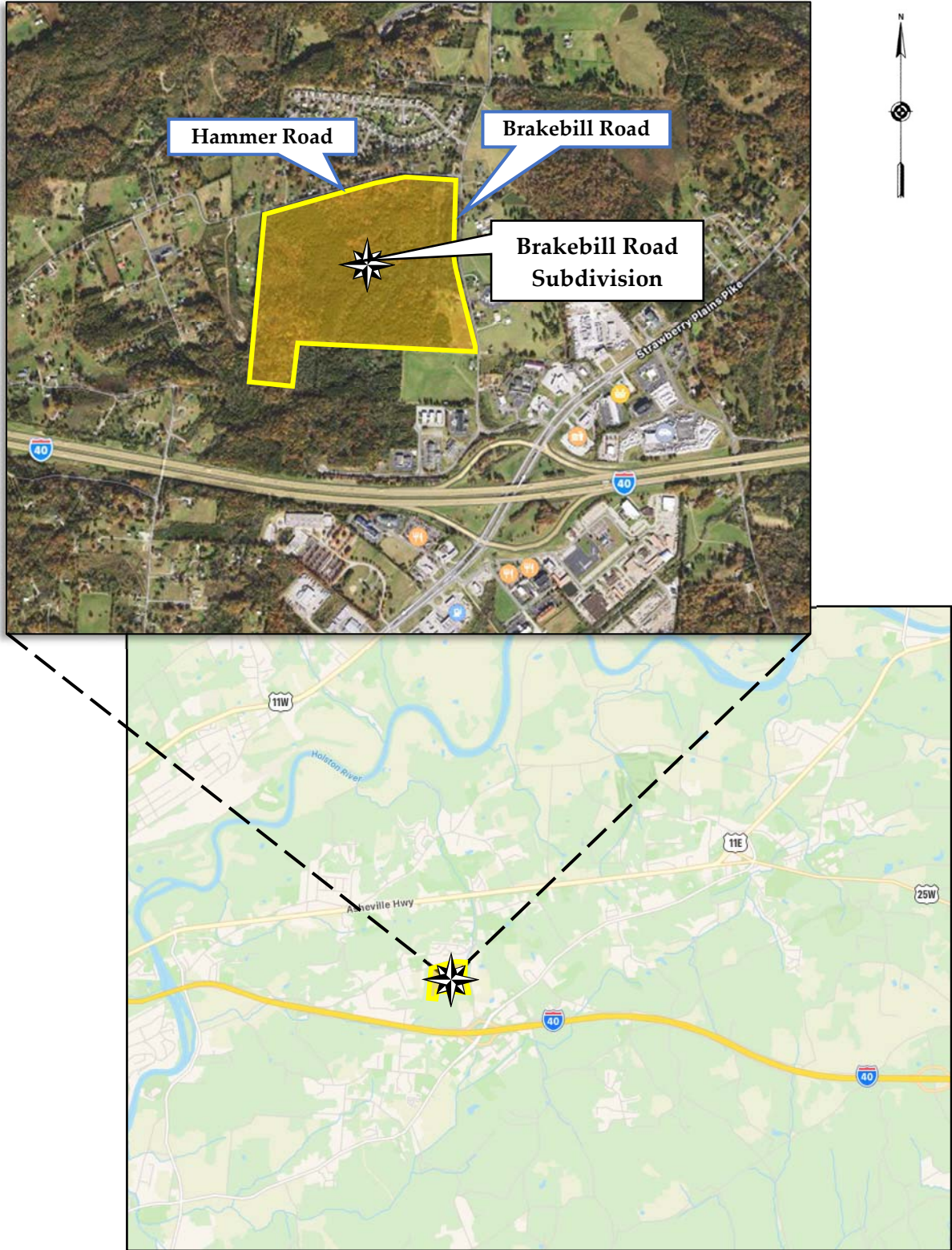


Figure 1
Location Map

■ **EXISTING ROADWAYS:**

Table 1 lists the characteristics of the key existing roadways adjacent to the development property and included in the study:

**TABLE 1
STUDY CORRIDOR CHARACTERISTICS**

NAME	CLASSIFICATION ¹	SPEED LIMIT	LANES	ROAD WIDTH ²	TRANSIT ³	PEDESTRIAN FACILITIES	BICYCLE FACILITIES
Asheville Highway (US 25W / Hwy 11E)	Major Arterial	55 mph	4 divided	100 feet	None	No sidewalks along roadway	No bike lanes
Brakebill Road	Major Collector	30 mph	2 undivided	18.5 feet	None	No sidewalks along roadway	No bike lanes
Hammer Road	Minor Collector	30 mph	2 undivided	16.5 feet	None	No sidewalks along roadway	No bike lanes
Strawberry Plains Pike	Minor Arterial	40 mph	4 divided	120 feet	None	No sidewalks along roadway	No bike lanes

¹ 2018 Major Road Plan by Knoxville/Knox County Planning

² Edge of curb to edge of curb or edge of pavements near project site

³ According to Knoxville Area Transit System Map

Asheville Highway (US 25W / Hwy 11E)

is a major arterial that traverses in a general northeast-southwest direction. According to Wikipedia, US 25W is 145.7 miles in length and runs in between Newport, Tennessee, and Corbin, Kentucky. Highway 11E is 120.9 miles in length and runs in between Knoxville, TN, and Bristol, Virginia. Closer to the study area, Asheville Highway provides convenient access to Knoxville to the southwest, Jefferson City to the northeast (via Hwy 11E), and Dandridge to the east (via US 25W). The posted speed limit on Asheville Highway is 55 mph.



**Brakebill Road at
Asheville Highway (US 25W / Hwy 11E)
(Looking South from Neals Landing Road)**

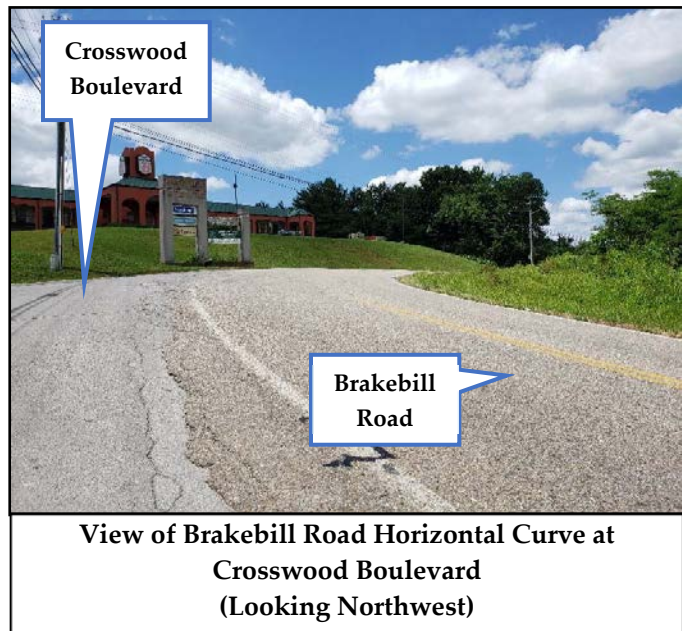
At the intersection of Brakebill Road, Asheville Highway is a divided highway with a grass median. A traffic signal controls the traffic movements at the 4-way intersection of Brakebill Road at Asheville Highway, and the signal heads are supported on span wires. There are utility street lights at the intersection of Asheville Highway (US 25W/Hwy 11E) at Brakebill Road. The road opposite of Brakebill Road at the signalized intersection is named Neals Landing Boulevard and is the entrance to the Neals Landing Subdivision.

Brakebill Road will provide immediate access to the proposed Brakebill Road Subdivision property and traverses in a north-south direction. Brakebill Road is 1.3 miles in length and traverses in between Asheville Highway (US 25W/Hwy 11E) to the north and Strawberry Plains Pike to the south. Commercial development is located on each end of Brakebill Road with residential, farm properties, a temple, and undeveloped land in between.

Brakebill Road has a relatively straight horizontal alignment for much of its length but does have some significant horizontal curvature. On the southern end of Brakebill Road, at the intersection with Crosswood Boulevard (before the terminus at Strawberry Plains Pike), there is a very sharp horizontal road curve with a significant vertical change in grade. The cross slope at this horizontal curve is over 10%, with a vertical grade of nearly 8%.

While Brakebill Road is classified as a major collector, the pavement is relatively narrow. Evidence of wheel tracking off the pavement is present along Brakebill Road. Brakebill Road intersects Strawberry Plains Pike at a divided highway section with a grass median. At this intersection, the minor roadway, Brakebill Road, is controlled by a Stop Sign (R1-1) for eastbound traffic while Strawberry Plains Pike northbound and southbound traffic operates freely.

Hammer Road traverses in a general northeast-southwest direction between Brakebill Road on the east side and transitions to Manis Road on the west side (near Interstate 40). Hammer Road is classified as a minor collector in the study area. Hammer Road was once a continuous road

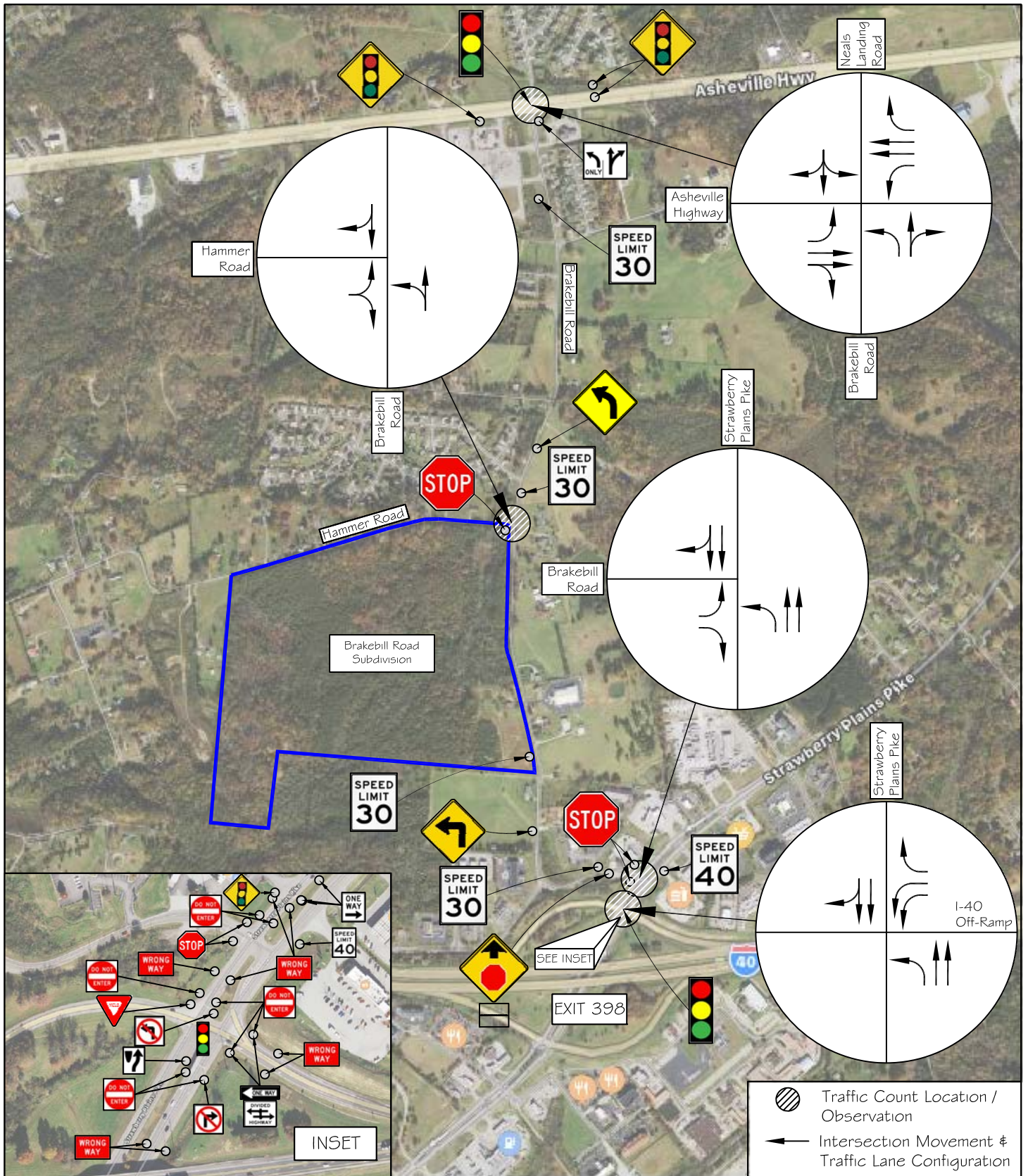


from Brakebill Road to what is now known as Governor John Sevier Highway (SR 168) before the construction of Interstate 40. Hammer Road currently ends on the north side of Interstate 40 at Manis Road, but commences again on the south side of Interstate 40 and eventually terminates at Governor John Sevier Highway (SR 168). Hammer Road is a relatively narrow road near the project site and consists entirely of individual residences and farm properties adjacent to the proposed development. The horizontal and vertical alignment on Hammer Road is relatively calm near the proposed development. However, several hundred feet to the west, Hammer Road has two sharp horizontal 90-degree curves. Hammer Road intersects Brakebill Road at a T-intersection. Northbound and southbound traffic on Brakebill Road operates freely at this intersection, while the eastbound approach at Hammer Road is controlled by a Stop Sign (R1-1).

Strawberry Plains Pike traverses in between Andrew Johnson Highway (Hwy 11E) to the northeast of the project site, past Governor John Sevier Highway (SR 168), and then ends at Thorngrove Pike to the southwest. In the study area, Strawberry Plains Pike is a divided highway with a grass median and has a significant amount of commercial businesses. Gas stations, restaurants, and hotels populate Strawberry Plains Pike adjacent to Interstate 40. Exit 398 of Interstate 40 at Strawberry Plains Pike attracts large amounts of truck traffic and motorists associated with the surrounding development. A traffic signal controls the intersection of Strawberry Plains Pike at the northern (and southern) Interstate 40 On/Off-Ramps, and the signal heads are supported on span wires. Roadway utility lighting is provided at the intersection of Strawberry Plains Pike with Brakebill Road and the Interstate 40 On/Off-Ramps (north and south side).



Figure 2 shows the lane configurations of the study area roadways and intersections, the study traffic count locations, and traffic signage in the study area. The traffic signage shown includes warning and regulatory signage. The pages following Figure 2 give an overview of the site study area with photographs.



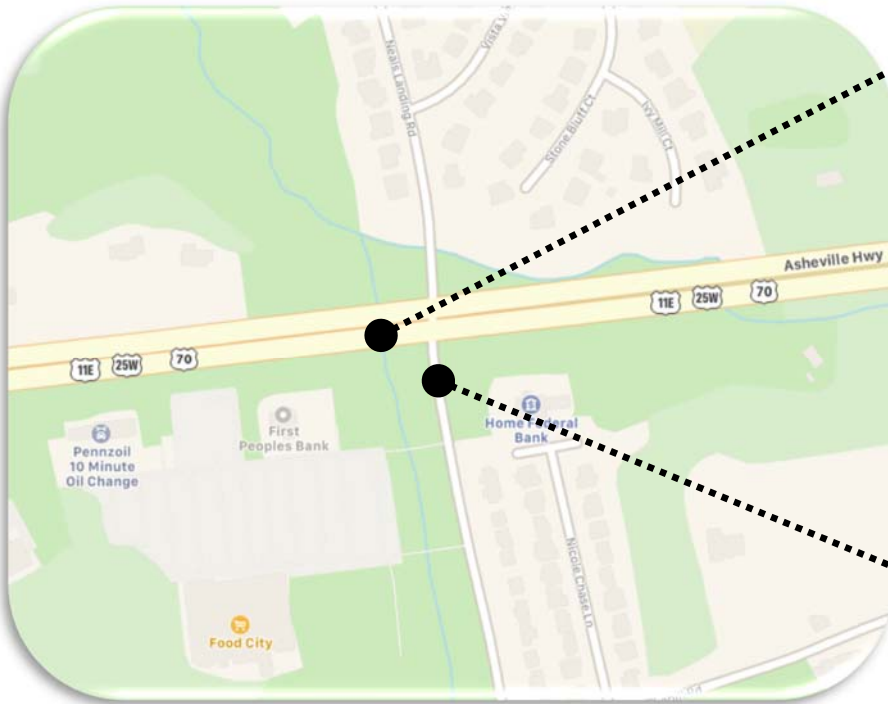
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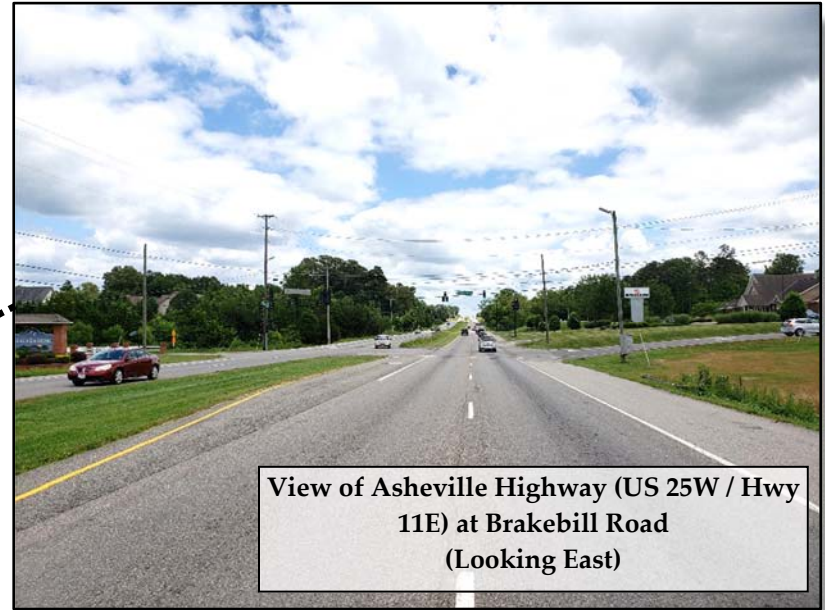


FIGURE 2
 Brakebill Road Subdivision
 Traffic Count Locations, Traffic Signage & Existing Lane Configurations

PHOTO EXHIBITS



Asheville Highway (US 25W / Hwy 11E) at Brakebill Road

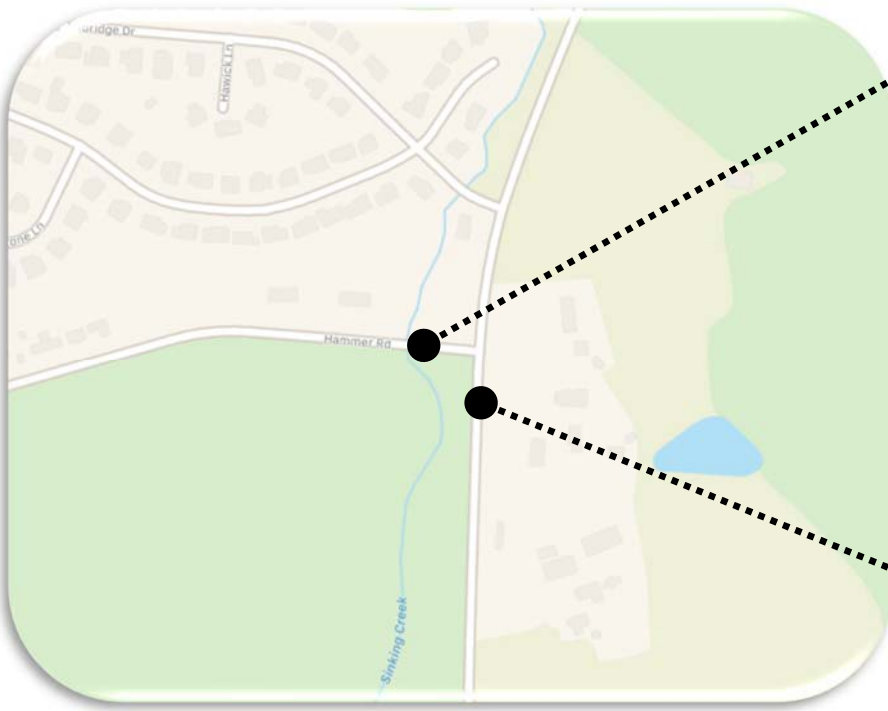


**View of Asheville Highway (US 25W / Hwy 11E) at Brakebill Road
(Looking East)**

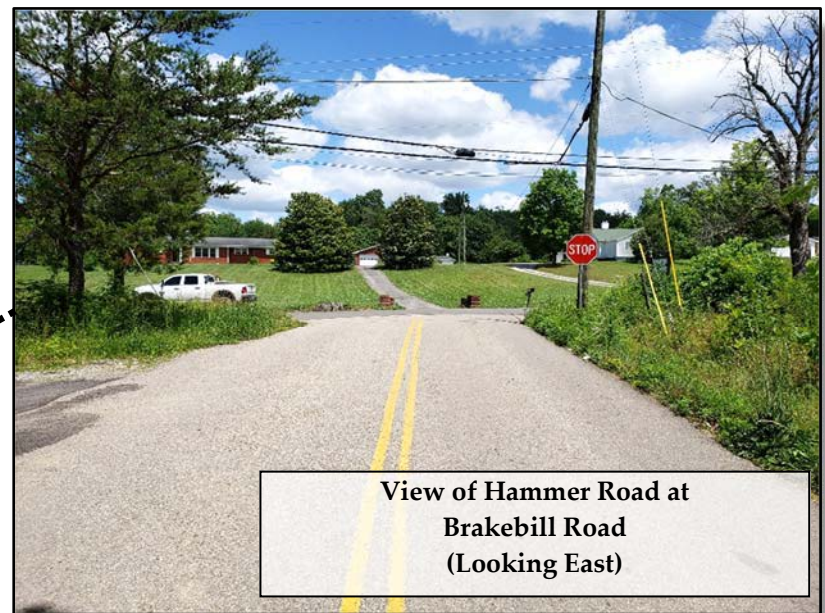


**View of Brakebill Road at
Asheville Highway (US 25W / Hwy 11E)
(Looking North)**

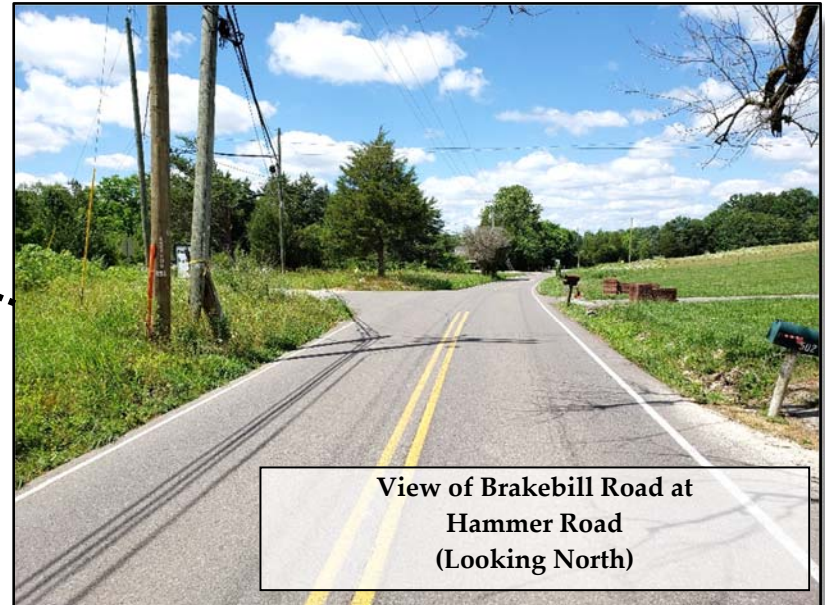
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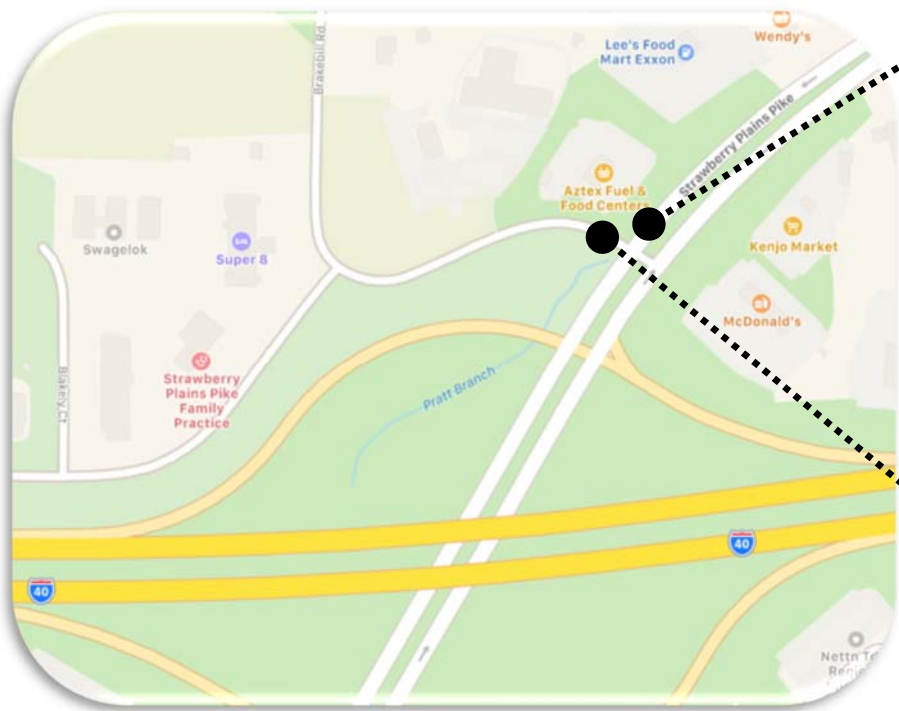
Brakebill Road at Hammer Road



**View of Hammer Road at
Brakebill Road
(Looking East)**



**View of Brakebill Road at
Hammer Road
(Looking North)**



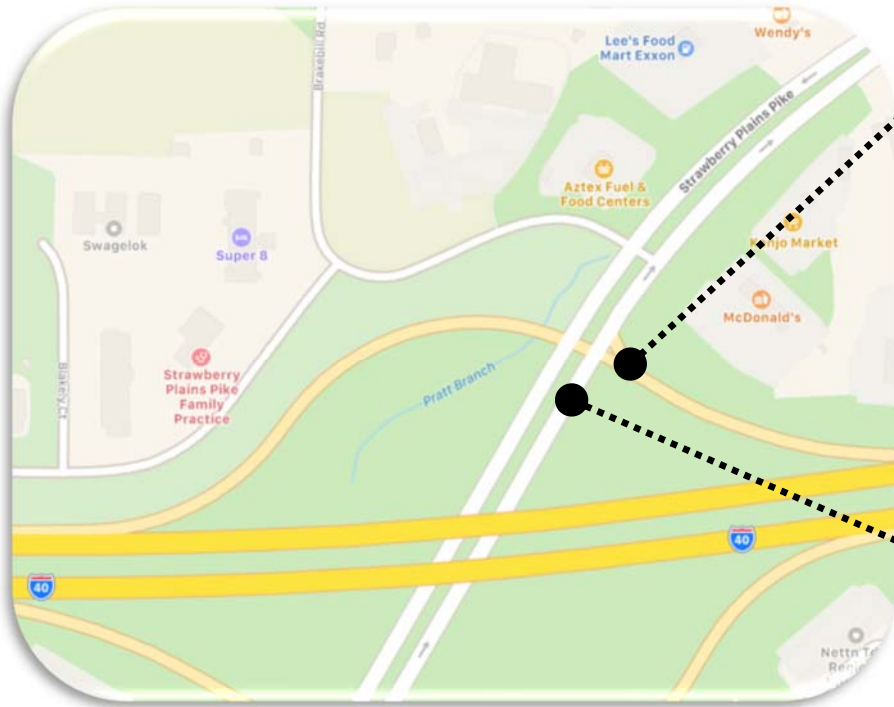
Brakebill Road at Strawberry Plains Pike



View of Strawberry Plains Pike at Brakebill Road (Looking Southwest)



View of Brakebill Road at Strawberry Plains Pike (Looking East)



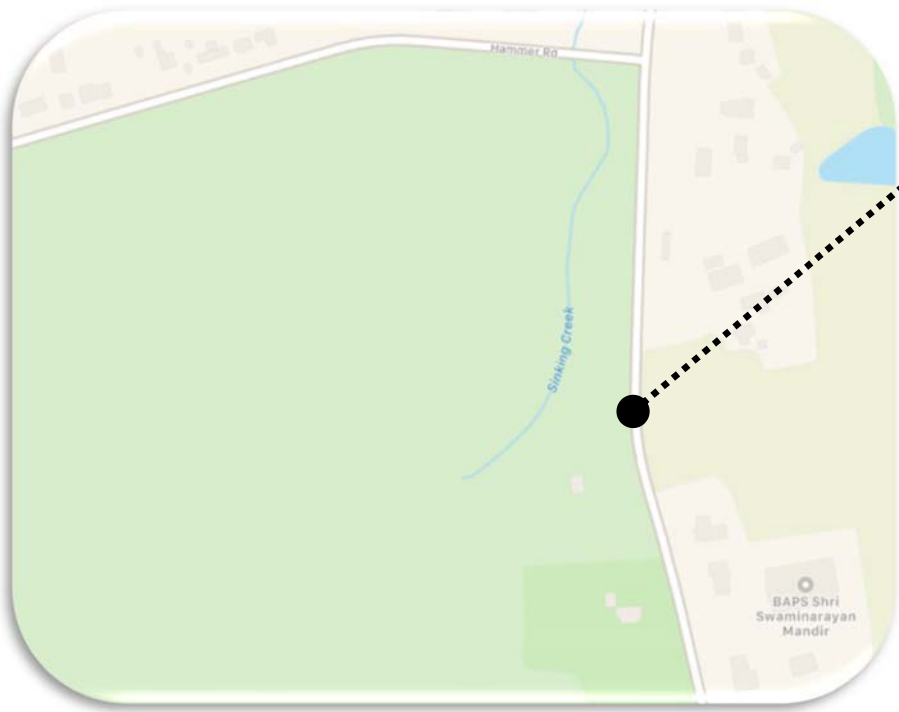
Interstate 40 On/Off Ramp (north side) at Strawberry Plains Pike



View of Interstate 40 On/Off Ramp (north side) at Strawberry Plains Pike (Looking Northwest)



View of Strawberry Plains Pike at Interstate 40 On/Off Ramp (north side) (Looking Northeast)



Brakebill Road



**View of Project Site at
Brakebill Road
(Looking Northwest)**

■ **EXISTING TRANSPORTATION VOLUMES PER MODE:**

There are two permanent vehicular traffic count locations nearby to this project site. One of these count locations is conducted by the Tennessee Department of Transportation (TDOT) every year. The Knoxville Regional TPO conducts the other count location. The count location data is the following:

- Existing vehicular roadway traffic:
 - TDOT reported Average Annual Daily Traffic (AADT) on Brakebill Road near the project site at 3,844 vehicles per day in 2018. From 2010 – 2018, this count station has indicated a 1.6% average annual growth rate.
 - The TPO reported Average Daily Traffic (ADT) on Strawberry Plains Pike to the south of Interstate 40 and the project site at 17,650 vehicles per day in 2016. Traffic data at this location on Strawberry Plains Pike has been collected sporadically throughout the past ten years. Due to this lack of regular data collection, a constant average annual growth rate for Strawberry Plains Pike is challenging to gauge. However, based on data only from 2006, 2008, 2012, and 2016, the average annual growth rate was calculated to be -1.4%. All the researched historical traffic count data for this report can be viewed in Appendix A.
- Existing bicycle and pedestrian volumes:

The average daily pedestrian and bicycle traffic along the study corridor is not known. A couple of pedestrians were observed at the intersections during the manual traffic counts. A single bicyclist was also seen on Brakebill Road. It is assumed that these volumes are minimal to non-existent in the study area.

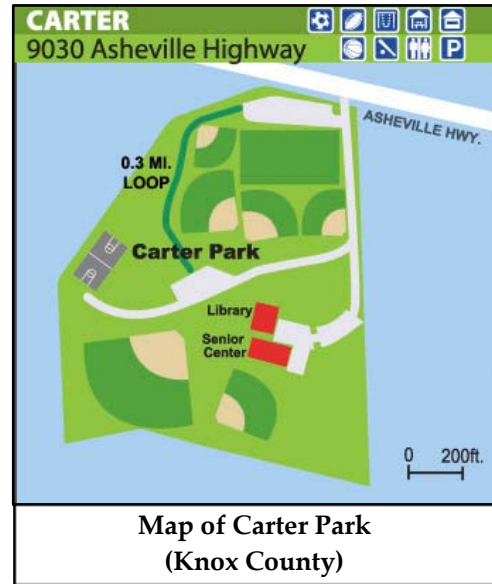
■ **ON-STREET PARKING:**

Currently, on-street parking is not allowed on any of the studied roadways adjacent to the project site.

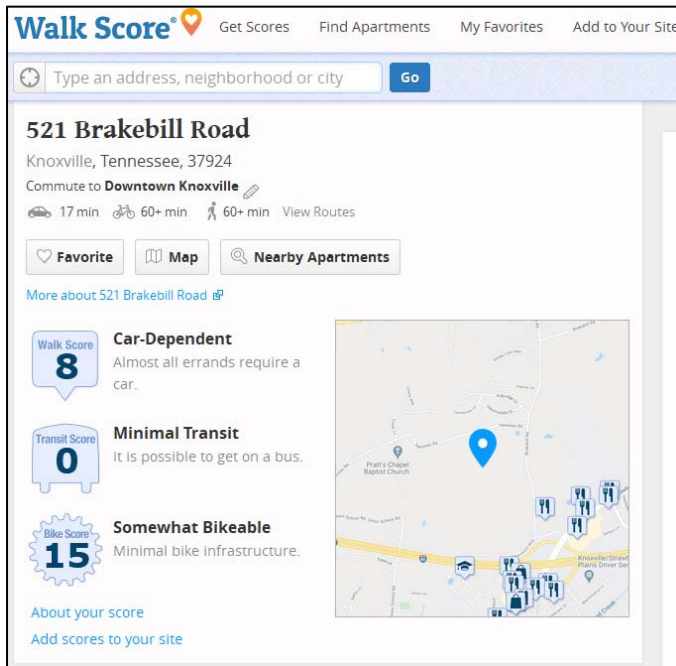
■ **PEDESTRIAN AND BICYCLE FACILITIES:**

Bicycle facilities (lanes) and pedestrian sidewalks are not currently available within the project site study area or any of the studied roadways.

In the area, the closest bicycle accommodation is located to the northeast of the site near the intersection of Andrew Johnson Highway (11E) and Asheville Highway (US 25W). These accommodations are provided at Carter Park and include a 0.3-mile paved trail, ball fields, and playground areas. This park is located 3.7 miles away by roadway via Brakebill Road and Asheville Highway (US 25W).



■ **WALK SCORE:**



A private company offers an online website at walkscore.com that grades and gives scores to locations within the United States based on “walkability”, “bikeability”, and transit availability. According to the website, the numerical values assigned for the Walk Score and the Bike Score are based on the distance to the closest amenity in various relevant categories (businesses, schools, parks, etc.) and are graded from 0 to 100. The Transit Score measures how well a location is served by public transit based on distance and type of nearby transit. The Transit Score is also graded from 0 to 100.

Appendix B shows maps and other information for the Walk Score, Bike Score, and Transit Score at the current property site address (521 Brakebill Road). Based on the project location, the location is graded with a Walk Score of 8. This Walk Score indicates that the site is completely dependent on vehicles for errands and travel. The site is graded with a Bike Score of 15, which means that there is minimal bike infrastructure but is somewhat bikeable. Also, based on the project location, the site is graded with a Transit Score of 0 due to no existing nearby public transportation options.

■ **TRANSIT SERVICES:**

The City of Knoxville has a network of public transit opportunities offered by Knoxville Area Transit (KAT). Bus service is not available in this area of Knox County. The overall KAT bus system map is in Appendix C. The closest public transit bus service is located 5 miles away via Asheville Highway (US 25W/Hwy 11E) at Chilhowee Drive adjacent to Holston Hills. This KAT service is Route 31 “Magnolia Avenue”. It operates on weekdays and a limited schedule on the weekends, and this route map is also included in Appendix C.

Other transit services include the East Tennessee Human Resource Agency (ETHRA) and the Community Action Committee (CAC), which provides transportation services when requested. Private taxis and ride-sharing opportunities (Uber, etc.) are also available.

PROJECT DESCRIPTION

■ LOCATION AND SITE PLAN:

The proposed plan layout given by Urban Engineering, Inc. is shown in Figure 3. As can be seen in the figure, one entrance, Road "B", will tie into Hammer Road 450 feet to the west of the intersection with Brakebill Road. The main entrance, Road "A", will tie into Brakebill Road approximately 1,065 feet to the south of Hammer Road. Six new streets will be constructed, and four of them will terminate at cul-de-sacs. The total lengths of the new streets together will be just over 9,460 feet (1.79 miles) in total length. The residential development will incorporate a portion of the total 100.6 acres with large amounts of open space/common areas. As shown in Figure 3, the Brakebill Road Subdivision is proposing 227 single-family detached houses and 95 single-family attached houses. The layout shows 95 of these homes as single-family attached lots on Road "E" and "F" and 227 as single-family detached lots on the north side. The size of the single-family detached lots will average 5,500 square feet (.13 acre) to 8,500 square feet (.20 acre) in size with a handful of lots near 1/3 acre. Each home will have a garage and driveway. The attached lots will average around 3,000 square feet. A clubhouse is proposed for the residents with a swimming pool to the south of the Road "A" entrance. The clubhouse will provide parking for residents, and vehicular access will only be available via Brakebill Road.

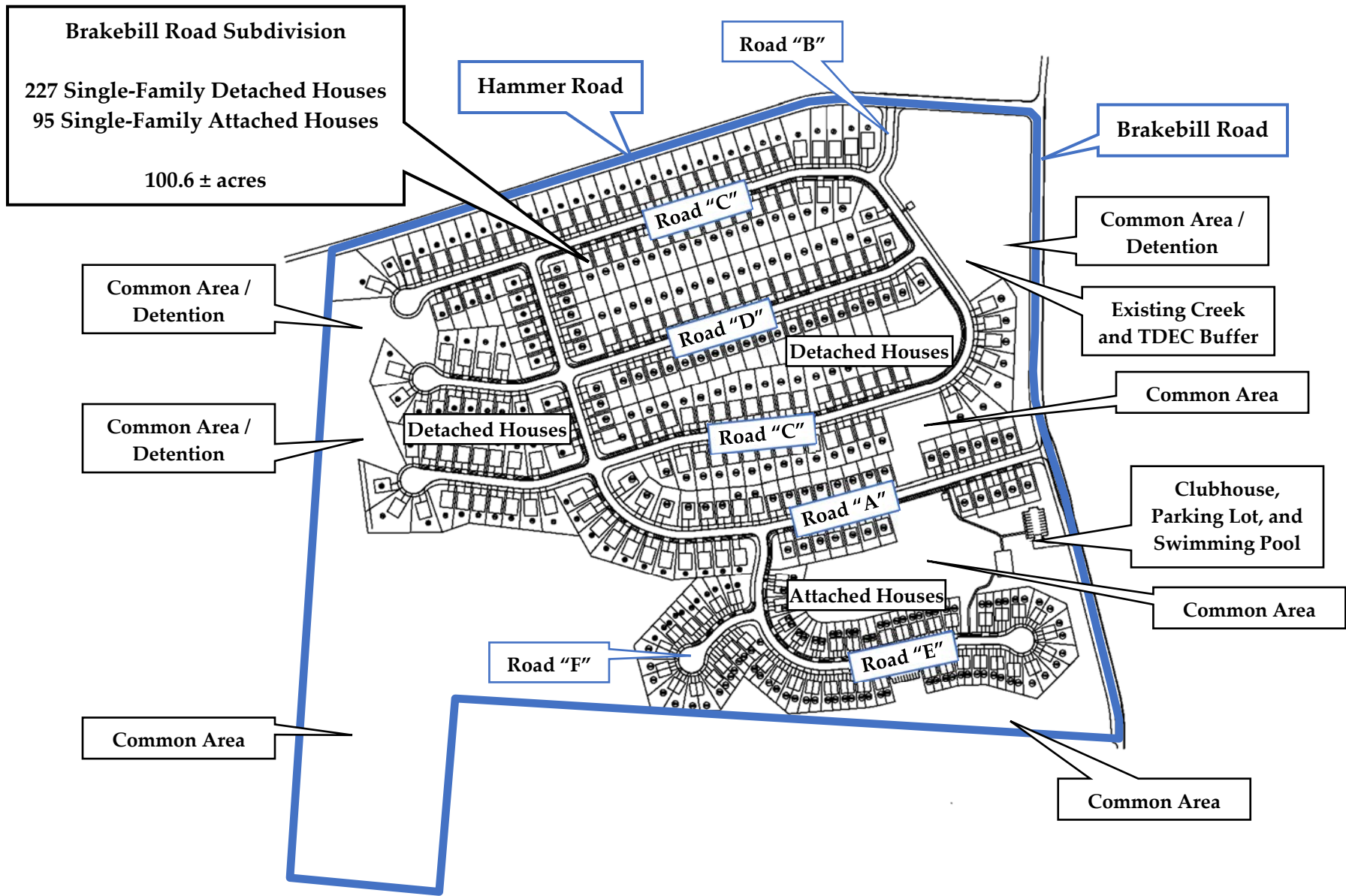


Abandoned Residence on Site Property

The existing site is currently unoccupied and nearly completely wooded. Two buildings are located on the property in the southeast corner and comprise an abandoned residence and car garage. As shown in KGIS mapping, a portion of Sinking Creek crosses the property in the northeast corner of the site property.

The schedule for completion of this new residential development is dependent on economic factors and construction

timelines. This project is also contingent on permitting, design, and other issues. However, after consultation with the site engineer, for this study, it was assumed that the total construction build-out of the development and full occupancy would occur within the next five years (2025).



20

Figure 3
Proposed Plan Layout
Brakebill Road Subdivision

■ **PROPOSED USES AND ZONING REQUIREMENTS:**

The property for the proposed development is within the Knox County limits (and just outside the City of Knoxville) and was rezoned to Planned Residential (PR) with a density of <9 units per acre in March of 2018. It was initially zoned Agricultural (A). The development property currently exists of two separate parcels (Parcel 267 and 267.01). The current zoning map is provided in Appendix D. The existing adjacent surrounding land uses are the following:

- Ten properties to the north on the opposite side of Hammer Road are zoned as Agricultural (A), and two properties are zoned as Low Density Residential (RA). One property is zoned as Planned Residential (PR) with a density of 1 - 3 dwelling units per acre. Most of these properties are currently occupied with single-family homes.
- Two properties are located to the west and are currently zoned Agricultural (A) and Planned Residential (PR) with a density of 1 – 8 dwelling units per acre. The one property that is zoned Agricultural (A) has a single-family residence. The other property zoned Planned Residential (PR) is vacant land, which appears to have been partially graded in the past in anticipation of residential development.
- To the south, two properties are zoned Agricultural (A). These two properties consist of vacant land and a single-family residence/farm property.
- The properties to the east on the opposite side of Brakebill Road are also zoned Agricultural (A). They consist of single-family residences and farm property. In addition to these residential properties, there is also a Hindu temple named BAPS Shri Swaminarayan Mandir.

The Planned Residential (PR) zone allows for a variety of land uses primarily within the residential realm. Uses permitted in this zone include single-family dwellings, duplexes, and multi-dwelling structures and developments.

■ **DEVELOPMENT DENSITY:**

The density allowed by Knox County for the development is nine dwelling units per acre based on the rezoning in March of 2018. With a maximum of 400 houses on 100.6 acres, the proposed density for the Brakebill Road Subdivision computes to 3.98 dwelling units per acre, which is far below the allowable of 9 units per acre.

■ **ON-SITE CIRCULATION:**

The total length of the six new streets within the development will be just over 9,460 feet (1.79 miles) in length and will be designed and constructed to Knox County, TN specifications. The new streets shown in Figure 3 are labeled Road “A” thru Road “F”. The internal roadways for the development will be paved with asphalt, include 8” extruded concrete curbs, and the lane widths will be 13 feet for a total of 26-foot pavement width. The street right-of-way within the development will be 50 feet. Based on the concept plan, concrete sidewalks are proposed on at least one side of each internal street. After construction, Knox County will maintain the streets.

■ **SERVICE AND DELIVERY VEHICLE ACCESS AND CIRCULATION:**

Besides residential passenger vehicles, the new streets will also provide access for service, delivery, maintenance, and fire protection/rescue vehicles. It is not expected that any of these other types of vehicles will impact roadway operations other than when they occasionally enter and exit the development. It is anticipated that curbside garbage collection services will be available for this residential subdivision. Concerning fire protection and rescue vehicles, the new roads will be designed and constructed to Knox County specifications and thus expected to be adequate in size. The internal roadways in the subdivision are expected to be able to accommodate these larger types of vehicles along with standard passenger vehicles.

TRAFFIC ANALYSIS OF EXISTING AND PROJECTED CONDITIONS

■ EXISTING TRAFFIC CONDITIONS:

Due to the current worldwide coronavirus pandemic, usable and accurate traffic count for analysis is not readily obtainable. Recently, the pandemic has not only closed schools and eliminated school-related traffic, but overall general traffic has been affected due to stay-at-home orders, work furloughs, job losses, and general anxiety with travel outside the home. According to the Federal Highway Administration (Traffic Volume Trends – March 2020), the State of Tennessee experienced 15.7% fewer miles driven by motorists in March of 2020 as compared to March 2019. It is assumed that this reduction increased in April during the height of the shutdowns. However, as of May 26, more community restrictions have been lifted in Knox County (known as Phase 2 of Knox County Reopening Plan), and overall travel has noticeably begun to increase and return closer to pre-lockdown levels in the area.

Because traffic counts conducted at this time would not yield accurate data, previous traffic count data was used for this study. The intersections that were recommended to be analyzed were previously studied for an unrelated development on the same property. For this previous study in March of 2018, traffic counts were conducted at the following existing unsignalized and signalized intersections:

- Asheville Highway (US 25W/Hwy 11E) at Brakebill Road
- Hammer Road at Brakebill Road
- Strawberry Plains Pike at Brakebill Road
- Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side)

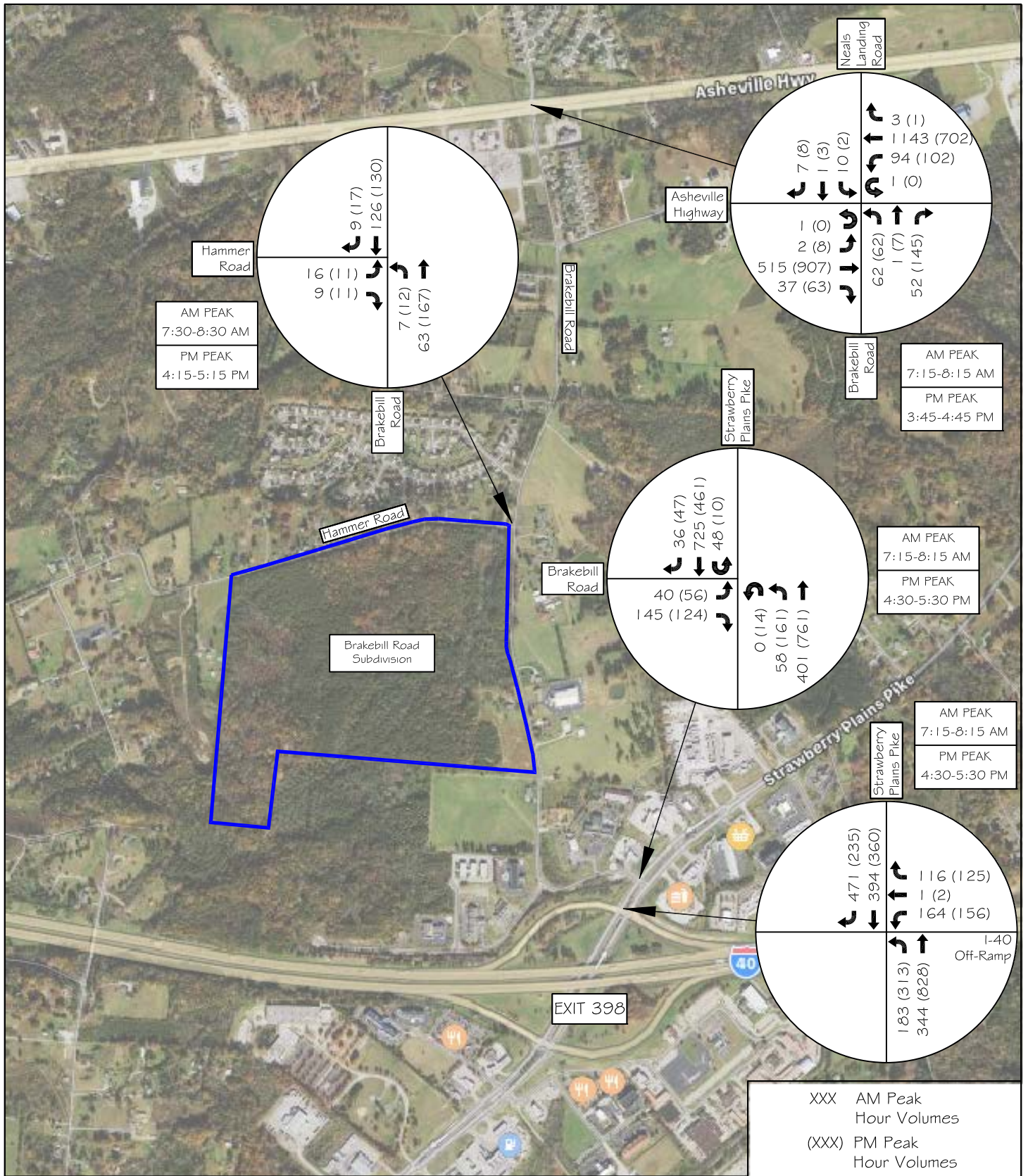
Quality Counts, LLC conducted traffic counts on Tuesday, March 20, 2018. The counts were performed while the local schools were in session. The intersections of Asheville Highway (US 25W/Hwy 11E) at Brakebill Road and Hammer Road at Brakebill Road were counted from 7 – 9 am and 2 – 6 pm. The intersections of Strawberry Plains Pike at Brakebill Road and Strawberry Plains Pike at the Interstate 40 On/Off-Ramp (north side) were counted from 7 – 9 am, 11 am – 1 pm, and 2 – 6 pm. Based on the traffic volumes counted at the intersections, the AM and PM peak hour of traffic were observed at the following times:

- Asheville Highway (US 25W/Hwy 11E) at Brakebill Road
7:15 – 8:15 AM / 3:45 – 4:45 PM
- Hammer Road at Brakebill Road
7:30 – 8:30 AM / 4:15 – 5:15 PM
- Strawberry Plains Pike at Brakebill Road
7:15 – 8:15 AM / 4:30 – 5:30 PM
- Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side)
7:15 – 8:15 AM / 4:30 – 5:30 PM

The manual tabulated traffic counts can be reviewed in Appendix E. In Figure 4a, the volumes are shown from the 2018 traffic counts during the AM and PM peak hours observed at each intersection. (Note: For the intersection of Strawberry Plains Pike at Brakebill Road, the Quality Counts, LLC data in the appendix shows the traffic count with Brakebill Road as the southbound approach and Strawberry Plains Pike as the westbound and eastbound approach. This report shows Brakebill Road as the eastbound approach and Strawberry Plains Pike as the northbound and southbound approaches.)

The next figure, Figure 4b, shows the traffic volumes at the intersections for the current year, 2020 based on the 2018 traffic volumes. The conversion of the traffic volumes from 2018 to 2020 was accomplished by applying a +2% annual growth rate for two years. A +2% annual growth rate was based on the historical TDOT data for Brakebill Road shown in Appendix A. From 2010 to 2018, the TDOT count location on Brakebill Road has demonstrated an average annual growth rate of +1.6%.

In addition to the existing intersections requested by the Planning Department, an additional traffic count was conducted on March 20, 2018 (by Ajax Engineering, LLC) just to the north of the project site at the intersection of Kilbridge Drive and Brakebill Road during the AM and PM peak hours. This intersection serves as an access point on Brakebill Road to an existing residential subdivision named Stonehaven. The AM and PM peak hour traffic count at this intersection is shown in Figure 4c. The results of this count will be discussed later in the report.

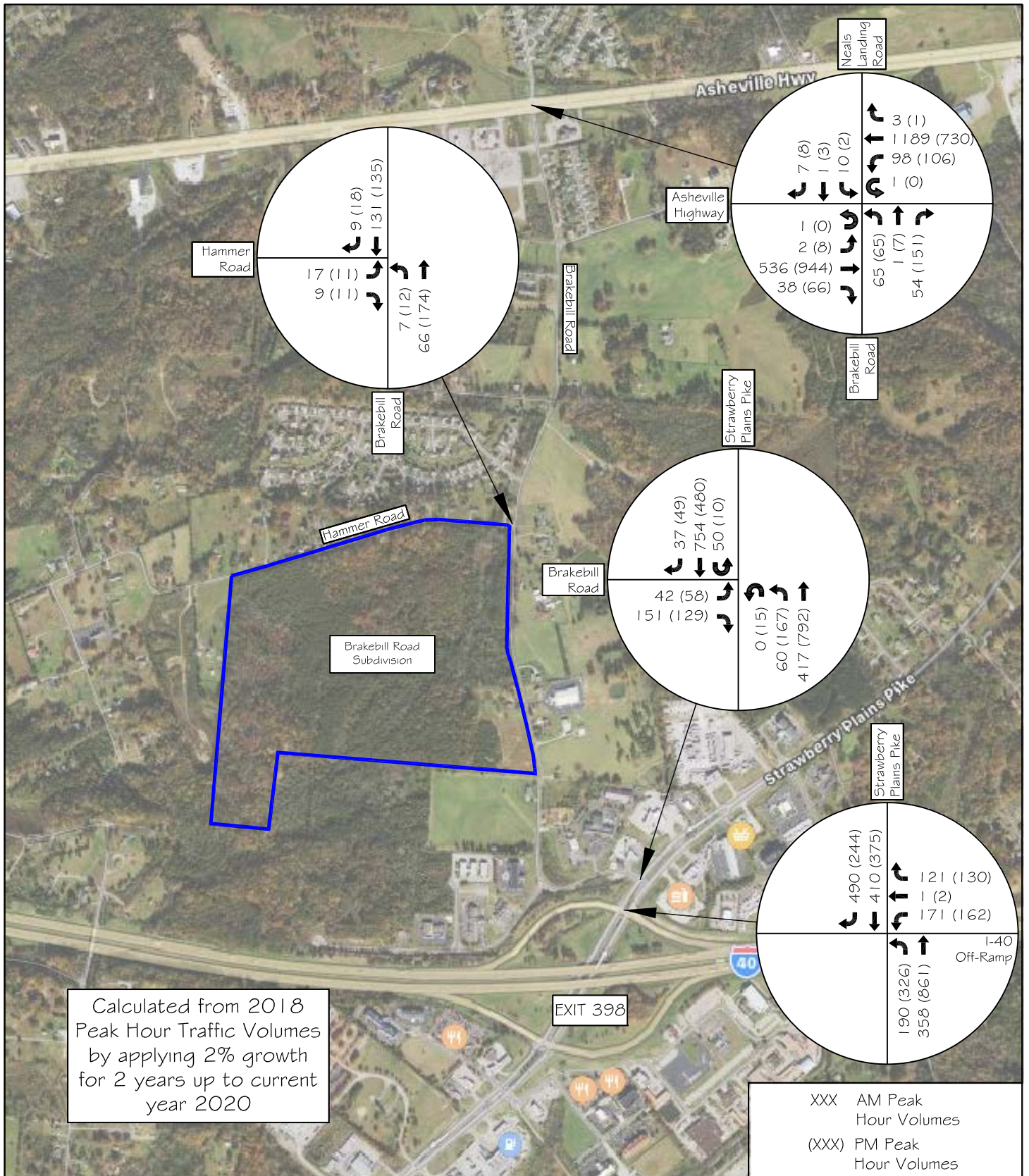


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FIGURE 4a
 Brakebill Road Subdivision
 2018 Peak Hour Traffic Volumes



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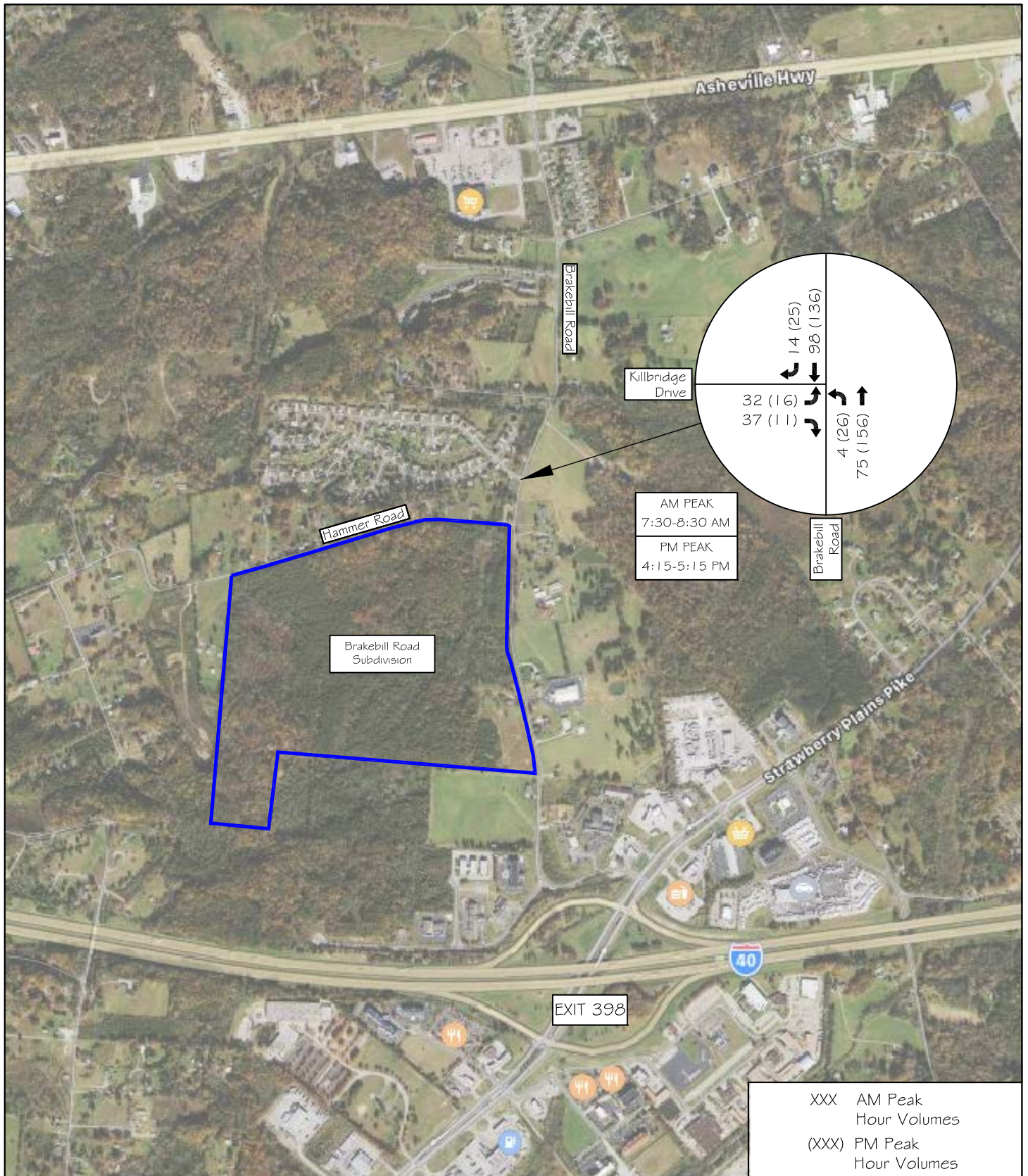
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FIGURE 4b

Brakebill Road Subdivision

2020 Peak Hour Traffic Volumes -
 EXISTING TRAFFIC CONDITIONS
 (Adjusted 2018 Peak Hour Volumes)



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FIGURE 4c

Brakebill Road Subdivision

2018 Peak Hour Traffic Volumes -
Brakebill Road at Kilbridge Drive

Capacity analyses were undertaken to determine the Level of Service (LOS) for the studied intersections for the present year 2020 traffic volumes shown in Figure 4b. The capacity analyses were calculated by following the methods outlined in the Highway Capacity Manual (HCM) and using Synchro Traffic Software (Version 8).

Methodology:

LOS is a qualitative measurement developed by the transportation profession to express how well an intersection or roadway performs based on a driver's perception. LOS designations include LOS A through LOS F. The designation of LOS A signifies a roadway or intersection operating at best, while LOS F signifies road operations at worst. This grading system provides a reliable, straightforward means to communicate road operations to the public. The HCM lists level of service criteria for unsignalized intersections and signalized intersections.



LOS is defined by delay per vehicle (seconds), and roadway facilities are also characterized by the volume-to-capacity ratio (v/c). For example, a delay of 20 seconds at an unsignalized intersection would indicate LOS C, and this delay would represent the additional delay a motorist would experience traveling through the intersection. Also, for example, a v/c ratio of 0.75 for an approach at an unsignalized intersection would indicate that it is operating at 75% of its available capacity. The designations for LOS, which are based on delay, are reported differently for unsignalized and signalized intersections. This difference is primarily due to motorists having different expectations between the two road facilities. Generally, for most instances, the boundary of LOS D / LOS E is considered the upper limit of acceptable delay during peak periods in urban and suburban areas.

For unsignalized intersections, LOS is measured in terms of delay (in seconds). This measure is an attempt to quantify delay that includes travel time, driver discomfort, and fuel consumption. For unsignalized intersections, the analysis assumes that the mainline


thru and right-turn traffic does not stop and is not affected by the traffic on the minor side streets. Thus, the LOS for a two-way stop (or yield) controlled intersection is defined by the delay for each minor approach and major street left-turn movements. Table 2 lists the level of service criteria for unsignalized intersections. The analysis results of unsignalized intersections using the HCM methodologies are conservative due to the more significant vehicle gap parameters used in the method. More often, in normal road conditions, drivers are more willing to accept smaller gaps in traffic than what is modeled using the HCM methodology. The unsignalized intersection methodology also does not account for more significant gaps sometimes produced by nearby upstream and downstream signalized intersections. For unsignalized intersections, in most instances, the upper limit of acceptable delay during peak hours is the LOS D/E boundary at 35 seconds.

For signalized intersections, LOS is based upon delay (in seconds) for approaches within the intersection and the overall operation of the traffic entering an intersection. This delay is a measurement of driver discomfort, frustration, fuel consumption, lost travel time, and is dependent on traffic signal cycle lengths, lengths of green phases, and the quality of traffic progression. This control delay includes deceleration/acceleration delay, queue move-up time, and stopped delay time. Table 3 lists the level of service criteria for signalized intersections. For signalized intersections, in most instances, the upper limit of acceptable delay during peak hours is the LOS D/E boundary at 55 seconds.

For the analysis of the signalized intersections, the traffic signal timing information was obtained from the City of Knoxville and this information is shown in Appendix F. The intersections of Asheville Highway (US 25W/Hwy 11E) at Brakebill Road and Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side) operate with actuated traffic signals. They are currently not in coordination with any other traffic signals.

From the capacity calculations, the results from the existing peak hour vehicular traffic can be seen in Tables 4a and 4b for the intersections. Table 4a contains the results for the two existing unsignalized intersections, and Table 4b includes the results of the two existing signalized intersections. The intersections in the tables are shown with a LOS designation, delay (in seconds), and v/c ratio (volume/capacity) for the AM and PM peak hours, and the graphs highlight the results. Appendix G includes the worksheets from the capacity analyses for the existing peak hour vehicular traffic.

Most of the intersection approaches and intersections are shown to operate at an adequate level during the existing AM and PM peak hours for vehicular traffic. However, for the intersection of Strawberry Plains Pike at Brakebill Road, the existing peak hour level of service is calculated as extremely poor during the AM and PM peak hours for eastbound left-turning traffic. High delays for this movement are experienced by motorists attempting to turn left from Brakebill Road onto northbound Strawberry Plains Pike due to the sizeable conflicting traffic volumes.

