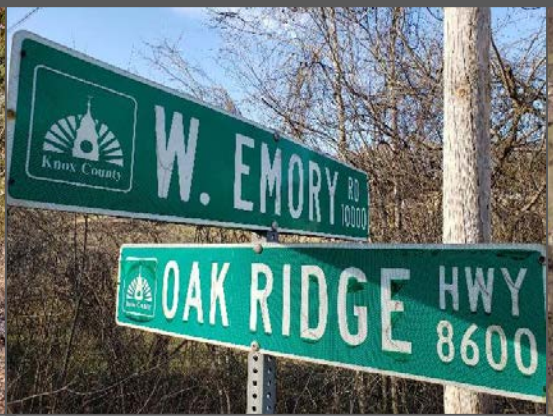
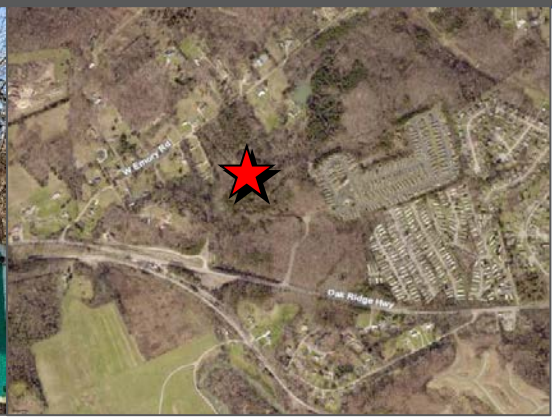
AJAX ENGINEERING

CIVIL ENGINEERING / TRAFFIC ENGINEERING

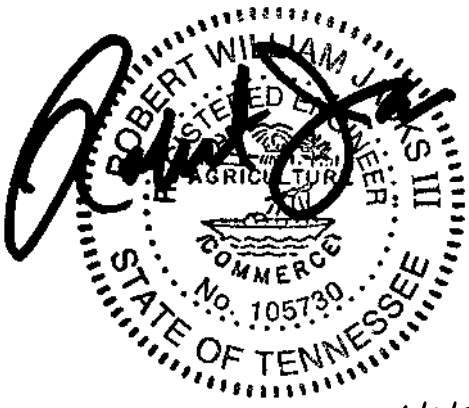
Transportation Impact Study
Pebblepass Road Subdivision
Knox County, Tennessee





April 2021

Prepared for:
M & M Partners
114 Durwood Road
Knoxville, TN 37922



4/1/2021

11812 Black Road / Knoxville, TN 37932 • (865) 556-0042 • ajaxengineering@gmail.com

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EXECUTIVE SUMMARY

Preface:

M & M Partners is proposing a residential development between West Emory Road and Oak Ridge Highway in Northwest Knox County, TN. This proposed residential development's official name has not been decided but is referred to as "Pebblepass Road Subdivision" in this study. This development will consist of a maximum of 82 single-family detached residential houses on 29.31± acres. This development is anticipated to be fully built-out and occupied by the year 2026 and will have one entrance at Pebblepass Road. This study's primary purpose is to determine and evaluate the potential impacts of the development on the adjacent transportation system. The study includes a review of the primary access roads and intersections and is a Level 1 study established by Knoxville/Knox County Planning. Recommendations and mitigation measures will be offered if transportation operations have been projected to be below recognized engineering standards.

Study Results:

The findings of this study include the following:

- At full build-out and occupancy, the Pebblepass Road Subdivision with a maximum of 82 single-family detached residential houses is calculated to generate 867 trips on an average weekday. Of these trips, 64 are estimated to occur during the AM peak hour and 84 trips in the PM peak hour in the year 2026.
- This development will have one entrance. The entrance will be on the south side of the development at an existing intersection that will be modified at Pebblepass Road and Diamondview Way. The new entrance at this existing intersection is calculated in the projected conditions to operate with minimal vehicle delays. Further to the south of the proposed development, the southbound left-turn movement on Pebblepass Road at the existing intersection with Oak Ridge Highway has been calculated to operate with high vehicle delays in the existing conditions. The same southbound left-turn movement is projected to operate with even higher delays in 2026 when the proposed development is completed. This intersection was evaluated, and it was determined not to meet Warrant #1 or #2 for a traffic signal in the existing or projected 2026 conditions. However, the intersection currently meets Warrant #3, Condition A, but TDOT does not typically install a traffic signal primarily based on Warrant #3.

Recommendations:

The following recommendations are offered based on the study analyses. The recommendations are offered to minimize the traffic impacts of the proposed development on the adjacent road system while attempting to achieve an acceptable traffic flow and safety level. The recommendations marked with an asterisk indicate an existing transportation need and are not associated with the proposed development's projected impacts.

- It is recommended that traffic counts be conducted again at the intersection of Oak Ridge Highway at Pebblepass Road when either the current pandemic has ended and overall traffic volumes return closer to pre-pandemic levels, or when it is surmised that overall traffic volumes have reached a "new normal". This will allow for a re-examination of the intersection, a re-comparison of the Traffic Signal Warrants, and establish a timeframe of if and when this intersection could be signalized. Traffic crash data should also be included in the examination. Serious consideration should be given to the transition of this intersection to a traffic signal in the future due to the potential high vehicle delays on the southbound minor approach of Pebblepass Road and high vehicle speeds on Oak Ridge Highway.
* • Intersection sight distance from Pebblepass Road at Oak Ridge Highway must not be impacted by future landscaping or signage. Looking to the west from Pebblepass Road, some existing vegetation in the northwest corner could potentially interfere with sight distance if not maintained. This vegetation should be removed and maintained in the future. A licensed land surveyor must verify the available sight distance at this location, but it appears to be adequate based on a visual review.
* • The existing double yellow centerline on Pebblepass Road is recommended to be re-applied up to the stop bar line at Oak Ridge Highway.
* • It is recommended that the white lane line that delineates the left and right-turn lanes on Pebblepass Road be extended to the white stop bar and the existing white lane line be re-applied.
* • It is recommended that the raised center concrete island and bollards be removed from Pebblepass Road near the intersection with Oak Ridge Highway and replaced with full-depth asphalt. The double yellow centerline pavement marking needs to be extended to the stop bar.
* • The existing street signage assembly needs to be modified. It is currently being held together with a bungee cord.

- While outside the scope of this study, a concern regarding the existing curbing and guardrail along Oak Ridge Highway is presented in this report. The guardrail face is located 3" - 4" outside the concrete curb's back edge. The guardrail's top edge is approximately 14" above the top of the concrete curb and 22" above the pavement. TDOT standard drawings and guidelines state that guardrails should be installed flush with the face of curbing and should be 31" above the edge of the pavement. When this guideline is not followed, there is a concern that the existing curbing on Oak Ridge Highway could potentially cause errant vehicles to launch up and over the guardrail.
- It is recommended that a Stop Sign (R1-1) and a 24" white stop bar be applied to the Diamondview Way approach pavement at the modified intersection of Pebblepass Road/Road "B" (development entrance). The stop bar should be applied at a minimum of 4 feet away from the edge of Pebblepass Road/Road "B" and should be placed at the desired stopping point that provides the maximum sight distance. An existing Stop Sign (R1-1) currently exists on this east approach of Diamondview Way but will need to be relocated after the cul-de-sac is modified to a t-intersection.
- Intersection sight distance at Diamondview Way must not be impacted by future landscaping or signage. Based on a posted speed limit of 25-mph on Pebblepass Road/Road "B", the required intersection sight distance (ISD) is 250 feet looking in each direction from Diamondview Way. Based on an assumed level grade and a posted speed limit of 25-mph, the SSD is calculated to be 155 feet for northbound and southbound vehicles on Pebblepass Road. The site designer must verify that these distances will be available.
- It is recommended that a 25-mph Speed Limit Sign (R2-1) be posted at the beginning of Road "B" off Pebblepass Road. End of roadway signage (OM4-1) should be installed at the northern end of Road "B".
- Stop Signs (R1-1) and 24" white stop bars should be installed on the new internal streets, as shown in the report.
- Sight distance at the new internal intersections in the development must not be impacted by new signage or future landscaping. With a speed limit of 25-mph in the development, the intersection sight distance requirement is 250 feet. The stopping sight distance required is 155 feet for a level road grade. The site designer should ensure that sight distance lengths are met.
- All drainage grates and covers for the residential development need to be

pedestrian and bicycle safe.

- The United States Postal Service (USPS) has implemented changes to its delivery guidelines 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. Several roads within the development have long and straight road segments. The possible need for traffic calming measures inside the development should be coordinated with Knox County Engineering and Public Works during the detailed design phase.
- The proposed lots (Lots #40, 41, 60, and 61) within the development adjacent to West Emory Road should not be allowed to have direct access.
- 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 will be located between West Emory Road to the north and Oak Ridge Highway to the south in Northwest Knox County, TN. No road access is proposed to West Emory Road to the north. Pebblepass Road is an existing road to the south that will provide access between the proposed residential development and Oak Ridge Highway. Pebblepass Road currently provides access to a 150-unit mobile home park to the east of the proposed development property. The proposed residential development will comprise four internal paved roads built for a maximum of 82 single-family residential houses on 29.31± acres. Transportation impacts associated with the proposed development were analyzed at the following existing and proposed roadways and intersections, where the most significant impact is expected and as requested by Knoxville/Knox County Planning:

- Oak Ridge Highway (SR 62) at Pebblepass Road
- Pebblepass Road/Road "B" (development entrance) at Diamondview Way

The proposed development entrance, Road "B", will tie into the existing cul-de-sac of Pebblepass Road and Diamondview Way.

The proposed development property is in a rural area of Northwest Knox County, TN, that is rapidly becoming more urbanized. There are many single-family residences, mobile home parks, unused/woodland properties, farm properties, and churches near this development. The proposed site property is currently undeveloped and is entirely forested.

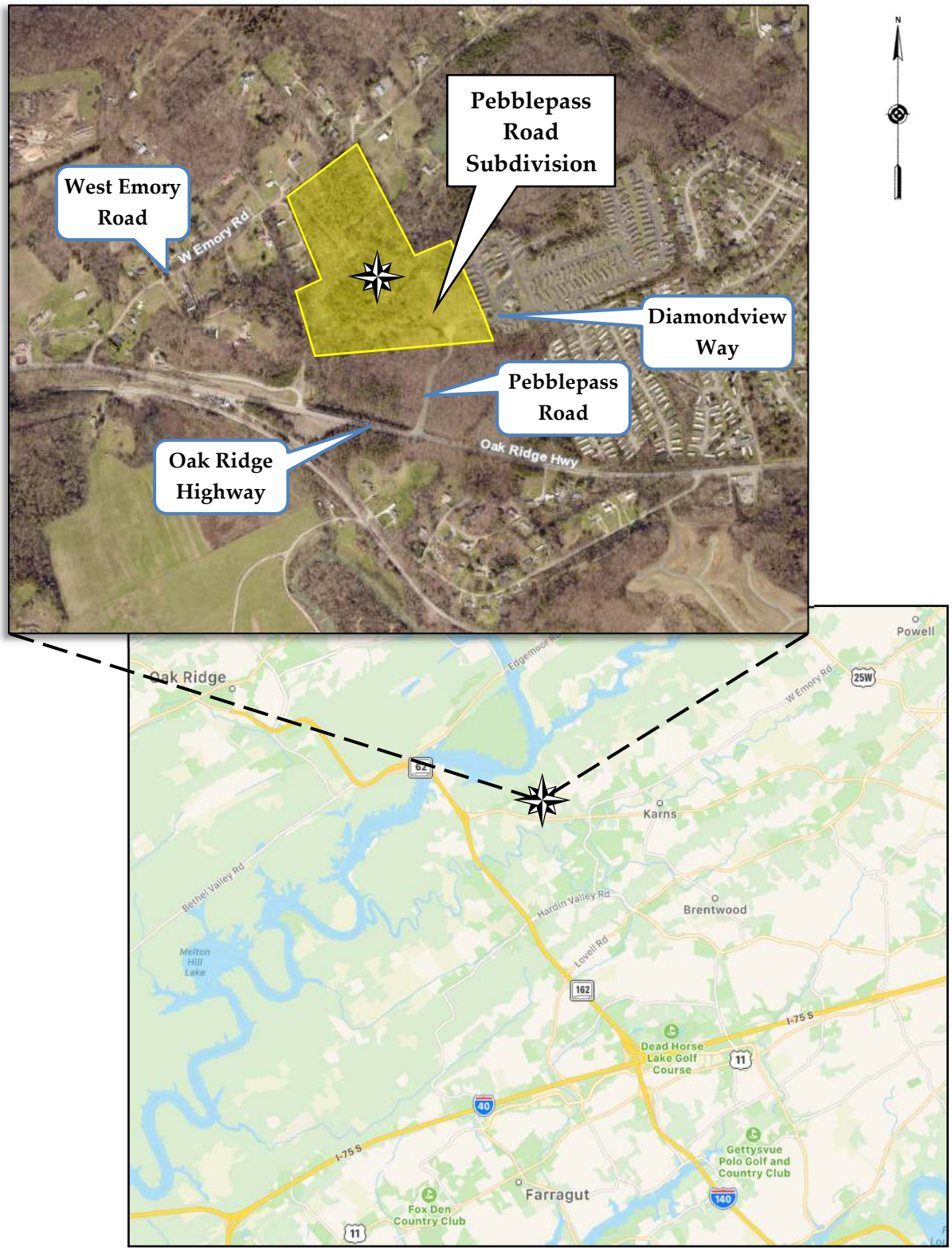


Figure 1
Location Map

- **EXISTING ROADWAYS:**

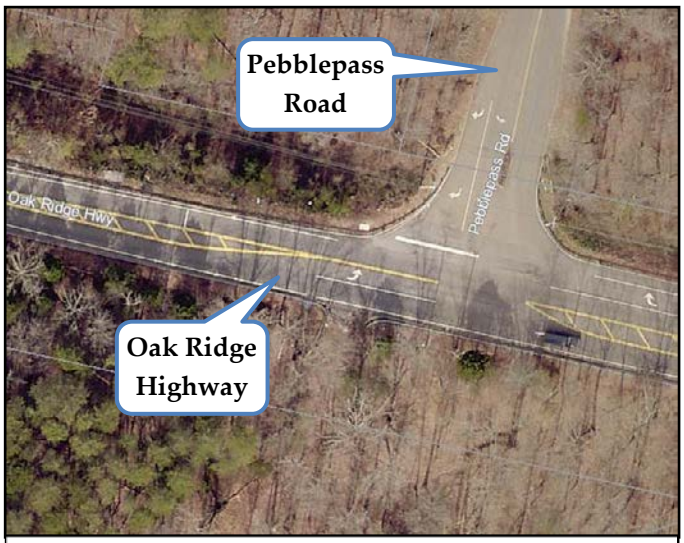
Table 1 lists the characteristics of the key existing roadways adjacent to the development property and included in the study:

TABLE 1
STUDY CORRIDOR CHARACTERISTICS

NAME	CLASSIFICATION [1]	SPEED LIMIT	LANES	ROAD WIDTH [2]	TRANSIT [3]	PEDESTRIAN FACILITIES	BICYCLE FACILITIES
Oak Ridge Highway (SR 62)	Major Arterial	55 mph	2 undivided	35 feet	None	No sidewalks along roadway	No bike lanes
Pebblepass Road	Local Street	Not Posted	2 undivided	26 feet	None	No sidewalks along roadway	No bike lanes
Diamondview Way	Local Street (Private)	15 mph	2 undivided	26 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

Oak Ridge Highway (SR 62) is a 2-lane major arterial that traverses in a generally east-west direction. According to Wikipedia, SR 62 is 89.9 miles in length and runs between Putnam County, Tennessee, and Henley Street (US 441/SR 33) in downtown Knoxville, TN. Closer to the study area, Oak Ridge Highway provides convenient access to Oak Ridge to the northwest and Pellissippi Parkway to the west, and destinations to the east towards Knoxville, TN. The posted speed limit on Oak Ridge Highway is 55 mph near Pebblepass Road.



Oak Ridge Highway (SR 62) at Pebblepass Road

At the intersection of Pebblepass Road, Oak Ridge Highway is a 2-lane highway flanked with detached concrete curb and w-beam guardrails on the roadways' edges. A separate left-turn lane and a separate right-turn lane are provided for eastbound and westbound traffic on Oak Ridge

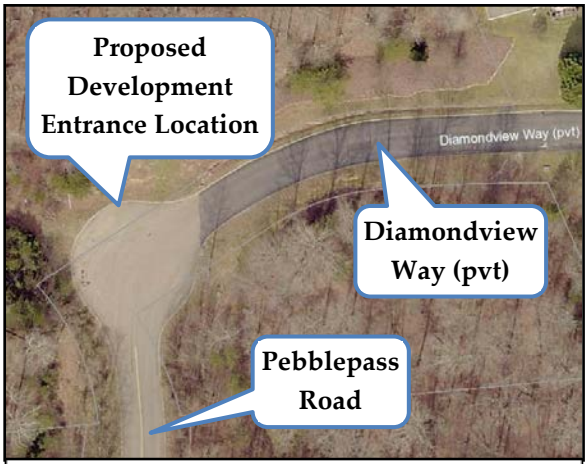
Grooved Rumble Strips on Oak Ridge Highway

Highway for turns onto Pebblepass Road. The eastbound left-turn lane provides 75 feet of storage, and the right-turn lane provides 125 feet for deceleration. Grooved pavement rumble strips are located on the white edge lines on Oak Ridge Highway on both sides. On the north side of the intersection, Pebblepass Road is controlled by a Stop Sign (R1-1) at Oak Ridge Highway. There are utility street lights on the northwest and northeast corner of the Oak Ridge Highway at Pebblepass Road intersection.

Pebblepass Road is an 800-foot long, 2-lane local street that traverses north and south between Diamondview Way and Oak Ridge Highway. Pebblepass Road currently only provides access to the Volunteer Village mobile home park. This street does not have a posted speed limit and was designed and constructed with several horizontal curves that limit vehicle speeds. Concrete detached curbs flank Pebblepass Road, and the road is 26 feet in width. Pebblepass Road has two southbound exiting lanes at Oak Ridge Highway that provides 85 feet of storage for both a separate left and right-turn lane. Pebblepass Road also has a short 18-foot center raised median that separates northbound and southbound traffic just to the north of Oak Ridge Highway. This median is 5 feet in width with detached concrete curbs, has landscape shrubs, and on each end of the median, 6" steel bollards filled with concrete. This median is 50 feet from the nearest edge of the thru lane on Oak Ridge Highway.

Raised Center Median on Pebblepass Road

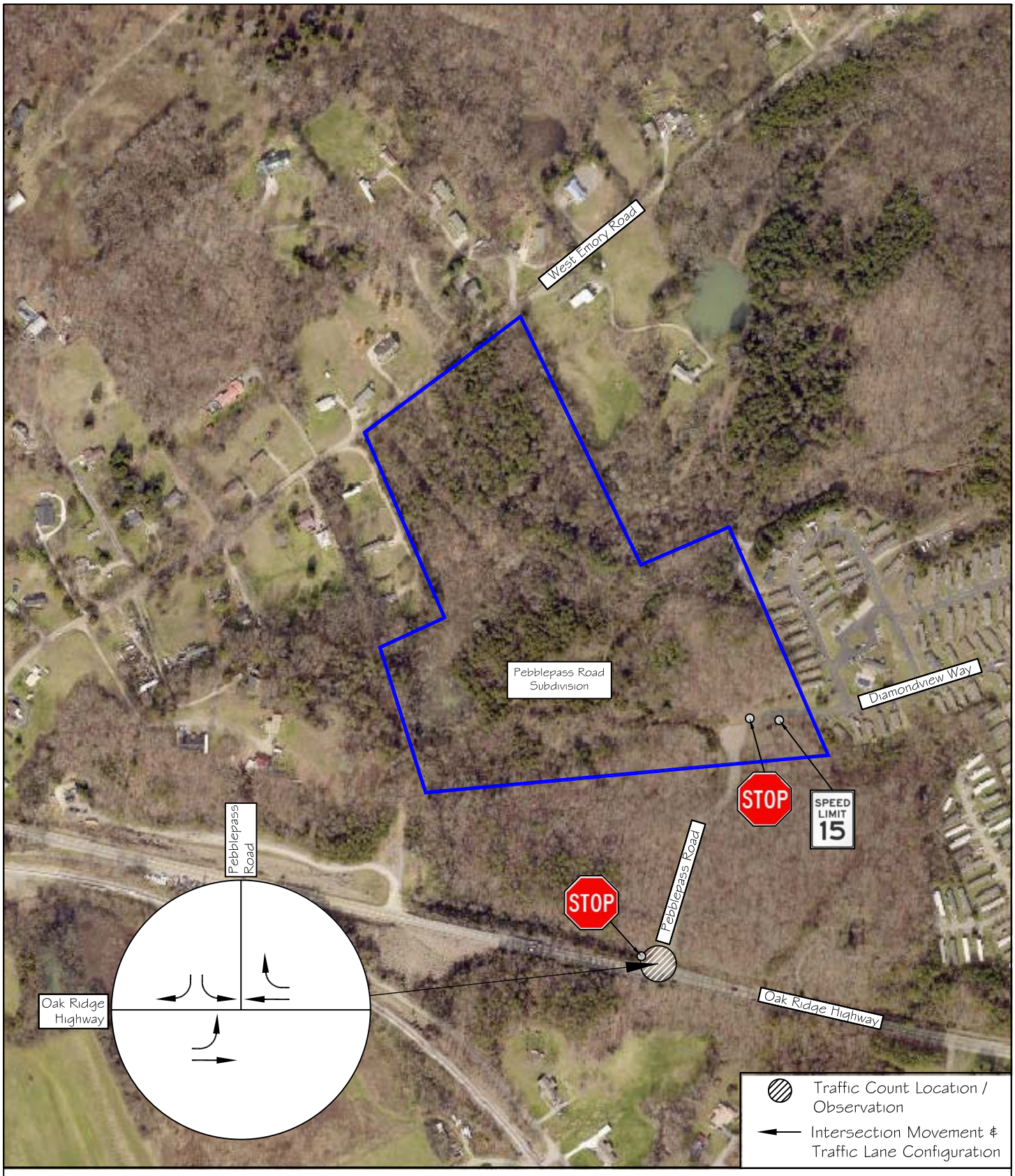
On the north side, Pebblepass Road ends at an 80-foot diameter cul-de-sac that intersects with Diamondview Way. Pebblepass Road enters the cul-de-sac on the south side, and Diamondview Way intersects from the east side. Diamondview Way is a private road and provides access to Volunteer Village, a 150-unit mobile home park. Traffic movements on Pebblepass Road at the cul-de-sac are not controlled, but Diamondview Way is controlled by at Stop Sign (R1-1). The proposed



Cul-de-Sac Intersection of Pebblepass Road at Diamondview Way

development entrance for Pebblepass Road Subdivision, Road "B", will tie into this cul-de-sac intersection on the north side. The cul-de-sac will be modified into a t-intersection.

Figure 2 shows the lane configurations of the roadways and intersection examined in the study, the study traffic count location, and traffic signage in the near vicinity. The traffic signage shown only includes warning and regulatory signage. The pages following Figure 2 give an overview of the site study area with photographs.



