

MEMORANDUM

Date: June 24, 2022

To: Mr. Tim Crockett, P.E. – Crockett Engineering

From: Ms. Shawn White, P.E., PTOE

CBB Job Number: 031-21

Project: Updated Site Plan Memo
Proposed Silver Lakes Residential Development
Columbia, Missouri

CBB completed a traffic study in May 2021, for the proposed Silver Lakes residential development, previously referred to as the Richland Tract. It is our understanding the site plan has been updated to reflect ongoing discussions with the City. Specifically, the new site plan reflects sight modifications to the internal roadways within the subdivision. The original Silver Lakes concept plan is shown in **Figure 1** with the updated plan shown in **Figure 2**.



Figure 1: Original Silver Lakes Concept Plan (provided by others)



Figure 2: Updated Silver Lakes Concept Plan (provided by others)

The original traffic study was based on the then proposed 348 single-family homes while the current development plan consists of 351 single-family homes. The net difference is an increase of three single-family homes which would be negligible.

While the internal layout within the subdivision was modified slightly, the proposed Silver Lakes development will still have two access drives on Richland Road and three access drives on Olivet Road essentially in the same location as previously studied. As such, the minor modifications in the updated site plan would not impact how the proposed site trips were assigned to the respective subdivision streets.

It is our opinion that the findings and recommendations in the May 2021 traffic study would remain valid.

Please do not hesitate to contact me via email at swhite@cbbtraffic.com or by phone at 314-449-9572 with any questions.

May 28, 2021

Mr. Tim Crockett, P.E.
Crockett Engineering
1000 West Nifong Boulevard, Building 1
Columbia, MO 65203

RE: Traffic Impact Study
Proposed Residential Development – Silver Lakes
Richland Road between Rolling Hills Road and Olivet Road
Columbia, Missouri
CBB Job No. 030-21

Dear Mr. Crockett:

As requested, CBB has completed a traffic impact study pertaining to a residential development, known as Silver Lakes, located on the north side of Richland Road just west of Olivet Road, in Columbia, Missouri. The location of the site relative to the surrounding area is depicted in **Figure 1**.

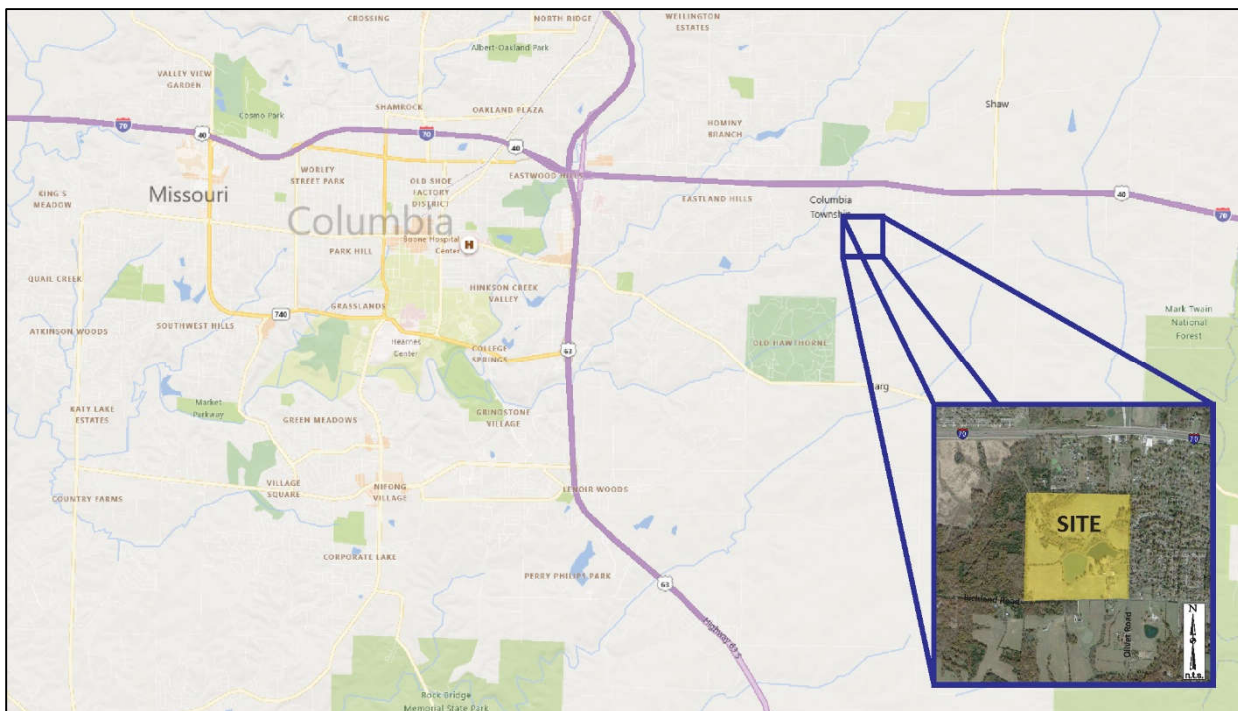


Figure 1: Project Location Map



Based on the site plan provided, the proposed development will include approximately 348 single-family homes. In conjunction with the proposed Silver Lakes development, Olivet Road would be extended north of Richland Road along the east side of the site. Access is proposed via two new drives on Richland Road and three new drive on the extension of Olivet Road. In addition, two stub streets are shown to connect to further development to the west with another two stub streets shown to connect to further development to the north. A schematic of the concept plan provided is shown in **Exhibit 1**.

The purpose of this study was to determine the number of additional trips that would be generated by the proposed development, assign the trips to the adjoining roadways, evaluate the impact of the additional trips on the operating conditions for the adjacent roadways, and determine the ability of motorists to safely enter and exit the site. If necessary, roadway improvements (lane additions and/or traffic control modifications) would be recommended to mitigate the impact of the development and to accommodate the additional traffic. The focus of this study was the AM and PM peak hours of a typical weekday.

CBB discussed the scope of work for this traffic study with the City of Columbia and Boone County at the commencement of the traffic study process. CBB also provided the City and Boone County a Technical Memo summarizing the proposed site trip generation and directional distribution estimates, as well as the Base traffic conditions and gained their consensus on the assumptions prior to completing the traffic analyses.

As requested by the City and County, the following key intersections were included in the study:

- Richland Road and Rolling Hills Road/Grace Lane;
- Richland Road and Olivet Road;
- Richland Road and St. Charles Road;
- Richland Road and Tradewinds Parkway;
- Richland Road and Rangeline Road (Route Z);
- St. Charles Road and Keene Street;
- St. Charles Road and Grace Lane;
- Highway WW and Rolling Hills Road;
- Highway WW and Olivet Road;
- Richland Road and the two site access drives; and
- Olivet Road and the three site access drives.



Exhibit 1: Preliminary Site Plan (provided by others)



As requested, the traffic impact study evaluated the following analysis scenarios for the weekday AM and PM peak hours:

- 2021 Base Conditions (existing traffic volumes plus approved but not built developments plus Discovery Parkway connection);
- 2021 Build Conditions (2021 Base plus proposed Silver Lakes trips); and
- 2021 Build Conditions - Alternate (2021 Build plus proposed Osburn Farms development trips).

The following report presents the methodology and findings relative to the Existing/Base and 2021 Build conditions.



EXISTING CONDITIONS

Area Roadway System: Richland Road is a local east-west roadway owned by Boone County, east of Rolling Hills Road and the City of Columbia west of Rolling Hills Road. Within the study area, Richland Road provides two travel lanes, one lane in each direction, and connects St. Charles Road on the west to Rangeline Road to the east. Richland Road has a posted speed limit of 45 miles per hour (mph). Shoulders, sidewalks, and marked bike lanes are not provided along the roadway.

Rolling Hills Road is two-lane roadway that runs north/south along the east side of Columbia and connects to Highway 63 approximately 4.75 miles to the south. Rolling Hills Road is owned by the City of Columbia. Rolling Hills Road consists of a 30-foot cross-section with two travel lanes, one lane in each direction, with curb and gutter. Sidewalk is provided along the east side of the roadway to near Highway WW. The posted speed on Rolling Hills Road south of Richland Road is 35 mph.

Rolling Hills Road north of Richland Road changes names to **Grace Lane** to the north to St. Charles Road and is owned by Boone County. Sidewalk is provided adjacent to some of the developed areas. Grace Lane has two travel lanes, one lane in each direction. Some sidewalk is also provided along Grace lane between Peeble Beach Drive/Volunteer Drive to Olivia Ray Drive. The posted speed on Grace Lane is 30 mph.

Highway WW (Broadway) is a minor arterial roadway that runs primarily east-west through the study area. Highway WW is owned and maintained by MoDOT. Within the study area, Highway WW provides two travel lanes, one in each direction. The posted speed limit is 45 mph west of Rolling Hills Road and 55 mph east of Rolling Hills Road. No sidewalks are provided along Highway WW through the study area. Paved shoulders are provided to the east of Cedar Grove Boulevard/Stone Mountain Parkway.

St. Charles Road is a major collector roadway owned and maintained by the City of Columbia. St. Charles Road consists of two-lanes (one lane in each direction) with a posted speed limit of 35 mph. St. Charles Road primarily runs in the northeast/southwest direction. Shoulders, sidewalks, and marked bike lanes are not provided along the roadway.

Rangeline Road (Route Z) is classified as a local roadway to the south of I-70 and a major collector to the north. This north-south, two-lane (one lane in each direction) road has a posted speed limit of 35 mph. Rangeline Road connects to I-70 less than one mile north of the Richland Road study intersection. Rangeline Road, south of I-70, is owned by Boone County and north of I-70 the roadway is owned by MoDOT. Curb and gutter are provided along both sides of North Rangeline Road; however, there are no sidewalks or marked bike lanes along the road.



Olivet Road is a local, north-south, roadway owned by Boone County. Olivet Road consist of two-lanes (one lane in each direction) from Richland Road to New Haven Road. The posted speed limit is 45 mph. Shoulders, sidewalks, and marked bike lanes are not provided along the roadway.

Tradewinds Parkway is a local roadway that runs north-south between Richland Road and the I-70 South Outer Road and is maintained by Boone County. Tradewinds Parkway provides a 40-foot cross-section with two unmarked travel lanes, one in each direction. The posted speed limit is 40 mph. No sidewalks or marked bike lanes are provided along the roadway.

Keene Street is a major collector roadway maintained by the City of Columbia. South of St. Charles Road, Keene Street is a three-lane road with one lane in each direction and a center two-way left-turn lane. North of the St. Charles Road intersection, Keene Street is a two-lane (one lane in each direction) roadway. The posted speed limit on Keene Street is 30 mph. Sidewalks exist along both sides of the roadway north of St. Charles Road, while complete sidewalks only exist along the west side of Keene Street south of the St. Charles Road intersection. Bicycle “shared lane markings” are displayed near the St. Charles Road intersection with dedicated bike lanes marked north and south of the intersection. Curb and gutter are provided along both sides of Keene Street.

The intersection of St. Charles Road and Keene Street is controlled by a traffic signal. The northbound and southbound left-turns operate under permissive/protected phasing. The eastbound approach provides a shared left-turn/through lane and a separate right-turn only lane from the medical office parking lot. The westbound approach provides a shared left-turn/through/right-turn lane. The northbound and southbound approaches provide a separate left-turn only lane and a shared through/right-turn lane. **Figure 2** provides an aerial view of the St. Charles Road and Keene Street intersection.

The intersection of Richland Road and St. Charles Road is controlled by a side-street stop sign. Traffic traveling on St. Charles Road can move freely through the intersection, while westbound traffic at Richland Road operates under stop control. St. Charles Road is a two-lane road with one lane in each direction. Richland Road provides a shared through/right-turn lane at the westbound approach. **Figure 3** provides an aerial view of the Richland Road and St. Charles Road intersection.

The intersection of Rolling Hills Road/Grace Lane and Richland Road is currently controlled as an All-Way STOP. A separate left-turn lane and shared through/right-turn lane is provided on northbound Rolling Hills Road and eastbound Richland Road, while a single lane approach (shared left/through/right-turn lane) is provided for westbound Richland Road and southbound Grace Lane. **Figure 4** provides an aerial view of the Richland Road and Rolling Hills Road/Grace Lane intersection.