TABLE 2
LEVEL OF SERVICE AND DELAY FOR UNSIGNALIZED INTERSECTIONS 

LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY (seconds/vehicle)
A	Little or no delay	0 - 10
B	Short Traffic Delays	>10 -15
C	Average Traffic Delays	>15 - 25
D	Long Traffic Delays	>25 - 35
E	Very Long Traffic Delays	>35 - 50
F	Extreme Traffic Delays	>50

Source: Highway Capacity Manual, 6th Edition

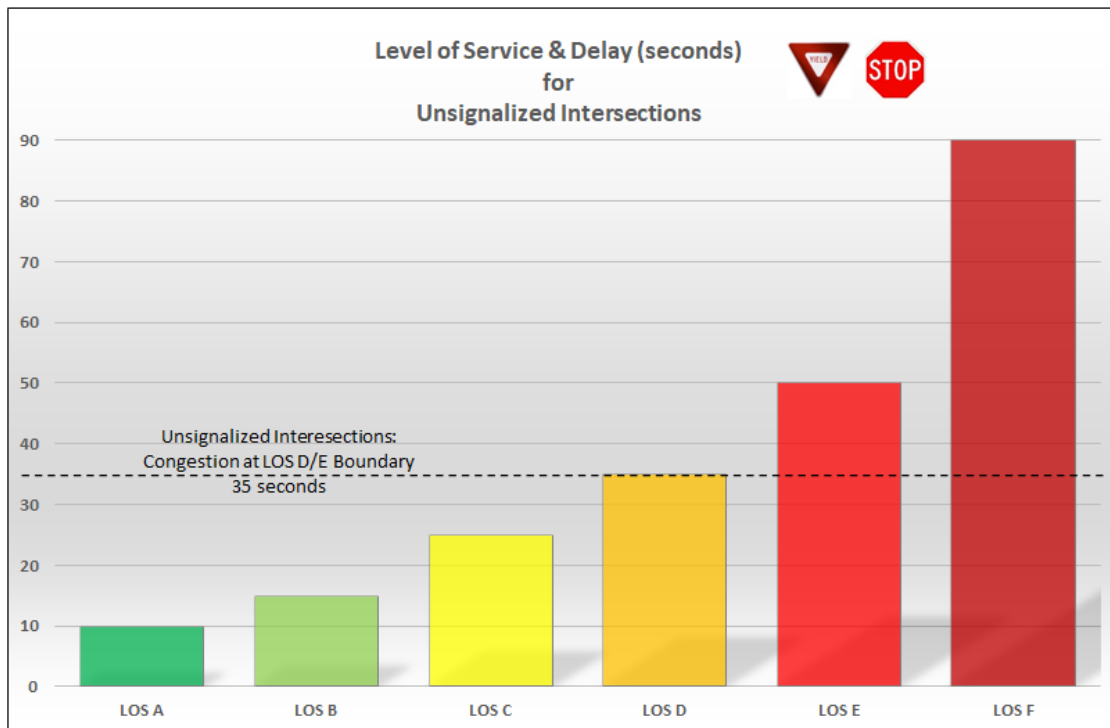


TABLE 3
LEVEL OF SERVICE AND DELAY FOR SIGNALIZED INTERSECTIONS



LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY (seconds/vehicle)
A	Operation with very low control delay. Progression is extremely favorable and most vehicles do not stop at all.	≤10.0
B	Generally good level of progression. More vehicles stop than with LOS A, causing higher levels of average delay.	> 10 - 20
C	Higher delays with individual cycle failures may begin at this level. Many vehicles may still pass through without stopping.	> 20 - 35
D	Approaching unstable flow. The influence of congestion becomes more noticeable. Many vehicles stop.	> 35 - 55
E	Considered the limit of acceptable delay. High delays indicated by poor progression, long cycle lengths, and high v/c ratios.	> 55 - 80
F	Unacceptable delay occurs. Progression is extremely poor with long cycle lengths and high v/c ratios.	>80

Source: Highway Capacity Manual, 6th Edition

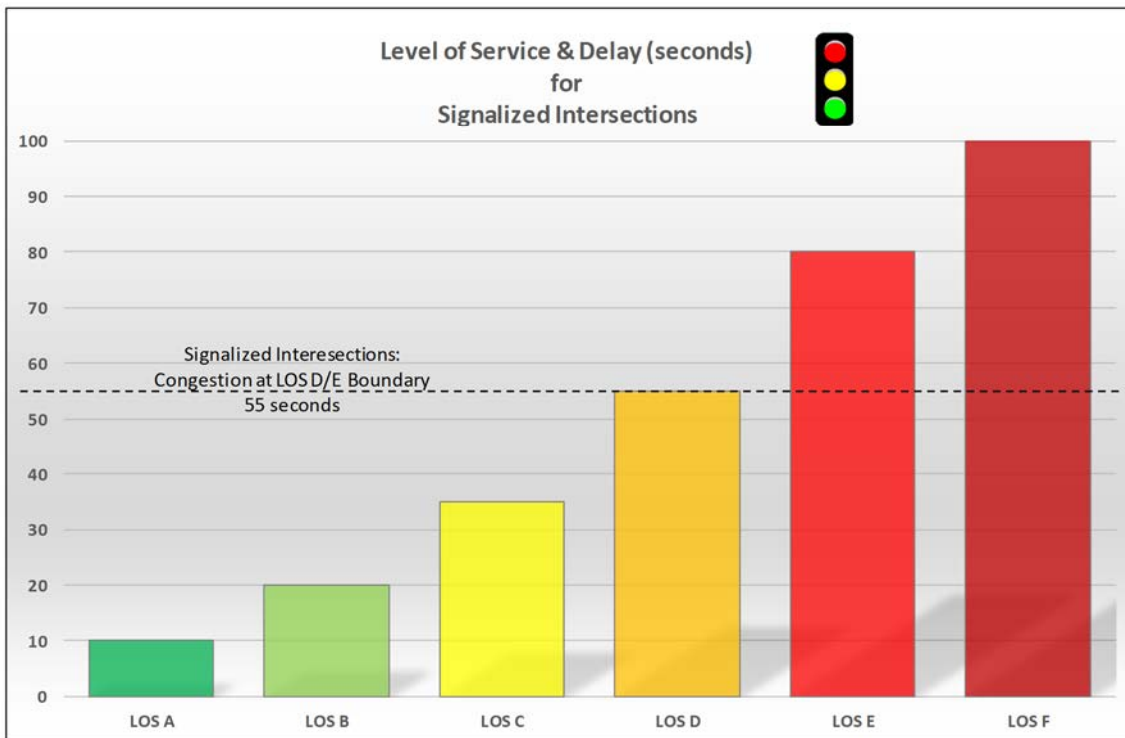




TABLE 4a
2020 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
EXISTING TRAFFIC CONDITIONS

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Hammer Road at Brakebill Road	 Unsignalized	Northbound Left	A	7.6	0.008	A	7.7	0.012
		Eastbound Left/Right	B	10.4	0.065	B	10.9	0.062
Strawberry Plains Pike at Brakebill Road	 Unsignalized	Northbound Left	B	11.5	0.142	B	10.6	0.254
		Eastbound Left	F	68.8	0.595	E	46.1	0.468
		Eastbound Right	B	14.9	0.310	B	11.3	0.202

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

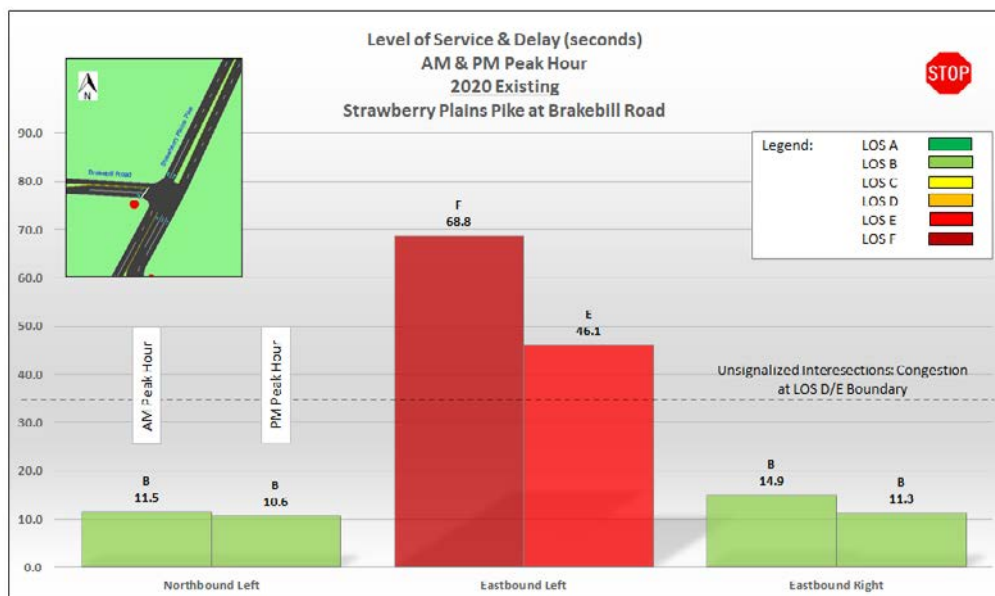
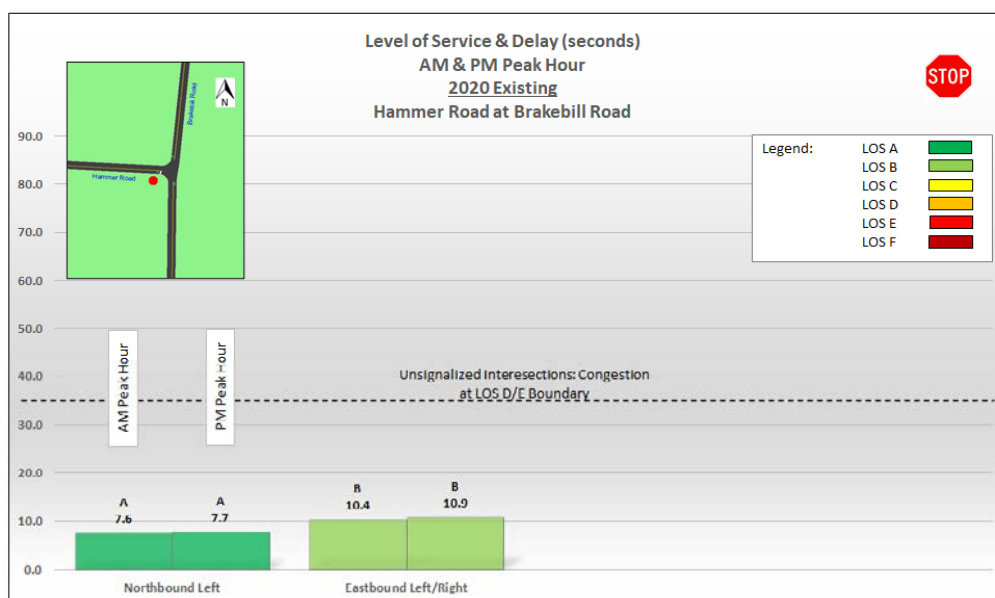


TABLE 4b
2020 SIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
EXISTING TRAFFIC CONDITIONS

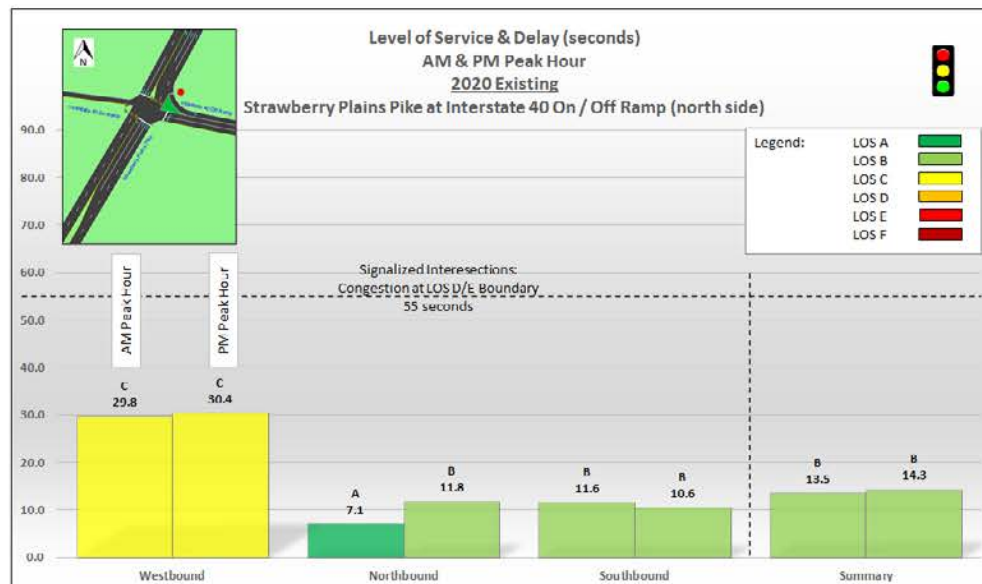
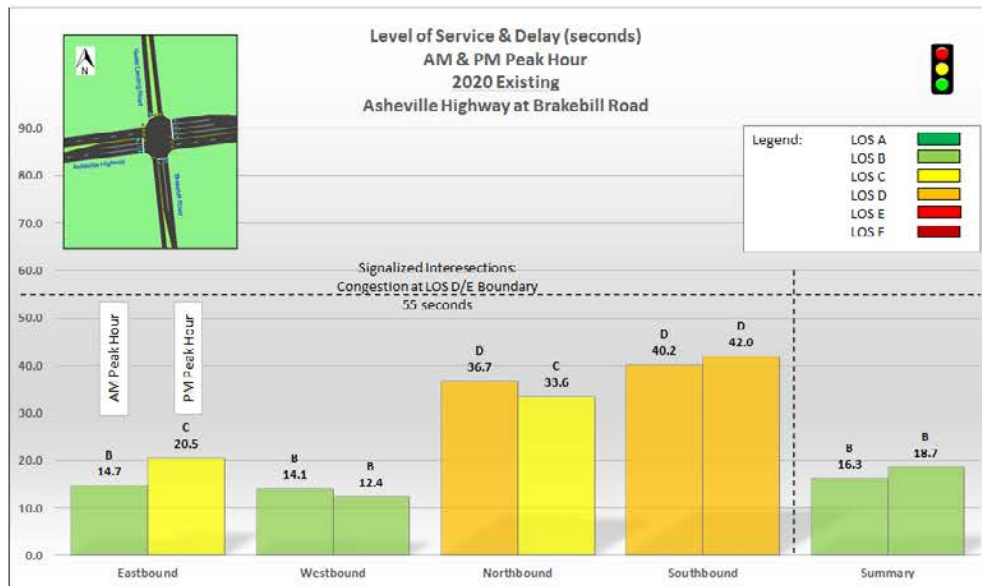
INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway at Brakebill Road		Eastbound	B	14.7	0.650	C	20.5	0.610
		Westbound	B	14.1		B	12.4	
		Northbound	D	36.7		C	33.6	
		Southbound	D	40.2		D	42.0	
		Summary	B	16.3		B	18.7	
Strawberry Plains Pike at Interstate 40 On / Off Ramp (north side)		Westbound	C	29.8	0.590	C	30.4	0.830
		Northbound	A	7.1		B	11.8	
		Southbound	B	11.6		B	10.6	
		Summary	B	13.5		B	14.3	

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

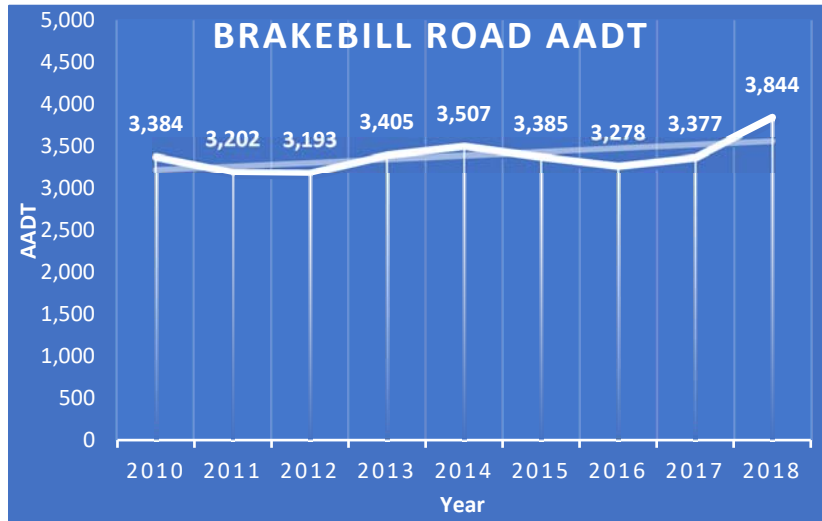
^c Volume to Capacity Ratio



■ **OPENING YEAR TRAFFIC CONDITIONS (WITHOUT PROJECT):**

Opening year traffic volumes represent the future condition the proposed study area is potentially subject to even without the proposed project being developed (no-build option). As previously stated, the build-out and full occupancy for this proposed new residential development is assumed to occur in the year 2025. This horizon year corresponds to five years for the development to reach full capacity and occupancy.

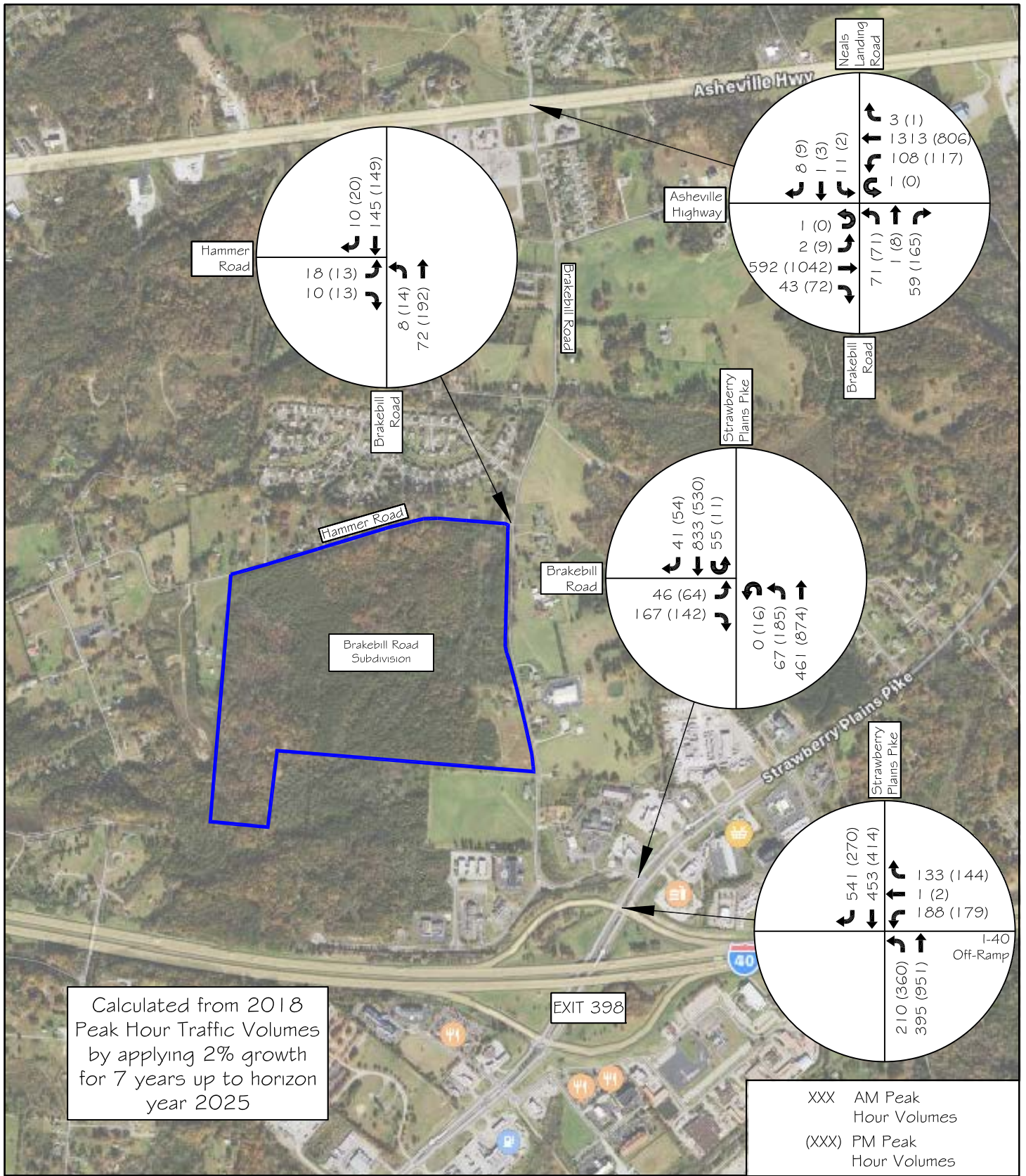
Vehicular traffic on Brakebill Road has shown marginal growth over the past few years, according to the TDOT count station. To ensure a reasonable traffic growth estimate for this study and to account for potential traffic growth in the study area, an average annual growth rate of 2% was used to calculate future growth up to



the year 2025 for the studied intersections. This is based on the historical TDOT data for Brakebill Road shown in Appendix A. From 2010 to 2018, the TDOT count location has shown an average annual growth rate of +1.6%. The results of this growth rate to the calculated existing 2020 traffic volumes from Figure 4b are shown in Figure 5. Figure 5 shows the projected opening year traffic volumes at the studied intersections in 2025 during the AM and PM peak hours.

Capacity analyses were conducted for the future projected conditions at the studied intersections in the year 2025 without the project being developed. The intersection of Strawberry Plains Pike at Brakebill Road was calculated to operate exceptionally poor during the AM and PM peak hours for eastbound left-turning traffic in the year 2025. The other intersections and intersection approaches are shown to operate at an adequate level during the AM and PM peak hours for vehicular traffic in the year 2025. It should be noted that the signalized intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side) is calculated to have an overall v/c ratio of 0.970 in the PM peak hour in the year 2025. This result indicates that the projected volumes at this intersection will be near capacity based on the existing number of traffic lanes. The results from the 2025 projected opening year traffic conditions (without project) can be seen in Tables 5a

and 5b for the intersections. Table 5a contains the results for the two existing unsignalized intersections, and Table 5b includes the results of the two existing signalized intersections. Appendix G contains the LOS capacity worksheets for the opening year conditions (without project) in the year 2025. It is important to point out that these projected calculated LOS designations for the intersections could potentially exist in the future, even without the proposed residential project being constructed and developed.



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NORTH

FIGURE 5
 Brakebill Road Subdivision
 2025 Peak Hour Traffic Volumes -
 OPENING YEAR TRAFFIC (WITHOUT PROJECT)

TABLE 5a
2025 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITHOUT PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Hammer Road at Brakebill Road	STOP Unsignalized	Northbound Left	A	7.6	0.010	A	7.8	0.014
		Eastbound Left/Right	B	10.7	0.072	B	11.4	0.077
Strawberry Plains Pike at Brakebill Road	STOP Unsignalized	Northbound Left	B	12.5	0.174	B	11.3	0.300
		Eastbound Left	F	128.5	0.838	F	71.2	0.631
		Eastbound Right	C	16.7	0.369	B	11.8	0.233

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

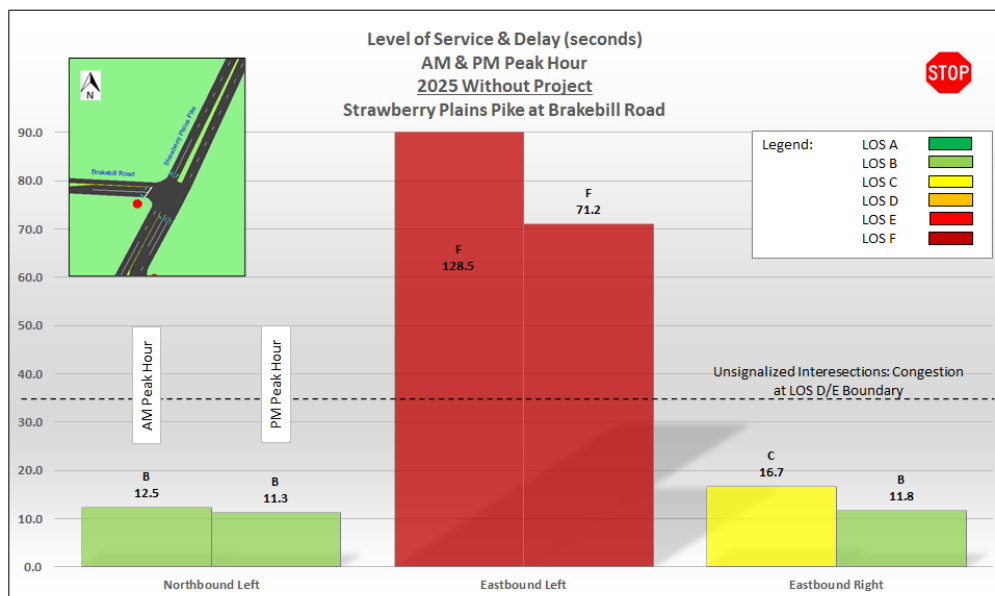
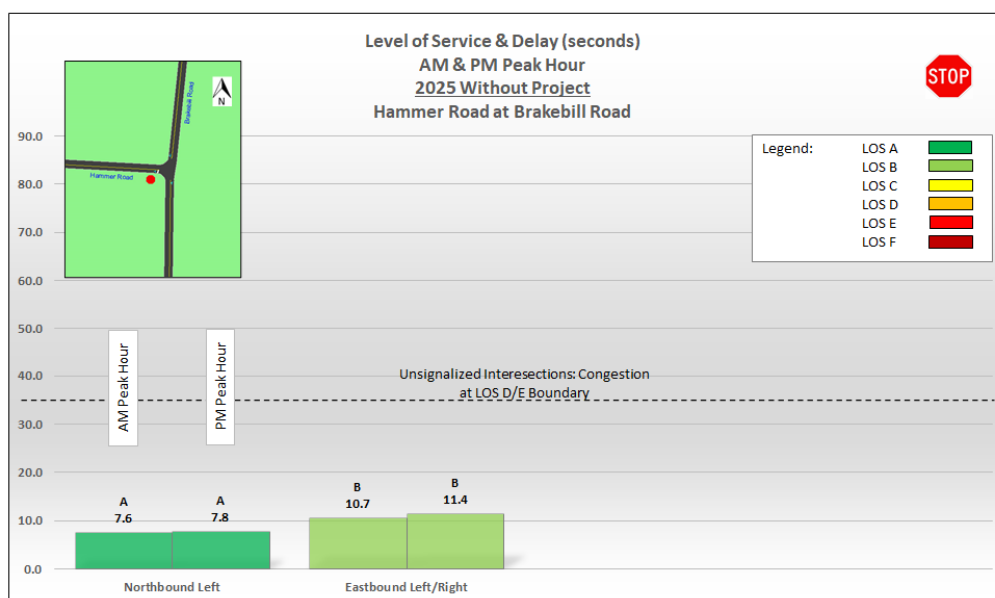


TABLE 5b
2025 SIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITHOUT PROJECT)

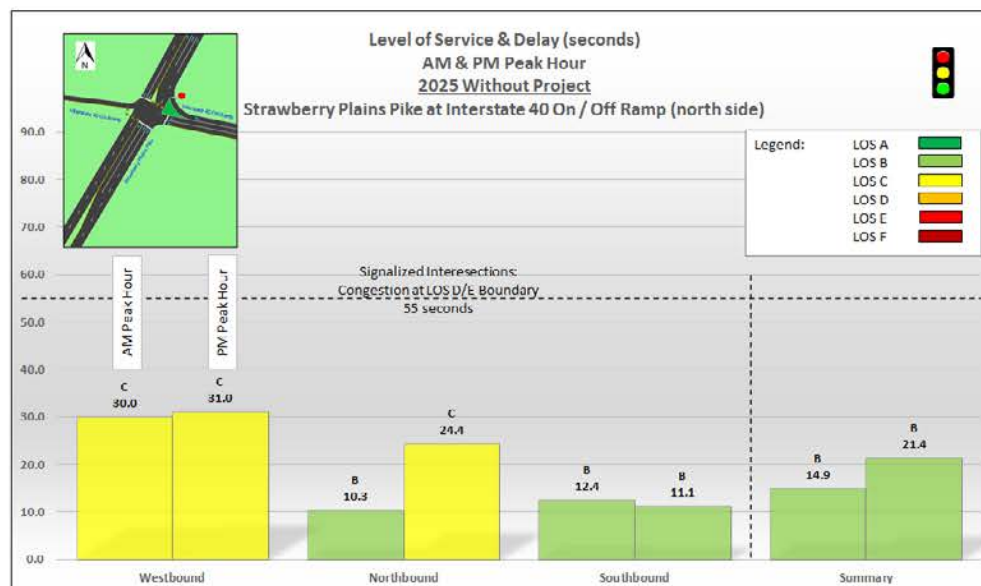
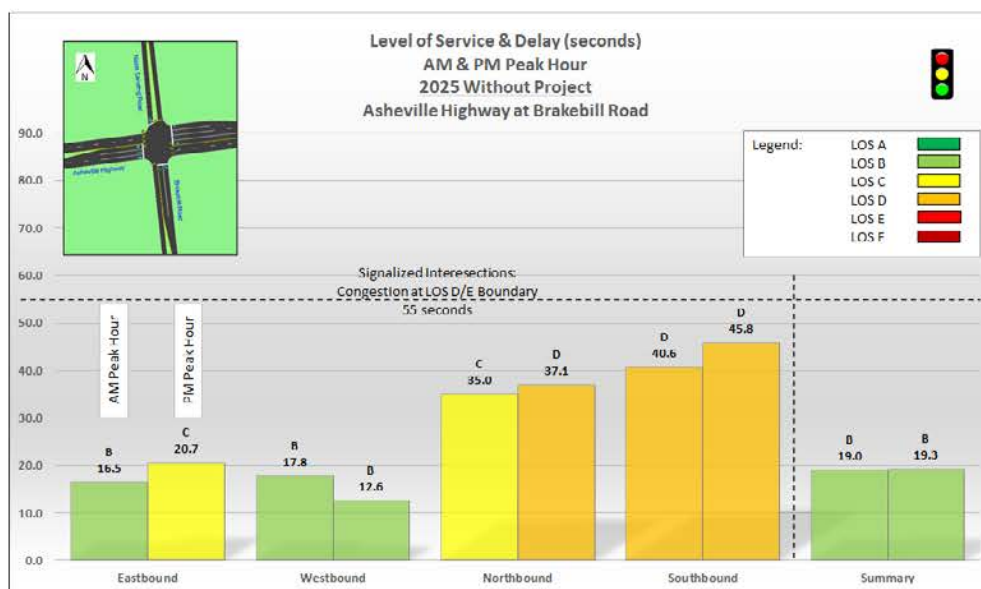
INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway at Brakebill Road	Signalized	Eastbound	B	16.5	0.710	C	20.7	0.650
		Westbound	B	17.8		B	12.6	
		Northbound	C	35.0		D	37.1	
		Southbound	D	40.6		D	45.8	
		Summary	B	19.0		B	19.3	
Strawberry Plains Pike at Interstate 40 On / Off Ramp (north side)	Signalized	Westbound	C	30.0	0.710	C	31.0	0.970
		Northbound	B	10.3		C	24.4	
		Southbound	B	12.4		B	11.1	
		Summary	B	14.9		B	21.4	

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume to Capacity Ratio



■ **TRIP GENERATION:**

The estimated amount of traffic that will be generated by the 227 single-family detached houses was calculated based upon rates and equations for peak hour trips provided by Trip Generation Manual, 10th Edition, a publication of the Institute of Transportation Engineers (ITE). The 95 single-family attached houses trip rates were based upon equations for peak hour trips provided by Knoxville-Knox County Planning. These equations were developed from local studies to estimate apartment trip generation in the surrounding area and published in December 1999.

A generated trip is a single or one-direction vehicle movement that is either entering or exiting the study site. The Trip Generation Manual is the traditional and most popular resource for determining trip generation rates when traffic impact studies are produced. The Manual lists and includes data for a variety of land uses and correlates trips generated based on different variables such as dwelling units, square footage, etc. The data from ITE and the local study for the proposed land uses are shown in Appendix H. A summary of this information is presented in the following table:

TABLE 6
TRIP GENERATION FOR BRAKEBILL ROAD SUBDIVISION
227 Single-Family Detached Houses and 95 Single-Family Attached Houses

ITE LAND USE CODE	LAND USE DESCRIPTION	UNITS	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#210	Single-Family Detached Housing	227 Houses	2,211	25%	75%		63%	37%	
				41	125	166	141	83	224
Local Trip Rate	Single-Family Attached Housing	95 Houses	912	22%	78%		55%	45%	
				11	40	51	41	33	74
Total New Volume Site Trips			3,123	52	165	217	182	116	298

ITE Trip Generation Manual, 10th Edition and Local Trip Rates
Trips calculated by using Fitted Curve Equation

For the Brakebill Road Subdivision, with 227 single-family detached houses and 95 single-family attached houses, it is estimated that 52 vehicles will enter, and 165 will exit, for a total of 217 generated trips during the AM Peak Hour in the year 2025. Similarly, it is estimated that 182

vehicles will enter, and 116 will exit, for a total of 298 generated trips during the PM Peak Hour in the year 2025. The calculated trips generated for an average weekday could be expected to be approximately 3,123 vehicles for the proposed development in the year 2025. No trip reductions were included in the analysis.

■ **TRIP DISTRIBUTION AND ASSIGNMENT:**

Figures 6a and 6b show the projected distribution for traffic entering and for traffic exiting, respectively, for the proposed development during the future AM and PM peak hours at the existing studied intersections and the new proposed intersections on Hammer Road and Brakebill Road. The percentages shown in the figures only pertain to the new trips generated by the proposed single-family detached residential lots that were calculated from the ITE and local trip generation rates.

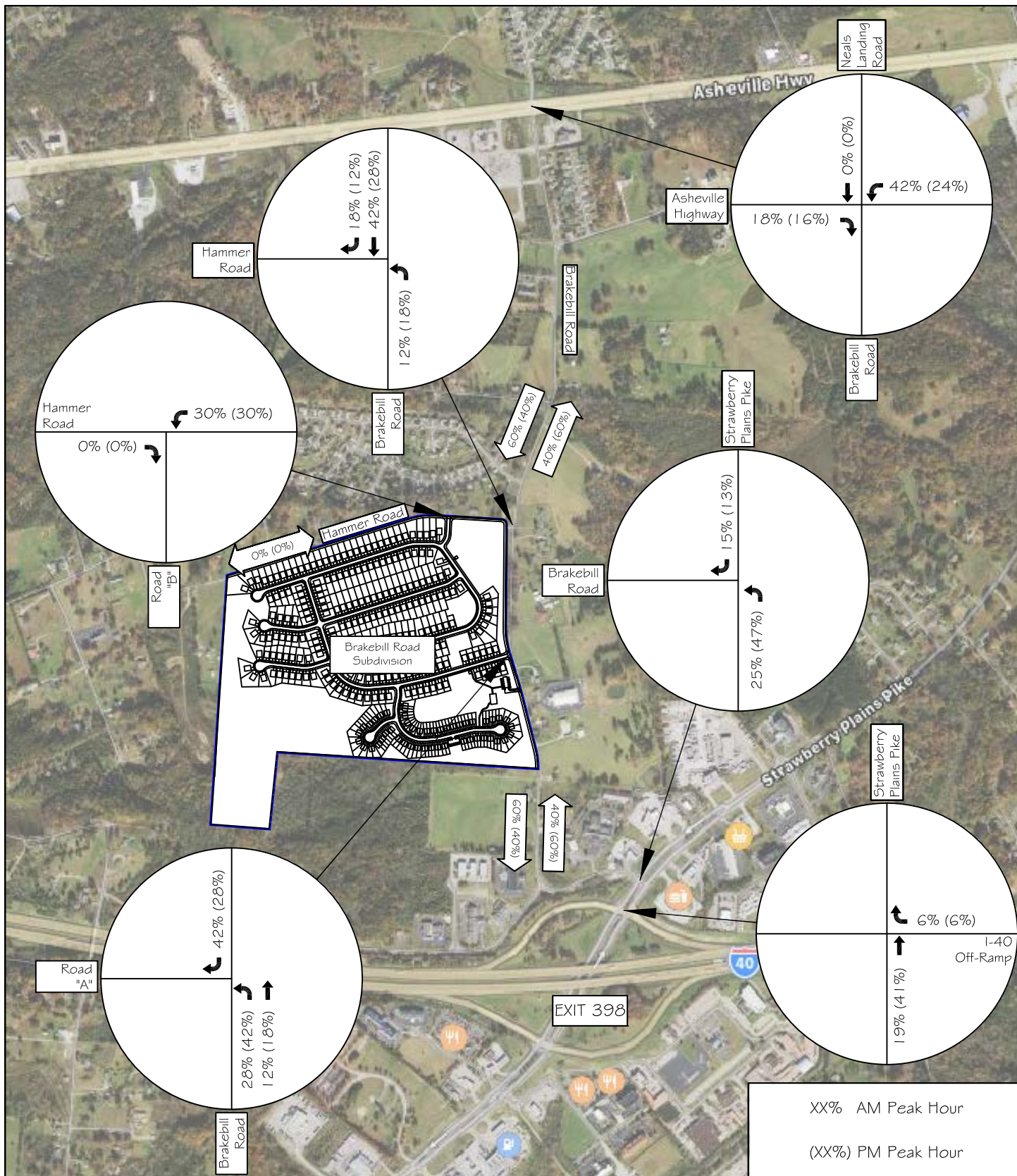
There are a variety of destinations that will potentially “attract” the projected traffic to and from the new development. These destinations will be accessed by utilizing Asheville Highway (US 25W/Hwy 11E) to the north and Strawberry Plains Pike to the south and east via Brakebill Road. In addition to employment centers and commercial development, traffic will travel to and from a variety of public and private elementary, middle, and high schools. This proposed development is zoned for Sunnyview Primary School, Carter Middle School, and Carter High School. These schools are located to the north of the proposed residential development. This would suggest there will be residential traffic to and from the north on Brakebill Road for those who do not utilize public school bus transportation.

To help estimate the projected trip distribution, and as discussed earlier, an additional traffic count was conducted just to the north of the project site at the intersection of Kilbridge Drive and Brakebill Road during the AM and PM peak hours. This intersection serves as an access point on Brakebill Road to an existing residential subdivision named Stonehaven. Stonehaven has several dozen single-family detached residential homes and has been filled out and is an established neighborhood. The results of this count are shown in Figure 4c and Appendix E. This count was conducted to gain a better understanding of the existing traffic patterns of a nearby residential development during the peak hours of traffic. This data was then correlated to the proposed traffic for the Brakebill Road Subdivision. Since this was an existing similar land use near this study development, the turning movement counts from Kilbridge Drive were assumed to be a reasonable estimate for the Brakebill Road Subdivision travel patterns and were used to help allocate the future traffic distribution. Based on this traffic count, an overall 60/40 split was assumed for travel to and from the north and south via Brakebill Road.

The traffic distributions shown and portioned at the new proposed intersections on Hammer Road and Brakebill Road for the residential development were based on assumed internal travel

times/distances and the layout within the development and the overall assumed 60/40 split. Specifically, with two entrances, it was assumed that 70% of generated traffic would enter and exit the intersection of Brakebill Road at Road "A". A smaller portion of 30% was assumed to enter and exit at the intersection of Hammer Road at Road "B". Also, it was assumed that none of the development traffic would enter or exit from and to the western side of Hammer Road. It is expected that only a minimal amount of traffic will come from or travel in this direction. A spreadsheet was developed to facilitate these trip distribution calculations, and the results are shown in Appendix I.

Figures 7a and 7b show the Traffic Assignment of the computed generated trips for traffic entering and for traffic exiting, respectively, at the new development during the future AM and PM peak hours. This assignment is based on the assumed distribution of trips shown in Figures 6a and 6b, and the total trips generated shown in Table 6.



11812 Black Road
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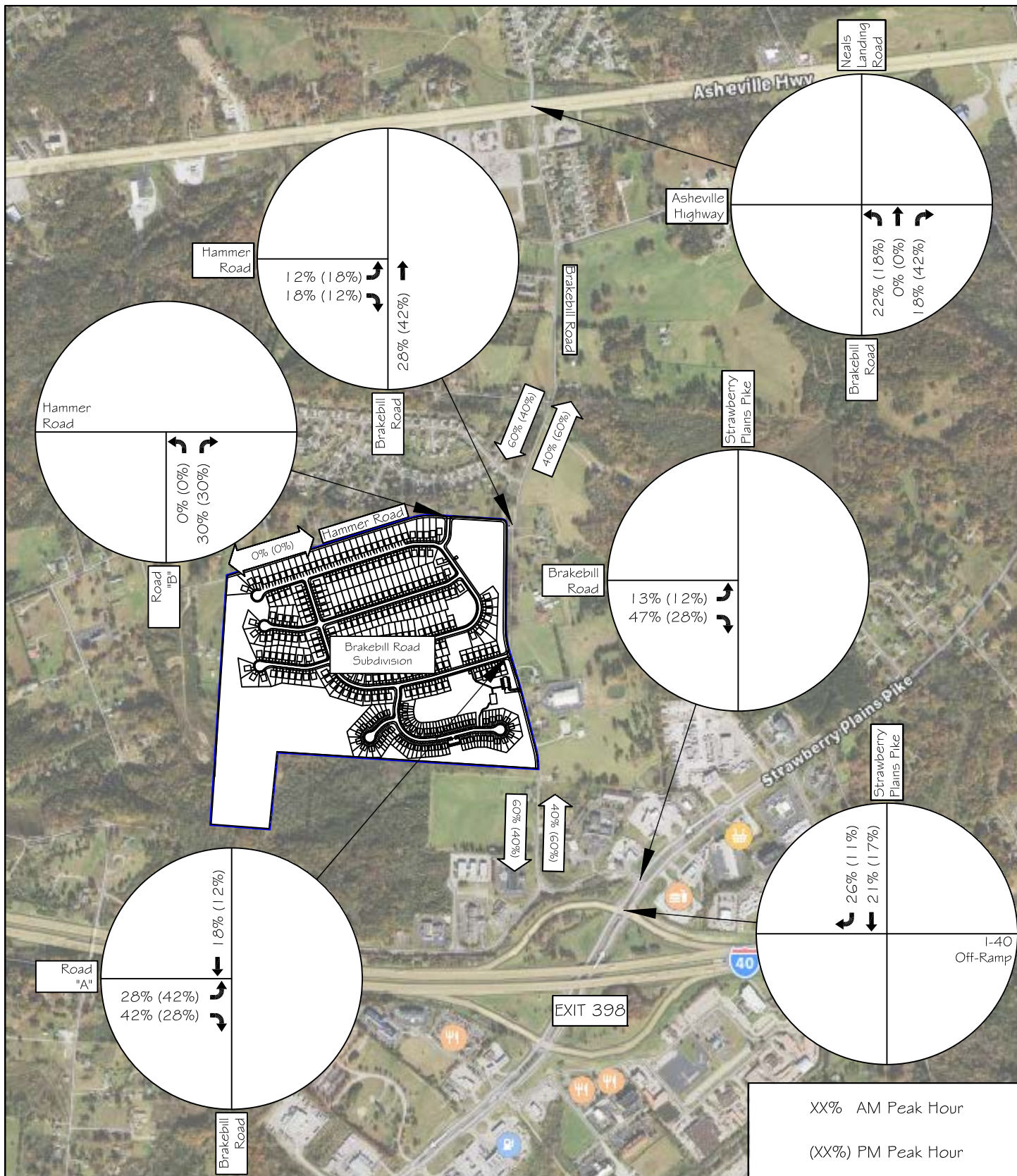
NOT TO SCALE



FIGURE 6a

Brakebill Road Subdivision

ENTERING
 Directional Distribution of Generated
 Traffic during AM and PM Peak Hour



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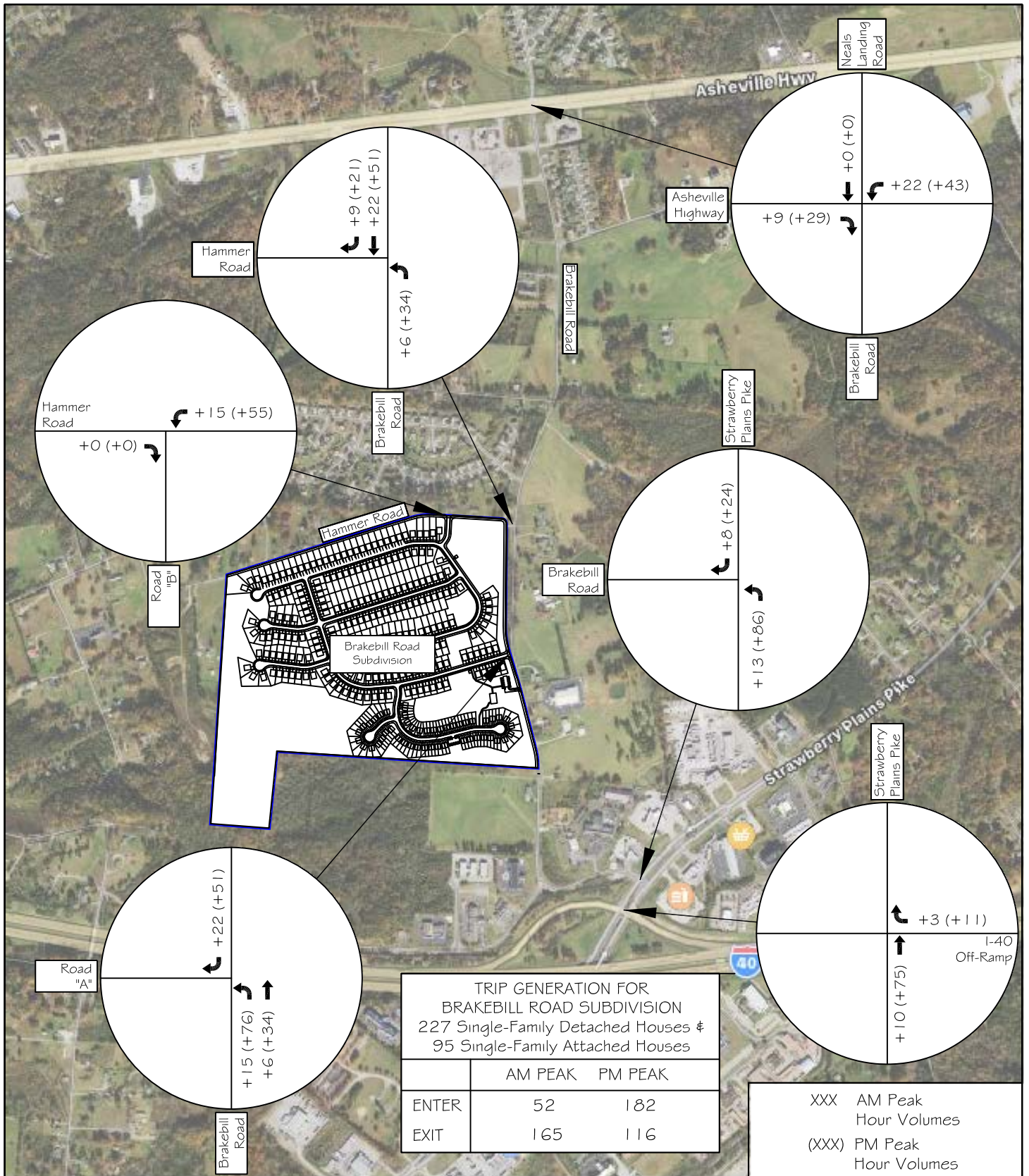


FIGURE 6b

Brakebill Road Subdivision

EXITING

Directional Distribution of Generated Traffic during AM and PM Peak Hour

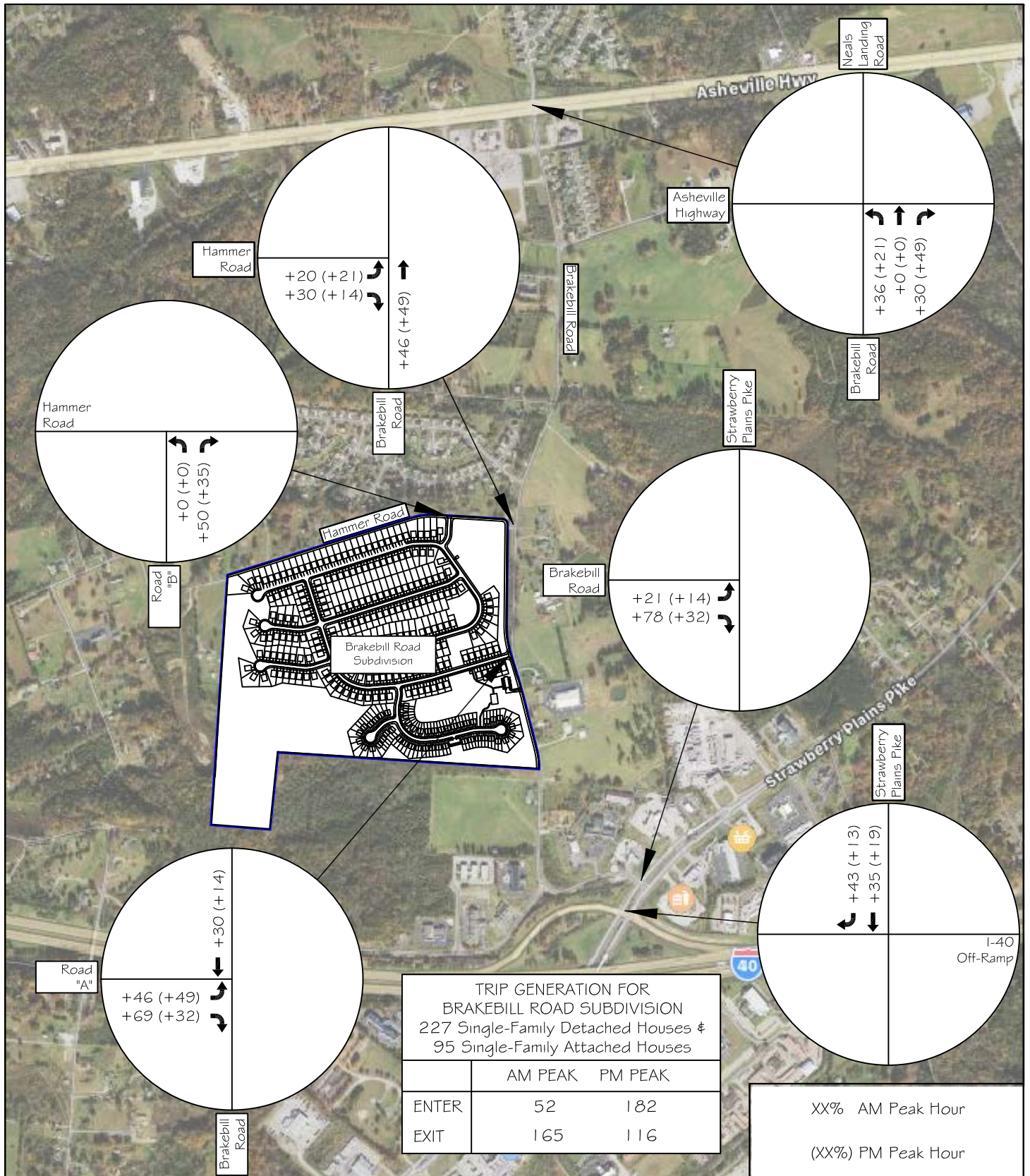


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NORTH

FIGURE 7a
 Brakebill Road Subdivision
 ENTERING
 Traffic Assignment of Generated Traffic during AM and PM Peak Hour



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FIGURE 7b

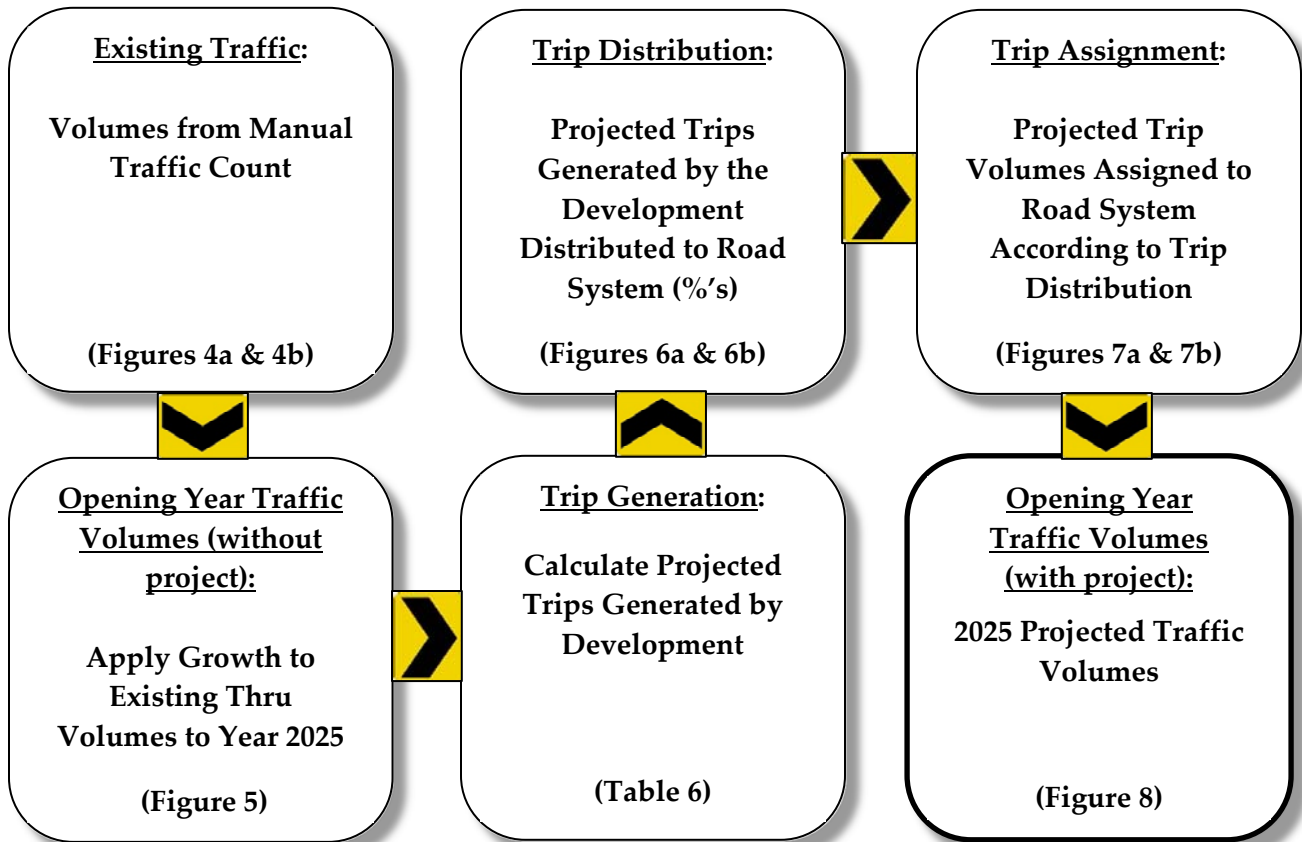
Brakebill Road Subdivision

EXITING

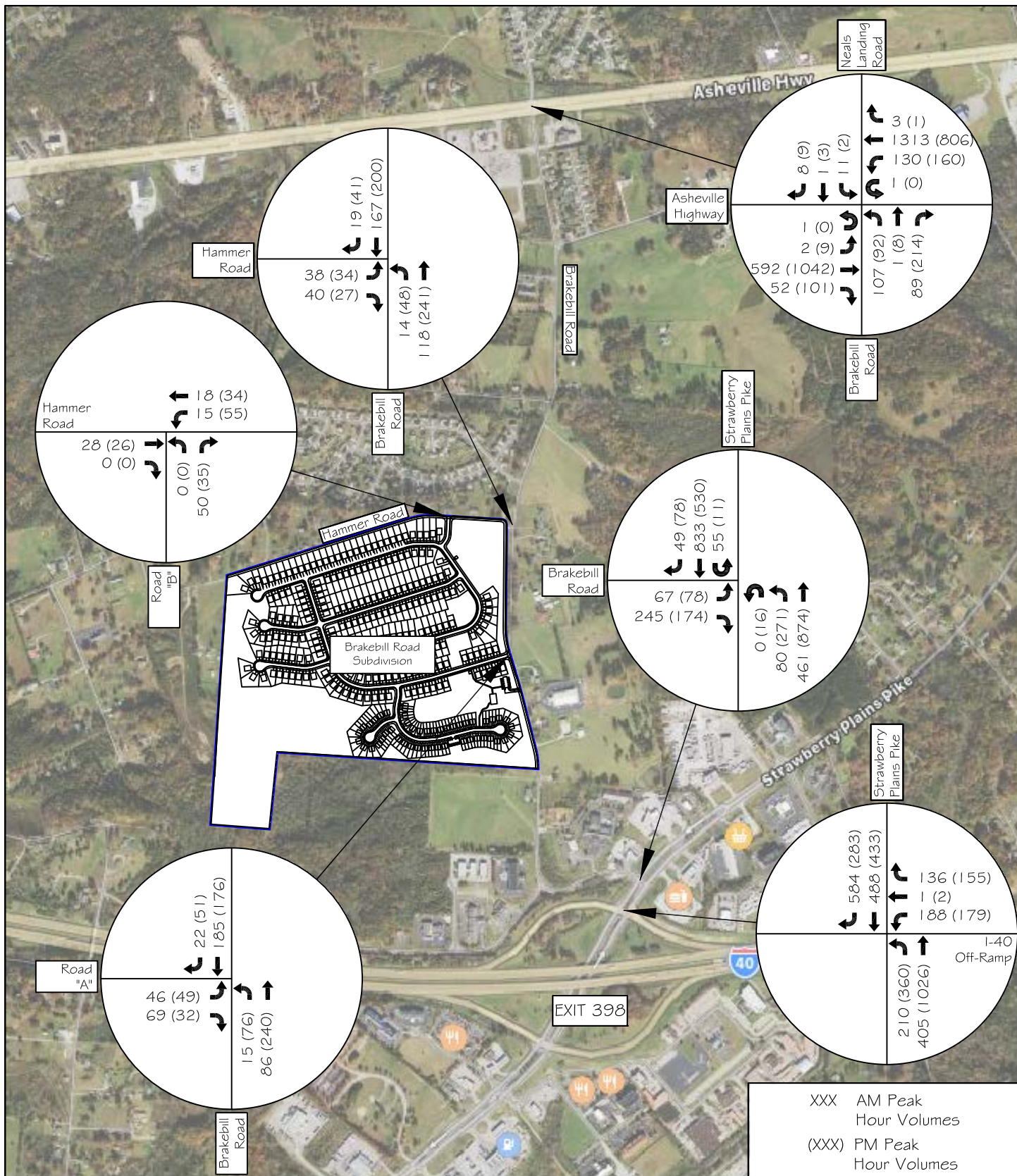
Traffic Assignment of Generated Traffic during AM and PM Peak Hour

■ **OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT):**

Overall, several additive steps were taken to estimate the total opening year projected traffic volumes at the studied intersections when the Brakebill Road Subdivision is fully constructed and occupied by the year 2025. The steps are illustrated below for clarity:



To calculate the total future projected traffic volumes at the studied intersections, the calculated peak hour traffic (from ITE Trip Generation and local trip rates) generated by the new Brakebill Road Subdivision were added to the 2025 opening year traffic (shown in Figure 5) by following the predicted directional distributions and assignments (shown in Figures 6a & 6b and 7a & 7b). This procedure was necessary to obtain the total projected traffic volumes at the time the development is fully built-out and occupied in the year 2025. Figure 8 shows the projected AM and PM peak hour volumes at the studied intersection for the year 2025 with the development traffic.



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NOT TO SCALE



FIGURE 8

Brakebill Road Subdivision

2025 Peak Hour Traffic Volumes -
OPENING YEAR TRAFFIC (WITH
PROJECT)

Capacity analyses were conducted to determine the projected Level of Service for vehicles at the existing and proposed intersections for the year 2025 with the development traffic. Appendix G includes the worksheets for these capacity analyses.

The results of the capacity calculations of the projected 2025 peak hour vehicular traffic at the studied intersections can be seen in Tables 7a, 7b, and 7c for the AM and PM peak hours. Table 7a contains the results for the two existing unsignalized intersections. Table 7b contains the results for the two proposed unsignalized intersections (subdivision entrances). Table 7c contains the results of the two existing signalized intersections. As can be seen in Table 7a, the eastbound left-turn movements at the intersection of Strawberry Plains Pike at Brakebill Road (previously calculated to operate poorly) will suffer intolerable delays in the projected conditions. This movement was shown to have a v/c ratio of 1.344 in the AM peak hour and 1.176 in the PM peak hour.

The new proposed intersections on Hammer Road and Brakebill Road are shown to operate very well with respect to level of service under unsignalized conditions in the future projected conditions, as shown in Table 7b. As shown in Table 7c, the existing intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side) is projected to operate with an overall v/c ratio of 1.00 during the PM peak hour which means the projected vehicle volumes are just at capacity. A v/c ratio will result in unstable traffic conditions and excessive vehicle queues.

Following Tables 7a thru 7c, summaries of the intersection analysis results are presented in Tables 8a thru 8d. These tables provide a side by side summary of each intersection for the existing conditions, the projected conditions in the year 2025 without the project, and the projected conditions in the year 2025 with the project.