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

NOT TO SCALE

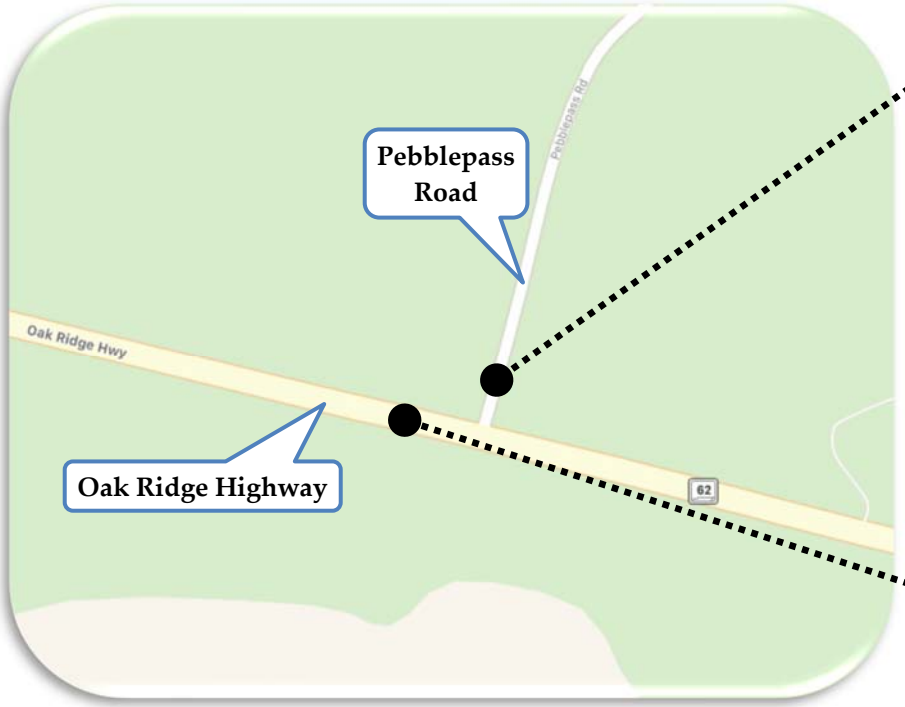
NORTH

FIGURE 2

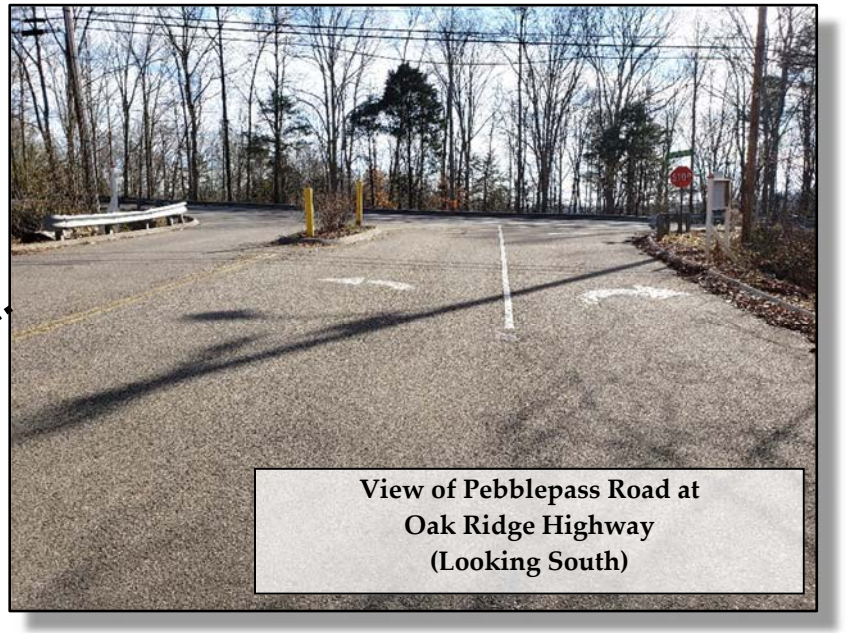
Pebblepass Road Subdivision

Traffic Count Location, Traffic Signage & Existing Lane Configurations

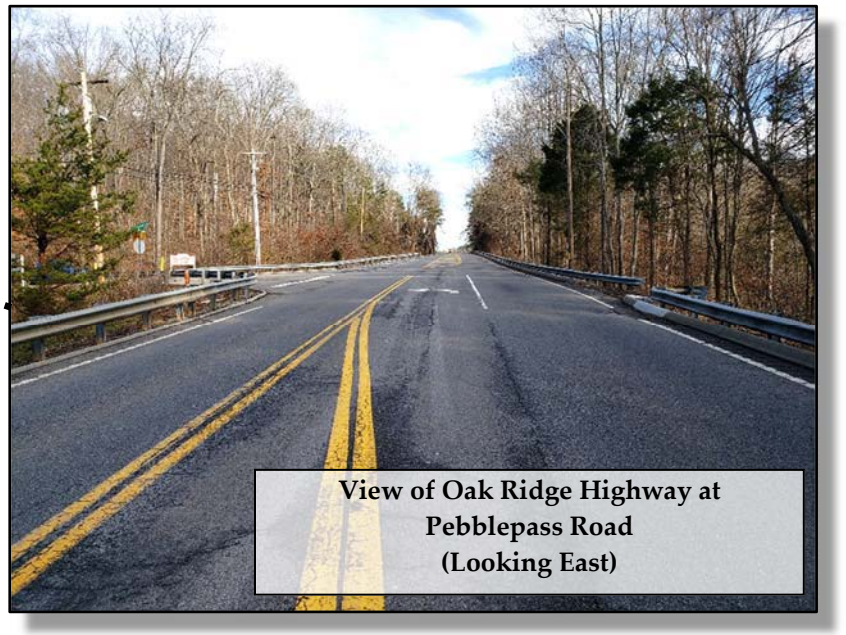
PHOTO EXHIBITS



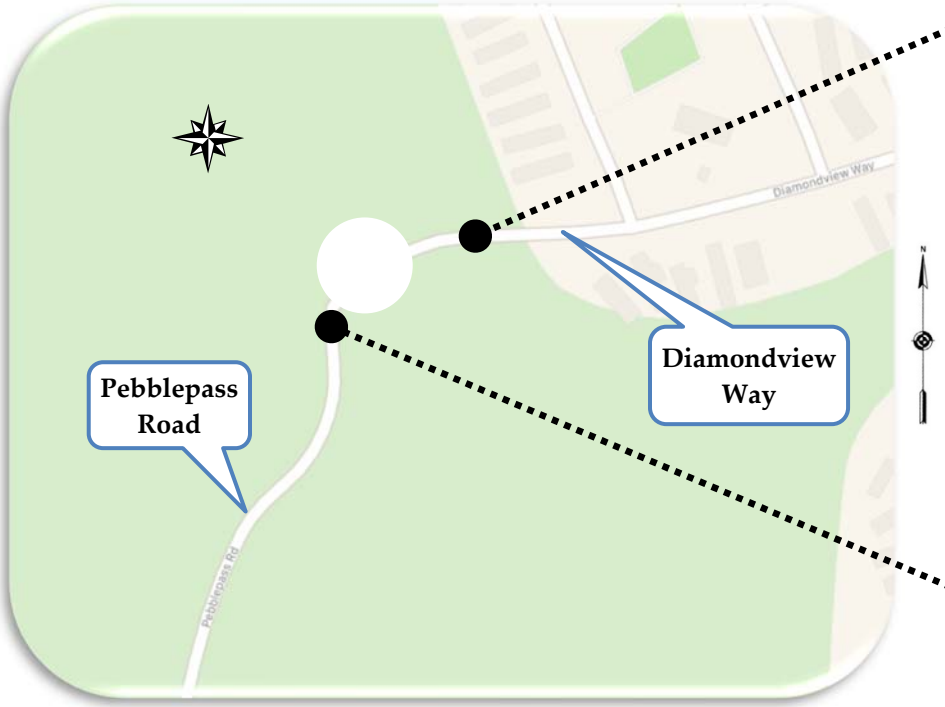
Oak Ridge Highway at Pebblepass Road



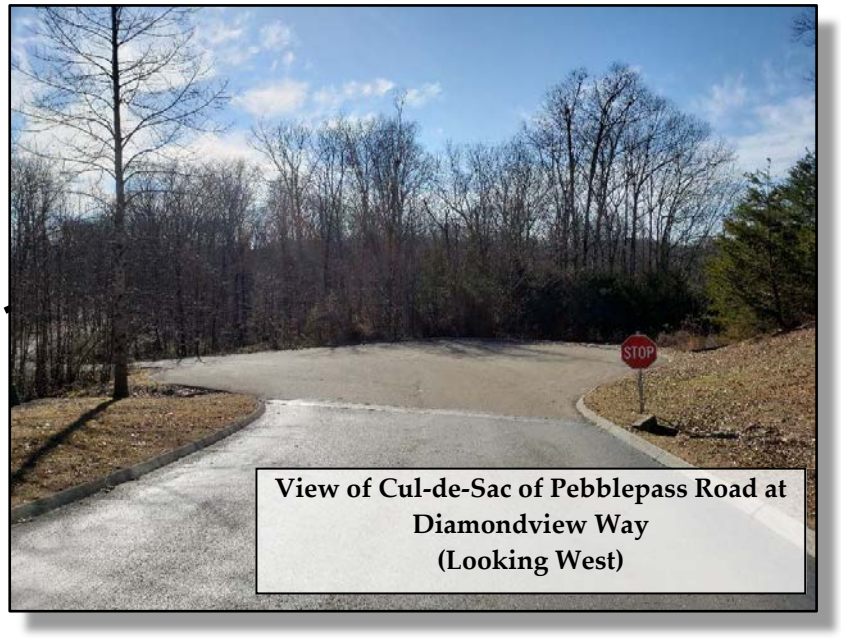
View of Pebblepass Road at Oak Ridge Highway (Looking South)



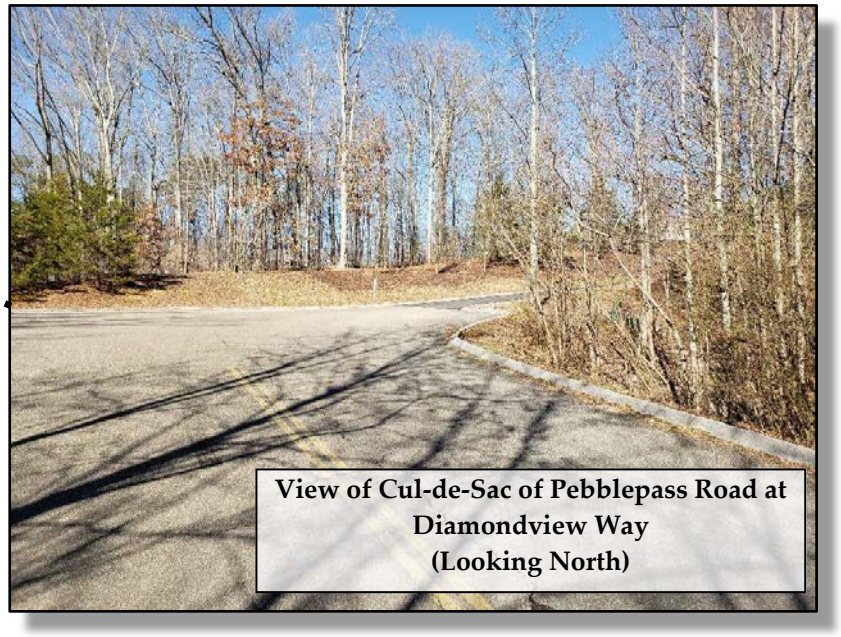
View of Oak Ridge Highway at Pebblepass Road (Looking East)



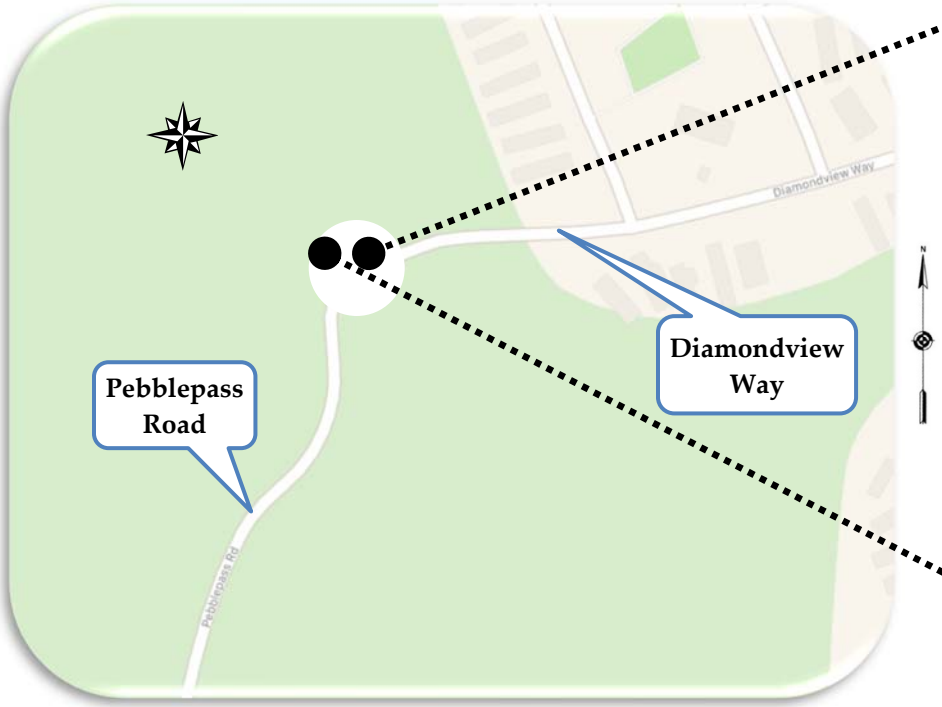
Pebblepass Road at Diamondview Way



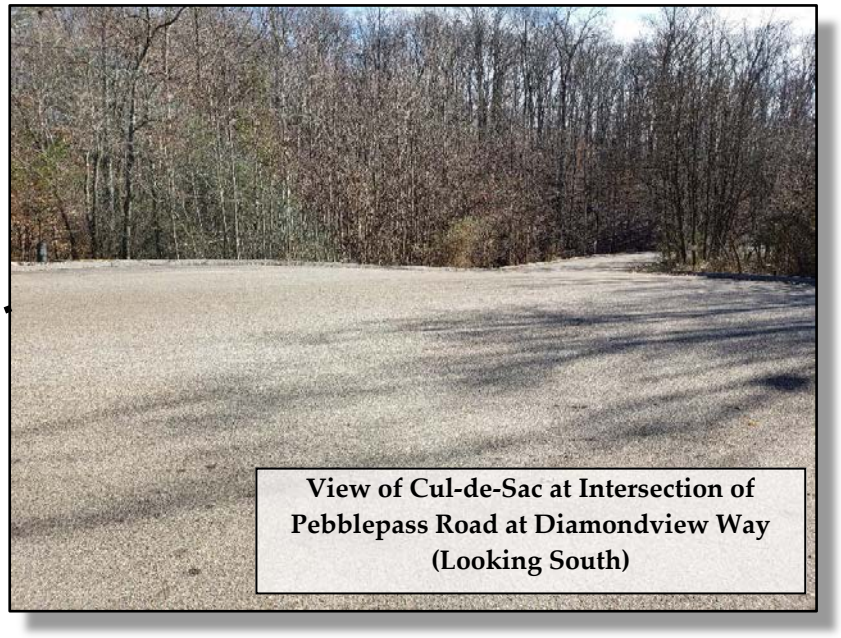
View of Cul-de-Sac of Pebblepass Road at Diamondview Way (Looking West)



View of Cul-de-Sac of Pebblepass Road at Diamondview Way (Looking North)



Pebblepass Road at Diamondview Way



View of Cul-de-Sac at Intersection of Pebblepass Road at Diamondview Way (Looking South)

View of Proposed Site (Looking Northeast)

- **EXISTING TRANSPORTATION VOLUMES PER MODE:**

There is one permanent vehicular traffic count location near the development site. This count location is conducted by the Tennessee Department of Transportation (TDOT) every year. The count location data is the following:

- Existing vehicular roadway traffic:
  - TDOT reported an Average Annual Daily Traffic (AADT) on Oak Ridge Highway to the east of Pellissippi Parkway and west of the project site at 10,957 vehicles per day in 2018. From 2008 – 2018, this count station has indicated a 0.2% average annual growth rate.

  The researched historical traffic count data for this report can be viewed in Appendix A.

- Existing bicycle and pedestrian volumes:

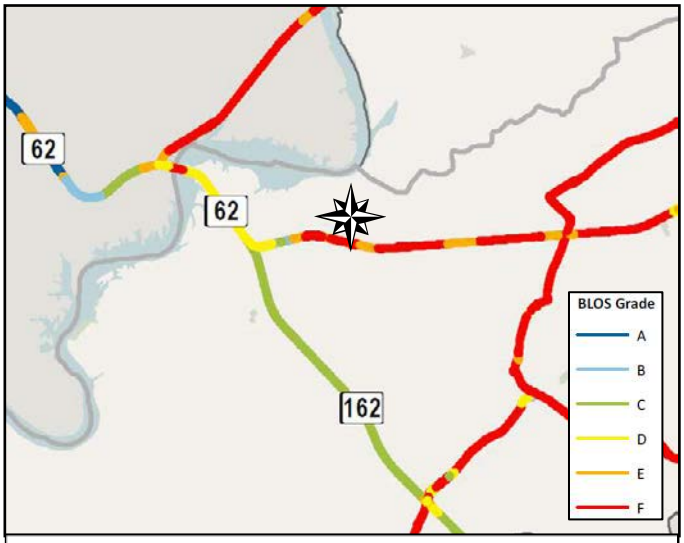
  The average daily pedestrian and bicycle traffic along and around the study area is not known. Only two pedestrians were observed at the Oak Ridge Highway at Pebblepass Road intersection during the manual traffic counts. Also, no bicyclists were observed during the manual traffic counts.

- **ON-STREET PARKING:**

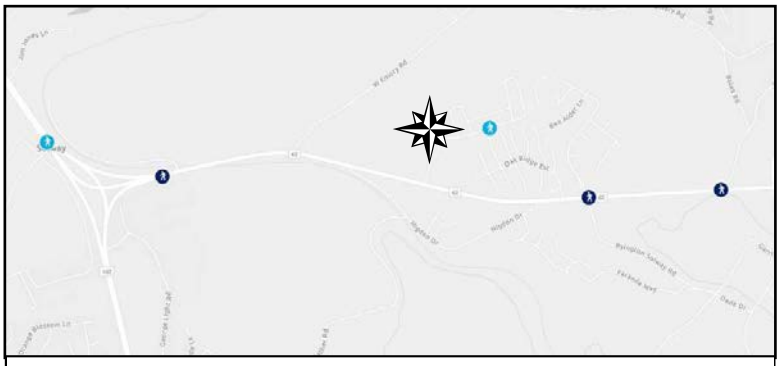
Currently, on-street parking is not allowed on any of the studied roadways adjacent to the project site.

- **PEDESTRIAN AND BICYCLE FACILITIES:**

Bicycle facilities (lanes) are not currently available within the project site study area or any studied roadways. Sidewalks are not provided either. Even though bicycle facilities are not provided on Oak Ridge Highway, TDOT has published mapping illustrating the Bicycle Level of Service (BLOS) for state routes in Knox County. BLOS is a nationally used measure of bicyclist comfort based on a roadway's geometry and traffic conditions. BLOS A designates the route as most suitable for bicyclists and BLOS F as the least suitable. The BLOS for Oak Ridge Highway in the study area is shown with E and F grades.



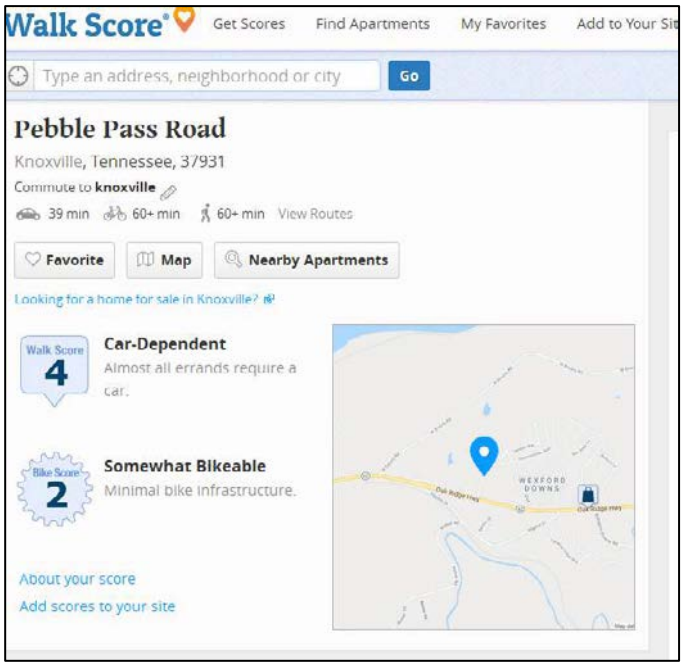
Mapping of Bicycle Level of Service (BLOS) - TDOT



Pedestrian Crashes in Study Area

The Knoxville Regional Transportation Planning Organization (TPO) provided a 2020 update to bicycle and pedestrian crash data for Knox County and a few other surrounding counties. According to the data, five of these incidents occurred within the vicinity of the study area. One occurred on Diamondview Way in the Volunteer Village mobile home park in 2013 that resulted in injuries. One occurred on Pellissippi Parkway to the north of Oak Ridge Highway and resulted in an injury. Three pedestrian crashes occurred on Oak Ridge Highway, and all resulted in fatalities. Two fatalities occurred in 2015, and one occurred in 2019. Not enough information was provided to determine the cause of any of these crashes.

- **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 property site address (Pebblepass Road). The project location is graded with a Walk Score of 4. This Walk Score indicates that the site is entirely dependent on vehicles for errands and travel. The site is graded with a Bike Score of 2, which means there is minimal bike infrastructure but is somewhat bikeable. The site is not given a transit score.

- **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 7.1 miles away to the south (by roadway) at the intersection of North Cedar Bluff Road at Fox Lonas Road. This KAT service is Route 16, "Cedar Bluff Connector". It operates on weekdays and 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 are also available in the study area.

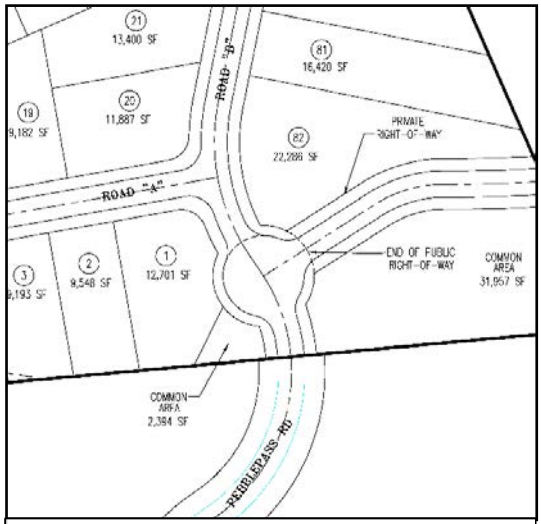
PROJECT DESCRIPTION

- **LOCATION AND SITE PLAN:**

The proposed plan layout given by Norvell & Poe is shown in Figure 3. As shown in the figure, four new streets will be constructed for the subdivision. The total length of the new streets in the subdivision will be 3,398 feet (0.64 miles).

The subdivision entrance, Road "B", will tie from the north into the existing cul-de-sac intersection of Pebblepass Road at Diamondview Way. The cul-de-sac will be re-configured as a t-intersection as part of the development, as shown below in more detail.

The 29.31-acre residential development will incorporate six common areas, with some used to contain stormwater facilities. The common areas will include a total of 5.7 acres. Many of the common areas will include an existing creek and 50' buffer that bisects the property. The largest common area will include a short walking trail and dog park. The development property is currently composed of a single parcel, with a portion of the parcel existing on the south side of the existing cul-de-sac. This small area on the south side is 0.73 acres in size and will remain as an undeveloped common area.



Transition of Cul-de-Sac to T-Intersection

As shown in Figure 3, Road "B" will terminate abruptly at the project property limits at the adjacent property to the north and east. This road termination indicates that future residential development may occur on the vacant property to the northeast, but a determination has not been made at this time. This decision will be dependent on the willingness of the adjacent property owner, the future real estate market, and other market forces. Nevertheless, Road "B" will be constructed as if future development may occur sometime in the future.

The single-family residential detached lots will average between 8,500 -10,500 square feet (~0.20 acre - 0.24 acre) in size, with a few lots up to nearly a half-acre. Each home will have a garage and driveway. Concrete sidewalks are not proposed for this development.

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, 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 (2026).

