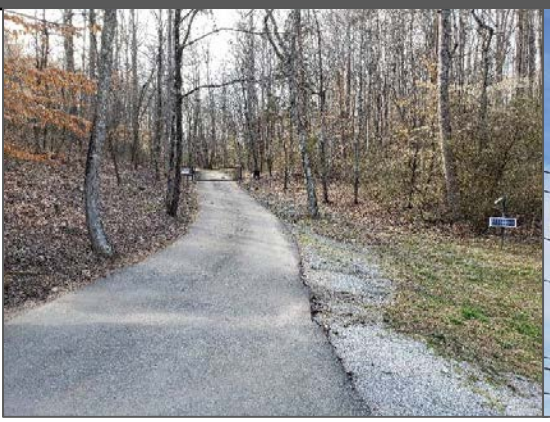
AJAX ENGINEERING

CIVIL ENGINEERING / TRAFFIC ENGINEERING

Transportation Impact Study
Catatoga Subdivision
Knox County, Tennessee



Revised April 2021

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EXECUTIVE SUMMARY

Preface:

HMH Development, Inc. is proposing a residential development off North Campbell Station Road between Yarnell Road and Hardin Valley Road in West Knox County, TN. This proposed residential development is named "Catatoga Subdivision". This development will consist of a maximum of 155 single-family detached residential houses on 80± acres. This development is anticipated to be fully built-out and occupied by the year 2026. 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 Catatoga Subdivision with a maximum of 155 single-family detached residential houses is calculated to generate 1,557 trips on an average weekday. Of these trips, 115 are estimated to occur during the AM peak hour and 155 trips in the PM peak hour in the year 2026.
- The development will have one entrance at North Campbell Station Road and will create a new unsignalized t-intersection. This intersection is projected to operate with minimal delays with adequate vehicular capacity. While outside the scope of this study but included in the manual traffic count, the existing intersection of North Campbell Station Road at Yarnell Road less than a half-mile to the south of the proposed development currently operates with high vehicle delays on the eastbound and westbound approaches on Yarnell Road.

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.

- It is recommended that a southbound right-turn lane be constructed on North Campbell Station Road at the subdivision entrance, Road "A". It is recommended that this right-turn lane be 50 feet in length with an 80-foot taper or the maximum length available within the right-of-way without encroachment to the adjacent north property.
- It is recommended that a northbound left-turn lane be constructed on North Campbell Station Road at the subdivision entrance, Road "A". It is recommended that this left-turn lane have a 50-foot storage length with a minimum 12:1 lane taper.
- It is recommended that a Stop Sign (R1-1) be installed, and a 24" white stop bar be applied to the Road "A" approach pavement at the intersection at North Campbell Station Road. The stop bar should be applied at a minimum of 4 feet away from the edge of North Campbell Station Road and should be placed at the desired stopping point that provides the maximum sight distance.
- Intersection sight distance on Road "A" at North Campbell Station Road must not be impacted by future landscaping or signage. Based on Inrix speed data of 36.8 mph and 37.4 mph in the northbound and southbound directions on North Campbell Station Road, the required intersection sight distance (ISD) is 368 feet to the south and 374 feet to the north at Road "A". Based on a 4% grade on North Campbell Station Road and the Inrix speed data, the stopping sight distance (SSD) is calculated to be 255 feet for northbound and 290 feet for southbound vehicles. The sight distance was verified in October 2020 and was determined to be adequate.
- It is recommended that a 25-mph Speed Limit Sign (R2-1) be posted near the front of Road "A" off North Campbell Station Road. It is also recommended that a "No Outlet" (W14-2aL) sign be posted near the front of Road "A". This sign can be posted below the street name sign.
- 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.
- Sidewalks should have appropriate ADA-compliant curbed ramps at intersection corners, and the sidewalks are recommended to be 5 feet minimum in width. Crosswalks should be marked on the road pavement where pedestrians are expected to cross.
- 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.
- Since the proposed layout of the Catatoga Subdivision only includes one means of ingress and egress and will have more than 150 houses, the subdivision entrance is recommended to be designed and constructed with a boulevard roadway section. At a minimum, the boulevard section should have a 10-foot median with 2 – 18-foot lanes within 60 feet of right-of-way. Typically, in Knox County, the boulevard road section is designed and constructed to the first intersecting street within the development. However, after discussion with Knox County Engineering, it was determined that it would be acceptable to keep the proposed boulevard design as shown in Figure 3.
- 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 residential development is shown on a map in Figure 1. The proposed development will be located off North Campbell Station Road between Hardin Valley Road to the north and Yarnell Road to the south in West Knox County, TN. The residential development will comprise several internal paved roads built for a maximum of 155 single-family residential houses on 80± acres. Transportation impacts associated with the proposed development were analyzed at the following existing roadways and intersections, where the most significant impact is expected and as requested by Knoxville/Knox County Planning:

- North Campbell Station Road at Yarnell Road
- North Campbell Station Road at Road "A" (Subdivision Entrance)

The proposed development property is in a rural area of West Knox County, TN, that is rapidly becoming more urbanized. There are many single-family residences, unused/woodland properties, and farm properties near this development. The proposed site property is currently undeveloped except for one residential house and a larger building recently but formerly used as a dog and cat kennel boarding business (Catatoga Kennels). The east side of the proposed development site is entirely forested, except for the buildings and a small lake. The western portion of the proposed site is currently used for farm production and has pockets of forest.

Catatoga Kennels Signage at North Campbell Station Road

The development will be potentially comprised of two properties. The main property is 62.5 acres and will contain 120 house lots. The other property is 17.5 acres and currently has a property agreement option that could provide area for an additional 35 house lots.

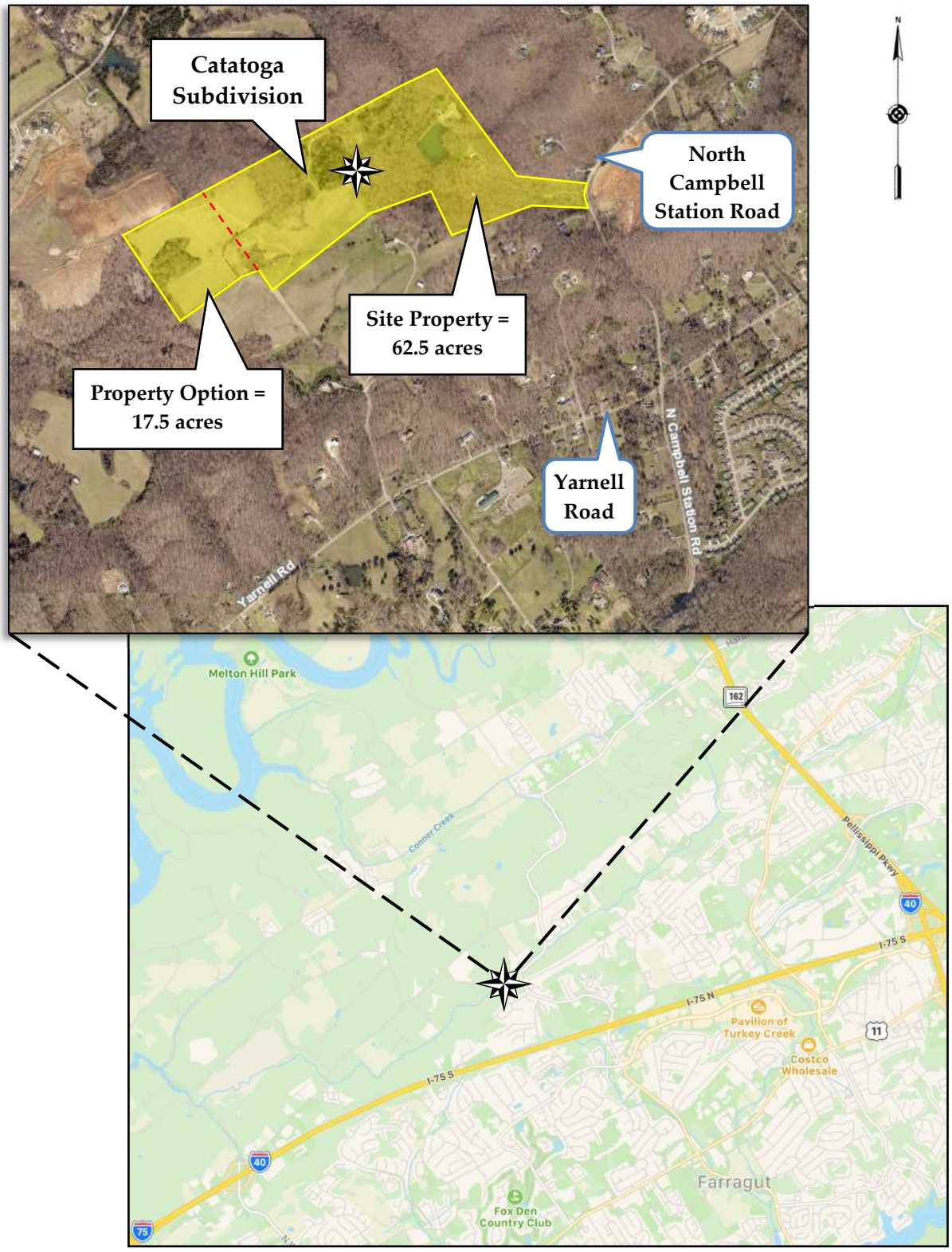


Figure 1
Location Map

- **EXISTING ROADWAYS:**

Table 1 lists the characteristics of the key existing roadway 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
North Campbell Station Road	Minor Arterial	30 mph	2 undivided	21 feet	None	No sidewalks along roadway	No bike lanes

[1] 2018 Major Road Plan by Knoxville/Knox County Planning
[2] Edge of pavement near project site
[3] According to Knoxville Area Transit System Map

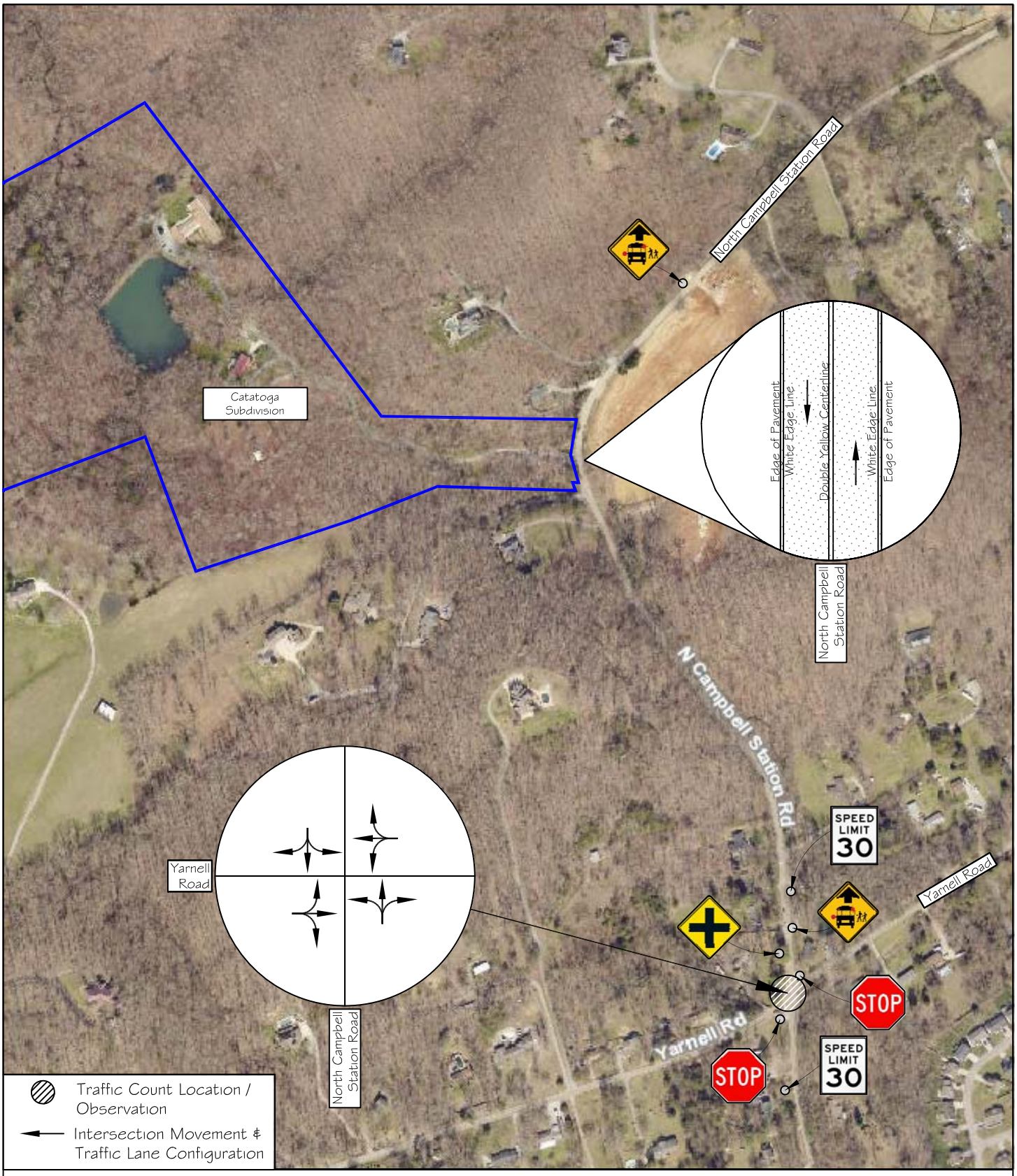
North Campbell Station Road is classified as a Minor Arterial and traverses in a general north-south direction but makes several turns in its length. On its south side, North Campbell Station Road begins at the signalized intersection of Kingston Pike (US 11/US 70/SR 1) in the Town of Farragut, and on its north side, the road terminates at a t-intersection with Hardin Valley Road for a total length of 4.8 miles. North Campbell Station Road provides access to Interstate 40/75 at Exit 373. This Interstate access is 2.3 miles to the south of the proposed Catatoga Subdivision entrance on North Campbell Station Road.

North Campbell Station Road at Proposed Subdivision Entrance Location, Road "A"

At the location of the subdivision's proposed entrance, Road "A", North Campbell Station Road currently consists of a 2-lane pavement section with faded white edge lines and a double yellow centerline. Pavement widths along North Campbell Road are assumed to be variable. Within several hundred feet of the subdivision's proposed access point, the pavement was measured to slightly fluctuate between 21 feet in width to just over 22 feet. Roadway lighting is not present in the adjacent area along North Campbell Station Road.

North Campbell Station Road makes an approximately 75° horizontal turn at a substantial road curve at the subdivision's proposed access point. The subdivision's proposed access point will intersect North Campbell Station Road near where the existing driveway is located for Catatoga Kennels and near the center of this existing horizontal curve.

Figure 2 shows the lane configurations of the roadways and intersections 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.



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NOT TO SCALE

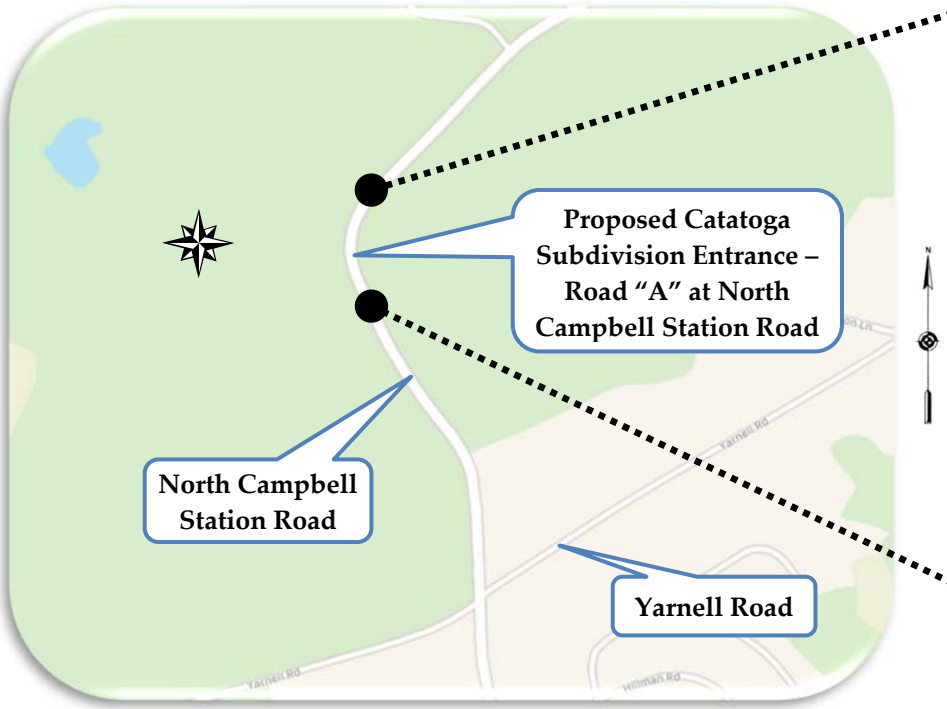
NORTH

FIGURE 2

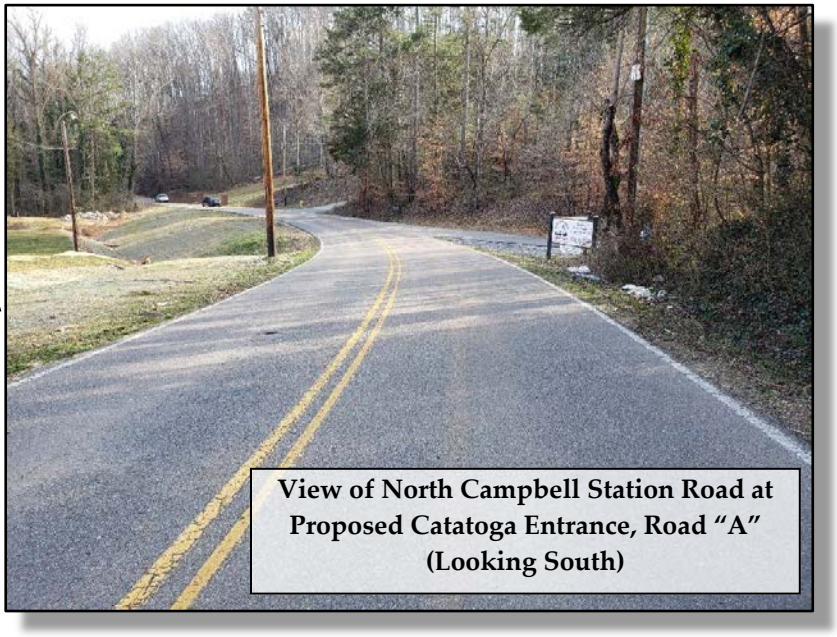
Catatoga Subdivision

Traffic Count Location, Traffic Signage & Existing Lane Configurations

PHOTO EXHIBITS

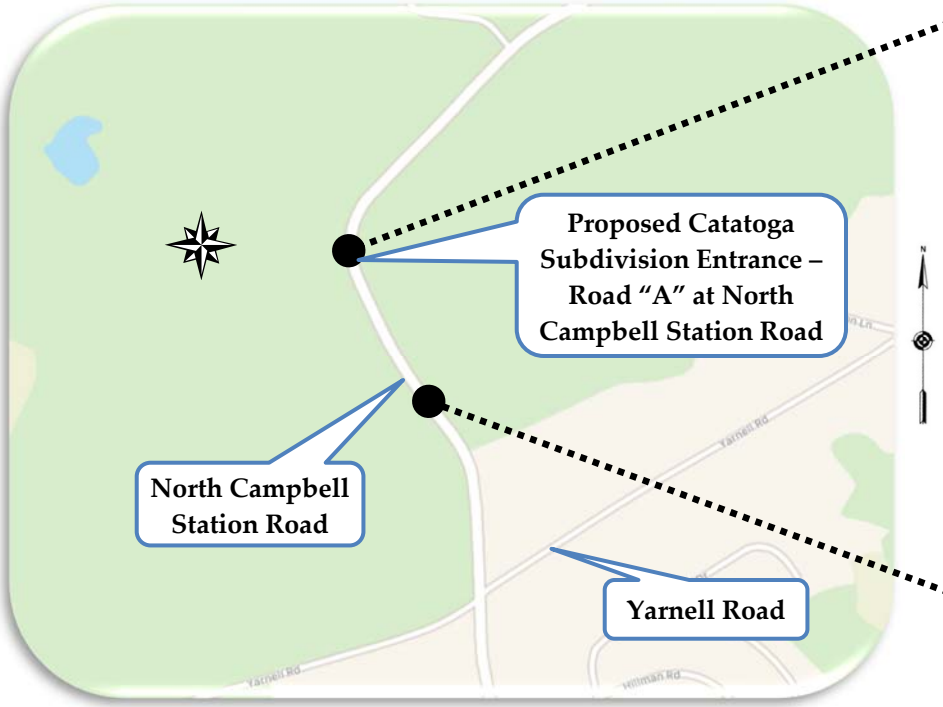


North Campbell Station Road

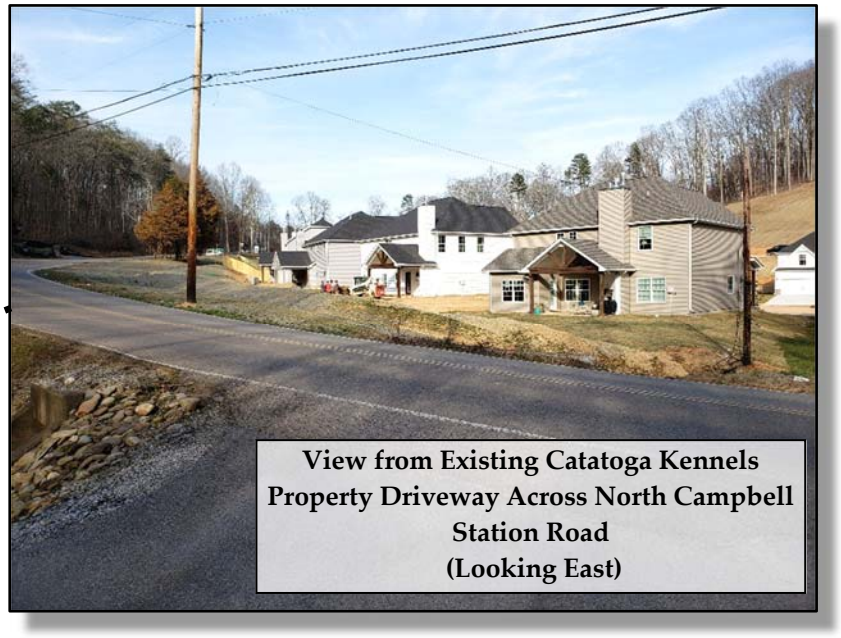


View of North Campbell Station Road at Proposed Catatoga Entrance, Road "A" (Looking South)