TABLE 7a
2025 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITH PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Hammer Road at Brakebill Road	STOP Unsignalized	Northbound Left	A	7.7	0.018	A	8.1	0.053
		Eastbound Left/Right	B	12.4	0.209	C	15.9	0.251
Strawberry Plains Pike at Brakebill Road	STOP Unsignalized	Northbound Left	B	12.9	0.210	C	16.4	0.551
		Eastbound Left	F	297.5	1.344	F	242.0	1.176
		Eastbound Right	C	21.1	0.547	B	12.6	0.293

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

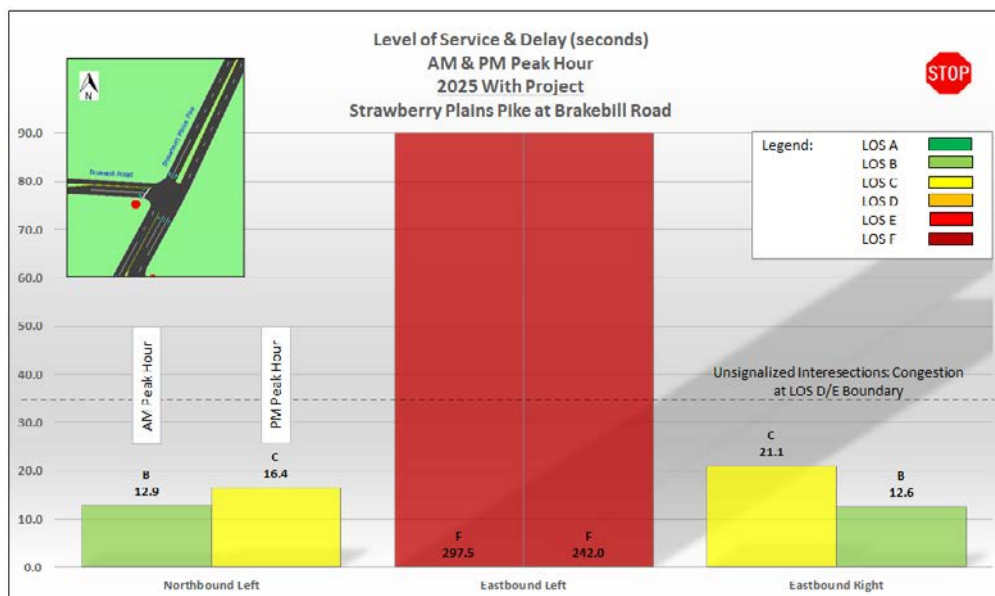
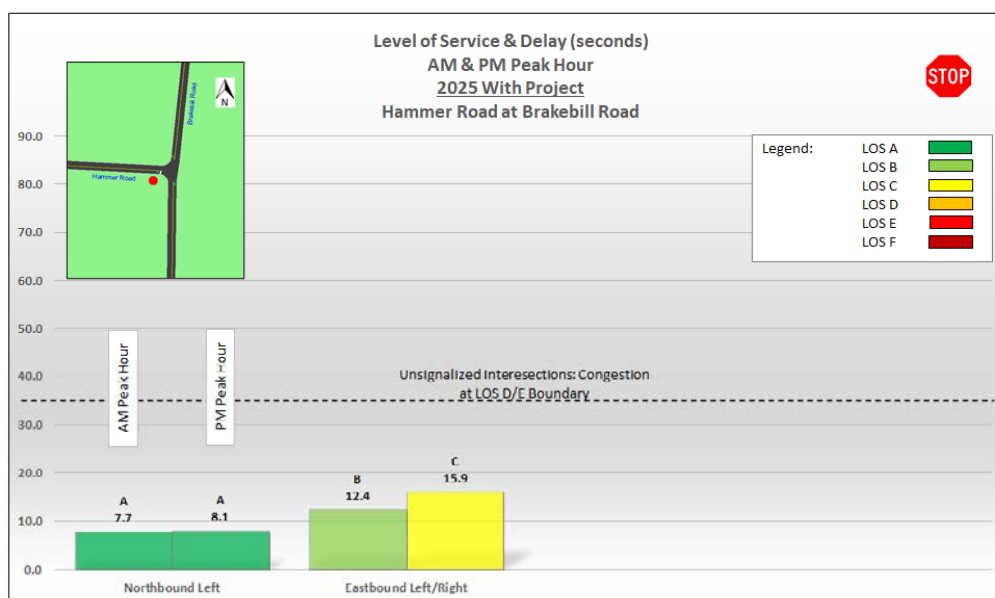




TABLE 7b
2025 NEW UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITH PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Brakebill Road at Road "A"	 Unsignalized	Northbound Left	A	7.7	0.012	A	7.9	0.064
		Eastbound Left/Right	B	10.8	0.172	B	13.8	0.180
Hammer Road at Road "B"	 Unsignalized	Northbound Left/Right	A	8.6	0.053	A	8.6	0.037
		Westbound Left	A	7.3	0.010	A	7.3	0.038

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

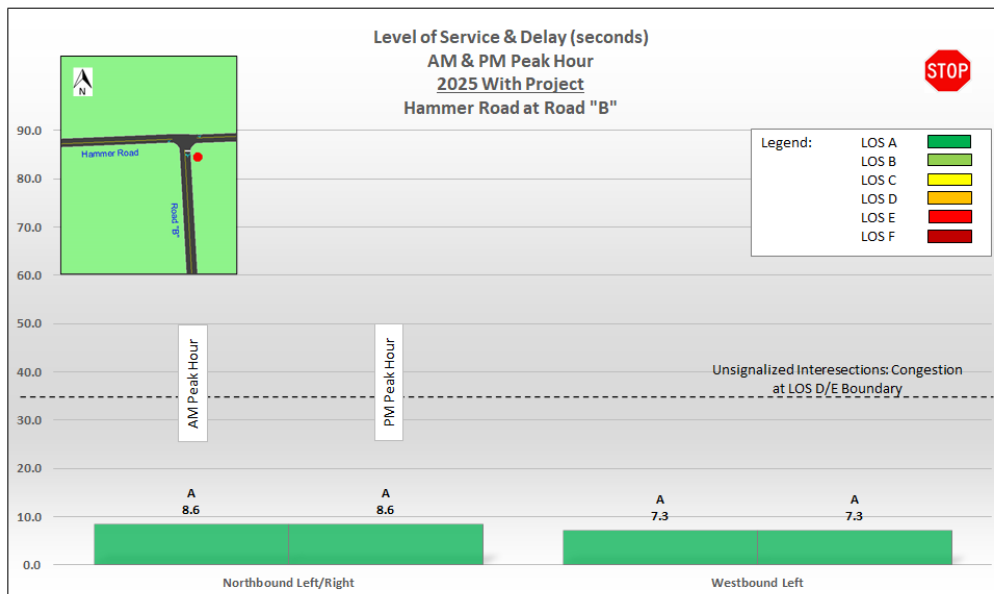
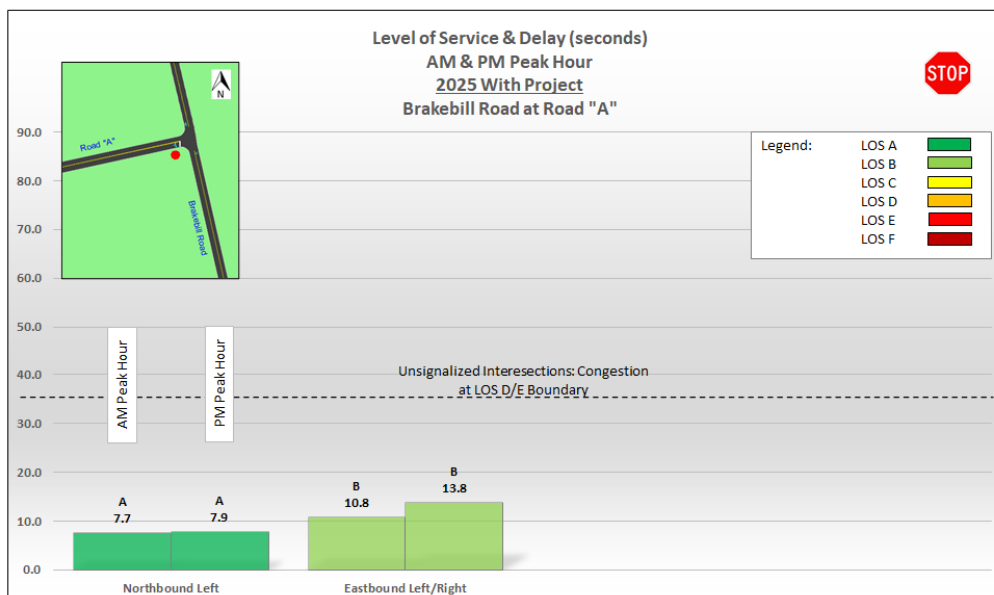


TABLE 7c
2025 SIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITH PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway at Brakebill Road	Signalized	Eastbound	B	18.5	0.740	C	22.8	0.710
		Westbound	C	19.6		B	14.6	
		Northbound	C	35.5		D	41.3	
		Southbound	D	41.7		D	50.1	
		Summary	C	21.3		C	22.2	
Strawberry Plains Pike at Interstate 40 On / Off Ramp (north side)	Signalized	Westbound	C	30.0	0.750	C	31.4	1.000
		Northbound	B	13.2		C	27.2	
		Southbound	B	13.1		B	11.1	
		Summary	B	16.0		C	23.0	

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

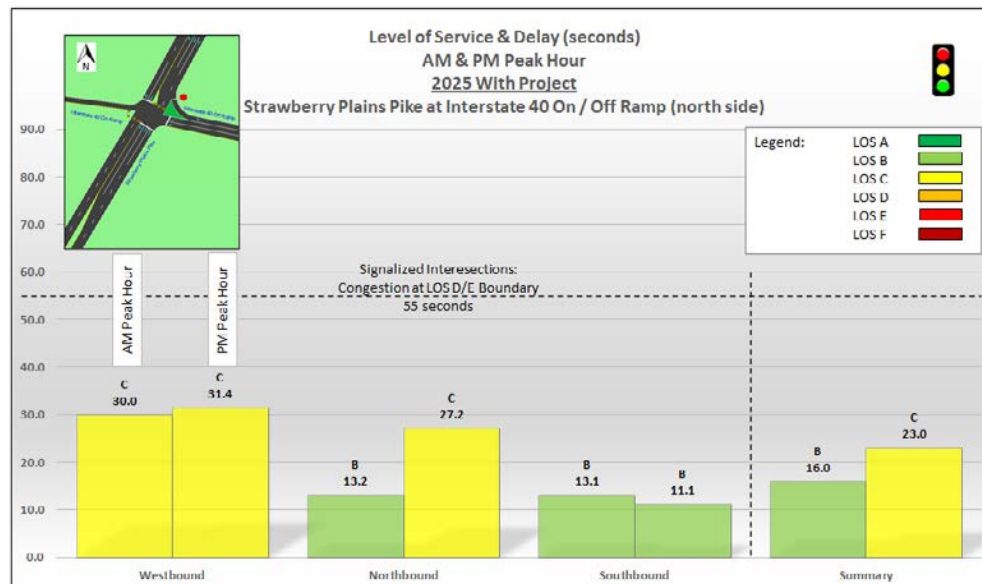
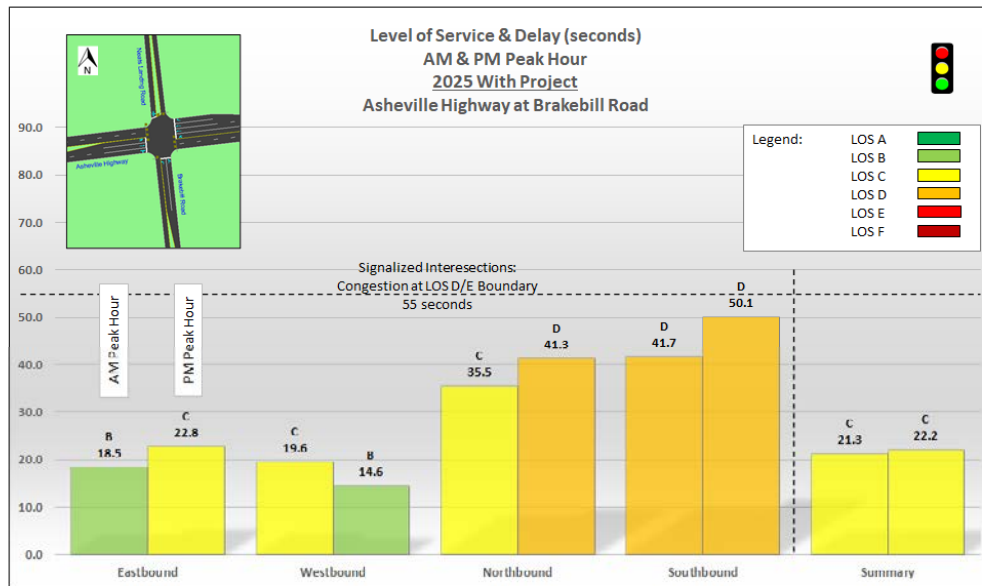



TABLE 8a
INTERSECTION CAPACITY ANALYSIS SUMMARY
HAMMER ROAD AT BRAKEBILL ROAD

LOCATION / PEAK HOUR MOVEMENT	2020 EXISTING			2025 WITHOUT PROJECT			2025 WITH PROJECT		
	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c
Hammer Road at Brakebill Road 									
AM Peak									
Northbound Left	A	7.6	0.008	A	7.6	0.010	A	7.7	0.018
Eastbound Left/Right	B	10.4	0.065	B	10.7	0.072	B	12.4	0.209
PM Peak									
Northbound Left	A	7.7	0.012	A	7.8	0.014	A	8.1	0.053
Eastbound Left/Right	B	10.9	0.062	B	11.4	0.077	C	15.9	0.251

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

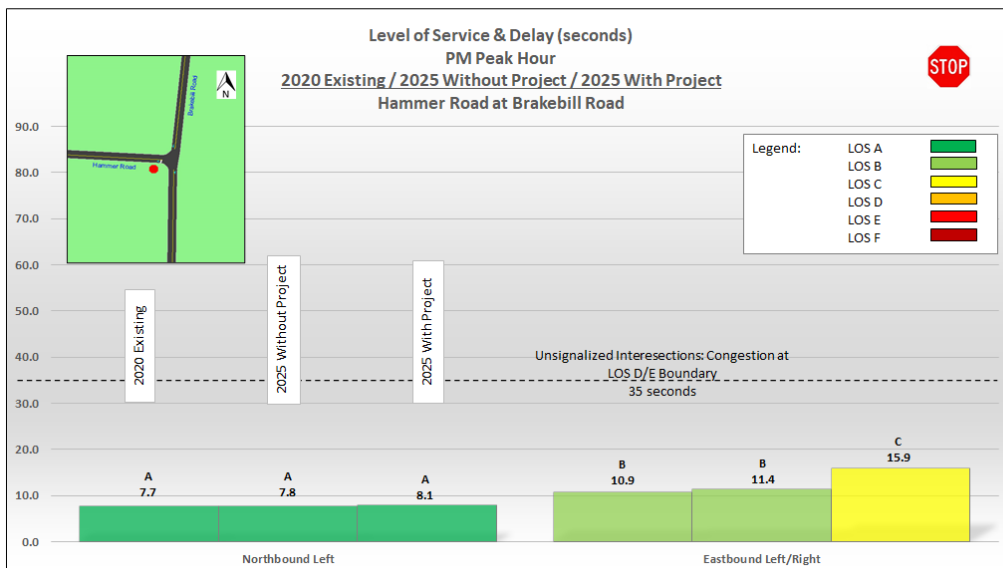
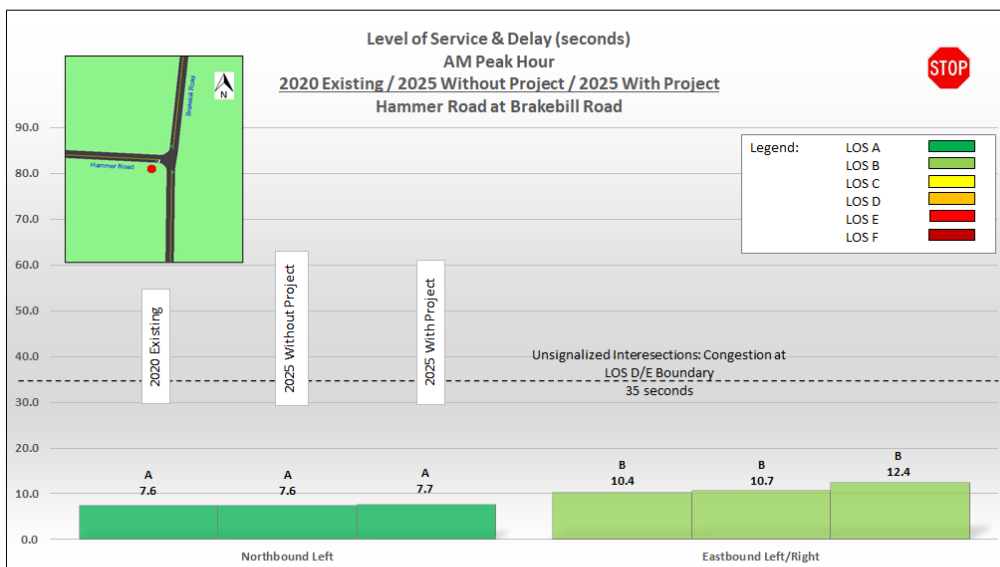


TABLE 8b
INTERSECTION CAPACITY ANALYSIS SUMMARY
STRAWBERRY PLAINS PIKE AT BRAKEBILL ROAD

LOCATION / PEAK HOUR MOVEMENT	2020 EXISTING			2025 WITHOUT PROJECT			2025 WITH PROJECT		
	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c
STOP									
Strawberry Plains Pike at Brakebill Road									
AM Peak									
Northbound Left	B	11.5	0.142	B	12.5	0.174	B	12.9	0.210
Eastbound Left	F	68.8	0.595	F	128.5	0.838	F	297.5	1.344
Eastbound Right	B	14.9	0.310	C	16.7	0.369	C	21.1	0.547
PM Peak									
Northbound Left	B	10.6	0.254	B	11.3	0.300	C	16.4	0.551
Eastbound Left	E	46.1	0.468	F	71.2	0.631	F	242.0	1.176
Eastbound Right	B	11.3	0.202	B	11.8	0.233	B	12.6	0.293

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

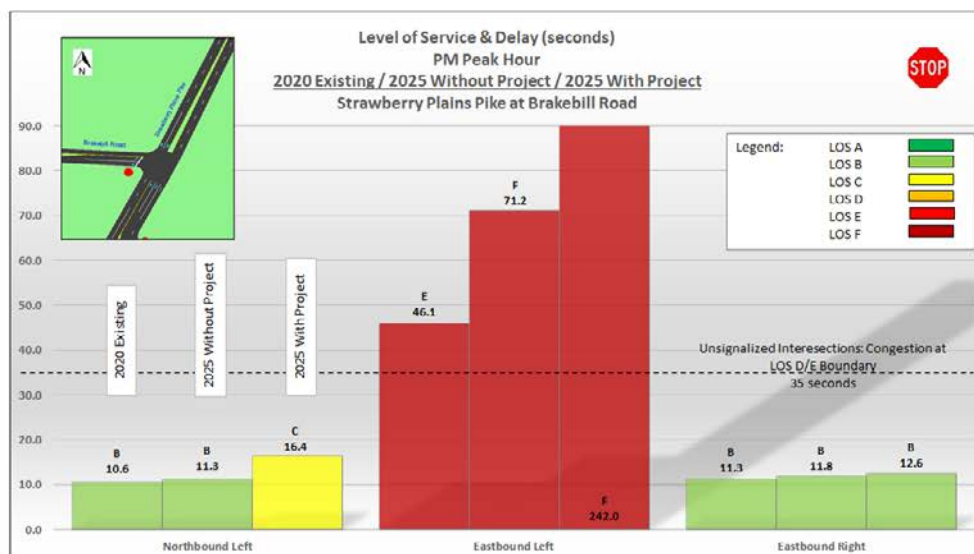
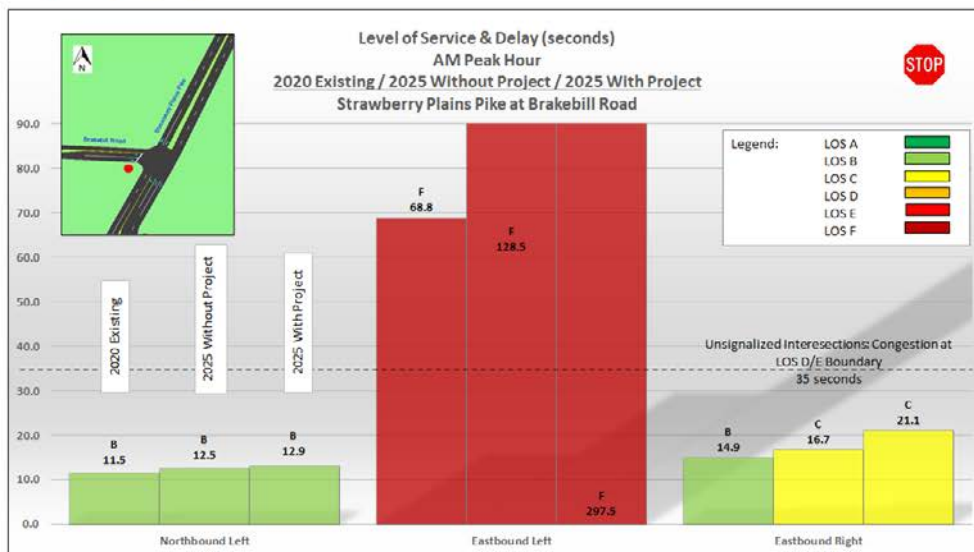


TABLE 8c
INTERSECTION CAPACITY ANALYSIS SUMMARY
ASHEVILLE HIGHWAY AT BRAKEBILL ROAD

LOCATION / PEAK HOUR MOVEMENT	2020 EXISTING			2025 WITHOUT PROJECT			2025 WITH PROJECT		
	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c
Asheville Highway at Brakebill Road 									
AM Peak									
Eastbound	B	14.7		B	16.5		B	18.5	
Westbound	B	14.1		B	17.8		C	19.6	
Northbound	D	36.7		C	35.0		C	35.5	
Southbound	D	40.2		D	40.6		D	41.7	
Summary	B	16.3	0.650	B	19.0	0.710	C	21.3	0.740
PM Peak									
Eastbound	C	20.5		C	20.7		C	22.8	
Westbound	B	12.4		B	12.6		B	14.6	
Northbound	C	33.6		D	37.1		D	41.3	
Southbound	D	42.0		D	45.8		D	50.1	
Summary	B	18.7	0.610	B	19.3	0.650	C	22.2	0.710

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume to Capacity Ratio

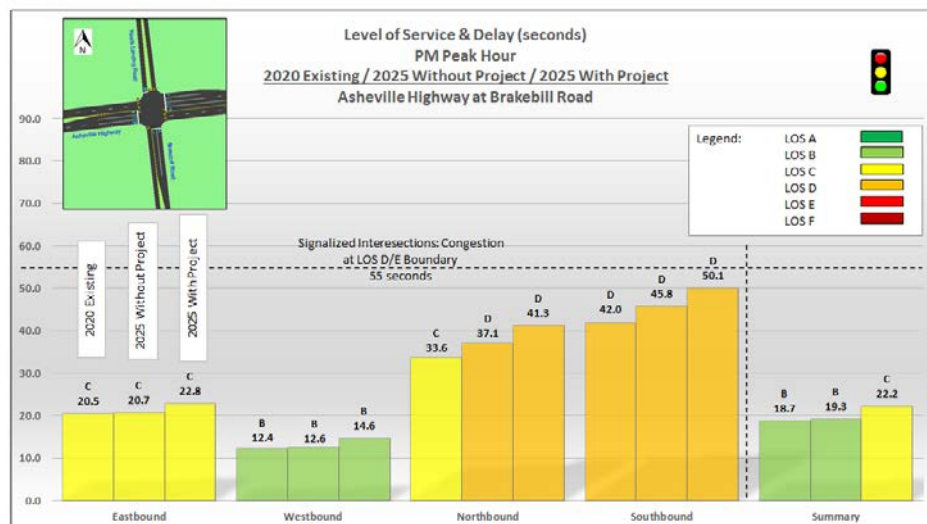
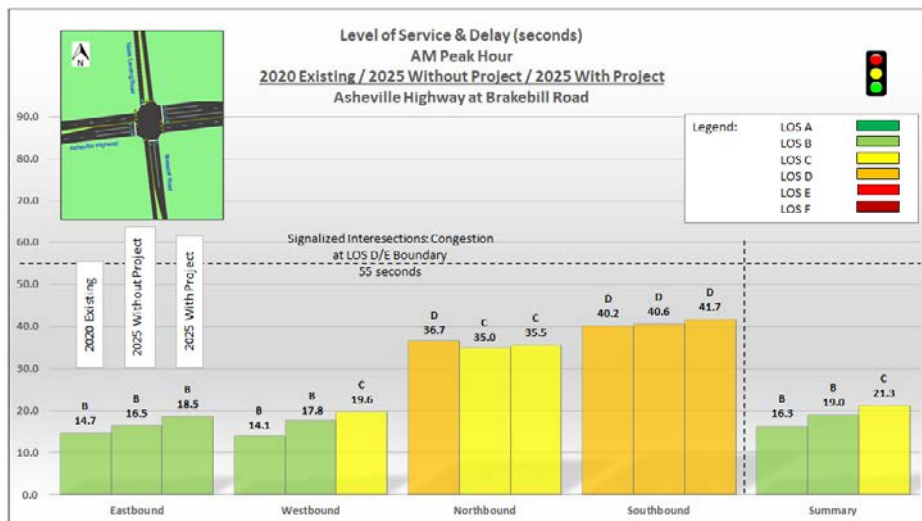


TABLE 8d
INTERSECTION CAPACITY ANALYSIS SUMMARY
STRAWBERRY PLAINS PIKE AT INTERSTATE 40 ON / OFF RAMP (NORTH SIDE)

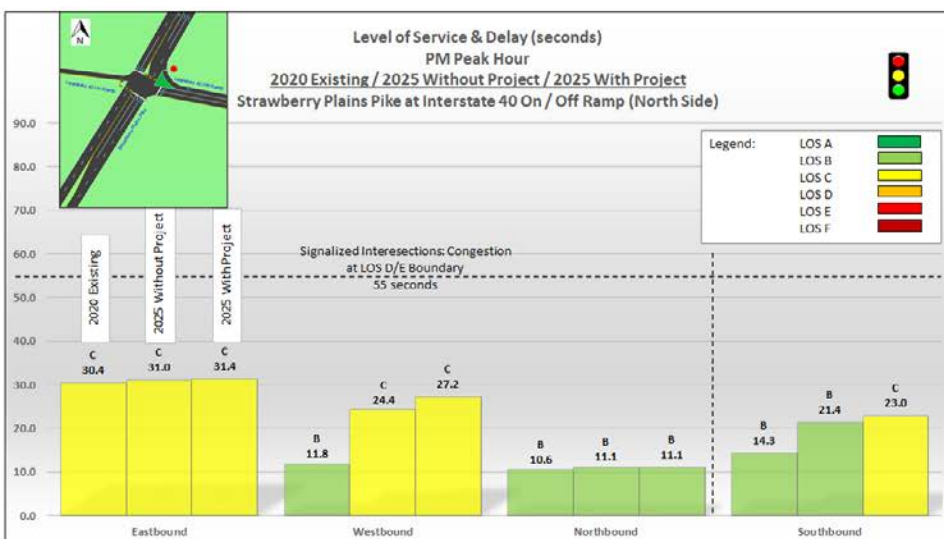
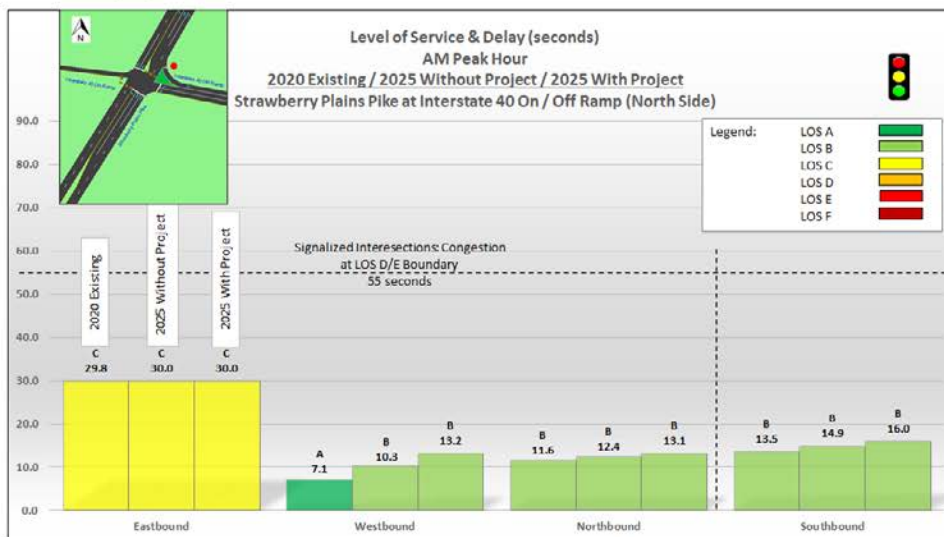
LOCATION / PEAK HOUR MOVEMENT	2020 EXISTING			2025 WITHOUT PROJECT			2025 WITH PROJECT		
	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c	LOS ^a	Delay ^b	v/c ^c
Strawberry Plains Pike at Interstate 40 On / Off Ramp (North Side)									
AM Peak									
Westbound	C	29.8		C	30.0		C	30.0	
Northbound	A	7.1		B	10.3		B	13.2	
Southbound	B	11.6		B	12.4		B	13.1	
Summary	B	13.5	0.590	B	14.9	0.710	B	16.0	0.750
PM Peak									
Westbound	C	30.4		C	31.0		C	31.4	
Northbound	B	11.8		C	24.4		C	27.2	
Southbound	B	10.6		B	11.1		B	11.1	
Summary	B	14.3	0.830	B	21.4	0.970	C	23.0	1.000

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio



■ **POTENTIAL SAFETY ISSUES:**

The study area was investigated for potential existing and future safety issues. A couple of features of the adjacent transportation system are discussed in the following pages.

■ **SPOT SPEED STUDY**

A spot speed study was conducted in March of 2018 (during the previous unrelated study) on the northbound and southbound approaches of Brakebill Road at two locations to determine free-flow speeds. The equipment used for the speed study was a Bushnell Speedster III Radar Speed Gun. The results of the study indicate that most of the traffic along Brakebill Road adjacent to the proposed development travels at a higher speed than the posted speed limit of 30 mph. The results of the spot speed study indicated that the observed 85th percentile speed was 40 mph for traffic on Brakebill Road near the proposed Road “A” intersection. The results of the spot speed study also indicated that the observed 85th percentile speed was 45 mph for traffic on Brakebill Road near the Hammer Road intersection. The spot speed field observations are provided in Appendix J.

■ **EVALUATION OF TURN LANE THRESHOLDS**

The proposed entrance intersections were evaluated for the need for separate turn lanes for entering vehicles into the development in the year 2025. The design policy that was used for these turn lane evaluations is based on “Knox County’s Access Control and Driveway Design Policy”. This design policy by Knox County relates vehicle volume thresholds based on prevailing speeds for two-lane and four-lane roadways. This Knox County policy is based on TDOT and nationally accepted guidelines for unsignalized intersections. A determination was made whether turn lanes are warranted using these criteria.

Based on the projected 2025 traffic volumes at the proposed Brakebill Road at Road “A” intersection and according to “Knox County’s Access Control and Driveway Design Policy”, a separate northbound left-turn lane on Brakebill Road will be just slightly below the warrant for entering vehicles and a separate southbound right-turn lane is not warranted. Even though the threshold for the northbound left-turn lane is not fully met, it is nonetheless recommended that this lane be provided. Separate left and right-turn lanes are not warranted at the intersection of Hammer Road at Brakebill Road or the proposed Hammer Road at Road “B” intersection. The

Knox County turn lane policy worksheets are in Appendix K.

The speed classification that was chosen for this evaluation was based on the spot speed study on Brakebill Road that showed the 85th percentile speeds of 40 mph and 45 mph. Therefore, this study evaluation used the Knox County classification for speeds of 36 to 45 mph with the calculated projected volumes for the intersections on Brakebill Road. For the intersection of Hammer Road at Road “B”, the intersection evaluation was based on the posted speed limit of 30 mph. Therefore, this intersection evaluation used the Knox County classification for speeds of 35 mph or less with the calculated projected volumes.

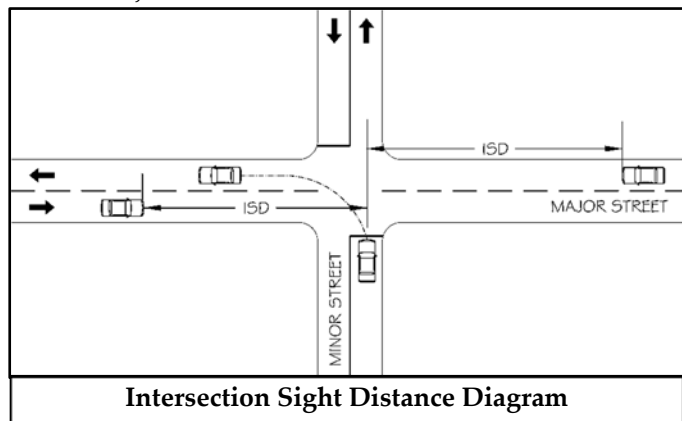
➤ **EVALUATION OF SIGHT DISTANCE**

For evaluating intersections, sight distance evaluations can be categorized into two categories: Stopping Sight Distance (SSD) and Intersection Sight Distance (ISD).

Methodology:

SSD is the distance required for a motorist to perceive, react, and for their vehicle to come to a complete stop before colliding with an object in the road. For evaluating intersections, this object would be another vehicle entering the intersection from a minor street. SSD can be considered the minimum visibility distance standard for evaluating the safety of an intersection.

ISD is based on the time required to perceive, react, and complete the desired traffic maneuver once a motorist on a minor street decides to perform a traffic maneuver. Three traffic maneuvers are available for vehicles stopped on a minor street at a 4-way intersection: left-turn from the minor road, right-turn from the minor road, and a crossing maneuver from the minor road across the major road. For turns from the minor street, ISD is needed to allow a stopped motorist on a minor street to turn onto a major street without being overtaken by an approaching vehicle. The most critical (longest) ISD is for left-turns from the minor street. The ISD for this maneuver includes the time to turn left and to



Intersection Sight Distance Diagram

clear half of the intersection without conflicting with the oncoming traffic from the left and to accelerate to the operating speed of the road without causing the approaching vehicles from the right to reduce their speed substantially. SSD can be considered the desirable visibility distance standard for evaluating the safety of an intersection. In general, SSD is generally more critical than ISD; however, the ISD must be at least the same distance or greater than SSD to provide safe operations at an intersection.

Based on an observed and calculated 85th percentile speed of 40 mph on Brakebill Road near the proposed Road “A” intersection; the required intersection sight distance would be 400 feet looking each direction at the intersection of Brakebill Road at Road “A” based on Knox County policy of requiring 10 feet of sight distance per 1 mph of speed. Based on an existing grade of 5% on Brakebill Road at the proposed Road “A” intersection, the SSD is calculated to be 330 feet for northbound vehicles (-5%) and 285 feet for southbound vehicles (+5%).

Based on a posted speed limit of 30 mph on Hammer Road, the required intersection sight distance would be 300 feet looking each direction at the intersection of Hammer Road at Road “B” based on Knox County policy of requiring 10 feet of sight distance per 1 mph of speed. Based on an existing grade of 8% on Hammer Road at the proposed Road “B” intersection and a speed of 30 mph, the SSD is calculated to be 225 feet for eastbound vehicles (-8%) and 185 feet for westbound vehicles (+8%).

A cursory examination of the sight distances at the proposed intersection locations on Brakebill Road and Hammer Road was undertaken. Using a Nikon Laser Rangefinder at the intersection of Brakebill Road at Road “A”, the sight distance was estimated to be approximately +550 feet to the north and +380 feet to the south looking from the proposed location of Road “A”. The visual estimate of 380 feet to the south is less than the ISD requirement of 400 feet. A more accurate measurement will need to be undertaken by a licensed land surveyor.

Using a Nikon Laser Rangefinder at the intersection of Hammer Road at Road “B”, the sight distance was estimated to be approximately +350 feet to the west, +375 feet to the east looking from the proposed location of Road “B”, and appears to meet the ISD and SSD requirements. A more accurate measurement will need to be undertaken by a licensed land surveyor.



View of Sight Distance on Hammer Road at Proposed Road "B" Intersection (Looking West from Road "B" Location)



View of Sight Distance on Hammer Road at Proposed Road "B" Intersection (Looking East from Road "B" Location)



View of Sight Distance on Brakebill Road at Proposed Road "A" Intersection (Looking North from Road "A" Location)



View of Sight Distance on Brakebill Road at Proposed Road "A" Intersection (Looking South from Road "A" Location)

► **DISCUSSION OF VEHICLE CRASHES ON BRAKEBILL ROAD**

There are several issues related to the safety and efficiency of vehicle traffic within the study area. These issues include high vehicle delays/high vehicle volumes, sight distances, vehicle crashes, and vehicle speeds. As part of the study process, the primary access road for this proposed development, Brakebill Road, was investigated further regarding vehicle crash history.

The Knoxville/Knox County Planning Department provided traffic crash data for Brakebill Road from the past three years. This data was obtained from the TDOT E-TRIMS (Enhanced Tennessee Roadway Information Management System) database. The crash data in the E-TRIMS system is from the statewide TITAN (Tennessee Integrated Traffic Analysis Network) database. The TITAN database includes all reportable vehicle crash data from Tennessee law enforcement agencies.

The crash data included the master record number, date and time, crash type, log mile location, number of injuries, weather conditions, light conditions, and number of vehicles involved. During the past three years (June 2017 to June 2020), the data showed 23 vehicle crashes occurring along Brakebill Road. A total of 10 crashes occurred on Strawberry Plains Pike at Brakebill Road. The total number of traffic crashes during the past three years is summarized in the following and further detailed in Figure 9:

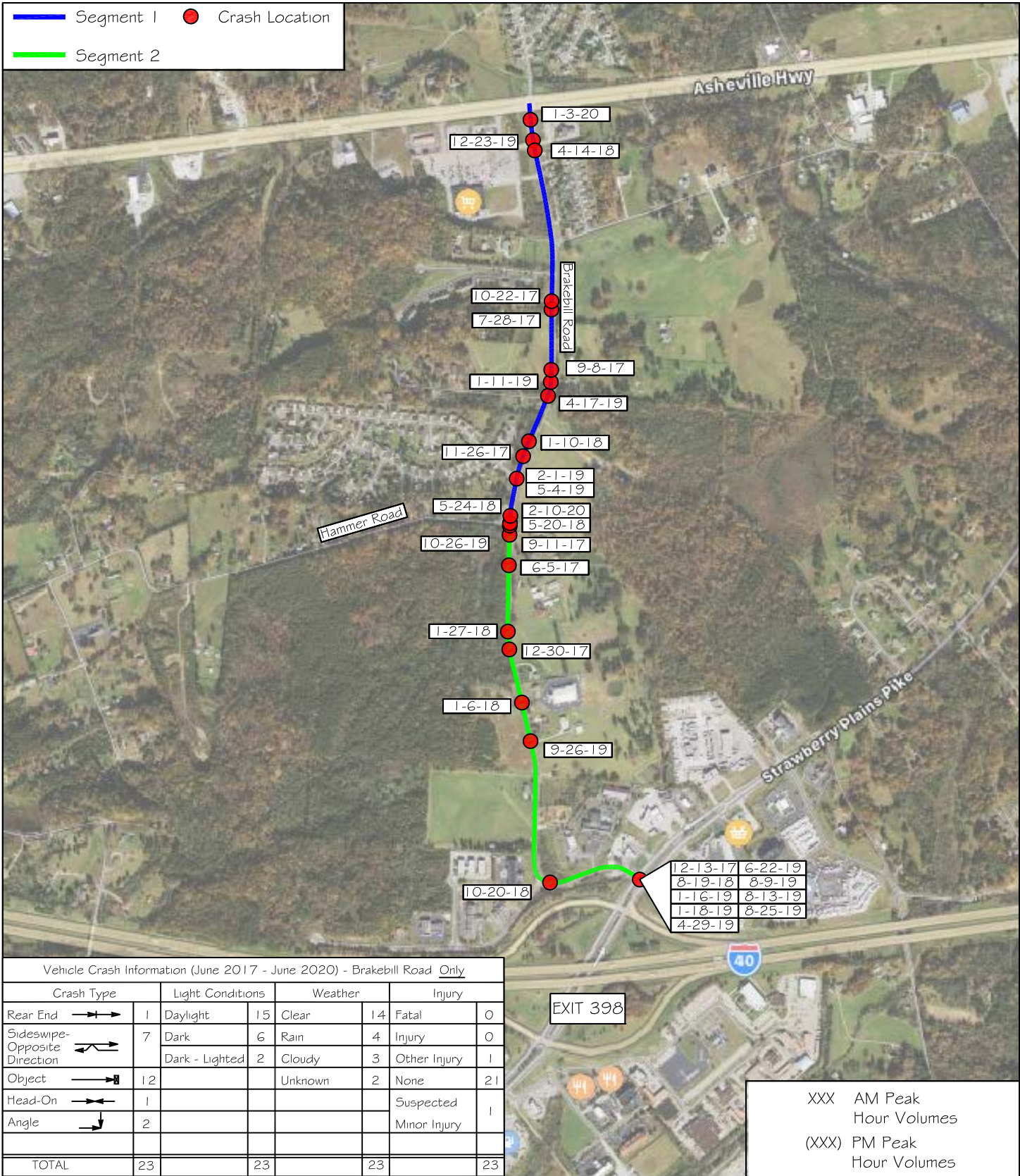
Crash Data from June 2017 to June 2020:

- o Brakebill Road – 23 Total Vehicle Crashes
 - 21 Vehicle Crashes with no injuries (property damage only)
 - 1 Vehicle Crash with two suspected minor injuries
 - 1 Vehicle Crash with one other injury
- o Strawberry Plains Pike at Brakebill Road – 9 Total Vehicle Crashes
 - 9 Vehicle Crashes with no injuries (property damage only)






A total of 17 out of 23 individual traffic crash reports that occurred on Brakebill Road were obtained from the Knox County Sheriff's Department. These crashes occurred on the Knox County portion of Brakebill Road. These individual crash reports provided more details into the specifics of each crash. Based on evaluating the obtained individual traffic crash reports that occurred on Brakebill Road, 10 of the 17 crashes indicated that the narrowness of Brakebill Road could have been a contributable factor. Of those ten crashes, six were opposite direction

sideswipe crashes in which vehicles suffered damage due to the vehicles swiping each other in the center of the road (many incidents were side-view mirrors being clipped). Two of the ten crashes involved striking off-road objects because the drivers perceived that an opposing vehicle was in their lane of traffic. These vehicles departed the roadway when their wheels left the pavement, and the driver lost control of their vehicles. Based on a review of the 23 crashes on Brakebill Road, wet pavement, weather, and time of day did not appear to be a causative factor. Only one vehicle crash occurred during wet weather (hydroplaned).

Based on statewide vehicle crash data, TDOT has compiled and calculated statewide crash rates for various types of intersections, road sections, and road spots in Tennessee based on rolling data from the past three years of current data. (TDOT defines a spot location as a section of roadway less than or equal to 0.10 mile.) This data is categorized by urban and rural areas, route type (major collector, local, etc.), type of roadway facility (number of lanes, etc.), and location type (intersection, section, or spot). The latest statewide crash rate tables for intersections, sections, and spots from TDOT was obtained for this study and is provided in Appendix L. The crash rates on Brakebill Road were investigated at two intersections and two sections. To calculate the section crash rates, Brakebill Road was broken into two sections: Asheville Highway (US 25W/Hwy 11E) to Hammer Road and Hammer Road to Strawberry Plains Pike. The intersection of Hammer Road at Brakebill Road and the intersection of Brakebill Road at Strawberry Plains Pike were calculated for an intersection crash rate. Other intersections on Brakebill Road (Crosswood Boulevard, Kilbridge Drive) did not experience enough crashes to consider analyzing.



Vehicle Crash Information (June 2017 - June 2020) - Brakebill Road Only

Crash Type	Light Conditions	Weather	Injury
Rear End 	1 Daylight	15 Clear	14 Fatal 0
Sideswipe-Opposite Direction 	7 Dark	6 Rain	4 Injury 0
	Dark - Lighted	2 Cloudy	3 Other Injury 1
Object 	12	Unknown	2 None 21
Head-On 	1		Suspected 1
Angle 	2		Minor Injury
TOTAL	23	23	23

XXX AM Peak Hour Volumes
(XXX) PM Peak Hour Volumes



11812 Black Road
Knoxville, TN 37932
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Email: ajaxengineering@gmail.com

NOT TO SCALE



FIGURE 9
Brakebill Road Subdivision
Vehicle Crash Data on Brakebill Road

TDOT has also developed a crash analysis computer file that compares the actual crash rates at roadway intersections, sections, and spots versus the state averages and is shown in Appendix L. Based on the number of crashes reported at the two intersections and the two road sections for the past three years; it does not appear that the calculated crash rates are considered high enough to obtain TDOT safety funding. To receive TDOT safety funding, the ratio of the actual crash rate to the critical crash rate (A/C ratio) would need to be 3.5 or higher. Appendix L includes the crash rate calculations for the two intersections and two road sections. The calculations show the actual crash rate vs. the statewide average crash rate (A/S) and the ratio of the actual crash rate vs. the critical crash rate (A/C). The critical crash rate (A/C) gives more weight to specific crash severities while the statewide average comparison (A/S) only considers total numbers. The calculated ratios are shown in the following table for the two intersections and two road sections, respectively:

Table 9
TDOT Vehicle Crash Rate Calculations

Strawberry Plains Pike, Knox County				LM 8.803
Intersection (Strawberry Plains Pike at Brakebill Road)				
9 Crashes	- 2017 - 2020	Actual	- 0.828	Acc/MVM
State Average	- 0.119	Acc/MVM	Critical	- 0.409
A/S Ratio	= 6.96		A/C Ratio	= 2.03
0 Fatal Crash		0 Incap. Injury Crash		0 Other Injury Crash
Brakebill Road, Knox County				LM 0.629
Intersection (Hammer Road at Brakebill Road)				
2 Crashes	- 2017 - 2020	Actual	- 0.446	Acc/MVM
State Average	- 0.118	Acc/MVM	Critical	- 0.607
A/S Ratio	= 3.78		A/C Ratio	= 0.73
0 Fatal Crash		0 Incap. Injury Crash		2 Other Injury Crash
Brakebill Road, Knox County				LM 0.000
Section 1 (Asheville Highway - Hammer Road)				
15 Crashes	- 2017 - 2019	Actual	- 5.664	Acc/MVM
State Average	- 2.002	Acc/MVM	Critical	- 4.214
A/S Ratio	= 2.83		A/C Ratio	= 1.34
0 Fatal Crash		0 Incap. Injury Crash		3 Other Injury Crash
Brakebill Road, Knox County				LM 0.000
Section 2 (Hammer Road - Strawberry Plains Pike)				
10 Crashes	- 2017 - 2019	Actual	- 3.417	Acc/MVM
State Average	- 2.002	Acc/MVM	Critical	- 4.098
A/S Ratio	= 1.71		A/C Ratio	= 0.83
0 Fatal Crash		0 Incap. Injury Crash		2 Other Injury Crash

CONCLUSIONS & RECOMMENDATIONS

The following is an overview of recommendations to minimize the traffic impacts of the proposed development on the adjacent road system while attempting to achieve an acceptable level of traffic flow and safety. An overview of the recommendations for the external roads and intersections is shown at the end of this report section in Figure 10.



Asheville Highway (US 25W/Hwy 11E) at Brakebill Road: This intersection was calculated to operate adequately with respect to the level of service during the existing conditions and during the projected conditions when the Brakebill Road Subdivision is completed and fully occupied in the year 2025. Some minor signal timing changes might be required in the future at the intersection to optimize the level of service and reduce queue lengths.



Hammer Road at Brakebill Road: The intersection at Hammer Road and Brakebill Road was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025.

- 2a) A separate left-turn lane or right-turn lane on Brakebill Road onto Hammer Road is not required based on the projected 2025 traffic volumes.
- 2b) The intersection of Hammer Road at Brakebill Road currently operates as a two-way stop-controlled T-intersection. At this intersection, Hammer Road operates under a stop condition but does not currently have a white stop bar installed. It is recommended that a 24" white stop bar be installed to increase the visibility of the stop condition at this approach.
- 2c) Vegetation in the southwest corner needs to be better controlled and maintained in the future to improve sight distance at this intersection.



Hammer Road at Road "B": The intersection of Hammer Road at Road "B" was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Road "B" entrance.

- 3a) A separate left-turn lane or right-turn lane on Hammer Road onto Road “B” is not required based on the projected 2025 traffic volumes.
- 3b) It is recommended that a Stop Sign (R1-1) and a 24” white stop bar be applied to the pavement of the Road “B” approach at Hammer Road. The stop bar should be applied at a minimum of 4 feet away from the edge of Hammer Road and should be placed at the desired stopping point that provides the maximum sight distance.
- 3c) Intersection sight distance at Road “B” must not be impacted by future landscaping or signage. A licensed land surveyor must verify the available sight distance at this proposed location. Based on a grade of 8% on Hammer Road and a posted speed limit of 30 mph, the required ISD is 300 feet looking towards the north and south, and the SSD is calculated to be 225 feet for eastbound vehicles (-8%) and 185 feet for westbound vehicles (+8%).
- 3d) Due to the narrowness of Hammer Road, it is recommended that a larger curb radius be designed and constructed that would facilitate right-turns off and on to Hammer Road at the Road “B” intersection. A larger curb radius would allow school buses and larger maintenance and delivery vehicles the opportunity to turn freely without overlapping into opposing traffic lanes.



Brakebill Road at Clubhouse Driveway: The intersection of Brakebill Road at the Clubhouse Driveway was not analyzed with respect to level of service. Only minor amounts of traffic will utilize this driveway. It is expected that this intersection will operate very well, but sight distance must be provided for safe operations. A licensed land surveyor must verify the available sight distance at this proposed location. Based on a grade of 5% on Brakebill Road and an 85th percentile speed of 40 mph, the required ISD is 400 feet looking towards the north and south, and the SSD is calculated to be 330 feet for northbound vehicles (-5%) and 285 feet for southbound vehicles (+5%).



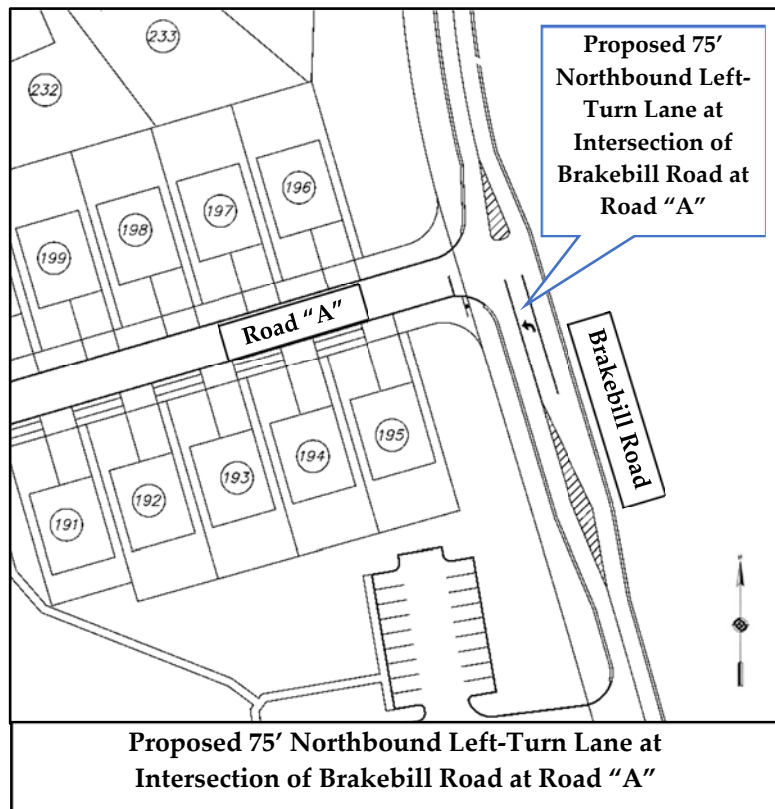
Brakebill Road at Road “A”: The intersection of Brakebill Road at Road “A” was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Road “A” entrance.

- 5a) A separate southbound right-turn lane on Brakebill Road onto Road "A" is not required based on the projected 2025 traffic volumes. Even though the threshold for the northbound left-turn lane is not fully met, it is nonetheless recommended that this lane be provided.

To estimate the required northbound left-turn storage length on Brakebill Road at Road "A", SimTraffic (Version 8) software was utilized, which performs micro-simulation and animation of vehicular traffic and calculates various vehicle parameters such as intersection vehicle queue lengths. Based on the software results from the projected volumes, the 95th percentile vehicle queue distance was calculated. The 95th percentile queue is the recognized measurement in the traffic engineering profession as the design standard used when considering queue distances. A 95th percentile queue means that there is a 95% certainty the vehicle queue will not extend beyond that point. The calculated queue results were based on averaging the outcome obtained during ten traffic simulations. The vehicle queue results from the SimTraffic software are in Appendix M. The 95th percentile queue for northbound left-turns on Brakebill Road at Road "A" was calculated to be 21 feet during the projected AM peak hour and 49 feet during the projected PM peak hour. Based on these results, the proposed storage length should have a minimum length of 75 feet, which is the Knox County standard minimum length for left-turn storage lanes.

- 5b) It is recommended that a Stop Sign (R1-1) and a 24" white stop bar be applied to the pavement of the Road "A" approach. The stop bar should be applied at a minimum of 4 feet away from the edge of Brakebill Road and should be placed at the desired stopping point that provides the maximum sight distance.
- 5c) Intersection sight distance at Road "A" must not be impacted by future landscaping or signage. A licensed land surveyor must verify the available sight distance at this proposed location. Based on a grade of 5% on Brakebill Road and an observed 85th percentile speed of 40 mph, the required ISD is 400 feet looking towards the north and south, and the SSD is calculated to be 330 feet for northbound vehicles (-5%) and 285 feet for southbound vehicles (+5%).

- 5d) Due to the narrowness of Brakebill Road, it is recommended that a larger curb radius be designed and constructed that would facilitate right-turns off and on to Brakebill Road at the Road "A" intersection. This would allow school buses and larger maintenance and delivery vehicles the opportunity to turn freely without overlapping into opposing traffic lanes. See the following exhibit that shows the proposed left-turn lane on Brakebill Road at Road "A". Urban Engineering, Inc. designed this layout.





Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side): This intersection was calculated to operate adequately with respect to the level of service during the existing conditions and during the projected conditions when the Brakebill Road Subdivision is completed and fully occupied in the year 2025. However, the v/c ratio of the intersection in the year 2025 without the project generated trips included in the analysis was calculated to be 0.970 during the PM peak hour. A v/c ratio of 1 would indicate that the traffic volumes are at the roadway capacity. This high v/c ratio at this intersection is primarily due to the projected amount of northbound left-turn vehicles.

The projected northbound left-turn lane volume in the PM peak hour was calculated to be 360 vehicles in 2025. Single left-turn lanes that are experiencing more than 300 vehicles/hour are many times recommended to be increased to dual left-turn lanes. In the future, if dual left-turn lanes for the northbound approach are constructed, the physical space for adding an additional northbound left-turn should be available by building a second lane in the existing 30-foot-wide grass median. The stormwater drainage system will need to be re-configured to construct an additional lane in the grass median. An additional lane would also need to be built for the westbound Interstate 40 On-Ramp. Options for constructing an additional lane on the westbound Interstate 40 On-Ramp could include merging the lanes downstream of the intersection and before the entrance to Interstate 40 or continuing the On-Ramp dual lanes to the entrance of Interstate 40 and merging the lanes further downstream on Interstate 40. Merging further downstream might be a better alternative due to a large amount of truck traffic.

Nonetheless, adding a second northbound left-turn lane would significantly reduce the v/c ratio at this intersection and increase the level of service. This additional lane could be expected to be needed soon based on the projected growth. A recommendation for extending the double westbound left-turn lanes of the Interstate 40 Off-Ramp by 25 feet is discussed in the following section. Both modifications at this intersection are projected needs due to overall traffic growth in the area, but not directly due to the proposed residential subdivision.



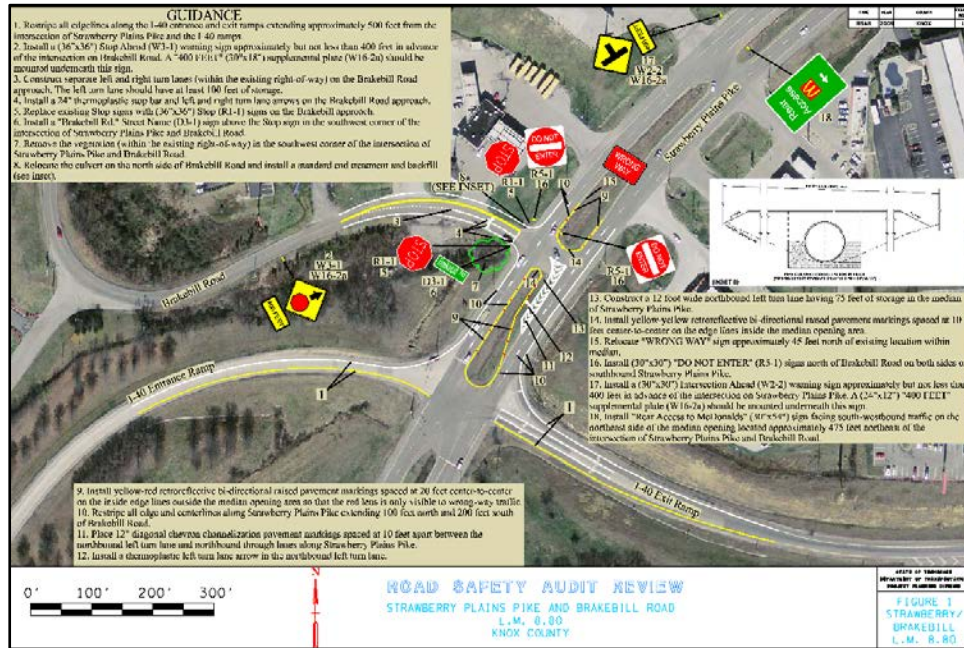
Strawberry Plains Pike at Brakebill Road: This intersection was calculated to be currently operating poorly with respect to the level of service for eastbound left-turns and operate extremely poor in the year 2025 without the project, or with the project generated traffic. While there are not excessive amounts of motorists attempting this turning movement, the number of conflicting volumes causes extreme delays for the eastbound left-turns trying to turn towards northbound Strawberry Plains Pike. Many times, eastbound left-turn drivers require the median space on Strawberry Plains Pike to provide a temporary haven before completing the left-turn entering the flow of northbound traffic. Drivers using the median as a haven potentially obstruct and conflict with the northbound left-turning vehicles. Competition for sight distance and physical space within the median occurs between northbound left-turns and eastbound left-turns when the eastbound left-turn movement uses the median as a mid-way haven.



**View of Median of Strawberry Plains Pike at Brakebill Road
(Looking South)**

- 7a) In 2010, the intersection of Strawberry Plains Pike at Brakebill Road was selected by TDOT to undergo a Road Safety Audit Review (RSAR). This intersection was identified by the TDOT safety needs planning process and was evaluated since the crash ratio at the time of the study in 2010 met the threshold for safety improvements. As part of the review, traffic counts were obtained, and the intersection was determined as meeting MUTCD (Manual on Uniform Traffic Control Devices) Warrants for traffic signalization. However, traffic signalization was deemed “undesirable” due to the short distance (approximately 270 feet) between this intersection and the signalized intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side). The TDOT RSAR report for this intersection in 2010 is in Appendix N. An overview of the 2010 TDOT recommended upgrades and changes at the intersection included the following:
- i. Re-striping and installation of pavement markings and raised markings
 - ii. Replacement and installation of new traffic signage
 - iii. Vegetation removal

- iv. Relocation of an existing stormwater culvert
- v. Construction of a new northbound left-turn lane at the intersection of Strawberry Plains Pike at Brakebill Road
- vi. Construction of a separate eastbound left-turn lane at the intersection of Strawberry Plains Pike at Brakebill Road



From the field review for this current traffic study, it appears that these recommendations were installed and constructed. However, some items such as pavement markings, vegetation removal, and retroreflective bi-directional raised pavement markings need to be refreshed and re-installed. However, most importantly, the construction of the recommended left-turn lane at the intersection of Strawberry Plains Pike at Brakebill Road was completed as prescribed.

- 7b) As an investigation into potential remediation for this intersection, and as a follow up to the TDOT review that indicated this intersection met warrants for traffic signalization in 2010; this intersection was re-examined with the 2020 (+2% adjusted 2018 volumes) traffic volumes with respect to traffic signal warrants. The traffic counts at this intersection were conducted from 7-9 am, 11 am–1 pm, and 2-6 pm for a total of 8 hours.

The Manual on Uniform Traffic Control Devices – 2009 Edition (MUTCD) presents nine different warrants that have been developed by the traffic engineering profession to determine whether a traffic signal is warranted. These warrants cover a broad range of minimum elements required to indicate whether a traffic signal is justified for any particular location. These elements consist of traffic volumes, pedestrian volumes, crash history, and other factors. The MUTCD explicitly states that a traffic control signal should not be installed unless one or more of the signal warrants in the manual are met. However, the satisfaction of a warrant does not entirely in itself justify the need for a traffic signal. Sometimes further engineering studies and judgments also need to be applied before justifying the need for a traffic signal to be installed. These additional studies are a particularly important step in ensuring that the installation of a traffic signal will not bring about degradations in safety and efficiencies.

The MUTCD defines nine different warrants, two of which are potentially applicable for this intersection at this time and are explained below:



Warrant 1, Eight-Hour Vehicular Volume:

Warrant 1 is comprised of 2 conditions – A and B. The Minimum Vehicular Volume, Condition A, is intended for application where the volume of intersecting traffic is the principal reason for consideration of signal installation. The Interruption of Continuous Traffic, Condition B, is intended for use at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.



Warrant 2, Four-Hour Vehicular Volume:

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The intersection of Strawberry Plains Pike at Brakebill Road was evaluated for justification for a traffic signal based on the MUTCD Warrants listed above and

the 2020 (+2% adjusted 2018 volumes) traffic count volumes. Brakebill Road was used as the minor side street for the warrant analysis, and Strawberry Plains Pike was the major street. According to the Federal Highway Administration (FHWA), the traffic signal warrants are intentionally written in a manner that provides a large amount of flexibility to engineers in terms of how they determine the number of moving lanes and the volume of approaching traffic used in the analysis. The decisions as to which approach lanes on the major and minor streets and the corresponding traffic volumes are determined by the engineering judgment of the engineer conducting the study or by the methods established by local and state agencies. Ultimately, the decision of the reviewing agency to determine whether right-turn volumes from the minor street should be included.

For the intersection of Strawberry Plains Pike at Brakebill Road, when the analysis includes right-turn volumes from Brakebill Road (the minor street approach), this intersection currently meets traffic signal warrants. The intersection meets Warrant #1, Condition B, and Warrant 2 based on the 2020 (+2% adjusted 2018 volumes) existing volumes collected for this study. However, if the right-turn volumes from Brakebill Road are not included, the intersection does not meet signal warrants. Nonetheless, justification could be made for a traffic signal at this location currently since it does meet a traffic signal warrant when including right-turns from the minor street approach. The results of the traffic signal warrant assessment at this intersection for the existing volumes of 2020 (+2% adjusted 2018 volumes) are in Appendix O, and Table 10 presents the results.

TABLE 10
TRAFFIC SIGNAL WARRANT SUMMARY

INTERSECTION	VOLUME WARRANT (REQUIRED NUMBER OF HOURS SATISFIED)			
	WARRANT 1			WARRANT 2
	CONDITION #1A (8 hours)	CONDITION #1B (8 hours)	CONDITION 1A & 1B - COMBINATION (8 hours)	(4 hours)
2020 (2% Adjusted 2018) - Existing Volumes Strawberry Plains Pike at Brakebill Road (100% of Right Turns Included on Brakebill Road)	Not Satisfied	Satisfied	Satisfied	Satisfied
2020 (2% Adjusted 2018) - Existing Volumes Strawberry Plains Pike at Brakebill Road (0% of Right Turns Included on Brakebill Road)	Not Satisfied	Not Satisfied	Not Satisfied	Not Satisfied

- 7c) With the results of the traffic signal warrant analysis indicating that this intersection could be justified to have a traffic signal installed, Synchro Traffic Software (Version 8) was used to design a preliminary plan for traffic signalization. This preliminary design included coordinating the existing traffic signal at Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side) with the proposed traffic signal at Strawberry Plains Pike at Brakebill Road. Based on an 80-second actuated-coordinated cycle, the preliminary design resulted in a much-improved level of service for eastbound left-turns on Brakebill Road at Strawberry Plains Pike. The level of service results of this initial design for the two intersections are shown in Table 11, and Appendix G includes the worksheets for these capacity analyses. The results shown in Table 11 consists of the recommended addition of a northbound left-turn lane at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side). Also, the results of the calculated vehicle queue lengths based on the preliminary traffic signal design are shown in Table 12.