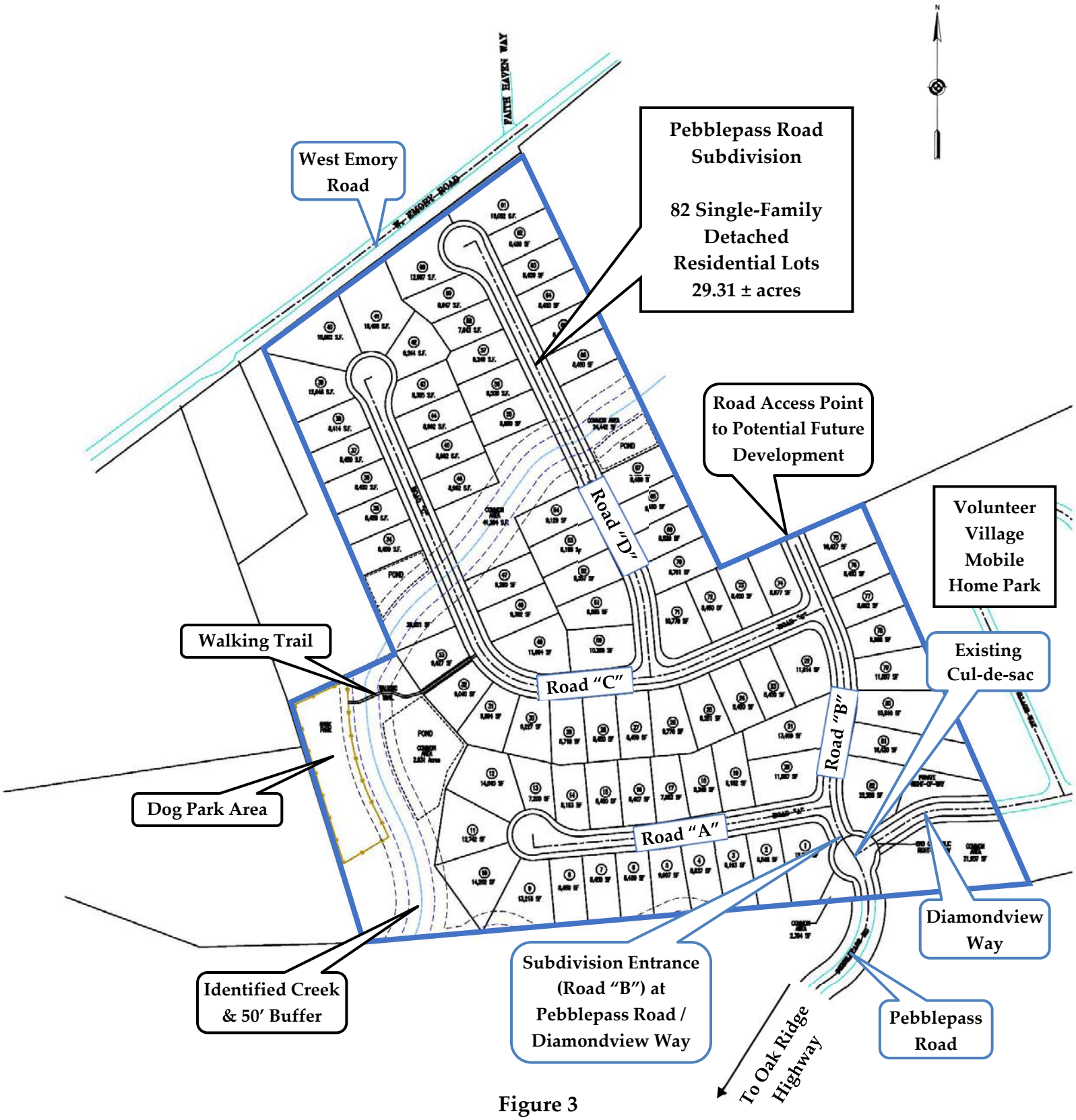


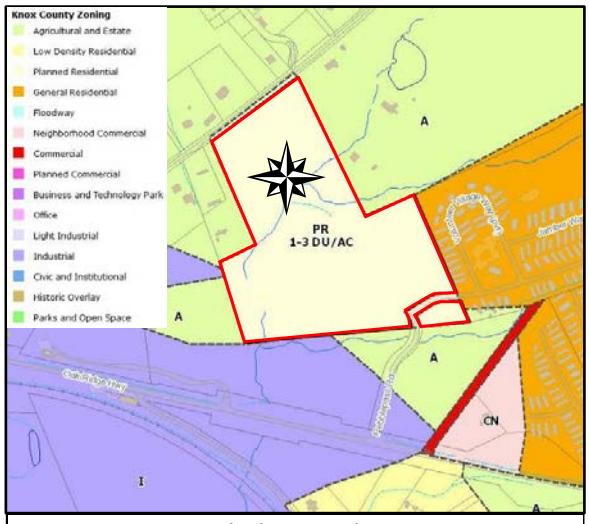
Figure 3
Proposed Plan Layout
Pebblepass Road Subdivision

Not to Scale

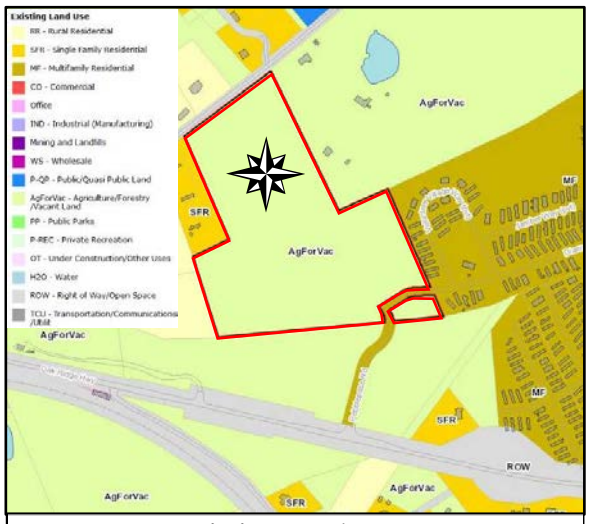
- **PROPOSED USES AND ZONING REQUIREMENTS:**

The development property parcel is zoned as Planned Residential (PR) with a density of 1 – 3 dwelling units per acre. The most recent published zoning map is provided in Appendix D. The Planned Residential (PR) zone allows for various land uses primarily within the residential realm. Uses permitted in this zone include single-family dwellings, duplexes, and multi-dwelling structures and developments. The existing adjacent surrounding zoning and land uses are the following:

- All the properties to the north, west, and northeast are in the Agricultural (A) zone except for a narrow sliver portion of a single property to the west. This property to the west is zoned as Agricultural (A), with the narrow sliver portion zoned as Industrial (I). These properties have land uses consisting of agricultural/forestry/vacant land, single-family residences, and rural residential.
- To the south, a single property is zoned as Industrial (I) on the southwest side and is zoned as Agricultural (A) on the southeast side. This property to the south is fully forested and exists on both sides of Pebblepass Road.
- The property to the east comprises the Volunteer Village mobile home park and is zoned as General Residential (RB). This mobile home park has a capacity of 150 units.



Existing Zoning



Existing Land Uses

- **DEVELOPMENT DENSITY:**

The Pebblepass Road Subdivision's proposed density is based on a maximum of 82 houses on 29.31 acres. The density computes to 2.8 dwelling units per acre and is less than the maximum allowed of 3 dwelling units per acre.

- **ON-SITE CIRCULATION:**

The total length of the four new streets within the development will be 3,398 feet (0.64 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 "D". The development will have asphalt paved internal roadways and include 8" extruded concrete curbs. The lane widths internally will be 13 feet each for a total 26-foot pavement width. The street right-of-way within the development will be 50 feet. Concrete sidewalks are not being proposed along the internal roads. Knox County will maintain the streets in the subdivision after construction, and these will be dedicated public roads.

- **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. None of these other types of vehicles will impact roadway operations other than when they occasionally enter and exit the development. It is expected that curbside garbage collection services will be available for this residential subdivision. The new roads will be designed and constructed to Knox County specifications and expected to be adequate for fire protection and rescue vehicles. The subdivision's internal roadways are anticipated to accommodate the larger vehicle types and standard passenger vehicles.

TRAFFIC ANALYSIS OF EXISTING AND PROJECTED CONDITIONS

EXISTING TRAFFIC CONDITIONS:

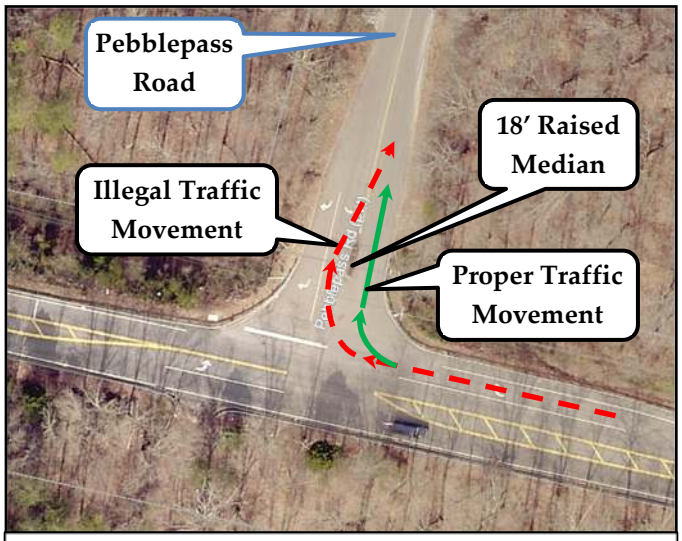
Over the past year, the Covid-19 pandemic has not only closed schools and eliminated school-related traffic, but overall general traffic has been affected due to stay-at-home orders, work layoffs, job furloughs, and general anxiety with travel outside the home. More recently, while overall travel has noticeably increased and returned closer to pre-pandemic levels in the area, there is still a potential reduction in overall travel. This reduction can be attributed to some school-age children and families choosing to learn virtually online and due to professions and jobs that have transitioned to at-home work for the time being. Knox County Planning compiled traffic count data during the Fall of 2020 and determined that overall traffic volumes were still reduced compared to Fall 2019. A few of the Fall 2020 traffic counts compiled by Knox County Planning showed slight increases in growth over the past year, but most of the counts have shown decreases ranging from 5% up to 30%.

For this study, traffic counts were conducted at the existing unsignalized intersection of Oak Ridge Highway (SR 62) at Pebblepass Road as requested by Knox County Engineering.

Manual traffic counts were obtained on Tuesday, February 9th, 2021, for a total of eight hours. The counts were conducted to tabulate the morning and afternoon peak periods. Local county public schools were in session when the traffic counts were conducted. Based on the traffic volumes counted, the AM and PM peak hour of traffic were observed at the following times:

- Oak Ridge Highway (SR 62) at Pebblepass Road
  7:15 – 8:15 AM / 4:30 – 5:30 PM

The manual tabulated traffic counts can be reviewed in Appendix E, and some observations are listed below.



Illegal Maneuver Observed at Intersection of Oak Ridge Highway at Pebblepass Road

During the manual traffic counts, one illegal traffic maneuver was observed that could have severe consequences. This observed maneuver was a westbound right-turning motorist that "over-shot" the turn and the raised center median on Pebblepass Road and entered the wrong side of the road. It is unknown if this was a one-time occurrence or occurs more often.

Also, many of the entering eastbound left-turn movements off Oak Ridge Highway were observed sharply turning onto Pebblepass Road due to rapid oncoming traffic on Oak Ridge Highway. Sharp turns could result in the front end of southbound vehicles in the left-turn lane on Pebblepass Road being clipped.

Many Knox County school buses were observed during the traffic counts. However, most of the traffic observed during the traffic counts were typical passenger vehicles with some large trucks and heavy vehicles. Large trucks and heavy vehicles were primarily observed in the thru movements on Oak Ridge Highway, but school buses were observed entering and exiting at Pebblepass Road. No bicyclists were observed during the traffic counts. One pedestrian was observed walking eastbound on the north side of Oak Ridge Highway. One pedestrian was observed walking south on Pebblepass Road to Oak Ridge Highway and returning towards the north.

As discussed earlier, Knox County Planning has determined that traffic volumes in the area are still potentially reduced due to the ongoing pandemic. At the direction of Knox County Planning, to account for potentially reduced traffic volumes due to the pandemic, this study has increased the tabulated traffic volumes by a factor of 20%. This percentage is an average value based on the local area sampling of traffic volumes comparing Fall 2019 traffic volumes with the recently obtained Fall 2020 traffic volumes. Figure 4a shows the volumes from the existing traffic counts during the AM and PM peak hours observed at the studied intersection. Figure 4b shows the volumes from the existing traffic counts during the AM and PM peak hours observed at the studied intersection increased with the 20% factor.

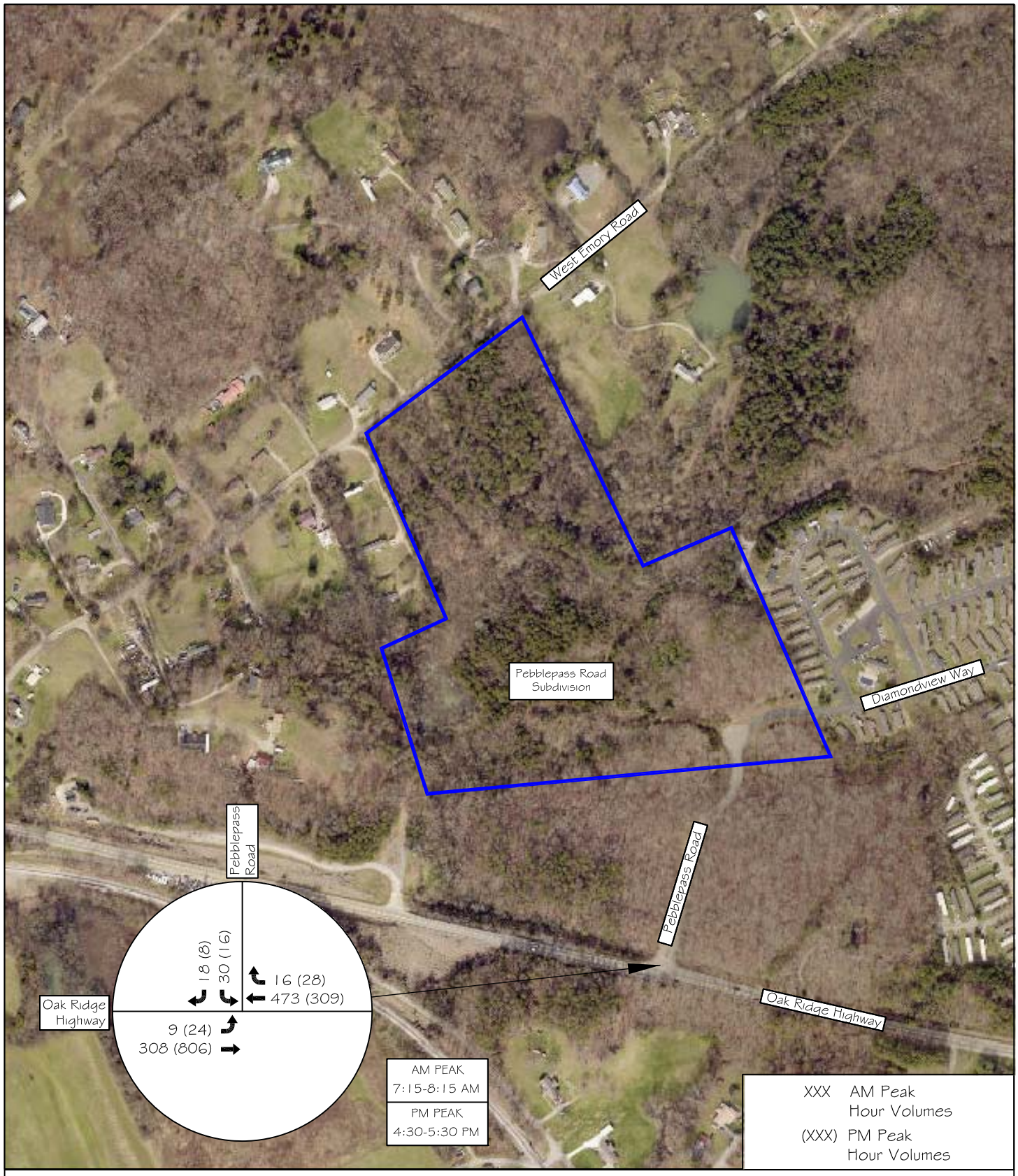


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FIGURE 4a

Pebblepass Road Subdivision

2021 Peak Hour Traffic Volumes - EXISTING TRAFFIC CONDITIONS

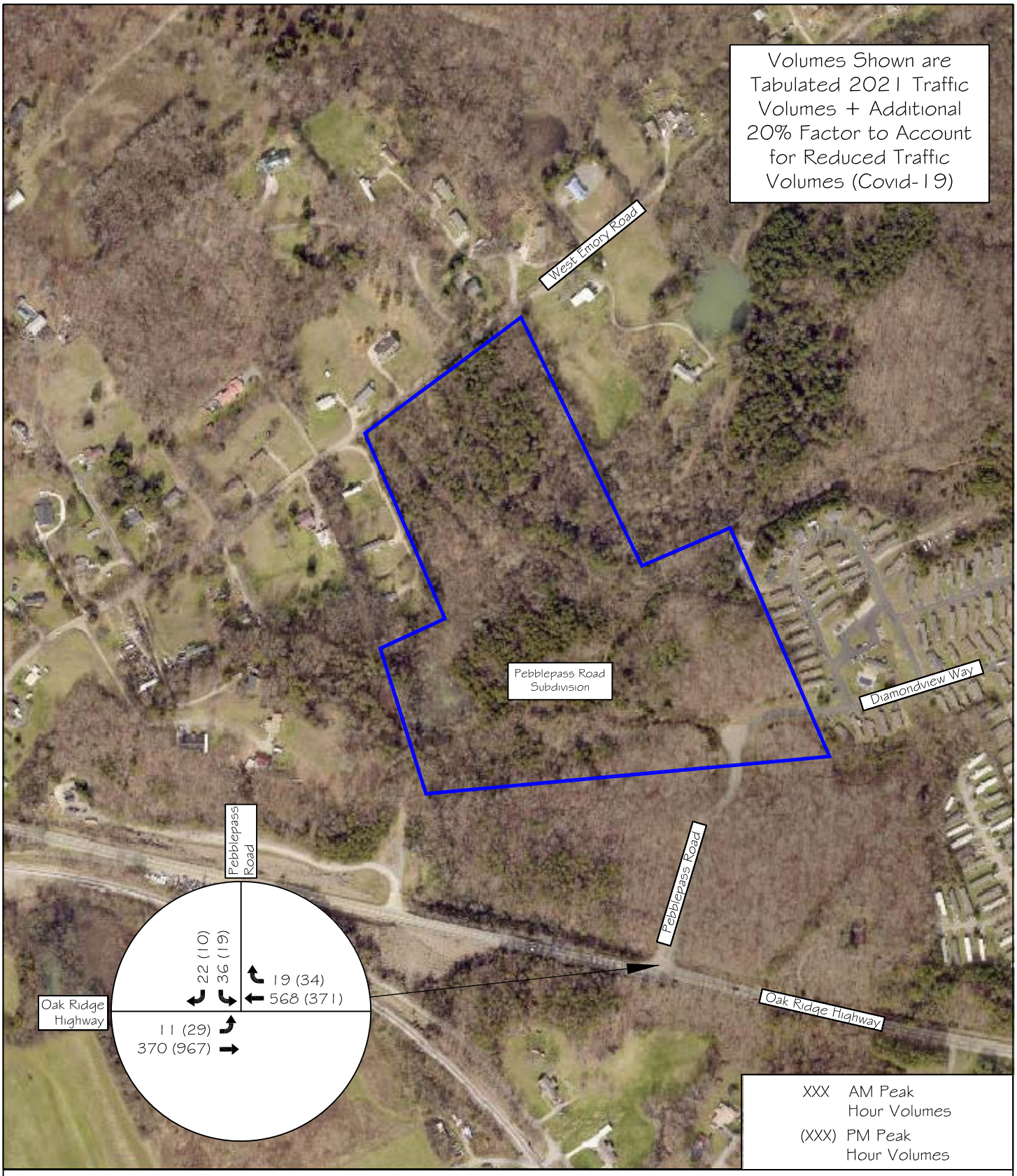

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FIGURE 4b

Pebblepass Road Subdivision

2021 Peak Hour Traffic Volumes with 20% Factor Increase - EXISTING TRAFFIC CONDITIONS

Capacity analyses were undertaken to determine the Level of Service (LOS) for the unsignalized intersection of Oak Ridge Highway at Pebblepass Road for both the existing year 2021 traffic volumes shown in Figure 4a and Figure 4b with a 20% factor increase. The capacity analyses were calculated by following the Highway Capacity Manual (HCM) methods and 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. This delay represents 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. LOS designations, 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 LOS D / LOS E boundary 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.

Capacity calculations at the intersection from the existing peak hour traffic are shown in Tables 3a and 3b. Table 3a shows the results based on the existing tabulated traffic counts. Table 3b shows the results based on the existing tabulated traffic counts with a 20% factor increase. 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. Appendix F includes the worksheets from the capacity analyses for the existing peak hour vehicular traffic.

The southbound left-turn lane of Pebblepass Road at the intersection with Oak Ridge Highway is calculated to operate adequately in the existing AM Peak Hour and poorly during the existing PM peak hour. When the traffic volumes are increased by 20%, the results indicate LOS D and LOS E with considerable vehicle delays in the AM and PM peak hour for the southbound left-turn lane. The eastbound left-turns from Oak Ridge Highway are calculated to be LOS A in the existing conditions and the existing conditions with a 20% factor increase.

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

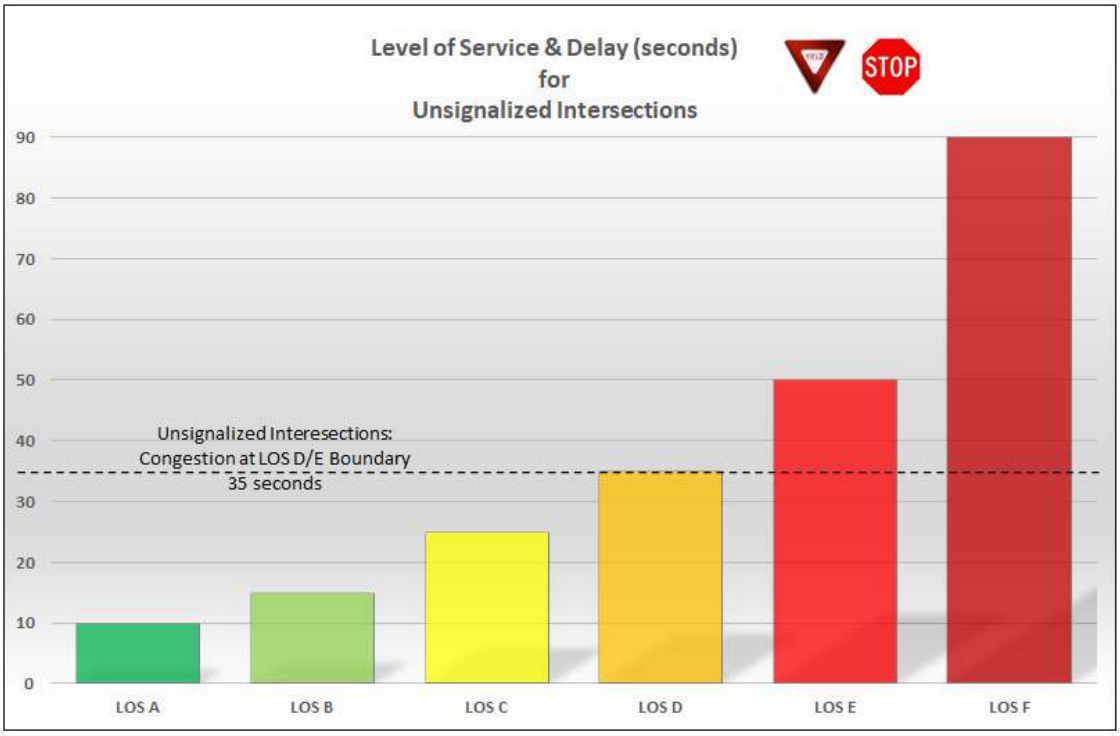


TABLE 3a
2021 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS - EXISTING TRAFFIC CONDITIONS

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Oak Ridge Highway at Pebblepass Road	Unsignalized	Eastbound Left	A	8.9	0.020	A	8.3	0.030
		Southbound Left	C	19.7	0.140	D	30.0	0.140
		Southbound Right	B	12.4	0.050	B	10.6	0.020

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for unsignalized intersections
[a] Level of Service
[b] Average Delay (sec/vehicle)
[c] Volume-to-Capacity Ratio

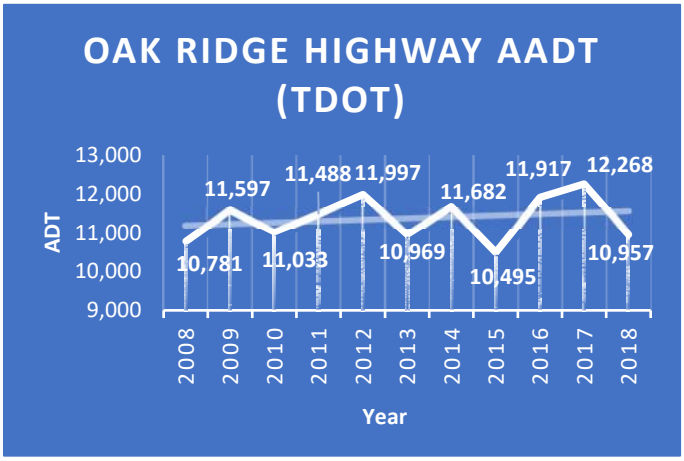
TABLE 3b
2021 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS - EXISTING TRAFFIC CONDITIONS (+20%)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Oak Ridge Highway at Pebblepass Road	Unsignalized	Eastbound Left	A	9.4	0.020	A	8.6	0.040
		Southbound Left	D	26.1	0.220	E	46.5	0.250
		Southbound Right	B	13.7	0.070	B	11.2	0.030

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for unsignalized intersections
[a] Level of Service
[b] Average Delay (sec/vehicle)
[c] Volume-to-Capacity Ratio

- **OPENING YEAR TRAFFIC CONDITIONS (WITHOUT THE 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 development is assumed to occur in 2026. This horizon year corresponds to five years for this residential development to reach full capacity and occupancy.



Vehicular traffic on Oak Ridge Highway has shown minimal growth over the past few years, according to the permanent TDOT traffic count station and as shown in Appendix A. To conservatively account for potential traffic growth in the study area, an average annual growth rate of 1% was used to calculate future growth up to 2026 for the studied intersection. This growth rate is applied on top of the 20% factor applied to the tabulated existing traffic counts to account for reduced traffic levels from the current pandemic. The 1% growth factor was only applied to the thru volumes on Oak Ridge Highway. The turn movements at Oak Ridge Highway at Pebblepass Road were not increased since the mobile home park is completely built-out and is not expected to grow. The results of this growth rate applied to the existing 2021 traffic volumes from Figure 4b (with 20% factor) are shown in Figure 5. Figure 5 shows the projected opening year traffic volumes at the studied intersection in 2026 during the AM and PM peak hours without the project.