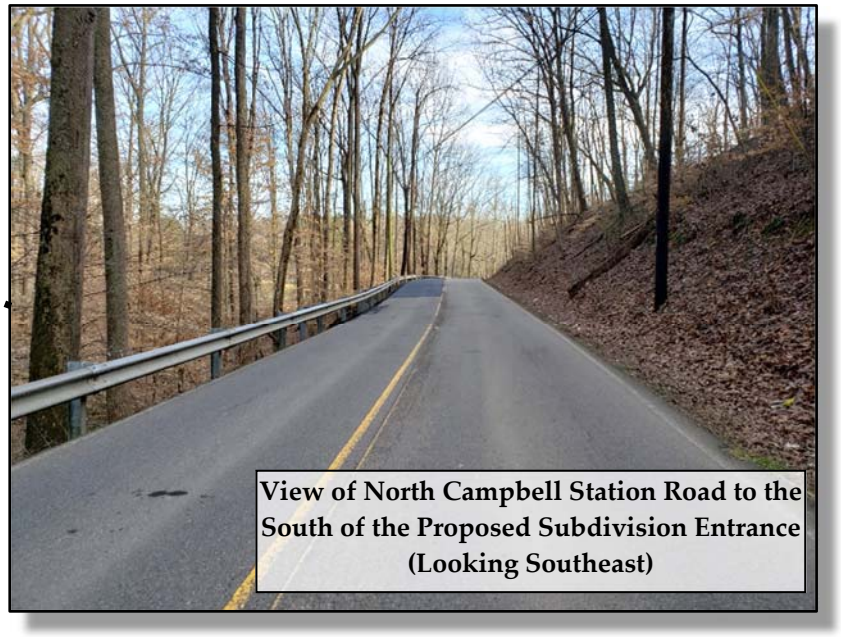
View of North Campbell Station Road at Proposed Catatoga Entrance, Road "A" (Looking North)



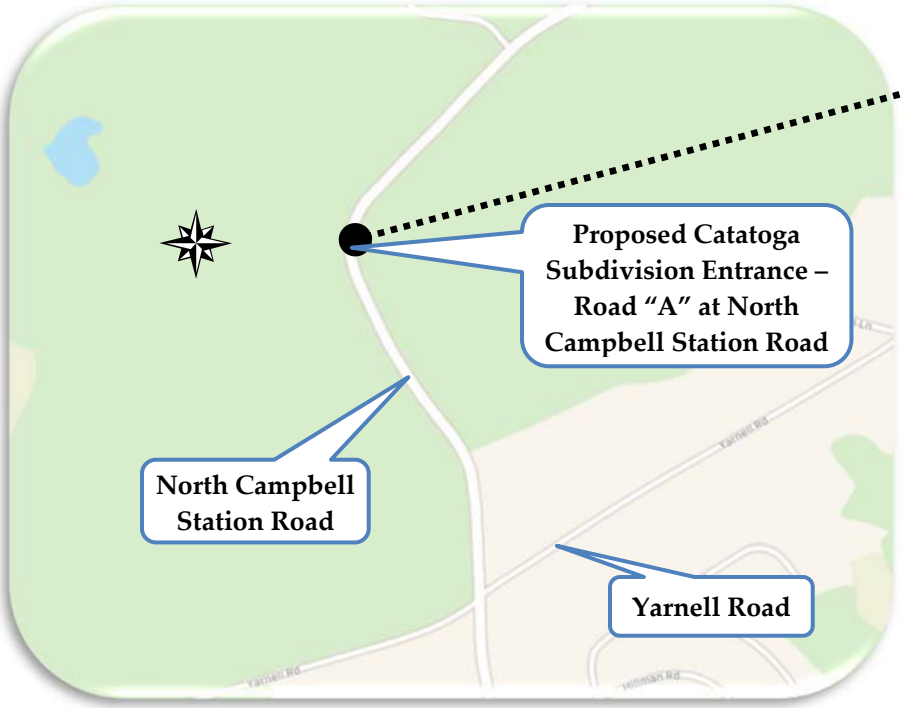
North Campbell Station Road



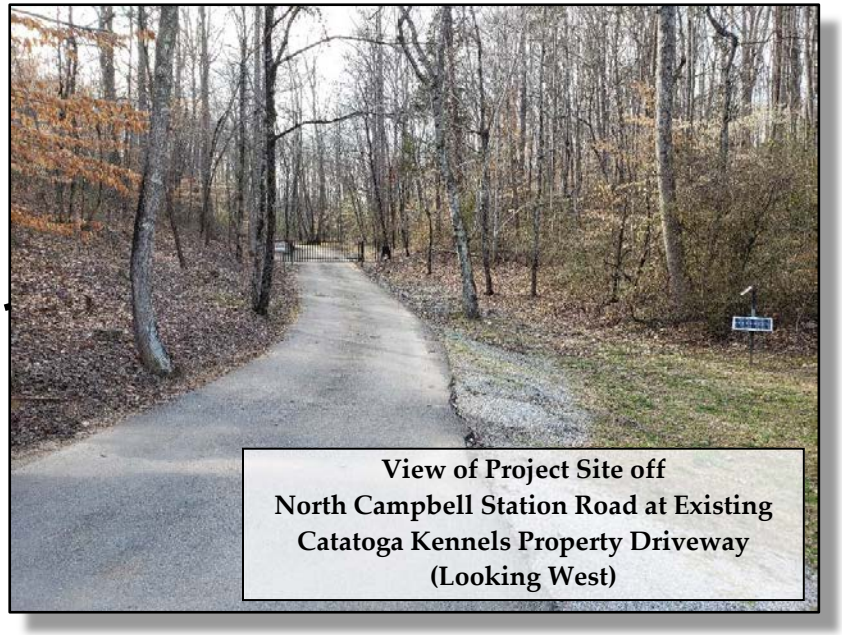
View from Existing Catatoga Kennels Property Driveway Across North Campbell Station Road (Looking East)



View of North Campbell Station Road to the South of the Proposed Subdivision Entrance (Looking Southeast)



North Campbell Station Road



- **EXISTING TRANSPORTATION VOLUMES PER MODE:**

There is one yearly vehicular traffic count location near the project site and one semi-yearly location. The yearly count is conducted by the Tennessee Department of Transportation (TDOT), and the Knoxville Transportation Planning Organization (TPO) conducts the other. The traffic count location data is the following:

- Existing vehicular roadway traffic:
  - TDOT reported an Average Annual Daily Traffic (AADT) on North Campbell Station Road, south of the project site and south of Yarnell Road, at 5,593 vehicles per day in 2018. From 2008 – 2018, this count station has indicated a 3.8% average annual growth rate.
  - The Knoxville TPO reported an Average Daily Traffic (ADT) on North Campbell Station Road, south of Hardin Valley Road and north of the project site, at 5,700 vehicles per day in 2019. This count location has had sporadic counts conducted. From 2010 – 2019, this count station has indicated a 6.3% average annual growth rate.

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

- Existing bicycle and pedestrian volumes:

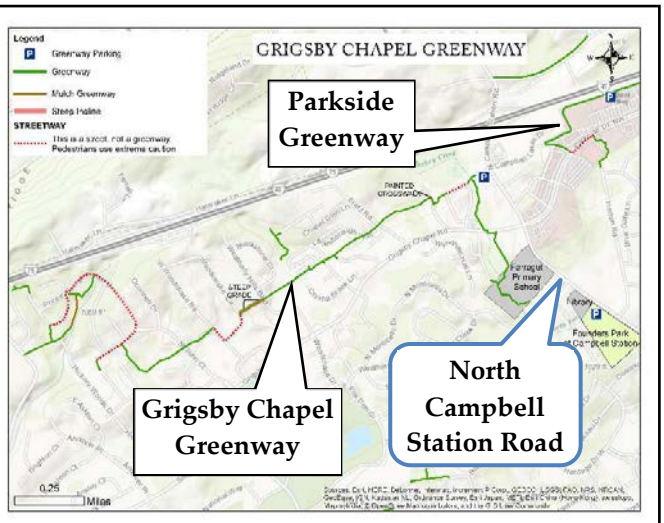
  The average daily pedestrian and bicycle traffic along and around the study corridor is not known. No pedestrians or bicyclists were observed during the manual traffic counts. Due to the topography, lack of shoulders, road widths, and road traffic volumes, it is not expected that pedestrians or bicyclists occur in the study area on any regular basis.

- **ON-STREET PARKING:**

Currently, on-street parking is not allowed on North Campbell Station Road adjacent to the project site.

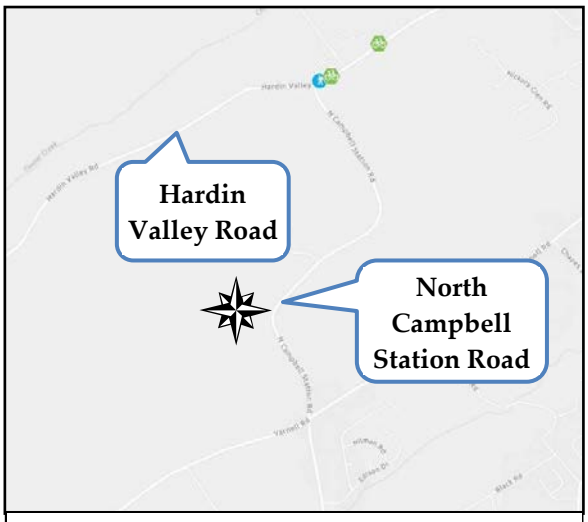
- **PEDESTRIAN AND BICYCLE FACILITIES:**

Bicycle lanes are not currently available within the project site study area except for further south near the Interstate System. The Parkside Greenway and the Grigsby Chapel Greenway are located to the south, approximately 2.5 miles (by roadway) to the south of the proposed residential development.



Mapping of Greenway Facilities from Town of Farragut

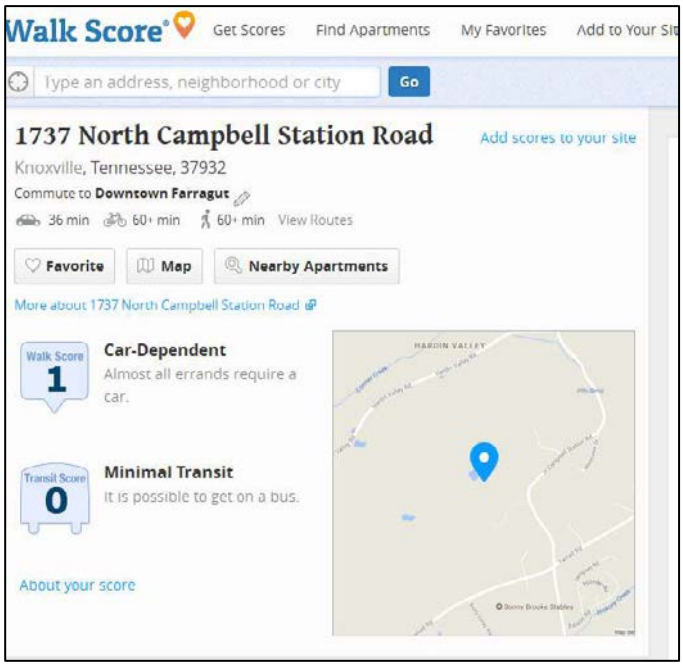
The Parkside Greenway is an asphalt trail that is 2 miles in length. It runs parallel to Interstate 40/75 from Lovell Road to near North Campbell Station Road. Grigsby Chapel Greenway is an asphalt trail that is 2.4 miles in length. It also runs roughly parallel to Interstate 40/75 and has a short section to the south towards Farragut Primary School.



Bicycle and Pedestrian Crashes in 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, three of these incidents occurred within the vicinity of the study area. All of them occurred on Hardin Valley Road near North Campbell Station Road. Two bicycle crashes with no injuries occurred in 2014 due to vehicle drivers' failing to yield. One pedestrian crash occurred in 2018 and resulted in an injury. Not enough information was provided to determine the cause of this crash.

- **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 approximate property site address (1737 North Campbell Station Road). The project location is graded with a Walk Score of 1. This Walk Score indicates that the site is entirely dependent on vehicles for errands and travel. The site is not given a bicycle score and a transit score of 0 due to the lack of transit opportunities.

- **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 6.8 miles away to the southeast (by roadway) on Sherrill Boulevard at Park West Hospital. 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

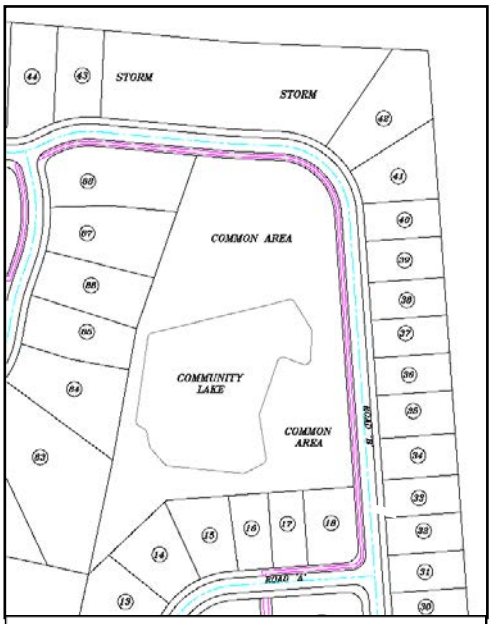
- **LOCATION AND SITE PLAN:**

The proposed plan layout given by Urban Engineering, Inc. is shown in Figure 3. As shown in the figure, three new streets will be constructed for the subdivision. The total length of the three new streets in the subdivision will be 7,133 feet (1.35 miles). A fourth street, Road "D", is shown on the plan as a stub-out, and this road would be fully constructed if the 17.5-acre property to the west is purchased and developed. The subdivision entrance, Road "A", will intersect North Campbell Station Road at a new t-intersection. This entrance will be approximately 0.4 miles to the northwest of the existing North Campbell Station Road at Yarnell Road intersection.

The current plan shown in Figure 3 shows 120 single-family detached house lots on 60.5 acres. The developer has a property option for the 17.5-acre parcel adjacent and to the west. This property would provide enough space to provide up to an additional 35 single-family detached house lots if this property is purchased.

In addition to home sites, the subdivision will contain common areas that will also incorporate stormwater control facilities. It will also include an existing 1.5-acre lake and provide a lakeside clubhouse for subdivision residents.

The single-family residential detached lots will average between 9,500 -20,000 square feet (~ 0.22 acre - 0.46 acre) in size, with a few lots up to nearly an acre. Each home will have a garage and driveway. Concrete sidewalks are proposed for this development. A portion of the sidewalks will be along Road "B", and the other portion will be to the rear of lots that back up to each other.



Subdivision Common Areas with Community Lake

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).

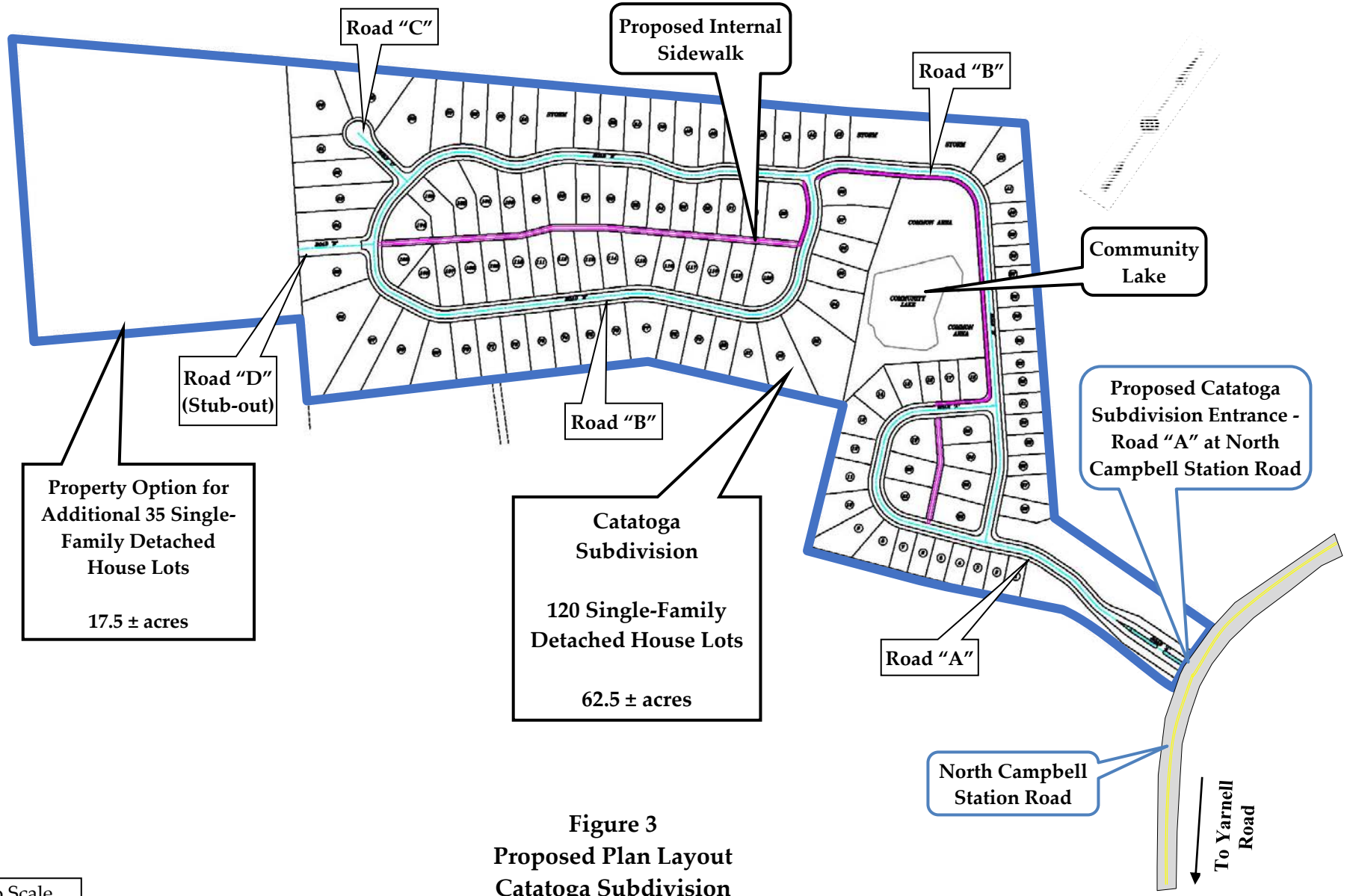


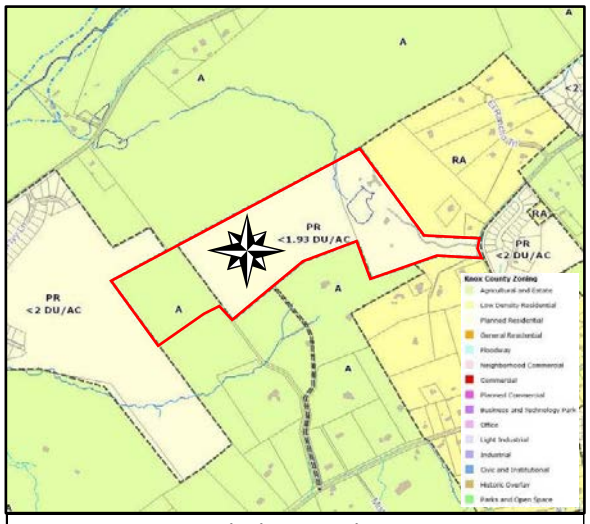
Figure 3
Proposed Plan Layout
Catatoga Subdivision

Not to Scale

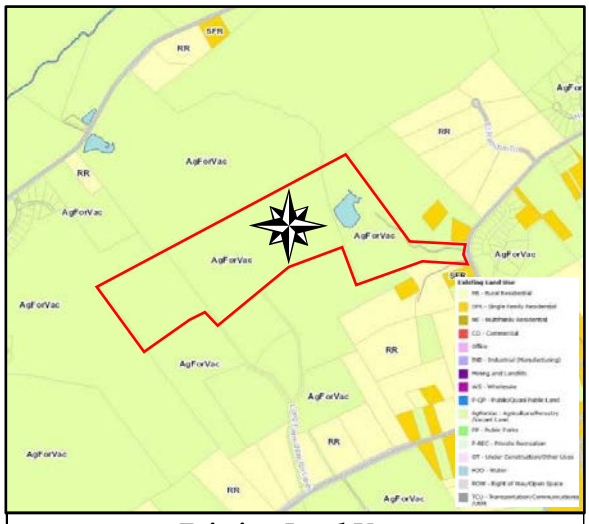
- **PROPOSED USES AND ZONING REQUIREMENTS:**

The main development property of 62.5 acres comprises two parcels, and both are zoned as Planned Residential (PR) with a density of less than 1.93 dwelling units per acre. The adjacent property 17.5-acre parcel to the west that could be purchased is zoned as Agricultural (A). The 17.5-acre parcel will be requested to be re-zoned to Planned Residential (PR) if purchased for this development. 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 land uses are the following:

- The properties to the northwest are zoned as Planned Residential (PR) and exist in the recently constructed Vining Mill Subdivision. Directly to the north, one large property is zoned Agricultural (A) and is entirely undeveloped with farm area and forest.
- To the northeast and southeast, all the properties are zoned as Single-Family Residential (RA). These properties consist of standalone single-family residences within a large amount of forested area.
- To the south, three properties are zoned as Agricultural (A) and consist of standalone single-family homes, undeveloped properties, and forest.



Existing Zoning



Existing Land Uses

- **DEVELOPMENT DENSITY:**

The Catatoga Subdivision's proposed density is based on a maximum of 155 houses on 80 acres. The density computes to 1.93 dwelling units per acre, equal to the maximum allowed for the property's Planned Residential (PR) designation.