Figure 2: Aerial View of the St. Charles Road and Keene Street Intersection

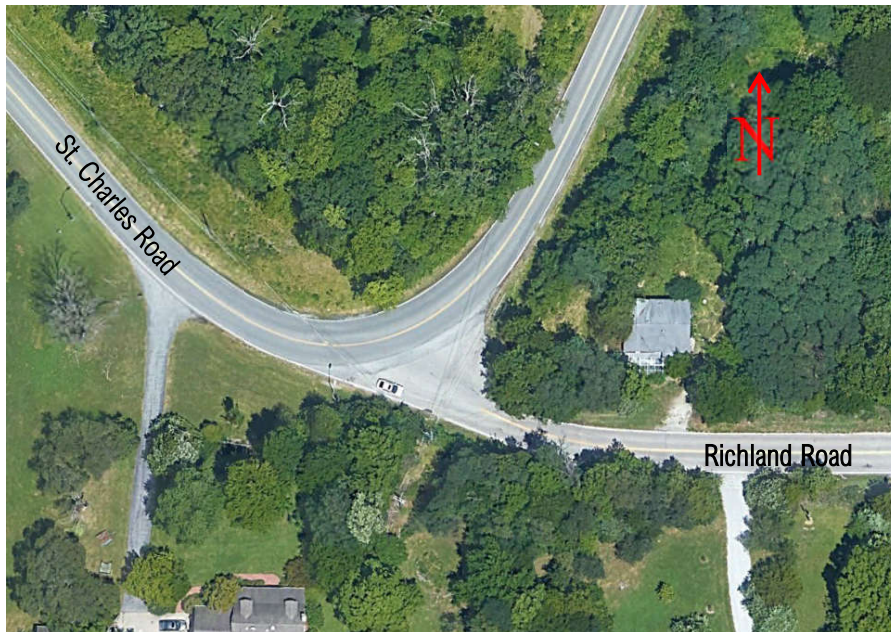


Figure 3: Aerial View of the Richland Road and St. Charles Road Intersection



Figure 4: Aerial View of the Richland Road and Rolling Hills Road Intersection

The intersection of Richland Road and Olivet Road is a side-street stop control with Olivet Road stopping at Richland Road. All approaches consist of a single lane. **Figure 5** provides an aerial view of the Richland Road and Olivet Road intersection.



Figure 5: Aerial View of the Richland Road and Olivet Road Intersection



The intersection of Richland Road and Tradewinds Parkway Road is a side-street stop control with Tradewinds Parkway required to stop at Richland Road. All approaches consist of a single shared lane. **Figure 6** provides an aerial view of the Richland Road and Tradewinds Parkway intersection.



Figure 6: Aerial View of the Richland Road and Tradewinds Parkway Intersection

The intersection of Richland Road and Rangeline Road is a side-street stop control with Rangeline Road required to stop at Richland Road. All approaches consist of a single shared lane. **Figure 7** provides an aerial view of the Richland Road and Rangeline Road intersection.

The intersection of St. Charles Road and Grace Lane is a side-street stop control with Grace Lane required to stop at St. Charles Road. All approaches consist of a single shared lane. **Figure 8** provides an aerial view of the St. Charles Road and Grace Lane intersection.

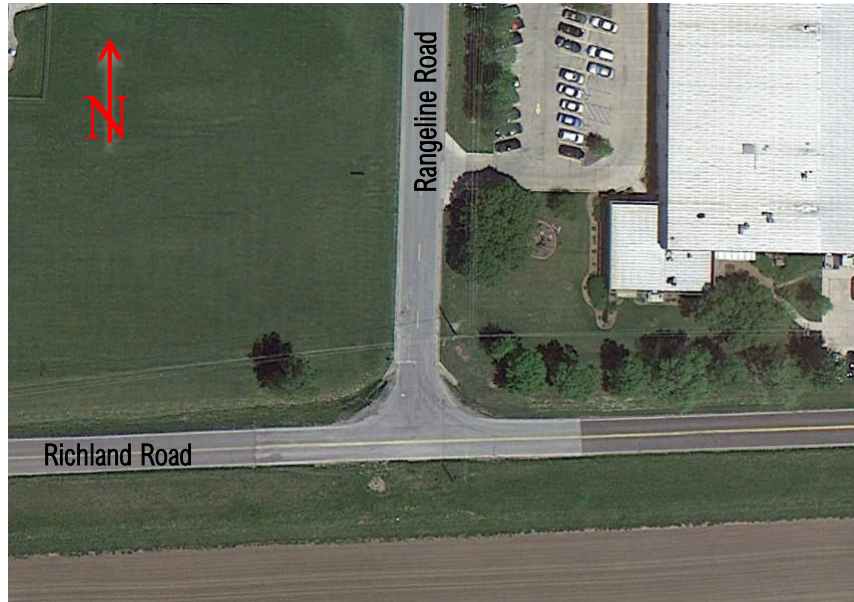


Figure 7: Aerial View of the Richland Road and Rangeline Road Intersection



Figure 8: Aerial View of the St. Charles Road and Grace Lane Intersection

Highway WW and Rolling Hills Road intersect at a roundabout. The eastbound and westbound Highway WW approaches consist of a single lane. The northbound and southbound Rolling Hills Road approaches consists of a separate left-turn only lane and a shared through/right-turn lane. **Figure 9** provides an aerial view of the Highway WW and Rolling Hills Road roundabout.

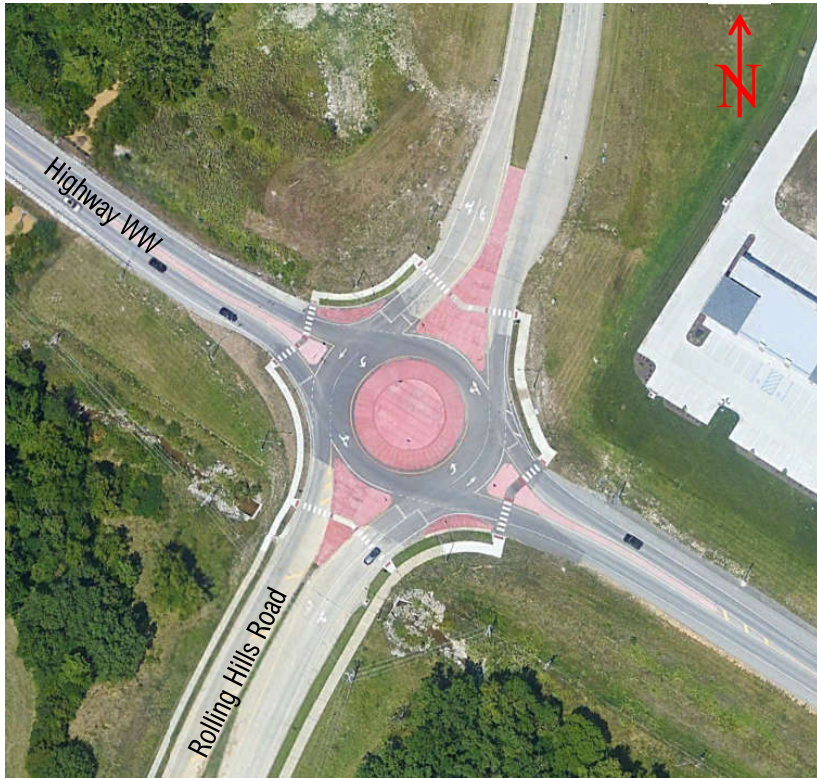


Figure 9: Aerial View of the Highway WW and Rollings Hills Road Intersection

The intersection of Highway WW and Olivet Road is a side-street stop control with Olivet Road required to stop at Highway WW. All approaches consist of a single shared lane. **Figure 10** provides an aerial view of the Highway WW and Olivet Road intersection.

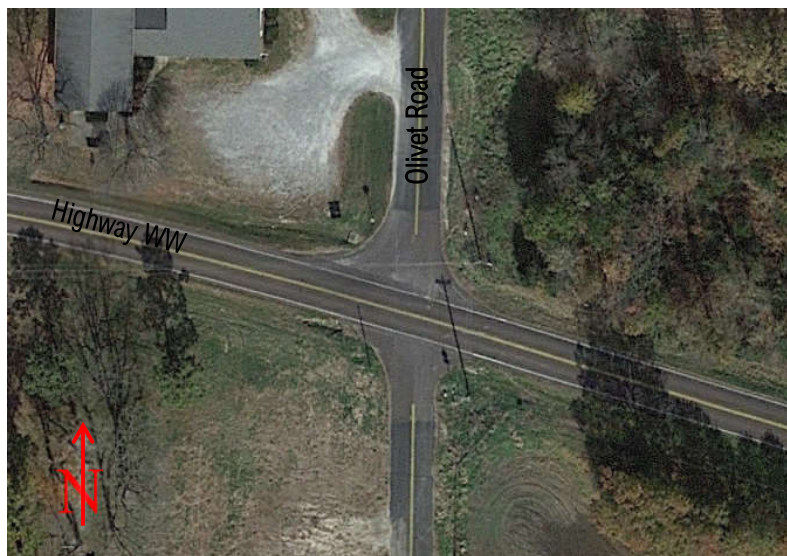


Figure 10: Aerial View of the Highway WW and Olivet Road Intersection



Existing Traffic Volumes: Video, turning movement traffic counts were conducted during the third week of March 2020. A 13-hour turning movement count (6:00 a.m. - 7:00 p.m.) was collected at the intersection of Richland Road and Rolling Hills Road. Morning commuter peak period (7:00 - 9:00 a.m.) and afternoon commuter peak period (4:00 - 6:00 p.m.) video traffic counts were collected at the following intersections:

- Richland Road and Olivet Road;
- Richland Road and St. Charles Road;
- St. Charles Road and Keene Street;
- Highway WW and Rolling Hills Road; and
- Highway WW and Olivet Road.

It should be noted that these counts were collected just before the region was significantly impacted by the COVID-19 pandemic. As such, CBB's 2020 traffic counts were compared to traffic counts collected by CBB in May 2014 for The Brooks development at Rolling Hills Road and Richland Road to verify that the 2020 volumes are reasonably accurate. The 2020 traffic counts are slightly higher than the 2014 traffic volumes, therefore the recent counts collected in March 2020 were used for this traffic impact study.

Additional video, turning movement traffic counts were collected for the AM and PM peak periods the second week of March 2021 at the following locations:

- Richland Road and Rangeline Road (Route Z);
- Richland Road and Tradewinds Parkway; and
- St. Charles Road and Grace Lane.

Since the additional counts collected in March 2021 were collected during the lingering effects of COVID-19, historical traffic count data was used to determine if any adjustments to the counts were needed. Consequently, the counts collected in March 2021 were increased approximately 20 percent to account for the lower traffic volumes collected as compared to pre-COVID levels.

Based on the traffic data collected, the morning peak hour occurred between 7:15 and 8:15 a.m. and the afternoon peak hour occurred between 4:30 and 5:30 p.m. The existing peak hour volumes are summarized in **Exhibit 2**. The estimated Average Daily Traffic (ADT) volumes are also shown in the Exhibit.

Given the traffic characteristics in the area and the anticipated trip generation for the proposed development, the weekday AM and PM peak periods would represent a "worst-case scenario" with regards to the traffic impact. If traffic operations are acceptable during these peak periods, it can be reasoned that conditions would be acceptable throughout the remainder of the day.



Exhibit 2: Existing Traffic Volumes



AREA APPROVED DEVELOPMENTS

At the time of the March 2020 traffic counts, there were several approved developments in the immediate area that were approved but not fully built out, including the following:

- Zumwalt Tract (in approval process);
- Crescent Ridge (approved);
- Brooks Phase I and II (approved);
- The Vineyards (approved); and
- Elk Park gas station (now open).