Capacity analyses were conducted for the projected conditions at the Oak Ridge Highway at Pebblepass Road intersection in 2026 without the project being developed. The results from the 2026 projected opening year traffic conditions (without the project) can be seen in Table 4 for the intersection. The calculation worksheets are in Appendix F. It is important to point out that these projected calculated LOS designations for the intersection could exist in the future, even without the proposed residential project being constructed and developed. The southbound left-turn lane on Pebblepass Road at Oak Ridge Highway is calculated to operate even worse (LOS D and LOS F) during the projected AM and PM peak hours even without the project in 2026.

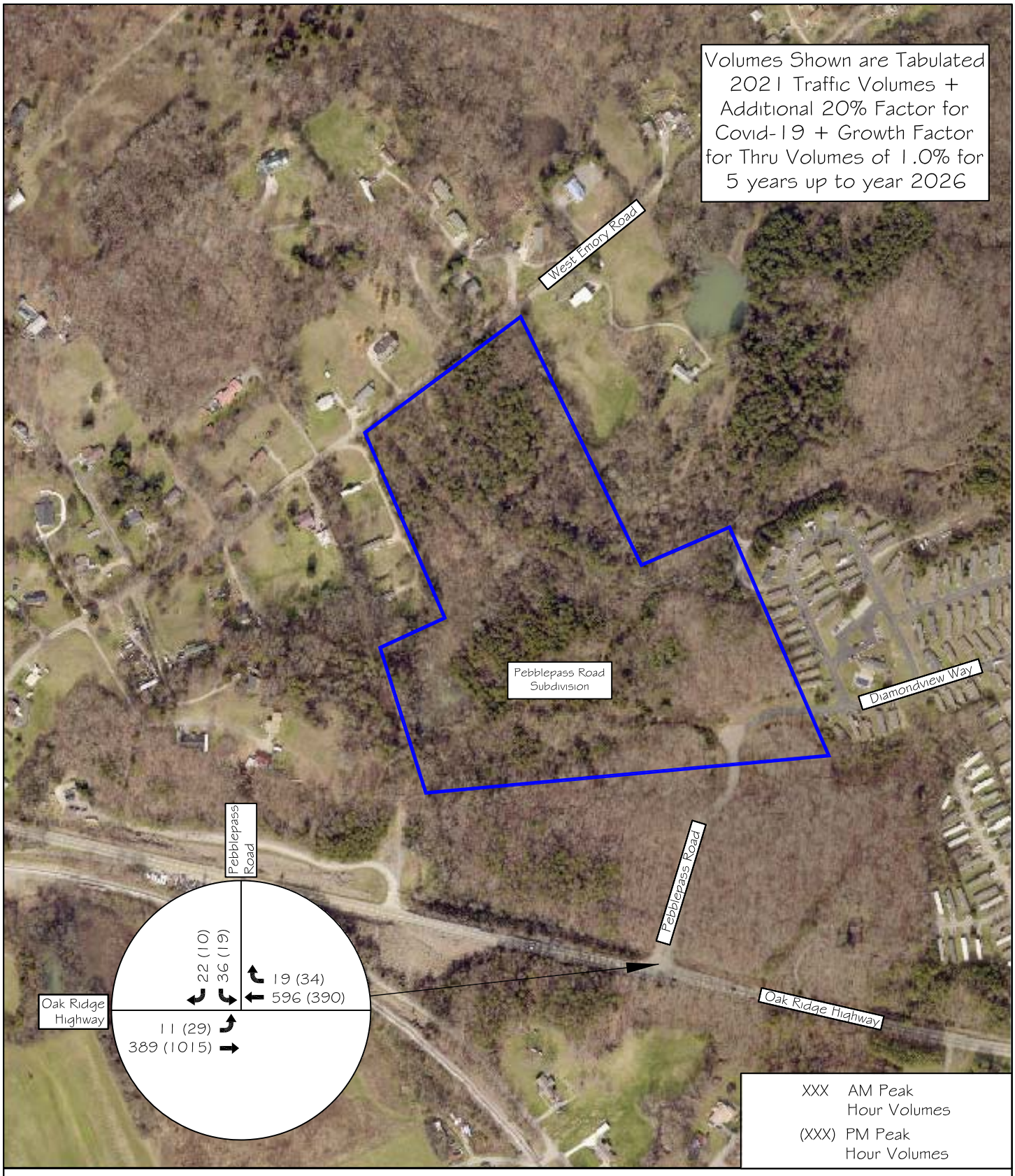


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FIGURE 5

Pebblepass Road Subdivision

2026 Peak Hour Traffic Volumes - OPENING YEAR TRAFFIC (WITHOUT THE PROJECT)

TABLE 4
2026 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS - OPENING YEAR (2026 WITHOUT THE PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Oak Ridge Highway at Pebblepass Road	 Unsignalized	Eastbound Left	A	9.5	0.020	A	8.6	0.040
		Southbound Left	D	28.2	0.240	F	53.0	0.280
		Southbound Right	B	14.2	0.070	B	11.4	0.030

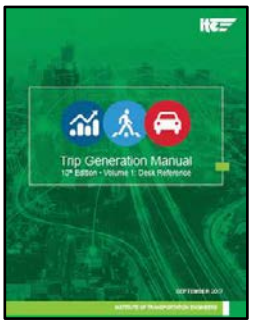
Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for unsignalized intersections

[a] Level of Service

[b] Average Delay (sec/vehicle)

[c] Volume-to-Capacity Ratio

▪ TRIP GENERATION:



The estimated amount of traffic generated by the proposed residential development 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). 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 various land uses and correlates trips generated based on different variables such as dwelling units, square footage, etc. The data from ITE for the proposed land use is shown in Appendix G. A summary of this information is presented in the following table:

TABLE 5
TRIP GENERATION FOR PEBBLEPASS ROAD SUBDIVISION
82 Single-Family Detached 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	82 Houses	867	25%	75%		63%	37%	
				16	48	64	53	31	84
Total New Volume Site Trips			**867**	**16**	**48**	**64**	**53**	**31**	**84**

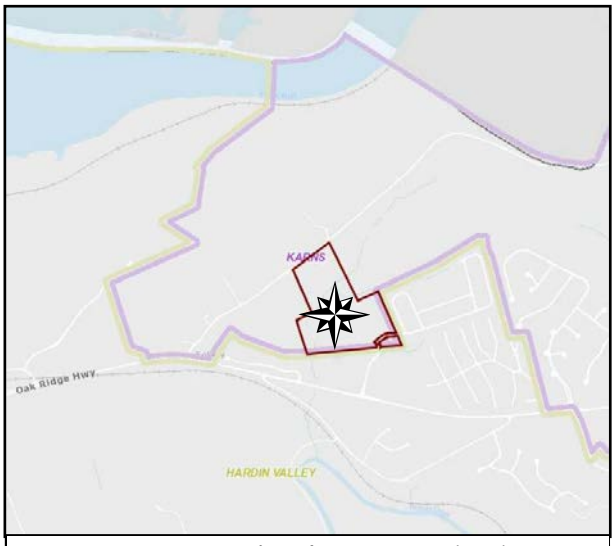
ITE Trip Generation Manual, 10th Edition
Trips calculated by using Fitted Curve Equation

For the proposed residential subdivision, with 82 single-family detached houses, it is estimated that 16 vehicles will enter and 48 will exit, for a total of 64 generated trips during the AM Peak Hour in the year 2026. Similarly, it is estimated that 53 vehicles will enter, and 31 will exit, for a total of 84 generated trips during the PM Peak Hour in the year 2026. The calculated trips generated for an average weekday are expected to be 867 vehicles for the proposed development in 2026. No trip reductions were included in the analysis.

- **TRIP DISTRIBUTION AND ASSIGNMENT:**

Figure 6 shows the projected distribution for traffic entering and exiting the proposed subdivision. The percentages shown only pertain to the trips generated by the new proposed residential dwellings in the development calculated from the ITE Trip Generation Manual.

The percentages assumed and shown in Figure 6 are based on the traffic count results at the Oak Ridge Highway at Pebblepass Road intersection. The turning movement counts from this intersection were assumed to be a reasonable estimate for the Pebblepass Road Subdivision travel patterns since it includes the adjacent residential development traffic patterns from Volunteer Village. This is an existing similar land use near the proposed development, and Pebblepass Road is the only access point for the Volunteer Village mobile home park.



Property Zoning for Karns Schools

Various outside developments will potentially "attract" the projected generated traffic to and from the new residential subdivision. In addition to employment centers and commercial development, some traffic will travel to and from various public and private elementary, middle, and high schools. This site development property is currently zoned for Karns Elementary School, Middle School, and High School. The development property is located just outside and north of the Hardin Valley elementary and middle school zones. All the Karns public schools are to the east of the subdivision off Oak Ridge Highway.

The distribution of generated traffic entering and exiting the subdivision is based on an overall observed 65% / 35% split of traffic on Oak Ridge Highway in the AM peak hour and a more even split in the PM peak hour for entering vehicles. The observed distribution was 65% of traffic traveling to and from the east (Knoxville) and 35% to and from the west (Pellissippi Parkway and Oak Ridge). Figure 7 shows the Traffic Assignment of the computed trips generated by the subdivision (from Table 5) and applying the intersection movement volumes based on the assumed distribution of trips shown in Figure 6.

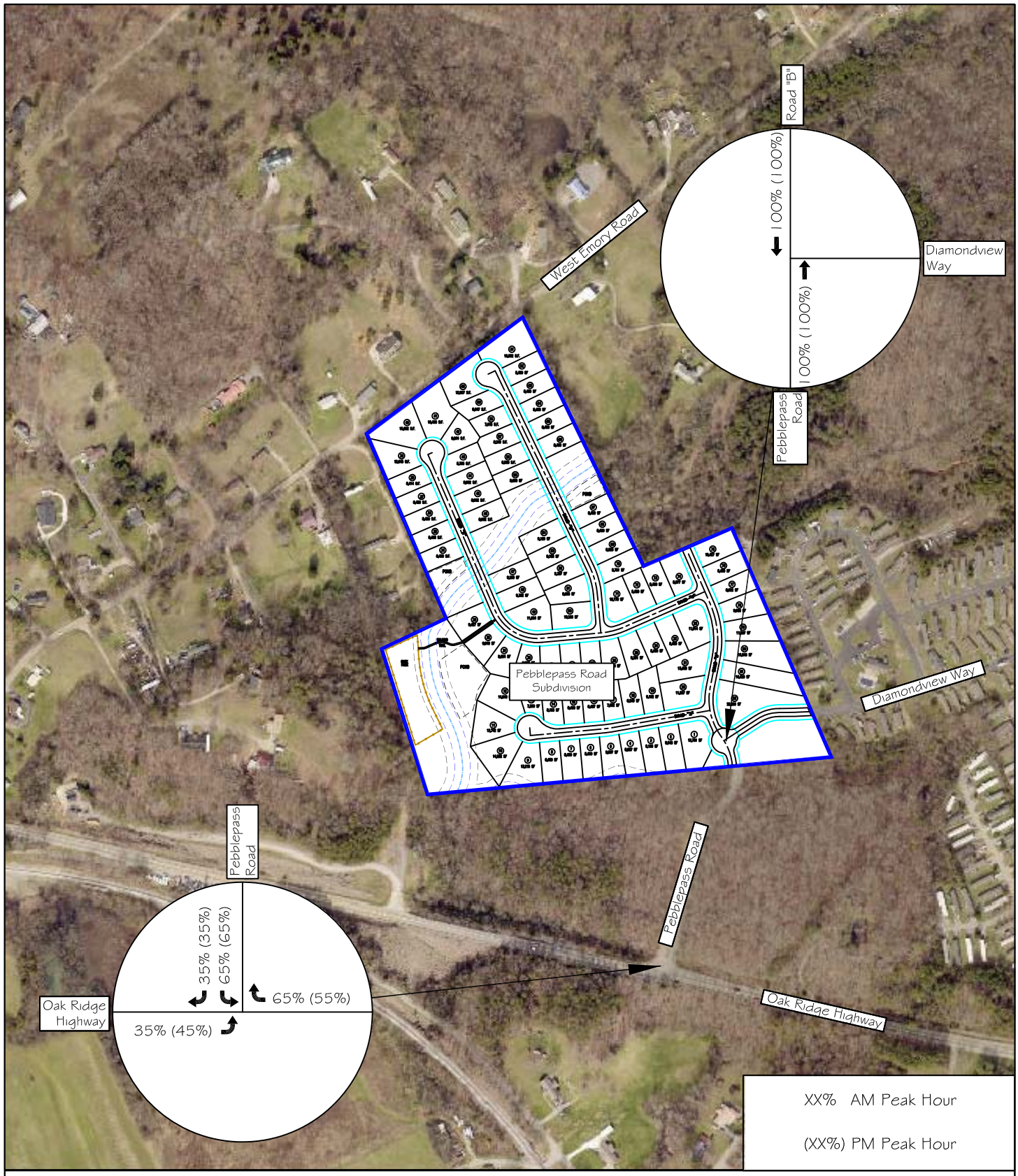


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FIGURE 6

Pebblepass Road Subdivision

Directional Distribution of Generated Traffic during AM and PM Peak Hour

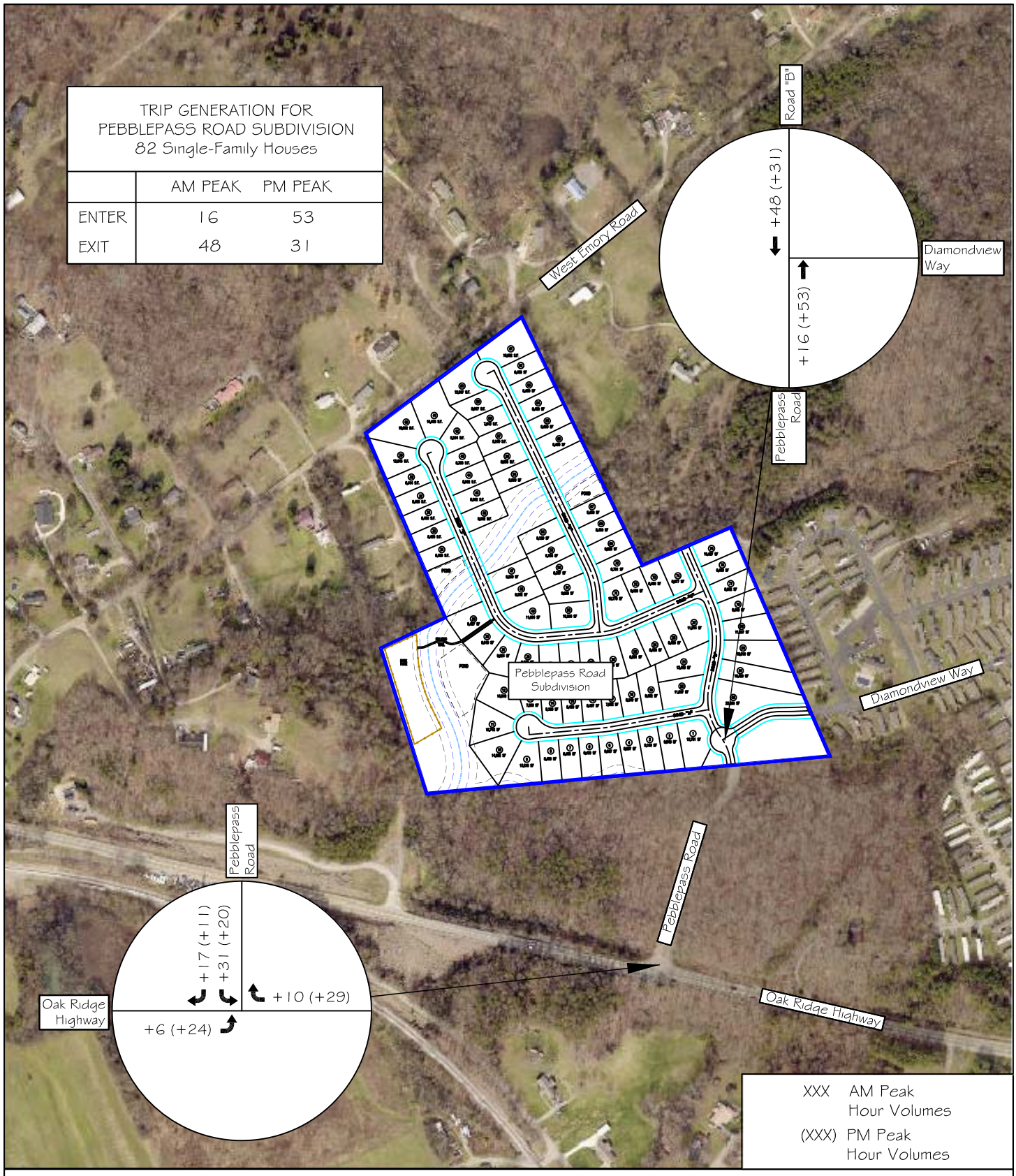

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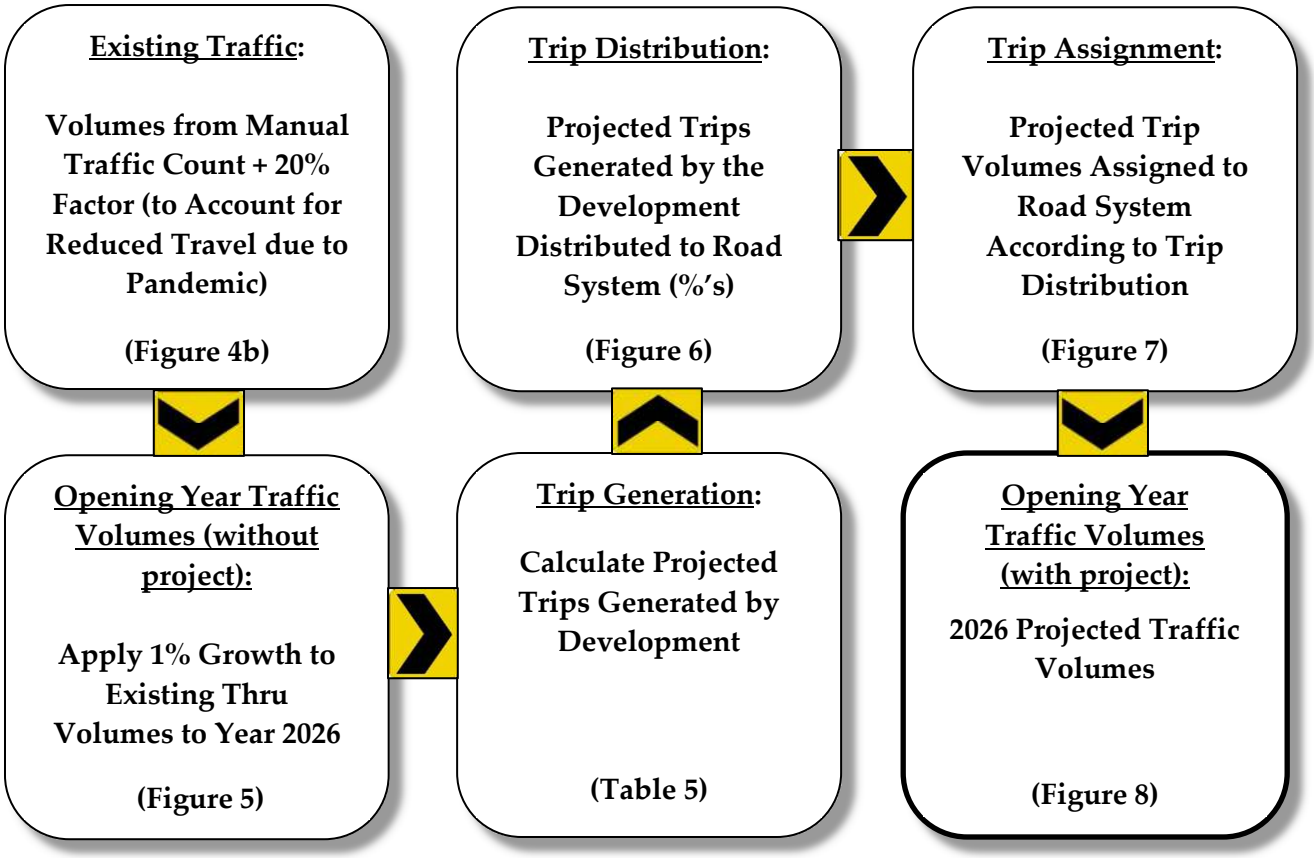
FIGURE 7

Pebblepass Road Subdivision

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 intersection when the Pebblepass Road Subdivision is entirely constructed and occupied by 2026. The steps are illustrated below for clarity:



To calculate the total future projected traffic volumes at the studied intersection, the calculated peak hour traffic (from ITE Trip Generation) generated by the new Pebblepass Road Subdivision was added to the 2026 opening year traffic (Figure 5) by following the predicted directional distributions and assignments (Figures 6 and 7). This procedure was completed to obtain the total projected traffic volumes when the development is fully built-out and occupied in 2026. Figure 8 shows the projected AM and PM peak hour volumes at the studied intersections for 2026 with the development traffic. The turning volumes at the Pebblepass Road/Road "B" at Diamondview Way intersection are synthesized from the observed entering and exiting volumes during the manual traffic count at the intersection of Oak Ridge Highway at Pebblepass Road.

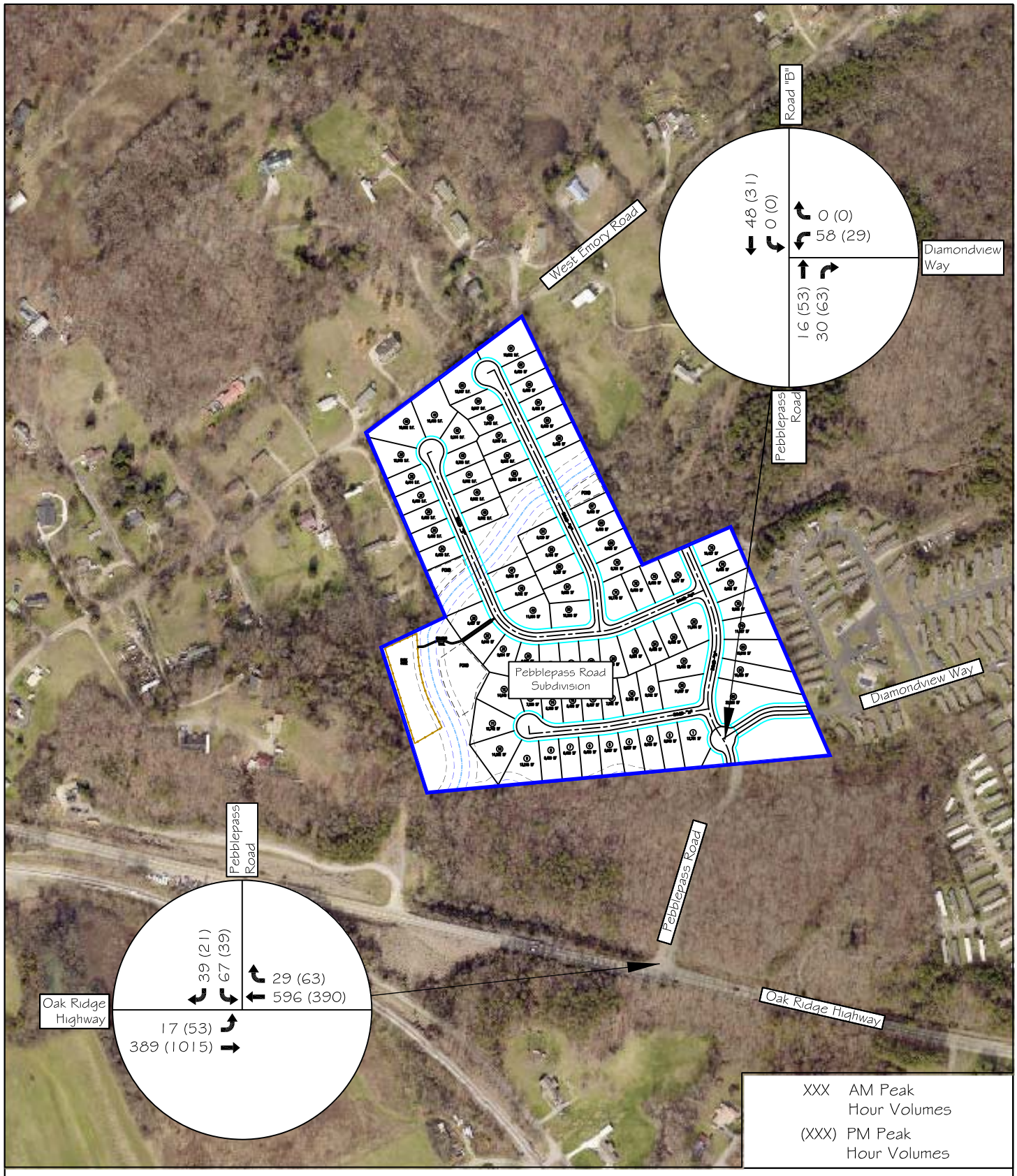


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FIGURE 8

Pebblepass Road Subdivision

2026 Peak Hour Traffic Volumes - OPENING YEAR TRAFFIC (WITH PROJECT)

Capacity analyses were conducted to determine the projected Level of Service for vehicles at the studied intersections with the development traffic in the year 2026. Appendix F includes the worksheets for these capacity analyses.