- **ON-SITE CIRCULATION:**

The total length of the three new streets within the development will be 7,133 feet (1.35 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". Road "D" will be a stub-out for a potential connection to the 17.5-acre parcel to the west. All of the development internal roadways will be asphalt paved 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 being proposed along Road "B" and internally between the rear lots in some areas. 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 recently compiled traffic count data in Fall 2020 and determined that overall traffic volumes are still reduced compared to Fall 2019 before the pandemic. A few of the Fall 2020 traffic counts compiled by Knox County Planning showed slight increases, but most count locations in the County have shown decreases ranging from 5% up to 30%.

For this study, an 8-hour traffic count was conducted at the existing unsignalized intersection of North Campbell Station Road at Yarnell Road as requested by Knox County Engineering. Knox County Engineering specifically requested this traffic count location and length since they are in the process of potentially improving this intersection outside and not related to the impacts of this development.

Manual traffic counts were obtained on Tuesday, March 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 hours of traffic were observed at 7:15 – 8:15 AM and 3:15 - 4:15 PM at the intersection.

The afternoon peak hour of traffic at the intersection is noticeably earlier than most typical locations. This earlier peak hour is suspected due to Hardin Valley school's relative proximity and earlier dismissals compared to later traditional work-related peak flows. The manual tabulated traffic counts can be reviewed in Appendix E, and some observations are listed below.

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 eastbound and westbound approaches on Yarnell Road. No bicyclists or pedestrians were observed during the traffic counts.

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 intersection of North Campbell Station Road at Yarnell Road. Figure 4b shows the volumes from the existing traffic counts during the AM and PM peak hours observed at the intersection increased with the 20% factor. The traffic volumes shown on North Campbell Station Road at the subdivision entrance's proposed location are synthesized from the northbound and southbound volumes at the intersection of North Campbell Station Road at Yarnell Road. For this study, it is assumed that the trips generated from a few single-family homes to the north of Yarnell Road on North Campbell Station Road do not appreciably alter the traffic volumes between the two locations.

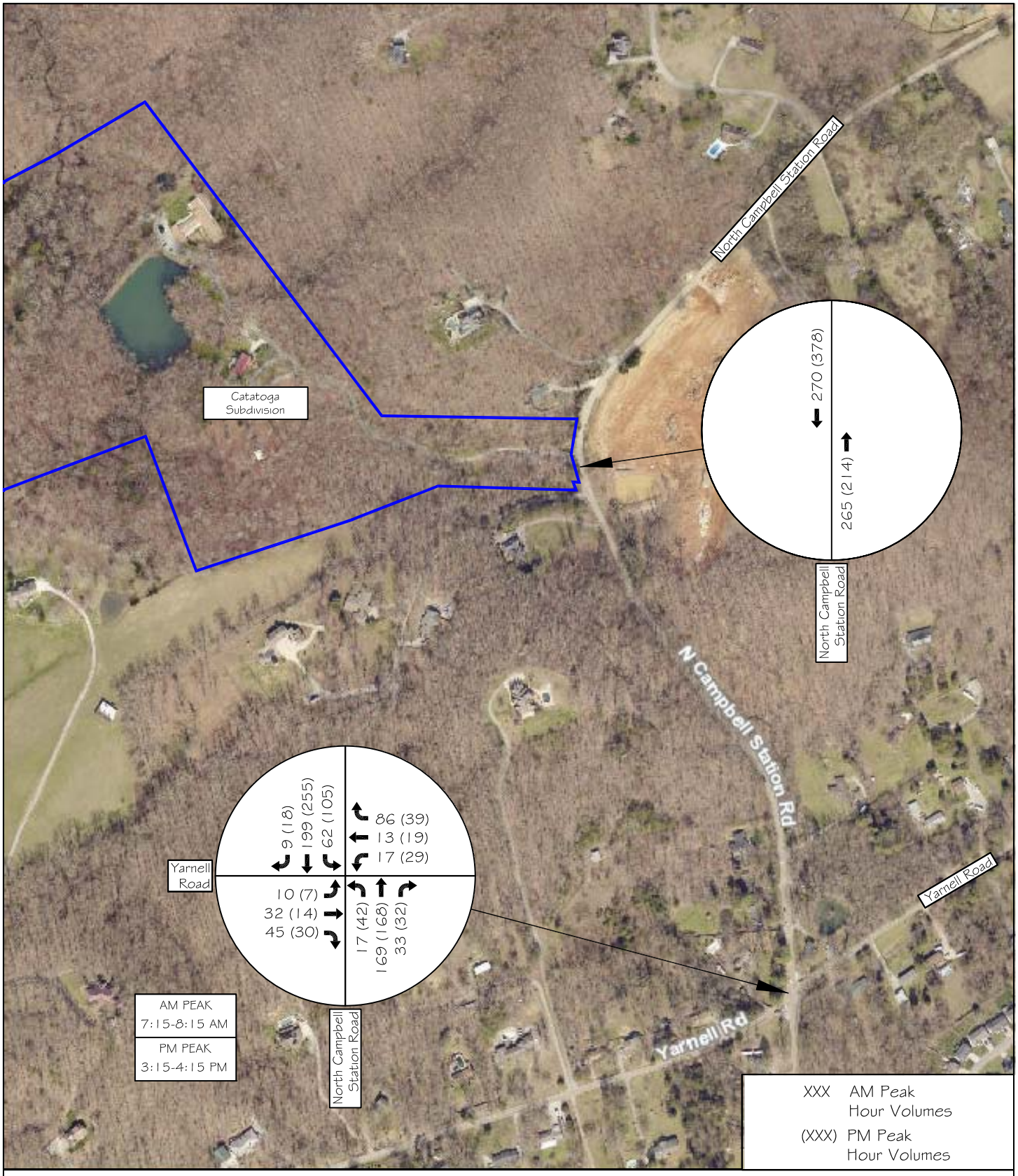


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FIGURE 4a

Catatoga Subdivision

2021 Peak Hour Traffic Volumes - EXISTING TRAFFIC CONDITIONS

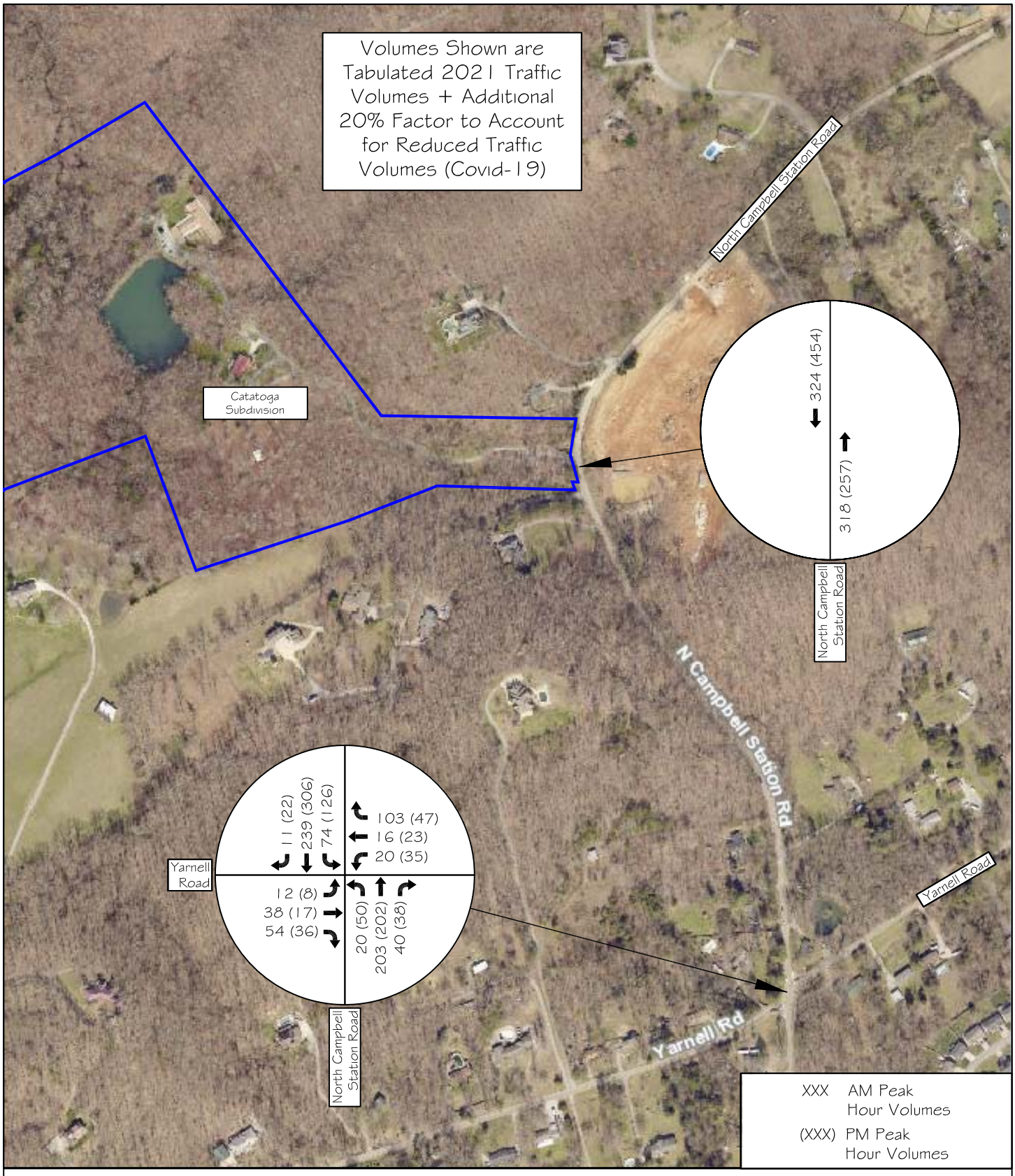

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FIGURE 4b

Catatoga 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 North Campbell Station Road at Yarnell 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 intersection in the tables is 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 intersection of North Campbell Station Road at Yarnell Road was calculated only for the existing conditions. It was not calculated for the future conditions since they are not required for this Level 1 study. The calculations and results provided for this intersection in the existing conditions are offered in this study as a courtesy.

As shown in the tables, the northbound and southbound approaches at the intersection are calculated to operate at LOS A with minimal vehicle delays. However, the eastbound and westbound approaches at the intersection are calculated to operate poorly, especially in the existing conditions with a 20% growth factor. When the tabulated traffic volumes are increased by 20%, the results indicate LOS E and LOS F with considerable vehicle delays in the PM peak hour for the eastbound and westbound approaches.

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

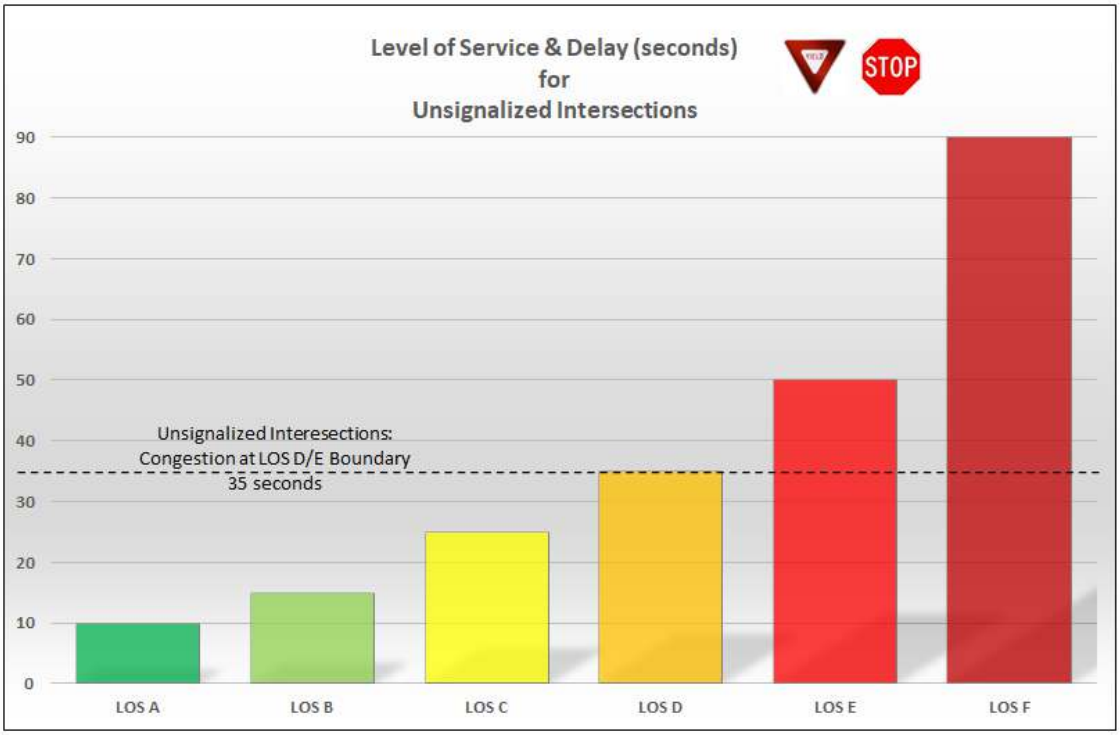


TABLE 3a
2021 INTERSECTION CAPACITY ANALYSIS RESULTS -
EXISTING TRAFFIC CONDITIONS

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]
North Campbell Station Road at Yarnell Road	Unsignalized	Eastbound Left/Thru/Right	C	17.8	0.320	C	25.0	0.310
		Westbound Left/Thru/Right	B	14.6	0.300	D	32.9	0.490
		Northbound Left/Thru/Right	A	0.8	0.020	A	1.7	0.040
		Southbound Left/Thru/Right	A	2.6	0.070	A	4.0	0.150

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

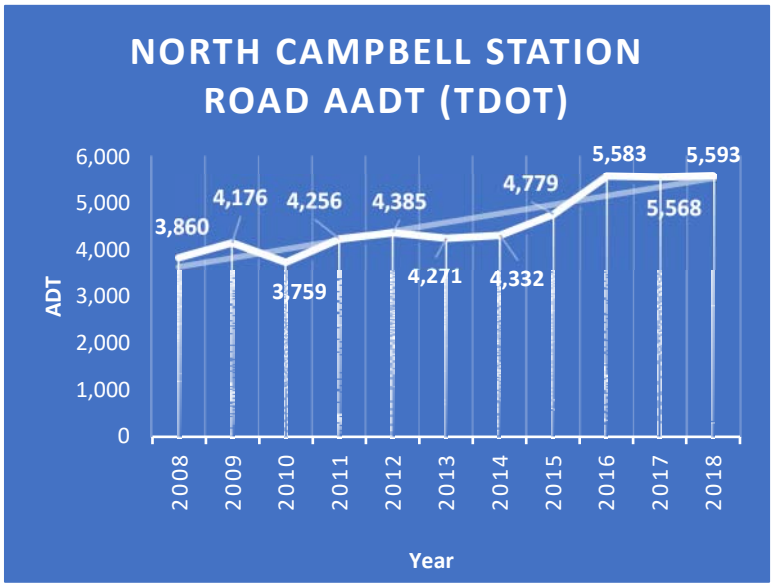
TABLE 3b
2021 INTERSECTION CAPACITY ANALYSIS RESULTS -
EXISTING TRAFFIC CONDITIONS (+20%)

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]
North Campbell Station Road at Yarnell Road	Unsignalized	Eastbound Left/Thru/Right	D	25.0	0.470	E	46.9	0.540
		Westbound Left/Thru/Right	C	19.4	0.440	F	97.7	0.890
		Northbound Left/Thru/Right	A	0.8	0.020	A	1.8	0.050
		Southbound Left/Thru/Right	A	2.8	0.090	A	4.5	0.190

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology
[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 North Campbell Station Road has shown significant growth over the past few years, according to the permanent traffic count stations and as shown in Appendix A. To conservatively account for potential traffic growth in the study area, an average annual growth rate of 5% was used to calculate future growth up to 2026 for the studied location. 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 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 proposed entrance in 2026 during the AM and PM peak hours without the project.

Capacity analyses were not conducted for the projected conditions at the North Campbell Station Road at Road "A" intersection in 2026 without the project being developed since this intersection does not exist in this scenario.

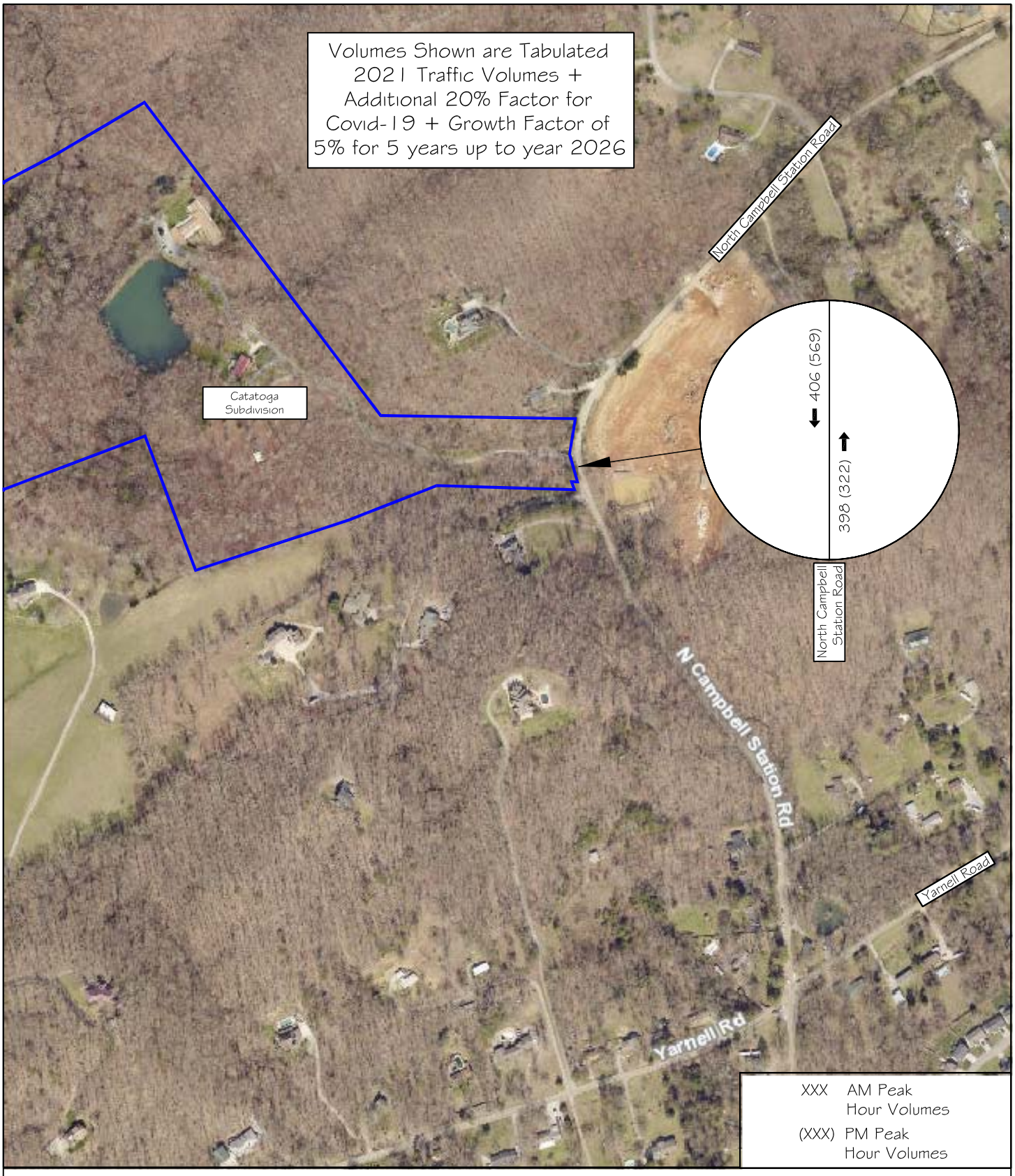


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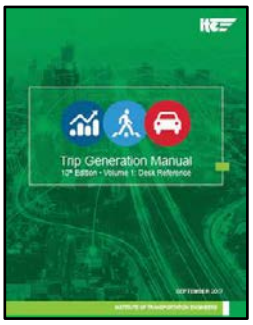
FIGURE 5

Catatoga Subdivision

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

- **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 4
TRIP GENERATION FOR CATATOGA SUBDIVISION
155 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	155 Houses	1,557	25%	75%		63%	37%	
				29	86	115	98	57	155
Total New Volume Site Trips			**1,557**	**29**	**86**	**115**	**98**	**57**	**155**

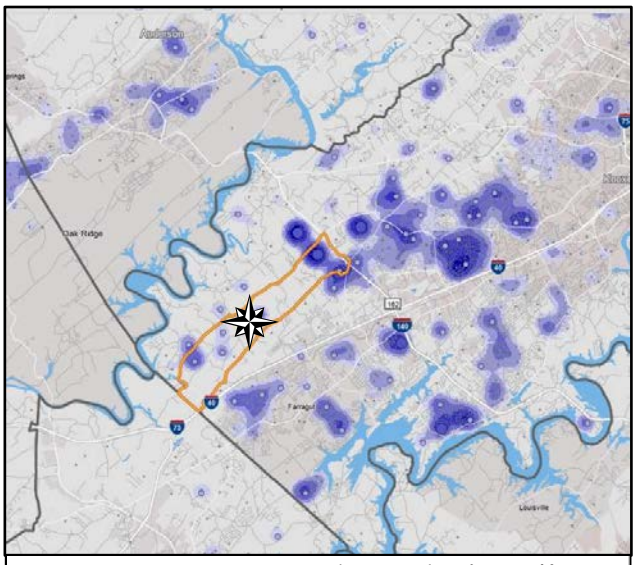
ITE Trip Generation Manual, 10th Edition
Trips calculated by using Fitted Curve Equation

For the proposed residential subdivision, with a maximum of 155 single-family detached houses, it is estimated that 29 vehicles will enter and 86 will exit, for a total of 115 generated trips during the AM Peak Hour in the year 2026. Similarly, it is estimated that 98 vehicles will enter, and 57 will exit, for a total of 155 generated trips during the PM Peak Hour in the year 2026. The calculated trips generated for an average weekday are expected to be 1,557 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 and shown in Table 4.

The percentages assumed and shown in Figure 6 are based on several sources and factors. The first source is based on the traffic count results at the intersection of North Campbell Station Road at Yarnell Road. The turning movement counts from this intersection were assumed to be a reasonable estimate for the Catatoga Subdivision travel patterns.