The approved developments are graphically shown in **Figure 11**. Based on information provided by Crocket Engineering, it is our understanding that as of March 2020 (the time of the traffic counts) the Vineyards development had 273 homes remaining to be built, the Brooks Phase 1 had 22 homes remaining to be built and the Brooks Phase 2 had 373 homes remaining to be built for a total of 668 homes that are approved but not built when the counts were performed. Based on information provided by the County, it is our understanding that an additional 36 homes are planned within the Sunrise Estates development. In addition, the proposed Zumwalt Tract currently in the review process would add another 157 homes if approved. In summary, this study considers the potential build-out of an additional 861 homes in the Base conditions.

In order to account for these approved/proposed but not built developments, the trip generation for the remaining homes within the five developments were estimated and assigned to the study intersections based on the respective traffic studies for each development. The amount of traffic the approved but not built residential developments would generate during the weekday AM and PM peak periods was estimated based upon information provided in the latest edition of the *Trip Generation Manual*. The estimates for the approved developments were based upon Land Use: 210 – Single-Family Detached Housing. Based on this data, the trip generation forecast for the approved but not built developments are shown in **Table 1**.



Figure 11: Approved Developments in Area



Table 1: Trip Estimate – Approved/Proposed Residential Developments

Land Use (ITE Code)	Unit	ADT (VPD)	Weekday AM Peak Hour			Weekday PM Peak Hour		
			In	Out	Total	In	Out	Total
The Vineyards Single-Family Homes (210)	273 Homes	2,620	50	150	200	165	100	265
Brooks – Phase 1 Single-Family Homes (210)	22 Homes	260	5	15	20	15	10	25
Brooks – Phase 2 Single-Family Homes (210)	373 Homes	3,490	65	205	270	225	135	360
Crestview (Sunrise Estates) Single-Family Homes (210)	36 Homes	405	10	20	30	25	15	40
Zumwalt Tract Single-Family Homes (210)	157 Homes	1,575	30	85	115	100	60	160
Total Approved/Proposed Residential Developments	861 Homes	8,350	160	475	635	530	320	850

* Trips rounded to nearest 5

The site-generated trips for the approved but not built developments (i.e., The Vineyards, The Brooks Phase 1 and 2, Crestview, and Zumwalt Tract) were assigned to the study intersections based on the respective trip distribution estimates from the traffic studies for each development.

To account for the recently constructed convenience store with gas station at Highway WW and Elk Park, the trip generation for the gas station were based on the February 2020 Traffic Study prepared by CBB. As detailed in the 2020 study, the trip generation estimate, including both new trips and pass-by trips, for the newly constructed convenience store with gas station is summarized in **Table 2**.

The site-generated trips for the newly constructed gas station were assigned to the study intersections based on the trip distribution assumptions in the 2020 traffic study.

The site-generated trips, as well as the ADT volumes, for the approved residential developments and the newly constructed gas station development are shown in **Exhibit 3**.



Exhibit 3: Approved/Planned Area Development Trips and Discovery Parkway Impact



Table 2: Trip Estimate – Super Convenience Store with Gas Pumps and Bank

Land Use	Size	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	Total	In	Out	Total
Super Convenience Store with Gas Pumps	4,800 ft ²	200	200	400	165	165	330
Bank	900 ft ²	5	5	10	10	10	20
Gas Station Pass-by Trips ^{1,2}		125	125	250	95	95	190
Gas Station New Trips ²		75	75	150	70	70	140
Bank New Trips ²		5	5	10	10	10	20

¹ Pass by Trips: Gas Station = 62% AM & 56% PM

² Trips rounded to nearest 5

In addition, it was requested the traffic impact along Rolling Hills Road and Grace Lane as a result of the pending connection of Discovery Parkway to Rolling Hills Road, approximately three miles south of the study area, also be considered. Based on discussions with the City and County, it was agreed that a 15 percent increase over the existing traffic volumes on Rolling Hills Road would be representative of the potential increase due to the Discovery Parkway connection.

The site-generated trips for the area approved developments (Exhibit 3) and the 15 percent increase to account for the Discovery Parkway Connection were added to the Existing Traffic Volumes (Exhibit 2) to develop the 2021 Base Traffic Volumes. The 2021 Base Traffic Volumes for the AM and PM peak hours are shown in **Exhibit 4**. The estimated ADT volumes are also shown in Exhibit 4 for the 2021 Base conditions.



Exhibit 4: 2021 Base Traffic Volumes



PROPOSED SITE

Once the base traffic volumes within the study area were established, the traffic associated with the proposed Silver Lakes development was considered.

Proposed Land Use: Based upon the concept plan provided by Crockett Engineering Consultants, previously shown in Exhibit 1, a single-family residential development is proposed north of Richland Road just west of Olivet Road. The site would consist of approximately 348 single family homes.

Site Access: As shown on the concept plan in conjunction with the proposed development, Olivet Road would be extended north of Richland Road along the frontage of the site. Access to the Silver Lakes development is proposed via two new drives on Richland Road and three new drive on the extension of Olivet Road. In addition, two stub streets are shown to connect to further development to the west with another two stub streets shown to connect to further development to the north.

Intersection Sight Distance: Based on guidelines published in *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO) often referred to as the *Green Book*, the intersection sight distance requirement for the proposed drives on both Richland Road and Olivet Road is 555 feet (assuming a 45 mph posted speed limit and 50 mph design speed). Note that the sight distance was not measured in the field to evaluate the available sight distance at the proposed site drive. It is recommended the site design engineer verify adequate sight distance is provided at the proposed site drives.

Furthermore, careful consideration should be given to sight distance obstructions when planning any future aesthetic enhancements, such as berms, fencing and landscaping, at any of the subdivision entrances to ensure that these improvements do not obstruct the view of entering and exiting traffic at the site intersections with the public roads. It is generally recommended that all improvements wider than two inches (posts, tree trunks, etc.) and higher than 3.5 feet above the elevation of the nearest pavement edge be held back at least 20 feet from the traveled roadway.

Trip Generation: Forecasts were prepared to estimate the amount of traffic that the proposed development would generate during the weekday AM and PM peak periods. These forecasts were based upon information provided in the latest edition of the *Trip Generation Manual*. Estimates for the proposed development were based upon Land Use: 210 – Single-Family Detached Housing.

The data provided for Peak Hour of the Adjacent Street was used for the traditional weekday AM and PM peak hour forecasts. Based on this data, the trip generation forecast for the



proposed Silver Lakes development is shown in **Table 3**. As shown, the proposed Silver Lakes development would generate a total of 255 trips during the weekday AM peak hour and 335 trips during the weekday PM peak hour.

Table 3: Trip Estimate – Silver Lakes

ITE Code	Land Use	Unit	ADT (VPD)	Weekday AM Peak Hour			Weekday PM Peak Hour		
				In	Out	Total	In	Out	Total
210	Single-Family Homes	348 Homes	3,275	65	190	255	210	125	335

* Rounded to nearest 5

Trip Distribution: The site-generated trips for the proposed Silver Lakes residential development were assigned into and out of the site based upon an estimated directional distribution. Based upon the existing travel patterns in the area, it is anticipated that the distribution of site-generated trips for the Silver Lakes development would be as follows:

- To/from the south via Olivet Road..... 10%
- To/from the east on Richland Road 18%
- To/from the west on Richland Road 72%
 - a. To/from the west on Richland Road 22%
 - b. To/from the north on Rolling Hills Road 15%
 - c. To/from the south on Rolling Hills Road 35%

The site-generated trips, as well as the ADT trips, were assigned to the adjacent roadway for the weekday AM and PM peak hours and are shown in **Exhibit 5**.

In an effort to better illustrate the increase in trips as a result of the proposed Silver Lakes development, the percent increase in site trips over the 2021 Base traffic volumes is summarized in **Table 4**. As shown in Table 4, the proposed Silver Lakes development will have the greatest traffic volume increase on Richland Road between Rolling Hills Road and the Silver Lakes development site with an estimated increase of 70 percent (i.e., 2,360 ADT) over the 2021 Base traffic volumes. The next highest increase is on Rolling Hills Road, south of Richland Road, where the proposed Silver Lakes development will have an estimated increase of 18 percent (i.e., 1,150 ADT) over the 2021 Base traffic volumes. The remaining roadway segments would have an estimated increase of less than 720 daily trips, or about 70 peak hour trips.



Exhibit 5: Silver Lakes Site-Generated Trips



Table 4: Site Trips as a Percent Increase over the 2021 Base Traffic Volumes

INTERSECTION	AVERAGE DAILY TRAFFIC VOLUMES (ADT)		
	2021 BASE TRAFFIC VOLUMES	SILVER LAKES TRIPS	% INCREASE IN TRAFFIC VOLUMES
Grace Lane – North of Richland Road	6,610	490	7%
Rolling Hills Road – South of Richland Rd	6,250	1,150	18%
Richland Road – West of Rolling Hills	2,140	720	34%
Richland Road – East of Rolling Hills	3,390	2,360	70%
Richland Road – East of Olivet Road	2,950	590	12%
Olivet Road – South of Richland Road	745	325	43%

2021 Build Traffic Volumes (2021 Base plus Silver Lakes Trips): The assigned traffic volumes resulting from the trip distribution for the proposed Silver Lakes development (Exhibit 5) were added to the 2021 Base traffic volumes (Exhibit 4) to determine the total volumes in the forecasted scenario. The forecasted, 2021 Build, traffic volumes for the weekday AM and PM peak hours are shown in **Exhibit 6**. The estimated ADT volumes are also shown in Exhibit 6 for the 2021 Build conditions.

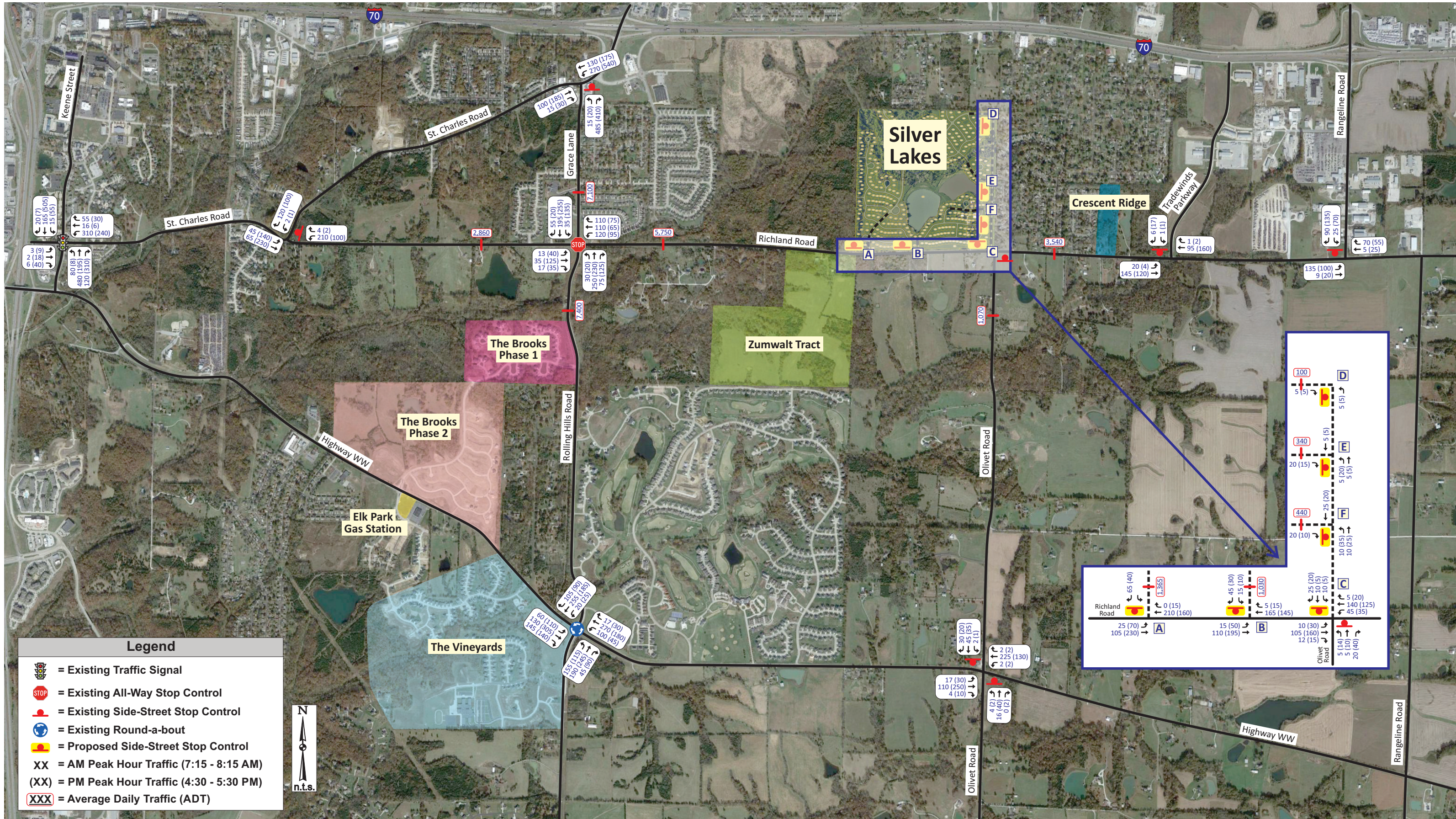


Exhibit 6: 2021 Build Traffic Volumes (2021 Base plus Silver Lakes)