TABLE 11
2025 INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITH PROJECT) WITH PRELIMINARY NEW TRAFFIC SIGNAL DESIGN

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Strawberry Plains Pike at Brakebill Road		Eastbound	D	35.6	0.550	C	32.5	0.700
		Northbound	A	3.8		A	4.6	
		Southbound	A	6.0		A	3.5	
		Summary	B	10.5		A	7.8	
Strawberry Plains Pike at Interstate 40 On / Off Ramp (north side)		Westbound	C	32.6	0.540	C	33.9	0.530
		Northbound	A	5.4		A	5.7	
		Southbound	A	6.8		B	11.3	
		Summary	B	10.8		B	11.7	

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for signalized intersections

^a Level of Service

^b Average Delay (sec/vehicle)

^c Volume-to-Capacity Ratio

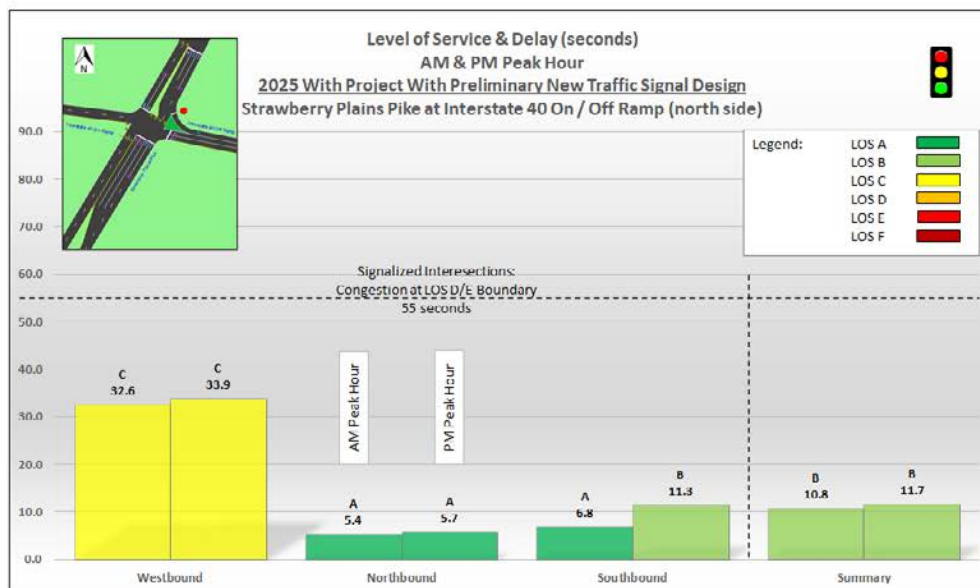
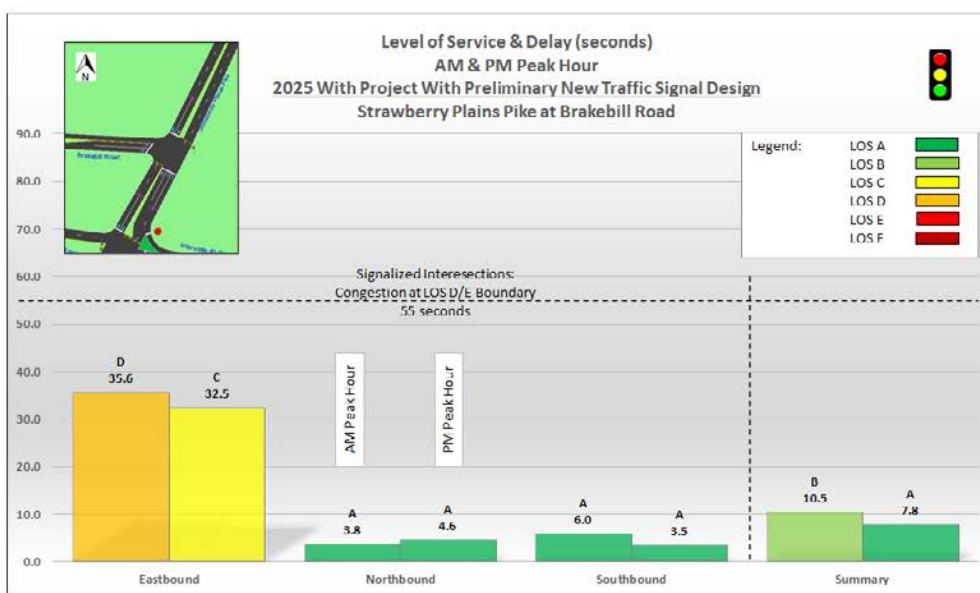
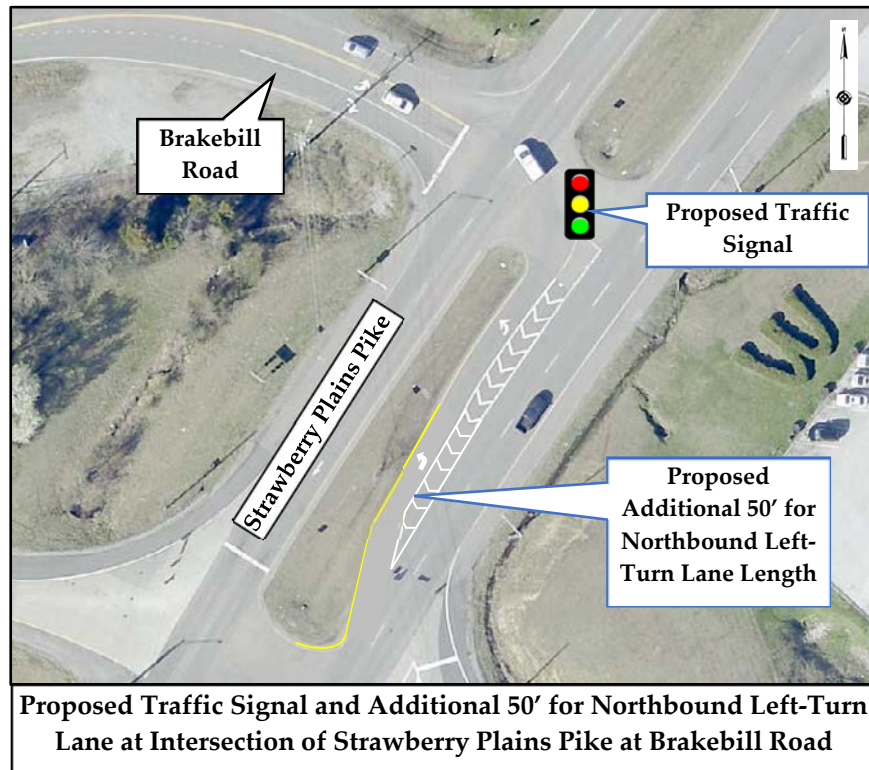


TABLE 12
TURN LANE STORAGE & VEHICLE QUEUE SUMMARY -
2025 PROJECTED PEAK HOUR TRAFFIC VOLUMES WITH PRELIMINARY NEW TRAFFIC SIGNAL DESIGN

INTERSECTION	APPROACH/ MOVEMENT	EXISTING STORAGE (ft)	PROPOSED STORAGE (ft)	SIMTRAFFIC 95 th PERCENTILE QUEUE LENGTH (ft)	
				AM PEAK HOUR	PM PEAK HOUR
Strawberry Plains Pike at Brakebill Road	Eastbound Left	120	120	90	83
	Northbound Left/U-Turn	150	200	97	175
Strawberry Plains Pike at I-40 On/Off Ramps	Westbound Left #1	200	225	156	196
	Westbound Left #2	200	225	214	243
	Northbound Left #1	190	190	126	131
	Northbound Left #2	-	190	199	202

Note: 95th percentile queues were calculated in SimTraffic 8 software

The results from SimTraffic of the queue analysis shown in Table 12 indicate that some of the turn lane lengths will need to be increased based on the projected volumes and the outcome of the preliminary signal timing design. The left northbound lane at Strawberry Plains Pike at Brakebill Road was calculated to have a 95th percentile queue length of 175 feet with an existing storage length of 150 feet in the PM peak hour. Meeting this storage would require this turn lane to be lengthened to its maximum length available in between the two intersections. An additional 50 feet is potentially possible but will require careful consideration since this additional length will encroach the intersection of Strawberry Plains Pike at Interstate 40 On/Off-Ramps (north side). The existing eastbound left-turn lane on Brakebill Road with 120 feet of storage is projected to be adequate operating with a traffic signal. See the following exhibit for clarification. Additionally, the channelized I-40 Westbound Off-Ramp right-turn lane will most likely need to be realigned to facilitate motorists making right-turns from the I-40 Off-Ramp when the northbound left-turn lane at the Strawberry Plains Parkway at Brakebill Road is extended.



Double Left-Turn on Interstate 40 Off-Ramp at Strawberry Plains Pike (Looking West)

Based on the 2025 projected volumes, other turn lane lengths will also need to be increased, and this includes the turn lanes at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side). The results indicated that the existing Interstate 40 Off-Ramp westbound dual left-turn lane storage lengths could be exceeded by what is currently available. In the projected PM Peak Hour, the vehicle queues for the westbound double left-turn lanes will exceed the existing storage length available. Distributing the projected queue lengths of 196 feet and 243 feet

across both lanes results in a total queue length of 219.5 feet in both lanes (196 feet + 243 feet / 2 lanes = 219.5 feet). Adding 25 feet to both left-turn lanes to a total of 225 feet would provide enough storage based on the projected volumes.



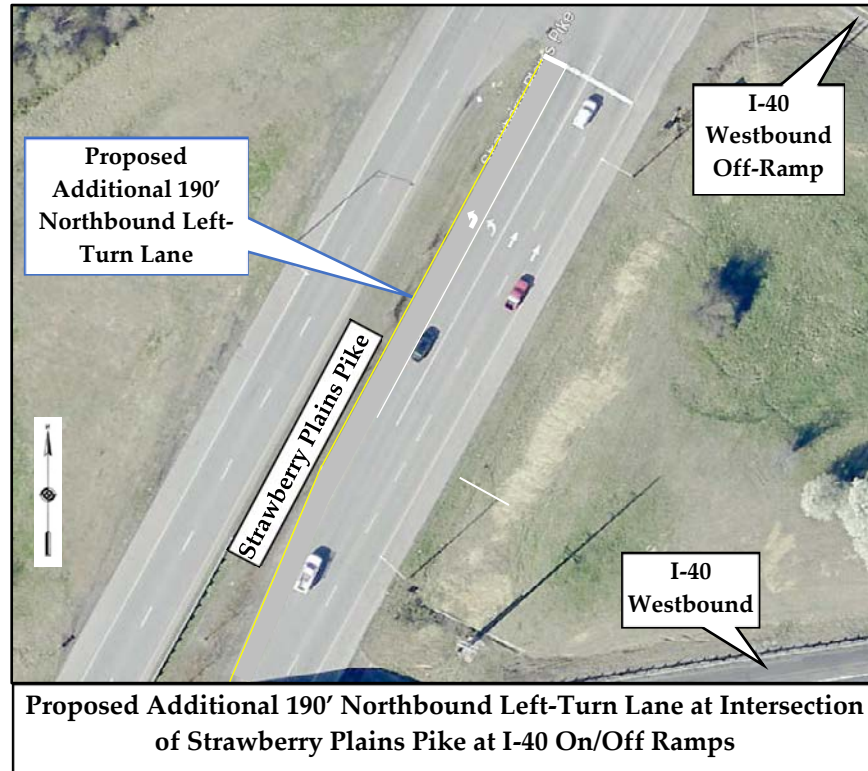
**Single Left-Turn on Strawberry Plains Pike at
Interstate 40 On/Off-Ramps
(Looking North)**

As discussed earlier, the addition of a second northbound left-turn lane at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off-Ramps (north side) with a similar storage lane length of 190 feet should be sufficient to handle the projected volumes. The software results indicated that the northbound left-turn lanes would have a 95th percentile queue of 131 feet and 202 feet in the PM Peak Hour. In actuality, the expected queue lengths could be more evenly distributed between the two lanes, which would result in a required length of 180 feet in both lanes

(131 feet + 202 feet / 2 lanes = 166.5 feet). Thus, adding an additional northbound left-turn lane with a similar length as the existing storage length of 190 feet should be sufficient. See the following exhibits that show the proposed modifications to the turn lanes.



**Proposed Additional 25' for Both Westbound Left-Turn Lane Lengths
at Intersection of Strawberry Plains Pike at I-40 On/Off Ramps**



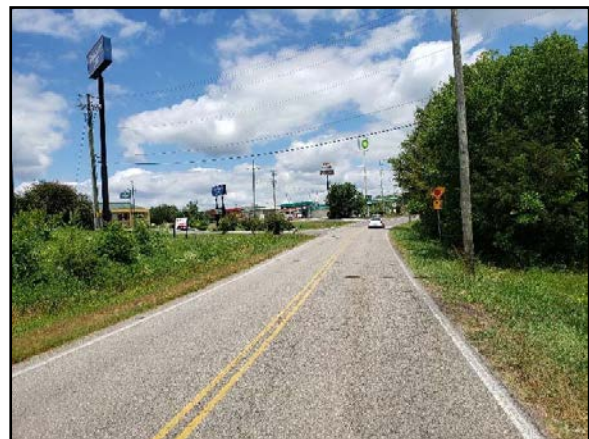
Further analysis of the coordinated signal system at these two intersections should be optimized based on the actual future volumes instead of the projected volumes. Using the actual future volumes versus the projected volumes from this study could reduce the projected peak queue lengths and the potential turn lane storage extensions required.

- 7d) It is recommended that this intersection be signalized. Signalization is recommended even though in 2010, TDOT deemed signalization as “undesirable” while meeting signal warrants.

This intersection currently meets warrants for traffic signalization, and it is projected to continue to meet signalization warrants in the future. It is recommended that this intersection be signalized before the Brakebill Road Subdivision is opened to residents. If this intersection is not signalized and experiences the potential increased traffic volumes, excessive vehicle delays will occur. Without remediation, this intersection could experience increased vehicle crashes due to impatient drivers. Possible issues to consider related to installing a

traffic signal at the intersection of Strawberry Plains Pike at Brakebill Road include the following:

- a. Shorter traffic signal cycle lengths are recommended since queue lengths tend to be shorter for short cycle lengths and will be necessary due to the short distance between the two intersections.
- b. The traffic signals on Strawberry Plains Pike at both intersections in the northbound and southbound approaches need to be carefully designed with respect to placement and visibility. The signal heads on these approaches will need to be installed with louvers or optically programmed signals to restrict signal visibility to these traffic lanes. Screening will be required to eliminate drivers from driving thru or not recognizing the first set of signal heads in the progression thru the two sets of signalized intersections.
- c. Advance traffic warning signage will be necessary for the approach of Brakebill Road at Strawberry Plains Pike due to the horizontal curvature of Brakebill Road. To highlight this need, it was observed during the field review that the current Stop Ahead Sign (W3-1) on the Brakebill Road approach was obscured by vegetation.



**Sign Obscured by Vegetation on
Brakebill Road Approach**



Brakebill Road: From the results discussed earlier in this report, it was shown that the calculated crash rates on Brakebill Road were not high enough to receive consideration for TDOT safety funding. Nonetheless, the narrowness of the roadway, the shoulder drop-offs, and the lack of a clear zone outside the roadway are potential factors in the road crashes. Based on evaluating the obtained individual traffic crash reports from Brakebill Road over the past three years, 10 of the 17 crashes indicated that the narrowness of Brakebill Road could have been a contributable factor. These ten crashes were either opposite direction sideswipes or road departures. As one can easily conclude, research has indicated that narrow roads have a significant influence on these types of crashes. Pictures showing the various pavement drop-offs and roadside hazards on Brakebill Road are shown below:



The most logical recommendation would include widening Brakebill Road. Brakebill Road is a major collector and an essential link between Asheville Highway (US 25E/Hwy 11E) and Strawberry Plains Pike at Interstate 40. Improving Brakebill Road with appropriate horizontal and vertical alignments, lane widths, shoulders, and clear zones would potentially significantly decrease the number of vehicle crashes. It is expected that

this road in the future will need to be widened and improved. In the interim, and to accommodate traffic growth and development in the area, several strategies should be employed to reduce the number of opposite direction sideswipes, and roadway departure crashes.

To determine appropriate strategies to potentially reduce traffic crashes on Brakebill Road, resources from the FHWA were reviewed. The following measures are recommended to be implemented on Brakebill Road:

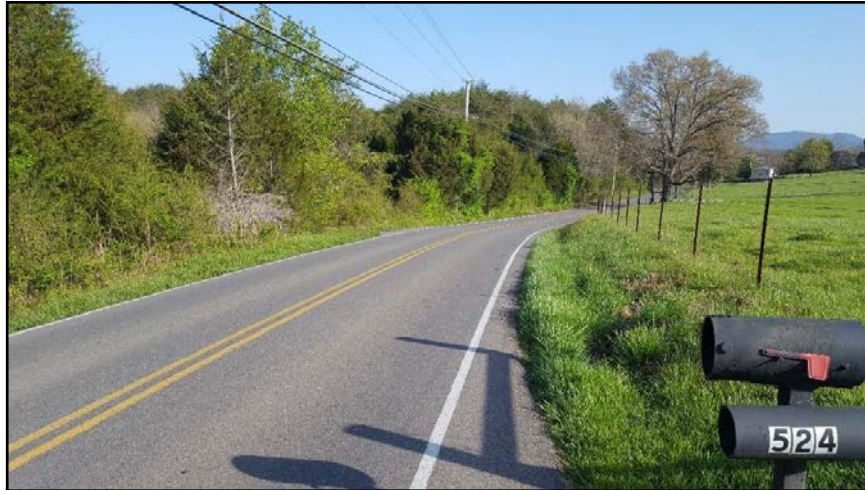
- a. Identify and remove or re-locate roadside hazards (ditches, utility poles, and trees): Research has indicated that increasing the clear zone prevents crashes. Most of the road departure crashes on Brakebill Road involved striking trees and utility poles. The next most common object struck was roadside ditches. According to research, 80% of all fatal crashes at curves are roadway departure crashes. (Source: Fatality Analysis Reporting System). Roadside hazards that have been identified and documented along Brakebill Road are shown in a picture summary located at the end of this section.

- b. Advance Warning Signs: Warning signs call attention to unexpected conditions on or next to the roadway. It is recommended that Advance Warning Signs be installed on Brakebill Road in advance of two of the horizontal curves where evidence of crash clusters have occurred. Advance Warning Curve Signs should be placed before the horizontal curve in both directions, just to the north of 524 Brakebill Road. Advisory Speed Plaques (W13-1P) may be used to supplement the warning signs if a subsequent engineering study supports it. The other location where an Advance Warning Curve Sign (W1-2R) should be installed is before the horizontal curve on Brakebill Road heading southbound near the intersection of Brakebill Road at Palmer



Deteriorated Curve Sign for NB Traffic on Brakebill Road near Kilbridge Drive

Lane. An Advance Warning Curve Sign (W1-2L) is already posted for the northbound direction on Brakebill Road but should be replaced due to its deteriorated nature and lack of reflectivity.



**Horizontal Curve on Brakebill Road near 524 Brakebill Road
(Looking North)**



**Horizontal Curve on Brakebill Road near Palmer Lane
(Looking South)**

Another advance warning sign on Brakebill Road that needs correction is the existing Advance Turn Sign (W1-1L) near 604 Brakebill Road for southbound traffic. It is currently leaning and needs to be reset and stabilized.



**Leaning Sign near
 604 Brakebill Road**

- c. Installation of Rumble Strips (along the edgeway and the center of the road): According to the FHWA, edgeway and centerline rumble strips are an effective countermeasure to reduce vehicle departure crashes, head-on collisions, and opposite direction sideswipe crashes. A table from NCHRP Report 641, Guidance for the Design and Application of Shoulder and Centerline Rumble Strips, is shown below, which shows the reduction in crash history based on before and after research studies on urban and rural two-lane roads.

Center line Rumble Strip – Reduction in crash frequency from before to after rumble strip implementation for head-on and opposite direction sideswipe fatal and injury collisions		
	Percent reduction in crash frequency from before to after rumble strip implementation	Standard Error
Rural two-lane roads	45%	6%
Urban two-lane roads	64%	27%

Excerpt from Table 67 of NCHRP Report 641.

Shoulder Rumble Strip – Reduction in crash frequency from before to after rumble strip implementation for single-vehicle run-off-road fatal and injury crashes		
	Percent reduction in crash frequency from before to after rumble strip implementation	Standard Error
Rural two-lane roads	36%	10%
Rural freeways	17%	7%

Excerpt from Table 28 of NCHRP Report 641.

The results from the NCHRP (National Cooperative Highway Research Program) report show significant reductions in head-on, opposite direction sideswipes, and roadway departure crashes after installation of rumble strips on two-lane roadways. It is recommended both centerline and edge line rumble strips are installed on Brakebill Road at a minimum at the two horizontal curves identified above where Advance Curve Signs are recommended. In the recent past, clusters of crashes have occurred at these horizontal curves and could be reduced in the future with the installation of rumble strips. Other horizontal curves on Brakebill Road should be considered as well or the entire length of Brakebill Road. TDOT provides a standard installation detail (T-M-16) for asphalt shoulder rumble stripe for non-access-controlled routes.

Some potential issues to consider related to installing rumble strips involve the following:

- i. Pavement: The asphalt pavement of the roadway needs to be of sufficient thickness and quality to install rumble strips.
- ii. Bicyclists: Rumble strips can be detrimental to bicycle travel and hazardous to bicyclists. However, currently, there is little evidence of regular bicycle travel on Brakebill Road.
- iii. Noise: Rumble strips can be a nuisance with respect to the noise generated from vehicles traveling over the strips. The sound is beneficial to the driver inside the vehicle to give a warning but can be a nuisance to those who live nearby. Brakebill Road is not a densely populated area, but there are residences adjacent to the two horizontal curves where rumble strips are recommended. There are options to reduce noise by reducing rumble strip widths, installing sinusoidal-shaped rumble strips which do not produce as much noise, and by discontinuing rumble strips near intersections and major driveways.

These potential issues are not expected to be a severe impediment to installing rumble strips on Brakebill Road. These measures should be beneficial to reducing the number of opposite direction sideswipes, and departure crashes on Brakebill Road. A picture summary of the identified roadside hazards along Brakebill Road is listed in the following pages. These identified roadside

hazards are comprised of vegetation obstructions, drainage ditches, utility poles, trees, and road shoulder drop-offs.



**Roadside vegetation obscures sight distance for turning vehicles at Crosswood Boulevard and Brakebill Road
(Looking Northwest)**



**Steep road/shoulder drop-off and deteriorated pavement near 701 Brakebill Road Driveway
(Looking North)**



**Large trees and utility poles adjacent to the roadway near 512 Brakebill Road with shoulder drop-off into the drainage ditch
(Looking North)**



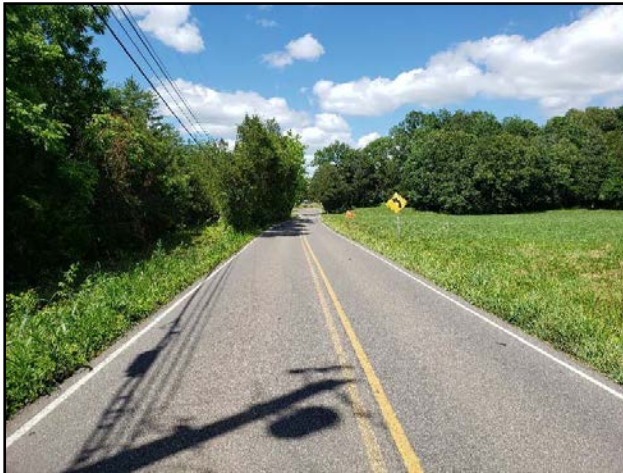
**Large trees and utility poles adjacent to the roadway near 508 Brakebill Road with shoulder drop-off into the drainage ditch
(Looking North)**



**Large trees and utility poles adjacent to the roadway near 428 Brakebill Road with shoulder drop-off into the drainage ditch
(Looking South)**



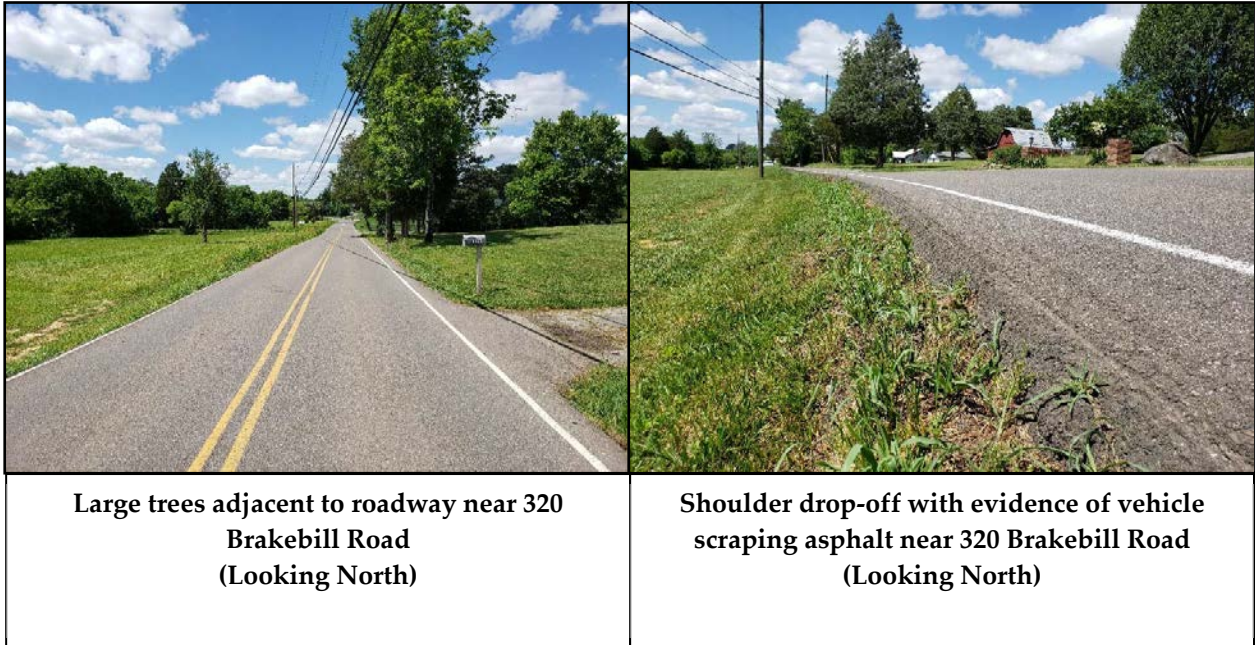
**Large trees adjacent to the roadway just south of Kilbridge Drive with shoulder drop-off into the drainage ditch
(Looking North)**



**Large trees adjacent to roadway near 420 Brakebill Road with shoulder drop-off into the drainage ditch
(Looking North)**



**Utility poles adjacent to roadway near 322 Brakebill Road with shoulder drop-off
(Looking South)**



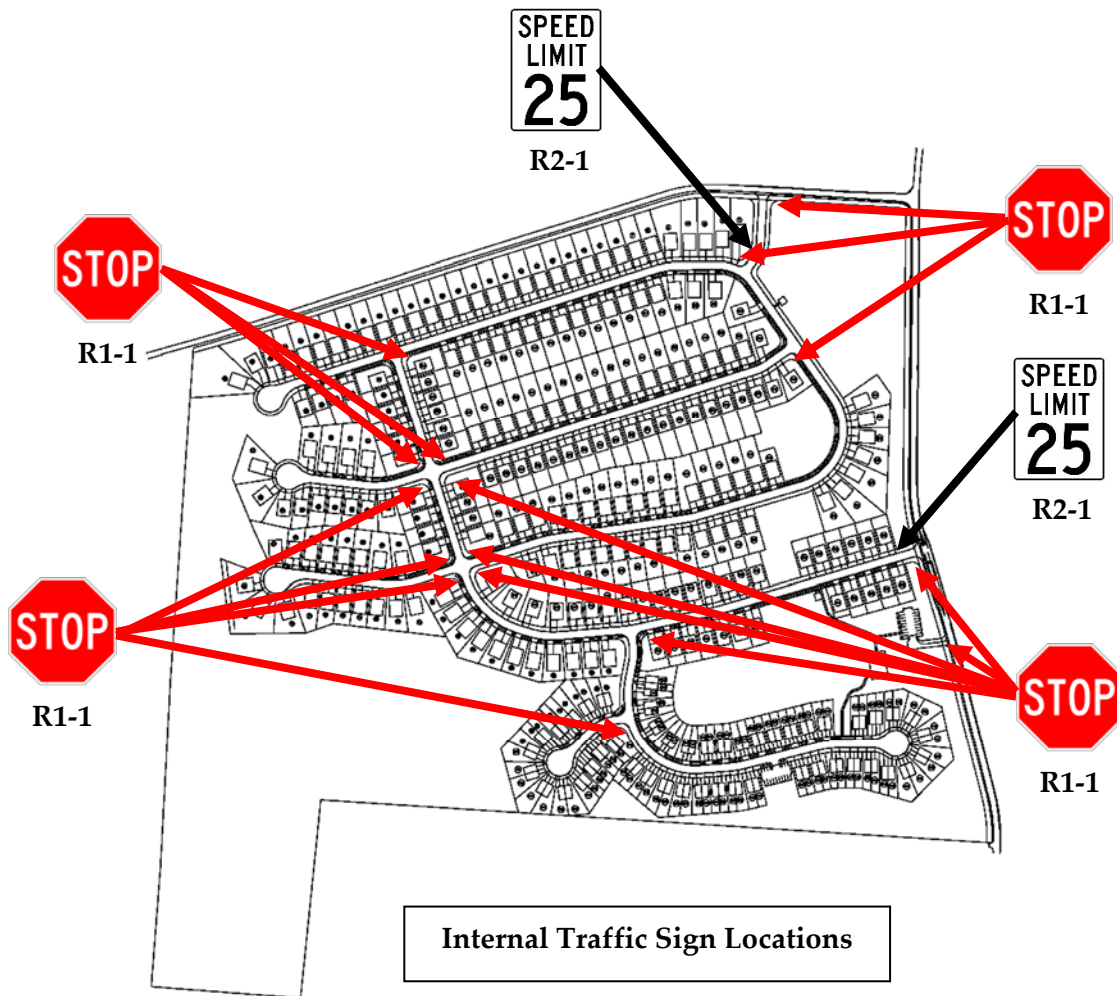
- d. Pavement Markings: The existing pavement markings along Brakebill Road are faded and are recommended to be refreshed. The pavement markings on Brakebill Road within the City limits are notably diminished and need the markings to be re-applied.





Brakebill Road Subdivision Internal Roads: The current concept plan shows six new streets being constructed within the development, as shown in Figure 3.

- 9a) It is recommended that 25-mph Speed Limit Signs (R2-1) be posted near the front of both new streets, Road "A" and Road "B", off Brakebill Road and Hammer Road, respectively.
- 9b) Stop Signs (R1-1) with 24" white stop bars and the other traffic signage should be installed at the locations as shown below:



- 9c) Sight distance at the new intersections in the subdivision must not be impacted by new signage or future landscaping. For a posted speed limit of 25-mph in the subdivision, the intersection sight distance requirement is 250 feet. The stopping

sight distance required is 155 feet for a level road grade. The road layout designer should ensure that these sight distance lengths are met, and they should be labeled on the plans.

9d) All drainage grates and covers for the residential development need to be pedestrian and bicycle safe.

9e) The internal sidewalks that are proposed for the development should have appropriate ADA compliant curbed ramps at intersection corners, and the sidewalks are recommended to be 5 feet minimum in width.

9f) The United States Postal Service (USPS) has recently implemented changes to its guidelines for delivery in new residential subdivisions. If directed by the local post office, the designer should include an area within the development with a parking area for a centralized mail delivery center.



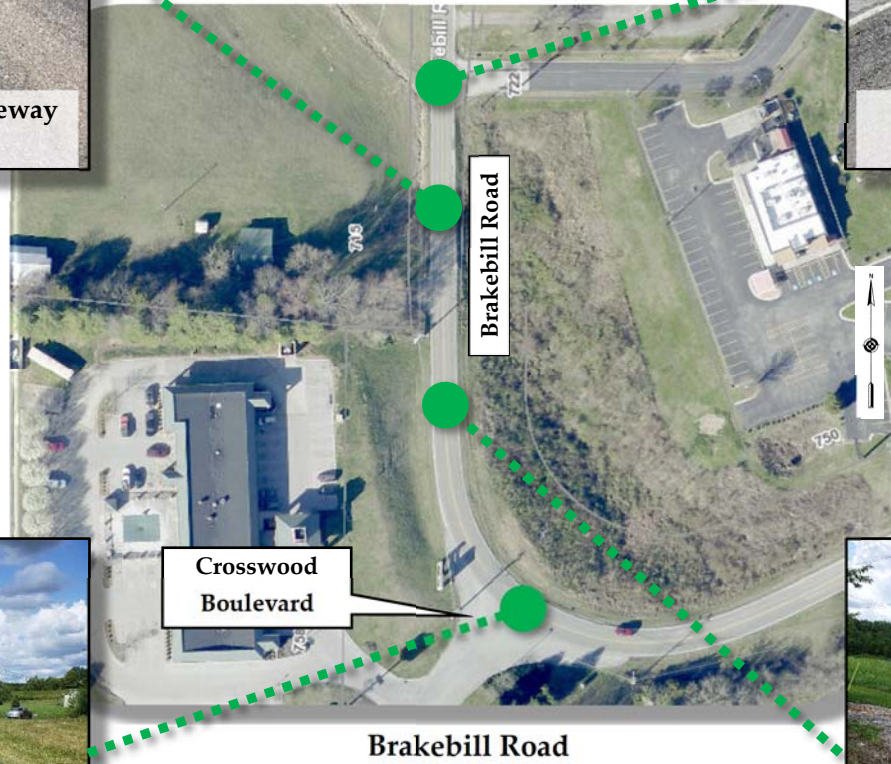
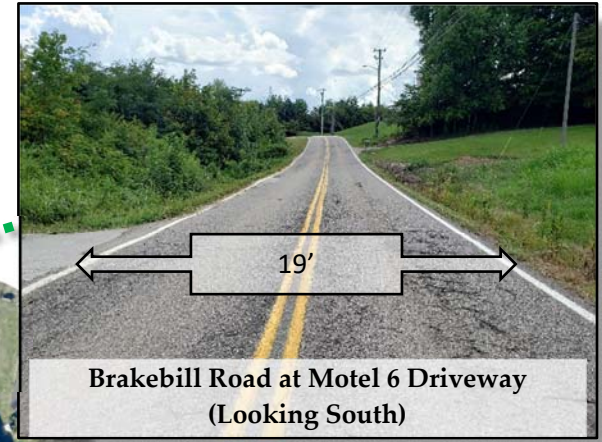
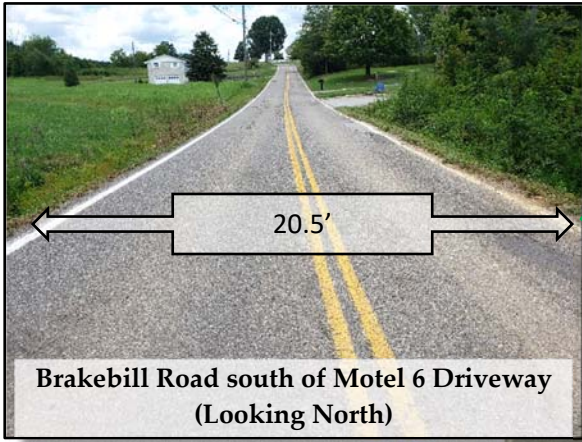
9g) Traffic calming measures might be needed for this development. Sections of the horizontal alignment for proposed Road "A", "C", and "D" within the development have long and straight road segments. The possible need for traffic calming measures inside the development will need to be coordinated with Knox County Engineering and Public Works during the detailed design phase.

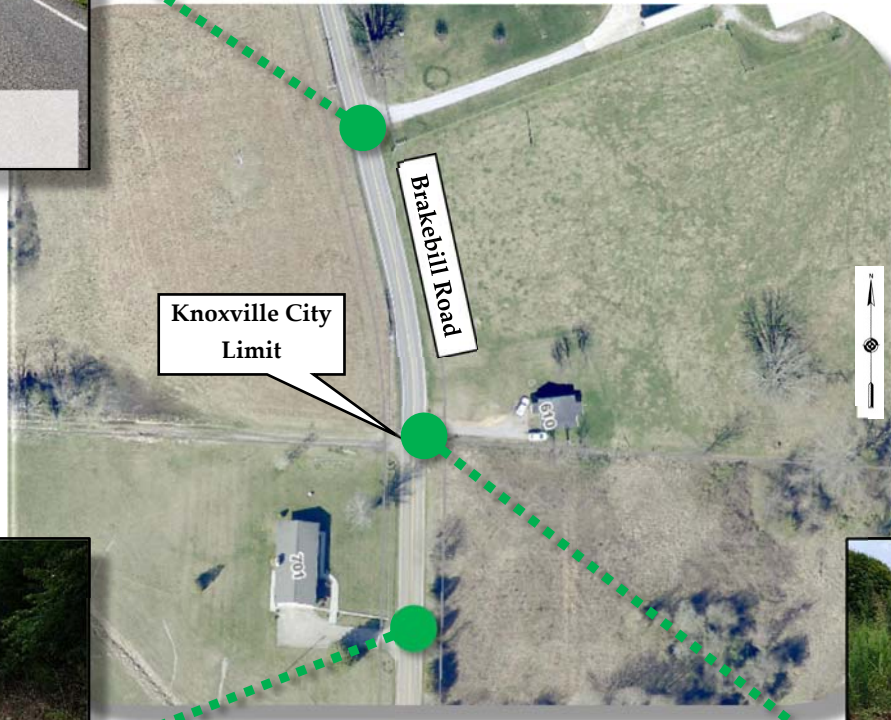
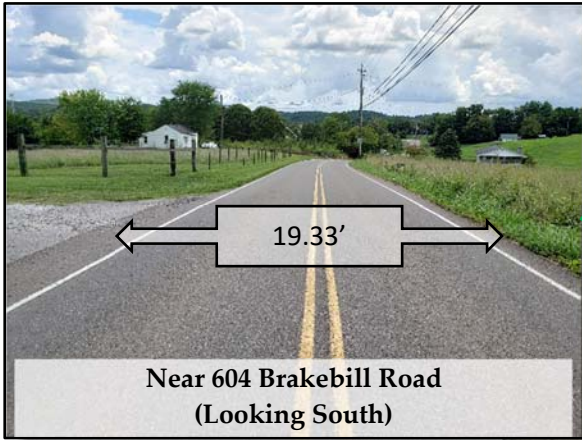
9h) All road grade and intersection elements internally and externally should be designed to AASHTO, TDOT, and Knox County specifications and guidelines to ensure proper operation.

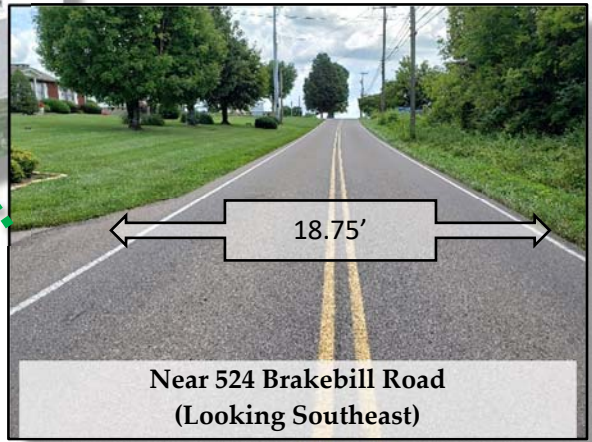
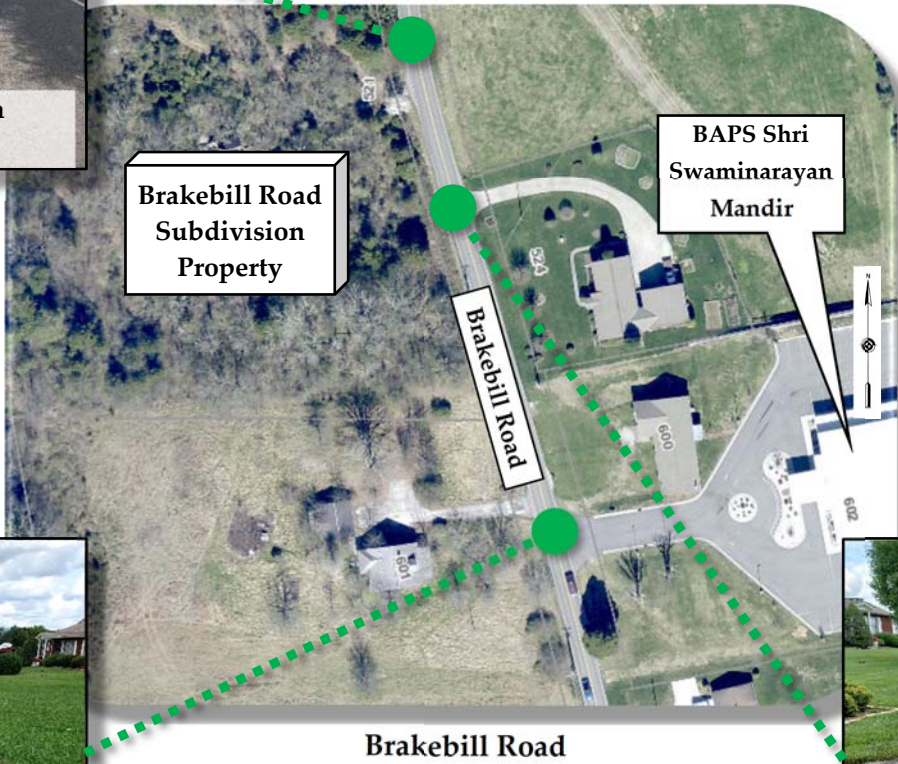


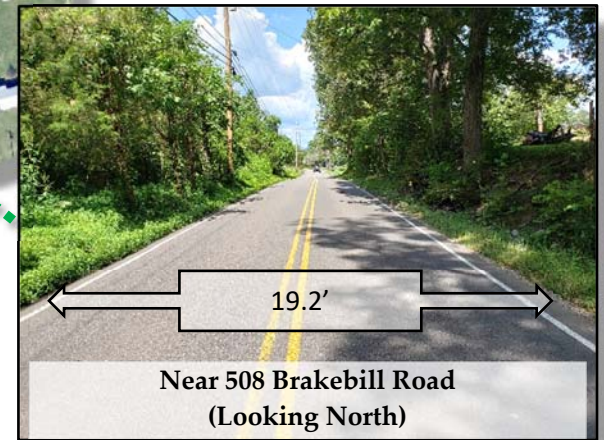
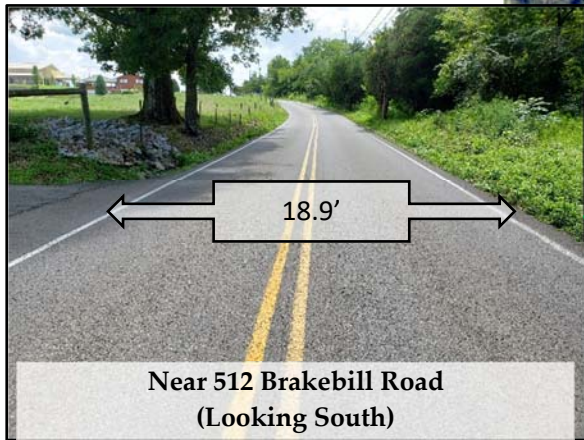
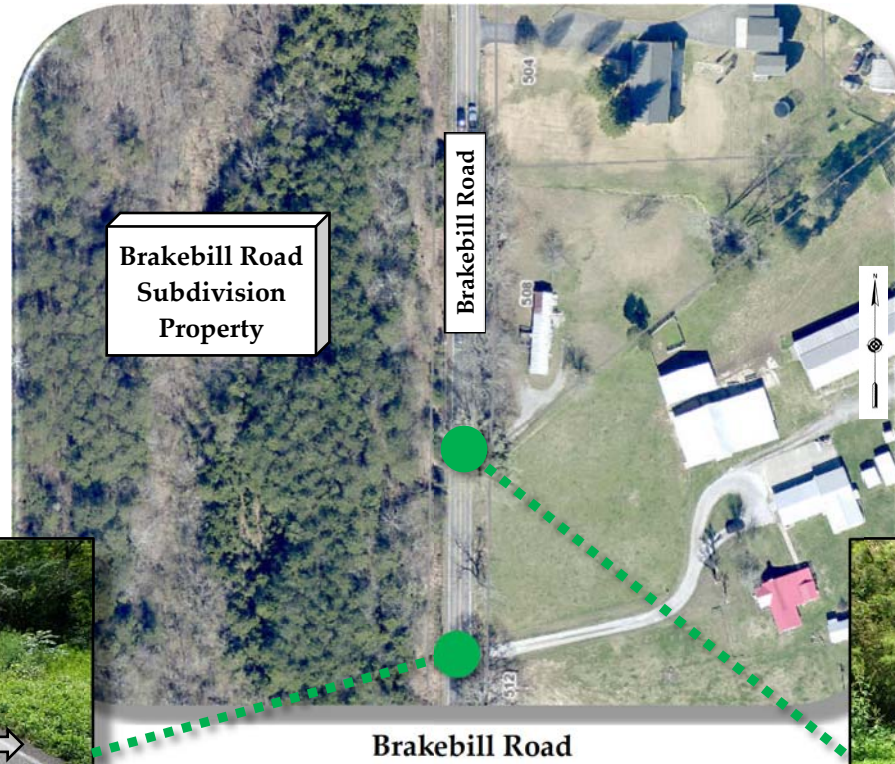
Brakebill Road Widths (Addendum): As requested in the TIS Comment Response Document for Brakebill Road Subdivision dated August 19, 2020, road width information was collected on Brakebill Road in between Hammer Road and the 90-degree curve at the intersection with Crosswood Boulevard.

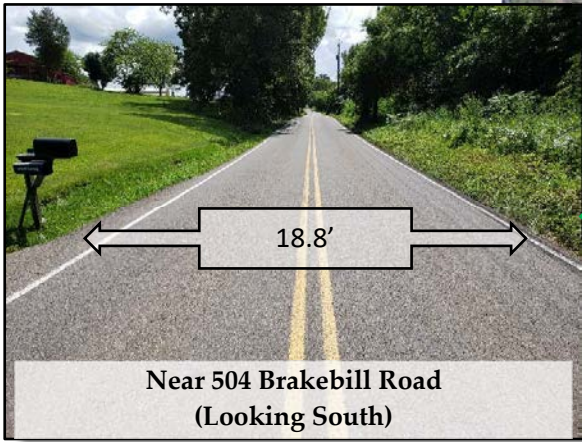
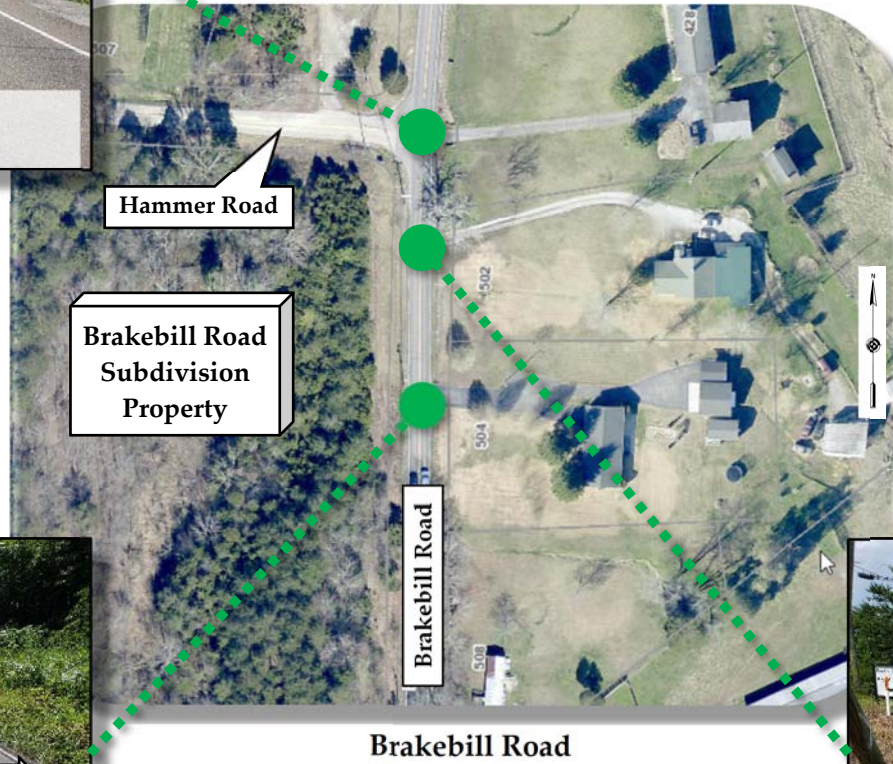
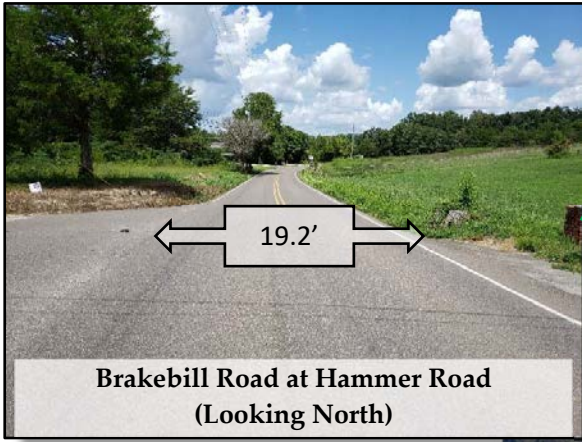
The information shown on the following pages lists the pavement width measurements that were made and shows photographs of these road width measurements locations. These road measurements are not the absolute minimum and maximum widths but are a representative sample of the roads. They were taken at driveways and other locations that are readily identifiable on Brakebill Road.

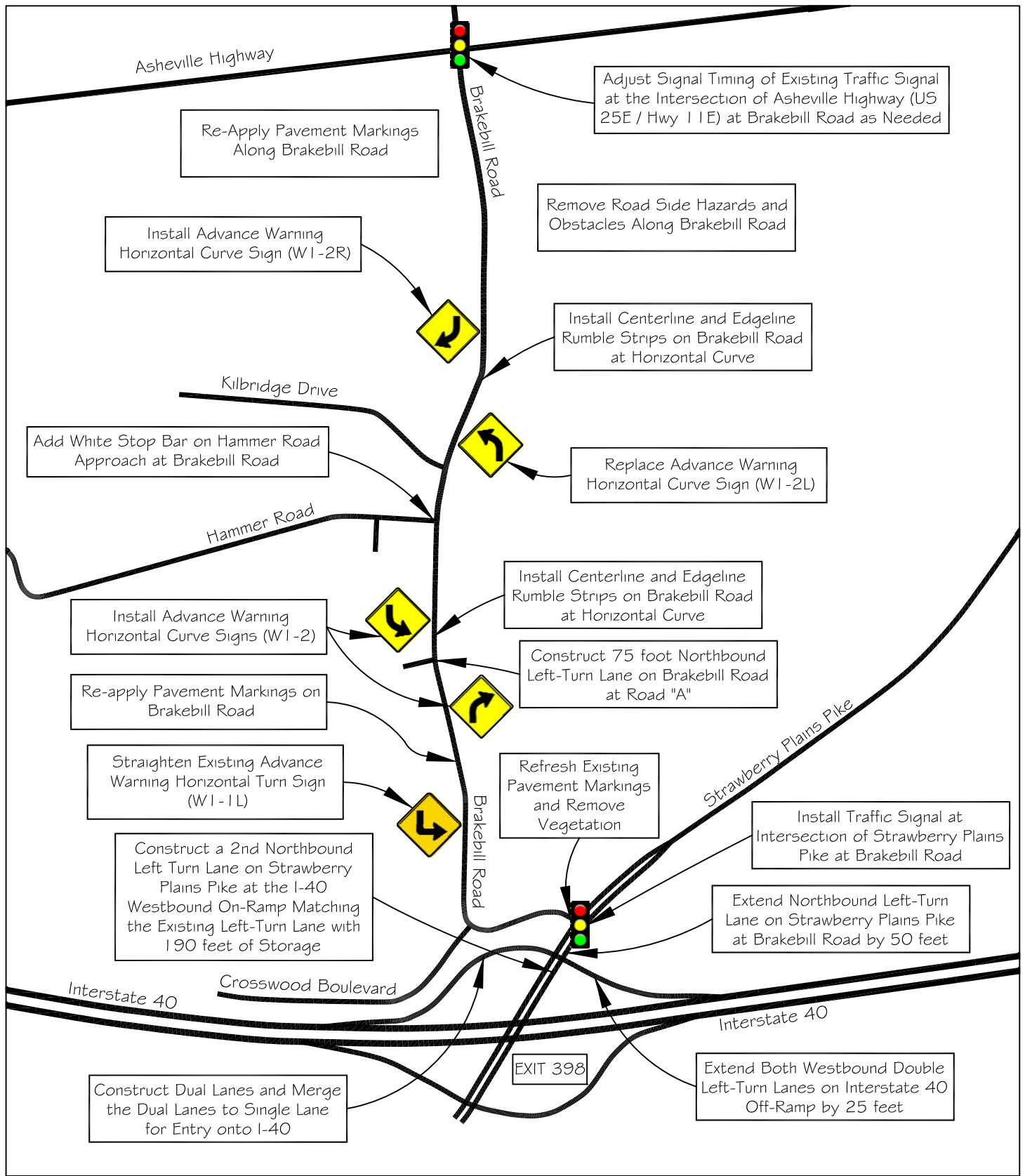












11812 Black Road
 Knoxville, TN 37932
 Phone: (865) 556-0042
 Email: ajaxengineering@gmail.com

NOT TO SCALE



FIGURE 10

Brakebill Road Subdivision

Summary of Recommended External Road Improvements

APPENDIX A

HISTORICAL TRAFFIC COUNT DATA

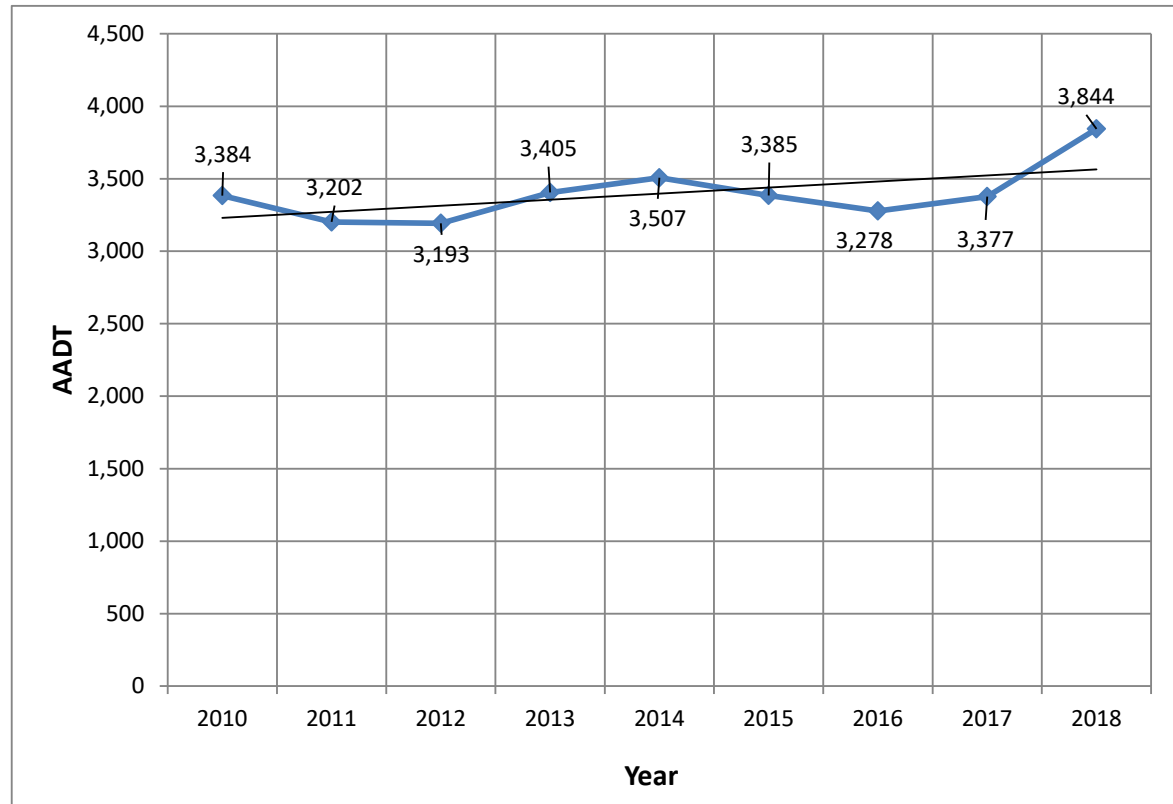
Historical Traffic Counts

Organization: TDOT

Station ID #: 000472

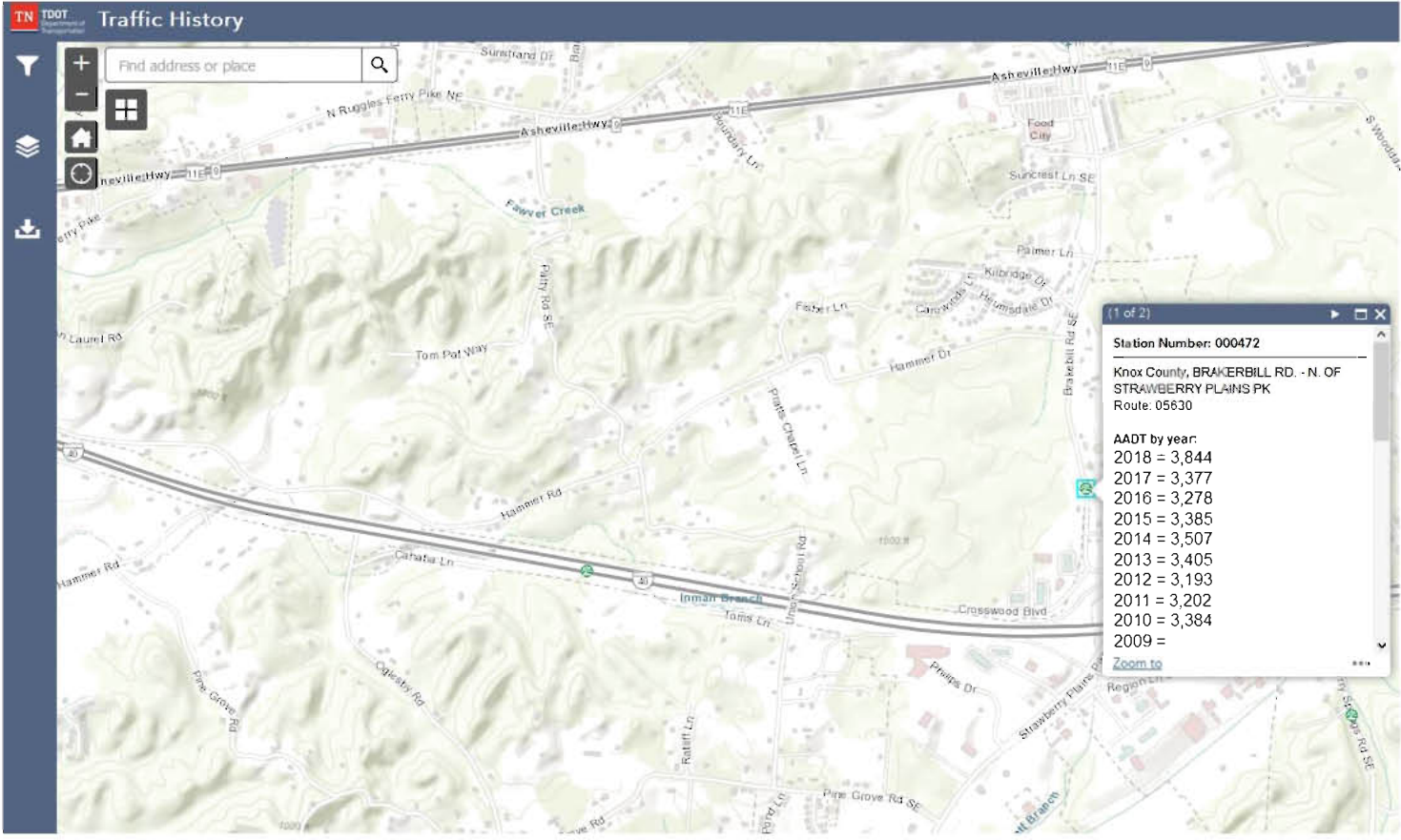
Location: Brakebill Road (North of Strawberry Plains Pike)

YEAR	AADT	
2008	n/a	
2009	n/a	
2010	3,384	Trendline
2011	3,202	
2012	3,193	
2013	3,405	
2014	3,507	
2015	3,385	
2016	3,278	
2017	3,377	
2018	3,844	



2010 - 2018 Growth Rate = 13.6%

Average Annual Growth Rate = 1.6%



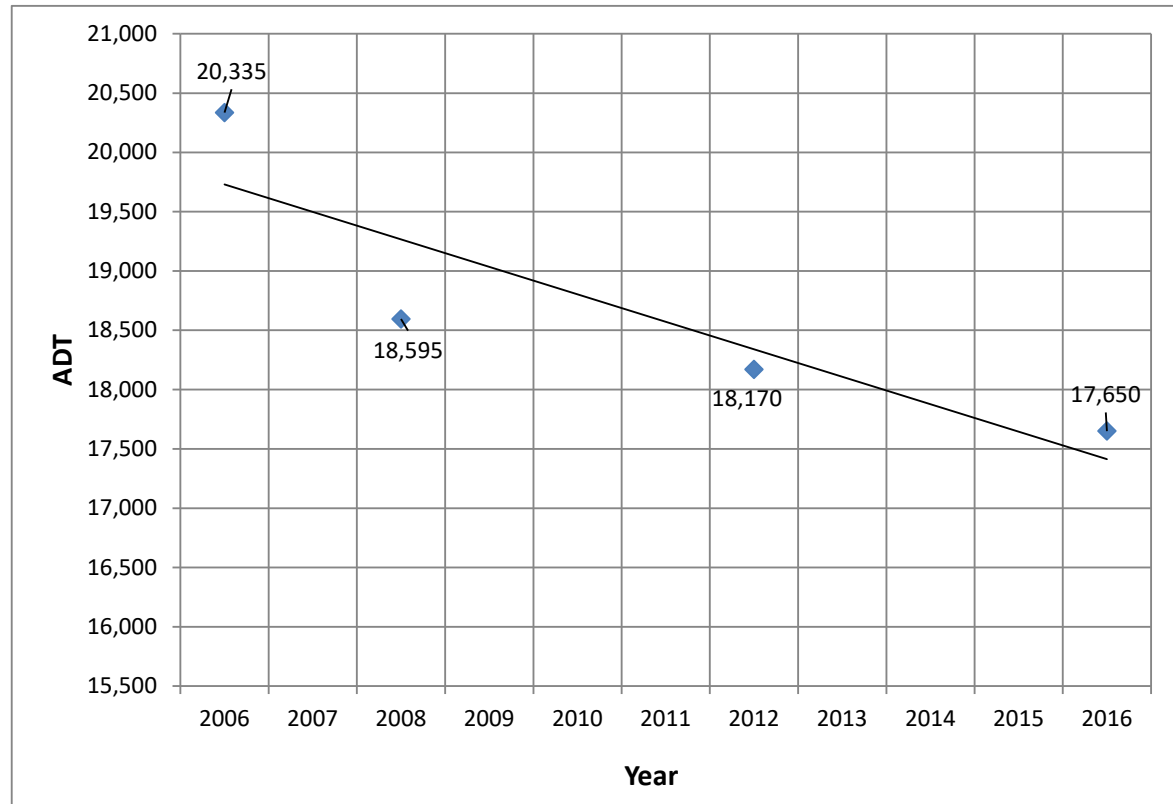
Historical Traffic Counts

Organization: MPC

Station ID #: 093C327

Location: Strawberry Plains Pike (South of I-40)

YEAR	ADT	Trendline
2006	20,335	
2007		
2008	18,595	
2009		
2010		
2011		
2012	18,170	
2013		
2014		
2015		
2016	17,650	

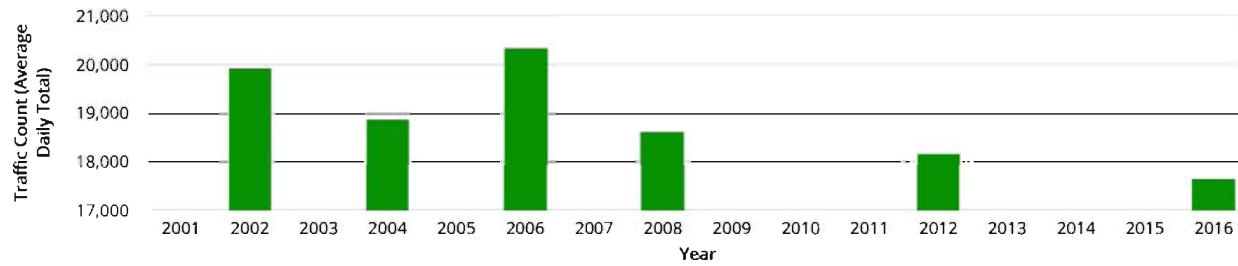


2006 - 2016 Growth Rate = -13.2%

Average Annual Growth Rate = -1.4%



Strawberry Plains Pk - N of I-40E Ex (Station ID: 093C327)




APPENDIX B

WALK SCORE


WALKSCORE




(from walkscore.com)


Walk Score  [Get Scores](#) [Find Apartments](#) [My Favorites](#) [Add to Your Site](#)

521 Brakebill Road

Knoxville, Tennessee, 37924

Commute to **Downtown Knoxville** 

 17 min  60+ min  60+ min [View Routes](#)

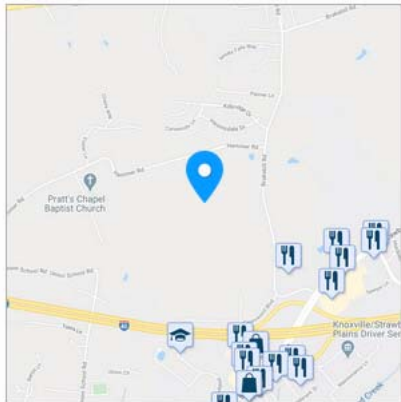
[More about 521 Brakebill Road](#) 

Walk Score
8
Car-Dependent
Almost all errands require a car.