As expected, the additional traffic generated from the proposed residential subdivision increased the calculated vehicle delays for the southbound left-turn lane on Pebblepass Road at Oak Ridge Highway in the year 2026 (without the project). The addition of the generated trips resulted in excessive vehicle delays for the southbound left-turn lane on Pebblepass Road at Oak Ridge Highway. The subdivision entrance, Road "B" at Pebblepass Road and Diamondview Way, is calculated to operate very well with respect to the Level of Service and will have minimal vehicle delays. The projected 2026 peak hour vehicular traffic results at the studied intersections can be seen in Table 6 for the AM and PM peak hours.

A summary of the Oak Ridge Highway at Pebblepass Road intersection analysis results is presented in Table 7. A graph of the results follows the table highlighting the LOS results. This table and graph provide a side-by-side summary of the intersection for the following: 2021 existing conditions (+ 20%), projected conditions in the year 2026 without the project, and projected conditions in the year 2026 with the project.

TABLE 6
2026 UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS - OPENING YEAR (2026 WITH PROJECT)

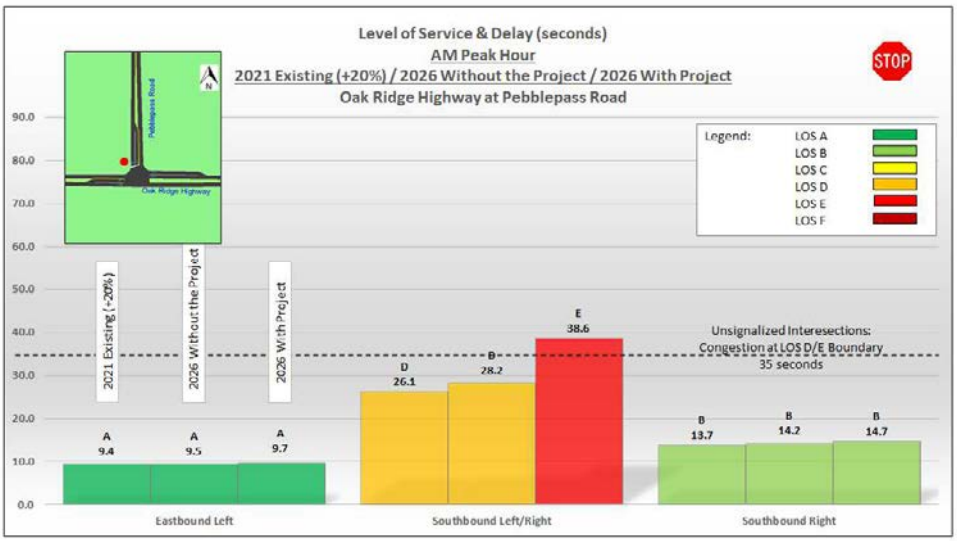
INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Oak Ridge Highway at Pebblepass Road	STOP Unsignalized	Eastbound Left	A	9.7	0.040	A	8.9	0.070
		Southbound Left	E	38.6	0.460	F	98.6	0.640
		Southbound Right	B	14.7	0.120	B	11.6	0.050
Pebblepass Road / Road "B" at Diamondview Way	STOP Unsignalized	Westbound Left/Right	A	9.2	0.070	A	9.3	0.040
		Southbound Left/Thru	A *	0.0	0.000	A *	0.0	0.000

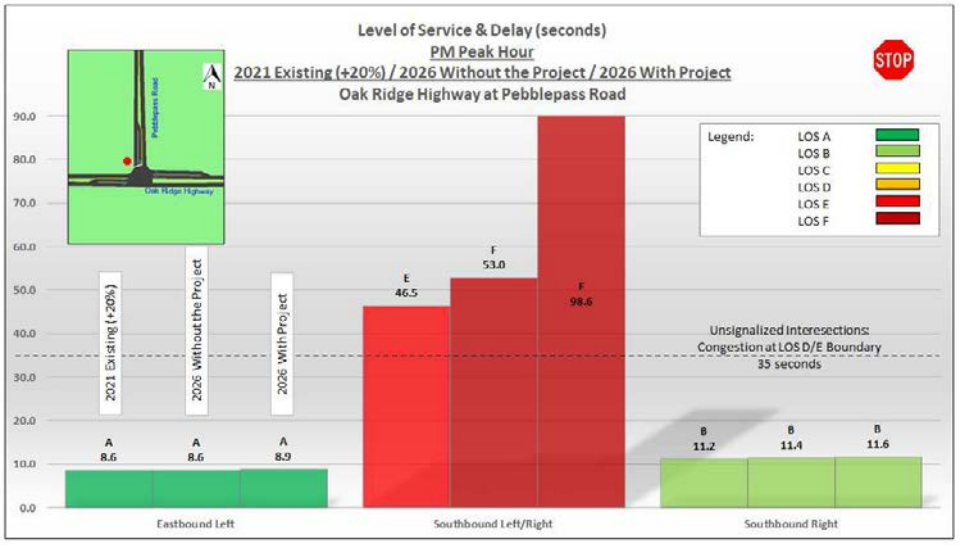
Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for unsignalized intersections
[a] Level of Service
[b] Average Delay (sec/vehicle)
[c] Volume-to-Capacity Ratio
* Actual calculated LOS is not provided due to zero volumes projected

TABLE 7
INTERSECTION CAPACITY ANALYSIS SUMMARY
OAK RIDGE HIGHWAY AT PEBBLEPASS ROAD

LOCATION / PEAK HOUR MOVEMENT	2021 EXISTING (+20%)			2026 WITHOUT THE PROJECT			2026 WITH PROJECT		
	LOS[a]	Delay[b]	v/c[c]	LOS[a]	Delay[b]	v/c[c]	LOS[a]	Delay[b]	v/c[c]
Oak Ridge Highway at Pebblepass Road		STOP							
AM Peak									
Eastbound Left	A	9.4	0.020	A	9.5	0.020	A	9.7	0.040
Southbound Left/Right	D	26.1	0.220	D	28.2	0.240	E	38.6	0.460
Southbound Right	B	13.7	0.070	B	14.2	0.070	B	14.7	0.120
PM Peak									
Eastbound Left	A	8.6	0.040	A	8.6	0.040	A	8.9	0.070
Southbound Left/Right	E	46.5	0.250	F	53.0	0.280	F	98.6	0.640
Southbound Right	B	11.2	0.030	B	11.4	0.030	B	11.6	0.050

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology for unsignalized 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. One feature of the adjacent transportation system is discussed in the following pages.

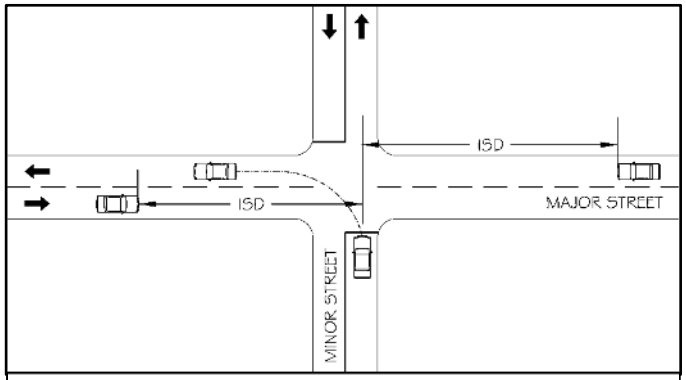
EVALUATION OF SIGHT DISTANCE

For intersections, sight distance evaluations have two categories: Stopping Sight Distance (SSD) and Intersection Sight Distance (ISD).

Methodology:

SSD is the distance required for a motorist to perceive, react, and the 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 clear half of the intersection without conflicting with the oncoming traffic from the left and accelerating to the road's operating speed 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



Intersection Sight Distance Diagram

> 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 a posted speed limit of 55-mph on Oak Ridge Highway (SR 62), the ISD would be 655 feet looking in each direction at Pebblepass Road based on the guidelines outlined in A Policy on Geometric Design of Highway and Streets by AASHTO (American Association of State Highway and Transportation Officials). This sight distance standard is applied at this intersection since it is located on a State Route and supersedes Knox County ISD policy. This standard is also shown in TDOT Standard Drawing (RD01-SD-3). Based on an existing 6% grade on Oak Ridge Highway at Pebblepass Road and a posted speed limit of 55-mph, the SSD is calculated to be 450 feet for eastbound and 555 feet for westbound vehicles.

A cursory examination of the sight distances on Oak Ridge Highway was undertaken. Based on visual observation, it appears that the intersection sight distance from Pebblepass Road at Oak Ridge Highway intersection looking to the east and west is adequate. Using a Nikon Laser Rangefinder at Pebblepass Road at Oak Ridge Highway, the intersection sight distance was estimated to be 700 feet to the east and west. A licensed land surveyor should verify sight distances at this intersection. Images of the existing sight distances are presented below with the intersection respective required ISD and SSD.

View of Sight Distance on Oak Ridge Highway at Pebblepass Road (Looking East)

View of Sight Distance on Oak Ridge Highway at Pebblepass Road (Looking West)

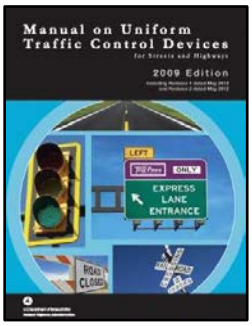
CONCLUSIONS & RECOMMENDATIONS

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 traffic flow and safety level. Overall, the biggest concern is for the southbound left-turn lane of Pebblepass Road at Oak Ridge Highway that currently operates with high vehicle delays in the peak hours. The requirement of increasing the tabulated traffic volumes by 20% resulted in worse Levels of Service (LOS) and substantial vehicle delays for this lane in the projected 2026 conditions.

1 **Oak Ridge Highway at Pebblepass Road:** This intersection was calculated to operate poorly in the existing conditions and worse in the projected conditions in 2026 for left-turning exiting vehicles from Pebblepass Road. Several discussions regarding this are offered.

1a) As an investigation into potential remediation for this intersection, this intersection was examined with respect to traffic signal warrants.

Methodology:



The Manual on Uniform Traffic Control Devices – 2009 Edition (MUTCD) presents nine different warrants that the traffic engineering profession has developed 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 manual's signal warrants 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 installation. These additional studies are a significant step in ensuring that a traffic signal's installation 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.

Even though nine warrants are offered to justify a traffic signal, according to the TDOT Traffic Signal Manual, the agency gives precedence to Warrant #1 (Eight Hour Vehicular Volume) and Warrant #7 (Crash Experience). Even though Warrant #2 is not a primary warrant used by TDOT, it is included in this study. Furthermore, TDOT does not allow installing a traffic signal on a state route based on speculative developments or unrealized traffic volumes.

The intersection of Oak Ridge Highway at Pebblepass Road was evaluated for justifying a traffic signal based on the MUTCD Warrants listed above and the existing (+20% adjusted) traffic count volumes. Pebblepass Road was used as the minor side street for the warrant analysis, and Oak Ridge Highway was the major street. Warrant #7 was not analyzed at the intersections for this study. Warrant #7 was not included because one of the primary criteria for an intersection to meet the warrant is that an "Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency…" It is not believed that any specific alternatives have been implemented and observed at this intersection; therefore, this warrant was not included in this study.

The evaluation concluded that for the existing (+20% adjusted) traffic volumes, the intersection does not currently meet Warrant #1 or Warrant #2. The volumes at the intersection were not large enough to meet the Warrants even though the Level of Service calculations determined that the southbound left-turn lane currently operates at LOS D and LOS E during the AM and PM peak hour.

Since easily identifiable remedies to reduce southbound left-turn vehicle delays are not readily apparent for this intersection, the intersection was examined further with respect to traffic signal warrants. As stated previously, TDOT does not typically accept justification for traffic signals except for Warrant #1 and #7. Warrant #7 was not examined for this study. Another warrant, Warrant #3, is an alternative method to justify a traffic signal at this location. Warrant #3 is usually only used in rare instances such as locations near office complexes, manufacturing plants, etc. According to the MUTCD, Warrant #3 "is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street."

The additional evaluation shows that Warrant #3, Condition A, was met for the Oak Ridge Highway at Pebblepass Road intersection for the existing (+20% adjusted) traffic volumes. Appendix H shows the traffic signal warrant assessment for this evaluation.

Outside of allowing the intersection to be signalized based on the existing volumes meeting Warrant #3, the intersection was analyzed to determine if and when the traffic volumes would justify a traffic signal based on Warrant #1. A spreadsheet was developed for the study to determine the traffic volumes generated by the development being added to the intersection of Oak Ridge Highway at Pebblepass Road during the highest 8 hours of traffic based on the assumed traffic distribution in the projected conditions. This spreadsheet is shown in Appendix H. Based on an average growth rate of 1% of thru traffic on Oak Ridge Highway and at full build-out and occupancy of the proposed 82 homes, it is calculated that this intersection will not meet Warrant #1 or Warrant #2 in the year 2026. Only five of the required eight hours for Warrant #1 will be met in 2026 based on the projected volumes. Only one hour of the required four hours for Warrant #2 will be met. However, Warrant #3, Condition A, will still be met in the projected conditions.

It is recommended that traffic counts be conducted again at this intersection when either the current pandemic has ended and overall traffic volumes return closer to pre-pandemic levels, or when it is surmised that overall traffic volumes have reached a "new normal" to ensure these evaluations are valid and reasonable. This will allow for a re-examination of the intersection, a re-comparison of the Traffic Signal Warrants, and establish a timeframe of if and when this intersection could be signalized. Traffic crash data should also be included in the examination.

- Furthermore, as part of the evaluation of the projected conditions, the projected vehicle queue lengths at the intersection were examined based on the projected 2026 traffic volumes. The previously mentioned Synchro Traffic Software includes SimTraffic. The Synchro portion of the software performs the macroscopic calculations for intersections, and SimTraffic performs micro-simulation and animation of vehicular traffic. SimTraffic (Version 8) software was utilized to estimate whether the existing turn lane storage lengths at the intersection of Oak Ridge Highway at Pebblepass Road will be adequate with the projected volumes.

  Based on the software results from the projected 2026 volumes, the 95th percentile vehicle queue lengths were calculated based on the intersection operating in unsignalized conditions. The 95th percentile vehicle queue is the recognized measurement in the traffic engineering profession as the design standard used when considering queue lengths. A 95th percentile vehicle queue means a 95% certainty that the vehicle queue will not extend beyond that point. The calculated vehicle queue results were based on averaging the outcome obtained during ten traffic simulations. The vehicle queue results from the SimTraffic software are in Appendix I. The 95th percentile queue lengths at the intersection are shown in Table 8.

  Based on these results, the existing storage turn lane lengths at the intersection will be adequate in the projected conditions in 2026, operating under unsignalized conditions. Based on these results, if the intersection continues operation as unsignalized in the projected 2026 conditions, the calculations also show that southbound left-turn lane queues will not back up far enough to block southbound right-turn motorists on Pebblepass Road.

TABLE 8
TURN LANE STORAGE & VEHICLE QUEUE SUMMARY -
2026 PROJECTED PEAK HOUR TRAFFIC VOLUMES

INTERSECTION	APPROACH/ MOVEMENT	EXISTING STORAGE (ft)	SIMTRAFFIC 95th PERCENTILE QUEUE LENGTH (ft)	
			AM PEAK HOUR	PM PEAK HOUR
Oak Ridge Highway at Pebblepass Road	Eastbound Left	75	32	46
	Southbound Left	85	74	72
	Southbound Right	85	55	31

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

- If these projected volumes are realized in 2026 with the associated long left-turn vehicle delays on Pebblepass Road, the potential exists for decreased traffic safety. Without adequate traffic gaps on Oak Ridge Highway and considerable delays, left-turn motorists could be tempted to enter the Oak Ridge Highway traffic stream that they would otherwise not attempt. This could lead to traffic conflicts and the potential for traffic crashes.

  Overall, serious consideration should be given to the transition of this intersection to a traffic signal in the future due to the potential high vehicle delays on the southbound approach and high vehicle speeds on Oak Ridge Highway. This consideration should include an investigation to determine if there is a history of crashes occurring at this intersection. Furthermore, if future additional development to the northwest of the current property is pursued, traffic signalization warrants will most likely be met due to additional generated traffic volumes.

- Another potential remedy could include a median acceleration lane for left-turn motorists turning and heading eastbound on Oak Ridge Highway. Currently, there is not enough road width on Oak Ridge Highway to allow a left-turn vehicle to pause in the center of the highway. In theory, a median acceleration lane would allow for southbound left-turn motorists to cross the westbound traffic lane without regard to the eastbound opposing thru motorists. It would also provide a temporary refuge that would provide an opportunity for acceleration and allow vehicles to enter the eastbound travel stream without significantly reducing the eastbound traffic stream speeds. However, it is not recommended that a median acceleration lane be provided for southbound left-turn motorists for this situation.

Median acceleration lanes are typically provided in median separated highways. Oak Ridge Highway does not have a median, and the existing highway width precludes a median acceleration lane from being constructed. Typically, median acceleration lanes are constructed for left-turn movements when they consist of more heavy trucks and vehicles.

Furthermore, other detrimental aspects of median acceleration lanes are that many motorists do not effectively use them; they are challenging to merge due to blind spots and cause unease to thru motorists. Due to the limited width of Oak Ridge Highway and the detrimental aspects, it is believed that the costs involved with modifying this intersection to include a median acceleration lane would far outweigh the benefits.

- Even with the projected high delays at this intersection, several existing beneficial aspects are present. These aspects include the existing separate left-turn lanes, the existing westbound right-turn deceleration lane, and the existing intersection street lighting. Also, there is the possibility that the additional 20% factor, which was applied to the existing tabulated traffic volumes, in addition to the projected trip generation, may overestimate the projected vehicle delay conditions. It remains to be seen whether the reactions to the pandemic may result in fewer trips being generated due to a transition of more people working from home. This could be a temporary condition, but there are forecasts that this could be a more permanent reality. The pandemic and technology have allowed for greater acceptance and possibility of a lasting shift for several professions working from home rather than traveling to and from the work office.

1b) Intersection sight distance from Pebblepass Road at Oak Ridge Highway must not be impacted by future landscaping or signage. Looking to the west from Pebblepass Road, some existing vegetation in the northwest corner could potentially interfere with sight distance if not maintained. This vegetation should be removed and maintained in the future. A licensed land surveyor must verify the available sight distance at this location.

Sight Distance on Oak Ridge Highway at Pebblepass Road (Looking West)

1c) It is recommended that the existing double yellow centerline on Pebblepass Road be re-applied up to the stop bar line at Oak Ridge Highway.

It is also recommended that the white lane line that delineates the left and right-turn lanes on Pebblepass Road be extended to the white stop bar in addition to re-applying the existing white lane line. It appears that the re-surfacing of Oak Ridge Highway has covered a portion of the original white lane line. Installing this marking will improve the delineation of the turn lanes.

Refresh Yellow Center Pavement Markings and White Lane Line on Pebblepass Road at Oak Ridge Highway (Looking South)

1d) It is recommended that the raised center concrete island and bollards be removed from Pebblepass Road near the intersection with Oak Ridge Highway and replaced with full-depth asphalt and the double yellow centerline pavement markings extended to the stop bar. The island appears to be for landscaping and serves no useful transportation purpose.

1e) The existing street signage assembly needs to be repaired. It is currently being held together with a bungee cord.

Street Sign at Intersection of Oak Ridge Highway at Pebblepass Road

1f) While outside the scope of this study, a concern regarding the existing guardrail along Oak Ridge Highway is presented in this report. As described earlier, on this section of Oak Ridge Highway near the intersection with Pebblepass Road, the highway is flanked with detached concrete curbing and w-beam guardrails. Particularly on the south side of Oak Ridge Highway, the curbing is 8″ in height and width and is located about a foot outside the pavement white edge line. The guardrail face is located 3″ - 4″ outside the back edge of the concrete curb. The guardrail's top edge is approximately 14″ above the top of the concrete curb and 22″ above the pavement.

Guardrail and Detached Concrete Curb on South Side of Oak Ridge Highway near Pebblepass Road (Looking West)

It is not known as to the reason concrete curbing has been installed on this stretch of Oak Ridge Highway. It is assumed to have been installed to restrict roadway drainage from causing erosion on the south side of the Oak Ridge Highway road embankment. However, TDOT standard drawings and guidelines (TDOT Standard Drawing S-PL-6) state that guardrail should be installed flush with the face of curbing and should be 31" above the edge of the pavement. Without the guardrail being flush with the curbing and the top of the guardrail being lower than 31", there is a concern that the curbing on Oak Ridge Highway could potentially cause errant vehicles to launch up and over the guardrail.

There could be a design exception or other reasoning behind allowing this placement. It is outside the scope of this study, but it is mentioned in this report since it was observed during the field review and raised concerns.

Road Embankment on South Side of Oak Ridge Highway near Pebblepass Road (Looking West)

Pebblepass Road/Road "B" at Diamondview Way: The intersection of Pebblepass Road/Road "B" at Diamondview Way was calculated to operate very well with respect to level of service in the projected conditions in 2026. Currently, Pebblepass Road intersects Diamondview Way at a cul-de-sac. Road "B" will be built on the north side of this intersection for the subdivision construction. The cul-de-sac will be transformed into a t-intersection with Diamondview Way being the minor side-street approach. The Diamondview Way approach will be designed to continue operating under stop control. Road "B" and Pebblepass Road are proposed to operate freely for north and south travel.

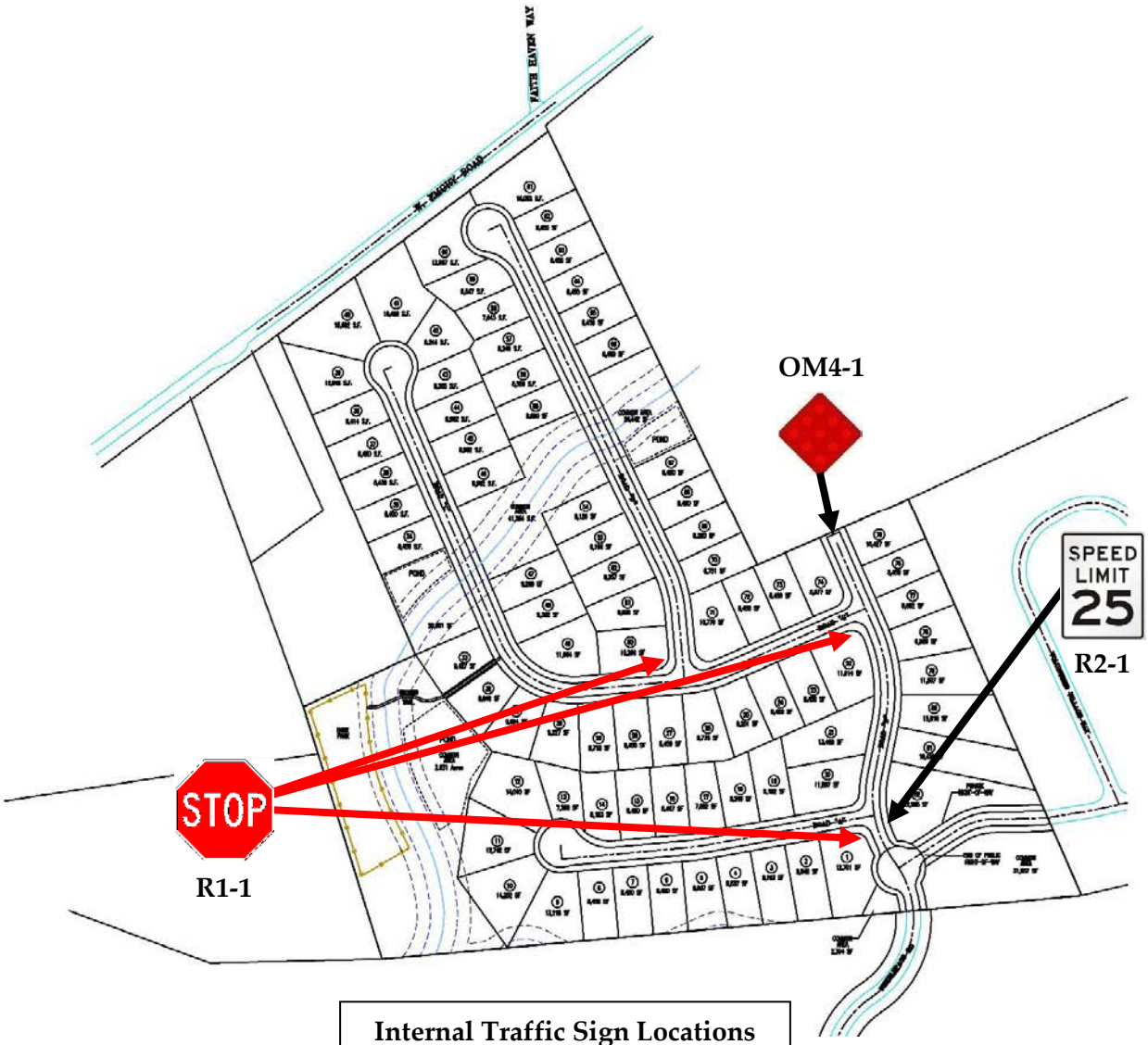
2a) It is recommended that a Stop Sign (R1-1) and a 24" white stop bar be applied to the Diamondview Way approach pavement at the modified intersection of Pebblepass Road/Road "B". The stop bar should be applied at a minimum of 4 feet away from the edge of Pebblepass Road/Road "B" and should be placed at the desired stopping point that provides the maximum sight distance. An existing Stop Sign (R1-1) currently exists on this east approach of Diamondview Way but will need to be relocated when the cul-de-sac is modified to a t-intersection.