TRAFFIC ANALYSIS

Study Procedures: The 2021 Base and Build operating conditions were analyzed using SYNCHRO 10, a macro-level analytical traffic flow model. SYNCHRO is based on study procedures outlined in the *Highway Capacity Manual*, published by the Transportation Research Board. This manual, which is used universally by traffic engineers to measure roadway capacity, establishes six levels of traffic service: Level A ("Free Flow"), to Level F ("Fully Saturated"). Levels of service (LOS) are measures of traffic flow, which consider such factors as speed, delay, traffic interruptions, safety, driver comfort, and convenience. Level C, which is normally used for highway design, represents a roadway with volumes ranging from 70% to 80% of its capacity. However, Level D is often considered acceptable for peak period conditions in urban and suburban areas.

The thresholds that define level of service at an intersection are based upon the type of control used (i.e., whether it is signalized or unsignalized) and the calculated delay. For signalized and all-way stop intersections, the average control delay per vehicle is estimated for each movement and aggregated for each approach and then the intersection as a whole. At intersections with partial (side-street) stop control, delay is calculated for the minor movements only since motorists on the main road are not required to stop.

Level of service is directly related to control delay. At signalized intersections, the level of service criteria differ from that at unsignalized intersections primarily because varying transportation facilities create different driver expectations. The expectation is that a signalized intersection is designed to carry higher traffic volumes, and consequently may experience greater delay than an unsignalized intersection. **Table 5** summarizes the thresholds used in the analysis for signalized and unsignalized intersections.

Table 5: Level of Service Thresholds

LEVEL OF SERVICE (LOS)	CONTROL DELAY PER VEHICLE (SEC/VEH)	
	SIGNALIZED INTERSECTIONS	UNSIGNALIZED INTERSECTIONS
A	≤ 10	0-10
B	> 10-20	> 10-15
C	> 20-35	> 15-25
D	> 35-55	> 25-35
E	> 55-80	> 35-50
F	> 80	> 50

Auxiliary Left-Turn Lane Warrants: The need for eastbound and westbound left-turn lanes on Richland Road at the proposed east driveway, proposed west driveway, and Olivet Road were



evaluated using the *Left-Turn Guidelines for Two-lane Roadway* nomograph which is based on criteria using MoDOT’s Access Management Guidelines (AMG). The MoDOT criteria provides guidelines for separate left-turn lanes on the through roadway by comparing the total advancing volume (which includes all turning traffic) to the total opposing volume (which includes opposing through and right-turn movements) during the design hour with respect to the number of mainline left-turns. Then, the percentage of left-turns is determined by dividing the number of left-turns by the total advancing volume. If the point lies to the right of the percentage line, then a left-turn lane should be considered. If the point is to the left of the line, then a left-turn lane is not necessary. Since, the posted speed on Richland Road is 45 mph, the 50-mph nomograph was used.

Figures 12 and 13, graphically illustrate the eastbound left-turn evaluations at the proposed west and east site drives, respectively, assuming the 2021 Build traffic volumes during the weekday AM and PM peak hours. Figures 14 and 15, graphically illustrate the eastbound and westbound left-turn evaluations at Olivet Road, respectively, assuming the 2021 Build traffic volumes during the weekday AM and PM peak hours.

As can be seen in Figure 12, a separate eastbound left-turn lane is warranted at the proposed Silver Lakes west site drive. As shown in Figure 13, a separate eastbound left-turn lane is not warranted at the proposed Silver Lakes east site drive. As shown in Figures 14 and 15, separate eastbound and westbound left-turn lanes are not warranted at Olivet Road in the 2021 Build conditions.

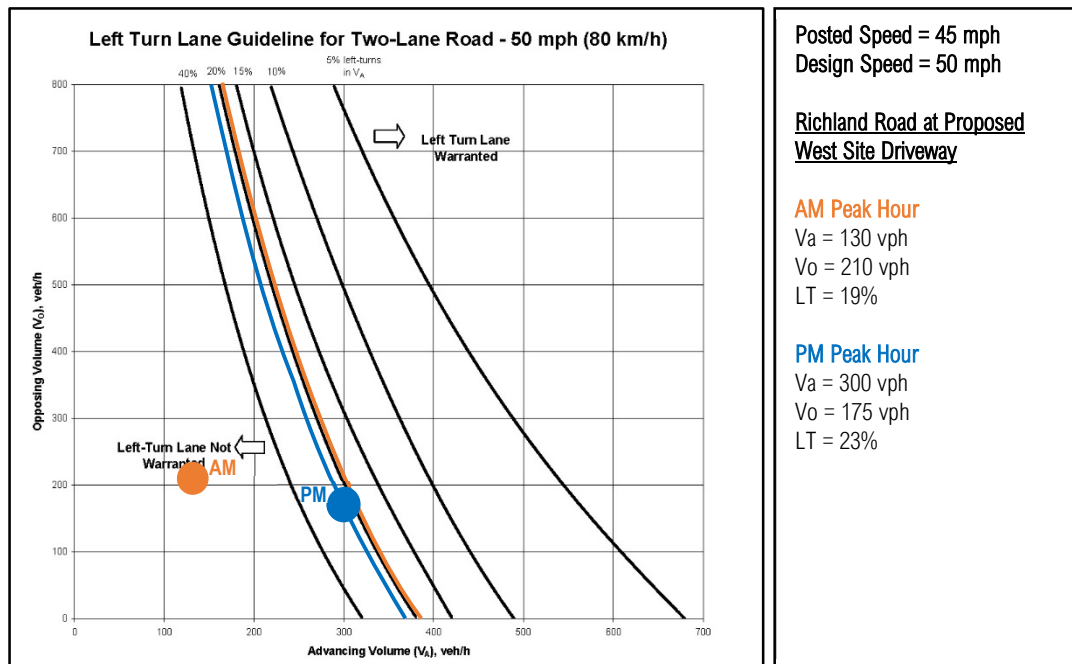


Figure 12: Eastbound Richland Road Left-Turn Warrant at West Site Drive – 2021 Build

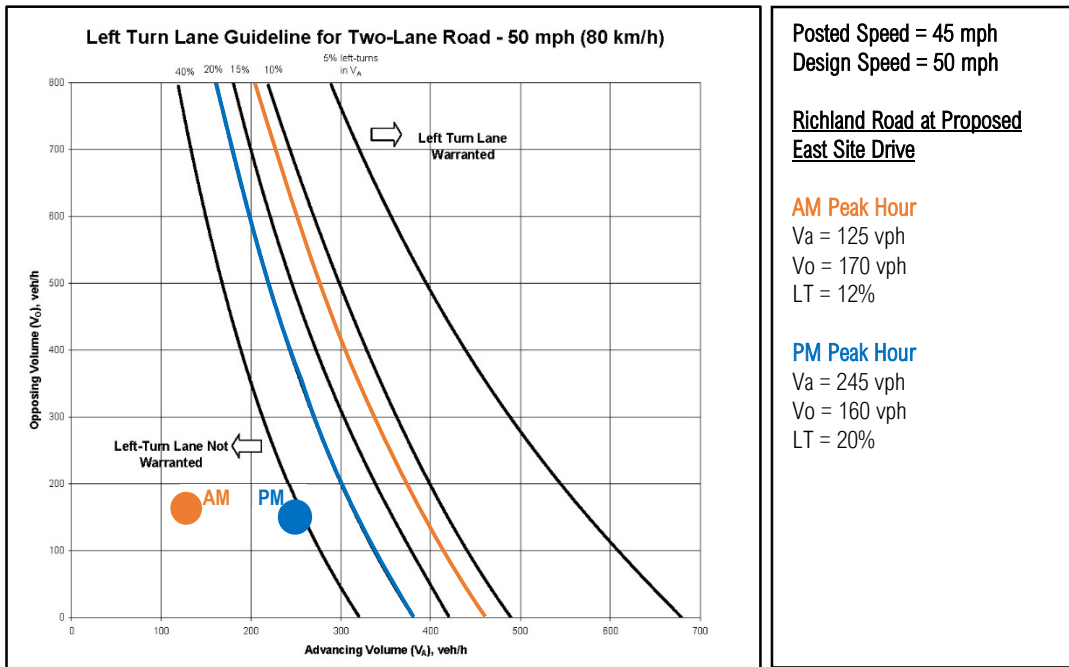


Figure 13: Eastbound Richland Road Left-Turn Warrant at East Site Drive – 2021 Build