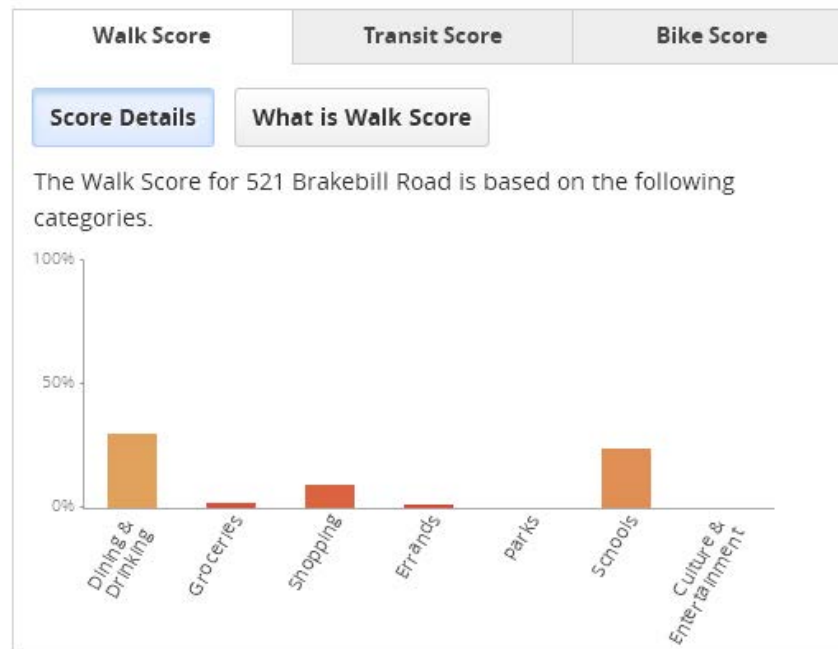
Transit Score
0
Minimal Transit
It is possible to get on a bus.

Bike Score
15
Somewhat Bikeable
Minimal bike infrastructure.

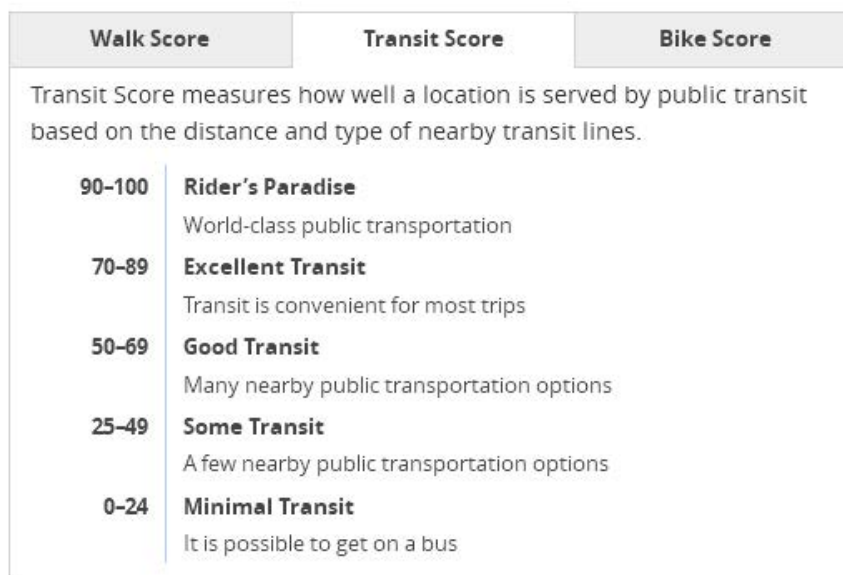
[About your score](#)
[Add scores to your site](#)



Scores for 521 Brakebill Road



Scores for 521 Brakebill Road



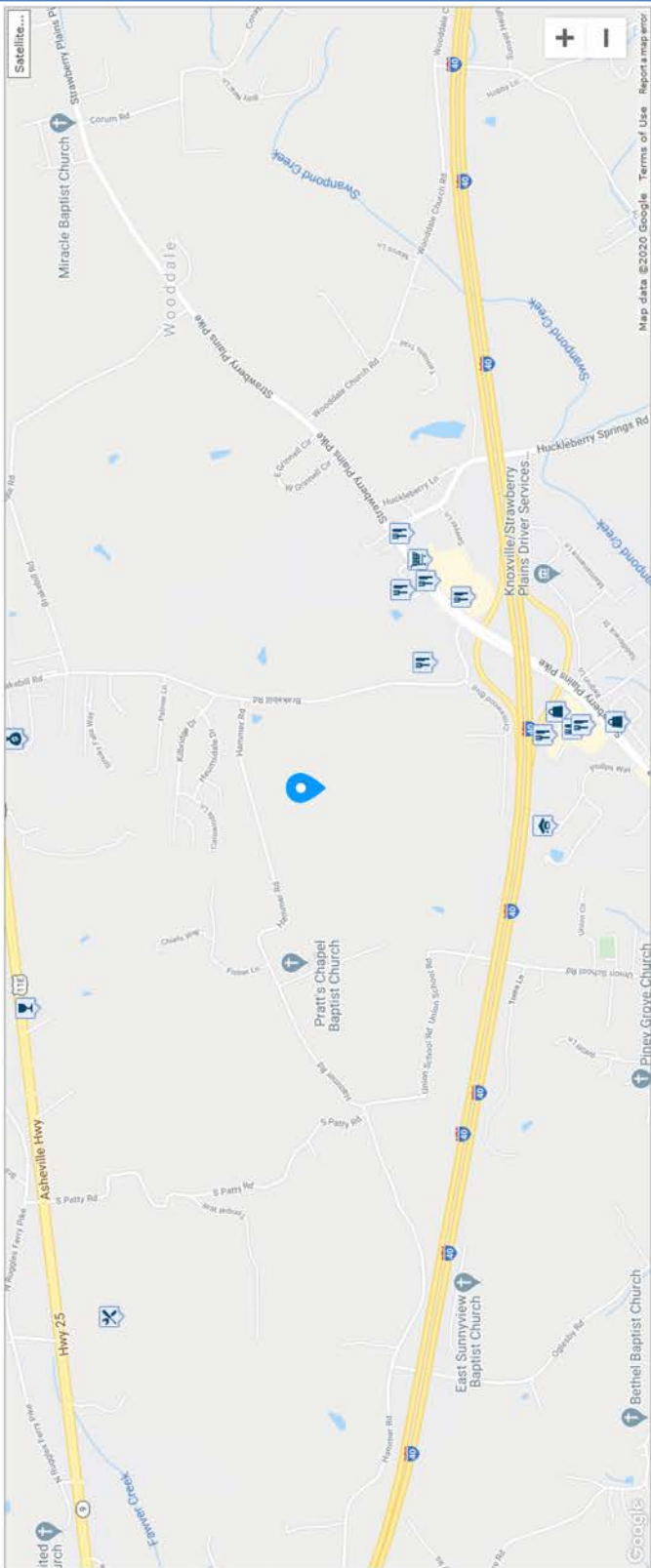
Scores for 521 Brakebill Road



Walk Score	Transit Score	Bike Score
<p>Bike Score measures whether an area is good for biking based on bike lanes and trails, hills, road connectivity, and destinations.</p>		
90-100	Biker's Paradise	Daily errands can be accomplished on a bike
70-89	Very Bikeable	Biking is convenient for most trips
50-69	Bikeable	Some bike infrastructure
0-49	Somewhat Bikeable	Minimal bike infrastructure

What's Nearby

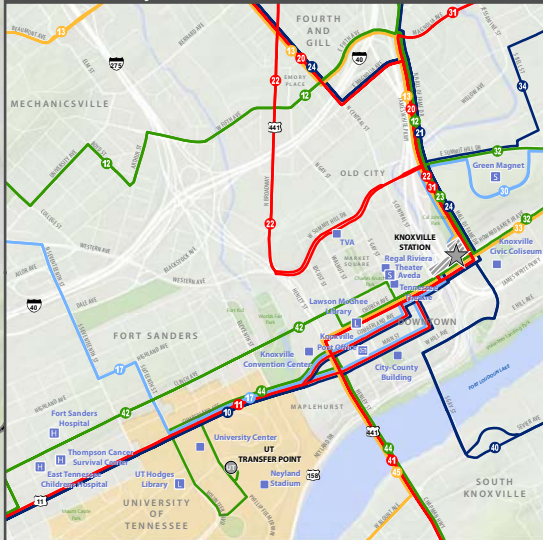
- Restaurants:**
 - Mad Creek < .4mi >
- Coffee:**
 - Keuring Green Mountain < 5.1mi >
- Bars:**
 - Six Pockets Sports Grill < .9mi >
- Groceries:**
 - M. C.'s Wine & Liquor < .6mi >
- Parks:**
 - Volunteer Park < 2.8mi >
- Schools:**
 - Cle School < .5mi >
- Shopping:**
 - Weigel's < .6mi >
- Entertainment:**
 - Historic Ramsay House < 3.7mi >
- Errands:**
 - U.S. Bank Branch < .8mi >
- Search Nearby:** < >



APPENDIX C

KNOXVILLE AREA TRANSIT MAP AND INFORMATION

Knoxville City Center



Legend

- Transfer Point
- Lift Service Area Boundary

Points of Interest

- Hospital
- School
- Library
- Point of Interest
- Post Office

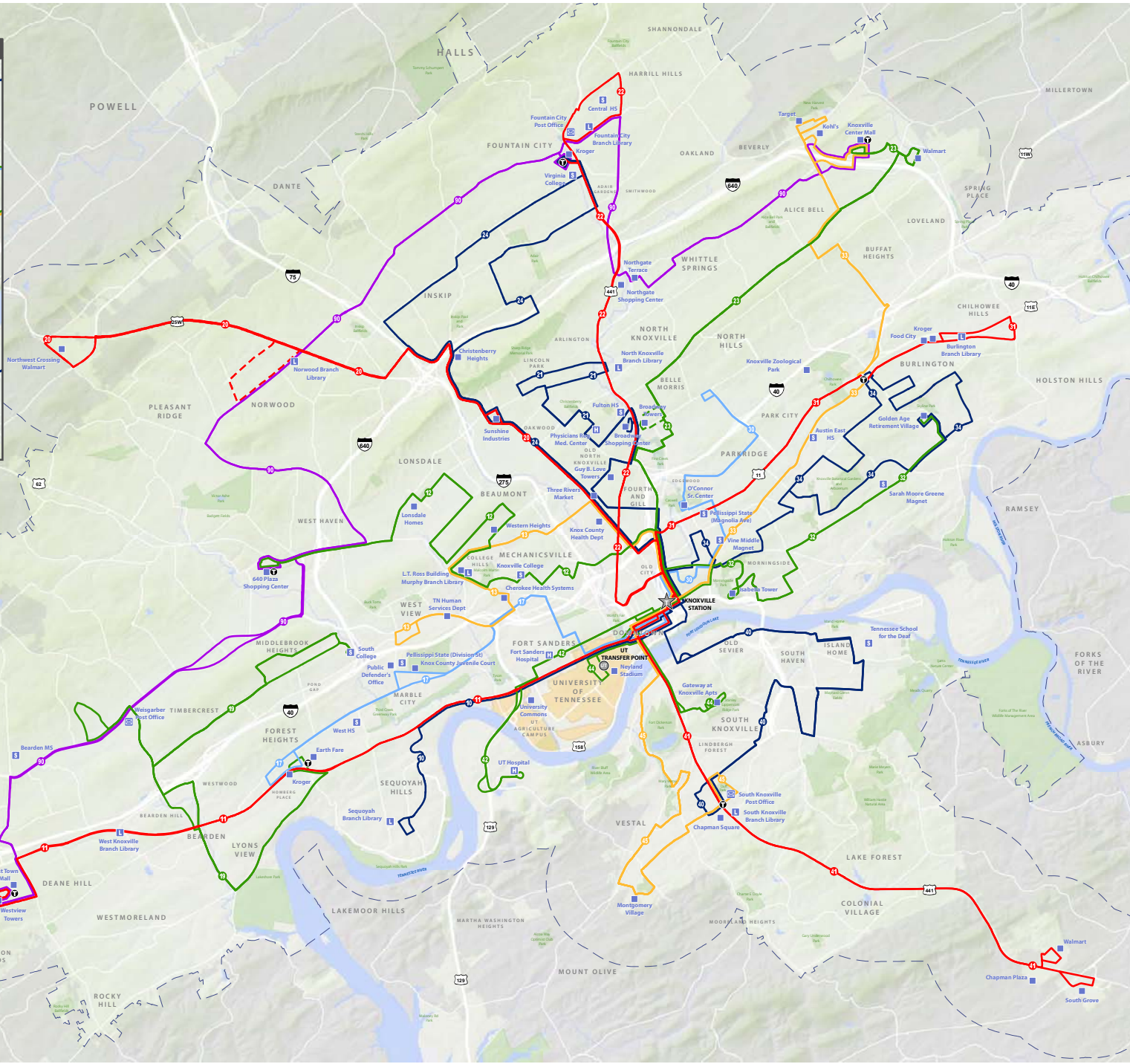
Distances

0 5 10 Minutes Walking

0 5 10 Minutes Biking

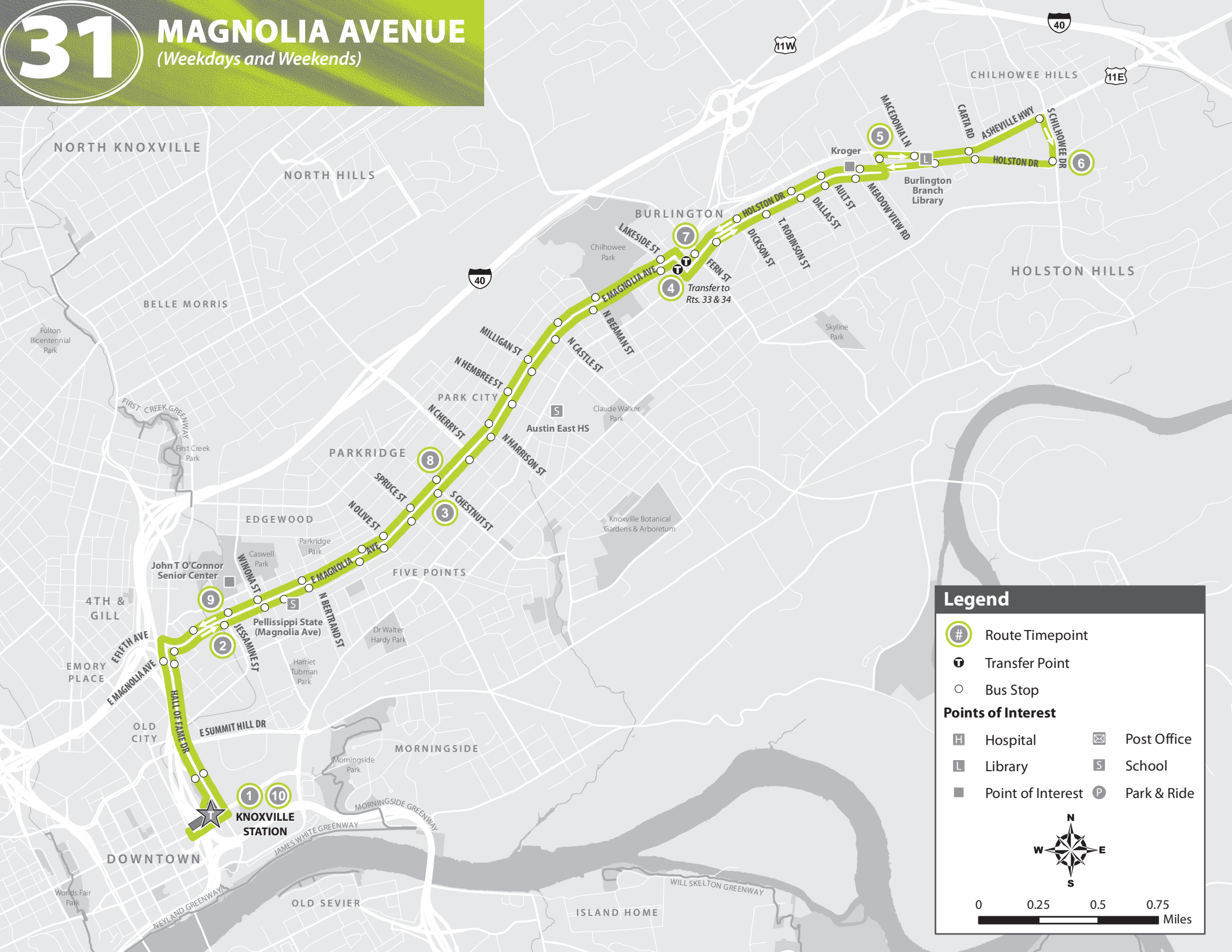
0 0.5 1 Map Scale in Miles

North



31 MAGNOLIA AVENUE

(Weekdays and Weekends)



Legend

- Route Timepoint
- Transfer Point
- Bus Stop

Points of Interest

Hospital	Post Office
Library	School
Point of Interest	Park & Ride

0 0.25 0.5 0.75 Miles



MAGNOLIA AVENUE

(Weekdays and Weekends)

SERVES:

- ★ Burlington Branch Library
- ★ Chilhowee Park
- ★ Holston Drive
- ★ Knoxville Station/Downtown

Kroger
Pellissippi State,
Magnolia Ave. Campus



Information Updated: January 6, 2020

Going away from Downtown						Going toward Downtown						
Transfer to:			Rts. 33 & 34			Rts. 33 & 34						
Knoxville Station—Platform F	Magnolia at Jessamine	Magnolia at Chestnut	Kirkwood St. Superstop (Arrives)	Kirkwood St. Superstop (Leaves)	Burns Rd at Asheville Hwy	Chilhowee at Holston	Kirkwood St. Superstop (Arrives)	Kirkwood St. Superstop (Leaves)	Magnolia at Chestnut	Magnolia at Jessamine	Knoxville Station	
1	2	3	4	5	6	7	8	9	10			
WEEKDAY SCHEDULE												
A.M.	—	—	—	—	—	5:38	5:43	5:51	5:53	5:59	6:04	6:10
						5:53	5:58	6:06	6:08	6:14	6:19	6:25
	—	—	—	—	—	6:08	6:13	6:21	6:23	6:29	6:34	6:40
						6:23	6:28	6:36	6:38	6:44	6:49	6:55
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	6:30	6:34	6:40	6:45	6:48	6:53	6:58	7:06	7:08	7:14	7:19	7:25
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:00	7:04	7:10	7:15	7:18	7:23	7:28	7:36	7:38	7:44	7:49	7:55
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:30	7:34	7:40	7:45	7:48	7:53	7:58	8:06	8:08	8:14	8:19	8:25
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:00	8:04	8:10	8:15	8:18	8:23	8:28	8:36	8:38	8:44	8:49	8:55
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:30	8:34	8:40	8:45	8:48	8:53	8:58	9:06	9:08	9:14	9:19	9:25
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:00	9:04	9:10	9:15	9:18	9:23	9:28	9:36	9:38	9:44	9:49	9:55
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	10:40
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	10:45	10:49	10:55	11:00	11:03	11:08	11:13	11:21	11:23	11:29	11:34	11:40
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	12:10
	11:45	11:49	11:55	12:00	12:03	12:08	12:13	12:21	12:23	12:29	12:34	12:40
P.M.	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:04	1:10
	12:45	12:49	12:55	1:00	1:03	1:08	1:13	1:21	1:23	1:29	1:34	1:40
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:04	2:10
	1:45	1:49	1:55	2:00	2:03	2:08	2:13	2:21	2:23	2:29	2:34	2:40
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:04	3:10
	2:45	2:49	2:55	3:00	3:03	3:08	3:13	3:21	3:23	3:29	3:34	3:40
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:04	4:10
	—	—	—	—	—	3:53	3:58	4:06	4:08	4:14	4:19	4:25
	3:45	3:49	3:55	4:00	4:03	4:08	4:13	4:21	4:23	4:29	4:34	4:40
	4:00	4:04	4:10	4:15	4:18	4:23	4:28	4:36	4:38	4:44	4:49	4:55
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:04	5:10
	4:30	4:34	4:40	4:45	4:48	4:53	4:58	5:06	5:08	5:14	5:19	5:25
	4:45	4:49	4:55	5:00	5:03	5:08	5:13	5:21	5:23	5:29	5:34	5:40
	5:00	5:04	5:10	5:15	5:18	5:23	5:28	5:36	5:38	5:44	5:49	5:55
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:04	6:10
	5:30	5:34	5:40	5:45	5:48	5:53	5:58	6:06	6:08	6:14	6:19	6:25
	5:45	5:49	5:55	6:00	6:03	6:08	6:13	6:21	6:23	6:29	6:34	6:40
	6:00	6:04	6:10	6:15	6:18	6:23	6:28	6:36	6:38	6:44	6:49	6:55
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	<i>To Garage</i>
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	<i>To Garage</i>

Need help reading this schedule?

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MAGNOLIA AVENUE

(Weekdays and Weekends)

SERVES:

- ★ Burlington Branch Library
- ★ Chilhowee Park
- ★ Holston Drive
- ★ Knoxville Station/Downtown

Kroger
Pellissippi State,
Magnolia Ave. Campus



Information Updated: January 6, 2020

Saturday-Sunday Schedule Route 31: Magnolia

Going away from Downtown						Going toward Downtown					
Transfer to:			Rts. 33 & 34			Rts. 33 & 34					
Knoxville Station—Platform F 1	Magnolia at Jessamine 2	Magnolia at Chestnut 3	Kirkwood St. Superstop (Arrives) (Leaves) 4	Burns Rd at Asheville Hwy 5	Chilhowee at Holston 6	Kirkwood St. Superstop (Arrives) (Leaves) 7	Magnolia at Chestnut 8	Magnolia at Jessamine 9	Knoxville Station 10		
SATURDAY SCHEDULE											
A.M.	—	—	—	—	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	—	—	—	—	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:40
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:10
	10:45	10:49	10:55	11:00	11:03	11:08	11:13	11:21	11:23	11:29	11:40
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:10
	11:45	11:49	11:55	12:00	12:03	12:08	12:13	12:21	12:23	12:29	12:40
P.M.	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:10
	12:45	12:49	12:55	1:00	1:03	1:08	1:13	1:21	1:23	1:29	1:40
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:10
	1:45	1:49	1:55	2:00	2:03	2:08	2:13	2:21	2:23	2:29	2:40
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:10
	2:45	2:49	2:55	3:00	3:03	3:08	3:13	3:21	3:23	3:29	3:40
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:10
	3:45	3:49	3:55	4:00	4:03	4:08	4:13	4:21	4:23	4:29	4:40
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:10
	4:45	4:49	4:55	5:00	5:03	5:08	5:13	5:21	5:23	5:29	5:40
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:10
	5:45	5:49	5:55	6:00	6:03	6:08	6:13	6:21	6:23	6:29	6:40
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:10
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:40
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	To Garage
SUNDAY SCHEDULE											
A.M.	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:10
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:10
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:10
P.M.	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:10
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:10
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:10
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:10
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:10
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:10
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:10
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:10
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:10
										9:05	To Garage

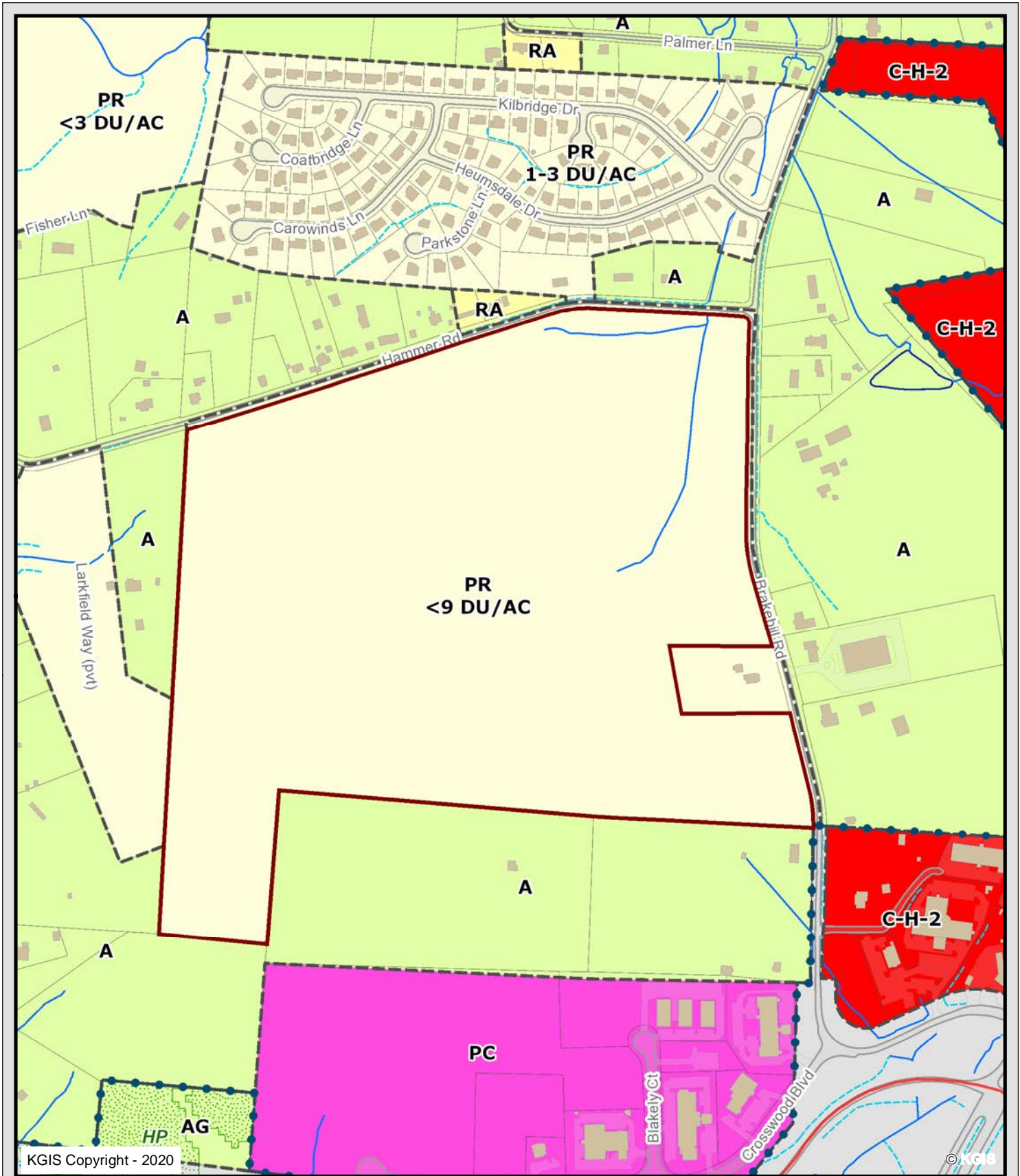
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APPENDIX D

ZONING MAP



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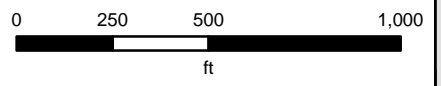
© KGIS

Brakebill Road Subdivision

Zoning Map



Printed: 6/8/2020 at 12:09:08 PM



Knoxville - Knox County - KUB Geographic Information System

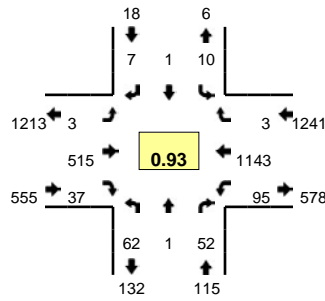
KGIS makes no representation or warranty as to the accuracy of his map and its information nor to its fitness for use. Any user of this map product accepts the same AS IS ,WITH ALL FAULTS, and assumes all responsibility for the use thereof, and futher covenants and agrees to hold KGIS harmless from any and all damage, loss, or liability arising from any use of this map product.

APPENDIX E

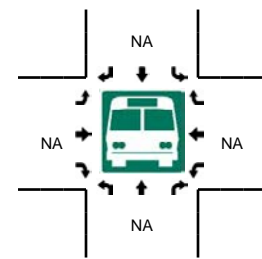
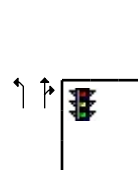
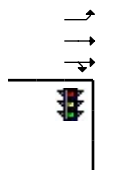
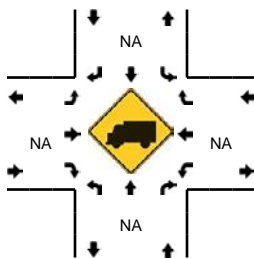
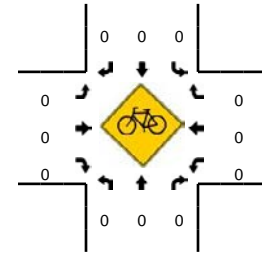
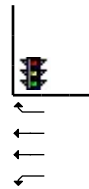
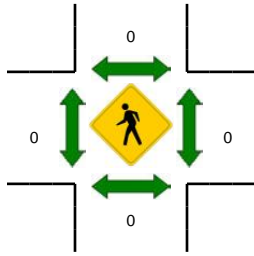
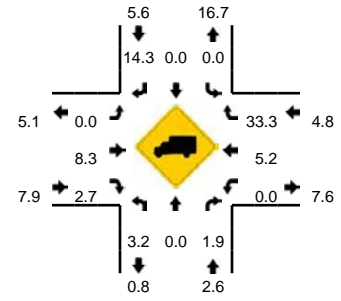
MANUAL TRAFFIC COUNT DATA

LOCATION: Brakebill Rd -- Asheville Hwy
CITY/STATE: Knoxville, TN

QC JOB #: 14618701
DATE: Tue, Mar 20 2018



Peak-Hour: 7:15 AM -- 8:15 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

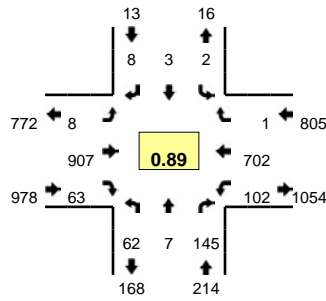


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Asheville Hwy (Eastbound)				Asheville Hwy (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	11	0	4	0	1	4	7	0	2	78	6	0	12	243	0	0	368	
7:15 AM	14	0	9	0	4	0	2	0	1	132	4	0	21	309	0	0	496	
7:30 AM	20	1	11	0	5	0	0	0	0	129	12	0	20	318	0	0	516	
7:45 AM	16	0	13	0	1	1	2	0	1	134	11	1	24	288	1	0	493	1873
8:00 AM	12	0	19	0	0	0	3	0	0	120	10	0	29	228	2	1	424	1929
8:15 AM	15	1	17	0	1	0	2	0	1	98	5	0	31	235	0	0	406	1839
8:30 AM	10	0	7	0	0	0	0	0	1	103	6	0	19	198	0	0	344	1667
8:45 AM	6	0	9	0	0	0	0	0	2	101	8	0	15	159	0	0	300	1474
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	80	4	44	0	20	0	0	0	0	516	48	0	80	1272	0	0	2064	
Heavy Trucks	4	0	0		0	0	0		0	44	4		0	28	0		80	
Pedestrians	0				0				0	0			0	0			0	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																	0	
Stopped Buses																	0	

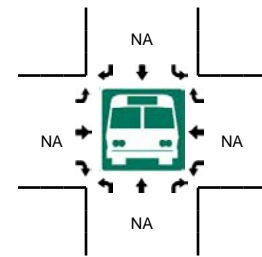
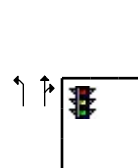
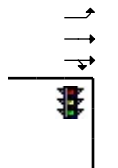
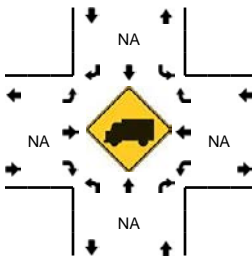
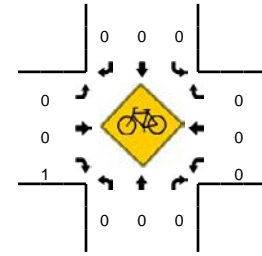
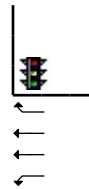
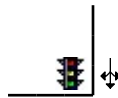
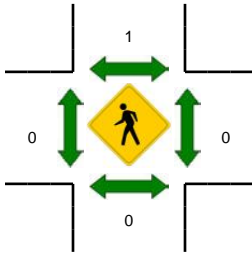
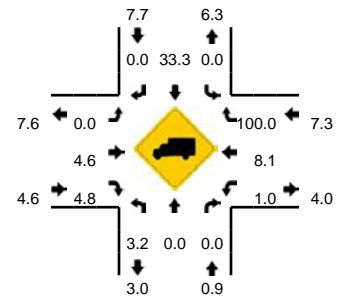
Comments:

LOCATION: Brakebill Rd -- Asheville Hwy
CITY/STATE: Knoxville, TN

QC JOB #: 14618702
DATE: Tue, Mar 20 2018



Peak-Hour: 3:45 PM -- 4:45 PM
Peak 15-Min: 3:45 PM -- 4:00 PM

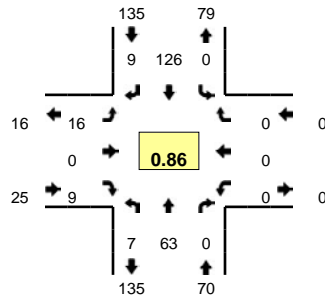


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Asheville Hwy (Eastbound)				Asheville Hwy (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	13	1	23	0	1	0	1	0	1	140	10	1	23	139	0	1	354	
2:15 PM	11	0	15	0	1	2	1	0	0	142	7	1	20	143	0	0	343	
2:30 PM	13	1	19	0	1	0	0	0	0	163	11	0	23	157	1	0	389	
2:45 PM	15	0	21	0	0	0	0	0	5	162	18	1	17	143	0	0	382	1468
3:00 PM	15	0	33	0	0	0	0	0	1	190	16	0	24	128	2	0	409	1523
3:15 PM	10	0	26	0	1	1	3	0	1	220	18	0	21	149	3	0	453	1633
3:30 PM	12	0	36	0	0	1	2	0	2	195	14	0	24	179	2	0	467	1711
3:45 PM	11	2	34	0	1	1	2	0	3	232	15	0	35	225	1	0	562	1891
4:00 PM	23	2	36	0	0	1	2	0	1	193	11	0	24	159	0	0	452	1934
4:15 PM	10	1	28	0	1	0	2	0	1	242	23	0	20	150	0	0	478	1959
4:30 PM	18	2	47	0	0	1	2	0	3	240	14	0	23	168	0	0	518	2010
4:45 PM	16	2	36	0	0	0	2	0	2	237	15	0	19	131	0	0	460	1908
5:00 PM	11	1	38	0	0	1	2	0	2	246	17	0	21	153	0	0	492	1948
5:15 PM	8	1	42	0	0	0	3	0	3	255	13	0	27	158	1	0	511	1981
5:30 PM	14	0	29	0	1	2	3	0	3	229	10	0	20	143	1	0	455	1918
5:45 PM	8	2	34	0	2	0	0	0	1	247	23	1	13	129	0	0	460	1918
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	44	8	136	0	4	4	8	0	12	928	60	0	140	900	4	0	2248	
Heavy Trucks	0	0	0		0	4	0		0	56	4		4	100	4		172	
Pedestrians		0				0				0				0			0	
Bicycles	0	0	0		0	0	0		0	0	1		0	0	0		1	
Railroad																		
Stopped Buses																		

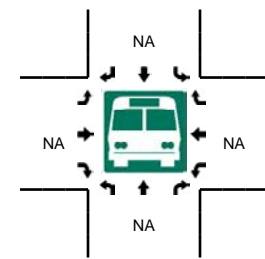
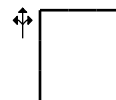
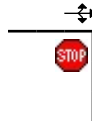
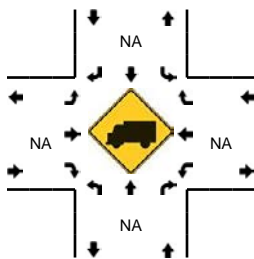
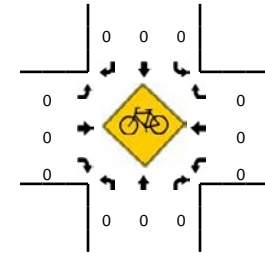
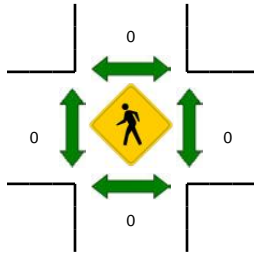
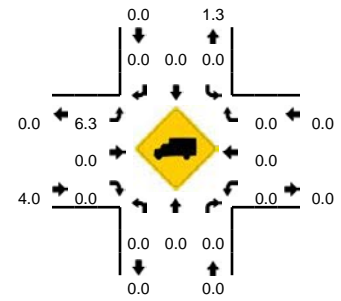
Comments:

LOCATION: Brakebill Rd -- Hammer Rd
CITY/STATE: Knoxville, TN

QC JOB #: 14618703
DATE: Tue, Mar 20 2018



Peak-Hour: 7:30 AM -- 8:30 AM
Peak 15-Min: 7:45 AM -- 8:00 AM

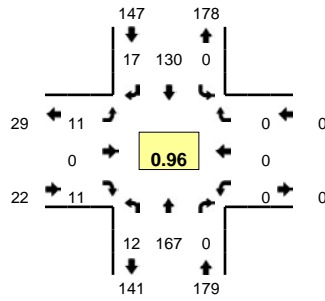


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Hammer Rd (Eastbound)				Hammer Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	2	11	0	0	0	25	0	0	1	0	0	0	0	0	0	0	39	
7:15 AM	0	8	0	0	0	31	0	0	1	0	1	0	0	0	0	0	41	
7:30 AM	1	16	0	0	0	31	1	0	1	0	2	0	0	0	0	0	52	
7:45 AM	3	22	0	0	0	37	0	0	3	0	2	0	0	0	0	0	67	199
8:00 AM	0	10	0	0	0	31	4	0	8	0	2	0	0	0	0	0	55	215
8:15 AM	3	15	0	0	0	27	4	0	4	0	3	0	0	0	0	0	56	230
8:30 AM	1	12	0	0	0	23	0	0	1	0	0	0	0	0	0	0	37	215
8:45 AM	0	12	0	0	0	18	0	0	2	0	3	0	0	0	0	0	35	183
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	12	88	0	0	0	148	0	0	12	0	8	0	0	0	0	0	268	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

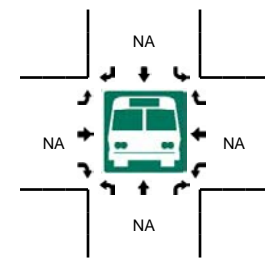
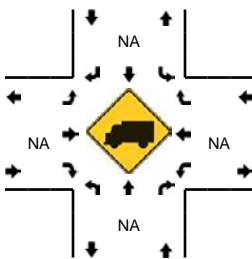
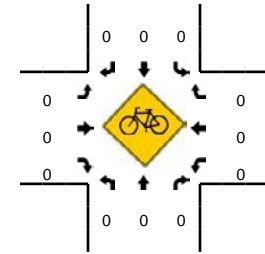
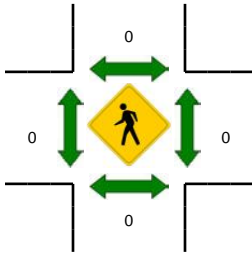
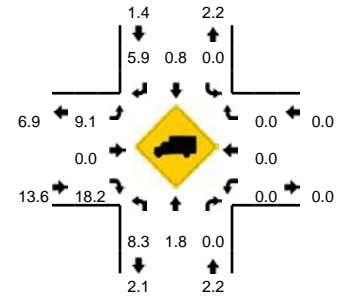
Comments:

LOCATION: Brakebill Rd -- Hammer Rd
CITY/STATE: Knoxville, TN

QC JOB #: 14618704
DATE: Tue, Mar 20 2018



Peak-Hour: 4:15 PM -- 5:15 PM
Peak 15-Min: 4:15 PM -- 4:30 PM

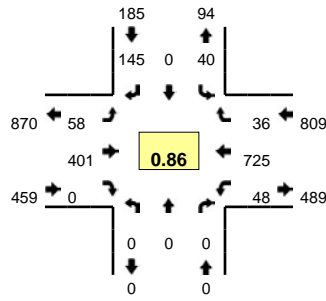


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Hammer Rd (Eastbound)				Hammer Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	0	23	0	0	0	30	3	0	2	0	0	0	0	0	0	0	58	
2:15 PM	0	23	0	0	0	28	2	0	1	0	2	0	0	0	0	0	56	
2:30 PM	2	17	0	0	0	27	1	0	3	0	1	0	0	0	0	0	51	
2:45 PM	6	25	0	0	0	35	1	0	6	0	2	0	0	0	0	0	75	240
3:00 PM	5	23	0	0	0	30	7	0	3	0	2	0	0	0	0	0	70	252
3:15 PM	2	22	0	0	0	30	3	0	3	0	4	0	0	0	0	0	64	260
3:30 PM	4	29	0	0	0	37	7	0	5	0	2	0	0	0	0	0	84	293
3:45 PM	8	38	0	0	0	30	9	0	6	0	3	0	0	0	0	0	94	312
4:00 PM	4	26	0	0	0	35	6	0	2	0	1	0	0	0	0	0	74	316
4:15 PM	4	36	0	0	0	42	2	0	5	0	2	0	0	0	0	0	91	343
4:30 PM	2	46	0	0	0	30	5	0	2	0	2	0	0	0	0	0	87	346
4:45 PM	3	40	0	0	0	25	5	0	2	0	5	0	0	0	0	0	80	332
5:00 PM	3	45	0	0	0	33	5	0	2	0	2	0	0	0	0	0	90	348
5:15 PM	1	33	0	0	0	34	4	0	1	0	3	0	0	0	0	0	76	333
5:30 PM	6	33	0	0	0	33	5	0	6	0	2	0	0	0	0	0	85	331
5:45 PM	2	34	0	0	0	45	1	0	0	0	2	0	0	0	0	0	84	335
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	16	144	0	0	0	168	8	0	20	0	8	0	0	0	0	0	364	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

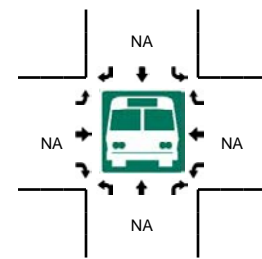
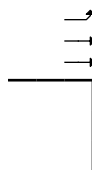
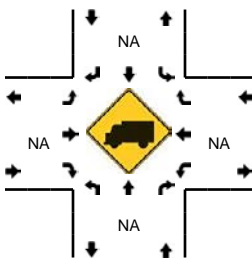
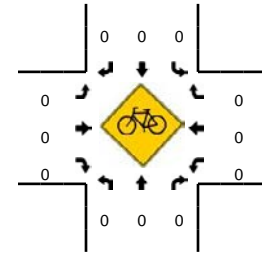
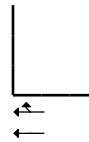
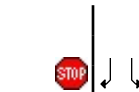
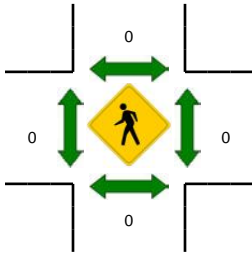
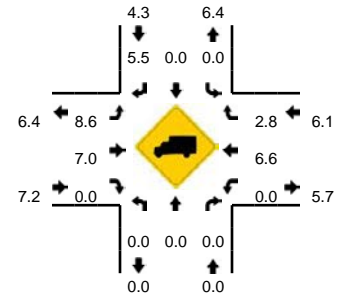
Comments:

LOCATION: Brakebill Rd -- Strawberry Plains Pike
CITY/STATE: Knoxville, TN

QC JOB #: 14618707
DATE: Tue, Mar 20 2018



Peak-Hour: 7:15 AM -- 8:15 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

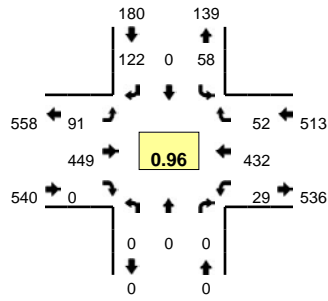


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	0	0	3	0	32	0	10	67	0	0	0	132	6	3	253	
7:15 AM	0	0	0	0	5	0	34	0	11	92	0	0	0	182	6	13	343	
7:30 AM	0	0	0	0	18	0	39	0	13	100	0	0	0	230	11	11	422	
7:45 AM	0	0	0	0	11	0	35	0	22	110	0	0	0	173	13	11	375	1393
8:00 AM	0	0	0	0	6	0	37	0	12	99	0	0	0	140	6	13	313	1453
8:15 AM	0	0	0	0	8	0	34	0	17	69	0	0	0	150	12	11	301	1411
8:30 AM	0	0	0	0	5	0	19	0	14	76	0	1	0	111	4	4	234	1223
8:45 AM	0	0	0	0	6	0	22	0	12	80	0	0	0	115	7	6	248	1096
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	0	0	0	0	72	0	156	0	52	400	0	0	0	920	44	44	1688	
Heavy Trucks	0	0	0	0	0	0	12	0	0	20	0	0	0	48	0	0	80	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

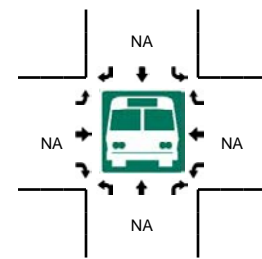
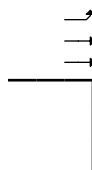
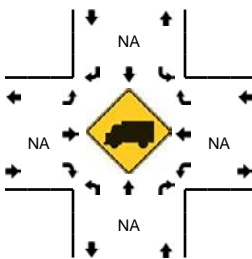
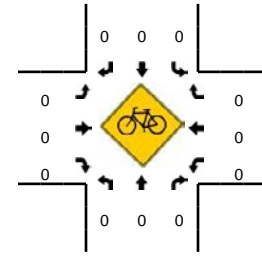
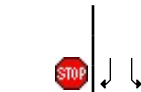
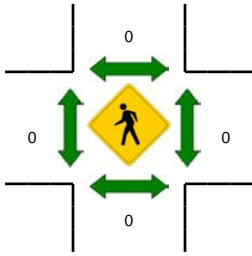
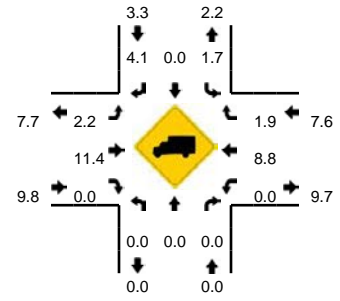
Comments:

LOCATION: Brakebill Rd -- Strawberry Plains Pike
CITY/STATE: Knoxville, TN

QC JOB #: 14618708
DATE: Tue, Mar 20 2018



Peak-Hour: 12:00 PM -- 1:00 PM
Peak 15-Min: 12:15 PM -- 12:30 PM

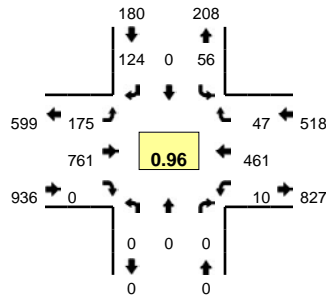


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
11:00 AM	0	0	0	0	8	0	20	0	9	94	0	0	0	110	5	6	252	
11:15 AM	0	0	0	0	13	0	25	0	19	99	0	1	0	87	9	5	258	
11:30 AM	0	0	0	0	12	0	32	0	26	101	0	0	0	100	18	3	292	
11:45 AM	0	0	0	0	10	0	27	0	16	113	0	0	0	104	6	2	278	1080
12:00 PM	0	0	0	0	17	0	25	0	16	128	0	0	0	96	8	4	294	1122
12:15 PM	0	0	0	0	13	0	35	0	25	105	0	2	0	115	18	7	320	1184
12:30 PM	0	0	0	0	8	0	33	0	25	116	0	2	0	106	12	10	312	1204
12:45 PM	0	0	0	0	20	0	29	0	21	100	0	0	0	115	14	8	307	1233
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	0	0	0	0	52	0	140	0	100	420	0	8	0	460	72	28	1280	
Heavy Trucks	0	0	0	0	0	0	4	0	4	40	0	0	0	52	4	0	104	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

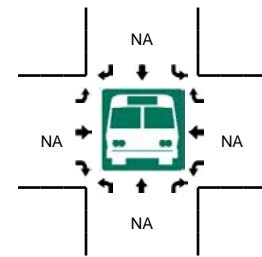
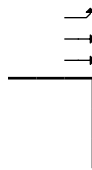
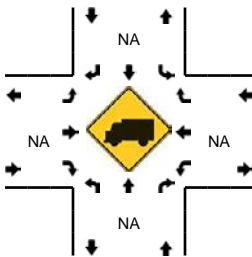
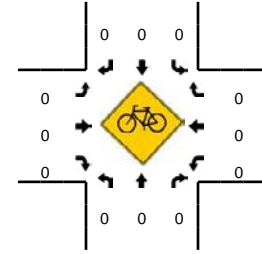
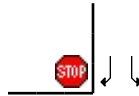
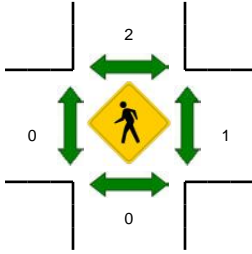
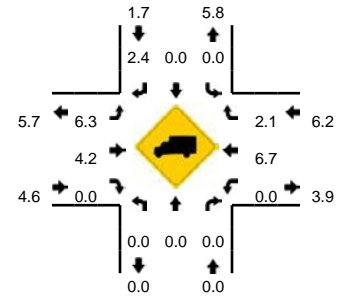
Comments:

LOCATION: Brakebill Rd -- Strawberry Plains Pike
CITY/STATE: Knoxville, TN

QC JOB #: 14618709
DATE: Tue, Mar 20 2018



Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 5:15 PM -- 5:30 PM

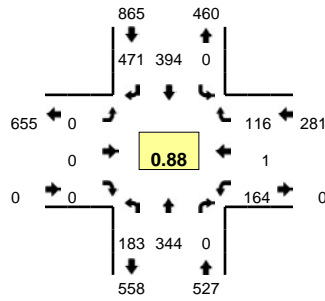


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	0	0	0	0	15	0	25	0	18	104	0	0	0	86	10	1	259	
2:15 PM	0	0	0	0	19	0	19	0	14	133	0	1	0	90	13	4	293	
2:30 PM	0	0	0	0	8	0	27	0	22	123	0	5	0	94	12	3	294	
2:45 PM	0	0	0	0	19	0	30	0	23	105	0	0	0	101	13	2	293	1139
3:00 PM	0	0	0	0	15	0	27	0	23	134	0	0	0	105	14	3	321	1201
3:15 PM	0	0	0	0	14	0	27	0	20	131	0	0	0	100	9	5	306	1214
3:30 PM	0	0	0	0	23	0	25	0	29	139	0	2	0	117	13	8	356	1276
3:45 PM	0	0	0	0	15	0	29	0	29	175	0	0	0	122	18	10	398	1381
4:00 PM	0	0	0	0	15	0	23	0	19	139	0	0	0	115	19	5	335	1395
4:15 PM	0	0	0	0	20	0	29	0	32	186	0	0	0	99	11	4	381	1470
4:30 PM	0	0	0	0	13	0	30	0	32	185	0	11	0	118	20	4	413	1527
4:45 PM	0	0	0	0	10	0	27	0	44	195	0	2	0	107	7	3	395	1524
5:00 PM	0	0	0	0	15	0	32	0	49	174	0	1	0	114	12	2	399	1588
5:15 PM	0	0	0	0	18	0	35	0	36	207	0	0	0	122	8	1	427	1634
5:30 PM	0	0	0	0	16	0	25	0	33	175	0	0	0	96	11	2	358	1579
5:45 PM	0	0	0	0	18	0	32	0	32	164	0	1	0	108	13	6	374	1558
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	72	0	140	0	144	828	0	0	0	488	32	4	1708	
Heavy Trucks	0	0	0	0	0	0	0	0	8	20	0	0	0	20	0	0	48	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

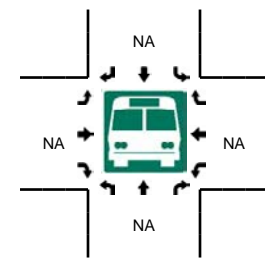
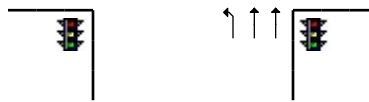
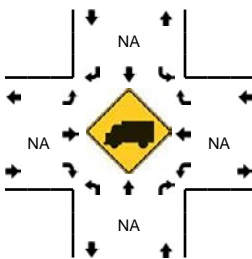
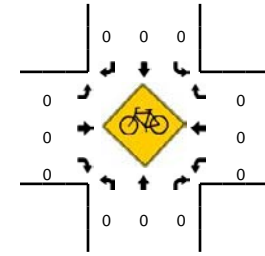
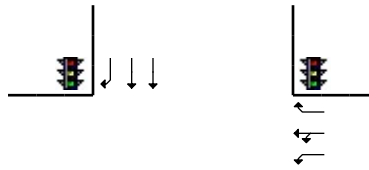
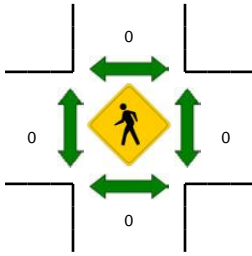
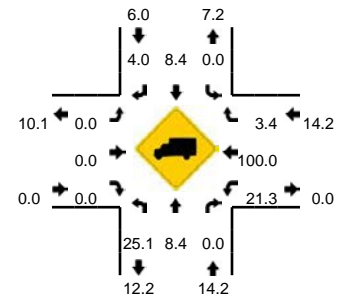
Comments:

LOCATION: Strawberry Plains Pike -- I-40 WB Ramps
CITY/STATE: Knoxville, TN

QC JOB #: 14618710
DATE: Tue, Mar 20 2018



Peak-Hour: 7:15 AM -- 8:15 AM
Peak 15-Min: 7:30 AM -- 7:45 AM

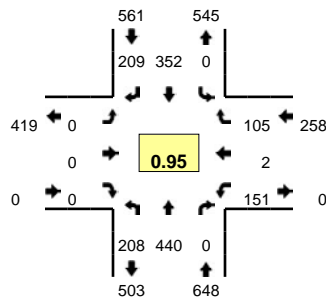


15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	47	43	0	0	0	77	92	0	0	0	0	0	44	0	21	0	324	
7:15 AM	48	74	0	0	0	91	119	0	0	0	0	0	36	0	28	0	396	
7:30 AM	48	94	0	0	0	105	153	0	0	0	0	0	39	0	34	0	473	
7:45 AM	46	97	0	0	0	106	113	0	0	0	0	0	52	1	35	0	450	1643
8:00 AM	41	79	0	0	0	92	86	0	0	0	0	0	37	0	19	0	354	1673
8:15 AM	47	66	0	0	0	89	99	0	0	0	0	0	46	0	27	0	374	1651
8:30 AM	46	67	0	0	0	72	60	0	0	0	0	0	39	0	28	0	312	1490
8:45 AM	39	69	0	0	0	79	62	0	0	0	0	0	35	0	29	0	313	1353
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	192	376	0	0	0	420	612	0	0	0	0	0	156	0	136	0	1892	
Heavy Trucks	44	24	0	0	0	32	16	0	0	0	0	0	32	0	4	0	152	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

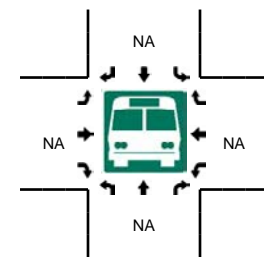
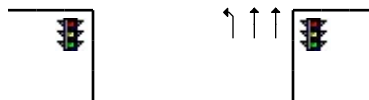
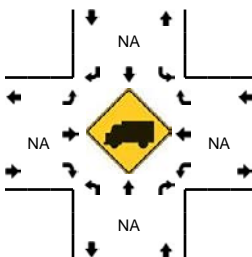
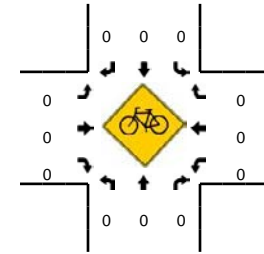
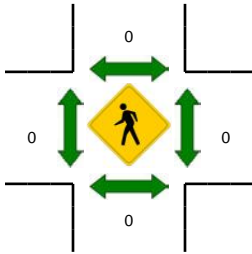
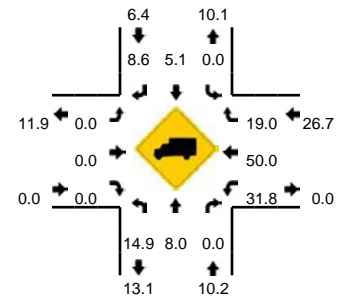
Comments:

LOCATION: Strawberry Plains Pike -- I-40 WB Ramps
CITY/STATE: Knoxville, TN

QC JOB #: 14618711
DATE: Tue, Mar 20 2018



Peak-Hour: 12:00 PM -- 1:00 PM
Peak 15-Min: 12:15 PM -- 12:30 PM

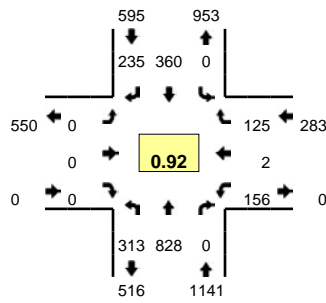


15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
11:00 AM	39	69	0	0	0	69	64	0	0	0	0	0	23	2	30	0	296	
11:15 AM	44	93	0	0	0	63	48	0	0	0	0	0	41	0	25	0	314	
11:30 AM	47	110	0	0	0	82	53	0	0	0	0	0	38	0	24	0	354	
11:45 AM	56	114	0	0	0	88	43	0	0	0	0	0	27	0	19	0	347	1311
12:00 PM	40	120	0	0	0	86	37	0	0	0	0	0	19	1	28	0	331	1346
12:15 PM	64	107	0	0	0	96	59	0	0	0	0	0	36	1	25	0	388	1420
12:30 PM	59	115	0	0	0	88	50	0	0	0	0	0	46	0	29	0	387	1453
12:45 PM	45	98	0	0	0	82	63	0	0	0	0	0	50	0	23	0	361	1467
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	256	428	0	0	0	384	236	0	0	0	0	0	144	4	100	0	1552	
Heavy Trucks	40	44	0	0	0	28	16	0	0	0	0	0	48	0	12	0	188	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

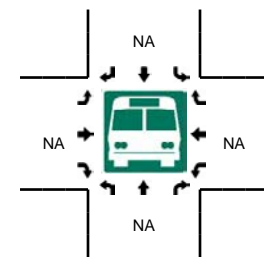
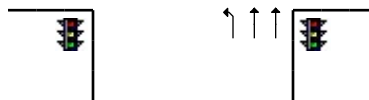
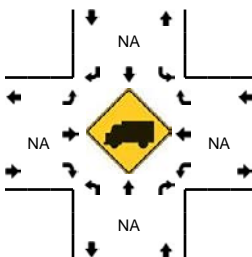
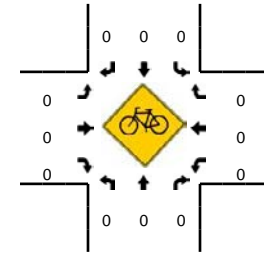
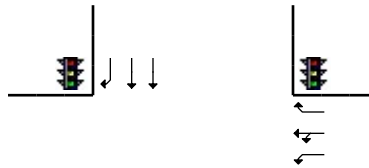
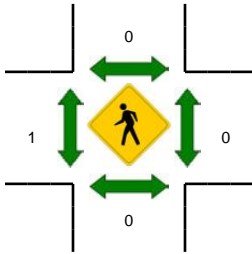
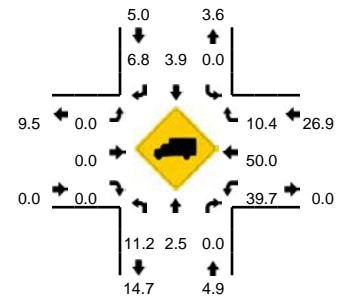
Comments:

LOCATION: Strawberry Plains Pike -- I-40 WB Ramps
CITY/STATE: Knoxville, TN

QC JOB #: 14618712
DATE: Tue, Mar 20 2018



Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:30 PM -- 4:45 PM



15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	57	94	0	0	0	52	55	0	0	0	0	0	32	2	31	0	323	
2:15 PM	48	114	0	0	0	72	41	0	0	0	0	0	37	1	23	0	336	
2:30 PM	54	127	0	0	0	64	56	0	0	0	0	0	41	0	21	0	363	
2:45 PM	72	104	0	0	0	77	49	0	0	0	0	0	30	0	31	0	363	1385
3:00 PM	57	131	0	0	0	91	52	0	0	0	0	0	45	0	22	0	398	1460
3:15 PM	53	127	0	0	0	67	59	0	0	0	0	0	42	0	20	0	368	1492
3:30 PM	83	143	0	0	0	99	52	0	0	0	0	0	30	0	34	0	441	1570
3:45 PM	44	161	0	0	0	109	60	0	0	0	0	0	31	0	36	0	441	1648
4:00 PM	43	124	0	0	0	81	65	0	0	0	0	0	21	0	26	0	360	1610
4:15 PM	67	189	0	0	0	85	50	0	0	0	0	0	41	0	29	0	461	1703
4:30 PM	105	202	0	0	0	98	68	0	0	0	0	0	35	1	38	0	547	1809
4:45 PM	82	216	0	0	0	71	57	0	0	0	0	0	52	0	27	0	505	1873
5:00 PM	75	196	0	0	0	83	61	0	0	0	0	0	36	0	32	0	483	1996
5:15 PM	51	214	0	0	0	108	49	0	0	0	0	0	33	1	28	0	484	2019
5:30 PM	49	170	0	0	0	85	42	0	0	0	0	0	42	0	38	0	426	1898
5:45 PM	40	166	0	0	0	100	45	0	0	0	0	0	43	0	30	0	424	1817
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	420	808	0	0	0	392	272	0	0	0	0	0	140	4	152	0	2188	
Heavy Trucks	24	52	0	0	0	16	12	0	0	0	0	0	72	4	24	0	204	
Pedestrians	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

TRAFFIC COUNT DATA

Major Street: Brakebill Road (NB - SB)
 Minor Street: Kilbridge Drive (EB)
 Traffic Control: Stop Control on Kilbridge Drive

3/20/2018 (Tuesday)
 Cloudy/Windy
 Conducted by: Ajax Engineering

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive		VEHICLE TOTAL	PEAK HOUR
	SOUTHBOUND		NORTHBOUND		EASTBOUND			
	THRU	RIGHT	LT	THRU	LT	RT		
7:00 AM	20	0	2	10	1	4	37	
7:15 AM	21	0	0	9	9	8	47	
7:30 AM	20	1	1	17	8	12	59	7:30 AM - 8:30 AM
7:45 AM	28	4	2	21	5	10	70	
8:00 AM	26	4	1	19	12	10	72	
8:15 AM	24	5	0	18	7	5	59	
8:30 AM	20	3	4	10	0	5	42	
8:45 AM	16	1	0	14	3	2	36	
TOTAL	175	18	10	118	45	56	422	
Peak % Exit	-	-	-	-	46%	54%		
Peak % Enter	-	78%	22%	-	-	-		
2:00 PM	28	2	4	20	1	4	59	
2:15 PM	29	3	2	24	3	2	63	
2:30 PM	27	3	0	19	4	1	54	
2:45 PM	32	5	2	30	2	1	72	
3:00 PM	39	3	1	23	4	0	70	
3:15 PM	30	5	3	22	3	2	65	
3:30 PM	35	4	3	32	2	5	81	
3:45 PM	39	4	10	34	2	5	94	
4:00 PM	36	6	3	27	4	2	78	
4:15 PM	44	7	4	36	7	2	100	4:15 PM - 5:15 PM
4:30 PM	26	9	5	46	2	6	94	
4:45 PM	28	1	8	34	3	2	76	
5:00 PM	38	8	9	40	4	1	100	
5:15 PM	35	6	5	29	4	4	83	
5:30 PM	35	7	7	31	4	1	85	
5:45 PM	43	9	5	30	1	4	92	
TOTAL	285	53	46	273	29	22	708	
Peak % Exit	-	-	-	-	59%	41%		
Peak % Enter	-	49%	51%	-	-	-		

2018 AM Peak Hour 7:30 AM - 8:30 AM

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive	
	SOUTHBOUND		NORTHBOUND		EASTBOUND	
	THRU	RIGHT	LT	THRU	LT	RT
7:30 AM	20	1	1	17	8	12
7:45 AM	28	4	2	21	5	10
8:00 AM	26	4	1	19	12	10
8:15 AM	24	5	0	18	7	5
TOTAL	98	14	4	75	32	37
PHF	0.88	0.70	0.50	0.89	0.67	0.77

2018 PM Peak Hour 4:15 PM - 5:15 PM

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive	
	SOUTHBOUND		NORTHBOUND		EASTBOUND	
	THRU	RIGHT	LT	THRU	LT	RT
4:15 PM	44	7	4	36	7	2
4:30 PM	26	9	5	46	2	6
4:45 PM	28	1	8	34	3	2
5:00 PM	38	8	9	40	4	1
TOTAL	136	25	26	156	16	11
PHF	0.77	0.69	0.72	0.85	0.57	0.46