2b) Intersection sight distance at Diamondview Way must not be impacted by future landscaping or signage. Based on a posted speed limit of 25-mph on Pebblepass Road/Road "B", the required intersection sight distance (ISD) is 250 feet looking in each direction from Diamondview Way. Based on an assumed level grade and a posted speed limit of 25-mph, the SSD is calculated to be 155 feet for northbound and southbound vehicles on Pebblepass Road. The site designer must verify that these distances will be available.

3 **Pebblepass Road Subdivision Internal Roads:** The current concept plan shows four new roads being constructed within the development, as shown in Figure 3.

3a) It is recommended that a 25-mph Speed Limit Sign (R2-1) be posted near the beginning of Road "B". End of roadway signage (OM4-1) should be installed at the northern end of Road "B".

3b) Stop Signs (R1-1) with 24" white stop bars and other traffic signage should be installed at the locations, as shown below:



Internal Traffic Sign Locations

3c) Sight distance at the new internal intersections in the development must not be impacted by new signage or future landscaping. With a speed limit of 25-mph in the development, the intersection sight distance requirement is 250 feet. The stopping sight distance required is 155 feet for a level road grade. The site designer should ensure that sight distance lengths are met.

3d) All drainage grates and covers for the residential development need to be pedestrian and bicycle safe.

3e) The United States Postal Service (USPS) has recently implemented changes to its delivery guidelines 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.

Centralized USPS Delivery Center

3f) Traffic calming measures might be needed for this development. Several roads within the development have long and straight road segments. The possible need for traffic calming measures inside the development should be coordinated with Knox County Engineering and Public Works during the detailed design phase.

3g) The proposed lots (Lots #40, 41, 60, and 61) within the development adjacent to West Emory Road should not be allowed to have direct access.

3h) 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.

APPENDIX A

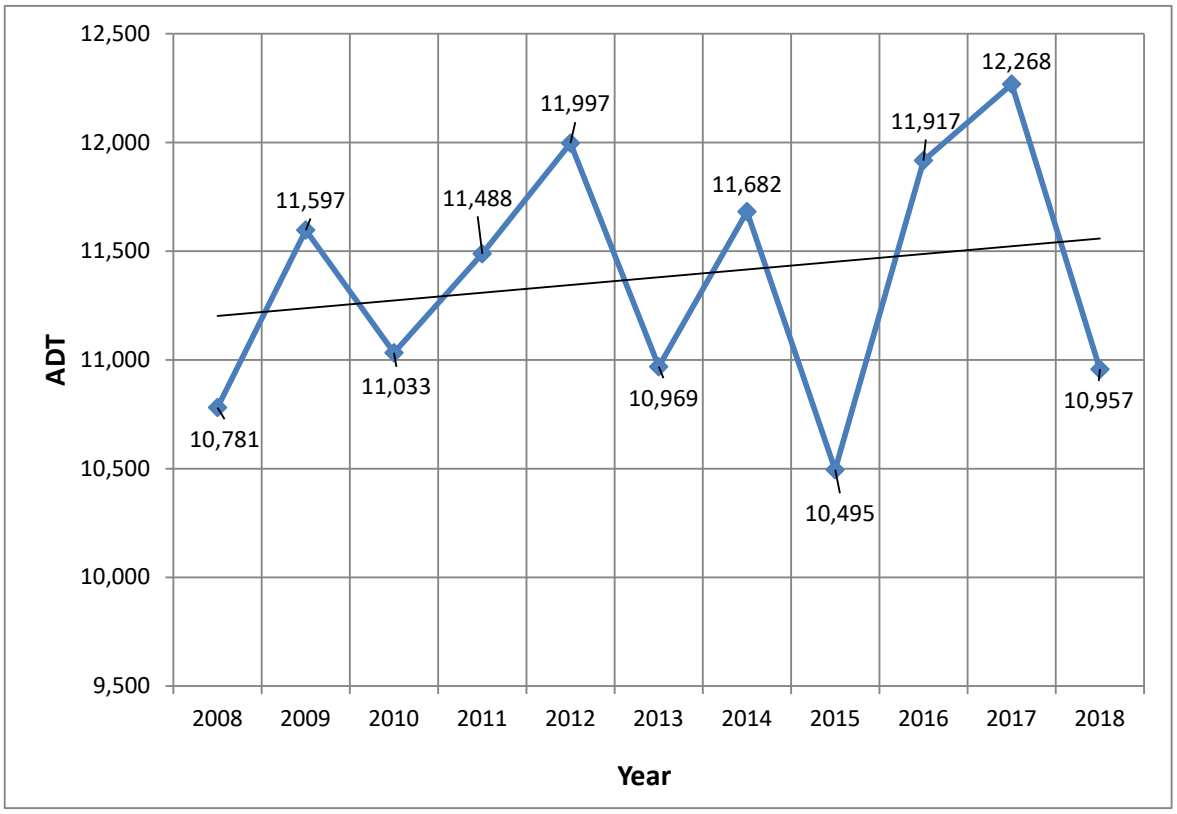
HISTORICAL TRAFFIC COUNT DATA

Historical Traffic Counts

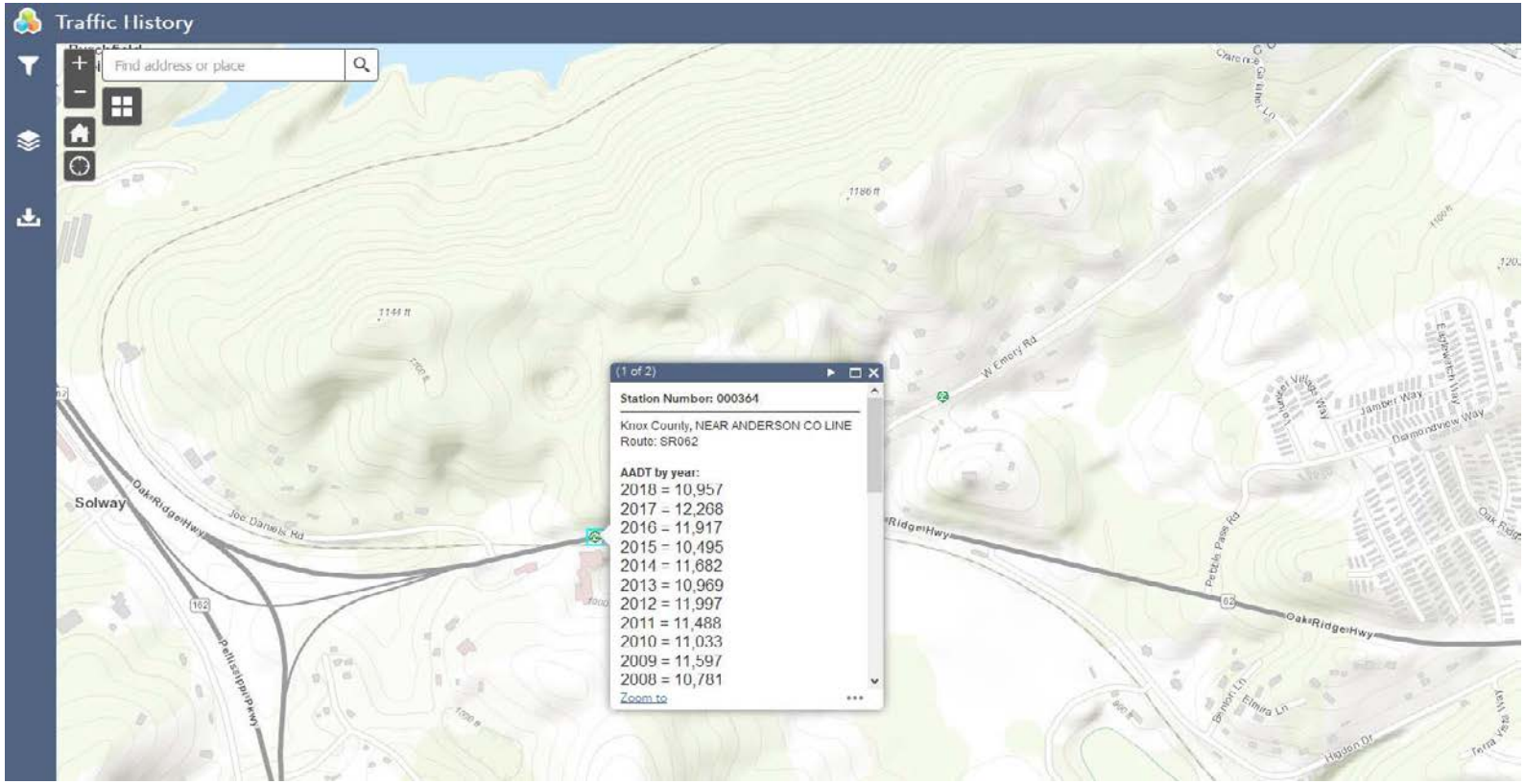
Organization: TDOT
Station ID #: 000364
Location: Oak Ridge Highway east of Pellissippi Parkway

YEAR	ADT
2008	10,781
2009	11,597
2010	11,033
2011	11,488
2012	11,997
2013	10,969
2014	11,682
2015	10,495
2016	11,917
2017	12,268
2018	10,957

Trendline



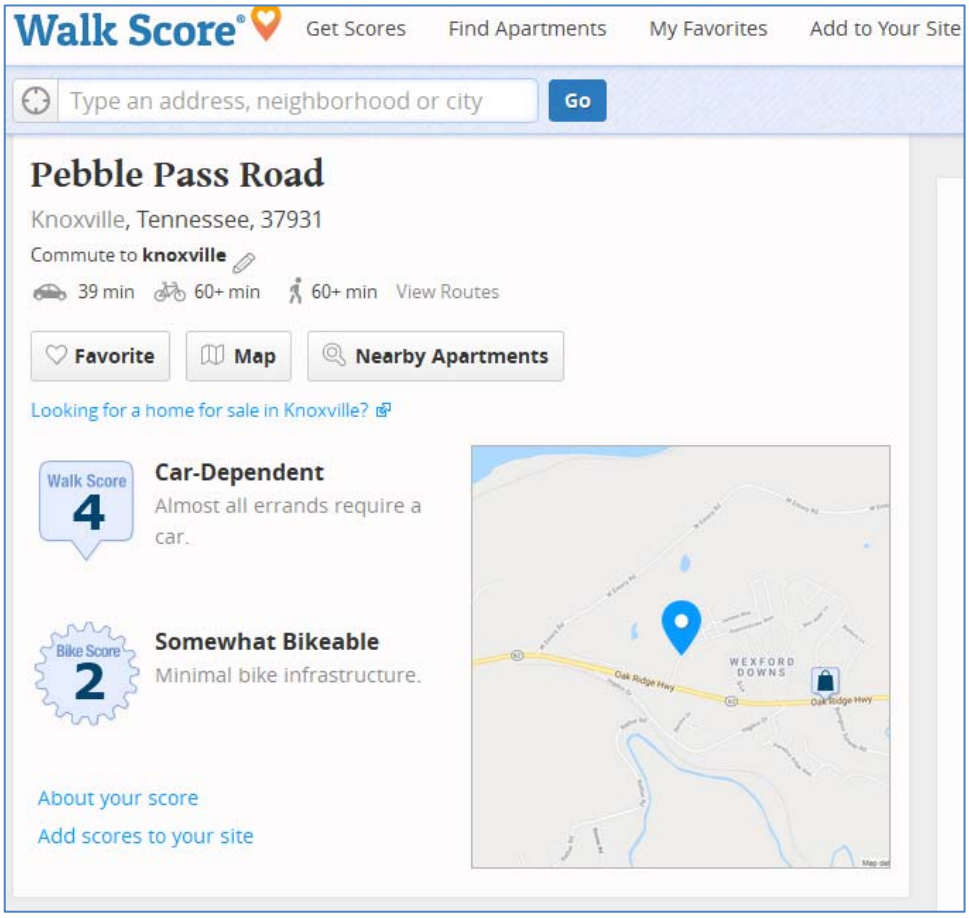
2008 - 2018 Growth Rate = 1.6%
Average Annual Growth Rate = 0.2%


Traffic History
Find address or place
(1 of 2)
Station Number: 000364
Knox County, NEAR ANDERSON CO LINE
Route: SR062
AADT by year:
2018 = 10,957
2017 = 12,268
2016 = 11,917
2015 = 10,495
2014 = 11,682
2013 = 10,969
2012 = 11,997
2011 = 11,488
2010 = 11,033
2009 = 11,597
2008 = 10,781
Zoom to
Solway
Oak Ridge Hwy
Joe Daniels Rd
W Emory Rd
Pebble Pass Rd
Higdon Dr
Elmira Ln
Jamber Way
Diamondview Way
1186 ft
1144 ft

APPENDIX B

WALK SCORE

WALKSCORE
(from walkscore.com)



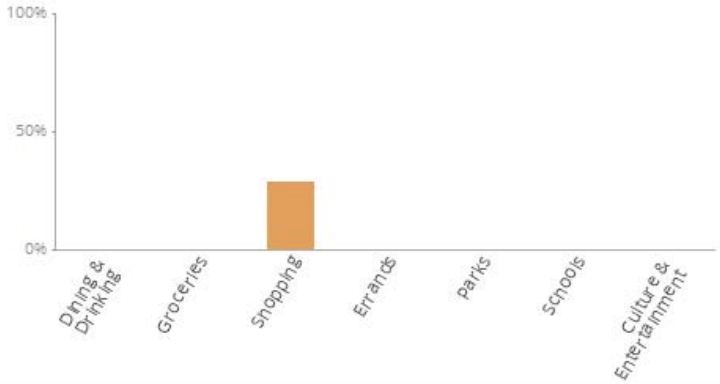
Scores for Pebble Pass Road

Walk Score 4 | Bike Score 2

Walk Score | **Transit Score** | **Bike Score**

Score Details | **What is Walk Score**

The Walk Score for Pebble Pass Road is based on the following categories.



Scores for Pebble Pass Road

Walk Score 4 | Bike Score 2

Walk Score | **Transit Score** | **Bike Score**

Transit Score measures how well a location is served by public transit based on the distance and type of nearby transit lines.

90–100	**Rider's Paradise** World-class public transportation
70–89	**Excellent Transit** Transit is convenient for most trips
50–69	**Good Transit** Many nearby public transportation options
25–49	**Some Transit** A few nearby public transportation options
0–24	**Minimal Transit** It is possible to get on a bus

Scores for Pebble Pass Road

Walk Score 4

Bike Score 2

Walk Score	Transit Score	Bike Score

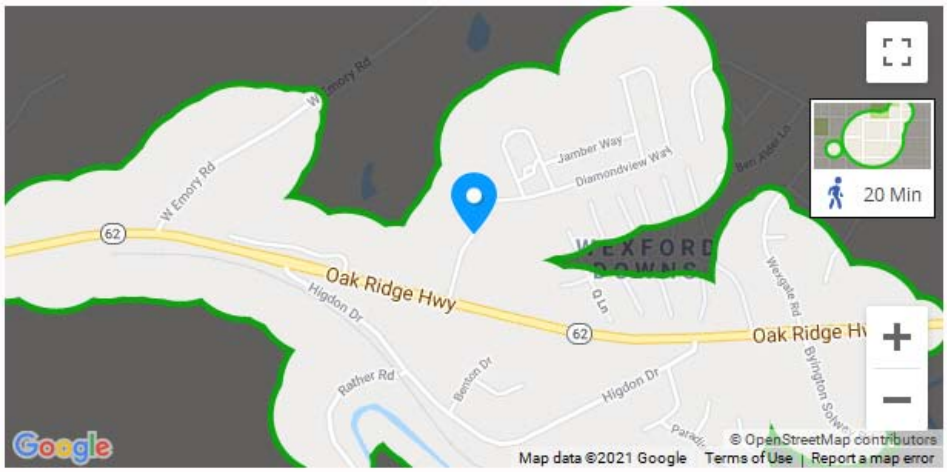
Bike Score measures whether an area is good for biking based on bike lanes and trails, hills, road connectivity, and destinations.

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

Travel Time Map

Add to your site

Explore how far you can travel by car, bus, bike and foot from Pebble Pass Road.



What's Nearby

Restaurants: D & B's Hot Dogs and Ice Cre... 1.4mi

Coffee: Starbucks 4.4mi

Bars: Roger 4.5mi

Groceries: Food City 3.3mi

Parks: Haw Ridge Park 1.7mi

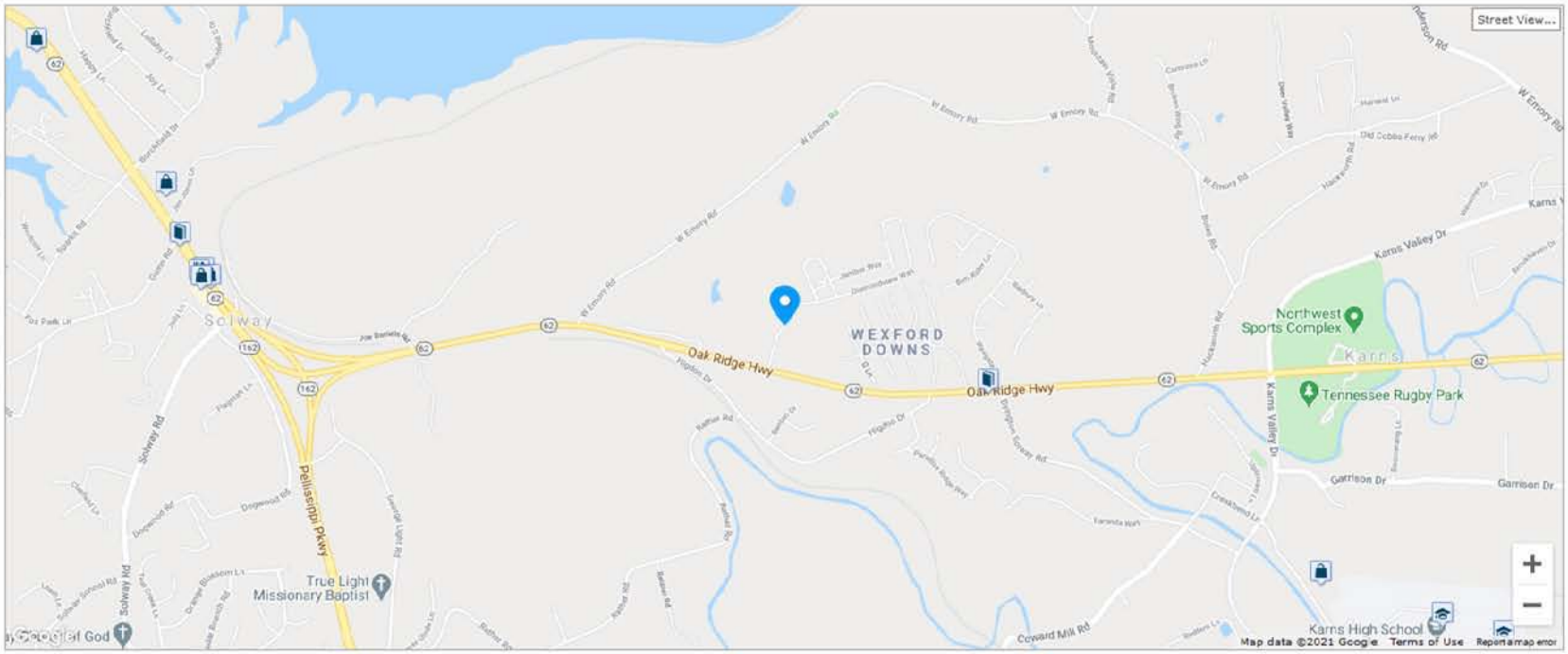
Schools: Karns High School 1.7mi

Shopping: The Book Exchange .5mi

Entertainment: Redbox 3.7mi

Errands: Y-12 Federal Credit Union 1.9mi

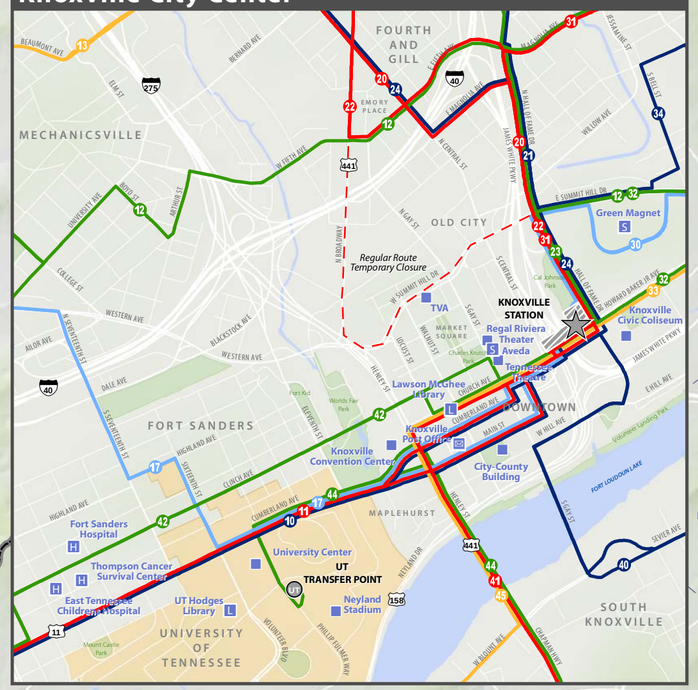
Search Nearby:



APPENDIX C

KNOXVILLE AREA TRANSIT MAP AND INFORMATION

Knoxville City Center



Legend

- Transfer Point
- Lift Service Area Boundary

Points of Interest

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

Distances

0 5 10 Minutes Walking

0 5 10 Minutes Biking

0 0.5 1 Map Scale in Miles

NORTH

FARE INFORMATION

With a base fare of $1.50, KAT offers a variety of passes. Please note that only the fares marked with an asterisk can be purchased when boarding the bus. Others are available at KAT's Customer Service Counter at Knoxville Station (301 Church Ave.) or by mail via katbus.com.

FARE TYPE	REGULAR FARE	REDUCED FARE
One-Ride Pass*	$1.50	$0.75
1 Day Pass*	$4.00	$2.00
7 Day Pass	$15.00	$7.50
30 Day Pass	$50.00	$25.00
20 Ride Pass	$25.00	$12.50
Transfer*	$0.50	$0.25

REDUCED FARE INFORMATION

A reduced fare is available to those who qualify. Qualifying individuals include seniors age 65 or over, Medicare card holders, students under the age of 18, and persons with disabilities. Proper identification (Medicare card or a valid KAT I.D. card) is required before boarding. For more information on how to obtain a discounted-fare I.D. visit katbus.com/fares or call 637-3000.

BUS STOPS ONLY!

KAT buses stop ONLY at locations designated by bus stop signs. Generally, bus stops are located at least every ¼ mile along the route.

KAT HOLIDAYS

KAT buses do not run on the following holidays:

- New Year's Day
- Independence Day
- Thanksgiving
- Christmas

Please note that KAT's Knoxville Station Customer Service counter is also closed during those days.

KAT buses run on a Saturday schedule on the following holidays:

- Martin Luther King, Jr. Day
- Memorial Day
- Labor Day
- Day after Thanksgiving
- Christmas Eve

KAT's administrative offices are closed on all holidays listed above.