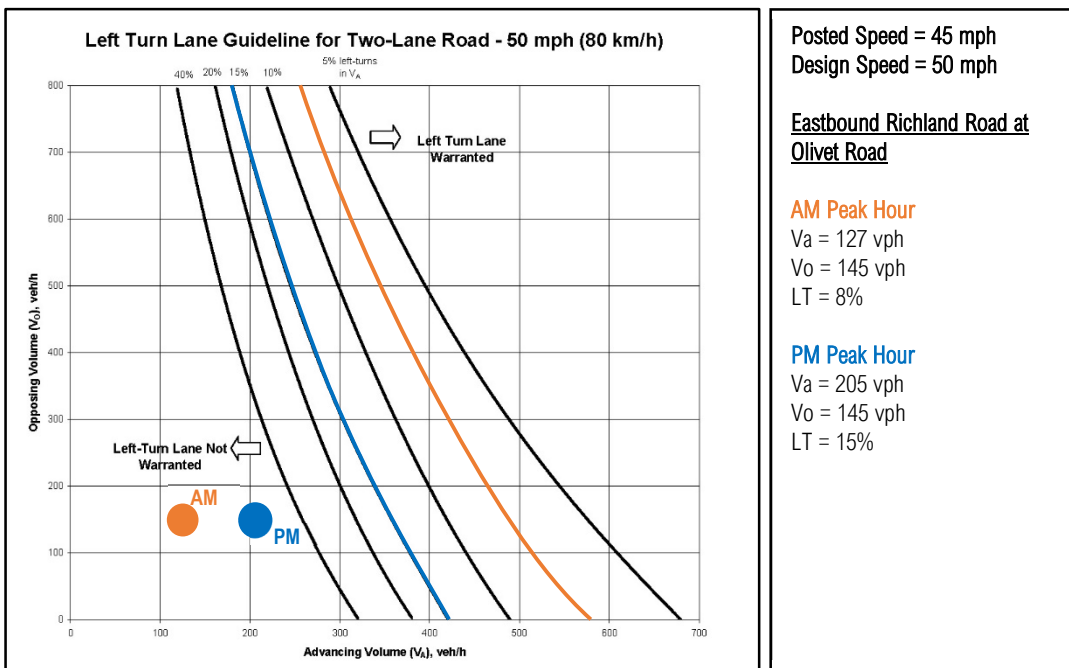


Figure 14: Eastbound Richland Road Left-Turn Warrant at Olivet Road – 2021 Build

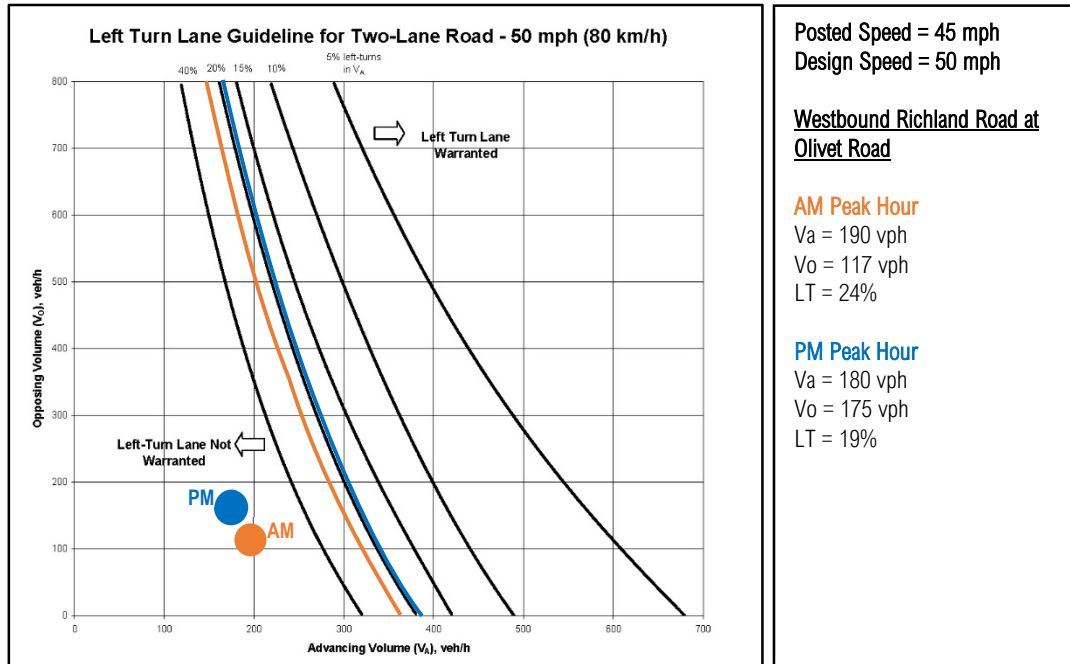


Figure 15: Westbound Richland Road Left-Turn Warrant at Olivet Road – 2021 Build

Auxiliary Right-Turn Lane Warrants: The need for eastbound and westbound right-turn lanes on Richland Road at the proposed west site drive, proposed east site drive, and Olivet Road were evaluated using the *Right-Turn Guidelines for Two-Lane Roadway* nomograph which is based on criteria from MoDOT’s AMG criteria. The MoDOT AMG provides guidelines for separate right-turn lanes on the through roadway by comparing the total advancing volume (which includes all turning traffic) to the number of mainline right-turns. The operating speed (posted speed limit) of the major roadway is used to determine if a right-turn lane is warranted. If the point lies to the right of the operating speed line, then a right-turn lane should be considered. If the plotted point is to the left of the line, then a left-turn lane is not necessary. Richland Road has a posted speed of 45 mph, so the 50-mph graph line was used.

Figures 16 and 17, graphically illustrate the westbound right-turn evaluations at the proposed west and east site drives, respectively, assuming the 2021 Build traffic volumes during the weekday AM and PM peak hours. **Figures 18 and 19**, graphically illustrate the westbound and eastbound right-turn evaluations on Richland Road at Olivet Road, respectively, assuming the 2021 Build traffic volumes during the weekday AM and PM peak hours.

As can be seen in Figures 16, 17, and 18, separate westbound right-turn lanes are not warranted at the proposed Silver Lakes west site drive, proposed Silver Lakes east site drive or Olivet Road. As shown in Figure 19, a separate eastbound right-turn lane is not warranted at Olivet Road.

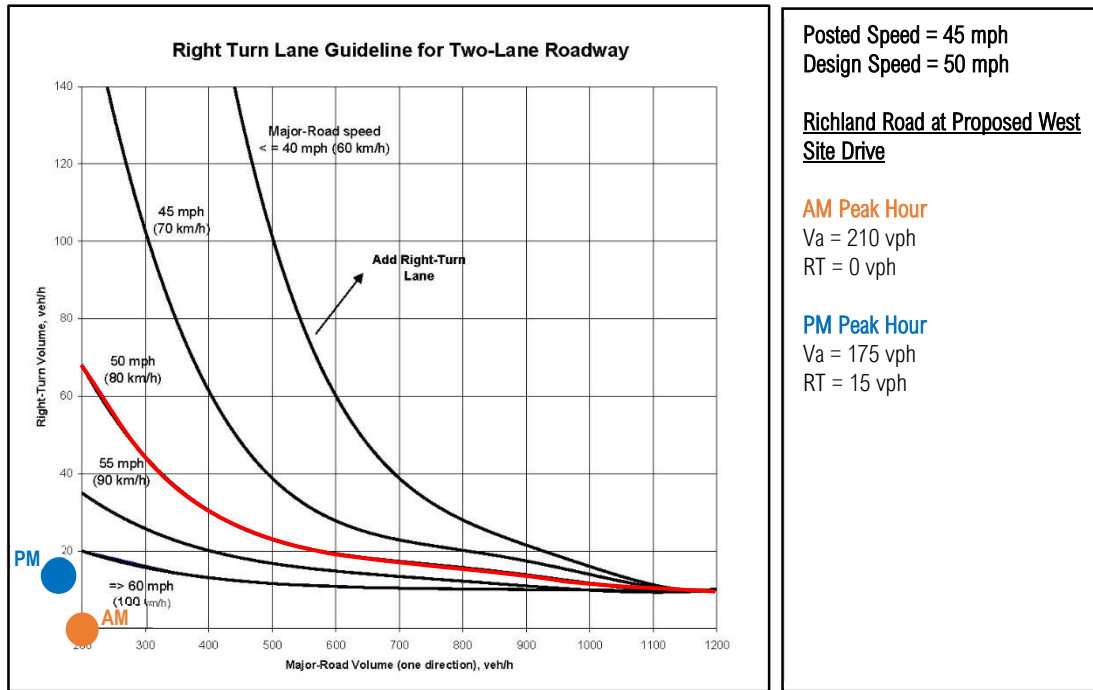


Figure 16: Westbound Richland Road Right-Turn Warrant at West Site Drive – 2021 Build

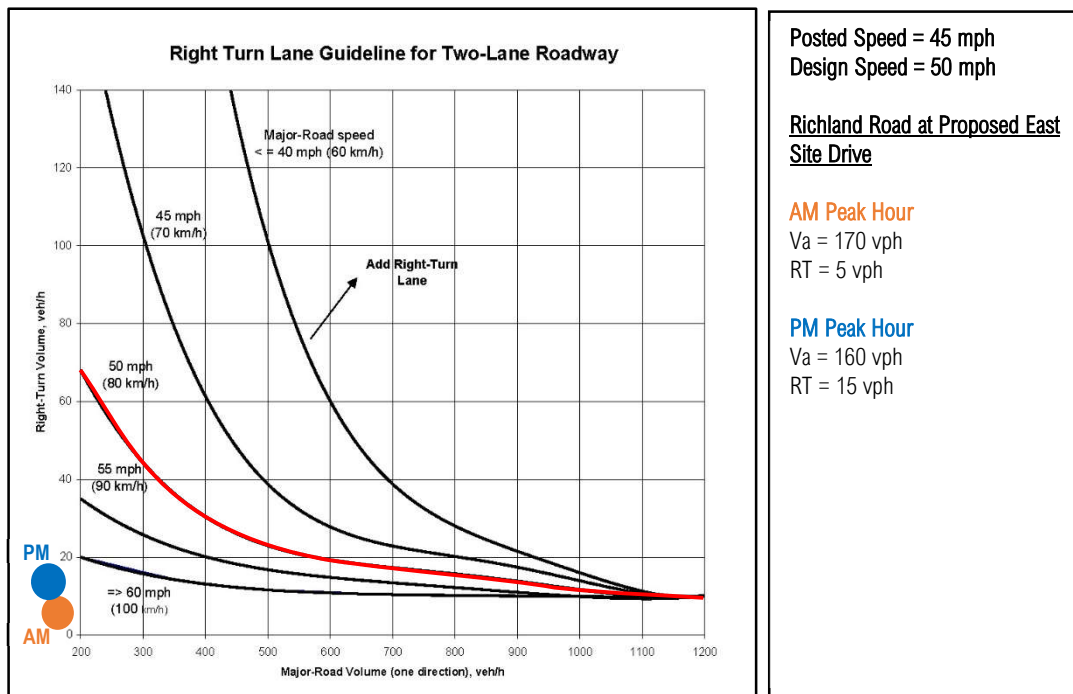


Figure 17: Westbound Richland Road Right-Turn at East Site Drive – 2021 Build

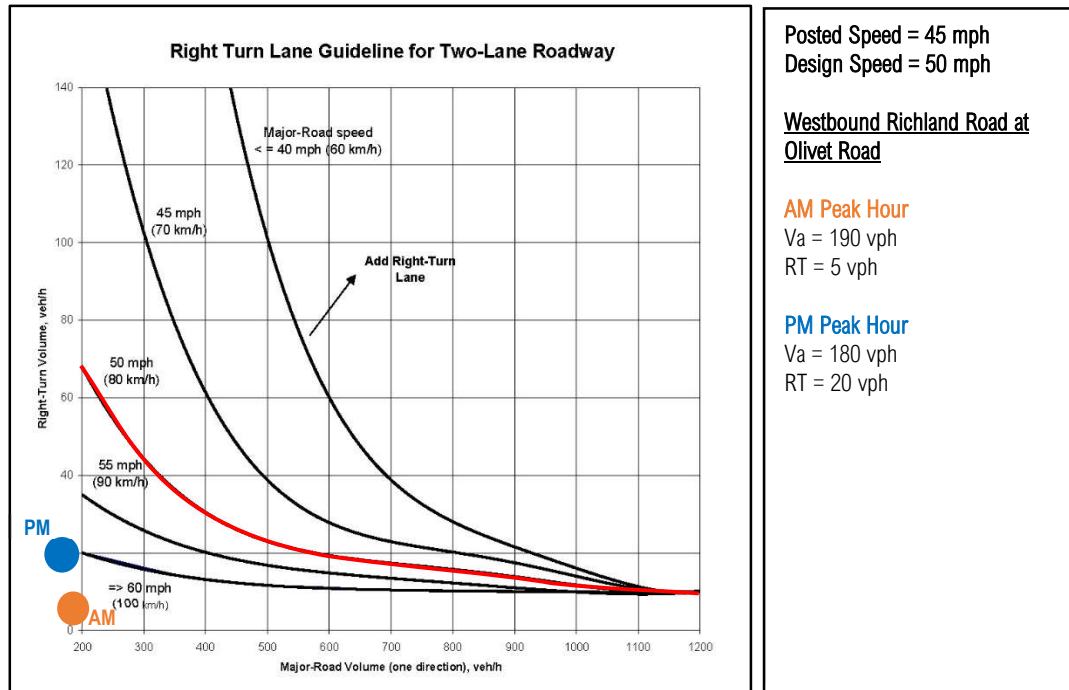


Figure 18: Westbound Richland Road Right-Turn Warrant at Olivet Road – 2021 Build