APPENDIX F

EXISTING TRAFFIC SIGNAL TIMING INFORMATION

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Intersection: BRAKEBILL

Thu Mar 29 14:57:19 2018

Startup Data:

Ring 1 - 2
 Start Phases 2 6
 UCF Entry Phases 4 8
 UCF Exit Phases 2 6

Start Overlaps Yellow at Power-up? NO
 Start in All Red at Power-up? NO
 Zone ID: 0
 Controller ID: 0
 Hold 2 sec. Minimum Red Revert? YES Red Revert Time: 4.0 sec.
 Override Holds if
 Uniform Code Flash Active? YES
 Dual Entry 1256? YES
 Dual Entry 3478? YES
 Passage Interval Sequential? YES
 Simultaneous Gap? NO
 Conditional Service set by Input? NO
 Conditional Service 1256? NO
 Conditional Service 3478? NO

Timing Data:

Interval	Time by Phase (sec.)							
	1	2	3	4	5	6	7	8
Initial	5	15	0	5	5	15	0	5
Passage	3.0	3.0	0.0	3.0	3.0	3.0	0.0	3.0
Yellow	4.0	5.0	0.0	4.0	4.0	5.0	0.0	4.0
Red Clear	1.0	2.0	0.0	2.5	1.0	2.0	0.0	2.5
Max 1	20	50	0	25	20	50	0	25
Max 2	20	50	0	25	20	50	0	25
Walk	0	15	0	0	0	0	0	0
Ped Clear	0	0	0	0	0	0	0	0

Max 3 Parameters

	1	2	3	4	5	6	7	8
Adjust (sec.)	0	0	0	0	0	0	0	0
Limit (sec.)	0	0	0	0	0	0	0	0
Set (max outs)	0	0	0	0	0	0	0	0
Clr (gap outs)	0	0	0	0	0	0	0	0

Functions:

	1	2	3	4	5	6	7	8
Min. Recall	N	Y	N	N	N	Y	N	N
Max. Recall	N	Y	N	N	N	Y	N	N
Ped. Recall	N	Y	N	N	N	N	N	N
Det. Non-lock	Y	N	N	Y	Y	N	N	Y
CNA I Active	N	Y	N	N	N	Y	N	N

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CNA II Active	N	N	N	N	N	N	N	N
Flashing Walks	N	N	N	N	N	N	N	N
Phase Omitted	N	N	Y	N	N	N	Y	N
Ped Omitted	Y	N	Y	Y	Y	Y	Y	Y
Soft Recall	N	N	N	N	N	N	N	N

Asheville Hwy and BRAKE.TXT

Ped Cl thru Yel N N N N N N N N N
 Ped Cl thru Red N N N N N N N N N

Begin Daylight Savings in week: 15
 End Daylight Savings in week: 45

Time of Day Changepoints:

Week Plan:

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Plan: 0	0	0	0	0	0	0	0
Plan: 1	0	0	0	0	0	0	0
Plan: 2	0	0	0	0	0	0	0
Plan: 3	0	0	0	0	0	0	0
Plan: 4	0	0	0	0	0	0	0
Plan: 5	0	0	0	0	0	0	0
Plan: 6	0	0	0	0	0	0	0
Plan: 7	0	0	0	0	0	0	0
Plan: 8	0	0	0	0	0	0	0
Plan: 9	0	0	0	0	0	0	0

Week Plan Implementation:

Week 1: 0	Week 14: 0	Week 27: 0	Week 40: 0
Week 2: 0	Week 15: 0	Week 28: 0	Week 41: 0
Week 3: 0	Week 16: 0	Week 29: 0	Week 42: 0
Week 4: 0	Week 17: 0	Week 30: 0	Week 43: 0
Week 5: 0	Week 18: 0	Week 31: 0	Week 44: 0
Week 6: 0	Week 19: 0	Week 32: 0	Week 45: 0
Week 7: 0	Week 20: 0	Week 33: 0	Week 46: 0
Week 8: 0	Week 21: 0	Week 34: 0	Week 47: 0
Week 9: 0	Week 22: 0	Week 35: 0	Week 48: 0
Week 10: 0	Week 23: 0	Week 36: 0	Week 49: 0
Week 11: 0	Week 24: 0	Week 37: 0	Week 50: 0
Week 12: 0	Week 25: 0	Week 38: 0	Week 51: 0
Week 13: 0	Week 26: 0	Week 39: 0	Week 52: 0

Special Day Plan Implementation (Plan-Week-Day):

Slot 1 0 - 0 - 0	Slot 18 0 - 0 - 0	Slot 35 0 - 0 - 0
Slot 2 0 - 0 - 0	Slot 19 0 - 0 - 0	Slot 36 0 - 0 - 0
Slot 3 0 - 0 - 0	Slot 20 0 - 0 - 0	Slot 37 0 - 0 - 0
Slot 4 0 - 0 - 0	Slot 21 0 - 0 - 0	Slot 38 0 - 0 - 0
Slot 5 0 - 0 - 0	Slot 22 0 - 0 - 0	Slot 39 0 - 0 - 0

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Slot 6 0 - 0 - 0	Slot 23 0 - 0 - 0	Slot 40 0 - 0 - 0
Slot 7 0 - 0 - 0	Slot 24 0 - 0 - 0	Slot 41 0 - 0 - 0
Slot 8 0 - 0 - 0	Slot 25 0 - 0 - 0	Slot 42 0 - 0 - 0
Slot 9 0 - 0 - 0	Slot 26 0 - 0 - 0	Slot 43 0 - 0 - 0
Slot 10 0 - 0 - 0	Slot 27 0 - 0 - 0	Slot 44 0 - 0 - 0
Slot 11 0 - 0 - 0	Slot 28 0 - 0 - 0	Slot 45 0 - 0 - 0
Slot 12 0 - 0 - 0	Slot 29 0 - 0 - 0	Slot 46 0 - 0 - 0
Slot 13 0 - 0 - 0	Slot 30 0 - 0 - 0	Slot 47 0 - 0 - 0
Slot 14 0 - 0 - 0	Slot 31 0 - 0 - 0	Slot 48 0 - 0 - 0
Slot 15 0 - 0 - 0	Slot 32 0 - 0 - 0	Slot 49 0 - 0 - 0
Slot 16 0 - 0 - 0	Slot 33 0 - 0 - 0	Slot 50 0 - 0 - 0
Slot 17 0 - 0 - 0	Slot 34 0 - 0 - 0	

Coordination Operating Modes:

Asheville Hwy and BRAKE.TXT

4 Splits / 4 Cycles? NO
 Unused Cycle Time to Side St.? NO
 Ckt 4 enables Aux TOD? NO
 Offset Interruption? NO
 Cycle 4 = 2 A.M. Sync? NO
 Split 2 = 2 A.M. Sync? NO
 Flash with Ckt 1? NO
 Invert Free Output? NO
 Auto Permissive? NO
 Cycle 4 = Flash? NO
 Enable Max 2 with Ckt 9? NO
 Conditional Service with Ckt 9? NO
 Invert Free Input? NO
 Activate CNA 1? YES
 Activate Walk Rest Modifier? YES
 Inhibit Max Termination? YES
 Enhanced Permissive? NO
 Use Split Matrix? YES
 Use Yellow Offset Timer? NO
 Interconnect? NO
 Maximum Dwell Time: 25 sec.
 Full Dwell? NO
 Short Route? YES

Phase Relationships:

Ring 1 - 2
 Hold 1 Phases 2 - 0
 Hold 1 Omit Phases 0 - 0
 Hold 2 Omit Phases 0 - 0
 Hold 3 Omit Phases 0 - 0
 Hold 3 Omit Phases 0 - 0
 Hold 3 Omit Phases 0 - 0
 Hold 3 Ped Omit 0 - 0

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|||||
Non Early Release Phases 0 - 0
Non Early Release Phases 0 - 0
Non Early Release Phases 0 - 0
Phases Omitted w/ Ckt 9 0 - 0
Phases Omitted w/ Ckt 9 0 - 0
Peds Omitted w/ Ckt 9 0 - 0
  
```

Phase Reverse by Cyc - Ofst
 1 - 2 0 - 0
 1 - 2 0 - 0
 5 - 6 0 - 0
 5 - 6 0 - 0
 3 - 4 0 - 0
 3 - 4 0 - 0
 7 - 8 0 - 0
 7 - 8 0 - 0

Split Plans:

	Percent per Phase							Permissives						
	1	2	3	4	5	6	7	8	Begin	End	Begin	End	Begin	End
Split 1	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 2	40	40	0	20	0	0	0	0	0	10	0	20	0	30

Asheville Hwy and BRAKE.TXT

Split 3	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 4	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 5	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 6	50	36	0	14	0	0	0	0	0	10	0	20	0	30
Split 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Split Matrix:

Cycle	Offset				
	1	2	3	4	5
1	1	1	1	5	5
2	3	3	3	3	3
3	6	2	4	4	4
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6

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 Filename: DATA\INT#4807.EL
 Intersection: BRAKEBILL

Thu Mar 29 14:57:19 2018

Offset Times:

Cycle	Offset				
	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0

Cycle Times:

Cycle	Time
1	80 sec.
2	95 sec.
3	120 sec.
4	0 sec.
5	0 sec.
6	0 sec.

Closed Loop Options:

TOD Flash/Aux? NO
 Free w/ Ckt 0? YES

Report Channel Failures to Central

Conflict Flash (3) Occurrence and Resume Normal
 Manual /Auto Flash (3) Occurrence and Resume Normal
 MCE (3) Occurrence and Resume Normal
 Preempt (0) Auto-log only
 Channel # 5 (0) Auto-log only

Asheville Hwy and BRAKE.TXT

Channel # 6 (0) Auto-log only
Channel # 7 (0) Auto-log only
Channel # 8 (0) Auto-log only
Door Open (3) Occurence and Resume Normal

Main Street Phs for Out of Step Test

Ring 1 - 2
2 - 0

Speed Trap Sensor Pairs

1-2 3-4 5-6 7-8
NO NO NO NO

Standard Overlaps:

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Intersection: BRAKEBILL Thu Mar 29 14:57:19 2018

Internal Overlap Program? YES

	Phase							
Program	1	2	3	4	5	6	7	8
Ovl A
Ovl B
Ovl C
Ovl D

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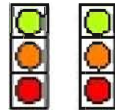
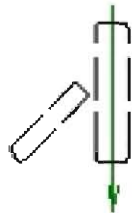
Asheville Hwy & Brakebill

LED Conversion completed
August 14, 2006

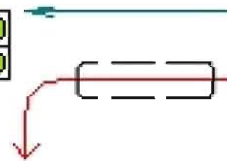


Neals Landing

04



06



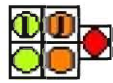
01

Asheville Hwy

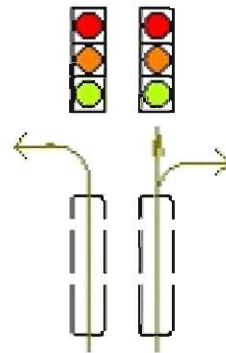
05



02



Asheville Hwy



08

Brakebill

Filename: DATA\INT#9103.EL

Intersection: I-40 WB RAMP

Thu Mar 29 14:59:41 2018

|||||

Startup Data:

Ring 1 - 2
 Start Phases 2 0
 UCF Entry Phases 4 0
 UCF Exit Phases 2 0

Start Overlaps Yellow at Power-up? NO
 Start in All Red at Power-up? NO
 Zone ID: 9
 Controller ID: 1
 Hold 2 sec. Minimum Red Revert? NO Red Revert Time: 0.0 sec.
 Override Holds if
 Uniform Code Flash Active? YES
 Dual Entry 1256? NO
 Dual Entry 3478? NO
 Passage Interval Sequential? NO
 Simultaneous Gap? NO
 Conditional Service set by Input? NO
 Conditional Service 1256? NO
 Conditional Service 3478? NO

Timing Data:

Interval	Time by Phase (sec.)							
	1	2	3	4	5	6	7	8
Initial	6	20	0	7	0	0	0	0
Passage	3.0	3.0	0.0	3.0	0.0	0.0	0.0	0.0
Yellow	4.0	4.0	0.0	4.0	0.0	0.0	0.0	0.0
Red Clear	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
Max 1	14	45	0	18	0	0	0	0
Max 2	14	45	0	18	0	0	0	0
Walk	0	20	0	0	0	0	0	0
Ped Clear	0	0	0	0	0	0	0	0

Max 3 Parameters

	1	2	3	4	5	6	7	8
Adjust (sec.)	0	0	0	0	0	0	0	0
Limit (sec.)	0	0	0	0	0	0	0	0
Set (max outs)	0	0	0	0	0	0	0	0
Clr (gap outs)	0	0	0	0	0	0	0	0

Functions:

	1	2	3	4	5	6	7	8
Min. Recall	N	Y	N	N	N	N	N	N
Max. Recall	N	Y	N	N	N	N	N	N
Ped. Recall	N	N	N	N	N	N	N	N
Det. Non-lock	Y	N	N	Y	N	N	N	N
CNA I Active	N	Y	N	N	N	Y	N	N

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Intersection: I-40 WB RAMP

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CNA II Active N N N N N N N N
 Flashing Walks N N N N N N N N
 Phase Omitted N N Y N Y Y Y Y
 Ped Omitted Y N Y Y Y Y Y Y
 Soft Recall N N N N N N N N

Straw Plains Pike and 40WB.TXT

Ped Cl thru Yel N N N N N N N N
 Ped Cl thru Red N N N N N N N N

Begin Daylight Savings in week: 15
 End Daylight Savings in week: 45

Time of Day Changepoints:

Base Day Plan 0

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
05:00	3	1	.	.	.
06:30	5	1	.	.	.
09:00	3	1	.	.	.
10:30	5	1	.	.	.
14:00	3	1	.	.	.
15:30	6	1	.	.	.
18:30	3	1	.	.	.
23:00	1	1	.	.	.

Base Day Plan 1

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
06:30	3	1	.	.	.
10:00	5	1	.	.	.
18:30	3	1	.	.	.
23:00	1	1	.	.	.

Week Plan:

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Plan: 0	1	0	0	0	0	0	1
Plan: 1	0	0	0	0	0	0	0
Plan: 2	0	0	0	0	0	0	0
Plan: 3	0	0	0	0	0	0	0
Plan: 4	0	0	0	0	0	0	0
Plan: 5	0	0	0	0	0	0	0
Plan: 6	0	0	0	0	0	0	0
Plan: 7	0	0	0	0	0	0	0
Plan: 8	0	0	0	0	0	0	0
Plan: 9	0	0	0	0	0	0	0

Week Plan Implementation:

Week 1: 0 Week 14: 0 Week 27: 0 Week 40: 0

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Intersection: I-40 WB RAMP Thu Mar 29 14:59:41 2018

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Week 2: 0	Week 15: 0	Week 28: 0	Week 41: 0
Week 3: 0	Week 16: 0	Week 29: 0	Week 42: 0
Week 4: 0	Week 17: 0	Week 30: 0	Week 43: 0
Week 5: 0	Week 18: 0	Week 31: 0	Week 44: 0
Week 6: 0	Week 19: 0	Week 32: 0	Week 45: 0
Week 7: 0	Week 20: 0	Week 33: 0	Week 46: 0
Week 8: 0	Week 21: 0	Week 34: 0	Week 47: 0
Week 9: 0	Week 22: 0	Week 35: 0	Week 48: 0
Week 10: 0	Week 23: 0	Week 36: 0	Week 49: 0
Week 11: 0	Week 24: 0	Week 37: 0	Week 50: 0
Week 12: 0	Week 25: 0	Week 38: 0	Week 51: 0
Week 13: 0	Week 26: 0	Week 39: 0	Week 52: 0

Special Day Plan Implementation (Plan-Week-Day):

Straw Plains Pike and 40WB.TXT

Slot 1	0 - 0 - 0	Slot 18	0 - 0 - 0	Slot 35	0 - 0 - 0
Slot 2	0 - 0 - 0	Slot 19	0 - 0 - 0	Slot 36	0 - 0 - 0
Slot 3	0 - 0 - 0	Slot 20	0 - 0 - 0	Slot 37	0 - 0 - 0
Slot 4	0 - 0 - 0	Slot 21	0 - 0 - 0	Slot 38	0 - 0 - 0
Slot 5	0 - 0 - 0	Slot 22	0 - 0 - 0	Slot 39	0 - 0 - 0
Slot 6	0 - 0 - 0	Slot 23	0 - 0 - 0	Slot 40	0 - 0 - 0
Slot 7	0 - 0 - 0	Slot 24	0 - 0 - 0	Slot 41	0 - 0 - 0
Slot 8	0 - 0 - 0	Slot 25	0 - 0 - 0	Slot 42	0 - 0 - 0
Slot 9	0 - 0 - 0	Slot 26	0 - 0 - 0	Slot 43	0 - 0 - 0
Slot 10	0 - 0 - 0	Slot 27	0 - 0 - 0	Slot 44	0 - 0 - 0
Slot 11	0 - 0 - 0	Slot 28	0 - 0 - 0	Slot 45	0 - 0 - 0
Slot 12	0 - 0 - 0	Slot 29	0 - 0 - 0	Slot 46	0 - 0 - 0
Slot 13	0 - 0 - 0	Slot 30	0 - 0 - 0	Slot 47	0 - 0 - 0
Slot 14	0 - 0 - 0	Slot 31	0 - 0 - 0	Slot 48	0 - 0 - 0
Slot 15	0 - 0 - 0	Slot 32	0 - 0 - 0	Slot 49	0 - 0 - 0
Slot 16	0 - 0 - 0	Slot 33	0 - 0 - 0	Slot 50	0 - 0 - 0
Slot 17	0 - 0 - 0	Slot 34	0 - 0 - 0		

Coordination Operating Modes:

4 Splits / 4 Cycles? NO
 Unused Cycle Time to Side St. ? NO
 Ckt 4 enables Aux TOD? NO
 Offset Interruption? NO
 Cycle 4 = 2 A.M. Sync? NO
 Split 2 = 2 A.M. Sync? NO
 Flash with Ckt 1? NO
 Invert Free Output? NO
 Auto Permissive? YES
 Cycle 4 = Flash? NO
 Enable Max 2 with Ckt 9? NO
 Conditional Service with Ckt 9? NO
 Invert Free Input? NO
 Activate CNA 1? YES

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Intersection: I-40 WB RAMP

Thu Mar 29 14:59:41 2018

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Activate Walk Rest Modifier? YES
Inhibit Max Termination? YES
Enhanced Permissive? NO
Use Split Matrix? YES
Use Yellow Offset Timer? NO
Interconnect? NO
Maximum Dwell Time: 0 sec.
Full Dwell? NO
Short Route? YES
    
```

Phase Relationships:

Ring 1 - 2

Hold 1 Phases	2 - 0
Hold 1 Omit Phases	0 - 0
Hold 2 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Ped Omit	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Phases Omitted w/ Ckt 9	0 - 0

Straw Plains Pike and 40WB.TXT

Phases Omitted w/ Ckt 9 0 - 0
 Peds Omitted w/ Ckt 9 0 - 0

Phase	Reverse by	Cyc	-	Ofst
1 - 2		0	-	0
1 - 2		0	-	0
5 - 6		0	-	0
5 - 6		0	-	0
3 - 4		0	-	0
3 - 4		0	-	0
7 - 8		0	-	0
7 - 8		0	-	0

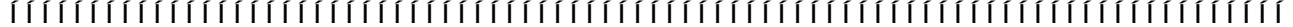
Split Plans:

	Percent per Phase								Permissives					
	1	2	3	4	5	6	7	8	Begin	End	Begin	End	Begin	End
Split 1	25	52	0	23	0	0	0	0	0	5	0	10	0	15
Split 2	21	55	0	24	0	0	0	0	0	5	0	10	0	15
Split 3	20	60	0	20	0	0	0	0	0	5	0	10	0	15
Split 4	20	50	0	30	0	0	0	0	0	0	0	0	0	0
Split 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Split 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Split Matrix:

Cycle	Offset				
	-1	2	3	4	5
1	1	0	0	0	0
2	0	0	0	0	0
3	2	0	0	0	0
4	0	0	0	0	0
5	3	0	0	0	0
6	4	0	0	0	0

Offset Times:

Cycle	Offset				
	-1	2	3	4	5
1	4	0	0	0	0
2	0	0	0	0	0
3	45	0	0	0	0
4	0	0	0	0	0
5	7	0	0	0	0
6	95	0	0	0	0

Cycle Times:

Straw Plains Pike and 40WB.TXT

Cycle
 1 70 sec.
 2 75 sec.
 3 80 sec.
 4 90 sec.
 5 100 sec.
 6 100 sec.

Closed Loop Options:

TOD Flash/Aux? YES
 Free w/ Ckt 0? YES

Report Channel Failures to Central
 Conflict Flash (3) Occurrence and Resume Normal

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Intersection: I-40 WB RAMP Thu Mar 29 14:59:41 2018

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    (3) Occurrence and Resume Normal
    Manual /Auto Flash (3) Occurrence and Resume Normal
    MCE (3) Occurrence and Resume Normal
    Preempt (3) Occurrence and Resume Normal
    Channel # 5 (3) Occurrence and Resume Normal
    Channel # 6 (3) Occurrence and Resume Normal
    Channel # 7 (3) Occurrence and Resume Normal
    Channel # 8 (3) Occurrence and Resume Normal
    Door Open (3) Occurrence and Resume Normal
    