2018 Census Bureau Work-Based Trips to/from Census Tract 59.05

The second source is based on work-related trips in the area. Work-based trips will be a significant driver of generated trips by the development. These trips are more likely to travel to and from the north and east. This assertion is based on data from the United States Census Bureau website for Census Tract 59.05, where the development property is located. Based on 2018 (latest available) census data and shown in Appendix H, most work-based trips are to and from the north and east. Those trips correspond to the Pellissippi Parkway Corridor, Oak Ridge, Middlebrook Pike area, and trips further northeast towards downtown Knoxville.

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 Hardin Valley Elementary, Middle School, and High School. All these public schools are to the north of the proposed subdivision, approximately 1.5 miles away off Hardin Valley Road.

The Knox County Schools Transportation Department has developed Parental Responsibility

Zones (PRZ) to determine whether a student is offered transportation services to and from school. According to the Knox County School system, the PRZ is defined as being 1.5 miles for grades 6 – 12 and 1.0 miles for grades K – 5 from the point where the students' parcel is accessed and the point where the busses unload at the school. Even though this proposed subdivision is close to the PRZ limit of 1.5 miles, it is not believed that any of the homes will be officially within this zone.

Figure 7 shows the Traffic Assignment of the computed trips generated by the subdivision (from Table 4) and applying the intersection movement volumes based on the assumed distribution of trips shown in Figure 6.

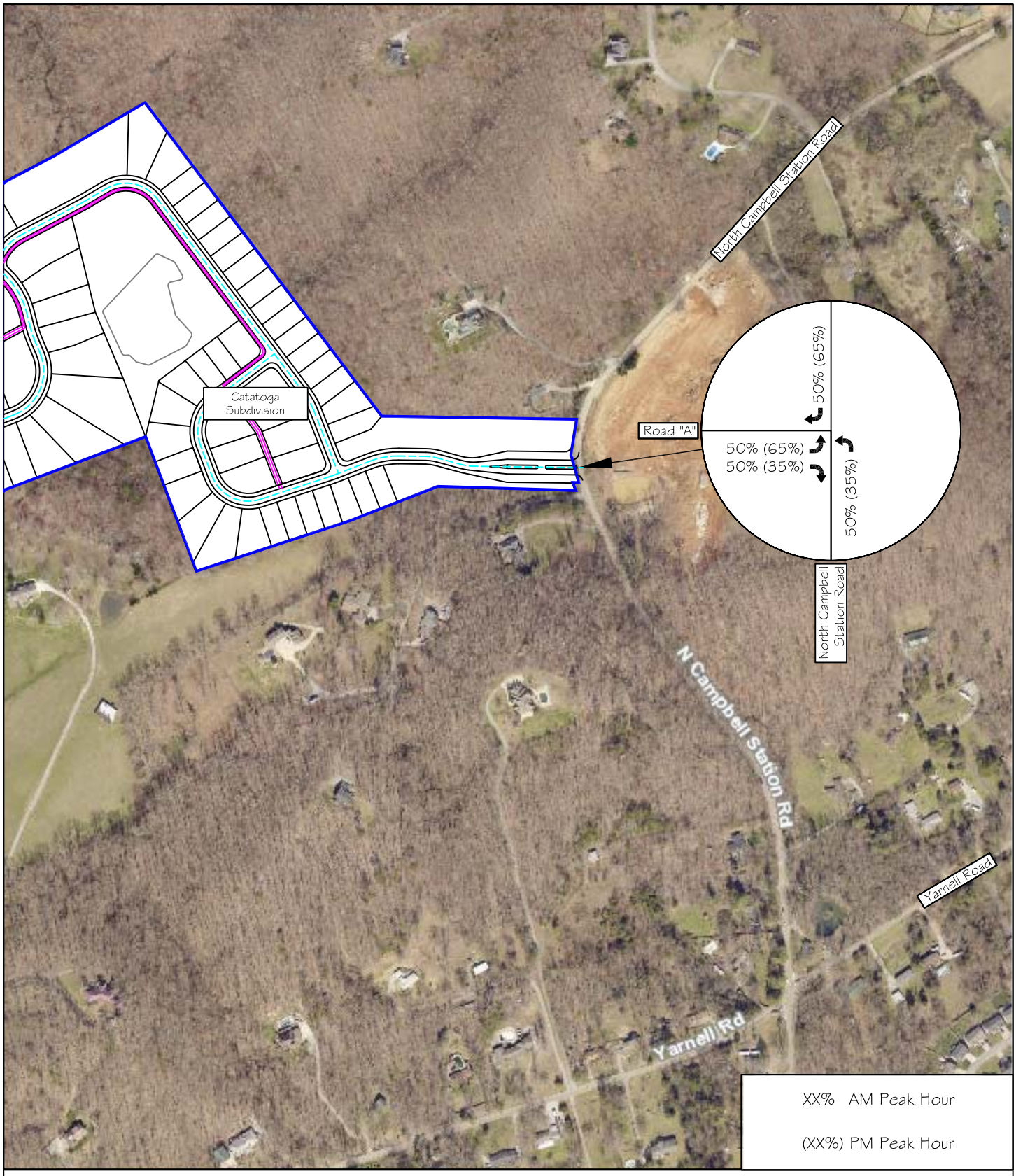


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FIGURE 6

Catatoga Subdivision

Directional Distribution of Generated Traffic during AM and PM Peak Hour

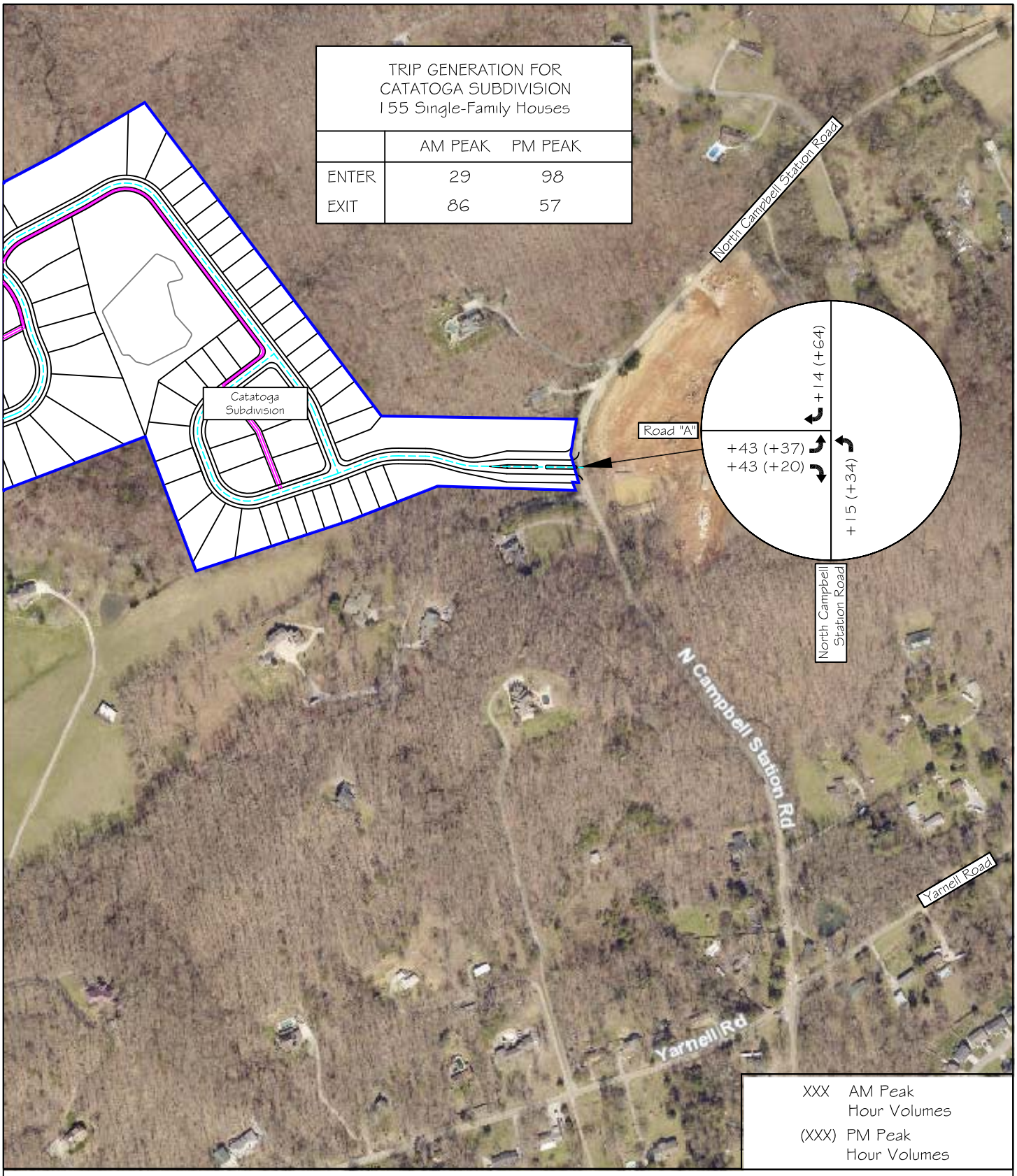

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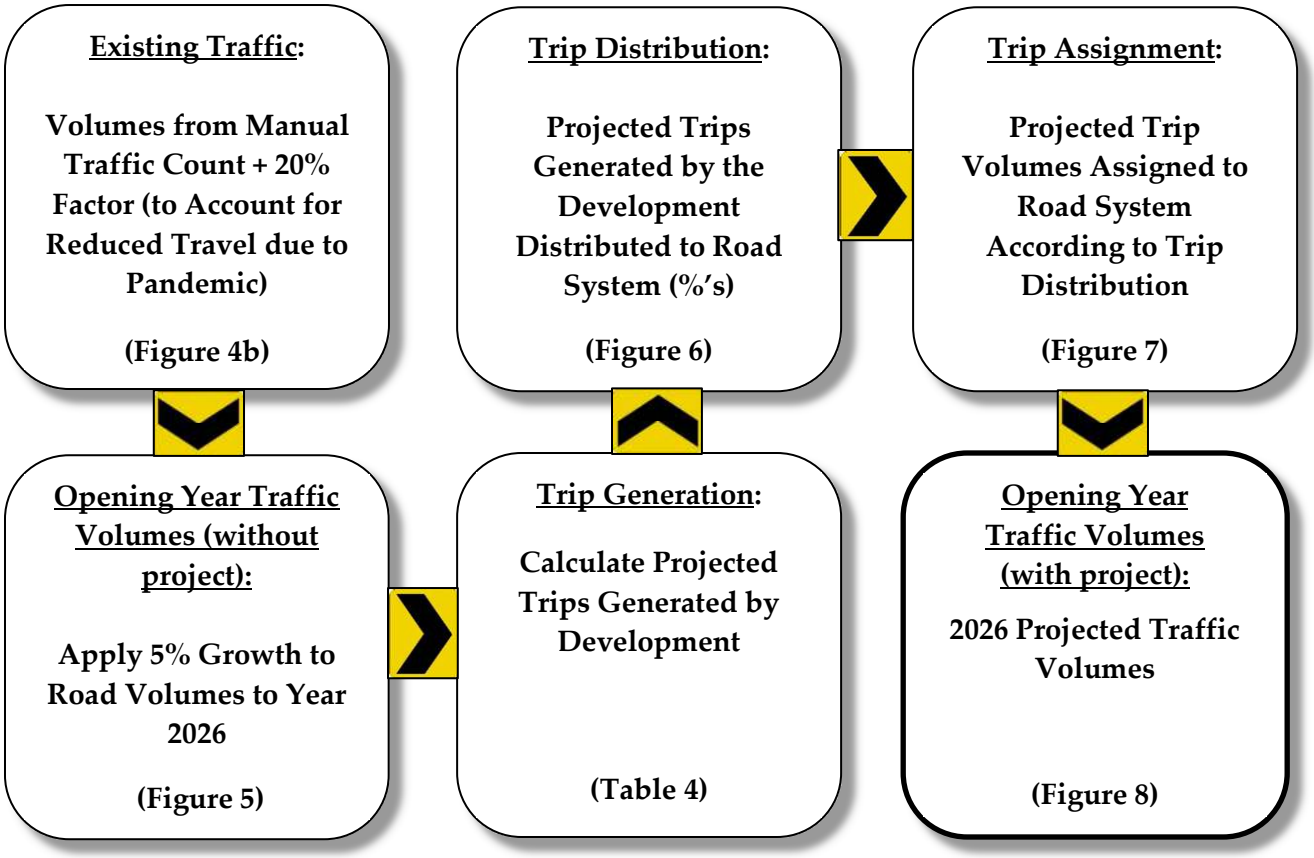
FIGURE 7

Catatoga 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 Catatoga 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 Catatoga 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 intersection for 2026 with the development traffic.

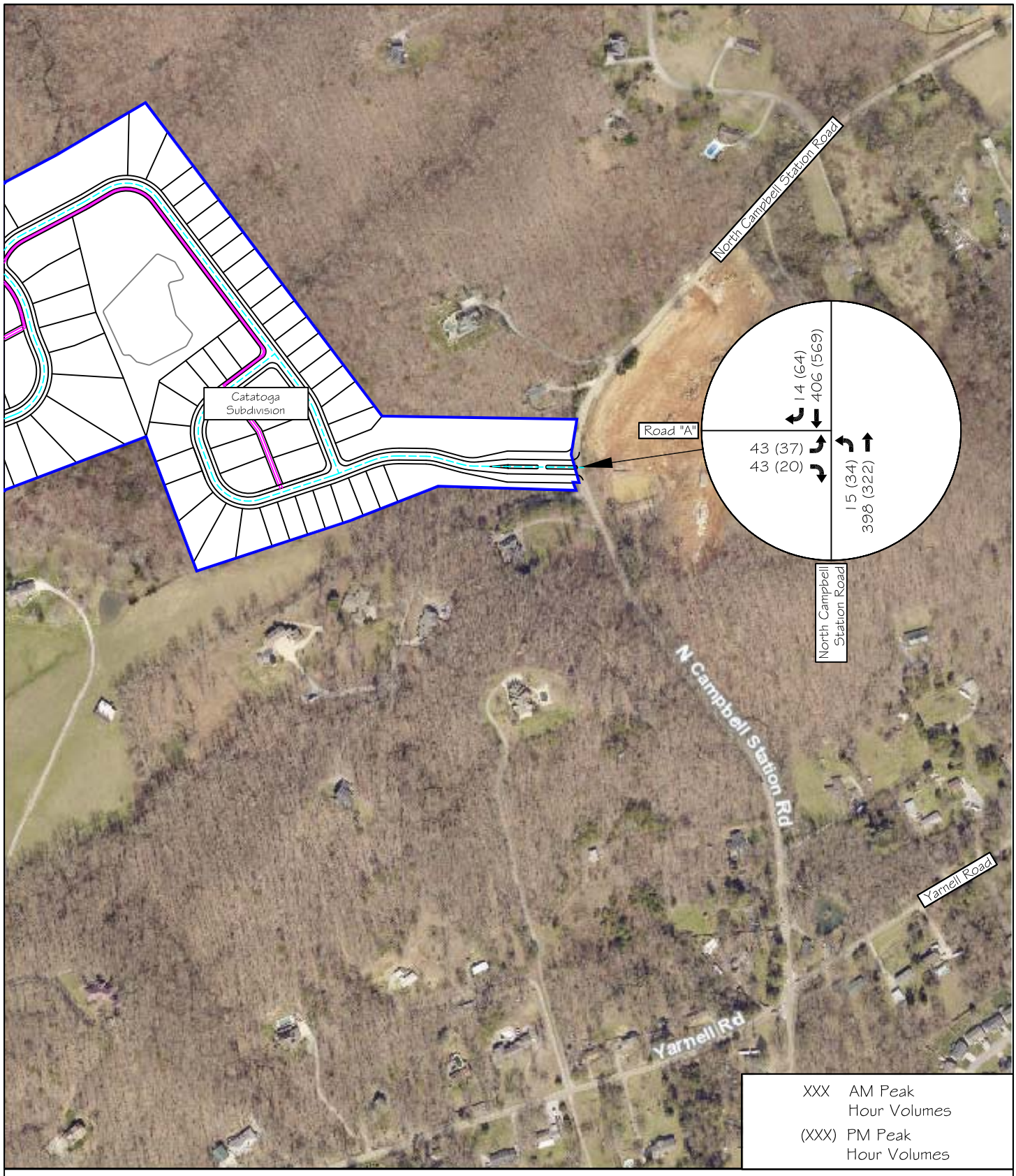


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FIGURE 8

Catatoga 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 proposed entrance intersection with the development traffic in the year 2026. Appendix F includes the worksheets for these capacity analyses.

As calculated, the traffic generated from the proposed residential subdivision with the projected volumes on North Campbell Station Road resulted in adequate LOS and vehicle delays at the intersection. The entrance exiting lane is expected to operate at LOS C in the projected AM and PM peak hours.

TABLE 5
2026 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]
North Campbell Station Road at Road "A"	Unsignalized	Eastbound Left/Right	C	17.0	0.240	C	21.9	0.230
		Northbound Left	A	0.5	0.020	A	1.3	0.040

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

▪ POTENTIAL SAFETY ISSUES:

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

EVALUATION OF TURN LANE THRESHOLDS

An evaluation of the need for separate auxiliary turn lanes on North Campbell Station Road for entering vehicles into the development at Road "A" in the year 2026 was conducted. The design policy used for these turn lane evaluations is based on "Knox County's Access Control and Driveway Design Policy". This design policy relates vehicle volume thresholds based on prevailing speeds for two-lane and four-lane roadways. This Knox County policy is based on TDOT and nationally accepted guidelines for unsignalized intersections.

The prevailing speeds chosen for this evaluation are based on data obtained by the County from "Inrix". According to Wikipedia, Inrix "provides location-based data and analytics, such as traffic and parking, to automakers, cities and road authorities worldwide, and in turn-by-turn navigation applications like Google Waze." Knox County has obtained access to this data from Inrix. Their data has indicated that the historical average daily speeds on North Campbell Station Road have been 36.8 mph and 37.4 mph in the northbound and southbound directions, respectively. Thus, the speed classification for this evaluation was 36 to 45 mph.

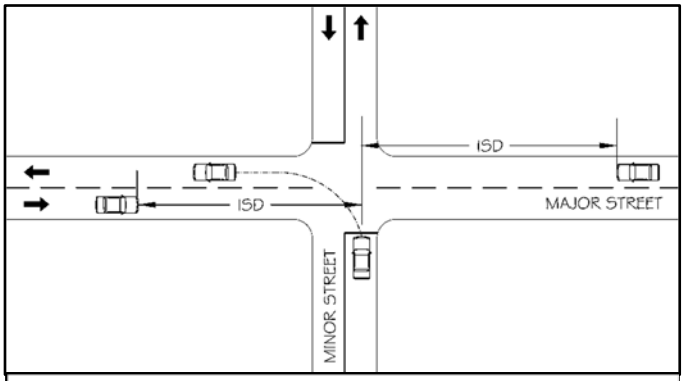
Based on the entering projected 2026 AM and PM peak hour traffic volumes at the Road "A" subdivision entrance and the Inrix speed data on North Campbell Station Road, there is a need for a separate northbound left-turn lane and a southbound right-turn lane on North Campbell Station Road. The Knox County turn lane policy worksheets are in Appendix I.

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.



Intersection Sight Distance Diagram

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 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 Inrix speed data of 36.8 mph and 37.4 mph in the northbound and southbound directions on North Campbell Station Road, the required intersection sight distance (ISD) is 368 feet to the south and 374 feet to the north at Road "A" based on Knox County policy of requiring 10 feet of sight distance per 1-mph of speed. Based on a 4% grade on North Campbell Station Road and the Inrix speed data, the stopping sight distance (SSD) is calculated to be 255 feet for northbound and 290 feet for southbound vehicles.

In October 2020, Urban Engineering, Inc. measured the available sight distance from the proposed entrance location on North Campbell Station Road. Sight distance was determined to be just over 400 feet to the north and just shy of 500 feet to the south. This certification was provided in a

letter and is shown in Appendix J.

Images of the existing sight distances are presented in the following with the required ISD and the actual measured sight distance.

View of Sight Distance on North Campbell Station Road at Proposed Entrance Road "A" Intersection (Looking Northeast)

View of Sight Distance on North Campbell Station Road at Proposed Entrance Road "A" Intersection (Looking Southeast)

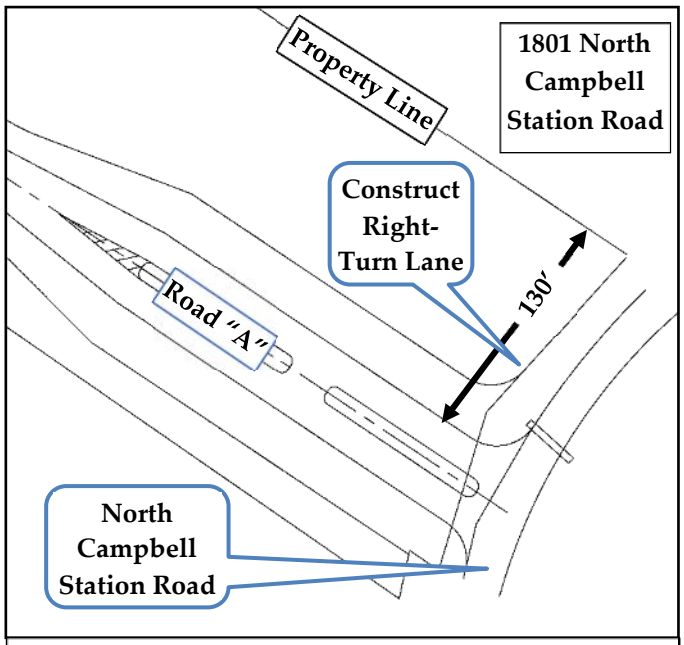
CONCLUSIONS & RECOMMENDATIONS

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.

1 **North Campbell Station Road at Road "A":** The intersection of North Campbell Station Road at Road "A" was calculated to operate very well with respect to level of service in the projected conditions in 2026.

1a) A separate exiting left-turn lane or right-turn lane on Road "A" at North Campbell Station Road is not required based on the projected 2026 traffic volumes and capacity analysis.