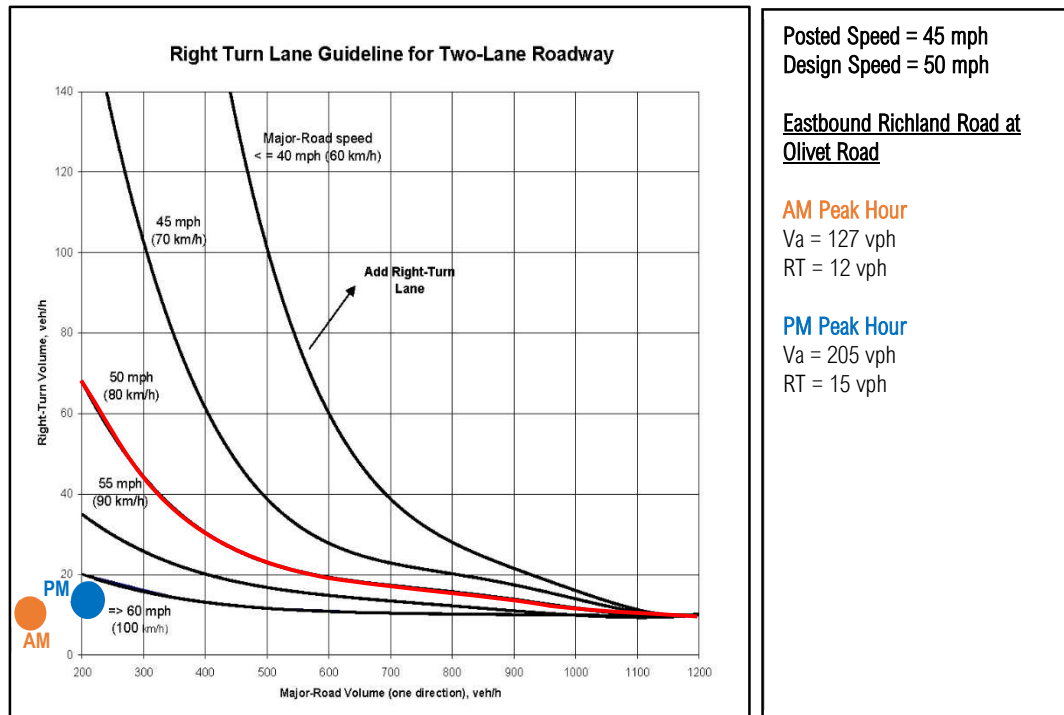


Figure 19: Eastbound Richland Road Right-Turn Warrant at Olivet Road – 2021 Build



Signal Warrants – Richland Road and Rolling Hills Road: The need for a traffic signal at Richland Road and Rolling Hills Road was evaluated using criteria outlined in the *Manual on Uniform Traffic Control Devices* (MUTCD), published by the Federal Highway Administration, United States Department of Transportation. Part Four of the MUTCD provides nine different warrants for signalization that are based on hourly traffic volumes, traffic operations, pedestrian volumes and crash experience, though Warrant 1 is typically the primary warrant considered when evaluating the need for a traffic signal. The Manual further states that a traffic signal should not be installed unless one or more warrants are satisfied, an engineering study indicates the installation will improve the overall safety and/or operation of the intersection, and that a traffic signal will not seriously disrupt progressive traffic flow.

Warrant 1 has two conditions, “A” and “B”. Condition “A” (Minimum Vehicular Volume) is intended for application where a large volume of intersecting traffic is the principal reason to consider a signal. Condition “B” (Interruption of Continuous Traffic) is intended for application where traffic volumes on a major street are so heavy that traffic on the minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. The minimum volume requirements are shown in **Figure 20**.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

^a Basic minimum hourly volume
^b Used for combination of Conditions A and B after adequate trial of other remedial measures
^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less

Figure 20: MUTCD Warrant 1A and 1B, Eight Hour Vehicular Volume

As shown in Figure 20, Warrant 1A requires approach volumes of at least 500 vph on the major road (Rolling Hills Road) and a minimum of 150 vph on the minor street approach (Richland



Road). Warrant 1B requires approach volumes of at least 750 vph on the major road (Rolling Hills Road) and a minimum of 75 vph on the minor street approach (Richland Road).

Existing Conditions: The March 2020 13-hour traffic counts were used to determine the hourly approach traffic volumes at the intersection of Rolling Hills Road and Richland Road in the Existing Conditions. The 2020 Existing signal warrants analysis performed at the intersection for Warrants 1A and 1B, Eight-Hour Vehicular Volumes, is provided in the Appendix. As shown, the 2020 Existing traffic volumes meet the minimum threshold for zero (0) hours for Warrant 1A and for Warrant 1B. As such, a traffic signal at the intersection of Rolling Hills Road and Richland Road is not warranted in the existing conditions.

2021 Base Conditions: As mentioned previously, there are several approved developments in the area that will add traffic to the Rolling Hills Road and Richland Road intersection. The hourly variation for residential trips provided by ITE was used to estimate the approved development trips that would be added to the Rolling Hills Road and Richland Road intersection for the same 13 hours of the day. The 2021 Base signal warrants analysis performed at the intersection for Warrants 1A and 1B, Eight-Hour Vehicular Volumes, is provided in the Appendix. As shown, the estimated 2021 Base traffic volumes meet the minimum threshold for one (1) hour for Warrant 1A and for zero (0) hours for Warrant 1B. As such, a traffic signal at the intersection of Rolling Hills Road and Richland Road is not warranted in the 2021 Base conditions.

2021 Build Conditions: Again, the hourly variation for residential trips provided by ITE was used to estimate the proposed Silver Lakes site trips that would be added to the Rolling Hills Road and Richland Road intersection for the same 13 hours of the day. These hourly Silver Lakes trip estimates were then added to the 2020 Base hourly traffic volumes to determine the 2021 Build hourly traffic volumes. The 2021 Build signal warrants analysis performed at the intersection for Warrants 1A and 1B, Eight-Hour Vehicular Volumes, is provided in the Appendix. As shown, the estimated 2021 Build traffic volumes meet the minimum threshold for five (5) hours for Warrant 1A and for one (1) hour for Warrant 1B. As such, a traffic signal at the intersection of Rolling Hills Road and Richland Road is not warranted in the 2021 Build conditions.

Operating Conditions: The study intersections were evaluated using the methodologies described previously. The existing lane configurations and traffic control were used in the analysis (i.e., no roadway or traffic control improvements). The proposed site drives were assumed to have one lane exiting and one lane entering.

Table 6 summarizes the results of these analyses, which reflect the 2021 Base and 2021 Build operating conditions and average delay for each of the study intersections during the weekday AM and PM peak hours. The maximum volume to capacity ratio (v/c) is also noted in the table to better understand the available capacity of the intersection and the impact of the proposed Silver Lakes on the overall capacity.



Table 6: 2021 Base and 2021 Build Capacity Analysis Summary

Intersection / Approach	AM Peak Hour		PM Peak Hour	
	2021 Base	2021 Build	2021 Base	2021 Build
St. Charles Road and Keene Street (Signalized)				
Eastbound St. Charles Road Approach	B (19.0)	B (19.0)	B (18.0)	C (20.8)
Westbound St. Charles Road Approach	D (53.2)	E (58.2)	D (50.1)	D (52.5)
Northbound Keene Street Approach	C (22.6)	C (27.2)	C (22.2)	C (25.5)
Southbound Keene Street Approach	C (20.6)	C (20.8)	C (20.2)	C (20.7)
Overall	C (30.9) v/c: 0.86	D (35.4) v/c: 0.90	C (26.4) v/c: 0.75	C (28.6) v/c: 0.80
St. Charles Road and Richland Road (Side-Street STOP)				
Eastbound St. Charles Road Approach	Free Flow	Free Flow	Free Flow	Free Flow
Westbound Richland Road Approach (Stop)	B (11.3)	B (11.9)	B (11.8)	B (12.5)
Southbound St. Charles Road Approach	A (<1.0)	A (<1.0)	A (<1.0)	A (<1.0)
Overall	A (5.2) v/c: 0.26	A (5.8) v/c: 0.32	A (1.8) v/c: 0.23	A (2.2) v/c: 0.25
Richland Road and Rolling Hills Road/Grace Lane (All-Way STOP)				
Eastbound Richland Road Approach	A (8.9)	B (10.1)	B (11.1)	C (15.6)
Westbound Richland Road Approach	B (12.9)	C (21.9)	B (13.5)	C (24.1)
Northbound Rolling Hills Road Approach	B (12.6)	C (17.3)	C (15.3)	E (35.1)
Southbound Grace Lane Approach	B (13.9)	C (17.8)	C (24.7)	F (65.1)
Overall	B (12.9) v/c: 0.50	C (18.5) v/c: 0.69	C (17.9) v/c: 0.73	E (39.9) v/c: 0.98
Richland Road and Olivet Road (Side-Street STOP)				
Eastbound Richland Road Approach	Free Flow	A (<1.0)	Free Flow	A (1.3)
Westbound Richland Road Approach	A (2.1)	A (2.0)	A (2.1)	A (1.7)
Northbound Olivet Road Approach	A (9.3)	B (10.3)	A (9.4)	B (11.2)
Southbound Olivet Road Approach		B (10.8)		B (10.5)
Overall	A (2.1) v/c: 0.05	A (3.2) v/c: 0.08	A (2.1) v/c: 0.09	A (3.3) v/c: 0.11

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)



Intersection / Approach	AM Peak Hour		PM Peak Hour	
	2021 Base	2021 Build	2021 Base	2021 Build
Richland Road and Tradewinds Parkway (Side-Street STOP)				
Eastbound Richland Road Approach	A (1.3)	A (1.0)	A (<1.0)	A (<1.0)
Westbound Richland Road Approach	Free Flow	Free Flow	Free Flow	Free Flow
Southbound Tradewinds Parkway Approach	A (9.0)	A (9.0)	A (9.2)	A (9.5)
Overall	A (1.0) v/c: 0.06	A (<1.0) v/c: 0.06	A (<1.0) v/c: 0.09	A (<1.0) v/c: 0.12
Richland Road and Rangeline Road (Side-Street STOP)				
Eastbound Richland Road Approach	A (7.3)	A (7.2)	A (6.2)	A (6.5)
Westbound Richland Road Approach	Free Flow	Free Flow	Free Flow	Free Flow
Southbound Rangeline Road Approach	A (9.5)	A (9.7)	B (10.9)	B (11.5)
Overall	A (6.2) v/c: 0.13	A (6.5) v/c: 0.28	A (7.1) v/c: 0.26	A (7.7) v/c: 0.32
St. Charles Road and Grace Lane (Side-Street STOP)				
Eastbound St. Charles Road Approach	Free Flow	Free Flow	Free Flow	Free Flow
Westbound St. Charles Road Approach	A (6.0)	A (6.1)	A (8.0)	A (8.4)
Northbound Grace Lane Approach	C (15.2)	C (16.4)	D (26.1)	D (32.6)
Overall	A (9.7) v/c: 0.60	B (10.5) v/c: 0.66	B (12.4) v/c: 0.73	B (14.7) v/c: 0.80
Highway WW and Rolling Hills Road (Roundabout)				
Eastbound Highway WW Approach	A (7.1)	A (7.7)	A (9.0)	B (10.0)
Westbound Highway WW Approach	A (8.6)	A (9.0)	A (6.8)	A (7.4)
Northbound Rolling Hills Road Approach	A (4.8)	A (5.0)	A (7.0)	A (7.9)
Southbound Rolling Hills Road Approach	A (8.7)	A (7.7)	A (5.9)	A (6.5)
Overall	A (7.2)	A (8.0)	A (7.5)	A (8.3)
Highway WW and Olivet Road (Side-Street STOP)				
Eastbound Highway WW Approach	A (1.1)	A (1.1)	A (<1.0)	A (1.0)
Westbound Highway WW Approach	A (<1.0)	A (<1.0)	A (<1.0)	A (<1.0)
Northbound Olivet Road Approach	B (12.7)	B (12.9)	B (12.9)	B (13.5)
Southbound Olivet Road Approach	B (11.8)	B (12.4)	B (11.3)	B (12.2)
Overall	A (2.4) v/c: 0.11	A (3.0) v/c: 0.29	A (2.2) v/c: 0.07	A (3.0) v/c: 0.11



Intersection / Approach	AM Peak Hour		PM Peak Hour	
	2021 Base	2021 Build	2021 Base	2021 Build
Richland Road and Proposed West Driveway (Side-Street STOP)				
Eastbound Richland Road Approach		A (1.6)		A (2.2)
Westbound Richland Road Approach		Free Flow		Free Flow
Southbound Proposed Driveway Approach		B (10.5)		B (10.7)
Richland Road and Proposed East Driveway (Side-Street STOP)				
Eastbound Richland Road Approach		A (1.0)		A (1.8)
Westbound Richland Road Approach		Free Flow		Free Flow
Southbound Proposed Driveway Approach		A (9.9)		A (10.1)
Olivet Road Extension and Proposed South Driveway (Side-Street STOP)				
Eastbound Proposed Driveway Approach		A (8.5)		A (8.4)
Northbound Olivet Road Extension Approach		A (3.7)		A (4.3)
Southbound Olivet Road Extension Approach		Free Flow		Free Flow
Richland Road and Proposed Center Driveway (Side-Street STOP)				
Eastbound Proposed Driveway		A (8.4)		A (8.4)
Northbound Olivet Road Extension Approach		A (3.6)		A (5.9)
Southbound Olivet Road Extension Approach		Free Flow		Free Flow
Richland Road and Proposed North Driveway (Side-Street STOP)				
Eastbound Proposed Driveway		A (8.3)		A (8.3)
Northbound Olivet Road Extension Approach		A (7.2)		A (7.2)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)

The v/c ratio, also referred to as degree of saturation, represents the sufficiency of an intersection to accommodate the vehicular demand. A v/c ratio less than 0.85 generally indicates that adequate capacity is available, and vehicles are not expected to experience significant queues and delays. As the v/c ratio approaches 1.0, traffic flow may become unstable, and delay and queuing conditions may occur. Once the demand exceeds the capacity (i.e., a v/c ratio greater than 1.0), traffic flow is unstable and excessive delay and queuing is expected.