```

Main Street Phs for Out of Step Test

Ring 1 - 2
 2 - 6

Speed Trap Sensor Pairs

1-2 3-4 5-6 7-8
 NO NO NO NO

Standard Overlaps:

Internal Overlap Program? YES

Program	Phase							
	1	2	3	4	5	6	7	8
Ovl A	X	X
Ovl B
Ovl C
Ovl D

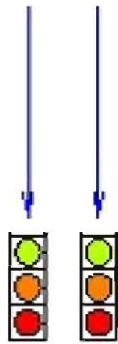
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Strawberry Plains Pk & I-40 WB Ramps



Strawberry Plains Pk

02

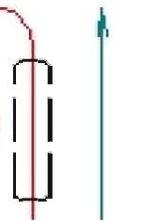


04

I-40 WB Exit



01



OLA 01+02

Strawberry Plains Pk

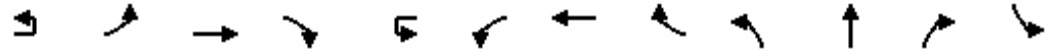
APPENDIX G
CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 8)

EXISTING TRAFFIC CONDITIONS

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations		↔	↕			↔	↕	↔	↕	↕		
Volume (vph)	1	2	536	38	1	98	1189	3	65	1	54	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.99			1.00	1.00	0.85	1.00	0.86		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3348			1814	3455	1220	1814	1654		
Flt Permitted		0.16	1.00			0.35	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		301	3348			665	3455	1220	1814	1654		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	4	4	558	49	4	121	1321	8	83	4	79	20
RTOR Reduction (vph)	0	0	4	0	0	0	0	4	0	72	0	0
Lane Group Flow (vph)	0	8	603	0	0	125	1321	4	83	11	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		39.3	38.3			51.4	45.4	45.4	7.4	7.4		
Effective Green, g (s)		39.3	38.3			51.4	45.4	45.4	7.4	7.4		
Actuated g/C Ratio		0.47	0.46			0.62	0.55	0.55	0.09	0.09		
Clearance Time (s)		5.0	7.0			5.0	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		
Lane Grp Cap (vph)		161	1548			525	1894	668	162	147		
v/s Ratio Prot		0.00	0.18			c0.02	c0.38	0.00	c0.05	0.01		
v/s Ratio Perm		0.02				0.12						
v/c Ratio		0.05	0.39			0.24	0.70	0.01	0.51	0.08		
Uniform Delay, d1		12.0	14.6			6.8	13.7	8.5	36.0	34.6		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.1	0.2			0.2	1.1	0.0	2.7	0.2		
Delay (s)		12.2	14.7			7.0	14.8	8.5	38.7	34.8		
Level of Service		B	B			A	B	A	D	C		
Approach Delay (s)			14.7				14.1			36.7		
Approach LOS			B				B			D		

Intersection Summary		
HCM 2000 Control Delay	16.3	HCM 2000 Level of Service
HCM 2000 Volume to Capacity ratio	0.65	B
Actuated Cycle Length (s)	82.8	Sum of lost time (s)
Intersection Capacity Utilization	60.2%	25.0
Analysis Period (min)	15	ICU Level of Service
c Critical Lane Group		B

HCM Signalized Intersection Capacity Analysis
 5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	1	7
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.97	
Satd. Flow (prot)	1678	
Flt Permitted	0.97	
Satd. Flow (perm)	1678	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	4	12
RTOR Reduction (vph)	11	0
Lane Group Flow (vph)	25	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.0	
Effective Green, g (s)	4.0	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	81	
v/s Ratio Prot	c0.01	
v/s Ratio Perm		
v/c Ratio	0.30	
Uniform Delay, d1	38.1	
Progression Factor	1.00	
Incremental Delay, d2	2.1	
Delay (s)	40.2	
Level of Service	D	
Approach Delay (s)	40.2	
Approach LOS	D	

Intersection Summary

Intersection

Int Delay, s/veh 1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	17	9	7	66	131	9
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	34	12	12	92	154	16

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	278	162	170 0
Stage 1	162	-	- -
Stage 2	116	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	671	876	1420 -
Stage 1	834	-	- -
Stage 2	882	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	665	876	1420 -
Mov Cap-2 Maneuver	665	-	- -
Stage 1	834	-	- -
Stage 2	874	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.4	0.9	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1420	-	710	-	-
HCM Lane V/C Ratio	0.008	-	0.065	-	-
HCM Control Delay (s)	7.6	0	10.4	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

HCM 2010 TWSC
 10: Strawberry Plains Pike & Brakebill Road

6/12/2020

Intersection

Int Delay, s/veh 4.9

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	42	151	60	417	50	754	37
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	75	162	91	458	54	954	54

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	1501	504	1008
Stage 1	1090	-	-
Stage 2	411	-	-
Critical Hdwy	6.2	6.72	4.28
Critical Hdwy Stg 1	5.2	-	-
Critical Hdwy Stg 2	5.2	-	-
Follow-up Hdwy	3.5	3.36	2.29
Pot Cap-1 Maneuver	147	524	642
Stage 1	345	-	-
Stage 2	689	-	-
Platoon blocked, %			
Mov Cap-1 Maneuver	126	524	642
Mov Cap-2 Maneuver	126	-	-
Stage 1	345	-	-
Stage 2	591	-	-

Approach	EB	NB	SB
HCM Control Delay, s	31.9	1.9	0.5
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	642	-	126	524	-	-
HCM Lane V/C Ratio	0.142	-	0.595	0.31	-	-
HCM Control Delay (s)	11.5	-	68.8	14.9	-	-
HCM Lane LOS	B	-	F	B	-	-
HCM 95th %tile Q(veh)	0.5	-	3	1.3	-	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↖↗		↖	↖	↕			↕↗	
Volume (vph)	0	0	0	172	0	121	190	358	0	0	410	490
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.19	1.00			1.00	
Satd. Flow (perm)				2937		1591	292	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	218	0	146	200	402	0	0	441	636
RTOR Reduction (vph)	0	0	0	0	0	125	0	0	0	0	295	0
Lane Group Flow (vph)	0	0	0	218	0	21	200	402	0	0	782	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.5		10.5	49.0	54.0			40.0	
Effective Green, g (s)				10.5		10.5	49.0	54.0			40.0	
Actuated g/C Ratio				0.14		0.14	0.66	0.72			0.54	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				413		224	330	2410			1680	
v/s Ratio Prot				c0.07		0.01	c0.07	0.12			0.25	
v/s Ratio Perm							c0.32					
v/c Ratio				0.53		0.09	0.61	0.17			0.47	
Uniform Delay, d1				29.7		27.9	6.6	3.2			10.7	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.2		0.2	8.0	0.1			0.9	
Delay (s)				30.9		28.0	14.7	3.4			11.6	
Level of Service				C		C	B	A			B	
Approach Delay (s)		0.0			29.8			7.1			11.6	
Approach LOS		A			C			A			B	

Intersection Summary

HCM 2000 Control Delay	13.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	74.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	8	944	66	106	730	1	65	7	151	2	3	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3427		1796	3359	812	1814	1683			1608	
Flt Permitted	0.31	1.00		0.14	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	586	3427		257	3359	812	1814	1683			1608	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	12	1004	97	145	936	4	97	8	196	4	4	8
RTOR Reduction (vph)	0	5	0	0	0	2	0	172	0	0	8	0
Lane Group Flow (vph)	12	1096	0	145	936	2	97	32	0	0	8	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	38.0	37.1		50.8	44.9	44.9	10.4	10.4			2.2	
Effective Green, g (s)	38.0	37.1		50.8	44.9	44.9	10.4	10.4			2.2	
Actuated g/C Ratio	0.46	0.44		0.61	0.54	0.54	0.12	0.12			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	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)	280	1524		317	1808	437	226	209			42	
v/s Ratio Prot	0.00	c0.32		c0.05	c0.28	0.00	c0.05	0.02			c0.01	
v/s Ratio Perm	0.02			0.23								
v/c Ratio	0.04	0.72		0.46	0.52	0.00	0.43	0.16			0.20	
Uniform Delay, d1	12.4	18.9		10.3	12.3	8.9	33.8	32.6			39.7	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	1.7		1.0	0.3	0.0	1.3	0.3			2.3	
Delay (s)	12.5	20.6		11.4	12.6	8.9	35.1	32.9			42.0	
Level of Service	B	C		B	B	A	D	C			D	
Approach Delay (s)		20.5			12.4			33.6			42.0	
Approach LOS		C			B			C			D	

Intersection Summary		
HCM 2000 Control Delay	18.7	HCM 2000 Level of Service
HCM 2000 Volume to Capacity ratio	0.61	B
Actuated Cycle Length (s)	83.4	Sum of lost time (s)
Intersection Capacity Utilization	59.8%	25.0
Analysis Period (min)	15	ICU Level of Service
c Critical Lane Group		B

Intersection

Int Delay, s/veh 1.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	11	11	12	174	135	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	20	20	16	191	175	21

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	409	186	197 0
Stage 1	186	-	- -
Stage 2	223	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	547	804	1341 -
Stage 1	804	-	- -
Stage 2	769	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	540	804	1341 -
Mov Cap-2 Maneuver	540	-	- -
Stage 1	804	-	- -
Stage 2	759	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.9	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1341	-	646	-	-
HCM Lane V/C Ratio	0.012	-	0.062	-	-
HCM Control Delay (s)	7.7	0	10.9	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

HCM 2010 TWSC
 10: Strawberry Plains Pike & Brakebill Road

6/12/2020

Intersection

Int Delay, s/veh 4

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	58	129	15	167	792	10	480	49
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	92	82	92	92	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	74	145	16	204	861	11	511	83

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	1444	297	739	594	0	628	-	0
Stage 1	574	-	-	-	-	-	-	-
Stage 2	870	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	159	717	495	951	-	582	-	-
Stage 1	586	-	-	-	-	-	-	-
Stage 2	434	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	159	717	865	865	-	582	-	-
Mov Cap-2 Maneuver	159	-	-	-	-	-	-	-
Stage 1	586	-	-	-	-	-	-	-
Stage 2	434	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	23.1	2.2	0.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	865	-	159	717	-	-
HCM Lane V/C Ratio	0.254	-	0.468	0.202	-	-
HCM Control Delay (s)	10.6	-	46.1	11.3	-	-
HCM Lane LOS	B	-	E	B	-	-
HCM 95th %tile Q(veh)	1	-	2.2	0.8	-	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↑↑			↑↓	
Volume (vph)	0	0	0	164	0	130	326	861	0	0	375	244
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.33	1.00			1.00	
Satd. Flow (perm)				2539		1490	560	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	219	0	159	435	897	0	0	452	284
RTOR Reduction (vph)	0	0	0	0	0	135	0	0	0	0	125	0
Lane Group Flow (vph)	0	0	0	219	0	24	435	897	0	0	611	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.1		11.1	49.0	54.0			40.0	
Effective Green, g (s)				11.1		11.1	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				375		220	492	2532			1731	
v/s Ratio Prot				c0.09		0.02	c0.11	0.25			0.19	
v/s Ratio Perm							c0.47					
v/c Ratio				0.58		0.11	0.88	0.35			0.35	
Uniform Delay, d1				29.8		27.7	7.0	4.0			10.1	
Progression Factor				1.00		1.00	1.00	1.00			0.99	
Incremental Delay, d2				2.3		0.2	20.1	0.4			0.6	
Delay (s)				32.2		27.9	27.1	4.4			10.6	
Level of Service				C		C	C	A			B	
Approach Delay (s)		0.0			30.4			11.8			10.6	
Approach LOS		A			C			B			B	

Intersection Summary

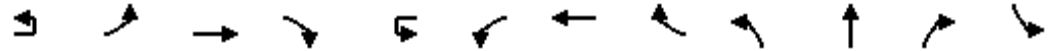
HCM 2000 Control Delay	14.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	75.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

OPENING YEAR TRAFFIC CONDITIONS (WITHOUT PROJECT)

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations		↔	↕			↔	↕	↔	↕	↕		
Volume (vph)	1	2	592	43	1	108	1313	3	71	1	59	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.99			1.00	1.00	0.85	1.00	0.86		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3347			1814	3455	1220	1814	1653		
Flt Permitted		0.11	1.00			0.31	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		208	3347			585	3455	1220	1814	1653		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	4	4	617	56	4	133	1459	8	91	4	87	22
RTOR Reduction (vph)	0	0	5	0	0	0	0	4	0	77	0	0
Lane Group Flow (vph)	0	8	668	0	0	137	1459	4	91	14	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		37.9	36.9			50.2	44.2	44.2	9.3	9.3		
Effective Green, g (s)		37.9	36.9			50.2	44.2	44.2	9.3	9.3		
Actuated g/C Ratio		0.45	0.44			0.60	0.53	0.53	0.11	0.11		
Clearance Time (s)		5.0	7.0			5.0	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		
Lane Grp Cap (vph)		113	1475			472	1824	644	201	183		
v/s Ratio Prot		0.00	0.20			c0.03	c0.42	0.00	c0.05	0.01		
v/s Ratio Perm		0.03				0.15						
v/c Ratio		0.07	0.45			0.29	0.80	0.01	0.45	0.07		
Uniform Delay, d1		14.0	16.3			7.9	16.1	9.4	34.8	33.3		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.3	0.2			0.3	2.6	0.0	1.6	0.2		
Delay (s)		14.2	16.6			8.2	18.7	9.4	36.4	33.5		
Level of Service		B	B			A	B	A	D	C		
Approach Delay (s)			16.5				17.8			35.0		
Approach LOS			B				B			C		

Intersection Summary

HCM 2000 Control Delay	19.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	83.7	Sum of lost time (s)	25.0
Intersection Capacity Utilization	63.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
 5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	1	8
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.97	
Satd. Flow (prot)	1671	
Flt Permitted	0.97	
Satd. Flow (perm)	1671	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	4	14
RTOR Reduction (vph)	13	0
Lane Group Flow (vph)	27	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.2	
Effective Green, g (s)	4.2	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	83	
v/s Ratio Prot	c0.02	
v/s Ratio Perm		
v/c Ratio	0.32	
Uniform Delay, d1	38.4	
Progression Factor	1.00	
Incremental Delay, d2	2.2	
Delay (s)	40.6	
Level of Service	D	
Approach Delay (s)	40.6	
Approach LOS	D	

Intersection Summary

Intersection

Int Delay, s/veh 1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	18	10	8	72	145	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	36	13	14	100	171	18

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	308	180	188 0
Stage 1	180	-	- -
Stage 2	128	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	642	855	1398 -
Stage 1	817	-	- -
Stage 2	869	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	635	855	1398 -
Mov Cap-2 Maneuver	635	-	- -
Stage 1	817	-	- -
Stage 2	859	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.7	0.9	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1398	-	682	-	-
HCM Lane V/C Ratio	0.01	-	0.072	-	-
HCM Control Delay (s)	7.6	0	10.7	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

Intersection

Int Delay, s/veh 7.5

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	46	167	67	461	55	833	41
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	82	180	102	507	60	1054	59

Major/Minor

	Minor2		Major1		Major2		
Conflicting Flow All	1660	557	1114	0	370	-	0
Stage 1	1204	-	-	-	-	-	-
Stage 2	456	-	-	-	-	-	-
Critical Hdwy	6.2	6.72	4.28	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.36	2.29	-	2.5	-	-
Pot Cap-1 Maneuver	119	486	584	-	846	-	-
Stage 1	307	-	-	-	-	-	-
Stage 2	659	-	-	-	-	-	-
Platoon blocked, %				-		-	-
Mov Cap-1 Maneuver	98	486	584	-	846	-	-
Mov Cap-2 Maneuver	98	-	-	-	-	-	-
Stage 1	307	-	-	-	-	-	-
Stage 2	544	-	-	-	-	-	-

Approach

	EB		NB		SB
HCM Control Delay, s	51.8		2.1		0.5
HCM LOS	F				

Minor Lane/Major Mvmt

	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	584	-	98	486	-	-
HCM Lane V/C Ratio	0.174	-	0.838	0.369	-	-
HCM Control Delay (s)	12.5	-	128.5	16.7	-	-
HCM Lane LOS	B	-	F	C	-	-
HCM 95th %tile Q(veh)	0.6	-	4.6	1.7	-	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↕			↕↕	
Volume (vph)	0	0	0	189	0	133	210	395	0	0	453	541
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.16	1.00			1.00	
Satd. Flow (perm)				2937		1591	236	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	160	221	444	0	0	487	703
RTOR Reduction (vph)	0	0	0	0	0	137	0	0	0	0	328	0
Lane Group Flow (vph)	0	0	0	239	0	23	221	444	0	0	862	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.9		10.9	49.0	54.0			40.0	
Effective Green, g (s)				10.9		10.9	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				427		231	298	2397			1671	
v/s Ratio Prot				c0.08		0.01	c0.09	0.13			0.28	
v/s Ratio Perm							c0.39					
v/c Ratio				0.56		0.10	0.74	0.19			0.52	
Uniform Delay, d1				29.8		27.8	8.5	3.4			11.2	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.6		0.2	15.3	0.2			1.1	
Delay (s)				31.4		27.9	23.8	3.5			12.4	
Level of Service				C		C	C	A			B	
Approach Delay (s)		0.0			30.0			10.3			12.4	
Approach LOS		A			C			B			B	

Intersection Summary

HCM 2000 Control Delay	14.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	58.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	1042	72	117	806	1	71	8	165	2	3	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3427		1796	3359	812	1814	1683			1610	
Flt Permitted	0.27	1.00		0.12	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	510	3427		220	3359	812	1814	1683			1610	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	13	1109	106	160	1033	4	106	9	214	4	4	9
RTOR Reduction (vph)	0	5	0	0	0	2	0	188	0	0	9	0
Lane Group Flow (vph)	13	1210	0	160	1033	2	106	35	0	0	8	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	44.3	43.3		57.4	51.4	51.4	10.8	10.8			2.3	
Effective Green, g (s)	44.3	43.3		57.4	51.4	51.4	10.8	10.8			2.3	
Actuated g/C Ratio	0.49	0.48		0.63	0.57	0.57	0.12	0.12			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	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)	264	1639		298	1907	461	216	200			40	
v/s Ratio Prot	0.00	c0.35		c0.05	0.31	0.00	c0.06	0.02			c0.01	
v/s Ratio Perm	0.02			0.29								
v/c Ratio	0.05	0.74		0.54	0.54	0.00	0.49	0.17			0.21	
Uniform Delay, d1	11.9	19.0		11.7	12.2	8.5	37.3	35.8			43.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	1.8		1.9	0.3	0.0	1.8	0.4			2.5	
Delay (s)	12.0	20.8		13.5	12.5	8.5	39.0	36.2			45.8	
Level of Service	B	C		B	B	A	D	D			D	
Approach Delay (s)		20.7			12.6			37.1			45.8	
Approach LOS		C			B			D			D	

Intersection Summary		
HCM 2000 Control Delay	19.3	HCM 2000 Level of Service
HCM 2000 Volume to Capacity ratio	0.65	B
Actuated Cycle Length (s)	90.5	Sum of lost time (s)
Intersection Capacity Utilization	63.6%	25.0
Analysis Period (min)	15	ICU Level of Service
c Critical Lane Group		B

Intersection

Int Delay, s/veh 1.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	13	13	14	192	149	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	24	24	19	211	194	24

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	453	205	217 0
Stage 1	205	-	- -
Stage 2	248	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	512	783	1318 -
Stage 1	786	-	- -
Stage 2	746	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	504	783	1318 -
Mov Cap-2 Maneuver	504	-	- -
Stage 1	786	-	- -
Stage 2	734	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.4	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1318	-	613	-	-
HCM Lane V/C Ratio	0.014	-	0.077	-	-
HCM Control Delay (s)	7.8	0	11.4	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

HCM 2010 TWSC
 10: Strawberry Plains Pike & Brakebill Road

6/12/2020

Intersection

Int Delay, s/veh 5

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	64	142	16	185	874	11	530	54
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	92	82	92	92	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	82	160	17	226	950	12	564	92

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	1595	328	815	655	0	694	-	0
Stage 1	634	-	-	-	-	-	-	-
Stage 2	961	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	130	686	443	902	-	528	-	-
Stage 1	551	-	-	-	-	-	-	-
Stage 2	395	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	130	686	811	811	-	528	-	-
Mov Cap-2 Maneuver	130	-	-	-	-	-	-	-
Stage 1	551	-	-	-	-	-	-	-
Stage 2	395	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	32	2.3	0.2
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	811	-	130	686	-	-
HCM Lane V/C Ratio	0.3	-	0.631	0.233	-	-
HCM Control Delay (s)	11.3	-	71.2	11.8	-	-
HCM Lane LOS	B	-	F	B	-	-
HCM 95th %tile Q(veh)	1.3	-	3.3	0.9	-	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

6/12/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↖↗		↖	↖	↕			↕↗	
Volume (vph)	0	0	0	181	0	144	360	951	0	0	414	270
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.29	1.00			1.00	
Satd. Flow (perm)				2539		1490	499	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	241	0	176	480	991	0	0	499	314
RTOR Reduction (vph)	0	0	0	0	0	144	0	0	0	0	126	0
Lane Group Flow (vph)	0	0	0	241	0	32	480	991	0	0	687	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.4		11.4	49.0	54.0			40.0	
Effective Green, g (s)				11.4		11.4	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				383		225	457	2522			1724	
v/s Ratio Prot				c0.09		0.02	c0.13	0.28			0.21	
v/s Ratio Perm							c0.56					
v/c Ratio				0.63		0.14	1.05	0.39			0.40	
Uniform Delay, d1				30.0		27.8	9.1	4.2			10.5	
Progression Factor				1.00		1.00	1.00	1.00			0.99	
Incremental Delay, d2				3.2		0.3	55.9	0.5			0.7	
Delay (s)				33.2		28.0	65.0	4.7			11.1	
Level of Service				C		C	E	A			B	
Approach Delay (s)		0.0			31.0			24.4			11.1	
Approach LOS		A			C			C			B	

Intersection Summary

HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	75.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

8/23/2020



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations		↔	↕			↔	↕	↔	↕	↕		
Volume (vph)	1	2	592	52	1	130	1313	3	107	1	89	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.99			1.00	1.00	0.85	1.00	0.85		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3341			1814	3455	1220	1814	1648		
Flt Permitted		0.11	1.00			0.29	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		213	3341			556	3455	1220	1814	1648		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	4	4	617	68	4	160	1459	8	137	4	131	22
RTOR Reduction (vph)	0	0	6	0	0	0	0	4	0	114	0	0
Lane Group Flow (vph)	0	8	679	0	0	164	1459	4	137	21	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		37.1	36.1			50.3	44.3	44.3	11.5	11.5		
Effective Green, g (s)		37.1	36.1			50.3	44.3	44.3	11.5	11.5		
Actuated g/C Ratio		0.43	0.42			0.58	0.51	0.51	0.13	0.13		
Clearance Time (s)		5.0	7.0			5.0	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		
Lane Grp Cap (vph)		110	1400			459	1777	627	242	220		
v/s Ratio Prot		0.00	0.20			c0.04	c0.42	0.00	c0.08	0.01		
v/s Ratio Perm		0.03				0.17						
v/c Ratio		0.07	0.48			0.36	0.82	0.01	0.57	0.10		
Uniform Delay, d1		15.5	18.2			9.0	17.6	10.2	35.0	32.7		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.3	0.3			0.5	3.2	0.0	3.0	0.2		
Delay (s)		15.8	18.5			9.5	20.8	10.2	38.0	32.9		
Level of Service		B	B			A	C	B	D	C		
Approach Delay (s)			18.5				19.6			35.5		
Approach LOS			B				B			D		

Intersection Summary

HCM 2000 Control Delay	21.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	86.1	Sum of lost time (s)	25.0
Intersection Capacity Utilization	65.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

8/23/2020



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	1	8
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.97	
Satd. Flow (prot)	1671	
Flt Permitted	0.97	
Satd. Flow (perm)	1671	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	4	14
RTOR Reduction (vph)	13	0
Lane Group Flow (vph)	27	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.3	
Effective Green, g (s)	4.3	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	83	
v/s Ratio Prot	c0.02	
v/s Ratio Perm		
v/c Ratio	0.32	
Uniform Delay, d1	39.5	
Progression Factor	1.00	
Incremental Delay, d2	2.2	
Delay (s)	41.7	
Level of Service	D	
Approach Delay (s)	41.7	
Approach LOS	D	

Intersection Summary

Intersection

Int Delay, s/veh 3.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	38	40	14	118	167	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	76	53	24	164	196	34

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	425	213	230 0
Stage 1	213	-	- -
Stage 2	212	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	539	817	1350 -
Stage 1	785	-	- -
Stage 2	786	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	528	817	1350 -
Mov Cap-2 Maneuver	528	-	- -
Stage 1	785	-	- -
Stage 2	770	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	12.4	1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1350	-	618	-	-
HCM Lane V/C Ratio	0.018	-	0.209	-	-
HCM Control Delay (s)	7.7	0	12.4	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.1	-	0.8	-	-

Intersection

Int Delay, s/veh 3.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	46	69	15	86	185	22
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	51	77	17	96	206	24

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	347	218	230 0
Stage 1	218	-	- -
Stage 2	129	-	- -
Critical Hdwy	6.4	6.2	4.1 -
Critical Hdwy Stg 1	5.4	-	- -
Critical Hdwy Stg 2	5.4	-	- -
Follow-up Hdwy	3.5	3.3	2.2 -
Pot Cap-1 Maneuver	654	827	1350 -
Stage 1	823	-	- -
Stage 2	902	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	645	827	1350 -
Mov Cap-2 Maneuver	645	-	- -
Stage 1	823	-	- -
Stage 2	890	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.8	1.1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1350	-	743	-	-
HCM Lane V/C Ratio	0.012	-	0.172	-	-
HCM Control Delay (s)	7.7	0	10.8	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.6	-	-

HCM 2010 TWSC
 10: Strawberry Plains Pike & Brakebill Road

8/23/2020

Intersection

Int Delay, s/veh 19.7

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	67	245	80	461	55	833	49
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	120	263	121	507	60	1054	71

Major/Minor

	Minor2		Major1		Major2		
Conflicting Flow All	1706	563	1125	0	370	-	0
Stage 1	1210	-	-	-	-	-	-
Stage 2	496	-	-	-	-	-	-
Critical Hdwy	6.2	6.72	4.28	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.36	2.29	-	2.5	-	-
Pot Cap-1 Maneuver	~ 112	482	578	-	846	-	-
Stage 1	305	-	-	-	-	-	-
Stage 2	633	-	-	-	-	-	-
Platoon blocked, %				-		-	-
Mov Cap-1 Maneuver	~ 89	482	578	-	846	-	-
Mov Cap-2 Maneuver	~ 89	-	-	-	-	-	-
Stage 1	305	-	-	-	-	-	-
Stage 2	500	-	-	-	-	-	-

Approach

	EB	NB	SB
HCM Control Delay, s	107.4	2.5	0.5
HCM LOS	F		

Minor Lane/Major Mvmt

	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	578	-	89	482	-	-
HCM Lane V/C Ratio	0.21	-	1.344	0.547	-	-
HCM Control Delay (s)	12.9	-	297.5	21.1	-	-
HCM Lane LOS	B	-	F	C	-	-
HCM 95th %tile Q(veh)	0.8	-	8.9	3.2	-	-

Notes

-: Volume exceeds capacity \$: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection

Int Delay, s/veh 4.9

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	28	0	15	18	0	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	31	0	17	20	0	56

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	31
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.1
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2
Pot Cap-1 Maneuver	-	-	1595
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1595
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.3	8.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1049	-	-	1595	-
HCM Lane V/C Ratio	0.053	-	-	0.01	-
HCM Control Delay (s)	8.6	-	-	7.3	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

8/23/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↕			↕↕	
Volume (vph)	0	0	0	189	0	136	210	405	0	0	488	584
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.13	1.00			1.00	
Satd. Flow (perm)				2937		1591	196	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	164	221	455	0	0	525	758
RTOR Reduction (vph)	0	0	0	0	0	140	0	0	0	0	327	0
Lane Group Flow (vph)	0	0	0	239	0	24	221	455	0	0	956	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.9		10.9	49.0	54.0			40.0	
Effective Green, g (s)				10.9		10.9	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				427		231	277	2397			1671	
v/s Ratio Prot				c0.08		0.01	c0.10	0.14			0.31	
v/s Ratio Perm							c0.42					
v/c Ratio				0.56		0.10	0.80	0.19			0.57	
Uniform Delay, d1				29.8		27.8	12.1	3.4			11.7	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.6		0.2	20.9	0.2			1.4	
Delay (s)				31.4		28.0	33.0	3.6			13.1	
Level of Service				C		C	C	A			B	
Approach Delay (s)		0.0			30.0			13.2			13.1	
Approach LOS		A			C			B			B	

Intersection Summary

HCM 2000 Control Delay	16.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

5: Brakebill Road/Neals Landing Road & Asheville Highway

8/23/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↕		↔	↕	↕	↔	↕			↕	
Volume (vph)	9	1042	101	160	806	1	92	8	214	2	3	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.85			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3411		1796	3359	812	1814	1681			1610	
Flt Permitted	0.27	1.00		0.11	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	524	3411		199	3359	812	1814	1681			1610	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	13	1109	149	219	1033	4	137	9	278	4	4	9
RTOR Reduction (vph)	0	7	0	0	0	2	0	243	0	0	9	0
Lane Group Flow (vph)	13	1251	0	219	1033	2	137	44	0	0	8	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	49.3	48.2		64.4	58.3	58.3	12.6	12.6			2.5	
Effective Green, g (s)	49.3	48.2		64.4	58.3	58.3	12.6	12.6			2.5	
Actuated g/C Ratio	0.50	0.48		0.65	0.59	0.59	0.13	0.13			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	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)	273	1652		308	1968	475	229	212			40	
v/s Ratio Prot	0.00	c0.37		c0.08	0.31	0.00	c0.08	0.03			c0.01	
v/s Ratio Perm	0.02			0.38								
v/c Ratio	0.05	0.76		0.71	0.52	0.00	0.60	0.21			0.21	
Uniform Delay, d1	12.8	20.9		17.0	12.3	8.6	41.1	39.0			47.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	2.0		7.5	0.3	0.0	4.2	0.5			2.5	
Delay (s)	12.8	22.9		24.6	12.6	8.6	45.2	39.5			50.1	
Level of Service	B	C		C	B	A	D	D			D	
Approach Delay (s)		22.8			14.6			41.3			50.1	
Approach LOS		C			B			D			D	

Intersection Summary		
HCM 2000 Control Delay	22.2	HCM 2000 Level of Service C
HCM 2000 Volume to Capacity ratio	0.71	
Actuated Cycle Length (s)	99.5	Sum of lost time (s) 25.0
Intersection Capacity Utilization	70.0%	ICU Level of Service C
Analysis Period (min)	15	
c Critical Lane Group		

Intersection

Int Delay, s/veh 3.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	34	27	48	241	200	41
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	62	49	64	265	260	48

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	677	284	308 0
Stage 1	284	-	- -
Stage 2	393	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	364	702	1219 -
Stage 1	714	-	- -
Stage 2	625	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	341	702	1219 -
Mov Cap-2 Maneuver	341	-	- -
Stage 1	714	-	- -
Stage 2	586	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	15.9	1.6	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1219	-	441	-	-
HCM Lane V/C Ratio	0.053	-	0.251	-	-
HCM Control Delay (s)	8.1	0	15.9	-	-
HCM Lane LOS	A	A	C	-	-
HCM 95th %tile Q(veh)	0.2	-	1	-	-

Intersection

Int Delay, s/veh 2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	49	32	76	240	176	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	54	36	84	267	196	57

Major/Minor	Minor2	Major1		Major2
Conflicting Flow All	660	224	252	0
Stage 1	224	-	-	-
Stage 2	436	-	-	-
Critical Hdwy	6.4	6.2	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-
Pot Cap-1 Maneuver	431	820	1325	-
Stage 1	818	-	-	-
Stage 2	656	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	399	820	1325	-
Mov Cap-2 Maneuver	399	-	-	-
Stage 1	818	-	-	-
Stage 2	607	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.8	1.9	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1325	-	501	-	-
HCM Lane V/C Ratio	0.064	-	0.18	-	-
HCM Control Delay (s)	7.9	0	13.8	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.2	-	0.6	-	-

HCM 2010 TWSC
 10: Strawberry Plains Pike & Brakebill Road

8/23/2020

Intersection

Int Delay, s/veh 14.2

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	78	174	16	271	874	11	530	78
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	32	82	92	63	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	100	196	50	330	950	17	564	132

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	1901	348	892	696	0	694	-	0
Stage 1	665	-	-	-	-	-	-	-
Stage 2	1236	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	~ 85	667	396	870	-	528	-	-
Stage 1	534	-	-	-	-	-	-	-
Stage 2	296	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	~ 85	667	691	691	-	528	-	-
Mov Cap-2 Maneuver	~ 85	-	-	-	-	-	-	-
Stage 1	534	-	-	-	-	-	-	-
Stage 2	296	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	90.2	4.7	0.3
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	691	-	85	667	-	-
HCM Lane V/C Ratio	0.551	-	1.176	0.293	-	-
HCM Control Delay (s)	16.4	-	242	12.6	-	-
HCM Lane LOS	C	-	F	B	-	-
HCM 95th %tile Q(veh)	3.4	-	7.1	1.2	-	-

Notes

~: Volume exceeds capacity \$: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection

Int Delay, s/veh 4.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	26	0	55	34	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	27	0	0	14	0	0
Mvmt Flow	29	0	61	38	0	39

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	29
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.1
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2
Pot Cap-1 Maneuver	-	-	1597
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1597
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	4.5	8.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1052	-	-	1597	-
HCM Lane V/C Ratio	0.037	-	-	0.038	-
HCM Control Delay (s)	8.6	-	-	7.3	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.1	-	-	0.1	-

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

8/23/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↖↗		↖	↖	↕			↕↗	
Volume (vph)	0	0	0	181	0	155	360	1026	0	0	433	283
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.28	1.00			1.00	
Satd. Flow (perm)				2539		1490	471	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	241	0	189	480	1069	0	0	522	329
RTOR Reduction (vph)	0	0	0	0	0	125	0	0	0	0	126	0
Lane Group Flow (vph)	0	0	0	241	0	64	480	1069	0	0	725	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.4		11.4	49.0	54.0			40.0	
Effective Green, g (s)				11.4		11.4	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				383		225	442	2522			1724	
v/s Ratio Prot				c0.09		0.04	c0.13	0.30			0.22	
v/s Ratio Perm							c0.58					
v/c Ratio				0.63		0.29	1.09	0.42			0.42	
Uniform Delay, d1				30.0		28.4	8.9	4.4			10.7	
Progression Factor				1.00		1.00	1.00	1.00			0.97	
Incremental Delay, d2				3.2		0.7	68.0	0.5			0.8	
Delay (s)				33.2		29.1	76.8	4.9			11.1	
Level of Service				C		C	E	A			B	
Approach Delay (s)		0.0			31.4			27.2			11.1	
Approach LOS		A			C			C			B	

Intersection Summary

HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	75.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

**OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT) WITH PRELIMINARY NEW
TRAFFIC SIGNAL DESIGN**

HCM Signalized Intersection Capacity Analysis

10: Strawberry Plains Pike & Brakebill Road

8/23/2020



Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Lane Configurations							
Volume (vph)	67	245	80	461	55	833	49
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)	-3%			1%	-2%		
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95		
Frt	1.00	0.85	1.00	1.00	0.99		
Flt Protected	0.95	1.00	0.95	1.00	1.00		
Satd. Flow (prot)	1832	1546	1648	3357	3387		
Flt Permitted	0.95	1.00	0.21	1.00	0.90		
Satd. Flow (perm)	1832	1546	365	3357	3050		
Peak-hour factor, PHF	0.56	0.93	0.66	0.91	0.92	0.79	0.69
Adj. Flow (vph)	120	263	121	507	60	1054	71
RTOR Reduction (vph)	0	114	0	0	0	5	0
Lane Group Flow (vph)	120	149	121	507	0	1180	0
Heavy Vehicles (%)	0%	6%	9%	7%	0%	7%	3%
Turn Type	Prot	Perm	Perm	NA	Perm	NA	
Protected Phases	4			2		6	
Permitted Phases		4	2		6		
Actuated Green, G (s)	12.2	12.2	57.8	57.8		57.8	
Effective Green, g (s)	12.2	12.2	57.8	57.8		57.8	
Actuated g/C Ratio	0.15	0.15	0.72	0.72		0.72	
Clearance Time (s)	5.0	5.0	5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	279	235	263	2425		2203	
v/s Ratio Prot	0.07			0.15			
v/s Ratio Perm		c0.10	0.33			c0.39	
v/c Ratio	0.43	0.64	0.46	0.21		0.54	
Uniform Delay, d1	30.7	31.8	4.6	3.6		5.0	
Progression Factor	1.00	1.00	0.86	0.60		1.00	
Incremental Delay, d2	1.1	5.5	5.6	0.2		0.9	
Delay (s)	31.8	37.4	9.6	2.4		6.0	
Level of Service	C	D	A	A		A	
Approach Delay (s)	35.6			3.8	6.0		
Approach LOS	D			A	A		

Intersection Summary			
HCM 2000 Control Delay	10.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

8/23/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔		↗	↔	↕			↕	
Volume (vph)	0	0	0	189	0	136	210	405	0	0	488	584
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	0.97	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	2787	3326			3130	
Flt Permitted				0.95		1.00	0.13	1.00			1.00	
Satd. Flow (perm)				2937		1591	380	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	164	221	455	0	0	525	758
RTOR Reduction (vph)	0	0	0	0	0	141	0	0	0	0	325	0
Lane Group Flow (vph)	0	0	0	239	0	23	221	455	0	0	958	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.2		11.2	53.8	58.8			43.0	
Effective Green, g (s)				11.2		11.2	53.8	58.8			43.0	
Actuated g/C Ratio				0.14		0.14	0.67	0.73			0.54	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				411		222	580	2444			1682	
v/s Ratio Prot				c0.08		0.01	c0.05	0.14			c0.31	
v/s Ratio Perm							0.20					
v/c Ratio				0.58		0.10	0.38	0.19			0.57	
Uniform Delay, d1				32.2		30.0	7.5	3.3			12.3	
Progression Factor				1.00		1.00	1.00	1.00			0.46	
Incremental Delay, d2				2.1		0.2	1.9	0.2			1.2	
Delay (s)				34.3		30.2	9.4	3.4			6.8	
Level of Service				C		C	A	A			A	
Approach Delay (s)		0.0			32.6			5.4			6.8	
Approach LOS		A			C			A			A	

Intersection Summary

HCM 2000 Control Delay	10.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

10: Strawberry Plains Pike & Brakebill Road

8/23/2020



Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Lane Configurations								
Volume (vph)	78	174	16	271	874	11	530	78
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)	-3%				1%		-2%	
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	0.95		0.95	
Frt	1.00	0.85		1.00	1.00		0.97	
Flt Protected	0.95	1.00		0.95	1.00		1.00	
Satd. Flow (prot)	1832	1607		1707	3454		3343	
Flt Permitted	0.95	1.00		0.38	1.00		0.93	
Satd. Flow (perm)	1832	1607		682	3454		3100	
Peak-hour factor, PHF	0.78	0.89	0.32	0.82	0.92	0.63	0.94	0.59
Adj. Flow (vph)	100	196	50	330	950	17	564	132
RTOR Reduction (vph)	0	172	0	0	0	0	18	0
Lane Group Flow (vph)	100	24	0	380	950	0	695	0
Heavy Vehicles (%)	0%	2%	0%	6%	4%	0%	7%	2%
Turn Type	Prot	Perm	Perm	Perm	NA	Perm	NA	
Protected Phases	4				2		6	
Permitted Phases		4	2	2		6		
Actuated Green, G (s)	9.7	9.7		60.3	60.3		60.3	
Effective Green, g (s)	9.7	9.7		60.3	60.3		60.3	
Actuated g/C Ratio	0.12	0.12		0.75	0.75		0.75	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	
Lane Grp Cap (vph)	222	194		514	2603		2336	
v/s Ratio Prot	c0.05				0.28			
v/s Ratio Perm		0.01		c0.56			0.22	
v/c Ratio	0.45	0.12		0.74	0.36		0.30	
Uniform Delay, d1	32.7	31.4		5.5	3.3		3.1	
Progression Factor	1.00	1.00		0.66	0.33		1.00	
Incremental Delay, d2	1.5	0.3		8.6	0.4		0.3	
Delay (s)	34.1	31.6		12.2	1.5		3.5	
Level of Service	C	C		B	A		A	
Approach Delay (s)	32.5				4.6		3.5	
Approach LOS	C				A		A	

Intersection Summary

HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

8/23/2020



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔		↗	↔	↕			↕	
Volume (vph)	0	0	0	181	0	155	360	1026	0	0	433	283
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	0.97	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	3139	3522			3250	
Flt Permitted				0.95		1.00	0.26	1.00			1.00	
Satd. Flow (perm)				2539		1490	871	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	241	0	189	480	1069	0	0	522	329
RTOR Reduction (vph)	0	0	0	0	0	129	0	0	0	0	125	0
Lane Group Flow (vph)	0	0	0	241	0	60	480	1069	0	0	727	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.7		11.7	53.3	58.3			40.0	
Effective Green, g (s)				11.7		11.7	53.3	58.3			40.0	
Actuated g/C Ratio				0.15		0.15	0.67	0.73			0.50	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				371		217	957	2566			1625	
v/s Ratio Prot				c0.09		0.04	c0.08	0.30			0.22	
v/s Ratio Perm							c0.25					
v/c Ratio				0.65		0.28	0.50	0.42			0.45	
Uniform Delay, d1				32.2		30.4	6.0	4.2			12.9	
Progression Factor				1.00		1.00	1.00	1.00			0.81	
Incremental Delay, d2				3.9		0.7	1.9	0.5			0.9	
Delay (s)				36.1		31.1	7.9	4.7			11.3	
Level of Service				D		C	A	A			B	
Approach Delay (s)		0.0			33.9			5.7			11.3	
Approach LOS		A			C			A			B	

Intersection Summary

HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX H
ITE TRIP GENERATION RATES

Land Use: 210

Single-Family Detached Housing

Description

Single-family detached housing includes all single-family detached homes on individual lots. A typical site surveyed is a suburban subdivision.

Additional Data

The number of vehicles and residents had a high correlation with average weekday vehicle trip ends. The use of these variables was limited, however, because the number of vehicles and residents was often difficult to obtain or predict. The number of dwelling units was generally used as the independent variable of choice because it was usually readily available, easy to project, and had a high correlation with average weekday vehicle trip ends.

This land use included data from a wide variety of units with different sizes, price ranges, locations, and ages. Consequently, there was a wide variation in trips generated within this category. Other factors, such as geographic location and type of adjacent and nearby development, may also have had an effect on the site trip generation.

Single-family detached units had the highest trip generation rate per dwelling unit of all residential uses because they were the largest units in size and had more residents and more vehicles per unit than other residential land uses; they were generally located farther away from shopping centers, employment areas, and other trip attractors than other residential land uses; and they generally had fewer alternative modes of transportation available because they were typically not as concentrated as other residential land uses.

Time-of-day distribution data for this land use are presented in Appendix A. For the six general urban/suburban sites with data, the overall highest vehicle volumes during the AM and PM on a weekday were counted between 7:15 and 8:15 a.m. and 4:00 and 5:00 p.m., respectively. For the two sites with Saturday data, the overall highest vehicle volume was counted between 3:00 and 4:00 p.m. For the one site with Sunday data, the overall highest vehicle volume was counted between 10:15 and 11:15 a.m.

The sites were surveyed in the 1980s, the 1990s, the 2000s, and the 2010s in California, Connecticut, Delaware, Illinois, Indiana, Maryland, Minnesota, Montana, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Vermont, and Virginia.

Source Numbers

100, 105, 114, 126, 157, 167, 177, 197, 207, 211, 217, 267, 275, 293, 300, 319, 320, 356, 357, 367, 384, 387, 407, 435, 522, 550, 552, 579, 598, 601, 603, 614, 637, 711, 716, 720, 728, 735, 868, 903, 925, 936

Single-Family Detached Housing (210)

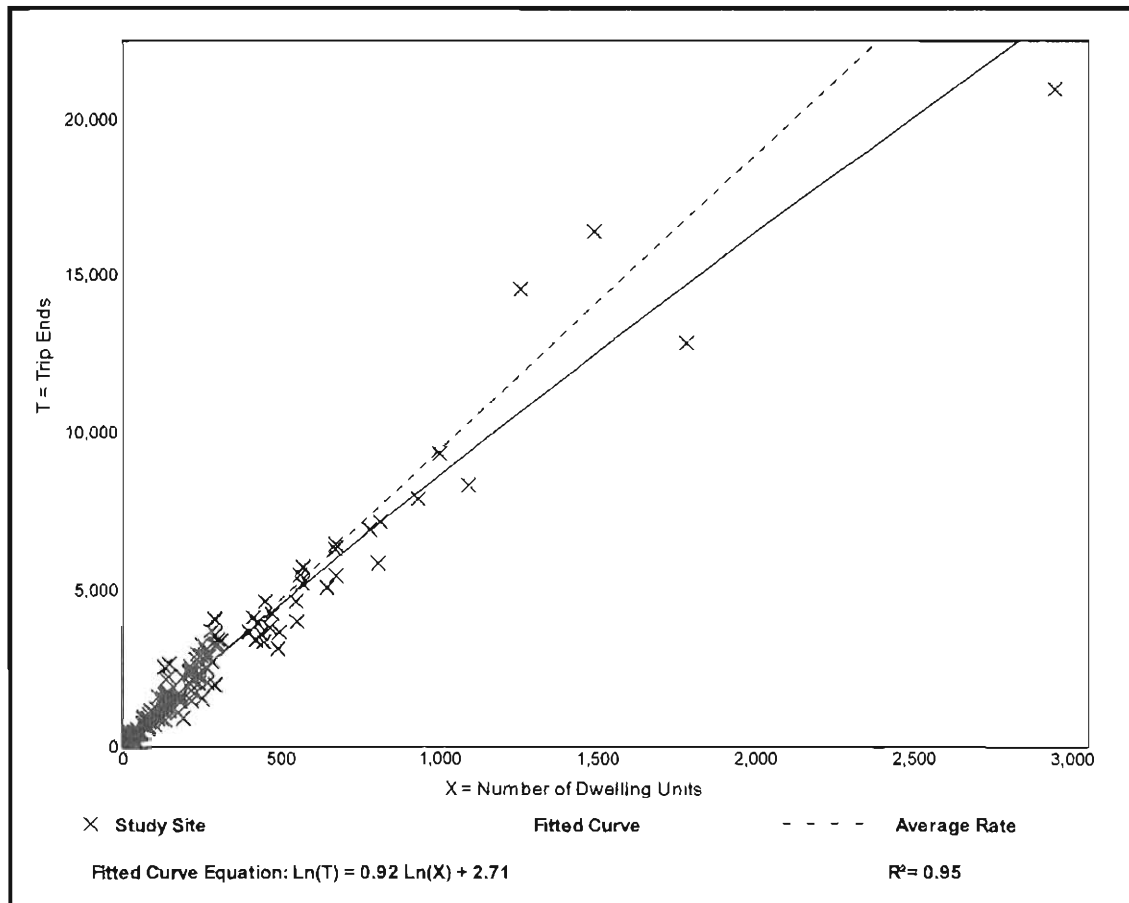
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 159
Avg. Num. of Dwelling Units: 264
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.44	4.81 - 19.39	2.10

Data Plot and Equation



Single-Family Detached Housing (210)

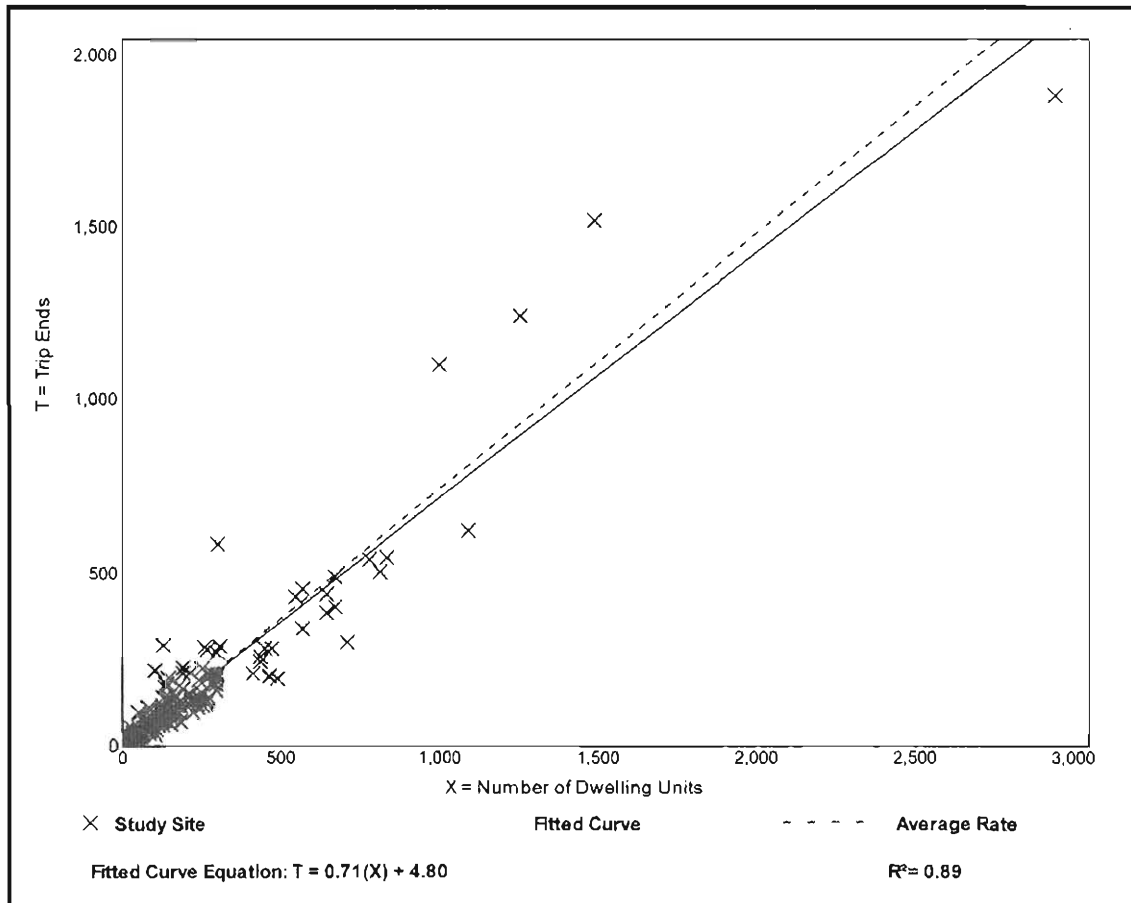
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban
 Number of Studies: 173
 Avg. Num. of Dwelling Units: 219
 Directional Distribution: 25% entering, 75% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.74	0.33 - 2.27	0.27

Data Plot and Equation



Single-Family Detached Housing (210)

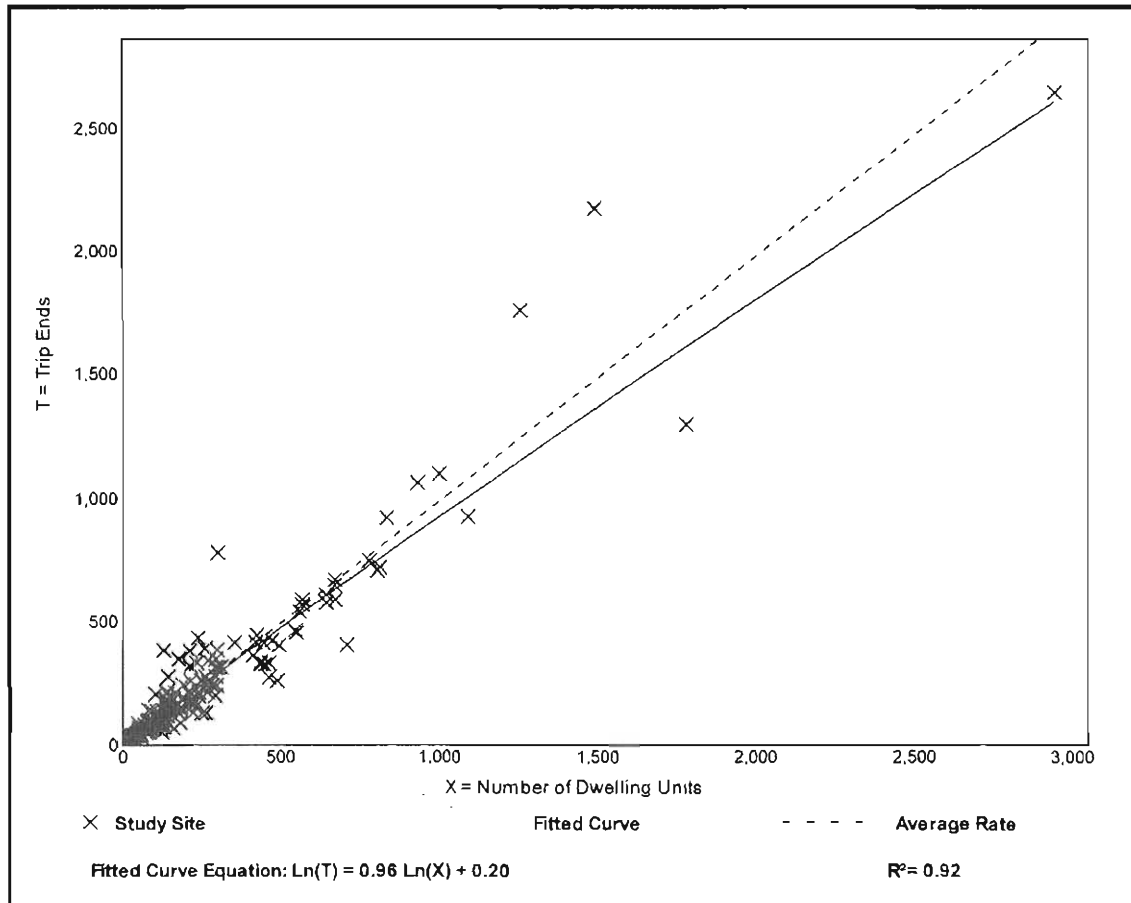
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Setting/Location: General Urban/Suburban
 Number of Studies: 190
 Avg. Num. of Dwelling Units: 242
 Directional Distribution: 63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.99	0.44 - 2.98	0.31

Data Plot and Equation



Local Apartment Trip Generation Study

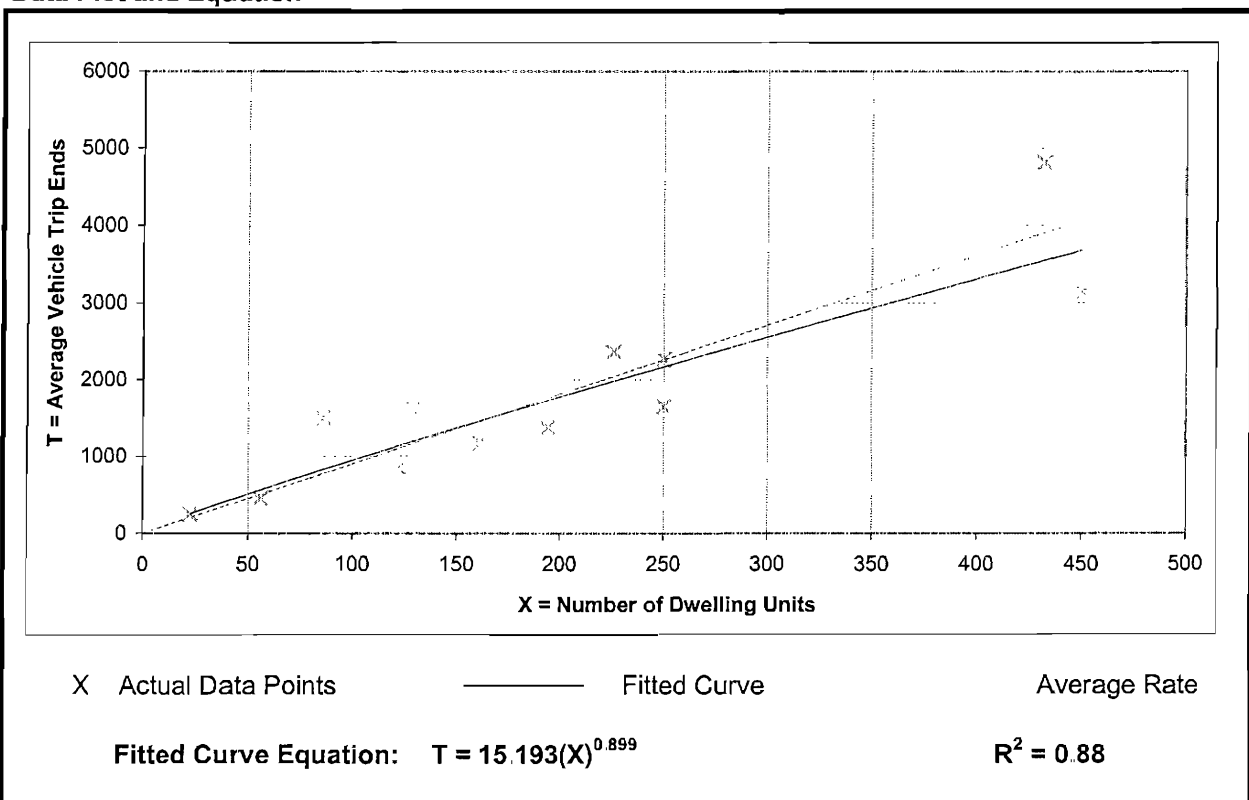
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 13
Average Number of Dwelling Units: 193
Directional Distribution: 50% entering, 50% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
9.03	6.59 - 17.41	2.47

Data Plot and Equation



Local Apartment Trip Generation Study

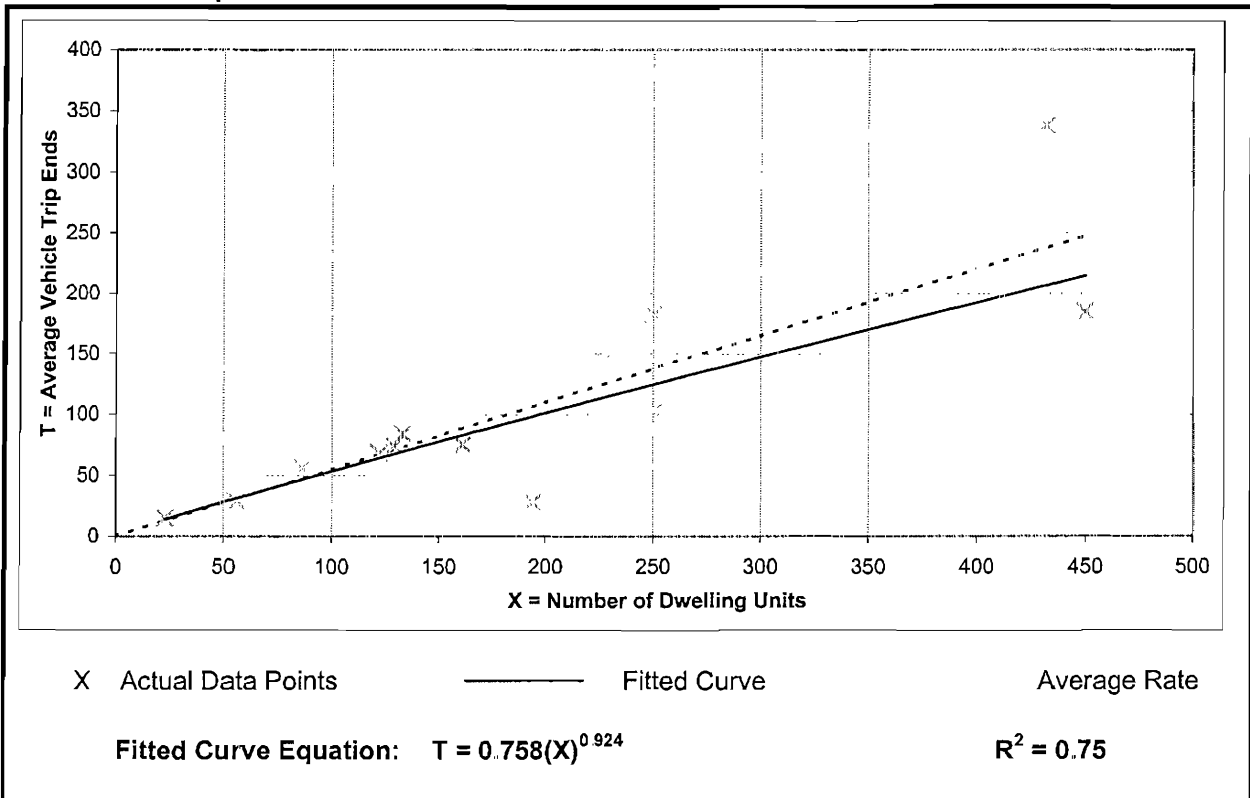
Average Vehicle Trip Ends vs: Dwelling Units
 On a: Weekday,
 Peak Hour of Adjacent Street Traffic,
 One Hour Between 7 and 9 a.m.

Number of Studies: 13
 Average Number of Dwelling Units: 193
 Directional Distribution: 22% entering, 78% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.55	0.14 - 0.78	0.18

Data Plot and Equation



Local Apartment Trip Generation Study

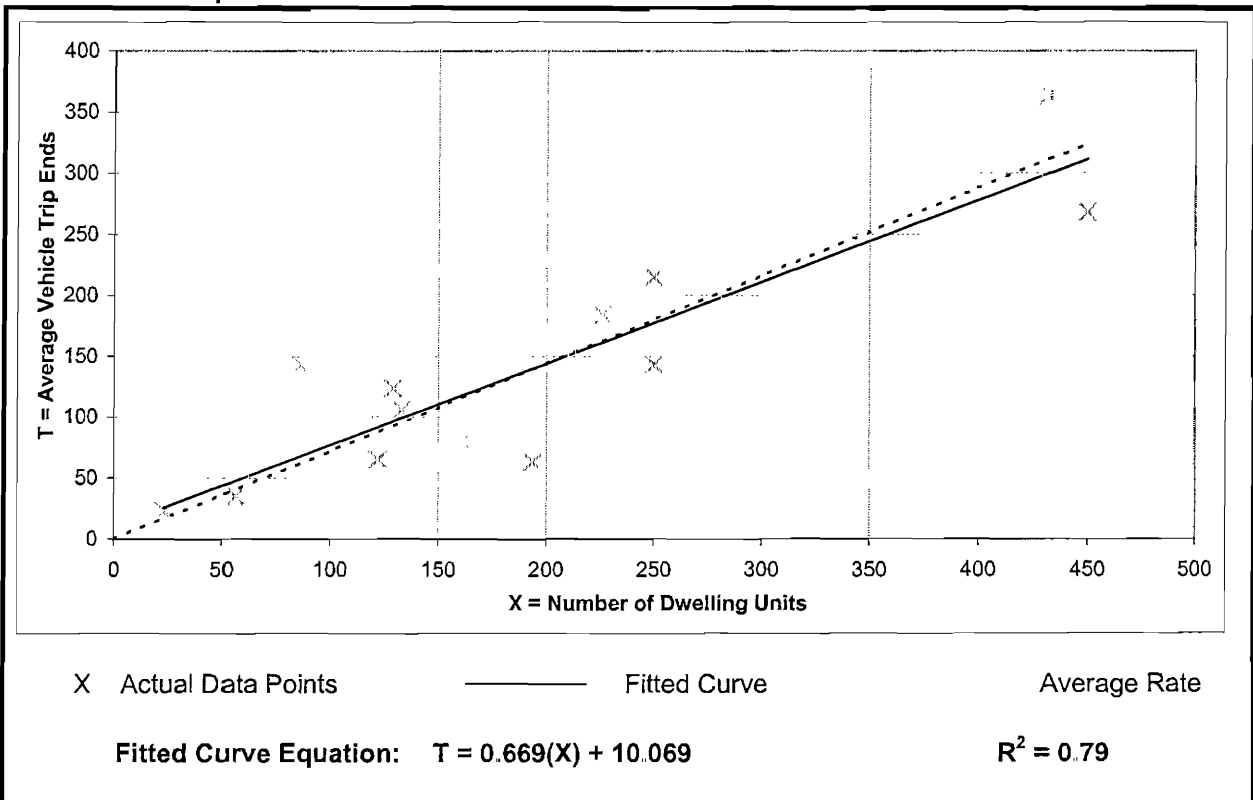
Average Vehicle Trip Ends vs: Dwelling Units
 On a: Weekday,
 Peak Hour of Adjacent Street Traffic,
 One Hour Between 4 and 6 p.m.

Number of Studies: 13
 Average Number of Dwelling Units: 193
 Directional Distribution: 55% entering, 45% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.72	0.32 - 1.66	0.25

Data Plot and Equation



TRIP GENERATION FOR BRAKEBILL ROAD SUBDIVISION
227 Single-Family Detached Houses and 95 Single-Family Attached Houses

ITE LAND USE CODE	LAND USE DESCRIPTION	UNITS	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#210	Single-Family Detached Housing	227 Houses	2,211	25%	75%		63%	37%	
				41	125	166	141	83	224
Local Trip Rate	Single-Family Attached Housing	95 Houses	912	22%	78%		55%	45%	
				11	40	51	41	33	74
Total New Volume Site Trips			3,123	52	165	217	182	116	298

ITE Trip Generation Manual, 10th Edition and Local Trip Rates
 Trips calculated by using Fitted Curve Equation

TRIP GENERATION FOR BRAKEBILL ROAD SUBDIVISION

227 Single-Family Detached Houses

227 Residential Houses = X

Weekday:

Fitted Curve Equation: $\text{Ln}(T) = 0.92 \text{Ln}(X) + 2.71$

$$\text{Ln}(T) = 0.92 * 5.42 + 2.71$$

$$\text{Ln}(T) = 7.70$$

$$\underline{\underline{T = 2,211 \text{ trips}}}$$

Peak Hour of Adjacent Traffic between 7 and 9 am:

Fitted Curve Equation: $T = 0.71(X) + 4.80$

$$T = 0.71 * 227 + 4.80$$

$$\underline{\underline{T = 166 \text{ trips}}}$$

Peak Hour of Adjacent Traffic between 4 and 6 pm:

Fitted Curve Equation: $\text{Ln}(T) = 0.96 \text{Ln}(X) + 0.2$

$$\text{Ln}(T) = 0.96 * 5.42 + 0.20$$

$$\text{Ln}(T) = 5.41$$

$$\underline{\underline{T = 224 \text{ trips}}}$$

TRIP GENERATION FOR BRAKEBILL ROAD SUBDIVISION

95 Single-Family Attached Houses

95 Residential Houses = X

Weekday:

Fitted Curve Equation: $T = 15.193(X)^{0.899}$

$$T = 15 * 59.98$$

$$T = \underline{\underline{912 \text{ trips}}}$$

Peak Hour of Adjacent Traffic between 7 and 9 am:

Fitted Curve Equation: $T = 0.758(X)^{0.924}$

$$T = 0.758 * 67$$

$$T = \underline{\underline{51 \text{ trips}}}$$

Peak Hour of Adjacent Traffic between 4 and 6 pm:

Fitted Curve Equation: $T = 0.669(X)+10.069$

$$T = 0.669 * 95 + 10.07$$

$$T = \underline{\underline{74 \text{ trips}}}$$

APPENDIX I

TRIP DISTRIBUTION SPREADSHEET CALCULATIONS

Brakebill Road Development - Trip Distribution Calculations - AM Peak

Inputted Value

Calculated Entering Value for Trip Distribution and Trip Assignment Figures

Calculated Exiting Value for Trip Distribution and Trip Assignment Figures

TOTAL DEVELOPMENT		
AM		
	ENTER	EXIT
# OF TOTAL TRIPS	52	165

ENTER % BY DIRECTION				EXIT % BY DIRECTION			
40% NB		60% SB		40% NB		60% SB	

RESIDENTIAL LOTS		
AM		
	ENTER	EXIT
% TOTAL ALL TRIPS	100%	100%

% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)						% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)																							
70% at Road "A"			30% at Road "B"			TOTAL	70% at Road "A"			30% at Road "B"			TOTAL																
NB	SB	TOTAL	WB	EB	TOTAL	NB	SB	TOTAL	WB	EB	TOTAL	NB	SB	TOTAL															
28%	42%	100%	30%	0%	100%	28%	42%	100%	30%	0%	100%	28%	42%	100%															
ENTER						EXIT																							
Brakebill Rd/Road A NB LEFT	Brakebill Rd/Road A SB RIGHT	Hammer Rd/Road B WB LEFT	Hammer Rd/Road B EB RIGHT	TOTAL		Brakebill Rd/Road A EB LEFT	Brakebill Rd/Road A EB RIGHT	Hammer Rd/Road B NB LEFT	Hammer Rd/Road B NB RIGHT	TOTAL		Brakebill Rd/Road A EB LEFT	Brakebill Rd/Road A EB RIGHT	Hammer Rd/Road B NB LEFT	Hammer Rd/Road B NB RIGHT	TOTAL													
15	22	15	0	52		46	69	0	50	165		46	69	0	50	165													
% 's						% 's																							
28%			42%			30%			0%			100%			28%			42%			0%			30%			100%		

THRU MOVEMENTS AT BRAKEBILL ROAD AT ROAD "A"

ENTER				EXIT			
BRAKEBILL NB THRU AT ROAD "A"				BRAKEBILL SB THRU AT ROAD "A"			
VOL'S		6		VOL'S		30	
%		12%		%		18%	
BRAKEBILL SB THRU AT ROAD "A"		BRAKEBILL NB THRU AT HAMMER (ENTERING AT ROAD "A")		BRAKEBILL NB THRU AT ROAD "A"		BRAKEBILL NB THRU AT HAMMER (EXITING FROM ROAD "A")	
VOL'S		0		VOL'S		0	
%		0%		%		28%	

TURNING MOVEMENTS AT "EXTERIOR" INTERSECTIONS

AM	PROJECTED %'s		PROJECTED TRIPS		PROJECTED MOVEMENT %'s	AM	PROJECTED TRIPS		PROJECTED MOVEMENT %'s
	ENTER	EXIT	ENTER	EXIT			ENTER	EXIT	
TOTAL TRIPS			52	165					
TO/FROM ASHEVILLE HIGHWAY	60%	40%	31	66					
TO/FROM STRAWBERRY PLAINS	40%	60%	21	99					
	100%	100%	52	165					
EXISTING TURNING %'s									
<u>ASHEVILLE/BRAKEBILL INTERSECTION:</u>					<u>HAMMER/BRAKEBILL INTERSECTION:</u>				
ENTER FROM ASHEVILLE HWY WB LT	70.0%		22		42%	ENTER FROM BRAKEBILL NB LT	45.0%	6	12%
ENTER FROM ASHEVILLE HWY EB RT	30.0%		9		18%	ENTER FROM BRAKEBILL SB RT	55.0%	9	18%
EXIT TO ASHEVILLE HWY NB LT		55.0%		36	22%	EXIT TO BRAKEBILL EB LT		20	12%
EXIT TO ASHEVILLE HWY NB RT		45.0%		30	18%	EXIT TO BRAKEBILL EB RT		30	18%
	100%	100%	31	66	100%		100%	100%	
<u>STRAW, PLAINS/BRAKEBILL INTERSECTION:</u>					<u>STRAW, PLAINS/I-40 RAMP INTERSECTION:</u>				
ENTER FROM STRAW, PLAINS NB LT	61.5%		13		25%	ENTER FROM I-40 WB RT	25.0%	3	6%
ENTER FROM STRAW, PLAINS SB RT	38.5%		8		15%	ENTER FROM STRAW, PLAINS NB THRU	75.0%	10	19%
EXIT TO STRAW, PLAINS EB LT		21.5%		21	13%	EXIT TO I-40 SB RT		43	26%
EXIT TO STRAW, PLAINS EB RT		78.5%		78	47%	EXIT TO STRAW, PLAINS SB THRU		35	21%
	100%	100%	21	99	100%		100%	100%	
			52	165					

Brakebill Road Development - Trip Distribution Calculations - PM Peak

Inputted Value

Calculated Entering Value for Trip Distribution and Trip Assignment Figures

Calculated Exiting Value for Trip Distribution and Trip Assignment Figures

TOTAL DEVELOPMENT		
PM		
	ENTER	EXIT
# OF TOTAL TRIPS	182	116

ENTER % BY DIRECTION				EXIT % BY DIRECTION			
60% NB		40% SB		60% NB		40% SB	

RESIDENTIAL LOTS		
PM		
	ENTER	EXIT
% TOTAL ALL TRIPS	100%	100%

% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)						% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)									
70% at Road "A"			30% at Road "B"			TOTAL	70% at Road "A"			30% at Road "B"			TOTAL		
NB	SB	WB	EB				NB	SB	WB	EB					
42%	28%	30%	0%			100%	42%	28%	30%	0%			100%		
ENTER						EXIT									
Brakebill Rd/Road A		Brakebill Rd/Road A		Hammer Rd/Road B		Hammer Rd/Road B		Brakebill Rd/Road A		Brakebill Rd/Road A		Hammer Rd/Road B		Hammer Rd/Road B	
NB LEFT		SB RIGHT		WB LEFT		EB RIGHT		EB LEFT		EB RIGHT		NB LEFT		NB RIGHT	
VOL'S 76		51		55		0		182		49		32		0	
%S 42%		28%		30%		0%		100%		42%		28%		0%	

THRU MOVEMENTS AT BRAKEBILL ROAD AT ROAD "A"

ENTER				EXIT			
BRAKEBILL NB THRU AT ROAD "A"				BRAKEBILL SB THRU AT ROAD "A"			
VOL'S 34		18%		VOL'S 14		12%	
BRAKEBILL SB THRU AT ROAD "A"				BRAKEBILL NB THRU AT ROAD "A"			
VOL'S 0		0%		VOL'S 0		0%	
BRAKEBILL SB THRU AT HAMMER (ENTERING AT ROAD "A")				BRAKEBILL NB THRU AT HAMMER (EXITING FROM ROAD "A")			
VOL'S 51		28%		VOL'S 49		42%	

TURNING MOVEMENTS AT "EXTERIOR" INTERSECTIONS

PM	PROJECTED %'s		PROJECTED TRIPS		PROJECTED MOVEMENT %'s	PM	PROJECTED TRIPS		PROJECTED MOVEMENT %'s	
	ENTER	EXIT	ENTER	EXIT			ENTER	EXIT		
TOTAL TRIPS			182	116						
TO/FROM ASHEVILLE HIGHWAY	40%	60%	73	70						
TO/FROM STRAWBERRY PLAINS	60%	40%	109	46						
	100%	100%	182	116						
EXISTING TURNING %'s										
<u>ASHEVILLE/BRAKEBILL INTERSECTION:</u>					<u>HAMMER/BRAKEBILL INTERSECTION:</u>					
ENTER FROM ASHEVILLE HWY WB LT	60.0%		43		24%	ENTER FROM BRAKEBILL NB LT	40.0%	34	18%	
ENTER FROM ASHEVILLE HWY EB RT	40.0%		29		16%	ENTER FROM BRAKEBILL SB RT	60.0%	21	12%	
EXIT TO ASHEVILLE HWY NB LT		30.0%		21	18%	EXIT TO BRAKEBILL EB LT		50.0%	21	18%
EXIT TO ASHEVILLE HWY NB RT		70.0%		49	42%	EXIT TO BRAKEBILL EB RT		50.0%	14	12%
	100%	100%	72	70	100%		100%	100%		
<u>STRAW, PLAINS/BRAKEBILL INTERSECTION:</u>					<u>STRAW, PLAINS/I-40 RAMP INTERSECTION:</u>					
ENTER FROM STRAW, PLAINS NB LT	77.5%		86		47%	ENTER FROM I-40 WB RT	13.0%	11	6%	
ENTER FROM STRAW, PLAINS SB RT	22.5%		24		14%	ENTER FROM STRAW, PLAINS NB THRU	87.0%	75	41%	
EXIT TO STRAW, PLAINS EB LT		31.0%		14	12%	EXIT TO I-40 SB RT		39.5%	13	11%
EXIT TO STRAW, PLAINS EB RT		69.0%		32	28%	EXIT TO STRAW, PLAINS SB THRU		60.5%	19	17%
	100%	100%	110	46	100%		100%	100%		
			182	116						

APPENDIX J

SPOT SPEED STUDY

SPOT SPEED STUDY

Location: Brakebill Road at Hammer Road
 Posted Speed Limit: 30 mph
 Equipment: Bushnell Speedster III Radar Speed Gun
 Direction: Northbound and Southbound

Date: 3/20/18
 Weather: Overcast/Windy
 Time: 4:00 PM
 Pavement Conditions: Dry

Vehicle #	Speed (mph)
1	39
2	44
3	43
4	46
5	46
6	45
7	51
8	45
9	39
10	40
11	42
12	42
13	38
14	42
15	34
16	44
17	39
18	42
19	41
20	43
21	39
22	40
23	37
24	41
25	38

Vehicle #	Speed (mph)
26	40
27	44
28	40
29	49
30	37
31	46
32	46
33	40
34	41
35	37
36	42
37	44
38	38
39	45
40	40
41	42
42	41
43	36
44	42
45	42
46	44
47	39
48	42
49	46
50	41

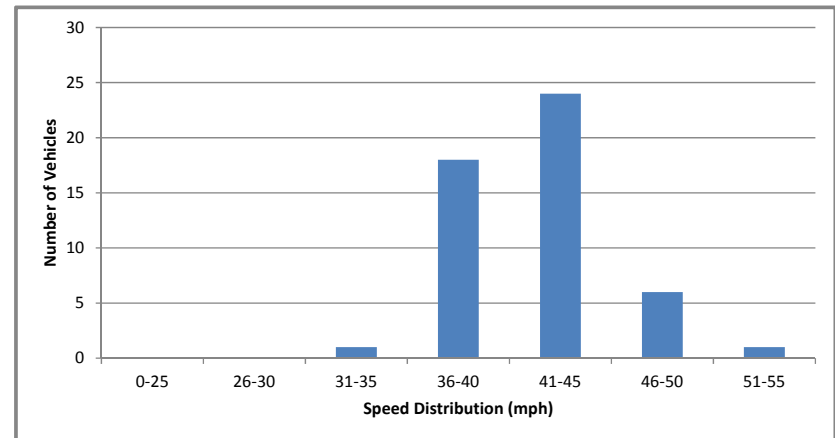
Sample Size Requirements (*ITE Manual of Transportation Engineering Studies*)

$$N = (S * K/E)^2$$

where: N = minimum number of measured speeds
 S = estimated sample standard deviation (mph)
 K = constant corresponding to desired confidence level
 E = permitted error in the average speed estimate (mph)

S = 5 mph (Table 3-2, page 38)
 K = 2.58 (Confidence level of 99% - Table 3-3, page 38)
 E = 2 mph assumed error range

Therefore, N = 42 observations needed



Average speed = 41.7 mph
 50th percentile speed = 42.0 mph
 85th percentile speed = 45.0 mph

SPOT SPEED STUDY

Location: Brakebill Road at Proposed Entrance (adjacent to Hindu temple)
 Posted Speed Limit: 30 mph
 Equipment: Bushnell Speedster III Radar Speed Gun
 Direction: Northbound and Southbound

Date: 3/20/18
 Weather: Overcast/Windy
 Time: 4:30 PM
 Pavement Conditions: Dry

Vehicle #	Speed (mph)
1	43
2	35
3	35
4	38
5	38
6	39
7	31
8	29
9	32
10	33
11	31
12	33
13	31
14	43
15	38
16	36
17	44
18	37
19	36
20	35
21	36
22	34
23	37
24	43
25	36

Vehicle #	Speed (mph)
26	39
27	36
28	40
29	44
30	43
31	40
32	30
33	34
34	34
35	37
36	35
37	35
38	37
39	39
40	32
41	26
42	31
43	37
44	29
45	36
46	35
47	44
48	38
49	39
50	39

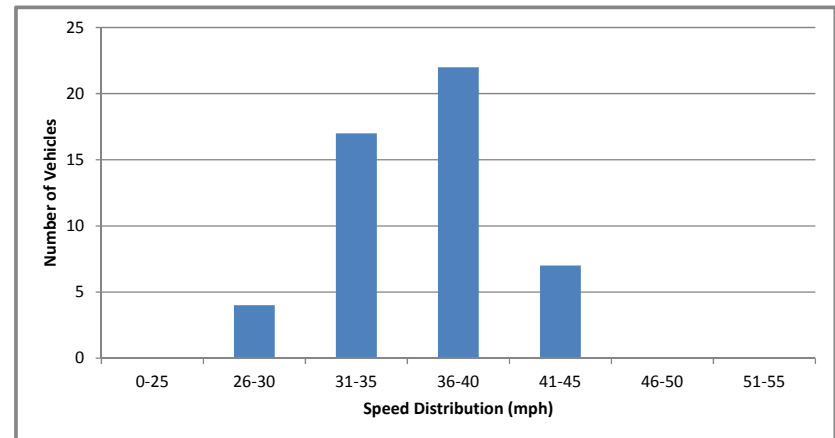
Sample Size Requirements (*ITE Manual of Transportation Engineering Studies*)

$$N = (S * K/E)^2$$

where: N = minimum number of measured speeds
 S = estimated sample standard deviation (mph)
 K = constant corresponding to desired confidence level
 E = permitted error in the average speed estimate (mph)

S = 5 mph (Table 3-2, page 38)
 K = 2.58 (Confidence level of 99% - Table 3-3, page 38)
 E = 2 mph assumed error range

Therefore, N = 42 observations needed



Average speed = 36.2 mph
 50th percentile speed = 36.0 mph
 85th percentile speed = 40.0 mph

APPENDIX K

KNOX COUNTY TURN LANE VOLUME THRESHOLD WORKSHEETS

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
19 + 167 = 186	200	140	105	90	70	60
100 - 149	180	140	110	80	70	60
150 - 199	160	115	85	75	65	55
200 - 249	130	100	75	65	60	50
250 - 299	110	70	60	55	50	45
300 - 349	100	65	55	50	45	40
350 - 399	90	60	50	45	40	35
400 - 449	80	55	45	40	35	30
450 - 499	70	45	35	30	25	25
500 - 549	65	40	35	30	25	25
550 - 599	60	35	30	25	20	20
600 - 649	55	35	30	25	20	20
650 - 699	50	35	30	25	20	20
700 - 749	45	35	30	25	20	20
750 or More	45	35	25	25	20	20

118

100 - 149

19 + 167 = 186

150 - 199

Hammer Road at Brakebill Road
2025 Projected AM NB Left Turns = 14
Left Turn Lane NOT Warranted

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149	70	60	50	45	40	35
150 - 199	60	55	45	40	35	30
200 - 249	55	50	40	35	30	30
250 - 299	50	45	35	30	30	30
300 - 349	45	40	35	30	25	25
350 - 399	40	35	30	25	25	20
400 - 449	35	30	30	25	20	20
450 - 499	30	25	25	20	20	20
500 - 549	25	25	20	20	20	15
550 - 599	25	20	20	20	20	15
600 - 649	25	20	20	20	20	15
650 - 699	20	20	20	20	20	15
700 - 749	20	20	20	15	15	15
750 or More	20	20	20	15	15	15

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

167

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199						
200 - 249 250 - 299					Yes	Yes
300 - 349 350 - 399				Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		Yes	Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Hammer Road at
Brakebill Road

2025 Projected AM
SB Right Turns = 19

Right Turn Lane NOT
Warranted

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99				Yes	Yes Yes	Yes Yes
100 - 149 150 - 199		Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

241

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
41 + 200 = 241						
100 - 149	250	180	140	110	80	70
150 - 199	200	140	105	90	70	60
200 - 249	160	115	85	75	65	55
250 - 299	130	100	75	65	60	50
300 - 349	110		70	60	55	45
350 - 399	100		65	55	50	40
400 - 449	90		60	50	45	35
450 - 499	80		55	45	40	30
500 - 549	70		45	35	35	25
550 - 599	65		40	35	30	25
600 - 649	60		35	30	25	25
650 - 699	55		35	30	25	20
700 - 749	50	35	30	25	20	20
750 or More	45	35	25	25	20	20

Hammer Road at Brakebill Road

2025 Projected PM NB Left Turns = 48

Left Turn Lane NOT Warranted

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149	70	60	50	45	40	35
150 - 199	60	55	45	40	35	30
200 - 249	55	50	40	35	30	30
250 - 299	50	45	35	30	30	30
300 - 349	45	40	35	30	25	25
350 - 399	40	35	30	25	25	20
400 - 449	35	30	30	25	20	20
450 - 499	30	25	25	20	20	20
500 - 549	25	25	20	20	20	15
550 - 599	25	20	20	20	20	15
600 - 649	25	20	20	20	20	15
650 - 699	20	20	20	20	20	15
700 - 749	20	20	20	15	15	15
750 or More	20	20	20	15	15	15

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199						
200 - 249 250 - 299					Yes	Yes
300 - 349 350 - 399			Yes	Yes	Yes	Yes
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

200

Fewer Than 25
25 - 49

Hammer Road at Brakebill Road

2025 Projected PM SB Right Turns = 41

Right Turn Lane NOT Warranted

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99				Yes	Yes	Yes
100 - 149 150 - 199		Yes	Yes	Yes	Yes	Yes
200 - 249 250 - 299	Yes	Yes	Yes	Yes	Yes	Yes
300 - 349 350 - 399	Yes	Yes	Yes	Yes	Yes	Yes
400 - 449 450 - 499	Yes	Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
22 + 185 = 207						
100 - 149	250	180	140	110	80	70
150 - 199	200	140	105	90	70	60
200 - 249	160	115	85	75	65	55
250 - 299	130	100	75	65	60	50
300 - 349	110		70	60	55	45
350 - 399	100		65	55	50	40
400 - 449	90		60	50	45	35
450 - 499	80		55	45	40	30
500 - 549	70		45	35	35	25
550 - 599	65		40	35	30	25
600 - 649	60		35	30	25	25
650 - 699	55		35	30	25	20
700 - 749	50	35	30	25	20	20
750 or More	45	35	25	25	20	20

Road "A" at Brakebill Road
2025 Projected AM NB Left Turns = 15
Left Turn Lane NOT Warranted

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149	70	60	50	45	40	35
150 - 199	60	55	45	40	35	30
200 - 249	55	50	40	35	30	30
250 - 299	50	45	35	30	30	30
300 - 349	45	40	35	30	25	25
350 - 399	40	35	30	25	25	20