1b) A southbound right-turn lane is warranted based on the projected traffic volumes. There is limited space between the development property line at North Campbell Station Road and the adjacent property to the north (1801 North Campbell Station Road). Approximately 130 feet exists between the property line to the north and the proposed northern edge of Road "A". With this constraint, it is recommended that this southbound right-turn lane be 50 feet in length with an 80-foot taper or the maximum length available within the right-of-way without encroaching the adjacent property. The new southbound right-turn lane should be marked with a right-turn pavement marking arrow symbol.



Proposed Road "A" at North Campbell Station Road

1c) A separate northbound left-turn lane on North Campbell Station Road is warranted for entering traffic into the subdivision at Road "A". 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 the vehicle queue lengths for the northbound approach at the intersection.

Based on the software results from the projected 2026 volumes, the 95th percentile vehicle queue lengths were calculated for the proposed northbound left-turn lane. The 95th percentile vehicle queue is the recognized measurement in the traffic engineering profession as the design standard used when considering queue lengths and 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 and the results from the SimTraffic software are in the Appendix. The calculated 95th percentile vehicle queue lengths for the northbound left-turn lane are 25 feet in the AM peak hour and 40 feet in the PM peak hour in 2026. These results indicate that a northbound left-turn lane with 50 feet of storage is adequate, which is the minimum allowable storage length of a left-turn lane in Knox County. Based on the vehicle speeds and the physical constraints of North Campbell Station Road, it is recommended the left-turn lane taper be a minimum of 12:1.

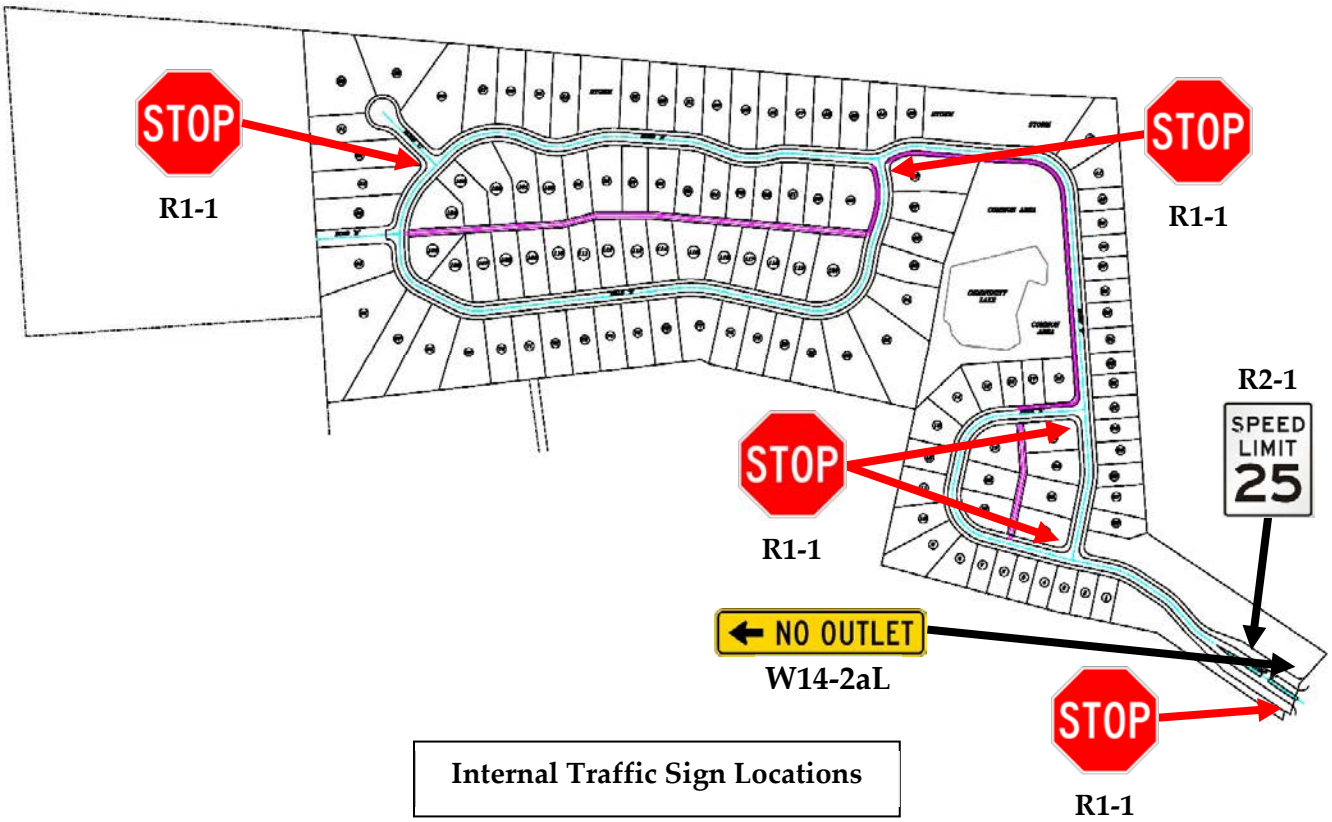
1d) It is recommended that a Stop Sign (R1-1) be installed, and a 24" white stop bar be applied to the pavement of the Road "A" approach at North Campbell Station Road. The stop bar should be applied at a minimum of 4 feet away from the edge of North Campbell Station Road and should be placed at the desired stopping point that provides the maximum sight distance.

1e) Intersection sight distance at Road "A" must not be impacted by future landscaping or signage. Based on Inrix speed data of 36.8 mph and 37.4 mph in the northbound and southbound directions on North Campbell Station Road, the required intersection sight distance (ISD) is 368 feet to the south and 374 feet to the north at Road "A". Based on a 4% grade on North Campbell Station Road and the Inrix speed data, the stopping sight distance (SSD) is calculated to be 255 feet for northbound and 290 feet for southbound vehicles. In October 2020, Urban Engineering, Inc. measured the available sight distance from the proposed entrance location on North Campbell Station Road. Sight distance was determined to be just over 400 feet to the north and just shy of 500 feet to the south.

2 **Catatoga Subdivision Internal Roads:** The current concept plan shows three new roads being constructed within the development, as shown in Figure 3. If Road "D" and other roads are proposed and constructed for the additional 17.5-acre available parcel, they should follow the same recommendations listed below.

2a) It is recommended that a 25-mph Speed Limit Sign (R2-1) be posted near the front of Road "A" off North Campbell Station Road. It is also recommended that a "No Outlet" (W14-2aL) sign be posted near the front of Road "A". This sign can be posted below the street name sign.

2b) 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

2c) 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.

2d) All drainage grates and covers for the residential development need to be pedestrian and bicycle safe.

2e) Sidewalks should have appropriate ADA-compliant curbed ramps at intersection corners, and the sidewalks are recommended to be 5 feet minimum in width. Crosswalks should be marked on the road pavement where pedestrians are expected to cross.

2f) 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

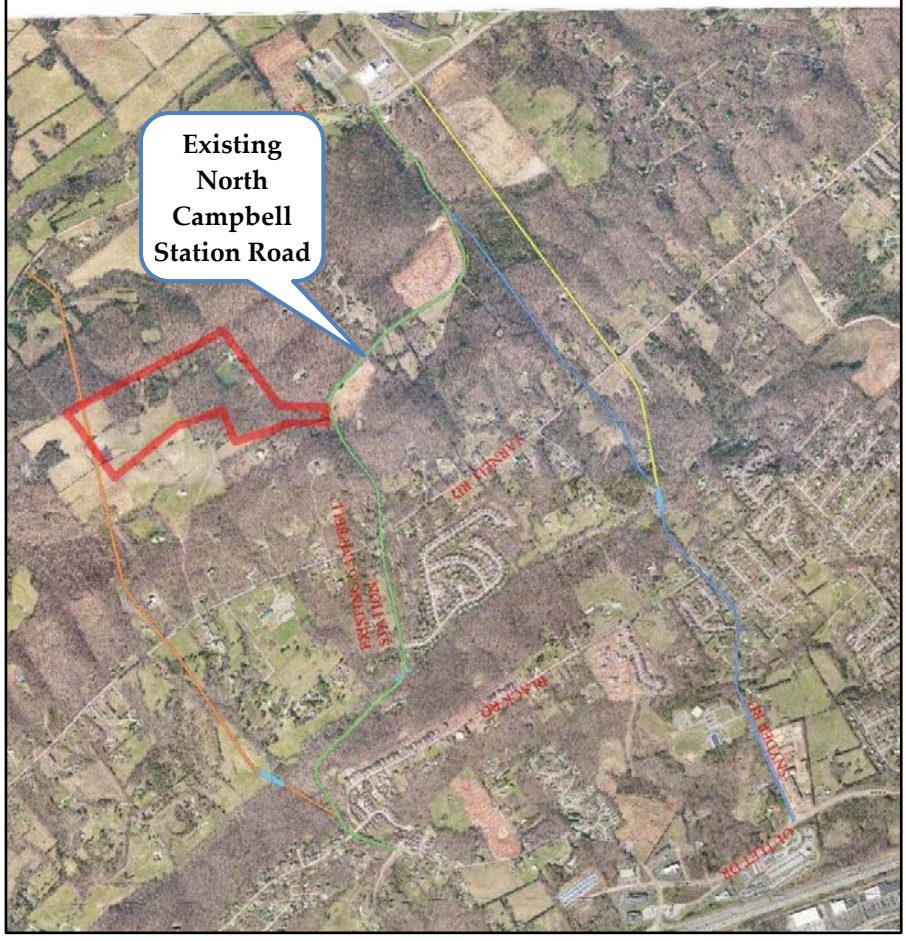
2g) For residential subdivisions with a single access point and more than 150 houses, the County has a long-standing unwritten design policy requiring a boulevard road typical section at the entrance. This policy is to ensure access to the subdivision during potential emergencies. Since the proposed layout of the Catatoga Subdivision only includes one means of ingress and egress and will potentially have 155 houses, the subdivision entrance is recommended to be designed and constructed with a boulevard roadway section. At a minimum, the boulevard section should have a 10-foot median with 2 – 18-foot lanes within 60 feet of right-of-way. For this policy in Knox County, a boulevard road section is typically designed and constructed to the first intersecting street within the development. However, after discussion with Knox County Engineering, it was determined that it would be acceptable to keep the proposed boulevard design shown in Figure 3.

2h) 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.

3

Future Transportation Issue: Knox County Engineering has indicated that they are in the planning stages of potentially re-routing North Campbell Station Road in between Hardin Valley Road and the Interstate system to the south. This investigation is due to high north and south traffic volumes and North Campbell Station Road safety issues. Re-routing the road would provide a more efficient and safer route between the two areas. The project is identified in the Knoxville Regional Transportation Planning Organization's Mobility Plan 2045. This project listing indicates that this re-routing will be 3.3 miles in length and has a horizon year of 2030. Three potential alternative routes are being investigated and are shown below for informational purposes. It is not believed that a final route has been selected. One of these routes is shown clipping the northwest corner of the proposed Catatoga Subdivision property. If this project is completed, thru traffic volumes on North Campbell Station Road at Road "A" will potentially be reduced due to traffic shifting to the new route for north and south travel. Whatever route is chosen will impact North Campbell Station Road's projected traffic volumes shown in this report.

Potential North Campbell Station Road Routes



APPENDIX A

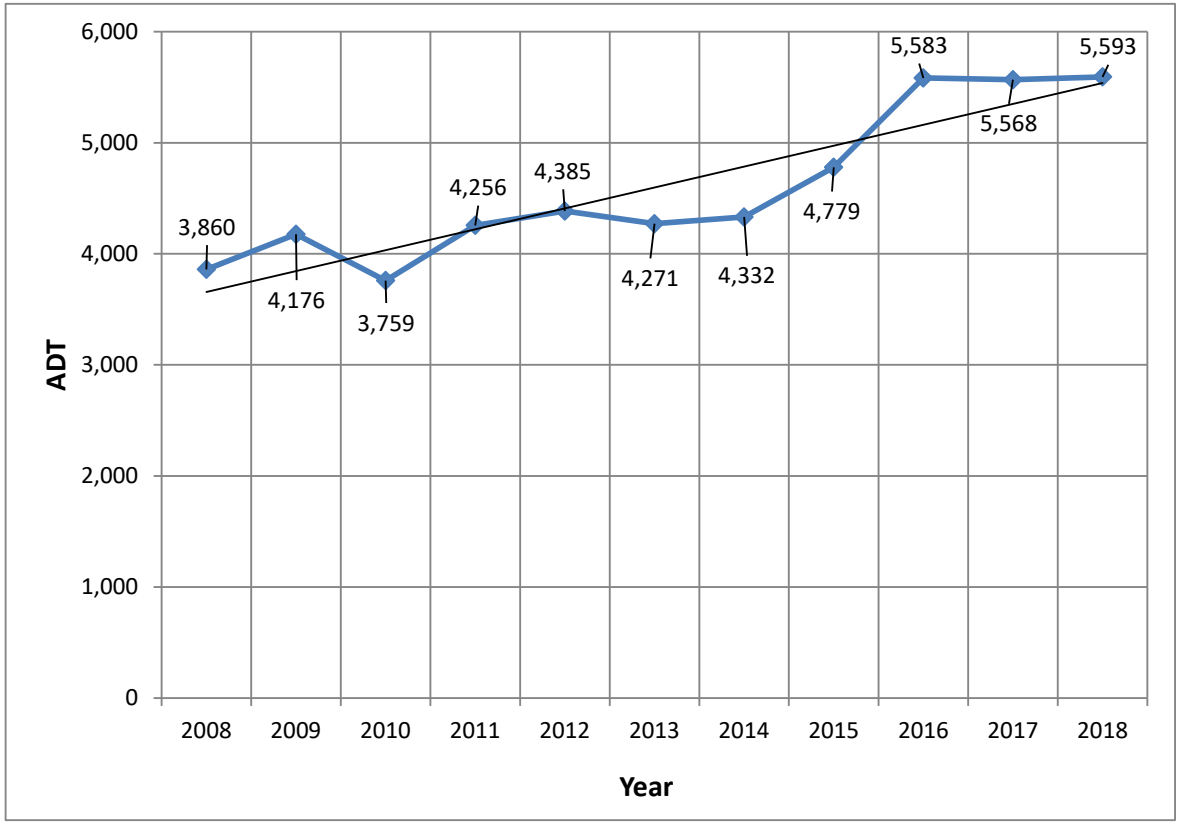
HISTORICAL TRAFFIC COUNT DATA

Historical Traffic Counts

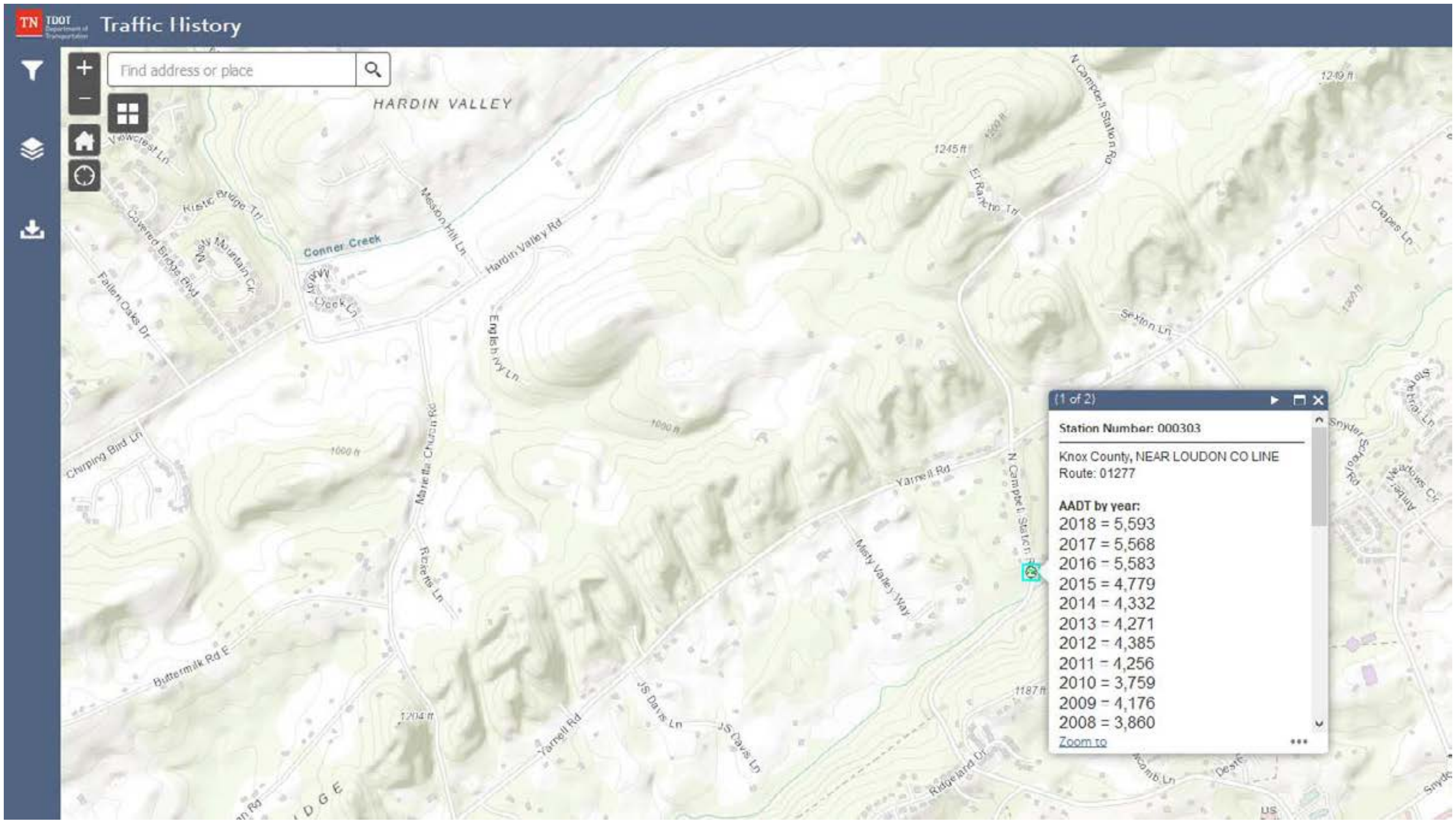
Organization: TDOT
Station ID #: 000303
Location: North Campbell Station Road, south of Yarnell Road

YEAR	ADT
2008	3,860
2009	4,176
2010	3,759
2011	4,256
2012	4,385
2013	4,271
2014	4,332
2015	4,779
2016	5,583
2017	5,568
2018	5,593

Trendline



2008 - 2018 Growth Rate = 44.9%
Average Annual Growth Rate = 3.8%

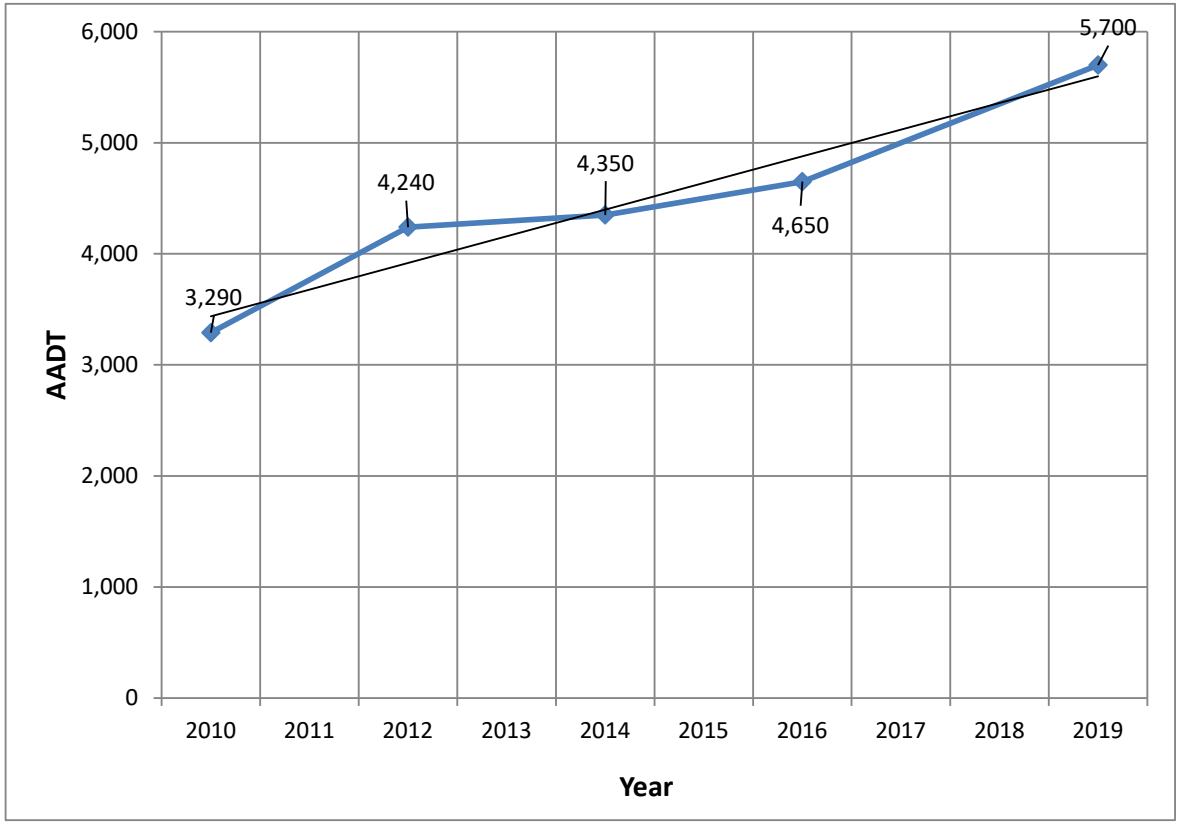

TN TDOT
Traffic History
Find address or place
HARDIN VALLEY
Conner Creek
Hardin Valley Rd
Yarnell Rd
N Campbell Station Rd
Marietta Church Rd
Buttermilk Rd E
Misty Valley Way
JS Davis Ln
Sexton Ln
El Rancho Trl
Chirping Bird Ln
Fallen Oaks Dr
Covered Bridge Blvd
Meadow Hill Ln
English Ivy Ln
Ridgeland Dr
(1 of 2)
Station Number: 000303
Knox County, NEAR LOUDON CO LINE
Route: 01277
AADT by year:
2018 = 5,593
2017 = 5,568
2016 = 5,583
2015 = 4,779
2014 = 4,332
2013 = 4,271
2012 = 4,385
2011 = 4,256
2010 = 3,759
2009 = 4,176
2008 = 3,860
Zoom to