16 CEDAR BLUFF CONNECTOR

(Weekdays and Saturdays)

Legend

- Route Timepoint
- Transfer Point
- Bus Stop

Points of Interest

- Hospital
- Library
- Point of Interest
- Post Office
- School
- Park & Ride

N W E S

0 0.25 0.5 Miles

Map revised: 02.21

16 CEDAR BLUFF CONNECTOR

(Weekdays and Saturdays)

SERVES:

- Cedar Bluff
- Knoxville Catholic High School
- Kroger at The Landing
- Parkwest Hospital
- Social Security Administration
- Walmart
- Windsor Square

kat KNOXVILLE AREA TRANSIT

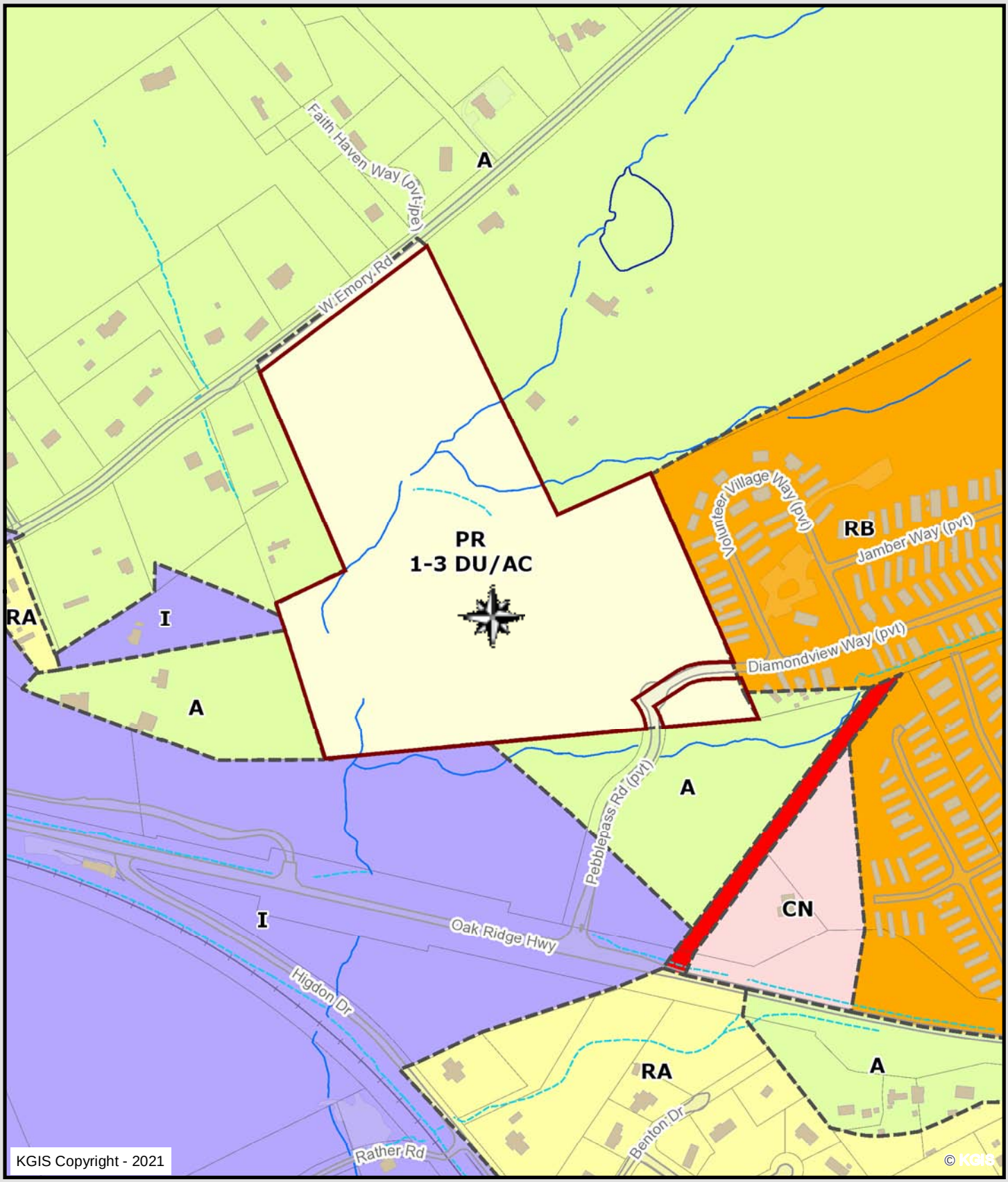
Information Updated: February 1, 2021

	Going from Wal Mart to Windsor Square				*Going from Windsor Square to Wal Mart*		
	T *Transfer to:*						*Rts. 11 & 90*
	Walmart 1	Park Village at Woodpark 2	Parkwest Hospital 3	Windsor Square 4	Parkwest Hospital 5	Cedar Bluff at Fox Lonas 6	Walmart 7
WEEKDAY SCHEDULE							
A.M.	6:15	6:27	6:32	6:42	6:50	6:54	7:10
	7:15	7:27	7:32	7:42	7:50	7:54	8:10
	8:15	8:27	8:32	8:42	8:50	8:54	9:10
	9:15	9:27	9:32	9:42	9:50	9:54	10:10
	10:15	10:27	10:32	10:42	10:50	10:54	11:10
	11:15	11:27	11:32	11:42	11:50	11:54	**12:10**
P.M.	**12:15**	**12:27**	**12:32**	**12:42**	**12:50**	**12:54**	**1:10**
	1:15	**1:27**	**1:32**	**1:42**	**1:50**	**1:54**	**2:10**
	2:15	**2:27**	**2:32**	**2:42**	**2:50**	**2:54**	**3:10**
	3:15	**3:27**	**3:32**	**3:42**	**3:50**	**3:54**	**4:10**
	4:15	**4:27**	**4:32**	**4:42**	**4:50**	**4:54**	**5:10**
	5:15	**5:27**	**5:32**	**5:42**	**5:50**	**5:54**	**6:10**
	6:15	**6:27**	**6:32**	**6:42**	**6:50**	**6:54**	**7:10**
	7:15	**7:27**	**7:32**	**7:42**	**7:50**	**7:54**	**8:10**
	8:15	**8:27**	**8:32**	**8:42**	**8:50**	**8:54**	**9:10**
	9:15	**9:27**	**9:32**	**9:42**	**9:50**	**9:54**	**10:10**
SATURDAY SCHEDULE							
A.M.	7:15	7:27	7:32	7:42	7:50	7:54	8:10
	8:15	8:27	8:32	8:42	8:50	8:54	9:10
	9:15	9:27	9:32	9:42	9:50	9:54	10:10
	10:15	10:27	10:32	10:42	10:50	10:54	11:10
	11:15	11:27	11:32	11:42	11:50	11:54	**12:10**
P.M.	**12:15**	**12:27**	**12:32**	**12:42**	**12:50**	**12:54**	**1:10**
	1:15	**1:27**	**1:32**	**1:42**	**1:50**	**1:54**	**2:10**
	2:15	**2:27**	**2:32**	**2:42**	**2:50**	**2:54**	**3:10**
	3:15	**3:27**	**3:32**	**3:42**	**3:50**	**3:54**	**4:10**
	4:15	**4:27**	**4:32**	**4:42**	**4:50**	**4:54**	**5:10**
	5:15	**5:27**	**5:32**	**5:42**	**5:50**	**5:54**	**6:10**
	6:15	**6:27**	**6:32**	**6:42**	**6:50**	**6:54**	**7:10**
	7:15	**7:27**	**7:32**	**7:42**	**7:50**	**7:54**	**8:10**
	8:15	**8:27**	**8:32**	**8:42**	**8:50**	**8:54**	**9:10**
	9:15	**9:27**	**9:32**	**9:42**	**9:50**	**9:54**	**10:10**

Need help reading this schedule?
Need other general information on how to ride?
Visit www.katbus.com or call 865-637-3000

APPENDIX D

ZONING MAP



Zoning Map

Knoxville - Knox County - KUB Geographic Information System

Printed: 2/7/2021 at 2:55:44 PM

0 200 400 800

ft

APPENDIX E

MANUAL TRAFFIC COUNT DATA

TRAFFIC COUNT DATA

Major Street: Oak Ridge Highway - SR 62 (WB-EB)
Minor Street: Pebblepass Road (SB)
Traffic Control: Stop Control on Pebblepass Road

2/9/2021 (Tuesday)
Mostly Cloudy, Cold
Conducted by: Ajax Engineering

	Pebblepass Road		Oak Ridge Highway		Oak Ridge Highway			
TIME	SOUTHBOUND		WESTBOUND		EASTBOUND		VEHICLE	PEAK
BEGIN	LT	RT	THRU	RT	LT	THRU	TOTAL	HOUR
7:00 AM	6	2	92	0	0	70	170	
7:15 AM	***5***	***5***	***111***	***2***	***4***	***74***	201	**7:15 AM - 8:15 AM**
7:30 AM	***8***	***6***	***143***	***2***	***4***	***73***	236	
7:45 AM	***7***	***3***	***117***	***3***	***1***	***82***	213	
8:00 AM	***10***	***4***	***102***	***9***	***0***	***79***	204	
8:15 AM	5	1	104	2	3	53	168	
8:30 AM	9	2	90	0	0	60	161	
8:45 AM	4	1	62	1	2	63	133	
TOTAL	54	24	821	19	14	554	1486	
11:00 AM	4	2	67	5	2	51	131	
11:15 AM	1	2	47	6	1	56	113	
11:30 AM	0	7	43	1	1	68	120	
11:45 AM	2	1	43	2	0	62	110	
12:00 PM	***6***	***2***	***41***	***1***	***2***	***64***	116	**12:00 PM - 1:00 PM**
12:15 PM	***4***	***2***	***64***	***1***	***3***	***52***	126	
12:30 PM	***4***	***2***	***53***	***2***	***6***	***65***	132	
12:45 PM	***5***	***3***	***58***	***5***	***0***	***61***	132	
TOTAL	26	21	416	23	15	479	980	
2:00 PM	6	4	55	2	5	70	142	
2:15 PM	4	1	56	3	4	69	137	
2:30 PM	1	1	48	2	1	92	145	
2:45 PM	4	2	70	7	6	94	183	
3:00 PM	3	2	61	5	1	99	171	
3:15 PM	5	2	61	5	4	83	160	
3:30 PM	6	5	78	11	1	62	163	
3:45 PM	9	2	69	12	3	76	171	
4:00 PM	6	3	71	7	5	110	202	
4:15 PM	3	2	70	5	2	199	281	
4:30 PM	***3***	***2***	***75***	***6***	***1***	***206***	293	**4:30 PM - 5:30 PM**
4:45 PM	***6***	***3***	***60***	***10***	***8***	***210***	297	
5:00 PM	***2***	***2***	***99***	***6***	***8***	***173***	290	
5:15 PM	***5***	***1***	***75***	***6***	***7***	***217***	311	
5:30 PM	4	1	67	5	1	164	242	
5:45 PM	3	4	75	5	0	133	220	
TOTAL	70	37	1090	97	57	2057	3408	

2021 AM Peak Hour **7:15 AM - 8:15 AM**

	Pebblepass Road		Oak Ridge Highway		Oak Ridge Highway	
TIME	SOUTHBOUND		WESTBOUND		EASTBOUND	
BEGIN	LT	RT	THRU	RT	LT	THRU
7:15 AM	5	5	111	2	4	74
7:30 AM	8	6	143	2	4	73
7:45 AM	7	3	117	3	1	82
8:00 AM	10	4	102	9	0	79
TOTAL	**30**	**18**	**473**	**16**	**9**	**308**
PHF	**0.75**	**0.75**	**0.83**	**0.44**	**0.56**	**0.94**

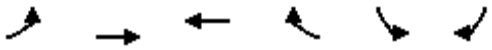
2021 PM Peak Hour **4:30 PM - 5:30 PM**

	Pebblepass Road		Oak Ridge Highway		Oak Ridge Highway	
TIME	SOUTHBOUND		WESTBOUND		EASTBOUND	
BEGIN	LT	RT	THRU	RT	LT	THRU
4:30 PM	3	2	75	6	1	206
4:45 PM	6	3	60	10	8	210
5:00 PM	2	2	99	6	8	173
5:15 PM	5	1	75	6	7	217
TOTAL	**16**	**8**	**309**	**28**	**24**	**806**
PHF	**0.67**	**0.67**	**0.78**	**0.70**	**0.75**	**0.93**

APPENDIX F

CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 8)

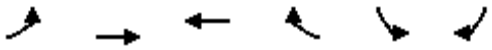
EXISTING TRAFFIC CONDITIONS



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	9	308	473	16	30	18
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.56	0.94	0.83	0.44	0.75	0.75
Hourly flow rate (vph)	16	328	570	36	40	24
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	606				930	570
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	606				930	570
tC, single (s)	4.2				6.5	6.3
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	98				86	95
cM capacity (veh/h)	929				285	513

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	16	328	570	36	40	24
Volume Left	16	0	0	0	40	0
Volume Right	0	0	0	36	0	24
cSH	929	1700	1700	1700	285	513
Volume to Capacity	0.02	0.19	0.34	0.02	0.14	0.05
Queue Length 95th (ft)	1	0	0	0	12	4
Control Delay (s)	8.9	0.0	0.0	0.0	19.7	12.4
Lane LOS	A				C	B
Approach Delay (s)	0.4		0.0		16.9	
Approach LOS					C	

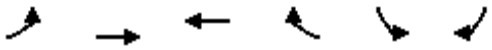
Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	34.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	11	370	568	19	36	22
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.56	0.94	0.83	0.44	0.75	0.75
Hourly flow rate (vph)	20	394	684	43	48	29
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	728				1117	684
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	728				1117	684
tC, single (s)	4.2				6.5	6.3
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	98				78	93
cM capacity (veh/h)	836				218	441

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	20	394	684	43	48	29
Volume Left	20	0	0	0	48	0
Volume Right	0	0	0	43	0	29
cSH	836	1700	1700	1700	218	441
Volume to Capacity	0.02	0.23	0.40	0.03	0.22	0.07
Queue Length 95th (ft)	2	0	0	0	20	5
Control Delay (s)	9.4	0.0	0.0	0.0	26.1	13.7
Lane LOS	A				D	B
Approach Delay (s)	0.4		0.0		21.4	
Approach LOS					C	

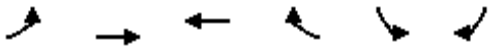
Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	24	806	309	28	16	8
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.75	0.93	0.78	0.70	0.67	0.67
Hourly flow rate (vph)	32	867	396	40	24	12
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	436				1327	396
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	436				1327	396
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				86	98
cM capacity (veh/h)	1134				168	657

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	32	867	396	40	24	12
Volume Left	32	0	0	0	24	0
Volume Right	0	0	0	40	0	12
cSH	1134	1700	1700	1700	168	657
Volume to Capacity	0.03	0.51	0.23	0.02	0.14	0.02
Queue Length 95th (ft)	2	0	0	0	12	1
Control Delay (s)	8.3	0.0	0.0	0.0	30.0	10.6
Lane LOS	A				D	B
Approach Delay (s)	0.3		0.0		23.5	
Approach LOS					C	

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	52.4%	ICU Level of Service	A
Analysis Period (min)	15		

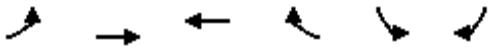


Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	29	967	371	34	19	10
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.75	0.93	0.78	0.70	0.67	0.67
Hourly flow rate (vph)	39	1040	476	49	28	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	524				1593	476
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	524				1593	476
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				75	97
cM capacity (veh/h)	1053				114	593

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	39	1040	476	49	28	15
Volume Left	39	0	0	0	28	0
Volume Right	0	0	0	49	0	15
cSH	1053	1700	1700	1700	114	593
Volume to Capacity	0.04	0.61	0.28	0.03	0.25	0.03
Queue Length 95th (ft)	3	0	0	0	23	2
Control Delay (s)	8.6	0.0	0.0	0.0	46.5	11.2
Lane LOS	A				E	B
Approach Delay (s)	0.3		0.0		34.4	
Approach LOS					D	

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		

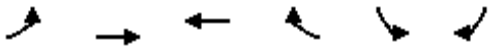
OPENING YEAR TRAFFIC CONDITIONS (WITHOUT THE PROJECT)



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	11	389	596	19	36	22
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.56	0.94	0.83	0.44	0.75	0.75
Hourly flow rate (vph)	20	414	718	43	48	29
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	761				1171	718
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	761				1171	718
tC, single (s)	4.2				6.5	6.3
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	98				76	93
cM capacity (veh/h)	812				202	422

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	20	414	718	43	48	29
Volume Left	20	0	0	0	48	0
Volume Right	0	0	0	43	0	29
cSH	812	1700	1700	1700	202	422
Volume to Capacity	0.02	0.24	0.42	0.03	0.24	0.07
Queue Length 95th (ft)	2	0	0	0	22	6
Control Delay (s)	9.5	0.0	0.0	0.0	28.2	14.2
Lane LOS	A				D	B
Approach Delay (s)	0.4		0.0		22.9	
Approach LOS					C	

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	41.4%	ICU Level of Service	A
Analysis Period (min)	15		

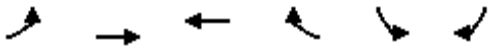


Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	29	1015	390	34	19	10
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.75	0.93	0.78	0.70	0.67	0.67
Hourly flow rate (vph)	39	1091	500	49	28	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	549				1669	500
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	549				1669	500
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				72	97
cM capacity (veh/h)	1031				103	575

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	39	1091	500	49	28	15
Volume Left	39	0	0	0	28	0
Volume Right	0	0	0	49	0	15
cSH	1031	1700	1700	1700	103	575
Volume to Capacity	0.04	0.64	0.29	0.03	0.28	0.03
Queue Length 95th (ft)	3	0	0	0	26	2
Control Delay (s)	8.6	0.0	0.0	0.0	53.0	11.4
Lane LOS	A				F	B
Approach Delay (s)	0.3		0.0		38.6	
Approach LOS					E	

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	17	389	596	29	67	39
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.56	0.94	0.83	0.44	0.75	0.75
Hourly flow rate (vph)	30	414	718	66	89	52
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	784				1193	718
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	784				1193	718
tC, single (s)	4.2				6.5	6.3
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	96				54	88
cM capacity (veh/h)	796				194	422

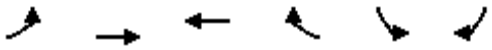
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	30	414	718	66	89	52
Volume Left	30	0	0	0	89	0
Volume Right	0	0	0	66	0	52
cSH	796	1700	1700	1700	194	422
Volume to Capacity	0.04	0.24	0.42	0.04	0.46	0.12
Queue Length 95th (ft)	3	0	0	0	55	10
Control Delay (s)	9.7	0.0	0.0	0.0	38.6	14.7
Lane LOS	A				E	B
Approach Delay (s)	0.7		0.0		29.8	
Approach LOS					D	

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	58	0	16	30	0	48
Sign Control	Stop		Free			Free
Grade	-3%		3%			0%
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	64	0	18	33	0	53
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	88	34			51	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	88	34			51	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	93	100			100	
cM capacity (veh/h)	918	1044			1568	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	64	51	53
Volume Left	64	0	0
Volume Right	0	33	0
cSH	918	1700	1568
Volume to Capacity	0.07	0.03	0.00
Queue Length 95th (ft)	6	0	0
Control Delay (s)	9.2	0.0	0.0
Lane LOS	A		
Approach Delay (s)	9.2	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	53	1015	390	63	39	21
Sign Control		Free	Free		Stop	
Grade		6%	-6%		4%	
Peak Hour Factor	0.75	0.93	0.78	0.70	0.67	0.67
Hourly flow rate (vph)	71	1091	500	90	58	31
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	590				1733	500
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	590				1733	500
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				36	95
cM capacity (veh/h)	995				90	575

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	71	1091	500	90	58	31
Volume Left	71	0	0	0	58	0
Volume Right	0	0	0	90	0	31
cSH	995	1700	1700	1700	90	575
Volume to Capacity	0.07	0.64	0.29	0.05	0.64	0.05
Queue Length 95th (ft)	6	0	0	0	77	4
Control Delay (s)	8.9	0.0	0.0	0.0	98.6	11.6
Lane LOS	A				F	B
Approach Delay (s)	0.5		0.0		68.2	
Approach LOS					F	

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	29	0	53	63	0	31
Sign Control	Stop		Free			Free
Grade	-3%		3%			0%
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	32	0	59	70	0	34
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	128	94			129	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	128	94			129	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	100			100	
cM capacity (veh/h)	871	969			1469	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	32	129	34
Volume Left	32	0	0
Volume Right	0	70	0
cSH	871	1700	1469
Volume to Capacity	0.04	0.08	0.00
Queue Length 95th (ft)	3	0	0
Control Delay (s)	9.3	0.0	0.0
Lane LOS	A		
Approach Delay (s)	9.3	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	16.6%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX G

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)

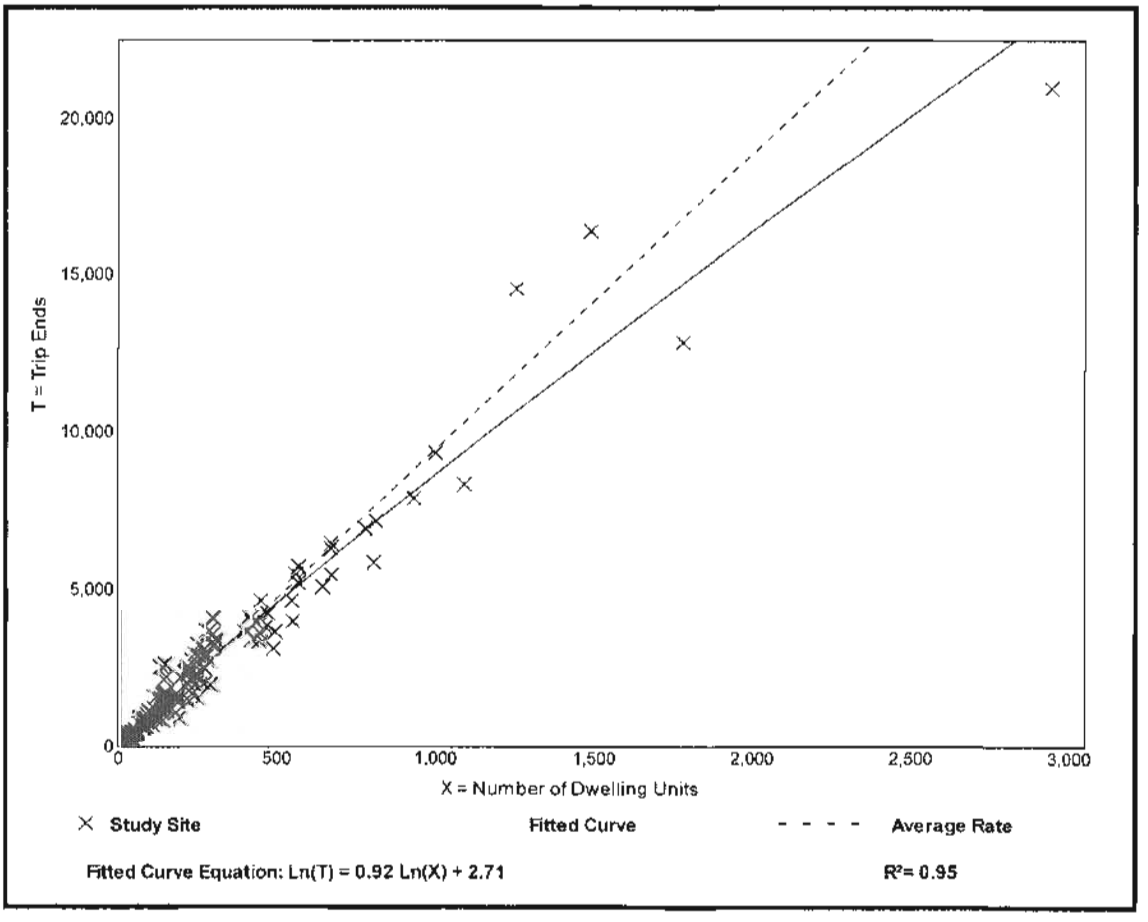
Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