As shown in the table, the comparison of the maximum v/c ratio between the 2021 Base and 2021 Build conditions show that the trips associated with the proposed Silver Lakes development only utilize about five percent of the intersection capacity with the exception of



the Richland Road and Rolling Hills Road intersection. In the AM peak hour, the v/c ratio increase from 0.50 to 0.69 with the Silver Lakes trips utilizing about 20 percent of the intersection capacity. In the PM peak hour, the v/c ratio increase from 0.73 to 0.98 with the Silver Lakes development trips utilizing about 25 percent of the intersection capacity. More importantly, in the PM peak hour, the v/c ratio at the intersection of Richland Road and Rolling Hills Road is 0.98 which is essentially “at capacity” and will likely result in long delays without roadway and/or traffic control improvements.

As shown, all of the study intersections operate at overall favorable levels of service (i.e., LOS D or better) in the 2021 Base conditions and would continue to operate at overall favorable levels of service during the peak hours for the 2021 Build conditions with the exception of the Richland Road and Rolling Hills Road intersection. In fact, most of the study intersections and the respective approaches to those intersections are forecasted to operate at highly desirable LOS B or better.

As shown, during the PM peak hour, the Richland Road and Rolling Hills Road intersection is forecasted to decline from overall LOS C with approximately 18 seconds of delay per vehicle on average to LOS E with approximately 40 seconds of delay per vehicle on average. Additionally, the southbound Grace Lane approach is forecasted to operate at LOS F in the PM peak hour.

As discussed previously, the 2021 Build traffic volumes at the intersection of Richland Road and Rolling Hills Road/Grace Lane are not forecasted to satisfy the minimum volume thresholds for signalization; though with additional development in the area, a traffic signal will eventually be warranted.

Alternatively, several improvement alternatives were considered at the intersection of Richland Road and Rolling Hills Road/Grace Lane as follows:

- Maintain All-Way Stop control with the addition of a southbound left-turn lane on Grace Lane and a westbound left-turn lane on Richland Road;
- Construct a traffic signal at the intersection with the addition of a southbound left-turn lane on Grace Lane and a westbound left-turn lane on Richland Road;
- Construct a single-lane roundabout at the intersection.

Table 7 summarizes the analysis results of the various improvement alternatives for the intersection of Richland Road and Rolling Hills Road/Grace Lane during the weekday AM and PM peak hours for the 2021 Build conditions.



Table 7: 2021 Build Richland Road and Rolling Hills Road/Grace Lane Improvement Alternatives

Intersection / Approach	AM Peak Hour			PM Peak Hour		
	All-Way Stop w/Left Turns on all Approaches	Signal w/Left Turns on all Approaches	Single lane Roundabout	All-Way Stop w/Left Turns on all Approaches	Signal w/Left Turns on all Approaches	Single lane Roundabout
Richland Road and Rolling Hills Road/Grace Lane						
Eastbound Richland Road Approach	A (9.4)	B (16.8)	A (4.6)	B (12.8)	C (24.7)	A (8.0)
Westbound Richland Road Approach	B (11.6)	B (15.1)	A (7.6)	B (12.1)	B (17.6)	A (6.4)
Northbound Rolling Hills Approach	C (15.2)	B (18.2)	A (5.7)	C (23.5)	B (19.8)	A (8.8)
Southbound Grace Lane Approach	B (12.4)	B (16.0)	A (6.5)	C (15.8)	B (14.6)	A (7.6)
Overall	B (12.9) v/c: 0.58	B (16.5) v/c: 0.55	A (6.5) v/c: 0.37	C (17.0) v/c: 0.73	B (18.4) v/c: 0.49	A (7.8) v/c: 0.44

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)

As shown in Table 7, all three improvement alternatives at the intersection of Richland Road and Rolling Hills Road/Grace Lane would provide favorable operations. Additionally, the v/c ratio for each improvement alternative would essentially improve the 2021 Build operations for the intersection to similar levels as the 2021 Base conditions, thus mitigating the impact of the proposed Silver Lakes trips.

As it will likely be several years before the 2021 Build traffic volumes are realized, since they account for the full build out of The Brooks, The Vineyards, the Zumwalt Tract and the proposed Silver Lakes development or about 1,200 homes in the area, the improvement alternative of adding the southbound and westbound left-turns lanes at the intersection and maintaining All-Way Stop control is reasonable.



TRAFFIC ANALYSIS – OSBURN FARMS ALTERNATE

There is another proposed development, known as Osburn Farms, currently in the conceptual phase less than one mile east of the proposed Silver Lakes developmnet. The proposed Osburn Farms residential development site is located on the south side of Richland Road between Tradewinds Parkway and Rangeline Road. It is our understanding the proposed Osburn Farms development will include approximately 350 single-family homes and 20 condominiums.

Osburn Farms Trip Generation: Forecasts were prepared to estimate the amount of traffic the proposed Osburn Farms development would generate during the weekday AM and PM peak periods. These forecasts were based upon information provided in the latest edition of the *Trip Generation Manual*. Estimates for the proposed development were based upon Land Use: 210 – Single-Family Detached Housing. Based on this data, the trip generation forecast for the proposed Osburn Farms development is shown in **Table 8**. As shown, the proposed Osburn Farms development would generate a total of 265 trips during the weekday AM peak hour and 355 trips during the weekday PM peak hour.

Table 8: Trip Estimate – Osburn Farms

ITE Code	Land Use	Unit	ADT (VPD)	Weekday AM Peak Hour			Weekday PM Peak Hour		
				In	Out	Total	In	Out	Total
210	Single-Family Homes and Condos	370 Homes	3,465	65	200	265	225	130	355

* Rounded to nearest 5

Osburn Farms Trip Distribution: The site-generated trips for the proposed Osburn Farms residential development were then assigned into and out of the site based upon an estimated directional distribution. Based upon the existing travel patterns in the area and the proximity to the primary office, commercial and institutional land use nodes, it is anticipated that the distribution of site-generated trips for Osburn Farms development would be as follows:

- To/from the south via Olivet Road..... 7%
- To/from the south via Rangeline Road 8%
- To/from the north via Tradewinds Parkway (toward I-70/St. Charles) 3%
- To/from the east on Richland Road 32%
- To/from the west on Richland Road 50%
 - a. To/from the west on Richland Road 18%
 - b. To/from the north on Rolling Hills Road 4%
 - c. To/from the south on Rolling Hills Road 28%



The Osburn Farms site-generated trips, as well as the ADT trips, were assigned to the adjacent roadway for the weekday AM and PM peak hours and are shown in **Exhibit 7**.

2021 Build Traffic Volumes – Osburn Farms Alternate (2021 Build plus Osburn Farms Trips):

The assigned traffic volumes resulting from the trip distribution for the proposed Osburn Farms development (Exhibit 7) were added to the 2021 Build traffic volumes (Exhibit 6) to determine the total volumes in the alternate scenario. The 2021 Build – Osburn Farms Alternate traffic volumes for the weekday AM and PM peak hours are shown in **Exhibit 8**. The estimated ADT volumes are also shown in Exhibit 8 for the 2021 Build - Osburn Farms Alternate conditions.

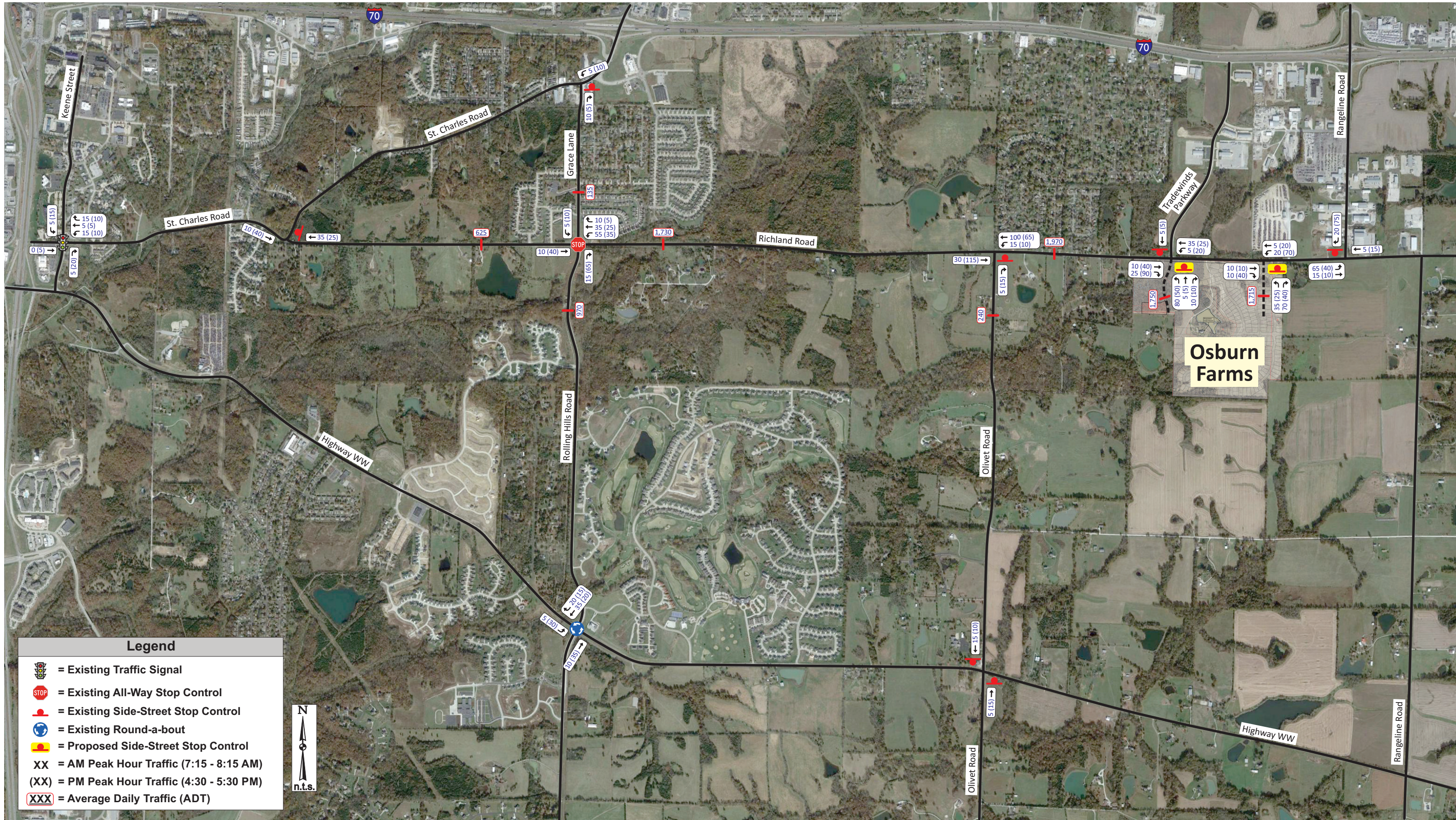


Exhibit 7: Osburn Farms Site-Generated Trips



Exhibit 8: Alternate 2021 Build Traffic Volumes (2021 Build plus Future Osburn Farms)



Auxiliary Left-Turn Lane Warrants – Osburn Farms Alternate: The need for eastbound and westbound left-turn lanes on Richland Road at the proposed Silver Lakes east drive and west site drive and Olivet Road were reevaluated based on criteria using MoDOT’s AMG.