Historical Traffic Counts

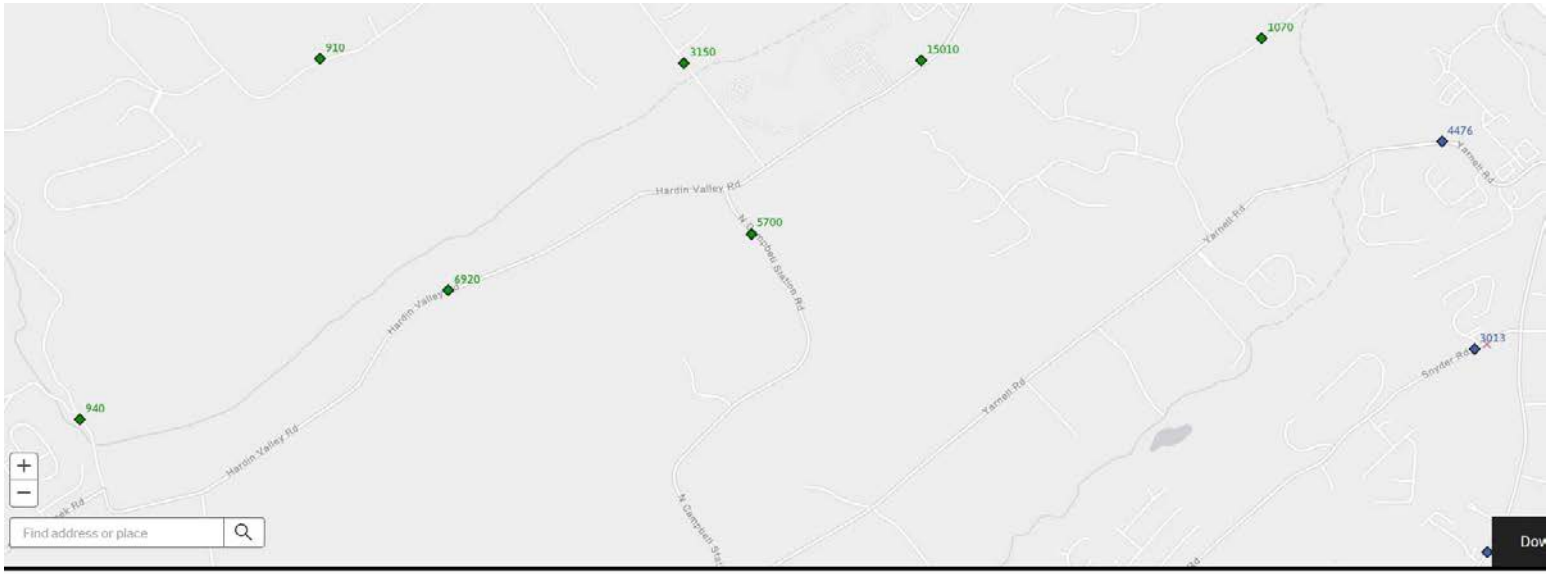
Organization: Knoxville TPO
Station ID #: 093M354
Location: North Campbell Station Road, south of Hardin Valley Road

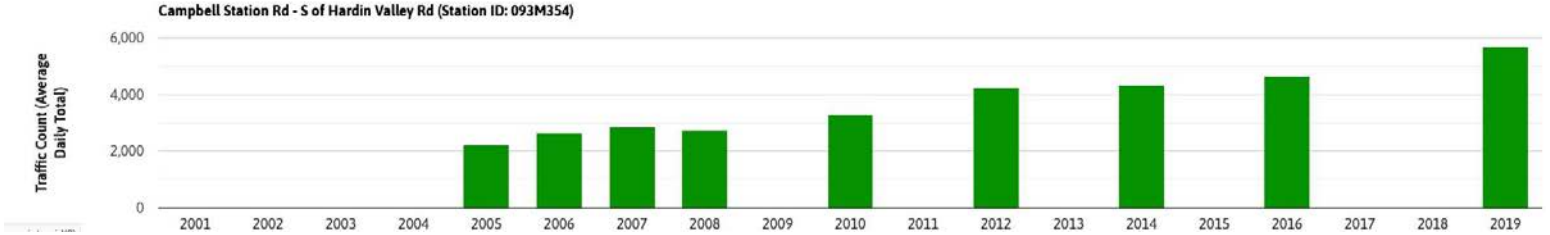
YEAR	AADT
2009	-
2010	3,290
2011	-
2012	4,240
2013	-
2014	4,350
2015	-
2016	4,650
2017	-
2018	-
2019	5,700

Trendline



2010 - 2019 Growth Rate = 73.3%
Average Annual Growth Rate = 6.3%

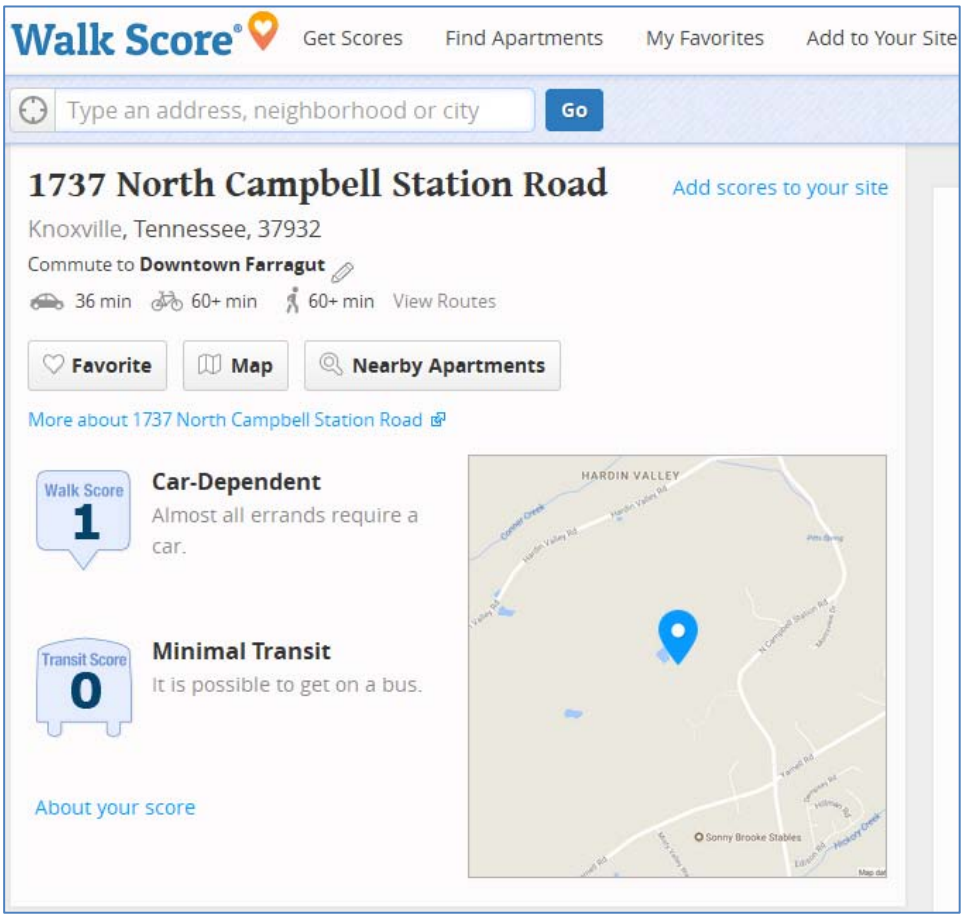

910
3150
15010
1070
4476
Hardin Valley Rd
5700
6920
Yarnell Rd
3013
940
Hardin Valley Rd
Yarnell Rd
Find address or place


Campbell Station Rd - S of Hardin Valley Rd (Station ID: 093M354)
Traffic Count (Average Daily Total)
6,000
4,000
2,000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

APPENDIX B

WALK SCORE

WALKSCORE
(from walkscore.com)



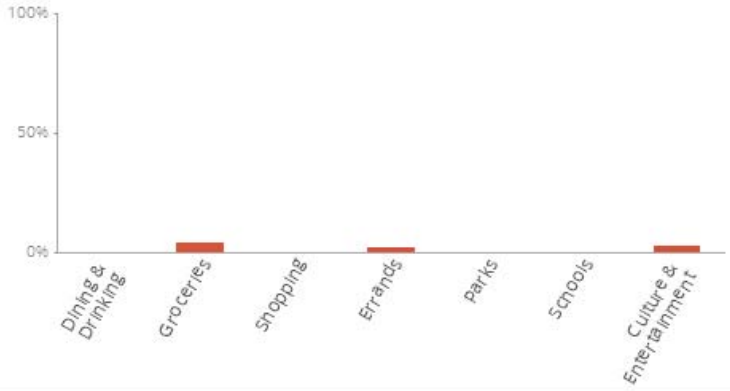
Scores for 1737 North Campbell Station Road

Walk Score
1

Walk Score | Transit Score | Bike Score

Score Details | What is Walk Score

The Walk Score for 1737 North Campbell Station Road is based on the following categories.



Scores for 1737 North Campbell Station Road

Walk Score
1

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 1737 North Campbell Station Road

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

What's Nearby

Restaurants:
Auntie Anne's 1.7mi

Coffee:
Starbucks 2.6mi

Bars:
Big Kahuna Wings 4mi

Groceries:
Food City - Hardin Valley .8mi

Parks:
Melton Hill Park 3.1mi

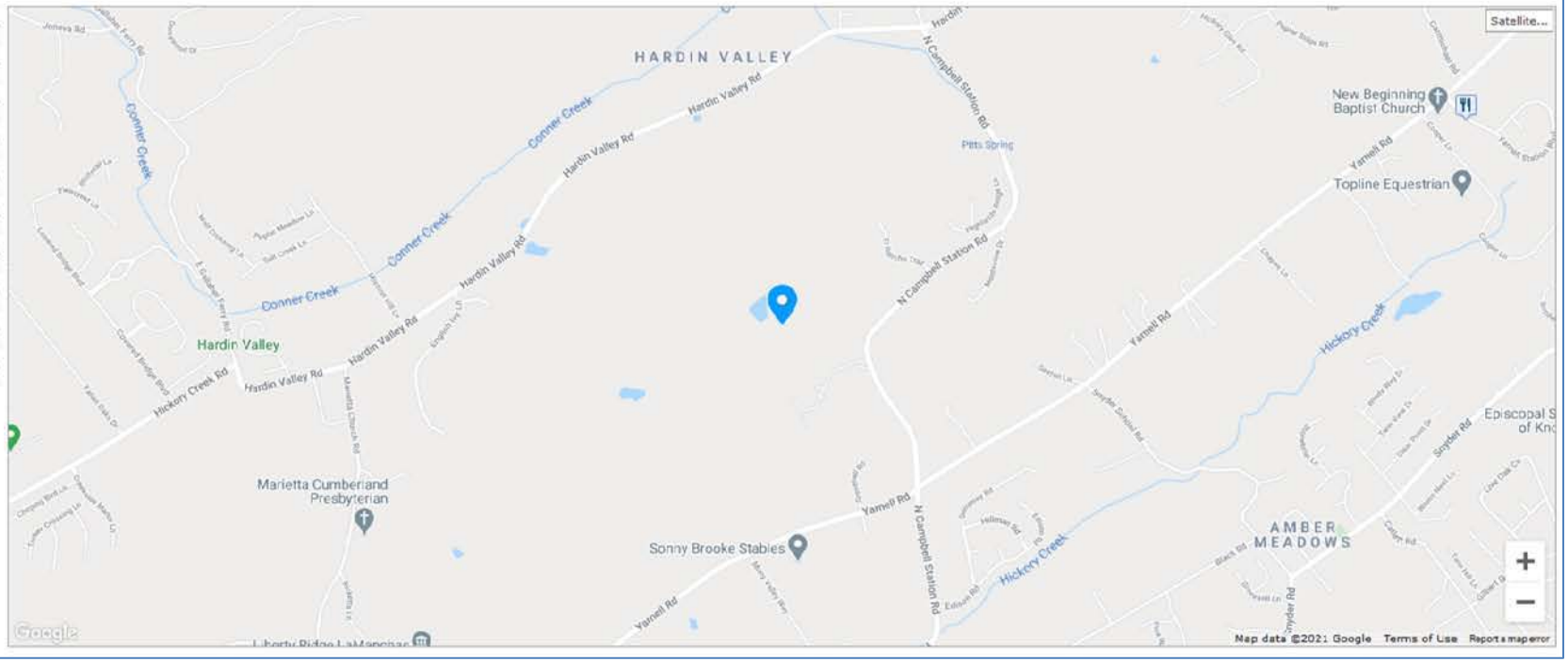
Schools:
Hardin Valley Elementary Sch... 1mi

Shopping:
Gatehouse Antique Market 2mi

Entertainment:
Redbox .8mi

Errands:
U.S. Bank Branch .8mi

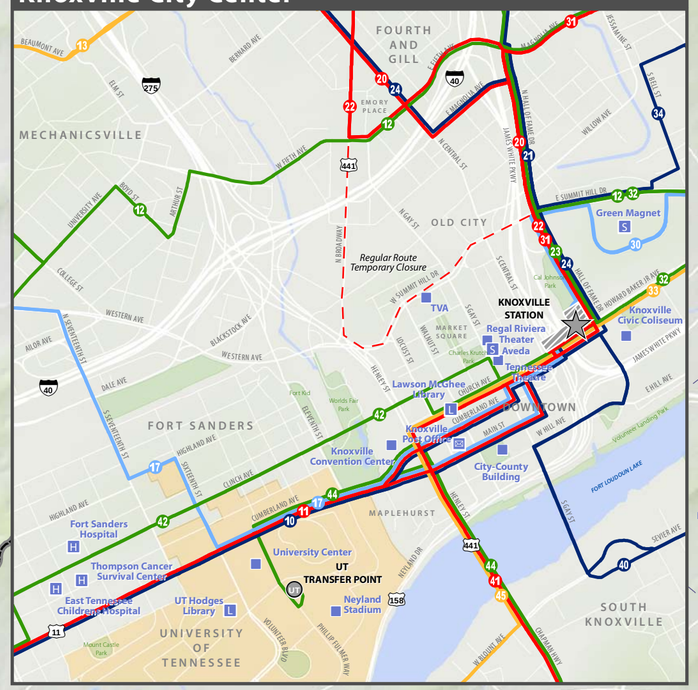
Search Nearby:



APPENDIX C

KNOXVILLE AREA TRANSIT MAP AND INFORMATION

Knoxville City Center



Legend

- Transfer Point
- Lift Service Area Boundary

Points of Interest

- Hospital
- 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

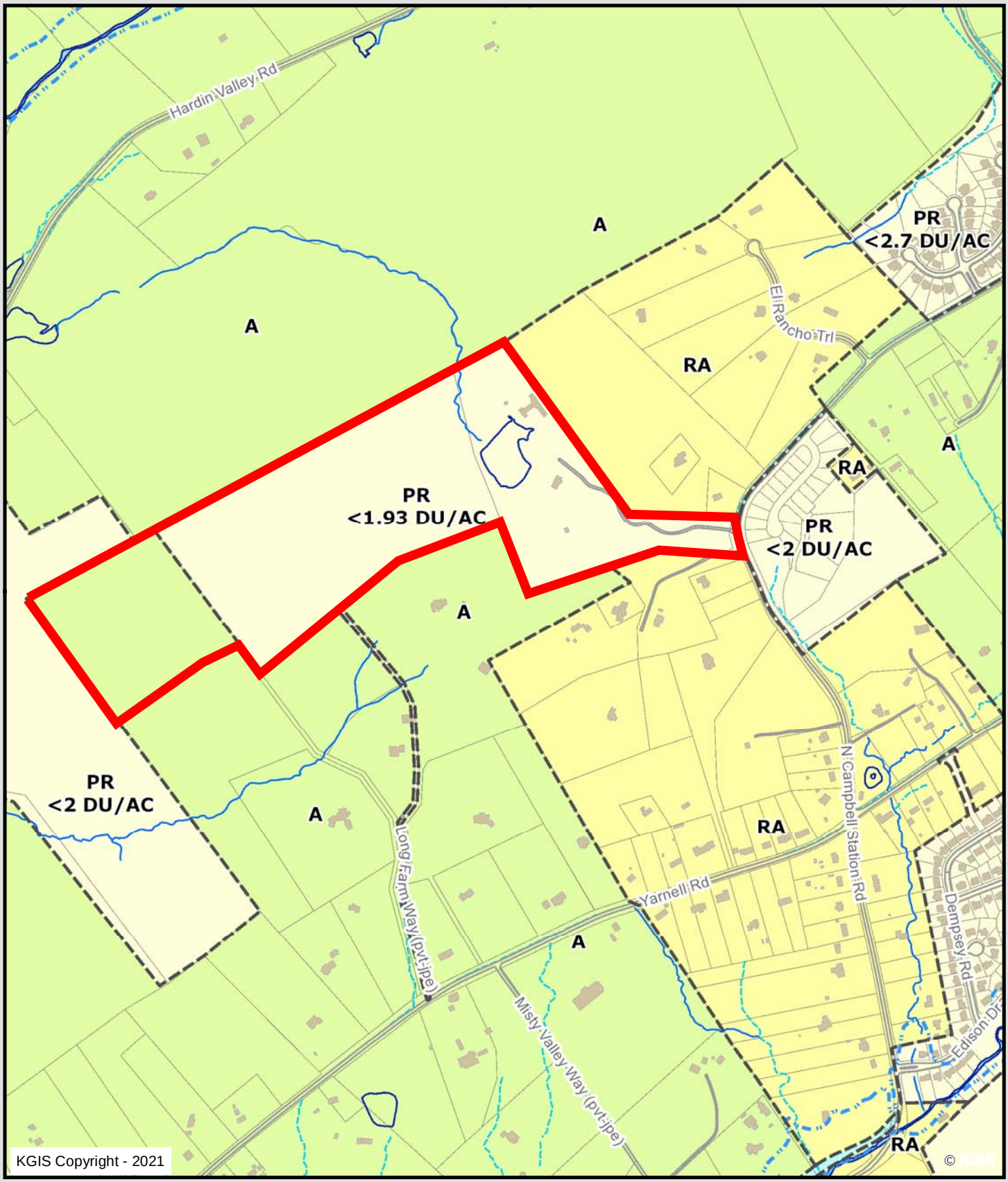
Information Updated: February 1, 2021

	Going from Wal Mart to Windsor Square				*Going from Windsor Square to Wal Mart*		
	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: 3/13/2021 at 3:58:06 PM

0 390 780 1,560

ft

APPENDIX E

MANUAL TRAFFIC COUNT DATA

TRAFFIC COUNT DATA

Major Street: North Campbell Station Road (SB-NB)
Minor Street: Yarnell Road (WB-EB)
Traffic Control: Stop Control on Yarnell Road

3/9/2021 (Tuesday)
Sunny, Warm
Conducted by: Ajax Engineering

	North Campbell Station Road			Yarnell Road			North Campbell Station Road			Yarnell Road				
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			VEHICLE	PEAK
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	TOTAL	HOUR
7:00 AM	8	27	1	3	2	14	4	29	5	0	2	10	105	
7:15 AM	***5***	***28***	***2***	***5***	***4***	***23***	***5***	***48***	***9***	***4***	***8***	***14***	***155***	**7:15 AM - 8:15 AM**
7:30 AM	***24***	***63***	***3***	***4***	***2***	***15***	***4***	***32***	***7***	***2***	***7***	***15***	***178***	
7:45 AM	***19***	***60***	***3***	***2***	***3***	***30***	***3***	***46***	***9***	***3***	***14***	***11***	***203***	
8:00 AM	***14***	***48***	***1***	***6***	***4***	***18***	***5***	***43***	***8***	***1***	***3***	***5***	***156***	
8:15 AM	19	47	1	3	1	19	5	30	4	2	4	6	141	
8:30 AM	6	37	0	4	4	4	5	27	4	0	1	11	103	
8:45 AM	0	30	1	5	0	3	2	23	5	1	5	6	81	
TOTAL	95	340	12	32	20	126	33	278	51	13	44	78	1122	
11:00 AM	4	25	0	1	1	0	8	8	13	3	3	5	71	
11:15 AM	1	22	0	2	2	2	4	4	4	1	2	3	47	
11:30 AM	***1***	***25***	***1***	***3***	***8***	***4***	***9***	***9***	***5***	***1***	***0***	***8***	***74***	**11:30 AM - 12:30 PM**
11:45 AM	***2***	***33***	***3***	***5***	***7***	***3***	***10***	***10***	***5***	***0***	***5***	***11***	***94***	
12:00 PM	***2***	***29***	***0***	***4***	***4***	***3***	***4***	***4***	***2***	***3***	***1***	***6***	***62***	
12:15 PM	***1***	***33***	***2***	***11***	***0***	***1***	***4***	***4***	***2***	***2***	***4***	***4***	***68***	
12:30 PM	3	42	0	3	2	1	7	7	1	0	1	3	70	
12:45 PM	3	30	4	8	5	3	9	9	4	4	3	5	87	
TOTAL	17	239	10	37	29	17	55	55	36	14	19	45	573	
2:00 PM	6	29	5	6	2	4	9	41	3	2	3	6	116	
2:15 PM	6	38	3	3	4	2	7	46	5	0	0	6	120	
2:30 PM	4	30	1	3	5	12	5	47	9	1	2	8	127	
2:45 PM	12	39	2	10	8	8	7	40	6	0	4	6	142	
3:00 PM	9	28	0	9	3	8	4	33	9	3	4	5	115	
3:15 PM	***10***	***56***	***5***	***8***	***3***	***14***	***7***	***53***	***7***	***4***	***4***	***4***	***175***	**3:15 PM - 4:15 PM**
3:30 PM	***37***	***64***	***7***	***7***	***6***	***10***	***13***	***36***	***8***	***1***	***4***	***7***	***200***	
3:45 PM	***50***	***85***	***5***	***5***	***4***	***11***	***11***	***42***	***13***	***0***	***2***	***12***	***240***	
4:00 PM	***8***	***50***	***1***	***9***	***6***	***4***	***11***	***37***	***4***	***2***	***4***	***7***	***143***	
4:15 PM	5	45	2	7	6	10	13	50	12	3	3	12	168	
4:30 PM	1	40	0	7	8	6	12	39	9	1	6	11	140	
4:45 PM	3	33	2	8	7	5	15	49	12	3	3	9	149	
5:00 PM	6	34	6	15	15	13	11	49	11	3	4	9	176	
5:15 PM	8	43	2	10	8	14	26	51	8	2	2	7	181	
5:30 PM	6	49	0	11	9	8	14	55	14	0	6	8	180	
5:45 PM	7	37	2	6	4	14	12	50	11	1	6	12	162	
TOTAL	178	700	43	124	98	143	177	718	141	26	57	129	2534	