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



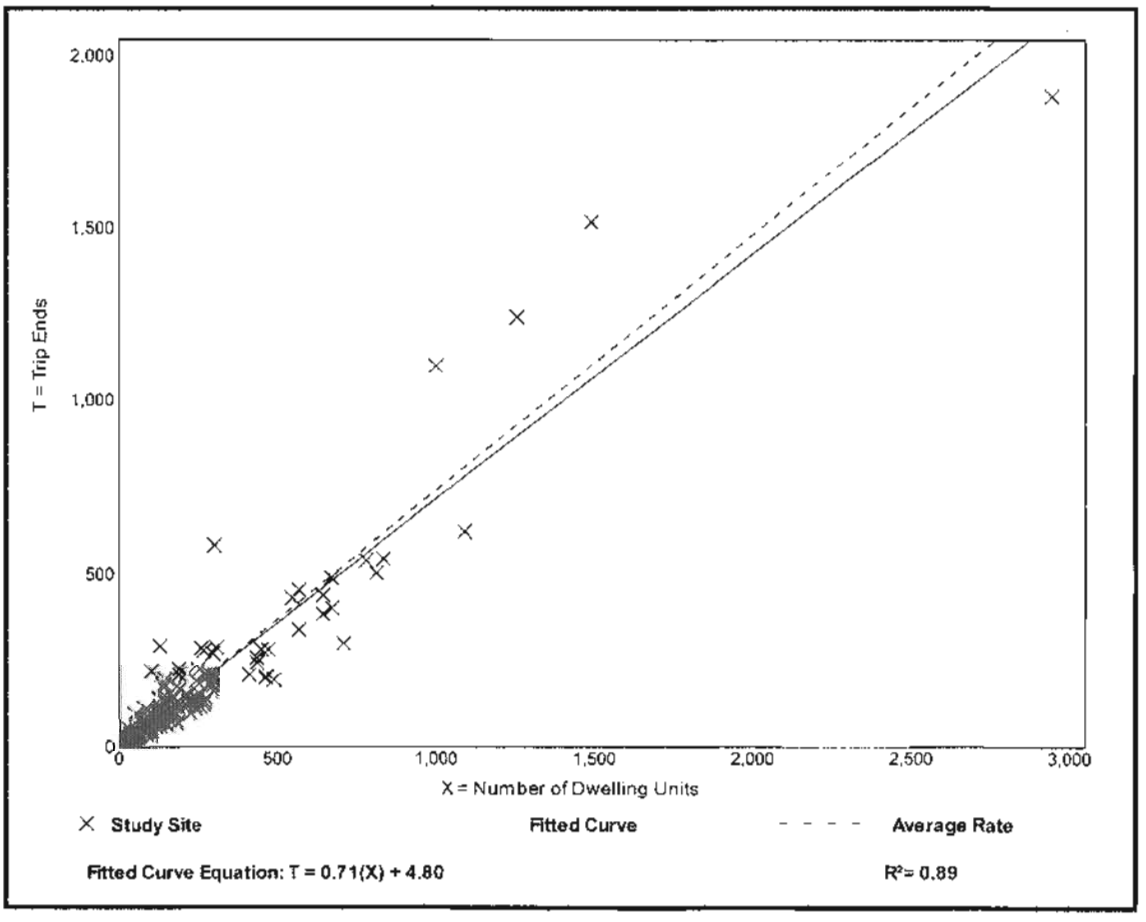
Single-Family Detached Housing
(210)

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



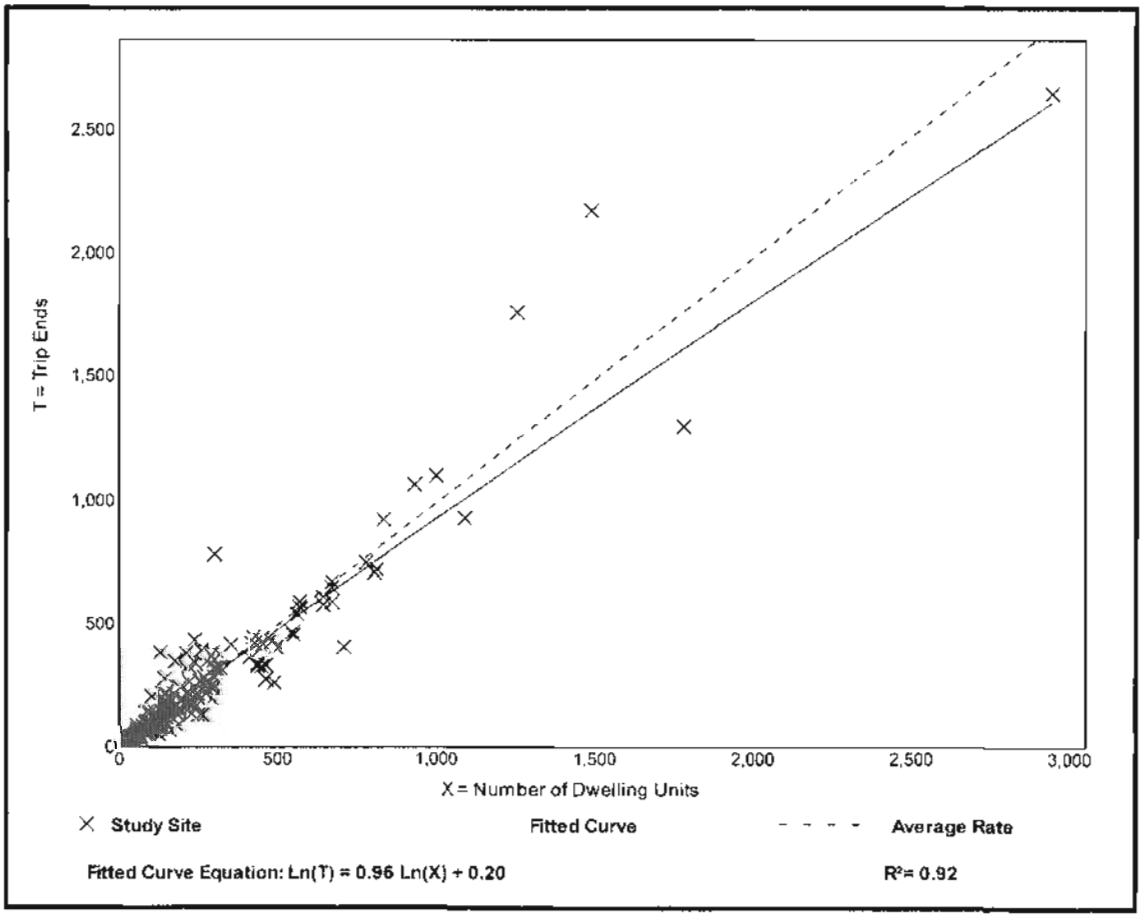
Single-Family Detached Housing
(210)

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



TRIP GENERATION FOR PEBBLEPASS ROAD SUBDIVISION

82 Single-Family Detached 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	82 Houses	867	25%	75%		63%	37%	
				16	48	64	53	31	84
Total New Volume Site Trips			**867**	**16**	**48**	**64**	**53**	**31**	**84**

ITE Trip Generation Manual, 10th Edition

Trips calculated by using Fitted Curve Equation

TRIP GENERATION FOR PEBBLEPASS ROAD SUBDIVISION

82 Single-Family Detached Houses

82 Residential Houses = X

Weekday:

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

$Ln(T) = 0.92 * 4.41 + 2.71$

$Ln(T) = 6.76$

T = 867 trips

Peak Hour of Adjacent Traffic between 7 and 9 am:

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

$T = 0.71 * 82 + 4.80$

T = 64 trips

Peak Hour of Adjacent Traffic between 4 and 6 pm:

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

$Ln(T) = 0.96 * 4.41 + 0.20$

$Ln(T) = 4.43$

T = 84 trips

APPENDIX H

MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

Traffic Signal Warrant Analysis

Project Name	**Pebblepass Road Subdivision**
Project/File #	**#2102**
Scenario	**2021 - Existing Traffic Volumes (+20%)**

Intersection Information	
Major Street Name	Oak Ridge Highway
North/South or East/West	E/W
Speed Limit > 40 mph	Yes
# of Approach Lanes	1
% of Right Turn Traffic to Include	0%
Minor Street Name	Pebblepass 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)	Yes
All-Way Stop Warrant	No

Traffic Signal Warrant Analysis

Oak Ridge Highway (Major 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	11	359		
8 - 9 AM	6	306		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	5	284		
12 - 1 PM	13	290		
1 - 2 PM				
2 - 3 PM	19	390		
3 - 4 PM	11	384		
4 - 5 PM	19	870		
5 - 6 PM	19	824		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			3,810	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		556	8	
8 - 9 AM		430	14	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM		240	17	
12 - 1 PM		259	11	
1 - 2 PM				
2 - 3 PM		275	17	
3 - 4 PM		323	40	
4 - 5 PM		331	34	
5 - 6 PM		379	26	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			2,960	0

Pebblepass Road (Minor Street) Volume

Northbound 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

Southbound 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	31		19	
8 - 9 AM	34		10	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	8		14	
12 - 1 PM	23		11	
1 - 2 PM				
2 - 3 PM	18		10	
3 - 4 PM	28		13	
4 - 5 PM	22		12	
5 - 6 PM	17		10	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			280	0

Traffic Signal Warrant Analysis

Warrants 1 - 3 (Volume Warrants)

Project Name	Pebblepass Road Subdivision
Project/File #	#2102
Scenario	2021 - Existing Traffic Volumes (+20%)

Intersection Information			
Major Street (E/W Road)	Oak Ridge Highway	Minor Street (N/S Road)	Pebblepass Road
Analyzed with	1 approach lane	Analyzed with	1 Approach Lane
Total Approach Volume	6770 vehicles	Total Approach Volume	280 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	1 percent applied	Right turn reduction of	1 percent applied

Reduction applied to warrant thresholds due to high speed on Oak Ridge Highway

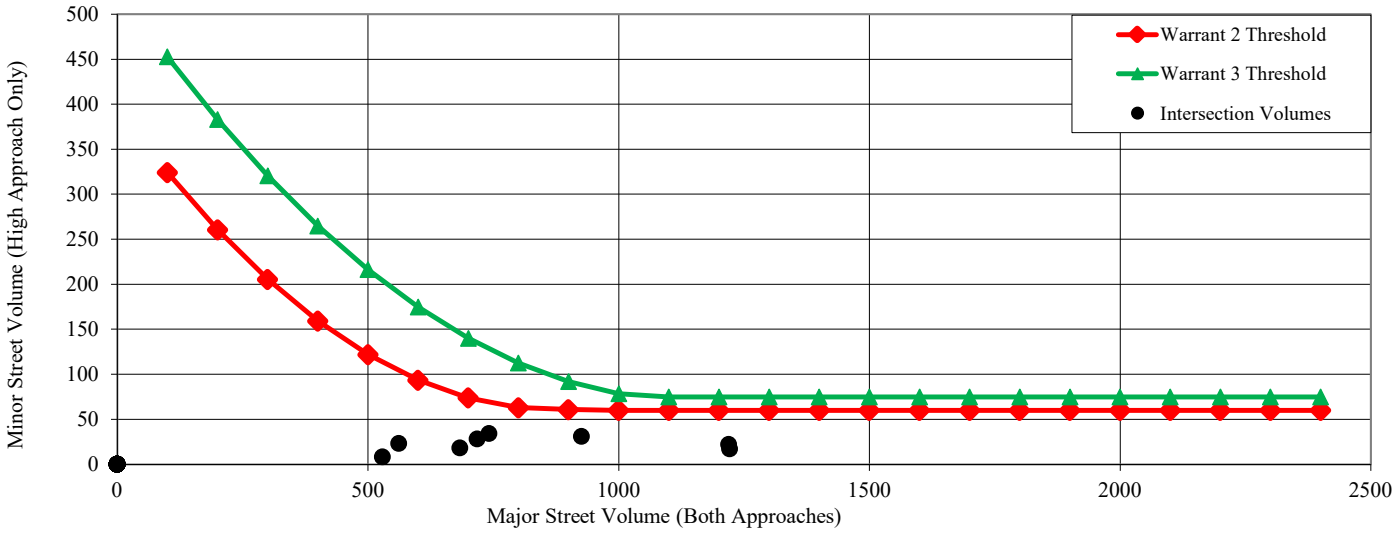
Warrant 1, Eight Hour Vehicular Volume			
	Condition A	**Condition B**	**Condition A+B***
Condition Satisfied?	**Not satisfied**	**Not satisfied**	**Not satisfied**
Required values reached for	0 hours	0 hours	0 (Cond. A) & 0 (Cond. B)
Criteria - Major Street (veh/hr)	350	525	280 (Cond. A) & 420 (Cond. B)
Criteria - Minor Street (veh/hr)	105	53	84 (Cond. A) & 42 (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 A	**Condition B**
Condition Satisfied?	**Satisfied**	**Not Satisfied**
Required values reached for	799 total, 150 minor, 6.3 delay	0 hours
Criteria - Total Approach Volume (veh in one hour)	650	See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)	150	
Criteria - Minor Street High Side Delay (veh-hrs)	5	

Figure 4C-2 (Warrant 2 - 70% Factor) & Figure 4C-4 (Warrant 3 - 70% Factor)



Traffic Signal Warrant Analysis

Project Name	**Pebblepass Road Subdivision**
Project/File #	**#2102**
Scenario	**2026 - Projected Traffic Volumes - 1% General Growth**

Intersection Information	
Major Street Name	Oak Ridge Highway
North/South or East/West	E/W
Speed Limit > 40 mph	Yes
# of Approach Lanes	1
% of Right Turn Traffic to Include	0%
Minor Street Name	Pebblepass 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)	Yes
All-Way Stop Warrant	No

Traffic Signal Warrant Analysis

Oak Ridge Highway (Major 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	18	377		
8 - 9 AM	11	321		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	9	298		
12 - 1 PM	17	305		
1 - 2 PM				
2 - 3 PM	24	410		
3 - 4 PM	17	403		
4 - 5 PM	26	914		
5 - 6 PM	26	865		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,041	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		584	21	
8 - 9 AM		452	24	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM		252	24	
12 - 1 PM		272	18	
1 - 2 PM				
2 - 3 PM		289	26	
3 - 4 PM		339	51	
4 - 5 PM		348	46	
5 - 6 PM		398	40	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			3,184	0

Pebblepass Road (Minor Street) Volume

Northbound 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

Southbound 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	69		40	
8 - 9 AM	63		25	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	28		25	
12 - 1 PM	45		23	
1 - 2 PM				
2 - 3 PM	45		24	
3 - 4 PM	61		31	
4 - 5 PM	59		32	
5 - 6 PM	58		32	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			660	0

Traffic Signal Warrant Analysis

Warrants 1 - 3 (Volume Warrants)

Project Name	Pebblepass Road Subdivision
Project/File #	#2102
Scenario	2026 - Projected Traffic Volumes - 1% General Growth

Intersection Information			
Major Street (E/W Road)	Oak Ridge Highway	Minor Street (N/S Road)	Pebblepass Road
Analyzed with	1 approach lane	Analyzed with	1 Approach Lane
Total Approach Volume	7225 vehicles	Total Approach Volume	660 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	1 percent applied	Right turn reduction of	1 percent applied

Reduction applied to warrant thresholds due to high speed on Oak Ridge Highway

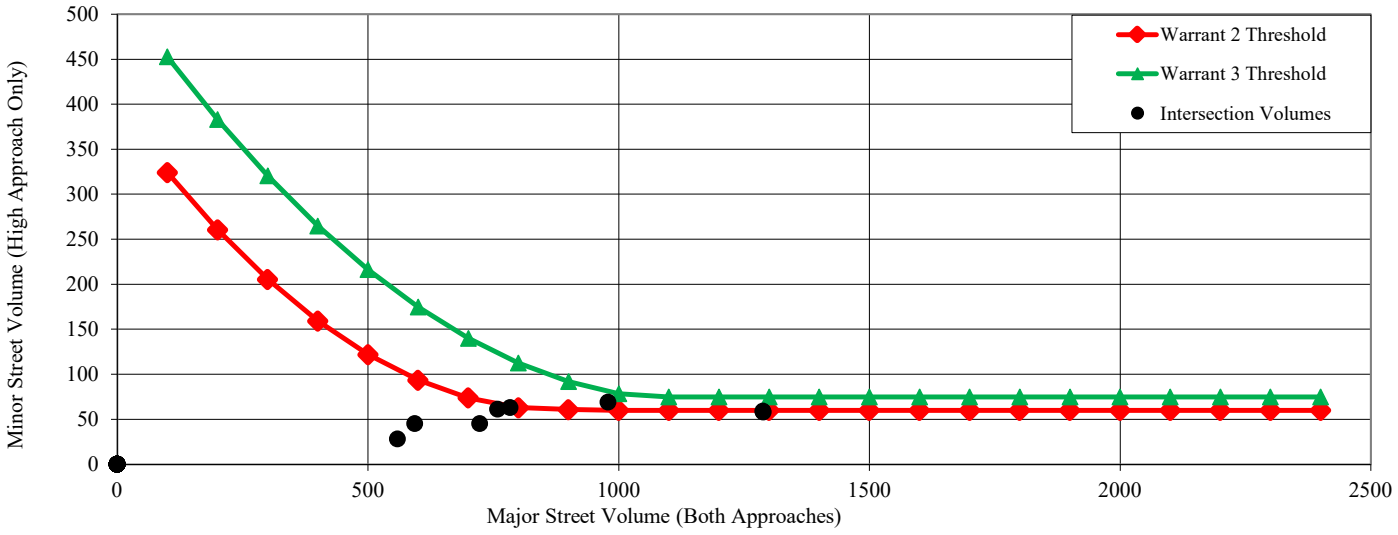
Warrant 1, Eight Hour Vehicular Volume			
	Condition A	**Condition B**	**Condition A+B***
Condition Satisfied?	**Not satisfied**	**Not satisfied**	**Not satisfied**
Required values reached for	0 hours	5 hours	0 (Cond. A) & 7 (Cond. B)
Criteria - Major Street (veh/hr)	350	525	280 (Cond. A) & 420 (Cond. B)
Criteria - Minor Street (veh/hr)	105	53	84 (Cond. A) & 42 (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	1 hour
Criteria	See Figure Below

Warrant 3, Peak Hour Vehicular Volume		
	Condition A	**Condition B**
Condition Satisfied?	**Satisfied**	**Not Satisfied**
Required values reached for	799 total, 150 minor, 6.3 delay	0 hours
Criteria - Total Approach Volume (veh in one hour)	650	See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)	150	
Criteria - Minor Street High Side Delay (veh-hrs)	5	

Figure 4C-2 (Warrant 2 - 70% Factor) & Figure 4C-4 (Warrant 3 - 70% Factor)



TRAFFIC SIGNAL WARRANTS

PROJECTED FUTURE VOLUMES IN YEAR 2026 WITH TRAFFIC GROWTH AND GENERATED TRAFFIC

	Pebblepass Road		Oak Ridge Highway		Oak Ridge Highway		
TIME	SOUTHBOUND		WESTBOUND		EASTBOUND		
BEGIN	LT	RT	THRU	RT	LT	THRU	
7:00 AM	6	2	92	0	0	70	Existing Volumes
7:15 AM	5	5	111	2	4	74	Existing Volumes
7:30 AM	8	6	143	2	4	73	Existing Volumes
7:45 AM	7	3	117	3	1	82	Existing Volumes
Sum	26	16	463	7	9	299	Sum
+20% Increase	31	19	556	8	11	359	Increase of 20% due to Covid
General Growth	0	0	27.8	0	0	17.95	Growth Rate of 1.0% for 5 year
Trips Generated 7-8 am	38	21	0	13	7	0	Trips Generated
2026	69	40	584	21	18	377	Total Sum
8:00 AM	10	4	102	9	0	79	
8:15 AM	5	1	104	2	3	53	
8:30 AM	9	2	90	0	0	60	
8:45 AM	4	1	62	1	2	63	
Sum	28	8	358	12	5	255	
+20% Increase	34	10	430	14	6	306	
General Growth	0	0	21.5	0	0	15.3	
Trips Generated 8-9 am	29	15	0	10	5	0	
2026	63	25	452	24	11	321	
11:00 AM	4	2	67	5	2	51	
11:15 AM	1	2	47	6	1	56	
11:30 AM	0	7	43	1	1	68	
11:45 AM	2	1	43	2	0	62	
Sum	7	12	200	14	4	237	
+20% Increase	8	14	240	17	5	284	
General Growth	0	0	12	0	0	14.2	
Trips Generated 11am-12 pm	20	11	0	7	4	0	
2026	28	25	252	24	9	298	
12:00 PM	6	2	41	1	2	64	
12:15 PM	4	2	64	1	3	52	
12:30 PM	4	2	53	2	6	65	
12:45 PM	5	3	58	5	0	61	
Sum	19	9	216	9	11	242	
+20% Increase	23	11	259	11	13	290	
General Growth	0	0	12.95	0	0	14.5	
Trips Generated 12-1 pm	22	12	0	7	4	0	
2026	45	23	272	18	17	305	
2:00 PM	6	4	55	2	5	70	
2:15 PM	4	1	56	3	4	69	
2:30 PM	1	1	48	2	1	92	
2:45 PM	4	2	70	7	6	94	
Sum	15	8	229	14	16	325	
+20% Increase	18	10	275	17	19	390	
General Growth	0	0	13.75	0	0	19.5	
Trips Generated 2-3 pm	27	14	0	9	5	0	
2026	45	24	289	26	24	410	
3:00 PM	3	2	61	5	1	99	
3:15 PM	5	2	61	5	4	83	
3:30 PM	6	5	78	11	1	62	
3:45 PM	9	2	69	12	3	76	
Sum	23	11	269	33	9	320	
+20% Increase	28	13	323	40	11	384	
General Growth	0	0	16.15	0	0	19.2	
Trips Generated 3-4 pm	33	18	0	11	6	0	
2026	61	31	339	51	17	403	
4:00 PM	6	3	71	7	5	110	
4:15 PM	3	2	70	5	2	199	
4:30 PM	3	2	75	6	1	206	
4:45 PM	6	3	60	10	8	210	
Sum	18	10	276	28	16	725	
+20% Increase	22	12	331	34	19	870	
General Growth	0	0	16.55	0	0	43.5	
Trips Generated 4-5 pm	37	20	0	12	7	0	
2026	59	32	348	46	26	914	
5:00 PM	2	2	99	6	8	173	
5:15 PM	5	1	75	6	7	217	
5:30 PM	4	1	67	5	1	164	
5:45 PM	3	4	75	5	0	133	
Sum	14	8	316	22	16	687	
+20% Increase	17	10	379	26	19	824	
General Growth	0	0	18.95	0	0	41.2	
Trips Generated 5-6 pm	41	22	0	14	7	0	
2026	58	32	398	40	26	865	

Assumed Average Growth Rate (%)=	1.0%	20% Increase due to Covid
Number of years =	5	
Horizon Year =	2026	# of Horizon Years = 5

Note 1: The entering and exiting traffic volumes are estimated based on trip generation of the entire development, based on assumed amounts of entering and exiting traffic, assumed percentages of directional traffic, and the assumed percentage of trips based on time of day (from TDOT Table 4.2 in Traffic Design Manual)

Note 2: It is assumed that the construction of homes is linear growth

Note 3: No general growth factor is applied to entering and exiting volumes at Pebblepass Road

Trips Generated by Entire Development: 867

Daily Trips Generated from Subdivision/Year: 173.4 = 867 / 5

867 trips by 2026

Traffic Movement Assumed Distribution:	AM	PM
	65% from WB RT, 20% from EB LT	55% from WB RT, 30% from EB LT
	65% to SB LT, 20% to SB RT	65% to SB LT, 20% to SB RT
	15% to and from north	

Single-Family Detached Housing #210

Entering and Exiting %'s (from ITE Trip Generation):			Directional Distribution Assumptions:			
25%	Entering	AM Hours	65%	from WB RT	65%	to SB LT
75%	Exiting		35%	from EB LT	35%	to SB RT
			0%	from EB RT	0%	to NB LT (at new north entrance)
50%	Entering	Mid-Day Hours	55%	from WB RT	65%	to SB LT (same as PM D. Distribution)
50%	Exiting		45%	from EB LT	35%	to SB RT (same as PM D. Distribution)
			0%	from EB RT	0%	to NB LT (at new north entrance)
63%	Entering	PM Hours	55%	from WB RT	65%	to SB LT
37%	Exiting		45%	from EB LT	35%	to SB RT
			0%	from EB RT	0%	to NB LT (at new north entrance)

TDOT Traffic Engineering Office - Table 4.2 - TDOT Traffic Design Manual
Population Tier = A (Knoxville)
TDOT Region 1 Average for Arterial Facilities (Two Lane)

Time of Day	Percentage of Trips
7-8 am	9.03%
8-9 am	6.78%
11 am-Noon	4.68%
Noon-1 pm	5.17%
2-3 pm	6.34%
3-4 pm	7.83%
4-5 pm	8.79%
5-6 pm	9.64%
	58.26%

For example, 7-8 AM for SB Right Turns:
Volume = (847 Daily Trips * (1/5)) * 75% Exiting * 20% Trips from SB RT * 9.03% Trips (at 7-8 AM)
Volume = 169.4 x .75 x .20 x .093

This spreadsheet is used to estimate the future project hourly volumes to determine if a intersection will meet traffic signal warrants

Check:

Enter:	**126**	
Exit:	**379**	
	505	**58.26% of daily total trips in 8 highest hours**

APPENDIX I

SIMTRAFFIC VEHICLE QUEUE LENGTHS

Intersection: 3: Oak Ridge Highway & Pebblepass Road

Movement	EB	SB	SB
Directions Served	L	L	R
Maximum Queue (ft)	44	90	79
Average Queue (ft)	9	37	21
95th Queue (ft)	32	74	55
Link Distance (ft)			384
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)	75	85	
Storage Blk Time (%)	0	1	0
Queuing Penalty (veh)	0	0	0

Intersection: 3: Oak Ridge Highway & Pebblepass Road

Movement	EB	WB	SB	SB
Directions Served	L	R	L	R
Maximum Queue (ft)	50	8	82	25
Average Queue (ft)	19	0	32	12
95th Queue (ft)	46	6	72	31
Link Distance (ft)				384
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	75	125	85	
Storage Blk Time (%)	0		3	
Queuing Penalty (veh)	0		1	

Ajax Engineering, LLC
11812 Black Road
Knoxville, TN 37932
ajaxengineering@gmail.com