400 - 449	35	30	30	25	20	20
450 - 499	30	25	25	20	20	20
500 - 549	25	25	20	20	20	15
550 - 599	25	20	20	20	20	15
600 - 649	25	20	20	20	20	15
650 - 699	20	20	20	20	20	15
700 - 749	20	20	20	15	15	15
750 or More	20	20	20	15	15	15

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

185

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199						
200 - 249 250 - 299					Yes	Yes
300 - 349 350 - 399				Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		Yes	Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Road "A" at Brakebill Road
2025 Projected AM SB Right Turns = 22
Right Turn Lane NOT Warranted

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99				Yes	Yes Yes	Yes Yes
100 - 149 150 - 199		Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

240

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
51 + 176 = 227						
100 - 149	250	180	140	110	80	70
150 - 199	200	140	105	90	70	60
200 - 249	160	115	85	75	65	55
250 - 299	130	100	75	65	60	50
300 - 349	110	90	70	60	55	45
350 - 399	100	80	65			40
400 - 449	90	70	60			35
450 - 499	80	65	55			30
500 - 549	70	60	45			25
550 - 599	65	55	40			25
600 - 649	60	45	35			25
650 - 699	55	35	35			20
700 - 749	50	35	30	25	20	20
750 or More	45	35	25	25	20	20

Road "A" at Brakebill Road
2025 Projected PM NB Left Turns = 76
Left Turn Lane Warrant Nearly Met

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149	70	60	50	45	40	35
150 - 199	60	55	45	40	35	30
200 - 249	55	50	40	35	30	30
250 - 299	50	45	35	30	30	30
300 - 349	45	40	35	30	25	25
350 - 399	40	35	30	25	25	20
400 - 449	35	30	30	25	20	20
450 - 499	30	25	25	20	20	20
500 - 549	25	25	20	20	20	15
550 - 599	25	20	20	20	20	15
600 - 649	25	20	20	20	20	15
650 - 699	20	20	20	20	20	15
700 - 749	20	20	20	15	15	15
750 or More	20	20	20	15	15	15

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

176

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25						
25 - 49						
50 - 99						
100 - 149						
150 - 199						
200 - 249						Yes
250 - 299					Yes	Yes
300 - 349				Yes	Yes	Yes
350 - 399			Yes	Yes	Yes	Yes
400 - 449			Yes	Yes	Yes	Yes
450 - 499			Yes	Yes	Yes	Yes
500 - 549		Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Road "A" at
Brakebill Road

2025 Projected PM
SB Right Turns = 51

Right Turn Lane NOT
Warranted

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25						
25 - 49					Yes	Yes
50 - 99				Yes	Yes	Yes
100 - 149			Yes	Yes	Yes	Yes
150 - 199		Yes	Yes	Yes	Yes	Yes
200 - 249	Yes	Yes	Yes	Yes	Yes	Yes
250 - 299	Yes	Yes	Yes	Yes	Yes	Yes
300 - 349	Yes	Yes	Yes	Yes	Yes	Yes
350 - 399	Yes	Yes	Yes	Yes	Yes	Yes
400 - 449	Yes	Yes	Yes	Yes	Yes	Yes
450 - 499	Yes	Yes	Yes	Yes	Yes	Yes
500 - 549	Yes	Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

TABLE 4A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	300 245	235 200	185 160	145 130	120 110	100 90
200 - 249 250 - 299	205 175	170 140		115 105	100 90	80 70
300 - 349 350 - 399	155 135			95 85	80 70	65 60
400 - 449 450 - 499	120 105			75 70	65 60	55 50
500 - 549 550 - 599	95 85			65 60	55 50	50 45
600 - 649 650 - 699	75 70	65 60	60 55	55 50	45 40	40 35
700 - 749 750 or More	65 60	55 50	50 45	45 40	35 35	30 30

18 →
28 →

Road "B" at Hammer Road
2025 Projected AM WB Left Turns = 15
Left Turn Lane NOT Warranted

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= / > 600
100 - 149 150 - 199	100 90	80 75	70 65	60 55	55 50	50 45
200 - 249 250 - 299	80 70	72 65	460 55	55 50	50 45	45 40
300 - 349 350 - 399	65 60	60 55	50 50	50 45	45 40	40 40
400 - 449 450 - 499	55 50	50 45	45 45	45 40	40 35	35 35
500 - 549 550 - 599	50 45	45 40	40 40	40 35	35 35	35 35
600 - 649 650 - 699	40 35	35 35	35 35	35 30	35 30	30 30
700 - 749 750 or More	30 30	30 30	30 30	30 30	30 30	30 30

* Or through volume only if a right-turn lane exists.

TABLE 4B
RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

RIGHT-TURN VOLUME	28 THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199	Road "B" at Hammer Road 2025 Projected AM EB Right Turns = 0 Right Turn Lane NOT Warranted					
200 - 249 250 - 299						
300 - 349 350 - 399						
400 - 449 450 - 499						
500 - 549 550 - 599		Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99					Yes	Yes Yes
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

TABLE 4A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	300 245	235 200	185 160	145 130	120 110	100 90
200 - 249 250 - 299	205 175	170 140	115 105	95 85	80 70	65 60
300 - 349 350 - 399	155 135	Road "B" at Hammer Road 2025 Projected PM WB Left Turns = 55 Left Turn Lane NOT Warranted		75 70	65 60	55 45
400 - 449 450 - 499	120 105			65 60	55 50	50 45
500 - 549 550 - 599	95 85			60	50	45
600 - 649 650 - 699	75 70	65 60	60 55	55 50	45 40	40 35
700 - 749 750 or More	65 60	55 50	50 45	45 40	35 35	30 30

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= / > 600
100 - 149 150 - 199	100 90	80 75	70 65	60 55	55 50	50 45
200 - 249 250 - 299	80 70	72 65	60 55	55 50	50 45	45 40
300 - 349 350 - 399	65 60	60 55	50 50	50 45	45 40	40 40
400 - 449 450 - 499	55 50	50 45	45 45	45 40	40 35	35 35
500 - 549 550 - 599	50 45	45 40	40 40	40 35	35 35	35 35
600 - 649 650 - 699	40 35	35 35	35 35	35 30	35 30	30 30
700 - 749 750 or More	30 30	30 30	30 30	30 30	30 30	30 30

* Or through volume only if a right-turn lane exists.

**TABLE 4B
RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS**

RIGHT-TURN VOLUME	26 THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199	Road "B" at Hammer Road 2025 Projected PM EB Right Turns = 0 Right Turn Lane NOT Warranted					
200 - 249 250 - 299						
300 - 349 350 - 399						
400 - 449 450 - 499						
500 - 549 550 - 599		Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99					Yes	Yes Yes
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.

APPENDIX L

TDOT STATEWIDE CRASH RATES & SPREADSHEET CALCULATIONS

Tennessee Department of Transportation
Statewide Average Crash Rates for Sections and Spots

Study: OFFICIAL HSIP STUDY 2017 - 2019
 Begin Date: 1/1/2017 End Date: 12/31/2019

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
Interstates and State Routes										
IS & SR	Rural	Section	2 OR 3 LN	0.024	0.098	0.365	1.101	1.588	0.122	23,617
IS & SR	Rural	Section	2 OR 3 LN W/TL	0.010	0.057	0.356	1.464	1.888	0.068	679
IS & SR	Rural	Section	4 OR MORE UNDIV	0.025	0.065	0.284	1.201	1.576	0.090	444
IS & SR	Rural	Section	4 OR MORE DIV	0.014	0.038	0.159	0.489	0.701	0.052	8,016
IS & SR	Rural	Section	4 OR MORE W TL	0.012	0.040	0.185	0.609	0.846	0.052	2,916
IS & SR	Rural	Section	FREEWAY	0.006	0.023	0.109	0.478	0.616	0.029	26,587
IS & SR	Rural	Spot	2 OR 3 LN	0.007	0.028	0.104	0.314	0.453	0.034	85,207
IS & SR	Rural	Spot	2 OR 3 LN W/TL	0.002	0.010	0.065	0.271	0.348	0.012	3,895
IS & SR	Rural	Spot	4 OR MORE UNDIV	0.005	0.012	0.050	0.215	0.281	0.017	2,709
IS & SR	Rural	Spot	4 OR MORE DIV	0.004	0.010	0.042	0.132	0.187	0.014	31,111
IS & SR	Rural	Spot	4 OR MORE W TL	0.003	0.010	0.044	0.147	0.203	0.013	12,532
IS & SR	Rural	Spot	FREEWAY	0.001	0.004	0.017	0.073	0.094	0.004	175,586
IS & SR	Urban	Section	2 OR 3 LN	0.014	0.070	0.525	1.900	2.507	0.083	10,910
IS & SR	Urban	Section	2 OR 3 LN W/TL	0.009	0.059	0.504	2.115	2.688	0.068	1,840
IS & SR	Urban	Section	4 OR MORE UNDIV	0.016	0.074	0.770	3.125	3.985	0.090	3,114
IS & SR	Urban	Section	4 OR MORE DIV	0.009	0.039	0.383	1.545	1.975	0.048	18,301
IS & SR	Urban	Section	4 OR MORE W TL	0.013	0.060	0.667	2.483	3.223	0.073	14,936
IS & SR	Urban	Section	FREEWAY	0.005	0.020	0.246	0.951	1.222	0.025	54,658
IS & SR	Urban	Spot	2 OR 3 LN	0.002	0.011	0.081	0.306	0.399	0.013	78,605
IS & SR	Urban	Spot	2 OR 3 LN W/TL	0.001	0.008	0.068	0.286	0.363	0.009	14,669
IS & SR	Urban	Spot	4 OR MORE UNDIV	0.002	0.008	0.087	0.369	0.465	0.009	40,684
IS & SR	Urban	Spot	4 OR MORE DIV	0.001	0.005	0.055	0.224	0.286	0.007	142,804
IS & SR	Urban	Spot	4 OR MORE W TL	0.002	0.007	0.079	0.295	0.382	0.008	133,134
IS & SR	Urban	Spot	FREEWAY	0.001	0.002	0.029	0.112	0.143	0.003	468,886

Note: Section rates are crashes per million vehicle miles.

Note: Spot rates are crashes per million vehicles. Spots are sections of roadway less than or equal to .10 mile.

Note: Severe crash rates are the sum of rates for fatal and incapacitating injury crashes.

Tennessee Department of Transportation
Statewide Average Crash Rates for Sections and Spots

Study: OFFICIAL HSIP STUDY 2017 - 2019
 Begin Date: 1/1/2017 End Date: 12/31/2019

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
Functionally Classified Local Roads										
FUNCT.	Rural	Section	2 OR 3 LN	0.031	0.129	0.566	1.831	2.556	0.160	7,535
FUNCT.	Rural	Section	2 OR 3 LN W/TL	0.000	0.048	0.145	1.402	1.596	0.048	41
FUNCT.	Rural	Section	4 OR MORE UNDIV	0.000	0.269	0.269	1.880	2.417	0.269	4
FUNCT.	Rural	Section	4 OR MORE DIV	0.000	0.000	0.000	0.000	0.000	0.000	0
FUNCT.	Rural	Section	4 OR MORE W TL	0.000	0.000	0.000	0.000	0.000	0.000	0
FUNCT.	Rural	Section	FREEWAY	0.000	1.224	0.000	7.345	8.569	1.224	1
FUNCT.	Rural	Spot	2 OR 3 LN	0.014	0.060	0.261	0.846	1.180	0.074	16,401
FUNCT.	Rural	Spot	2 OR 3 LN W/TL	0.000	0.008	0.029	0.303	0.340	0.008	241
FUNCT.	Rural	Spot	4 OR MORE UNDIV	0.000	0.045	0.134	0.448	0.627	0.045	22
FUNCT.	Rural	Spot	4 OR MORE DIV	0.000	0.000	0.000	1.268	1.268	0.000	2
FUNCT.	Rural	Spot	FREEWAY	0.000	0.089	0.000	0.716	0.805	0.089	11
FUNCT.	Urban	Section	2 OR 3 LN	0.012	0.070	0.697	2.568	3.346	0.082	16,913
FUNCT.	Urban	Section	2 OR 3 LN W/TL	0.006	0.050	0.695	2.711	3.461	0.056	1,798
FUNCT.	Urban	Section	4 OR MORE UNDIV	0.014	0.057	0.831	3.066	3.968	0.071	3,109
FUNCT.	Urban	Section	4 OR MORE DIV	0.009	0.037	0.527	2.426	3.000	0.046	4,146
FUNCT.	Urban	Section	4 OR MORE W TL	0.012	0.048	0.689	2.565	3.314	0.060	5,225
FUNCT.	Urban	Section	FREEWAY	0.013	0.015	0.325	1.328	1.681	0.028	530
FUNCT.	Urban	Spot	2 OR 3 LN	0.002	0.012	0.123	0.466	0.603	0.014	102,332
FUNCT.	Urban	Spot	2 OR 3 LN W/TL	0.001	0.007	0.093	0.374	0.475	0.008	14,001
FUNCT.	Urban	Spot	4 OR MORE UNDIV	0.002	0.007	0.102	0.401	0.511	0.009	29,839
FUNCT.	Urban	Spot	4 OR MORE DIV	0.001	0.005	0.073	0.337	0.417	0.006	35,459
FUNCT.	Urban	Spot	4 OR MORE W TL	0.002	0.006	0.085	0.322	0.414	0.007	44,753
FUNCT.	Urban	Spot	FREEWAY	0.002	0.002	0.045	0.185	0.234	0.003	4,706

Tennessee Department of Transportation
Statewide Average Crash Rates for Sections and Spots

Study: OFFICIAL HSIP STUDY 2017 - 2019
 Begin Date: 1/1/2017 End Date: 12/31/2019

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
High Risk Rural Roads										
MAJOR COL.	Rural	Section	2 OR 3 LN	0.026	0.119	0.461	1.396	2.002	0.144	8,226
MAJOR COL.	Rural	Section	2 OR 3 LN W/TL	0.008	0.078	0.227	1.851	2.163	0.086	128
MAJOR COL.	Rural	Section	4 OR MORE UNDIV	0.000	0.000	0.471	1.547	2.018	0.000	15
MAJOR COL.	Rural	Section	4 OR MORE DIV	0.000	0.148	0.702	1.663	2.514	0.148	27
MAJOR COL.	Rural	Section	4 OR MORE W TL	0.000	0.104	0.225	1.106	1.435	0.104	58
MAJOR COL.	Rural	Section	FREEWAY	0.000	0.000	0.235	0.471	0.706	0.000	4
MAJOR COL.	Rural	Spot	2 OR 3 LN	0.009	0.042	0.162	0.491	0.703	0.050	23,673
MAJOR COL.	Rural	Spot	2 OR 3 LN W/TL	0.001	0.014	0.046	0.362	0.423	0.016	697
MAJOR COL.	Rural	Spot	4 OR MORE UNDIV	0.000	0.009	0.066	0.283	0.358	0.009	106
MAJOR COL.	Rural	Spot	4 OR MORE DIV	0.000	0.025	0.132	0.427	0.583	0.025	159
MAJOR COL.	Rural	Spot	4 OR MORE W TL	0.000	0.021	0.039	0.214	0.273	0.021	336
MAJOR COL.	Rural	Spot	FREEWAY	0.000	0.000	0.082	0.164	0.247	0.000	12
MIN COL.	Rural	Section	2 OR 3 LN	0.032	0.130	0.551	1.811	2.524	0.162	6,815
MIN COL.	Rural	Section	2 OR 3 LN W/TL	0.000	0.028	0.140	1.228	1.396	0.028	36
MIN COL.	Rural	Section	4 OR MORE UNDIV	0.000	0.269	0.269	1.880	2.417	0.269	4
MIN COL.	Rural	Section	4 OR MORE DIV	0.000	0.000	0.000	0.000	0.000	0.000	0
MIN COL.	Rural	Section	4 OR MORE W TL	0.000	0.000	0.000	0.000	0.000	0.000	0
MIN COL.	Rural	Section	FREEWAY	0.000	2.536	0.000	10.144	12.680	2.536	0
MIN COL.	Rural	Spot	2 OR 3 LN	0.016	0.065	0.274	0.903	1.258	0.081	13,735
MIN COL.	Rural	Spot	2 OR 3 LN W/TL	0.000	0.005	0.028	0.272	0.305	0.005	213
MIN COL.	Rural	Spot	4 OR MORE UNDIV	0.000	0.045	0.134	0.448	0.627	0.045	22
MIN COL.	Rural	Spot	4 OR MORE DIV	0.000	0.000	0.000	1.268	1.268	0.000	2
MIN COL.	Rural	Spot	FREEWAY	0.000	0.175	0.000	1.048	1.222	0.175	6

Tennessee Department of Transportation
Statewide Intersection Crash Rates

Study: OFFICIAL HSIP STUDY 2017 - 2019

Begin Date: 1/1/2017 End Date: 12/31/2019

	Rural					Urban				
	2 Lane	2 Ln w/Turn	Multi-Lane			2 Lane	2 Ln w/Turn	Multi-Lane		
			Univided	Divided	Turn Lane			Univided	Divided	Turn Lane
Signalized Intersections										
Non-injury	0.511	0.450	0.647	0.395	0.355	0.562	0.483	0.611	0.555	0.479
Injury	0.122	0.093	0.128	0.158	0.122	0.145	0.116	0.171	0.162	0.150
Incap Inj	0.013	0.000	0.020	0.019	0.016	0.013	0.008	0.011	0.011	0.010
Fatal	0.001	0.000	0.003	0.005	0.002	0.001	0.001	0.001	0.002	0.001
Total	0.647	0.543	0.797	0.576	0.495	0.721	0.609	0.793	0.730	0.640
Full Stop Intersections										
Non-injury	0.330	0.000	0.185	0.671	1.734	0.468	0.710	0.105	0.574	0.000
Injury	0.086	0.000	0.000	0.268	0.447	0.115	0.042	0.000	0.100	0.000
Incap Inj	0.009	0.000	0.000	0.012	0.000	0.006	0.000	0.000	0.013	0.000
Fatal	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.426	0.000	0.185	0.952	2.181	0.589	0.752	0.105	0.688	0.000
Other Intersections										
Non-injury	0.081	0.078	0.085	0.050	0.044	0.118	0.096	0.133	0.090	0.083
Injury	0.030	0.018	0.031	0.026	0.016	0.033	0.025	0.033	0.026	0.025
Incap Inj	0.006	0.004	0.005	0.007	0.003	0.004	0.003	0.003	0.003	0.002
Fatal	0.002	0.000	0.001	0.002	0.001	0.001	0.000	0.001	0.001	0.000
Total	0.118	0.099	0.121	0.084	0.063	0.156	0.125	0.170	0.119	0.110

TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = Knox Date: 7/8/2020
 Route = Strawberry Plains Pike
 Location = Intersection (Strawberry Plains Pike at Brakebill Road)
 Highway Type = 4-lane divided
 FUNCTIONAL CLASS Minor Arterial
 DATA YEARS = 2017 - 2020 TITAN Data
 ADT YEARS USED= 2018
 COMMENTS =
 ANALYZED BY = RWJ

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE

BLM	ELM	Length	Average AADT	VMT
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.00 0 0

INTERSECTION

Log Mile =	8.803		Leg	Traffic AADT	
			North =	8,000	assumed
			East =		
			South =	8,000	
			West =	3,845	estimated
			<u>Entering AADT =</u>		<u>9,923</u>
			2018		

4-Lane Divided
2017 - 2020 Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	9	0	0	0		0
No. of Years	=	3.0					
SW avg. rate	=	0.119	0.001	0.003	0.004		0.026
2017 - 2019 HSIP							
Exposure (E)	=	10.8651					
Crash Rate (A)	=	0.828	0.000	0.000	0.000		0.000
Critical Rate (C)	=	0.409					
Severity Index (SI)	=	0.0000					
Actual Rate/SW Average	=	6.96	0.00	0.00	0.00		0.00
Ratio of A/C	=	2.03					

* Severe Crashes are the sum of fatal and incapacitating injury crashes

Strawberry Plains Pike, Knox County		LM 8.803	
Intersection (Strawberry Plains Pike at Brakebill Road)			
9 Crashes	- 2017 - 2020	Actual	- 0.828 Acc/MVM
State Average	- 0.119 Acc/MVM	Critical	- 0.409 Acc/MVM
A/S Ratio	= 6.96	A/C Ratio	= 2.03

TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = Knox Date: 7/7/2020
 Route = Brakebill Road
 Location = Intersection (Hammer Road at Brakebill Road)
 Highway Type = 2-lane undivided
 FUNCTIONAL CLASS Major Collector
 DATA YEARS = 2017 - 2020 TITAN Data
 ADT YEARS USED= 2018
 COMMENTS =
 ANALYZED BY = RWJ

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE
BLM ELM Length Average AADT VMT
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0
0.00 0.00 0.00 0 0

0.00 0 0

INTERSECTION Log Mile = 0.629	Leg Traffic AADT North = 3,845 assumed East = South = 3,845 West = 500 estimated <hr style="width: 50%; margin-left: auto; margin-right: 0;"/> Entering AADT = 4,095 2018
----------------------------------	--

2-Lane Undivided
 2017 - 2020 Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	2	0	0	0		2
No. of Years	=	3.0					
SW avg. rate	=	0.118	0.002	0.006	0.008		0.030
2017 - 2019 HSIP							
Exposure (E)	=	4.4840					
Crash Rate (A)	=	0.446	0.000	0.000	0.000		0.446
Critical Rate (C)	=	0.607					
Severity Index (SI)	=	1.0000					
Actual Rate/SW Average	=	3.78	0.00	0.00	0.00		14.87
Ratio of A/C	=	0.73					

* Severe Crashes are the sum of fatal and incapacitating injury crashes

Brakebill Road, Knox County		LM 0.629	
Intersection (Hammer Road at Brakebill Road)			
2 Crashes	- 2017 - 2020	Actual	- 0.446 Acc/MVM
State Average	- 0.118 Acc/MVM	Critical	- 0.607 Acc/MVM
A/S Ratio	= 3.78	A/C Ratio	= 0.73

TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = Knox Date: 7/7/2020
 Route = Brakebill Road
 Location = Section 1 (Asheville Highway - Hammer Road)
 Highway Type = 2-lane undivided
 FUNCTIONAL CLASS Major Collector
 DATA YEARS = 2017 - 2019 TITAN Data
 ADT YEARS USED= 2018
 COMMENTS =
 ANALYZED BY = RWJ

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE

BLM	ELM	Length	Average AADT	VMT
0.00	0.63	0.63	3,845	2,419
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.63 3,845 2,419

INTERSECTION Leg Traffic AADT
 Log Mile = North =
East =
South =
West =
Entering AADT =
2018

2-Lane Undivided
 2017 - 2019 Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	15	0	0	0		3
No. of Years	=	3.0					
SW avg. rate	=	2.002	0.026	0.119	0.145		0.461
2017 - 2019 HSIP							
Exposure (E)	=	2.6483					
Crash Rate (A)	=	5.664	0.000	0.000	0.000		1.133
Critical Rate (C)	=	4.214					
Severity Index (SI)	=	0.2000					
Actual Rate/SW Average	=	2.83	0.00	0.00	0.00		2.46
Ratio of A/C	=	1.34					

* Severe Crashes are the sum of fatal and incapacitating injury crashes

Revised 5/12/2010

Brakebill Road, Knox County		LM 0.000	
Section 1 (Asheville Highway - Hammer Road)			
15 Crashes	- 2017 - 2019	Actual	- 5.664 Acc/MVM
State Average	- 2.002 Acc/MVM	Critical	- 4.214 Acc/MVM
A/S Ratio	= 2.83	A/C Ratio	= 1.34

TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = **Knox** Date: **7/7/2020**
 Route = **Brakebill Road**
 Location = **Section 2 (Hammer Road - Strawberry Plains Pike)**
 Highway Type = **2-lane undivided**
 FUNCTIONAL CLASS **Major Collector**
 DATA YEARS = **2017 - 2019 TITAN Data**
 ADT YEARS USED = **2018**
 COMMENTS =
 ANALYZED BY = **RWJ**

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE

BLM	ELM	Length	Average AADT	VMT
0.63	1.32	0.70	3,845	2,672
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.70 3,845 2,672

INTERSECTION Leg Traffic AADT
 Log Mile = North =
East =
South =
West =
Entering AADT =
2018

2-Lane Undivided
 2017 - 2019 Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	10	0	0	0		2
No. of Years	=	3.0					
SW avg. rate	=	2.002	0.026	0.119	0.145		0.461
2017 - 2019 HSIP							
Exposure (E)	=	2.9261					
Crash Rate (A)	=	3.417	0.000	0.000	0.000		0.683
Critical Rate (C)	=	4.098					
Severity Index (SI)	=	0.2000					
Actual Rate/SW Average	=	1.71	0.00	0.00	0.00		1.48
Ratio of A/C	=	0.83					

* Severe Crashes are the sum of fatal and incapacitating injury crashes

Revised 5/12/2010

Brakebill Road, Knox County		LM 0.000	
Section 2 (Hammer Road - Strawberry Plains Pike)			
10 Crashes	- 2017 - 2019	Actual	- 3.417 Acc/MVM
State Average	- 2.002 Acc/MVM	Critical	- 4.098 Acc/MVM
A/S Ratio	= 1.71	A/C Ratio	= 0.83

APPENDIX M

SIMTRAFFIC QUEUING AND BLOCKING REPORTS

Queuing and Blocking Report

8/23/2020

Intersection: 21: Brakebill Road & Road "A"

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	70	36
Average Queue (ft)	37	4
95th Queue (ft)	60	21
Link Distance (ft)	217	356
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Queuing and Blocking Report

8/23/2020

Intersection: 21: Brakebill Road & Road "A"

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	60	67
Average Queue (ft)	33	16
95th Queue (ft)	56	49
Link Distance (ft)	217	356
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 10: Strawberry Plains Pike & Brakebill Road

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	R	UL	T	T	UT	TR
Maximum Queue (ft)	103	124	179	230	220	155	164
Average Queue (ft)	42	53	109	62	48	46	47
95th Queue (ft)	83	96	175	194	151	110	112
Link Distance (ft)		248		180	180	461	461
Upstream Blk Time (%)			1	3	2		
Queuing Penalty (veh)			0	15	9		
Storage Bay Dist (ft)	120		200				
Storage Blk Time (%)	0	0	1	3			
Queuing Penalty (veh)	0	0	6	7			

Intersection: 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	TR
Maximum Queue (ft)	223	260	128	187	243	252	178	172	187
Average Queue (ft)	64	149	8	34	118	87	56	92	118
95th Queue (ft)	196	243	75	131	202	181	126	151	188
Link Distance (ft)			358			451	451	180	180
Upstream Blk Time (%)			0					0	1
Queuing Penalty (veh)			0					0	3
Storage Bay Dist (ft)	225	225		190	190				
Storage Blk Time (%)	0	1		0	1	1			
Queuing Penalty (veh)	0	2		0	5	4			

Network Summary

Network wide Queuing Penalty: 52

Intersection: 10: Strawberry Plains Pike & Brakebill Road

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	R	UL	T	T	UT	TR
Maximum Queue (ft)	155	240	109	94	93	208	306
Average Queue (ft)	33	108	48	11	24	79	110
95th Queue (ft)	90	204	97	56	66	161	234
Link Distance (ft)		248		180	180	461	461
Upstream Blk Time (%)		1			0		
Queuing Penalty (veh)		0			0		
Storage Bay Dist (ft)	120		200				
Storage Blk Time (%)	0	10					
Queuing Penalty (veh)	0	6					

Intersection: 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	TR
Maximum Queue (ft)	203	254	65	188	222	138	87	184	191
Average Queue (ft)	42	129	3	30	116	43	23	99	149
95th Queue (ft)	156	214	51	126	199	102	61	172	215
Link Distance (ft)			358			451	451	180	180
Upstream Blk Time (%)			0					0	3
Queuing Penalty (veh)			0					1	19
Storage Bay Dist (ft)	225	225		190	190				
Storage Blk Time (%)	0	1		0	1				
Queuing Penalty (veh)	0	1		0	2				

Network Summary

Network wide Queuing Penalty: 29

APPENDIX N

TDOT ROAD SAFETY AUDIT REVIEW



STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
PROJECT PLANNING DIVISION
SUITE 1000, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-0334

Gerald F. Nicely
COMMISSIONER

Phil Bredesen
GOVERNOR

MEMORANDUM

To: Mr. Paul Degges, Chief Engineer

From:  Steve Allen, Director
Project Planning Division

Date: March 16, 2010

**Subject: RSAR INTERSECTION OF STRAWBERRY PLAINS PIKE AND
BRAKEBILL ROAD, KNOX COUNTY**

The Road Safety Audit Review for the intersection of Strawberry Plains Pike and Brakebill Road, Knox County, has been completed and the report is attached. This project was identified through the TDOT safety needs planning process. Strawberry Plains Pike is a divided four lane urban collector roadway. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

The following guidance was provided:

- **Figure 1**
 1. Restripe all edgelines along the I-40 entrance and exit ramps extending approximately 500 feet from the intersection of Strawberry Plains Pike and the I-40 ramps.
 2. Install a (36"x36") Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A "400 FEET" (30"x18") supplemental plate (W16-2a) should be mounted underneath this sign.
 3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
 4. Install a 24" thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
 5. Replace existing Stop signs with (36"x36") Stop (R1-1) signs on the Brakebill approach.
 6. Install a "Brakebill Rd." Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
 7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
 8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset on Figure 1).

9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12" diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.
13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
14. Install yellow-yellow retroreflective bi-directional raised pavement markings spaced at 10 feet center-to-center on the edge lines inside the median opening area.
15. Relocate "WRONG WAY" sign approximately 45 feet north of existing location within median.
16. Install (30"x30") "DO NOT ENTER" (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
17. Install a (30"x30") Intersection Ahead (W2-2) warning sign approximately but not less than 400 feet in advance of the intersection on Strawberry Plains Pike. A (24"x12") "400 FEET" supplemental plate (W16-2a) should be mounted underneath this sign.
18. Install "Rear Access to McDonalds" (30"x54") sign facing south-westbound traffic on the northeast side of the median opening located approximately 475 feet northeast of the intersection of Strawberry Plains Pike and Brakebill Road.

The estimated cost of improvements listed in this report is \$181,200. This includes \$13,600 of 100% federally funded items, \$150,800 of 90% federally funded items, and \$16,800 of 10% locally funded items. The local match to be provided by the City of Knoxville is \$16,800. These proposed improvements will be let to contract.

If you should need any further information, please contact me at (615) 741-2208.

Attachment

CC: Ed Cole, Gary Ogletree, Mike Tugwell, Steve Borden, Amanda Snowden, Jim Moore,
FILE

ROAD SAFETY AUDIT REPORT
INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL
ROAD
L.M. 8.80
KNOX COUNTY
PIN 113344.00



PREPARED BY
RPM TRANSPORTATION CONSULTANTS, LLC
FOR THE
TENNESSEE DEPARTMENT OF TRANSPORTATION
PROJECT PLANNING DIVISION

Approved by:	Signature	DATE
DIRECTOR Project Planning Division		3-16-10

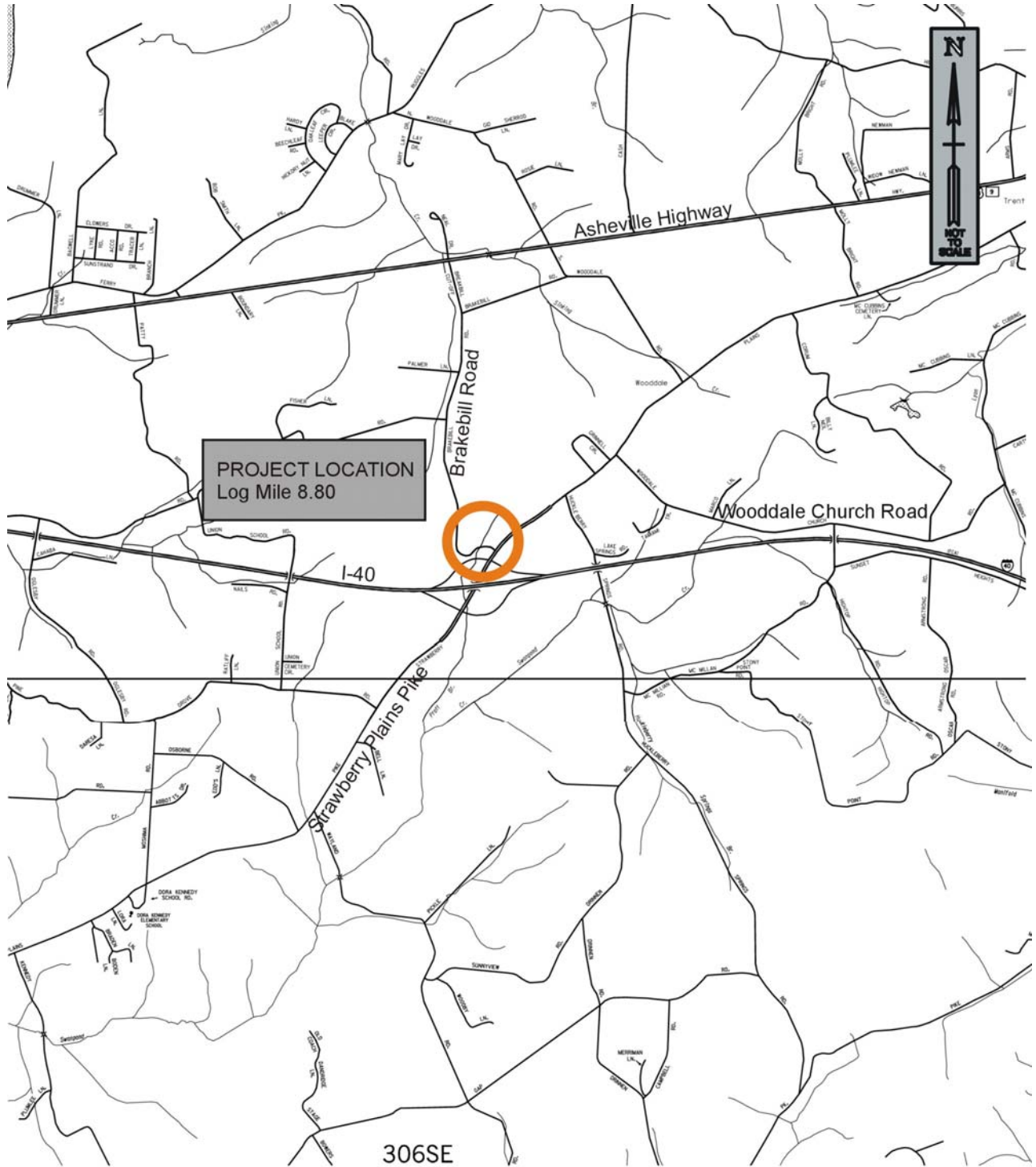
This document is covered by 23 USC § 409 and its production pursuant to fulfilling public planning requirements does not waive the provisions of § 409.

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80
Knoxville, Knox County Road Safety Audit Review



Project Location Map
(Not to Scale)

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80
Knoxville, Knox County Road Safety Audit Review



Project Area Map
(Not to Scale)

Road Safety Audit Review

Description of Project and Background

This project was identified through the TDOT safety needs planning process. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

RSAR Team Members

A RSAR team was assembled to evaluate the intersection of Strawberry Plains Pike and Brakebill Road in Knoxville, Knox County to determine appropriate safety measures.

Team Members

<u>Name</u>	<u>Organization</u>	<u>Phone</u>	<u>Email</u>
Paul Lane	TDOT – Project Planning	615-253-2432	paul.lane@tn.gov
Glenda Tyus	TDOT – Project Planning	615-741-1816	glenda.tyus@tn.gov
Randy Plummer	TDOT- Region 1 Design	865-594-2400	randy.plummer@tn.gov
Jay Morgan	TDOT- Region 1 Design	865-594-2400	jay.morgan@tn.gov
Henry Reid	TDOT- Region 1 Design	865-594-2400	henry.reid@tn.gov
Stephen Millsaps	City of Knoxville	865-215-6100	smillsaps@cityofknoxville.org
Bill Cole	City of Knoxville	865-215-6100	bcole@cityofknoxville.org
Jim Pointer	TDOT- District 15 Highway Maintenance	865-594-2718	N/A
John Sexton	Knox County Department of Engineering and Public Works	865-215-5860	john.sexton@knoxcounty.org
Amanda Snowden	TDOT- Region 1 Traffic	865-594-2400	amanda.snowden@tn.gov
Andy Padgett	TDOT- Region 1 Traffic	865-594-2456	andrew.padgett@tn.gov
Nathan Benditz	Knoxville TPO	865-215-2826	nathan.benditz@knoxtrans.org
Eric Jackson	TDOT- Traffic	615-741-0802	eric.jackson@tn.gov
Jeff Hammond	RPM Transportation	615-370-8410	jeffhammond@rpmtraffic.net
Blake Turner	RPM Transportation	615-370-8410	blaketurner@rpmtraffic.net

Information used in the Review

- City of Knoxville street map
- TRIMS Route Feature Description Listing
- TRIMS Highway Log Report
- TRIMS Geometric Report
- TRIMS Traffic Report
- TRIMS Road Segment Report
- ADAM historical traffic report
- TDOT Signal Warrant Study
- Hourly turning movements counts (included in appendix)
- Aerial photography
- Crash rate summary (included in appendix)
- Crash reports: 50090192, 50064350, 50064365, 50131679, 50075792, 50113006, 9858299, 50053558, 9275906, 9856871, 8115074, 9228217, 9229551, 8112521, 8551111, 9741760, 9737013

Pre-Briefing Summary

This project was identified through the TDOT safety needs planning process. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

A pre-brief meeting was held at 1:00 PM on Monday, October 12 at TDOT headquarters in Nashville. The following aspects of the intersection were discussed:

- The I-40 interchange location results in significant volumes of truck and tourism traffic.
- No turn lanes exist on Strawberry Plains Pike at this intersection.
- A study performed by TDOT Region I showed that MUTCD warrants for signalization are met.
- The intersection of Strawberry Plains Pike and Brakebill Road is located approximately 280 feet north of the signalized intersection of Strawberry Plains Pike and westbound I-40 ramps. This spacing would be undesirable for two signalized intersections.
- The intersection of Region Lane and Strawberry Plains Pike is approximately 480 feet south of the intersection of Strawberry Plains Pike and the eastbound I-40 ramps. These intersections are both signalized and operate acceptably.
- A slight downgrade exists on southbound Strawberry Plains Pike approaching the Brakebill Road intersection.

This intersection has experienced seventeen (17) crashes over the past three (3) years. The seventeen (17) crashes included fifteen (15) property damage, one (1) incapacitating injury crash, and one (1) non-incapacitating injury crash. Ten (10) (59%) of these were right angle crashes, and six (6) (35%) were rear end crashes, involving both northbound and southbound traffic along Strawberry Plains Pike. It was discussed that a northbound left turn lane and signalization would likely mitigate the rear end and right angle crashes, but that the signal spacing was undesirable.

Observations

An onsite field review was held at 2:00 PM ET on Monday, October 19, 2009. The following observations are provided concerning the location:

- Due to the lack of a northbound turn lane on Strawberry Plains Pike, vehicles queue inside the median opening in order to make a left turn onto Brakebill Road.
- A single eastbound lane on Brakebill Road serves both left and right turning traffic.
- The culvert opening north of Brakebill Road does not have a standard end treatment.
- A previous study called the Huckleberry Springs Loop Study had identified a possible connection from Huckleberry Springs Road to Brakebill Road.
- The unsignalized intersection of Strawberry Plains Pike and Brakebill Road is located 280 feet north of the signalized intersection of Strawberry Plains Pike and the westbound I-40 ramps.
- The “Brakebill Road” street name signs appeared to be undersized.
- Stop signs are located on both sides of Brakebill Road at its approach to Strawberry Plains Pike; both Brakebill Road stop signs appeared to be undersized.
- The edgelines and centerlines along Brakebill Road had limited visibility.
- No advance intersection warning sign was present north of Brakebill Road for southbound Strawberry Plains Pike traffic.
- A “Stop Ahead” sign was not present west of Strawberry Plains Pike on Brakebill Road.
- A high number of southbound to northbound U-turns on Strawberry Plains Pike were noted at the Brakebill Road median opening, particularly during the AM peak period. It is likely that these vehicles are accessing the McDonald’s restaurant.

Guidance

The following recommendations were developed by the RSAR team during the field review:

- Figure 1
 1. Restripe all edgelines along the I-40 entrance and exit ramps extending approximately 500 feet from the intersection of Strawberry Plains Pike and the I-40 ramps.
 2. Install a (36”x36”) Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A “400 FEET” (30”x18”) supplemental plate (W16-2a) should be mounted underneath this sign.
 3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
 4. Install a 24” thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
 5. Replace existing Stop signs with (36”x36”) Stop (R1-1) signs on the Brakebill approach.

6. Install a “Brakebill Rd.” Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset on Figure 1).
9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12” diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.
13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
14. Install yellow-yellow retroreflective bi-directional raised pavement markings spaced at 10 feet center-to-center on the edge lines inside the median opening area.
15. Relocate “WRONG WAY” sign approximately 45 feet north of existing location within median.
16. Install (30”x30”) “DO NOT ENTER” (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
17. Install a (30”x30”) Intersection Ahead (W2-2) warning sign approximately but not less than 400 feet in advance of the intersection on Strawberry Plains Pike. A (24”x12”) “400 FEET” supplemental plate (W16-2a) should be mounted underneath this sign.
18. Install “Rear Access to McDonalds” (30”x54”) sign facing south-westbound traffic on the northeast side of the median opening located approximately 475 feet northeast of the intersection of Strawberry Plains Pike and Brakebill Road.

The estimated cost of improvements listed in this report is \$181,200. This includes \$13,600 of 100% federally funded items, \$150,800 of 90% federally funded items, and \$16,800 of 10% locally funded items. The local match to be provided by the City of Knoxville is \$16,800. These proposed improvements will be let to contract. All items removed as part of this project shall be returned to the City of Knoxville.

**COST DATA SHEET
 TOTAL PROJECT COST**

Route:	LOCAL ROUTE 1124
Description:	INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD
County:	KNOX
Length:	INTERSECTION
Date:	1/25/2010

RIGHT-OF-WAY	\$	10,000
UTILITY RELOCATION	\$	24,000
CLEAR AND GRUBBING	\$	1,000
EARTHWORK	\$	17,000
PAVEMENT REMOVAL	\$	1,000
DRAINAGE	\$	15,000
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	51,000
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	4,000
TOPSOIL	\$	1,000
SEEDING	\$	0
SODDING	\$	3,000
SIGNING AND STRIPING	\$	8,400
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	15,200
MOBILIZATION	\$	6,000
CONSTRUCTION COST	\$	122,600
10% ENG. & CONT.	\$	12,300
TOTAL CONSTRUCTION COST	\$	134,900
10% PRELIMINARY ENGINEERING	\$	12,300
TOTAL COST *	\$	181,200

* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

COST DATA SHEET
100% Federally Funded Items

Route:	LOCAL ROUTE 1124
Description:	INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD
County:	KNOX
Length:	INTERSECTION
Date:	1/25/2010

RIGHT-OF-WAY	\$	0
UTILITY RELOCATION	\$	0
CLEAR AND GRUBBING	\$	0
EARTHWORK	\$	0
PAVEMENT REMOVAL	\$	0
DRAINAGE	\$	0
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	0
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	1,000
TOPSOIL	\$	0
SEEDING	\$	0
SODDING	\$	0
SIGNING AND STRIPING	\$	8,400
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	1,400
MOBILIZATION	\$	600
CONSTRUCTION COST	\$	11,400
10% ENG. & CONT.	\$	1,100
TOTAL CONSTRUCTION COST	\$	12,500
10% PRELIMINARY ENGINEERING	\$	1,100
TOTAL COST *	\$	13,600

* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

COST DATA SHEET
 90% Federally Funded

Route:	LOCAL ROUTE 1124
Description:	INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD
County:	KNOX
Length:	INTERSECTION
Date:	1/25/2010

RIGHT-OF-WAY	\$	9000
UTILITY RELOCATION	\$	21600
CLEAR AND GRUBBING	\$	900
EARTHWORK	\$	15,300
PAVEMENT REMOVAL	\$	900
DRAINAGE	\$	13,500
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	45,900
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	2,700
TOPSOIL	\$	900
SEEDING	\$	0
SODDING	\$	2,700
SIGNING AND STRIPING	\$	0
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	12,420
MOBILIZATION	\$	4,860
CONSTRUCTION COST	\$	100,080
10% ENG. & CONT.	\$	10,080
TOTAL CONSTRUCTION COST	\$	110,160
10% PRELIMINARY ENGINEERING	\$	10,080
TOTAL COST *	\$	150,800

* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

COST DATA SHEET
 10% Locally Funded

Route:	LOCAL ROUTE 1124
Description:	INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD
County:	KNOX
Length:	INTERSECTION
Date:	1/25/2010

RIGHT-OF-WAY	\$	1000
UTILITY RELOCATION	\$	2400
CLEAR AND GRUBBING	\$	100
EARTHWORK	\$	1,700
PAVEMENT REMOVAL	\$	100
DRAINAGE	\$	1,500
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	5,100
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	300
TOPSOIL	\$	100
SEEDING	\$	0
SODDING	\$	300
SIGNING AND STRIPING	\$	0
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	1,380
MOBILIZATION	\$	540
CONSTRUCTION COST	\$	11,120
10% ENG. & CONT.	\$	1,120
TOTAL CONSTRUCTION COST	\$	12,240
10% PRELIMINARY ENGINEERING	\$	1,120
TOTAL COST *	\$	16,800

* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80
Knoxville, Knox County Road Safety Audit Review



10/19/09: Looking west on Brakebill Rd. from Strawberry Plains Pk.



10/19/09: Looking south on Strawberry Plains Pk. from median

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80
Knoxville, Knox County Road Safety Audit Review



10/19/09: Looking north on Strawberry Plains Pk. from Brakebill Rd.



10/19/09: Looking north onto Strawberry Plains Pk. from median

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80
Knoxville, Knox County Road Safety Audit Review



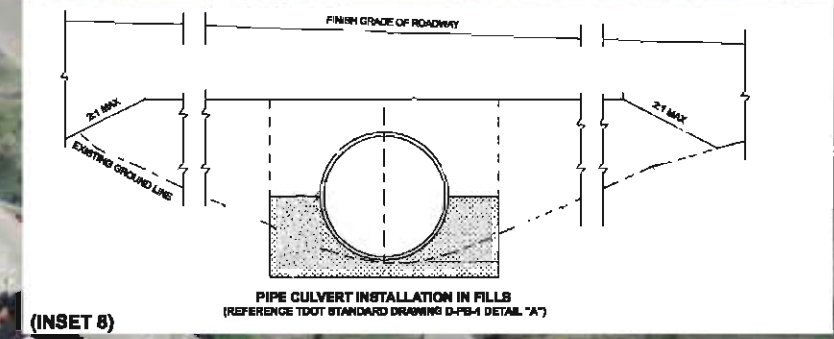
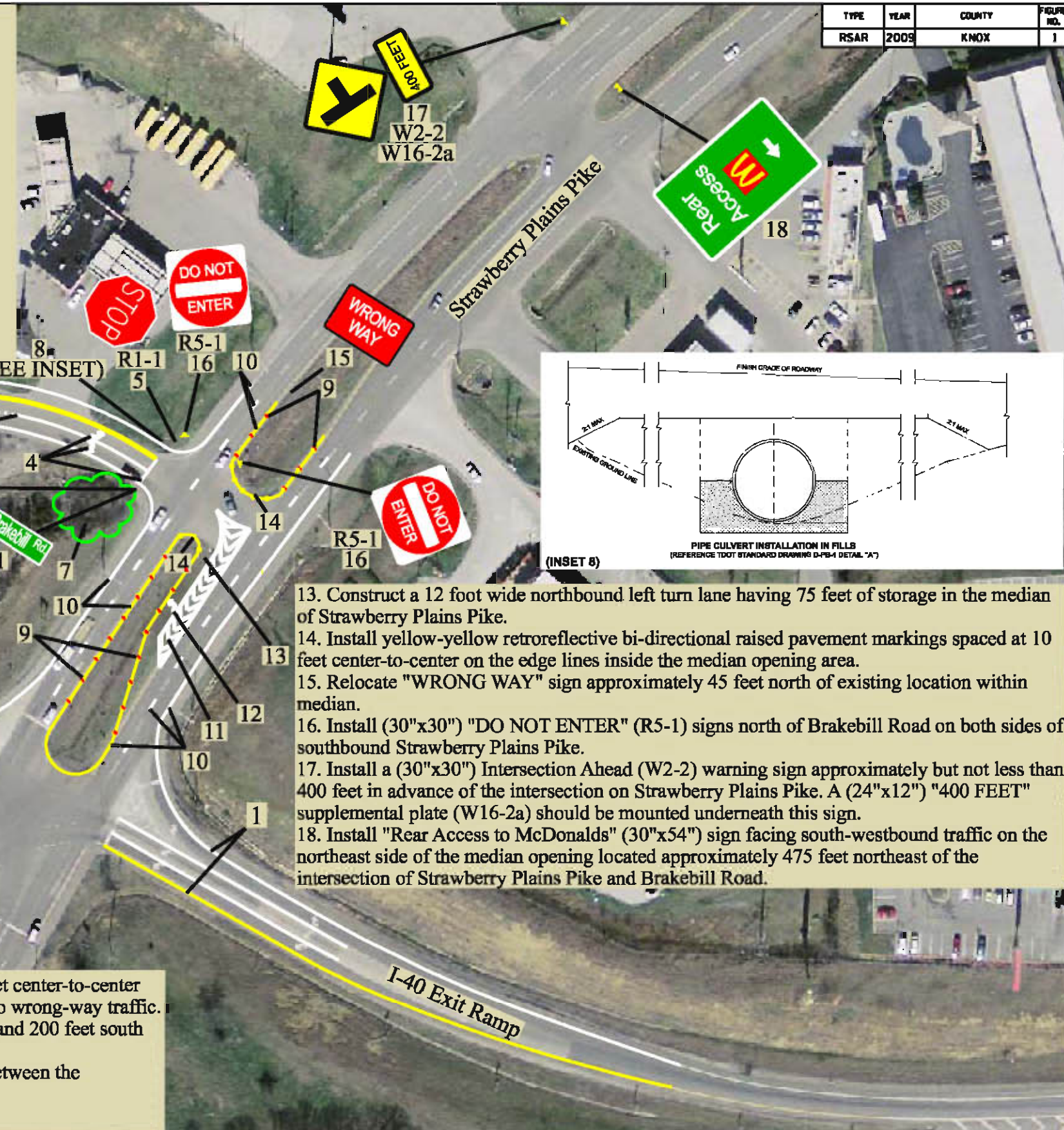
10/19/09: Looking east onto Strawberry Plains Pk. from Brakebill Rd.



10/19/09: Looking at the northern culvert opening at Brakebill Rd.

GUIDANCE

1. Restripe all edgelines along the I-40 entrance and exit ramps extending approximately 500 feet from the intersection of Strawberry Plains Pike and the I-40 ramps.
2. Install a (36"x36") Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A "400 FEET" (30"x18") supplemental plate (W16-2a) should be mounted underneath this sign.
3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
4. Install a 24" thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
5. Replace existing Stop signs with (36"x36") Stop (R1-1) signs on the Brakebill approach.
6. Install a "Brakebill Rd." Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset).



9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12" diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.

13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
14. Install yellow-yellow retroreflective bi-directional raised pavement markings spaced at 10 feet center-to-center on the edge lines inside the median opening area.
15. Relocate "WRONG WAY" sign approximately 45 feet north of existing location within median.
16. Install (30"x30") "DO NOT ENTER" (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
17. Install a (30"x30") Intersection Ahead (W2-2) warning sign approximately but not less than 400 feet in advance of the intersection on Strawberry Plains Pike. A (24"x12") "400 FEET" supplemental plate (W16-2a) should be mounted underneath this sign.
18. Install "Rear Access to McDonalds" (30"x54") sign facing south-westbound traffic on the northeast side of the median opening located approximately 475 feet northeast of the intersection of Strawberry Plains Pike and Brakebill Road.



ROAD SAFETY AUDIT REVIEW

STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD

L.M. 8.80
KNOX COUNTY

APPENDIX



Tennessee Department of Transportation
Region 1 Traffic Office

Counted By: RH & RN
Weather:
Major: 4L div
Minor: 2L

File Name : Strawberry Plains@Brakebill
Site Code : 0000047
Start Date : 2/10/2009
Page No : 1

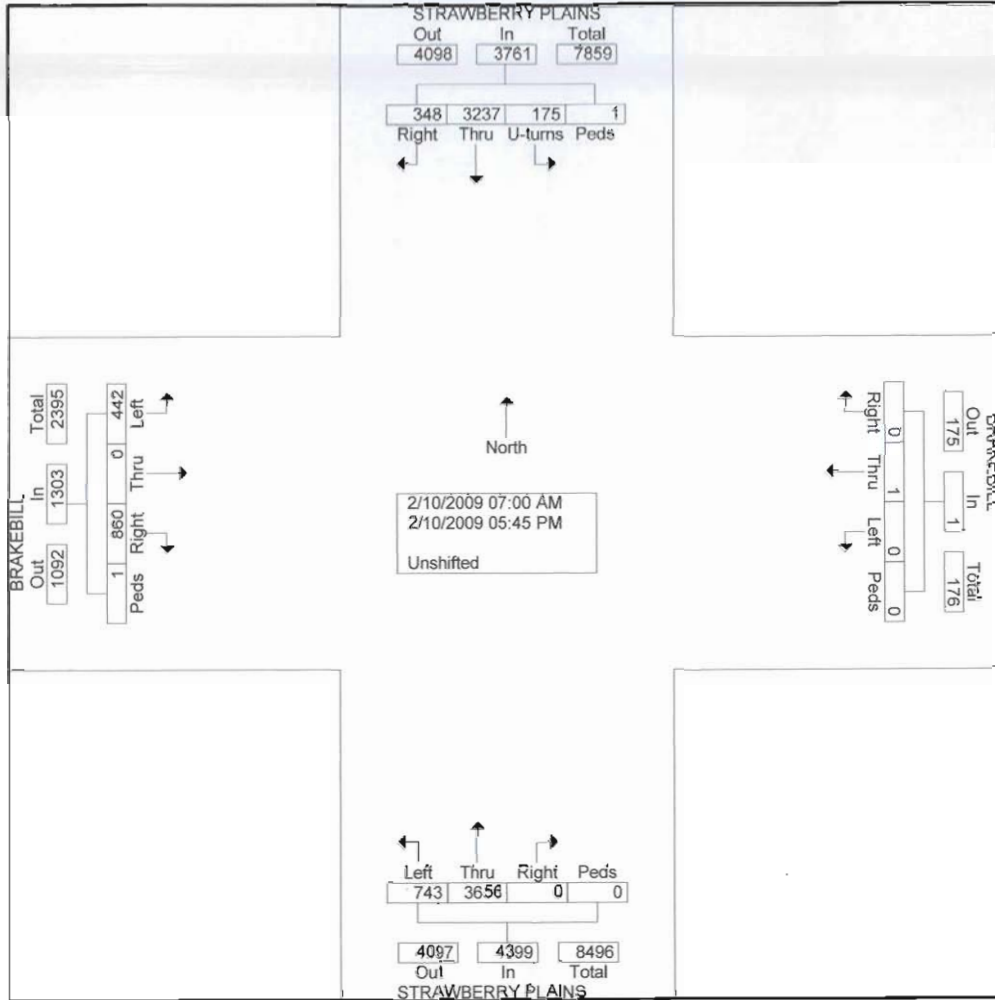
Groups Printed- Unshifted

Start Time	STRAWBERRY PLAINS Southbound					BRAKEBILL Westbound					STRAWBERRY PLAINS Northbound					BRAKEBILL Eastbound					Int. Total
	U-turns	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
07:00 AM	7	133	8	0	148	0	0	0	0	0	8	60	0	0	68	8	0	24	0	32	248
07:15 AM	4	144	19	0	167	0	0	0	0	0	19	47	0	0	66	7	0	28	0	35	268
07:30 AM	15	187	5	0	207	0	0	0	0	0	19	66	0	0	85	12	0	38	0	50	342
07:45 AM	14	156	5	0	175	0	0	0	0	0	17	79	0	0	96	12	0	39	0	51	322
Total	40	620	37	0	697	0	0	0	0	0	63	252	0	0	315	39	0	129	0	168	1180
08:00 AM	15	136	8	0	159	0	0	0	0	0	11	104	0	0	115	12	0	20	0	32	306
08:15 AM	8	123	4	0	135	0	0	0	0	0	13	70	0	0	83	8	0	20	0	28	246
08:30 AM	9	98	8	0	115	0	0	0	0	0	18	80	0	0	98	9	0	50	0	59	272
08:45 AM	5	101	9	0	115	0	0	0	0	0	11	64	0	0	75	11	0	31	0	42	232
Total	37	458	29	0	524	0	0	0	0	0	53	318	0	0	371	40	0	121	0	161	1056
11:00 AM	2	83	17	0	102	0	1	0	0	1	19	81	0	0	100	7	0	14	0	21	224
11:15 AM	4	76	11	0	91	0	0	0	0	0	25	72	0	0	97	16	0	23	0	39	227
11:30 AM	0	75	9	0	84	0	0	0	0	0	25	84	0	0	109	13	0	17	0	30	223
11:45 AM	4	74	15	0	93	0	0	0	0	0	15	79	0	0	94	3	0	29	0	32	219
Total	10	308	52	0	370	0	1	0	0	1	84	316	0	0	400	39	0	83	0	122	893
12:00 PM	9	70	13	0	92	0	0	0	0	0	21	92	0	0	113	17	0	17	0	34	239
12:15 PM	8	106	6	0	120	0	0	0	0	0	17	93	0	0	110	15	0	30	0	45	275
12:30 PM	7	92	14	0	113	0	0	0	0	0	15	89	0	0	104	17	0	21	0	38	255
12:45 PM	3	71	10	1	85	0	0	0	0	0	21	99	0	0	120	18	0	23	0	41	246
Total	27	339	43	1	410	0	0	0	0	0	74	373	0	0	447	67	0	91	0	158	1015
02:00 PM	5	75	10	0	90	0	0	0	0	0	15	87	0	0	102	17	0	28	1	46	238
02:15 PM	1	90	12	0	103	0	0	0	0	0	21	119	0	0	140	12	0	29	0	41	284
02:30 PM	3	104	14	0	121	0	0	0	0	0	15	115	0	0	130	11	0	28	0	39	290
02:45 PM	4	77	11	0	92	0	0	0	0	0	24	105	0	0	129	12	0	19	0	31	252
Total	13	346	47	0	406	0	0	0	0	0	75	426	0	0	501	52	0	104	1	157	1064
03:00 PM	6	72	9	0	87	0	0	0	0	0	27	120	0	0	147	23	0	36	0	59	293
03:15 PM	5	82	7	0	94	0	0	0	0	0	28	145	0	0	173	10	0	22	0	32	299
03:30 PM	3	100	10	0	113	0	0	0	0	0	25	137	0	0	162	16	0	27	0	43	318
03:45 PM	5	116	19	0	140	0	0	0	0	0	22	154	0	0	176	15	0	35	0	50	366
Total	19	370	45	0	434	0	0	0	0	0	102	556	0	0	658	64	0	120	0	184	1276
04:00 PM	3	92	8	0	103	0	0	0	0	0	33	131	0	0	164	17	0	30	0	47	314
04:15 PM	3	90	9	0	102	0	0	0	0	0	38	167	0	0	205	15	0	22	0	37	344
04:30 PM	5	94	18	0	117	0	0	0	0	0	33	172	0	0	205	16	0	27	0	43	365
04:45 PM	4	111	18	0	133	0	0	0	0	0	23	231	0	0	254	14	0	22	0	36	423
Total	15	387	53	0	455	0	0	0	0	0	127	701	0	0	828	62	0	101	0	163	1446
05:00 PM	4	100	15	0	119	0	0	0	0	0	47	170	0	0	217	16	0	32	0	48	384
05:15 PM	3	96	7	0	106	0	0	0	0	0	42	179	0	0	221	20	0	25	0	45	372
05:30 PM	3	101	9	0	113	0	0	0	0	0	37	195	0	0	232	23	0	22	0	45	390
05:45 PM	4	112	11	0	127	0	0	0	0	0	39	170	0	0	209	20	0	32	0	52	388
Total	14	409	42	0	465	0	0	0	0	0	165	714	0	0	879	79	0	111	0	190	1534
Grand Total	175	3237	348	1	3761	0	1	0	0	1	743	3656	0	0	4399	442	0	860	1	1303	9464
Apprch %	4.7	86.1	9.3	0		0	100	0	0		16.9	83.1	0	0		33.9	0	66	0.1		
Total %	1.8	34.2	3.7	0	39.7	0	0	0	0	0	7.9	38.6	0	0	46.5	4.7	0	9.1	0	13.8	



Tennessee Department of Transportation
Region 1 Traffic Office

File Name : Strawberry Plains@Brakebill
Site Code : 00000047
Start Date : 2/10/2009
Page No : 2



TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = Knox Date: 2/2/2010
 Route = 1124
 Location = Begin Strawberry Plains Pike
 Highway Type = 4 Lane Urban
 FUNCTIONAL CLASS= U/COLL
 DATA YEARS = 01/01/2005 To 12/31/2007
 ADT YEARS USED= 2008 TRIMS
 COMMENTS =
 ANALYZED BY = MN

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE	BLM	ELM	Length	Average AADT	VMT
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0
	0.00	0.00	0.00	0	0

0.00 0 0

INTERSECTION		Leg	Traffic AADT
Log Mile =	8.8	North =	6,420
		East =	0
		South =	6,420
		West =	500
		Entering AADT =	6,670

2008 Trims

4 Lane Urban
 01/01/2005 To 12/31/2007

	Total	Fatal	Incap. Injury	*Severe Crashes	Other Injury
No. of Crashes =	17	0	1	1	2
No. of Years =	3				
SW avg. rate =	0.190	0.001	0.005	0.006	0.047
05-07 S/W Rates					
Exposure (E) =	7.3037				
Crash Rate (A) =	2.328	0.000	0.137	0.137	0.274
Critical Rate (C) =	0.634				
Severity Index (SI) =	0.2353				
Actual Rate/SW Average =	12.25	0.00	27.38	22.82	5.83
Ratio of A/C =	3.67				

* Severe Crashes are the sum of fatal and incapacitating injury crashes

Intersection of Strawberry Plains Pike and Brakebill Rd. Crash Summary 2005-2007

Collision Type	Cause	Number of Crashes	Total	Percent of Total
Rear End	Stopped Quickly	5	6	35%
	Distracted	1		
	Hydroplane	0		
Right Angle	Pulled in Front	8	10	59%
	Distracted	1		
	Wreckless	1		
Head on	Wreckless	1	1	6%
Total Crashes		17		

Damage	Number of Crashes	Percentage of Total
Property Damage	15	88%
Injury	1	6%
Incapacitating Injury	1	6%
Fatality	0	0%
Total	17	

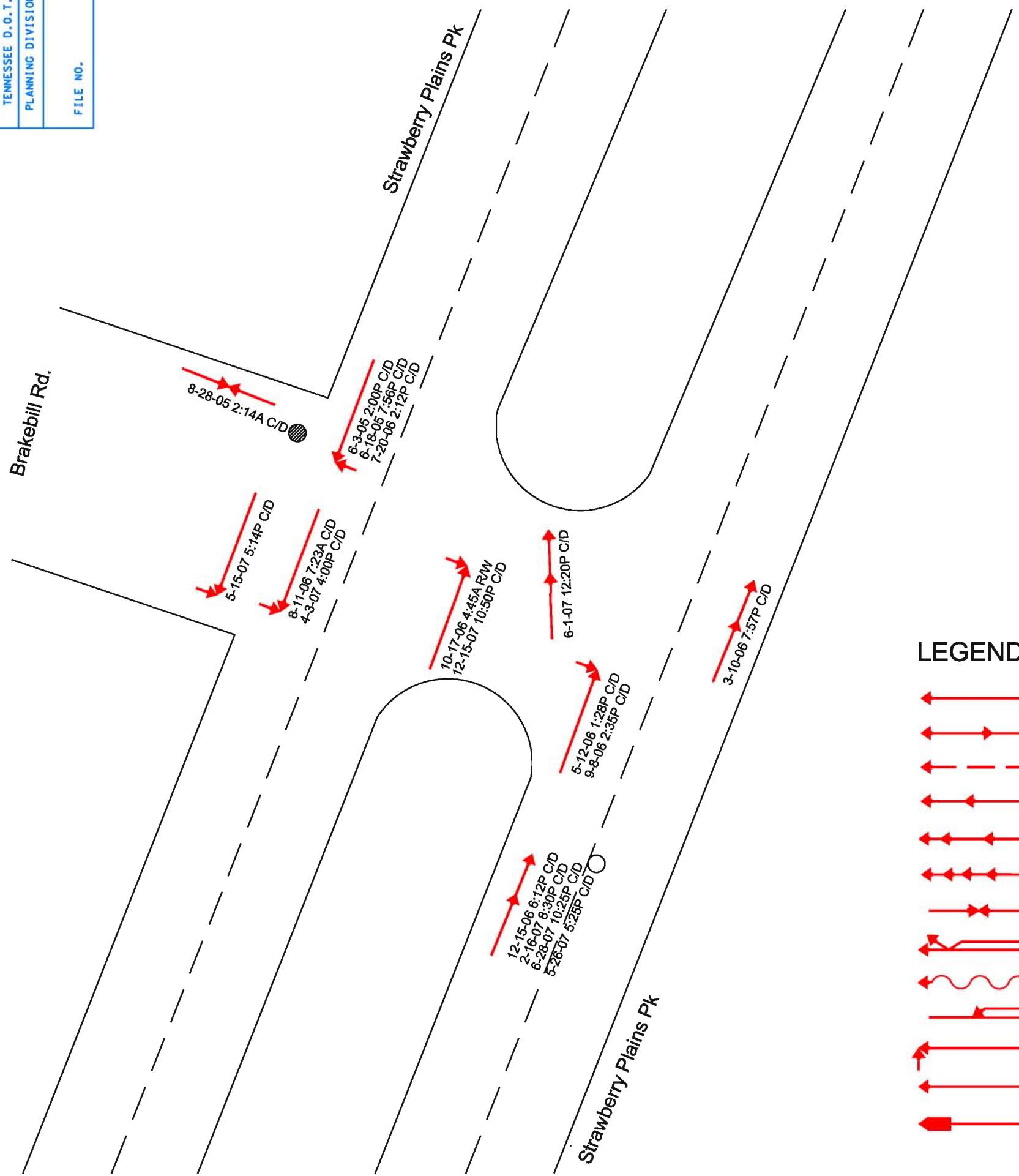
Time of Day	Number of Crashes	Percentage of Total
Day	12	71%
Night	5	29%
Total	17	

Conditions	Number of Crashes	Percentage of Total
C/D	16	94%
R/W	1	6%
Fog	0	0%
Total	17	

State Wide Average Crash Rating	Ra	0.19
Intersection Actual Accident Rate	R	2.6
Intersection Critical Accident Rate	Rc	0.63
Severity Index	SI	0.21
Ratio	R/Rc	4.1

LOCATION Strawberry Plains Pk/ Brakebill Rd.
 CITY Knoxville COUNTY Knox
 PERIOD COVERED 2005 to 2007
 DATE COMPLETED 10/8/09
 PREPARED BY RPM Transportation Consultants, LLC

TYPE	YEAR	PROJECT NO.	SHEET NO.
RSAR	2009		



NUMBER OF ACCIDENTS			
15	PROPERTY DAMAGE		
1	INCAPACITATING INJURY		
1	OTHER INJURY		
0	FATALITY		
17	TOTAL ACCIDENTS		

DAY	DRY	
	NIGHT	WET
12	5	1

LEGEND

- MOVING VEHICLE
- BACKING VEHICLE
- PEDESTRIAN
- REAR END
- THREE CAR REAR END
- FOUR CAR REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- RIGHT ANGLE
- AUTOMOBILE
- HEAVY TRUCKS & BUSESSES

LEGEND

- FATAL ACCIDENT
 - INCAPACITATING INJURY
 - INJURY ACCIDENT
 - PARKED VEHICLE
 - FIXED OBJECT
 - STOP SIGN ON APPROACH
- TIME**
 A = AM P = PM
- PAVEMENT CONDITION**
 D = DRY I = ICY W = WET
- WEATHER**
 C = CLEAR F = FOG R = RAIN



NOT TO SCALE

APPENDIX O

TRAFFIC SIGNALIZATION WARRANTS



Traffic Signal Warrant Analysis

CIVIL ENGINEERING / TRAFFIC ENGINEERING

Project Name	Brakebill Road Development
Project/File #	2006
Scenario	2020 - Existing Traffic Volumes

Intersection Information	
Major Street Name	Strawberry Plains Pike
North/South or East/West	N/S
Speed Limit > 40 mph	No
# of Approach Lanes	2 or more
% of Right Turn Traffic to Include	100%
Minor Street Name	Brakebill Road
# of Approach Lanes	1
% of Right Turn Traffic to Include	100%
Isolated Community < 10,000 pop	No

Additional Warrants to Consider	
Warrant 3, Peak Hour (A - Volume and Delay)	No
All-Way Stop Warrant	No



Traffic Signal Warrant Analysis

CIVIL ENGINEERING TRAFFIC ENGINEERING

Strawberry Plains Pike (Major Street) Volume

Northbound Volume by Hour				
Time	Left + U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	58	384		
8 - 9 AM	58	337		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	74	423		
12 - 1 PM	95	467		
1 - 2 PM				
2 - 3 PM	86	484		
3 - 4 PM	107	602		
4 - 5 PM	146	733		
5 - 6 PM	158	749		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,961	0

Southbound Volume by Hour				
Time	U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	40	746	37	
8 - 9 AM	35	537	30	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	17	417	40	
12 - 1 PM	30	449	54	
1 - 2 PM				
2 - 3 PM	10	386	50	
3 - 4 PM	27	462	56	
4 - 5 PM	17	457	59	
5 - 6 PM	11	458	46	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,471	0

Brakebill Road (Minor Street) Volume

Eastbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	38		146	
8 - 9 AM	26		116	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	45		108	
12 - 1 PM	60		127	
1 - 2 PM				
2 - 3 PM	63		105	
3 - 4 PM	70		112	
4 - 5 PM	60		113	
5 - 6 PM	70		129	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			1,388	0

Westbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM				
8 - 9 AM				
9 - 10 AM				
10 - 11 AM				
11 - 12 PM				
12 - 1 PM				
1 - 2 PM				
2 - 3 PM				
3 - 4 PM				
4 - 5 PM				
5 - 6 PM				
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			0	0



Traffic Signal Warrant Analysis

Warrants 1 - 3 (Volume Warrants)

Project Name	Brakebill Road Development
Project/File #	2006
Scenario	2020 - Existing Traffic Volumes

Intersection Information			
Major Street (N/S Road)	Strawberry Plains Pike	Minor Street (E/W Road)	Brakebill Road
Analyzed with	2 or more approach lanes	Analyzed with	1 Approach Lane
Total Approach Volume	9432 vehicles	Total Approach Volume	1388 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	0 percent applied	Right turn reduction of	0 percent applied

No speed or isolated community reduction applied to the warrant thresholds

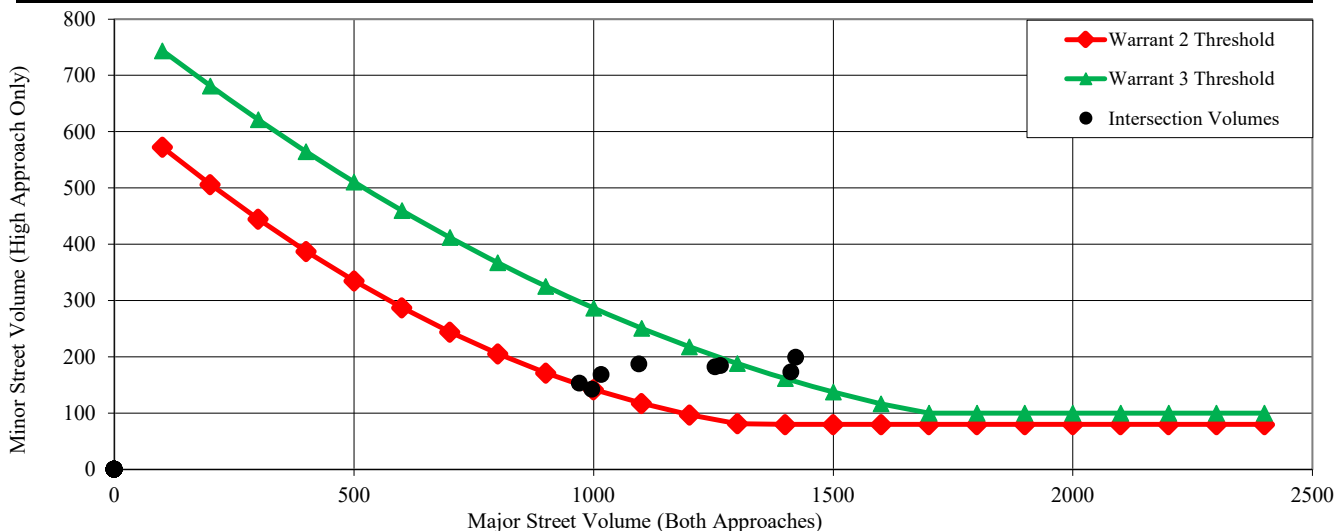
Warrant 1, Eight Hour Vehicular Volume			
	Condition A	Condition B	Condition A+B*
Condition Satisfied?	Not satisfied	Satisfied	Satisfied
Required values reached for	7 hours	8 hours	8 (Cond. A) & 8 (Cond. B)
Criteria - Major Street (veh/hr)	600	900	480 (Cond. A) & 720 (Cond. B)
Criteria - Minor Street (veh/hr)	150	75	120 (Cond. A) & 60 (Cond. B)

* Should be applied only after an adequate trail of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Warrant 2, Four Hour Vehicular Volume	
Condition Satisfied?	Satisfied
Required values reached for	7 hours
Criteria	See Figure Below

Warrant 3, Peak Hour Vehicular Volume		
	Condition A	Condition B
Condition Satisfied?	Not Examined	Satisfied
Required values reached for		2 hours
Criteria - Total Approach Volume (veh in one hour)		See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)		
Criteria - Minor Street High Side Delay (veh-hrs)		

Figure 4C-1 (Warrant 2) & Figure 4C-3 (Warrant 3)





Traffic Signal Warrant Analysis

CIVIL ENGINEERING / TRAFFIC ENGINEERING

Project Name	Brakebill Road Development
Project/File #	2006
Scenario	2020 - Existing Traffic Volumes

Intersection Information	
Major Street Name	Strawberry Plains Pike
North/South or East/West	N/S
Speed Limit > 40 mph	No
# of Approach Lanes	2 or more
% of Right Turn Traffic to Include	100%
Minor Street Name	Brakebill Road
# of Approach Lanes	1
% of Right Turn Traffic to Include	0%
Isolated Community < 10,000 pop	No

Additional Warrants to Consider	
Warrant 3, Peak Hour (A - Volume and Delay)	No
All-Way Stop Warrant	No



Traffic Signal Warrant Analysis

CIVIL ENGINEERING TRAFFIC ENGINEERING

Strawberry Plains Pike (Major Street) Volume

Northbound Volume by Hour				
Time	Left + U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	58	384		
8 - 9 AM	58	337		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	74	423		
12 - 1 PM	95	467		
1 - 2 PM				
2 - 3 PM	86	484		
3 - 4 PM	107	602		
4 - 5 PM	146	733		
5 - 6 PM	158	749		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,961	0

Southbound Volume by Hour				
Time	U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	40	746	37	
8 - 9 AM	35	537	30	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	17	417	40	
12 - 1 PM	30	449	54	
1 - 2 PM				
2 - 3 PM	10	386	50	
3 - 4 PM	27	462	56	
4 - 5 PM	17	457	59	
5 - 6 PM	11	458	46	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,471	0

Brakebill Road (Minor Street) Volume

Eastbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	38		146	
8 - 9 AM	26		116	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	45		108	
12 - 1 PM	60		127	
1 - 2 PM				
2 - 3 PM	63		105	
3 - 4 PM	70		112	
4 - 5 PM	60		113	
5 - 6 PM	70		129	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			1,388	0

Westbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM				
8 - 9 AM				
9 - 10 AM				
10 - 11 AM				
11 - 12 PM				
12 - 1 PM				
1 - 2 PM				
2 - 3 PM				
3 - 4 PM				
4 - 5 PM				
5 - 6 PM				
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			0	0



Traffic Signal Warrant Analysis

Warrants 1 - 3 (Volume Warrants)

Project Name	Brakebill Road Development
Project/File #	2006
Scenario	2020 - Existing Traffic Volumes

Intersection Information			
Major Street (N/S Road)	Strawberry Plains Pike	Minor Street (E/W Road)	Brakebill Road
Analyzed with	2 or more approach lanes	Analyzed with	1 Approach Lane
Total Approach Volume	9432 vehicles	Total Approach Volume	1388 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	0 percent applied	Right turn reduction of	1 percent applied

No speed or isolated community reduction applied to the warrant thresholds

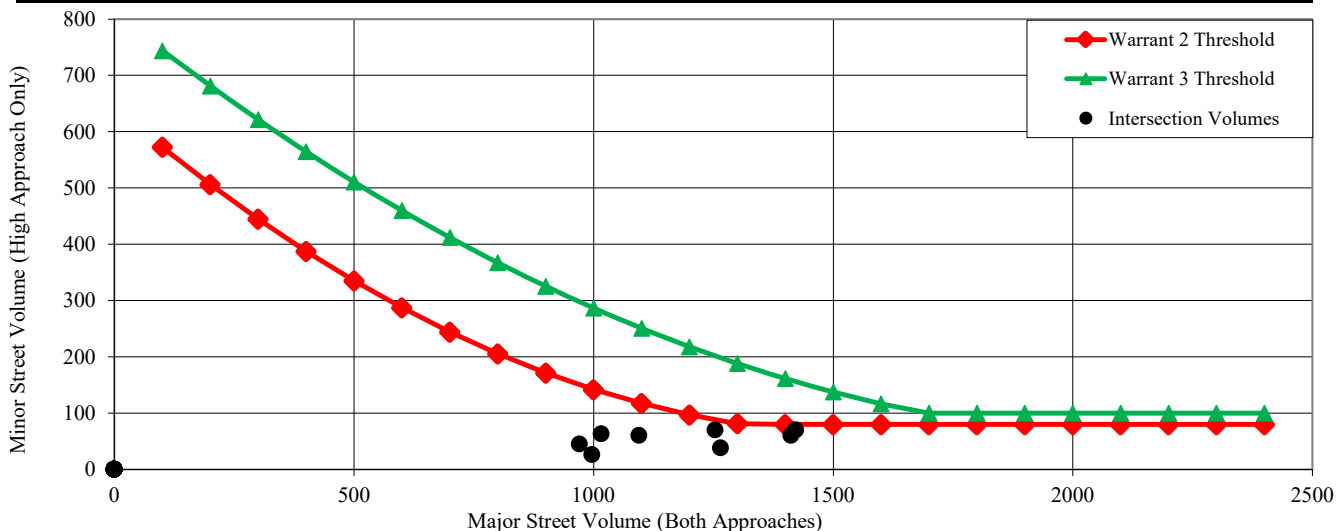
Warrant 1, Eight Hour Vehicular Volume			
Condition Satisfied?	Not satisfied	Not satisfied	Not satisfied
Required values reached for	0 hours	0 hours	0 (Cond. A) & 5 (Cond. B)
Criteria - Major Street (veh/hr)	600	900	480 (Cond. A) & 720 (Cond. B)
Criteria - Minor Street (veh/hr)	150	75	120 (Cond. A) & 60 (Cond. B)

* Should be applied only after an adequate trail of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Warrant 2, Four Hour Vehicular Volume	
Condition Satisfied?	Not satisfied
Required values reached for	0 hours
Criteria	See Figure Below

Warrant 3, Peak Hour Vehicular Volume		
Condition Satisfied?	Not Examined	Not Satisfied
Required values reached for		0 hours
Criteria - Total Approach Volume (veh in one hour)		See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)		
Criteria - Minor Street High Side Delay (veh-hrs)		

Figure 4C-1 (Warrant 2) & Figure 4C-3 (Warrant 3)



APPENDIX P

RESPONSE LETTER TO ADDRESS REVIEW COMMENTS



CIVIL ENGINEERING / TRAFFIC ENGINEERING

11812 Black Road
Knoxville, Tennessee 37932
Phone (865) 556-0042
ajaxengineering@gmail.com

August 24, 2020

PROJECT NAME: Brakebill Road Subdivision TIS

TO: Knoxville-Knox County Planning

**SUBJECT: TIS Comment Response Document for Brakebill Road Subdivision
(9-SB-20-C/9-D-20-UR)
Review Comments dated August 19, 2020**

Dear Knoxville-Knox County Planning Staff:

The following comment response document is submitted to address comments dated August 19, 2020.

- 1. Please provide figures showing all recommended improvements including possible dimensions.**

Response: Four exhibits were added to the report that highlights the major recommendations. These are located on page 68, 77, 78, and 79.

- 2. On page 1, please correct "the Knoxville-Knox County Planning Department" to "Knoxville-Knox County Planning".**

Response: On page 1, first paragraph, the "Knoxville-Knox County Planning Department" was changed to "Knoxville-Knox County Planning". This wording was also changed on Page 5 in the first paragraph.

- 3. On pages 1, 5, 19, & 39, the current site plan consists of 329 total dwelling units with 229 single-family detached units and 100 single-family attached units. However, the TIA has assumed 400 single-family detached units with an explanation that the methodology results in a more conservative approach by modeling a higher number of generated trips. The chosen methodology to assume a different number of units also assumes a site plan other than the one provided, and that raises a question of the**

directional distribution of site trips. This becomes a concern regarding the intersection of Brakebill Road at Hammer Road. The projected volume of northbound left-turns during the PM Peak is getting very close to meeting the warrant for a separate left-turn lane. We recommend that the study consider only the number and type of units shown in the current site plan, and the study should be revised to reflect those changes. For the single-family attached units, please use the Knoxville-Knox County Planning "Local Apartment" rate / worksheet for the trip generation.

Response: This change was made in several places and resulted in changes throughout the document. Specifically, the study was revised to reflect that the latest site plan shows 227 detached single-family houses and 95 attached single-family houses. The revised report reflects that the detached houses would be calculated using ITE's trip rates for Land Use Code #210, and the trips for the attached houses would be calculated using the local trip rate. The discussion of the generated trips was changed on pages 1 and 39-40.

4. **On page 43 and subsequent figures, the leader to the intersection of Hammer Road at Road B should be adjusted to point to that intersection for clarity.**

Response: The leader to the intersection of Hammer Road at Road "B" was adjusted to point to the intersection. This change was made in Figures 6a, 6b, 7a, 7b, and 8 on pages 43 thru 48.

5. **On page 66 last paragraph, the existing road should be Brakebill Road instead of Hammer Road. Also change in Table of Contents.**

Response: On page 66, the last paragraph, the existing road was changed to Brakebill Road instead of Hammer Road. This was also changed in the Table of Contents.

6. **In Appendix K (turn lane warrant worksheets), the right-turn warrant evaluations for Road B at Hammer Road, the road is called Brakebill Road.**

Response: In Appendix K, the right-turn warrant evaluation for Road "B" at Hammer Road was correctly labeled.

7. **Please include an evaluation of Brakebill Road width for safety concerns from Hammer Road to Strawberry Plains Pike.**

Response: An additional section was added on page 91, titled "Brakebill Road Widths (Addendum)". This section contains photographs and road width measurements on Brakebill Road as requested.

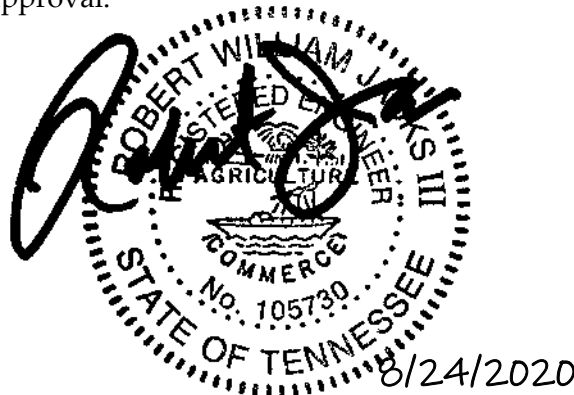
In addition to the requested revisions, other changes in the report include the following:

- Updated Title Page including owner name
- Updated Table of Contents
- Updated page footers
- Made minor grammatical changes to improve readability
- On page 1 changed company name from RP Homes to Maverick Development Group, LLC
- On page 3 and Figure 10, added recommendation to refresh pavement markings and clear vegetation at the intersection of Strawberry Plains Pike at Brakebill Road
- On page 4 and Figure 10, added recommendation to refresh pavement markings on Brakebill Road
- Updated number of housing units on page 1, 5, and 19
- Deleted recommendation for eastbound left-turn lane storage extension on Brakebill Road at Strawberry Plains Pike on page 3, 76, and Figure 10
- Revised Proposed Plan Layout, Figure 3 on page 20
- Revised Table 6 (Trip Generation) on page 39
- Updated trip generation tables in Figures 7a and 7b on pages 45 and 46
- Updated projected traffic volumes in Figures 7a, 7b, and 8 on pages 45, 46, and 48
- Updated v/c ratios in discussions on pages 49 and 68.
- Updated capacity analysis results in Tables 7a - 7c, 8a - 8c, and 11
- Added sight distance requirements to images on page 60
- Updated and revised Figure 10 on the last page
- Updated traffic volumes and capacity analysis results in Appendix G
- Added local trip rates to Appendix H and updated calculations
- The revised traffic movement volumes were updated in Appendix K. Also, the estimated vehicle queue lengths discussions were updated at the end of page 57, and on pages 67, 76, 77, and 78.
- Vehicle queue length results were updated on page 67, in Table 12, and Appendix M
- Added Appendix P to include this response letter

If you have any questions or further comments, please feel free to contact me at any time. I look forward to your review and approval.

Sincerely,

Ajax Engineering, LLC
Robert W. Jacks, P.E.



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