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

	North Campbell Station Road			Yarnell Road			North Campbell Station Road			Yarnell Road		
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
7:15 AM	5	28	2	5	4	23	5	48	9	4	8	14
7:30 AM	24	63	3	4	2	15	4	32	7	2	7	15
7:45 AM	19	60	3	2	3	30	3	46	9	3	14	11
8:00 AM	14	48	1	6	4	18	5	43	8	1	3	5
TOTAL	**62**	**199**	**9**	**17**	**13**	**86**	**17**	**169**	**33**	**10**	**32**	**45**
PHF	**0.65**	**0.79**	**0.75**	**0.71**	**0.81**	**0.72**	**0.85**	**0.88**	**0.92**	**0.63**	**0.57**	**0.75**
TRUCK %	**0.0%**	**3.5%**	**11.1%**	**5.9%**	**15.4%**	**2.3%**	**5.9%**	**5.3%**	**0.0%**	**10.0%**	**0.0%**	**0.0%**

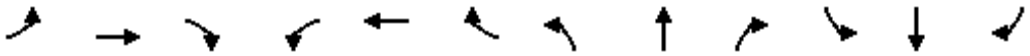
2021 PM Peak Hour **3:15 PM - 4:15 PM**

	North Campbell Station Road			Yarnell Road			North Campbell Station Road			Yarnell Road		
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
3:15 PM	10	56	5	8	3	14	7	53	7	4	4	4
3:30 PM	37	64	7	7	6	10	13	36	8	1	4	7
3:45 PM	50	85	5	5	4	11	11	42	13	0	2	12
4:00 PM	8	50	1	9	6	4	11	37	4	2	4	7
TOTAL	**105**	**255**	**18**	**29**	**19**	**39**	**42**	**168**	**32**	**7**	**14**	**30**
PHF	**0.53**	**0.75**	**0.64**	**0.81**	**0.79**	**0.70**	**0.81**	**0.79**	**0.62**	**0.44**	**0.88**	**0.63**
TRUCK %	**2.9%**	**1.2%**	**0.0%**	**0.0%**	**0.0%**	**5.1%**	**0.0%**	**4.8%**	**3.1%**	**14.3%**	**14.3%**	**0.0%**

APPENDIX F

CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 8)

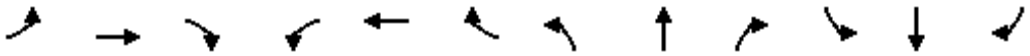
EXISTING TRAFFIC CONDITIONS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	32	45	17	13	86	17	169	33	62	199	9
Sign Control		Stop			Stop			Free			Free	
Grade		-6%			5%			-1%			-2%	
Peak Hour Factor	0.63	0.57	0.75	0.71	0.81	0.72	0.85	0.88	0.92	0.65	0.79	0.75
Hourly flow rate (vph)	16	56	60	24	16	119	20	192	36	95	252	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	826	717	258	787	705	210	264			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	826	717	258	787	705	210	264			228		
tC, single (s)	7.2	6.5	6.2	7.2	6.7	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.6	4.1	3.3	2.3			2.2		
p0 queue free %	93	83	92	90	95	86	98			93		
cM capacity (veh/h)	218	328	786	228	316	830	1277			1352		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	132	159	248	359
Volume Left	16	24	20	95
Volume Right	60	119	36	12
cSH	412	532	1277	1352
Volume to Capacity	0.32	0.30	0.02	0.07
Queue Length 95th (ft)	34	31	1	6
Control Delay (s)	17.8	14.6	0.8	2.6
Lane LOS	C	B	A	A
Approach Delay (s)	17.8	14.6	0.8	2.6
Approach LOS	C	B		

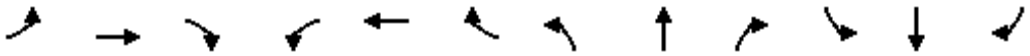
Intersection Summary				
Average Delay	6.4			
Intersection Capacity Utilization	46.2%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	38	54	20	16	103	20	203	40	74	239	11
Sign Control		Stop			Stop			Free			Free	
Grade		-6%			5%			-1%			-2%	
Peak Hour Factor	0.63	0.57	0.75	0.71	0.81	0.72	0.85	0.88	0.92	0.65	0.79	0.75
Hourly flow rate (vph)	19	67	72	28	20	143	24	231	43	114	303	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	990	859	310	942	844	252	317			274		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	990	859	310	942	844	252	317			274		
tC, single (s)	7.2	6.5	6.2	7.2	6.7	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.6	4.1	3.3	2.3			2.2		
p0 queue free %	88	75	90	82	92	82	98			91		
cM capacity (veh/h)	155	266	735	160	255	786	1221			1301		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	158	191	298	431
Volume Left	19	28	24	114
Volume Right	72	143	43	15
cSH	334	439	1221	1301
Volume to Capacity	0.47	0.44	0.02	0.09
Queue Length 95th (ft)	60	54	1	7
Control Delay (s)	25.0	19.4	0.8	2.8
Lane LOS	D	C	A	A
Approach Delay (s)	25.0	19.4	0.8	2.8
Approach LOS	D	C		

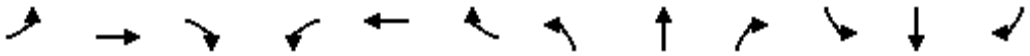
Intersection Summary				
Average Delay	8.4			
Intersection Capacity Utilization	53.4%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	14	30	29	19	39	42	168	32	105	255	18
Sign Control		Stop			Stop			Free			Free	
Grade		-6%			5%			-1%			-2%	
Peak Hour Factor	0.44	0.88	0.63	0.81	0.79	0.62	0.81	0.79	0.62	0.53	0.75	0.64
Hourly flow rate (vph)	16	16	48	36	24	63	52	213	52	198	340	28
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	1167	1118	354	1148	1107	238	368			264		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1167	1118	354	1148	1107	238	368			264		
tC, single (s)	7.2	6.6	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.1	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	86	90	93	73	86	92	96			85		
cM capacity (veh/h)	114	160	695	130	171	793	1202			1294		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	79	123	316	566
Volume Left	16	36	52	198
Volume Right	48	63	52	28
cSH	258	248	1202	1294
Volume to Capacity	0.31	0.49	0.04	0.15
Queue Length 95th (ft)	32	63	3	14
Control Delay (s)	25.0	32.9	1.7	4.0
Lane LOS	C	D	A	A
Approach Delay (s)	25.0	32.9	1.7	4.0
Approach LOS	C	D		

Intersection Summary				
Average Delay	8.1			
Intersection Capacity Utilization	49.6%	ICU Level of Service	A	
Analysis Period (min)	15			

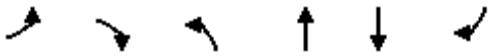


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	17	36	35	23	47	50	202	38	126	306	22
Sign Control		Stop			Stop			Free			Free	
Grade		-6%			5%			-1%			-2%	
Peak Hour Factor	0.44	0.88	0.63	0.81	0.79	0.62	0.81	0.79	0.62	0.53	0.75	0.64
Hourly flow rate (vph)	18	19	57	43	29	76	62	256	61	238	408	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	1401	1341	425	1377	1328	286	442			317		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1401	1341	425	1377	1328	286	442			317		
tC, single (s)	7.2	6.6	6.2	7.1	6.5	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.1	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	73	83	91	46	76	90	95			81		
cM capacity (veh/h)	67	110	634	80	119	745	1128			1237		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	95	148	379	680
Volume Left	18	43	62	238
Volume Right	57	76	61	34
cSH	176	167	1128	1237
Volume to Capacity	0.54	0.89	0.05	0.19
Queue Length 95th (ft)	69	159	4	18
Control Delay (s)	46.9	97.7	1.8	4.5
Lane LOS	E	F	A	A
Approach Delay (s)	46.9	97.7	1.8	4.5
Approach LOS	E	F		

Intersection Summary				
Average Delay	17.4			
Intersection Capacity Utilization	58.7%	ICU Level of Service	B	
Analysis Period (min)	15			

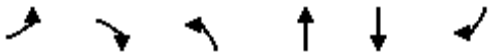
OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	43	43	15	398	406	14
Sign Control	Stop			Free	Free	
Grade	0%			5%	-5%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	48	48	17	442	451	16
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	934	459	467			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	934	459	467			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	84	92	98			
cM capacity (veh/h)	293	606	1105			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	96	459	467
Volume Left	48	17	0
Volume Right	48	0	16
cSH	395	1105	1700
Volume to Capacity	0.24	0.02	0.27
Queue Length 95th (ft)	23	1	0
Control Delay (s)	17.0	0.5	0.0
Lane LOS	C	A	
Approach Delay (s)	17.0	0.5	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	37	20	34	322	569	64
Sign Control	Stop			Free	Free	
Grade	0%			5%	-5%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	41	22	38	358	632	71
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	1101	668	703			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1101	668	703			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	82	95	96			
cM capacity (veh/h)	227	462	904			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	63	396	703
Volume Left	41	38	0
Volume Right	22	0	71
cSH	276	904	1700
Volume to Capacity	0.23	0.04	0.41
Queue Length 95th (ft)	22	3	0
Control Delay (s)	21.9	1.3	0.0
Lane LOS	C	A	
Approach Delay (s)	21.9	1.3	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
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)

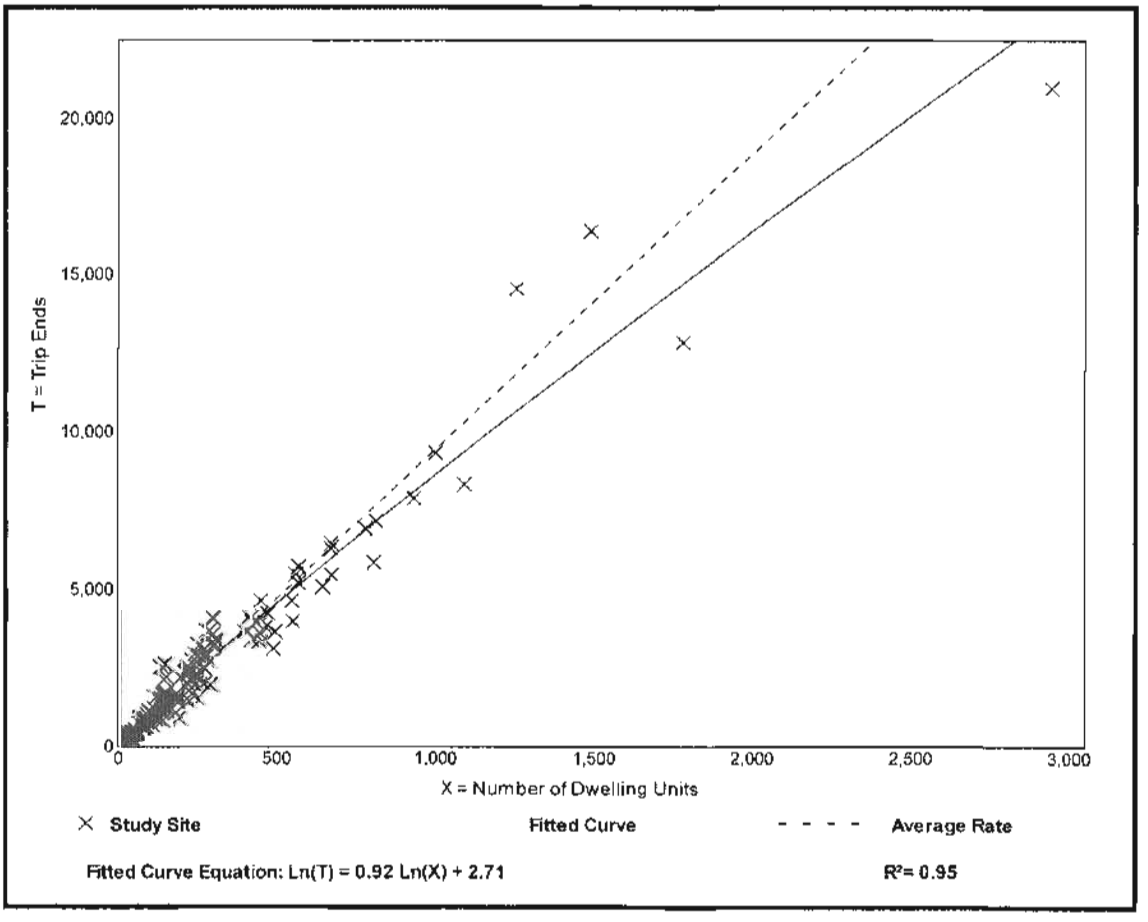
Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

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



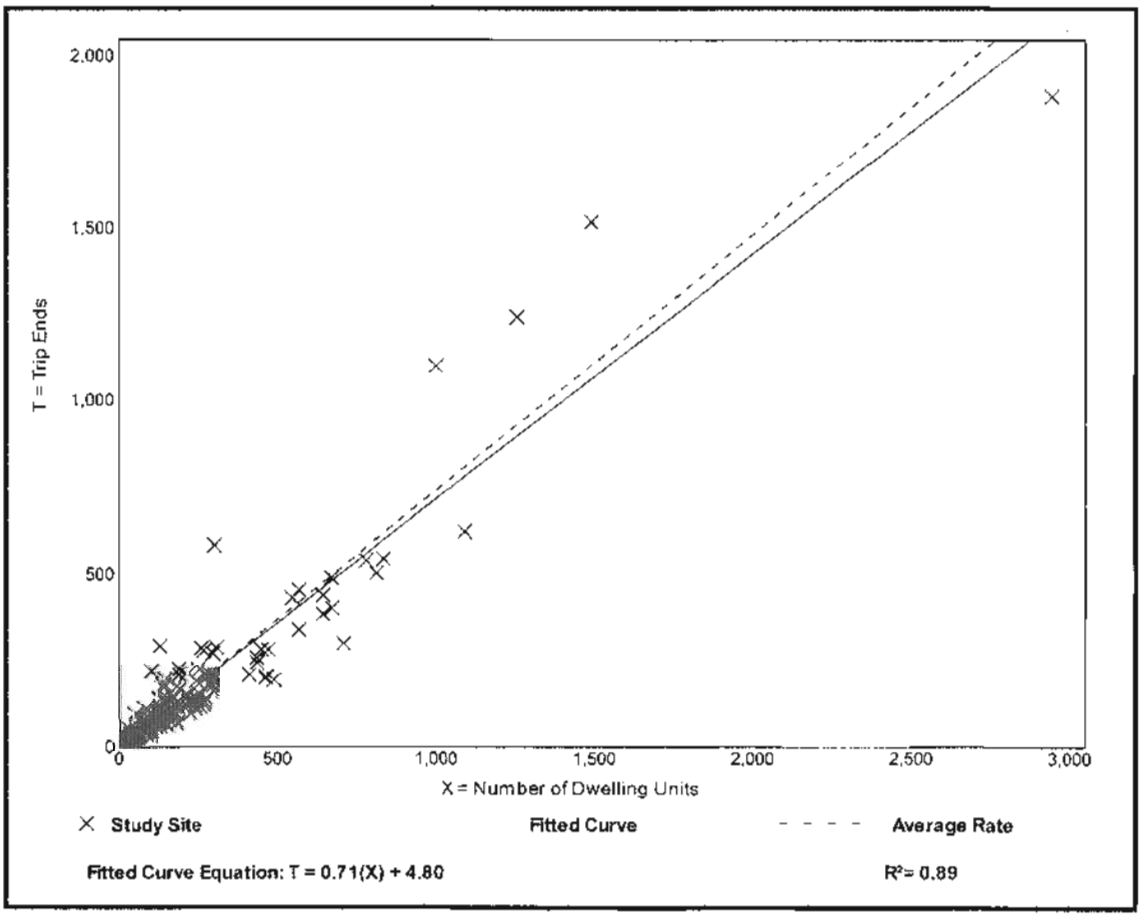
Single-Family Detached Housing
(210)

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



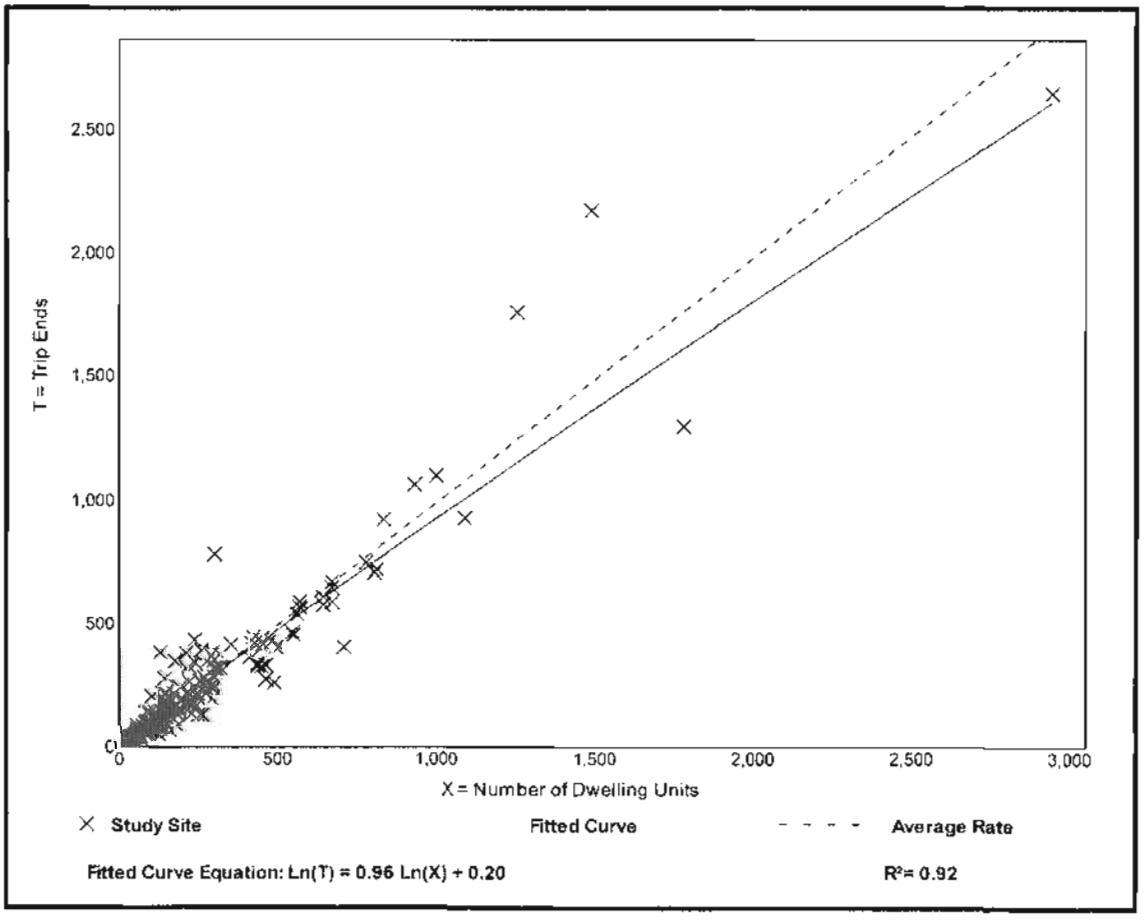
Single-Family Detached Housing
(210)

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 CATATOGA SUBDIVISION

155 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	155 Houses	1,557	25%	75%		63%	37%	
				29	86	115	98	57	155
Total New Volume Site Trips			**1,557**	**29**	**86**	**115**	**98**	**57**	**155**

ITE Trip Generation Manual, 10th Edition

Trips calculated by using Fitted Curve Equation

TRIP GENERATION FOR CATATOGA SUBDIVISION

155 Single-Family Detached Houses

155 Residential Houses = X

Weekday:

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

Ln(T) = 0.92 * 5.04 + 2.71

Ln(T) = 7.35

T = 1,557 trips

Peak Hour of Adjacent Traffic between 7 and 9 am:

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

T = 0.71 * 155 + 4.80

T = 115 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 * 5.04 + 0.20

Ln(T) = 5.04

T = 155 trips

APPENDIX H

2018 CENSUS BUREAU DATA

United States Census Bureau OnTheMap

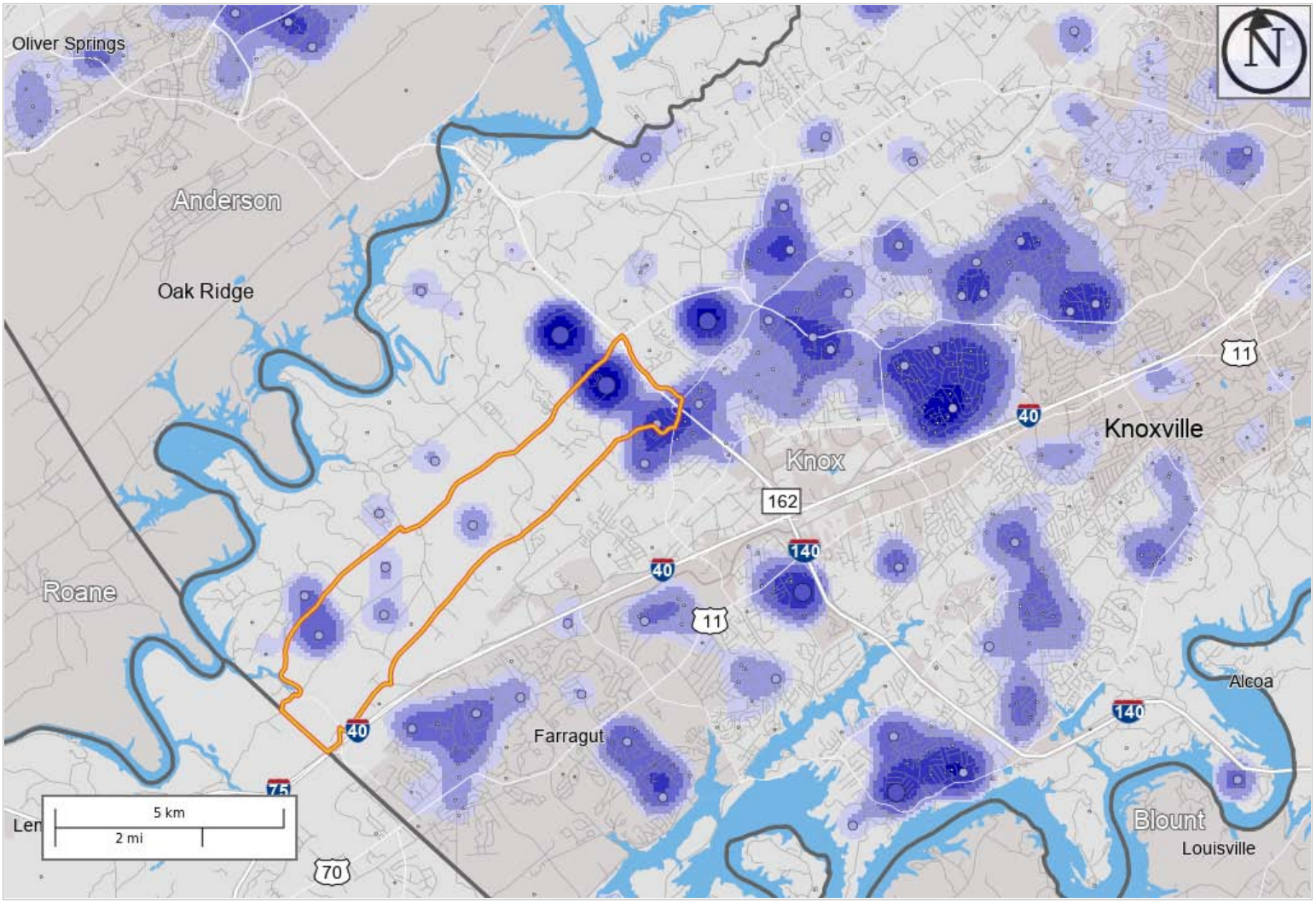
Distance/Direction Report - Work to Home

All Jobs for All Workers in 2018

Created by the U.S. Census Bureau's OnTheMap https://onthemap.ces.census.gov on 03/17/2021

Counts and Density of Home Locations for All Jobs in Work Selection Area in 2018

All Workers



Map Legend

Job Density [Jobs/Sq. Mile]

- 5 - 6
- 7 - 11
- 12 - 19
- 20 - 30

Job Count [Jobs/Census Block]

- 1 - 2
- 3 - 6
- 7 - 13

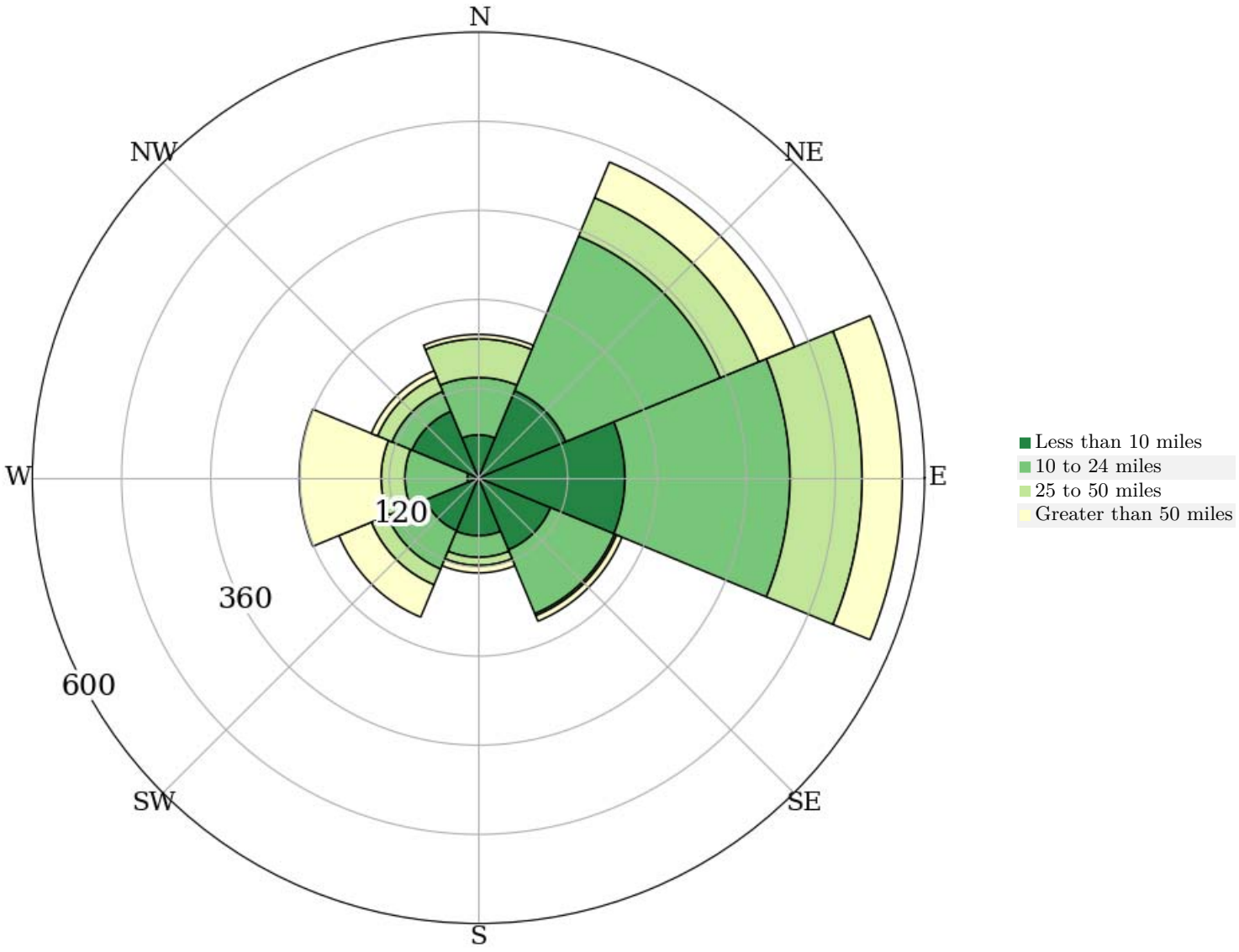
Selection Areas

- Analysis Selection

United States Census Bureau

All Jobs for All Workers in 2018

Distance and Direction from Work Census Block to Home Census Block, Employed in Selection Area



All Jobs for All Workers in 2018

Distance from Work Census Block to Home Census Block, Employed in Selection Area

Distance	2018 Count	2018 Share
Total All Jobs	2,160	100.0
Less than 10 miles	754	34.9
10 to 24 miles	815	37.7
25 to 50 miles	295	13.7
Greater than 50 miles	296	13.7

Additional Information

Analysis Settings

Analysis Type	Distance/Direction
Selection area as	Work
Year(s)	2018
Job Type	All Jobs
Selection Area	59.05 (Knox, TN) from Census Tracts
Selected Census Blocks	40
Analysis Generation Date	03/17/2021 15:21 - OnTheMap 6.8
Code Revision	5dc8e60ec2609d78ebfa7d4b188db13aacbb1ba6
LODES Data Version	20201117_1559

Data Sources

Source: U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2018).

Notes

1. Race, Ethnicity, Educational Attainment, and Sex statistics are beta release results and are not available before 2009.
2. Educational Attainment is only produced for workers aged 30 and over.
3. Firm Age and Firm Size statistics are beta release results for All Private jobs and are not available before 2011 and in 2018.

APPENDIX I

KNOX COUNTY TURN LANE THRESHOLD WORKSHEETS

TABLE 5A

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

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

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

406 + 14 = 420

398

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

North Campbell Station Road at Road "A"

2026 Projected AM NB Left Turns = 15

Turn Lane NOT Warranted

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

TABLE 5B

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

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

406

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

North Campbell Station Road at Road "A"

2026 Projected AM SB Right Turns = 14

Turn Lane NOT Warranted

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

TABLE 5A

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

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

569 + 64 = 633

322

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

North Campbell Station Road at Road "A"

2026 Projected AM NB Left Turns = 34

Turn Lane Warranted

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

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

TABLE 5B

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

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

569

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

64

North Campbell Station Road at Road "A"

2026 Projected AM SB Right Turns = 64

Turn Lane Warranted

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

APPENDIX J

SIGHT DISTANCE CERTIFICATION LETTER

URBAN ENGINEERING, INC.

CIVIL ENGINEERS • LAND PLANNERS • LAND SURVEYORS

October 22, 2020

Knox County Engineering and Public Works
Mr. Leo LaCamera, P.E. and Mr. Aaron Fritz, P.E.
205 West Baxter Avenue
Knoxville, TN 37917

And

Ms. Tarren Barrett, P.E.
Knoxville Regional TPO and MPC
400 Main Street, Suite 403
Knoxville, TN 37902

Re: 11-C-20-RZ / 11-A-20-SP

Dear Leo, Aaron and Tarren:

Sight distance was evaluated facing north and south from the proposed ingress / egress location. The posted speed along N Campbell Station Road at the project site is 30 MPH. Per the Knox County Subdivision Regulations, the required minimum available sight distance is 300 feet. In both directions, the available sight distance will exceed the minimum distance.

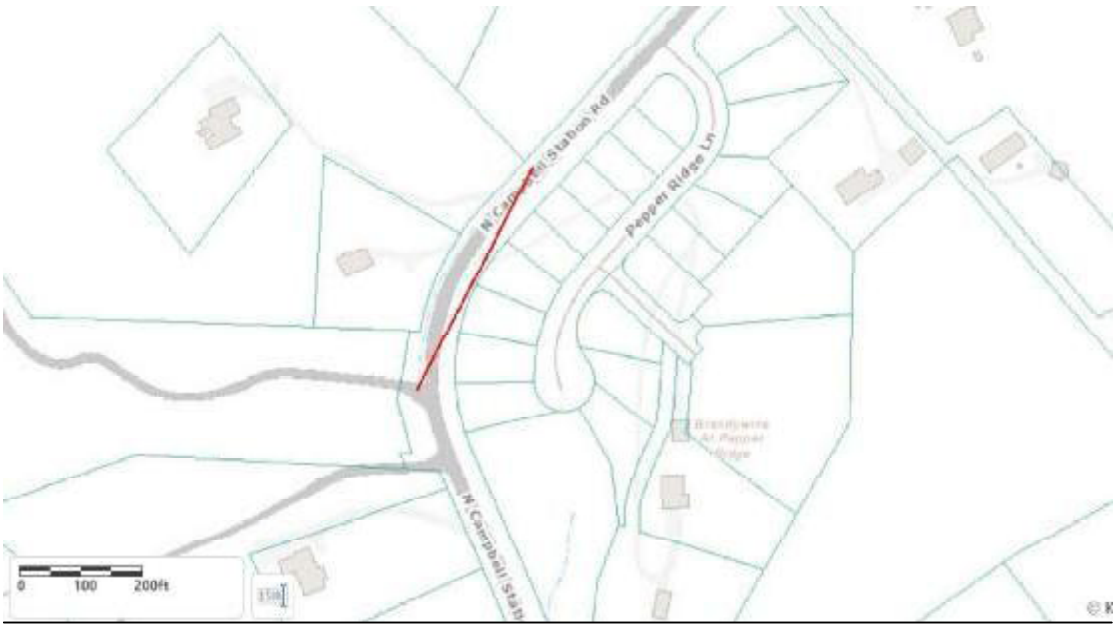
Attached to this letter you will find line of sight profiles in both directions, along with photographs taken from the entrance location facing both directions. Please do not hesitate to contact me if you have questions or comments about this letter or attachments.

Sincerely,

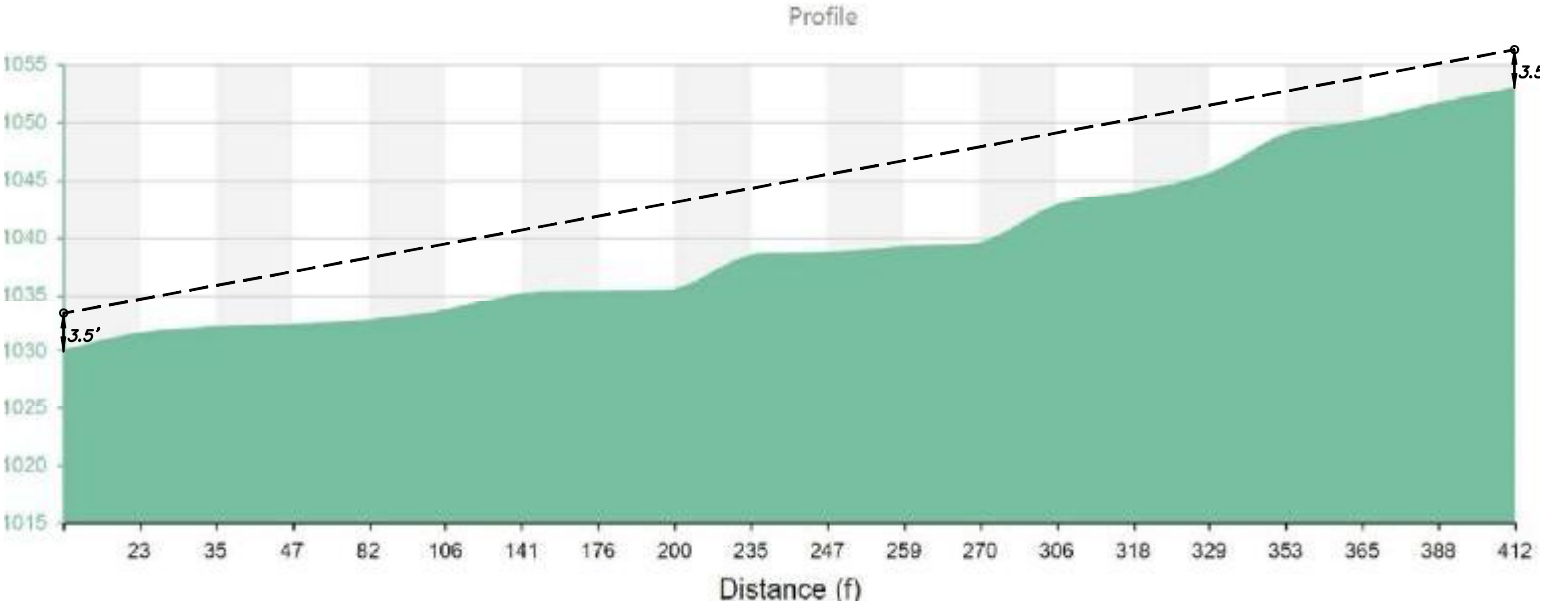
Urban Engineering, Inc.

Chris Sharp, P.E.

11852 KINGSTON PIKE • FARRAGUT, TENNESSEE 37934 • PHONE: 865-966-1924 • FAX: 865-315-7011



LINE OF SIGHT – N.T.S.



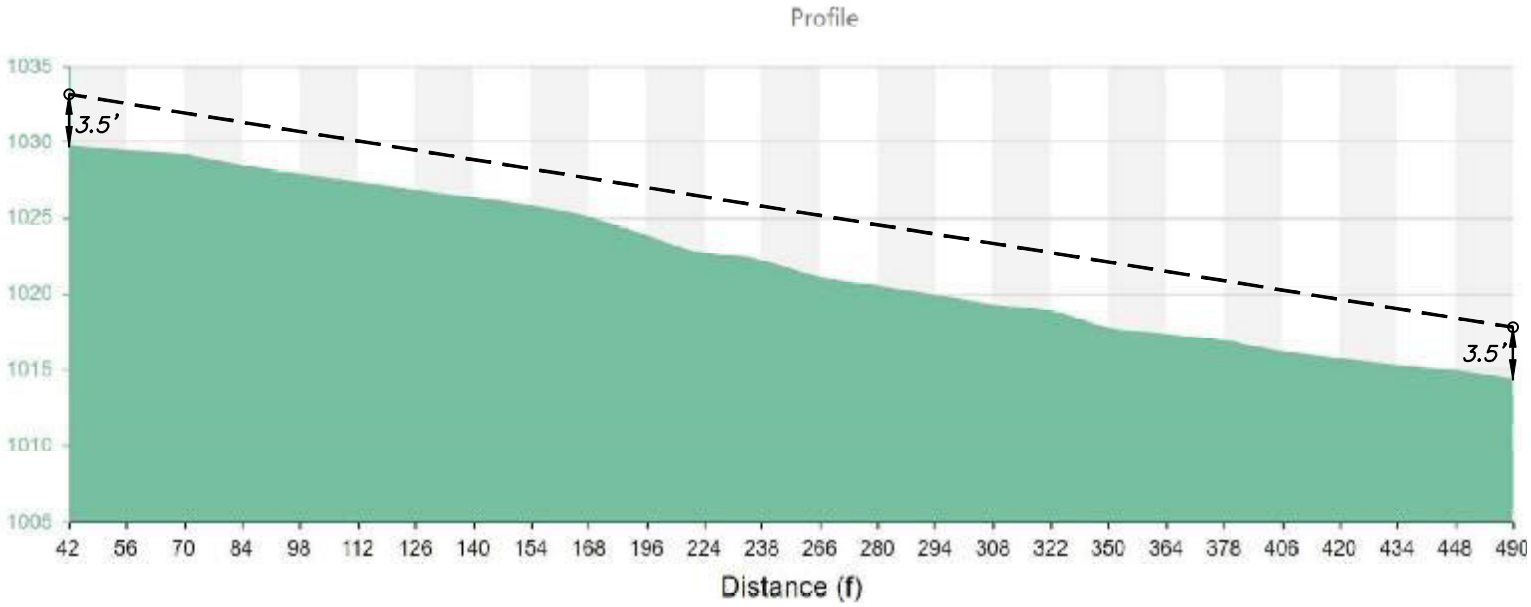
LINE OF SIGHT PROFILE – N.T.S.

SIGHT DISTANCE – NORTH

CATATOGA KENNELS

DISTRICT W6 — KNOX COUNTY, TN
CLT MAP 117 — PARCEL 12.03
SCALE: N.T.S. — OCTOBER 21, 2020

LINE OF SIGHT – N.T.S.



LINE OF SIGHT PROFILE – N.T.S.

SIGHT DISTANCE – SOUTH

CATATOGA KENNELS

DISTRICT W6	*KNOX COUNTY, TN*
CLT MAP 117	*PARCEL 12.03*
SCALE: N.T.S.	*OCTOBER 21, 2020*

Sight Distance From Ingress/Egress – North

Sight Distance From Ingress/Egress – South

APPENDIX K

SIMTRAFFIC VEHICLE QUEUE RESULTS

Intersection: 2: North Campbell Station Road & Catatoga Subdivision Road "A"

Movement	EB	NB
Directions Served	LR	L
Maximum Queue (ft)	72	33
Average Queue (ft)	31	6
95th Queue (ft)	56	25
Link Distance (ft)	389	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		50
Storage Blk Time (%)		0
Queuing Penalty (veh)		0

Intersection: 2: North Campbell Station Road & Catatoga Subdivision Road "A"

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	R
Maximum Queue (ft)	61	37	9	4
Average Queue (ft)	24	14	0	0
95th Queue (ft)	49	40	9	3
Link Distance (ft)	389		349	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)		50		50
Storage Blk Time (%)		0		
Queuing Penalty (veh)		0		

APPENDIX L

RESPONSE LETTER TO ADDRESS REVIEW COMMENTS

AJAX ENGINEERING
CIVIL ENGINEERING / TRAFFIC ENGINEERING

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

April 21, 2021

PROJECT NAME: Catatoga Subdivision TIS

TO: Knoxville-Knox County Planning

SUBJECT: TIS Comment Response Document for Catatoga Subdivision (5-SB-21-C)
Review Comments dated April 16, 2021

Dear Knoxville-Knox County Planning Staff:

The following comment response document is submitted to address comments dated April 16, 2021, and is included at the end of the revised report.

1. **As referenced in the TIS, there is a desire to provide multiple access points within subdivisions that contain more than 150 homes and when this is not feasible then a boulevard roadway section is recommended to be constructed from the entrance back to the first intersecting street. According to the site plan that has been submitted and also shown in the TIS, the boulevard extends only a relatively short distance into the site and instead should be extended to the first intersection of Road "A" and Road "B". Please coordinate with the site engineer to redesign as appropriate and include documentation of any necessary considerations made for transition/taper of the boulevard median in relation to potential driveway locations for lots 1-3.**

   Response: After discussion with Knox County Engineering and after attending the developer's meeting, it was determined that it would be acceptable to keep the original boulevard design submitted initially. This discussion is updated on page 43 in the Recommendations.

2. **The TIS provided an analysis of left turn lane warrants based on 2-lane roadways with a prevailing speed of 35 mph or less and a left-turn lane was very nearly warranted. We understand that the warrant tables were selected based on the posted speed limit of 30 mph on Campbell Station Rd however historical average speed data available to Knoxville-Knox County through an online application of archived travel**

time data known as "INRIX" indicates that this section of N. Campbell Station Rd has a daily average speed of 36.8 mph and 37.4 mph in the northbound and southbound directions respectively. Therefore, we are requesting that the left turn lane warrant analysis be conducted using the warrants for 2-lane roadways with a prevailing speed of 36 to 45 mph and the recommendations be revised accordingly including the necessity for installation of a potential northbound left turn lane and its required storage length.

Response: The study has been updated to reflect the new external vehicle speed data from Inrix. The updated results indicate a need for a left-turn lane on North Campbell Station Road in addition to a right-turn lane based on this speed data. This left-turn lane should have 50 feet of storage length based on the queue calculations. This updated discussion is shown on pages 37 and 40.

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

- Updated Title Page
- Updated Table of Contents
- Updated Page Footers
- Updated Recommendations
- Updated sight distance discussion on page 38 due to new Inrix data
- Added Appendix K to include vehicle queue results
- Added Appendix L to include this response letter

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

Sincerely,

Ajax Engineering, LLC
Robert W. Jacks, P.E.

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