Figures 21 and 22, graphically illustrate the eastbound left-turn evaluations at the proposed Silver Lakes west and east site drives, respectively, assuming the 2021 Build Osburn Farms Alternate traffic volumes during the weekday AM and PM peak hours. **Figures 23 and 24**, graphically illustrate the eastbound and westbound left-turn evaluations at Olivet Road, respectively, assuming the 2021 Build Osburn Farms Alternate traffic volumes during the weekday AM and PM peak hours.

As can be seen in Figure 21, a separate eastbound left-turn lane is warranted at the proposed Silver Lakes west site drive. As shown in Figure 22, a separate eastbound left-turn lane is warranted at the proposed Silver Lakes east site drive. As shown in Figures 23 and 24, separate eastbound and westbound left-turn lanes are not warranted at Olivet Road in the 2021 Build Osburn Farms Alternate conditions.

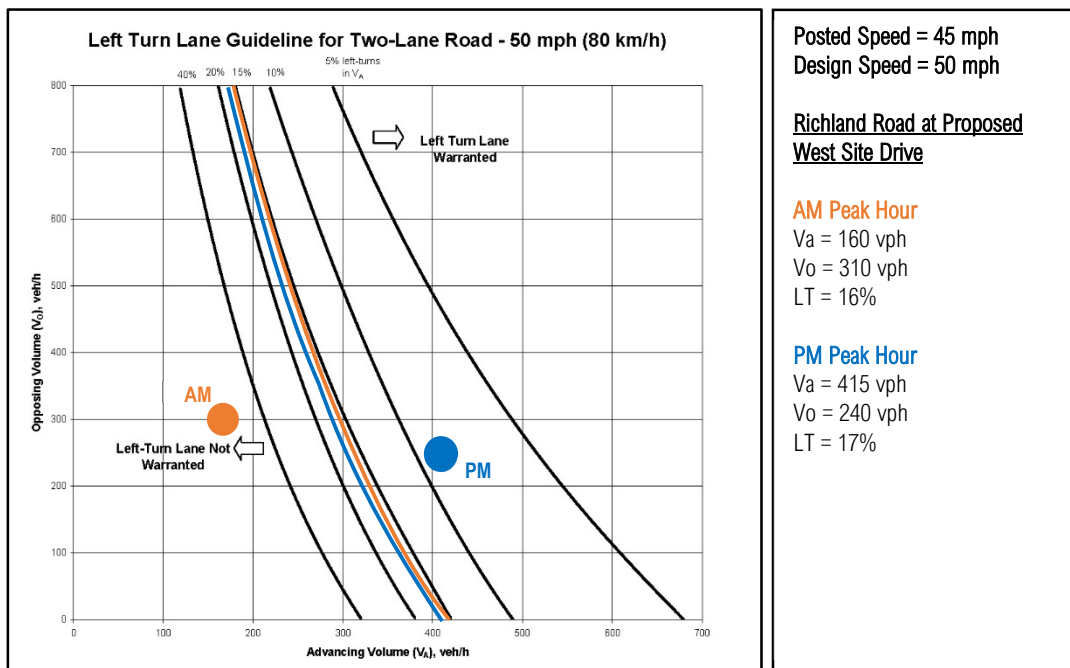


Figure 21: Eastbound Richland Road Left-Turn Warrant at West Site Drive – 2021 Build Osburn Farm Alternate

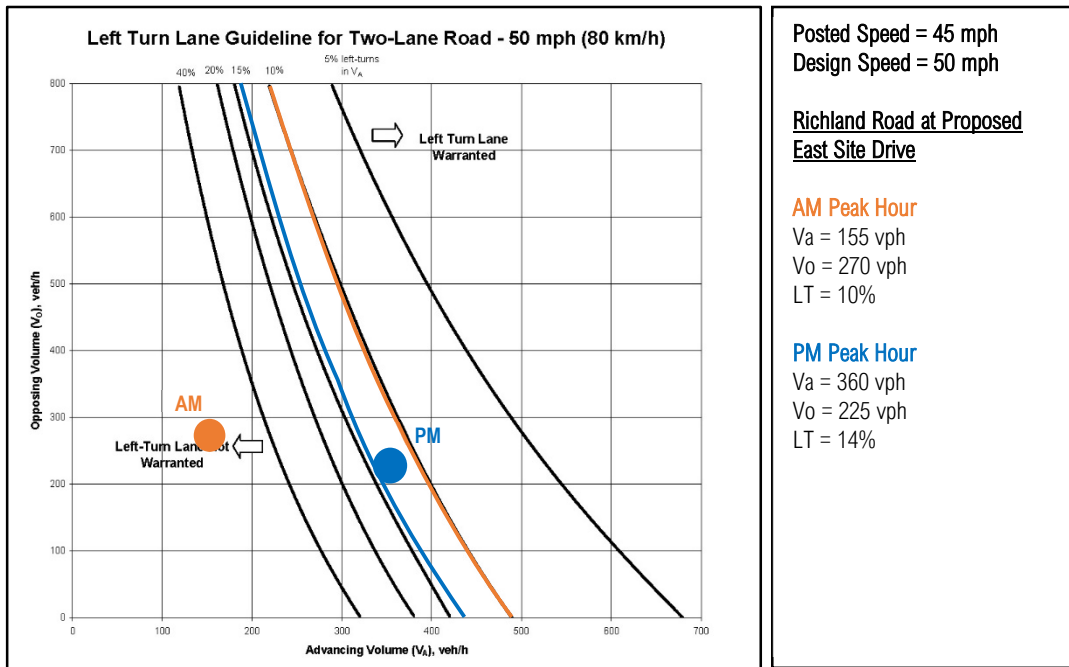


Figure 22: Eastbound Richland Road Left-Turn Warrant at East Site Drive – 2021 Build Osburn Farm Alternate

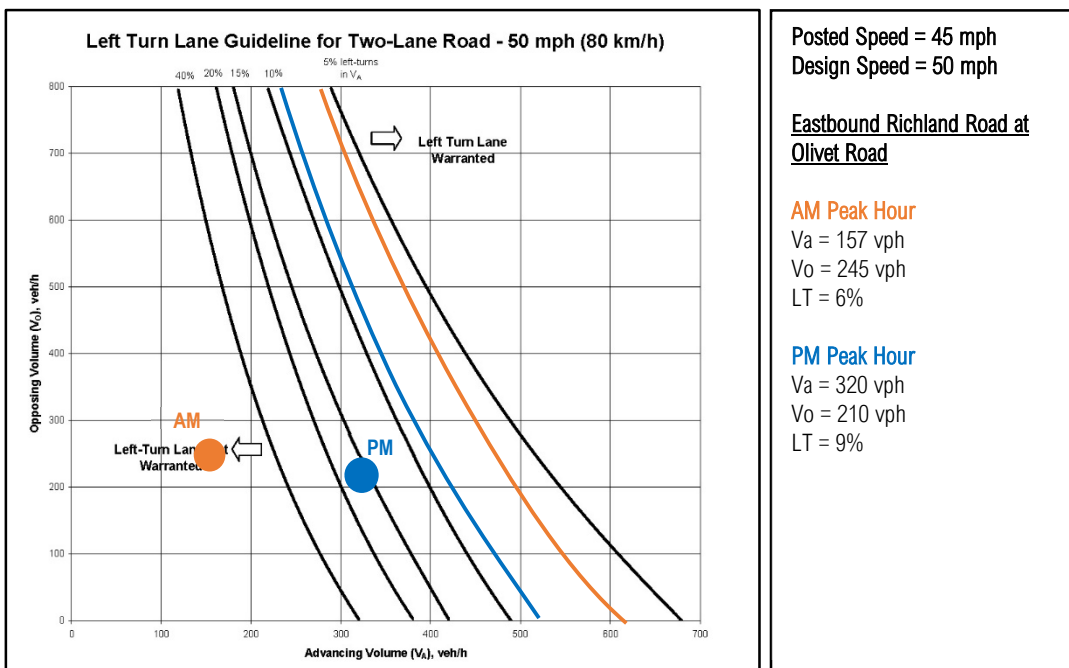


Figure 23: Eastbound Richland Road Left-Turn Warrant at Olivet Road – 2021 Build Osburn Farm Alternate

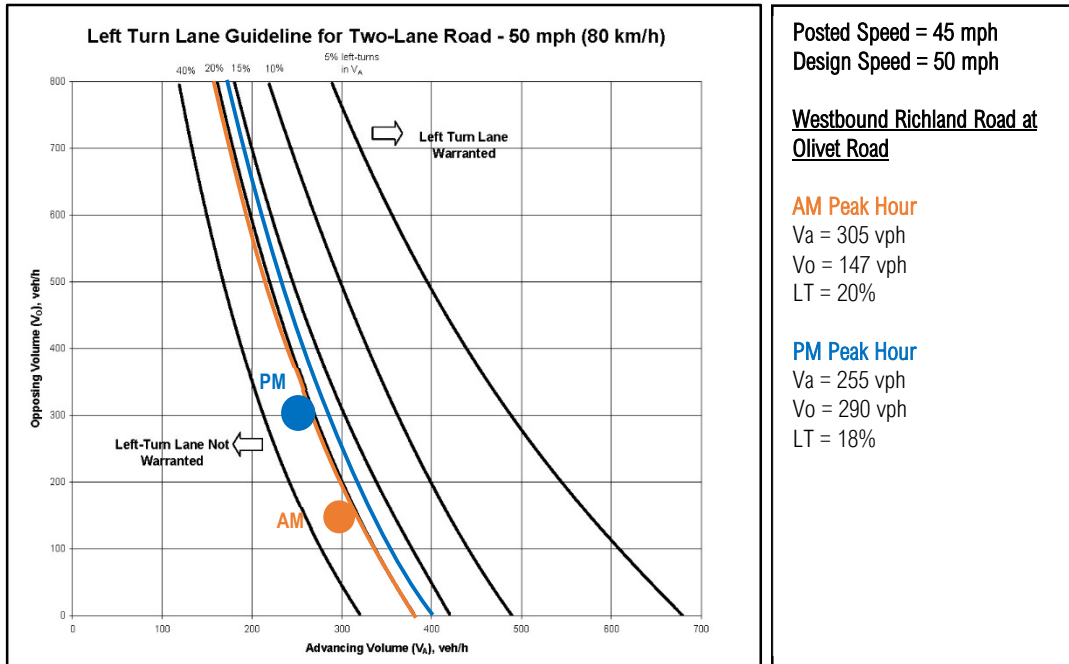


Figure 24: Westbound Richland Road Left-Turn Warrant at Olivet Road – 2021 Build Osburn Farm Alternate

Auxiliary Right-Turn Lane Warrants: The need for eastbound and westbound right-turn lanes on Richland Road at the proposed Silver Lakes west site drive, proposed Silver Lakes east site drive, and Olivet Road were reevaluated using the *Right-Turn Guidelines for Two-Lane Roadway* nomograph which is based on criteria from MoDOT’s AMG criteria.

Figures 25 and 26, graphically illustrate the westbound right-turn evaluations at the proposed Silver Lakes west and east site drives, respectively, assuming the 2021 Build Osburn Farms Alternate traffic volumes during the weekday AM and PM peak hours. **Figures 27 and 28**, graphically illustrate the westbound and eastbound right-turn evaluations on Richland Road at Olivet Road, respectively, assuming the 2021 Build Osburn Farms Alternate traffic volumes during the weekday AM and PM peak hours.

As can be seen in Figures 25, 26, and 27, separate westbound right-turn lanes are not warranted at the proposed Silver Lakes west site drive, proposed Silver Lakes east site drive or Olivet Road. As shown in Figure 28, a separate eastbound right-turn lane is not warranted at Olivet Road.

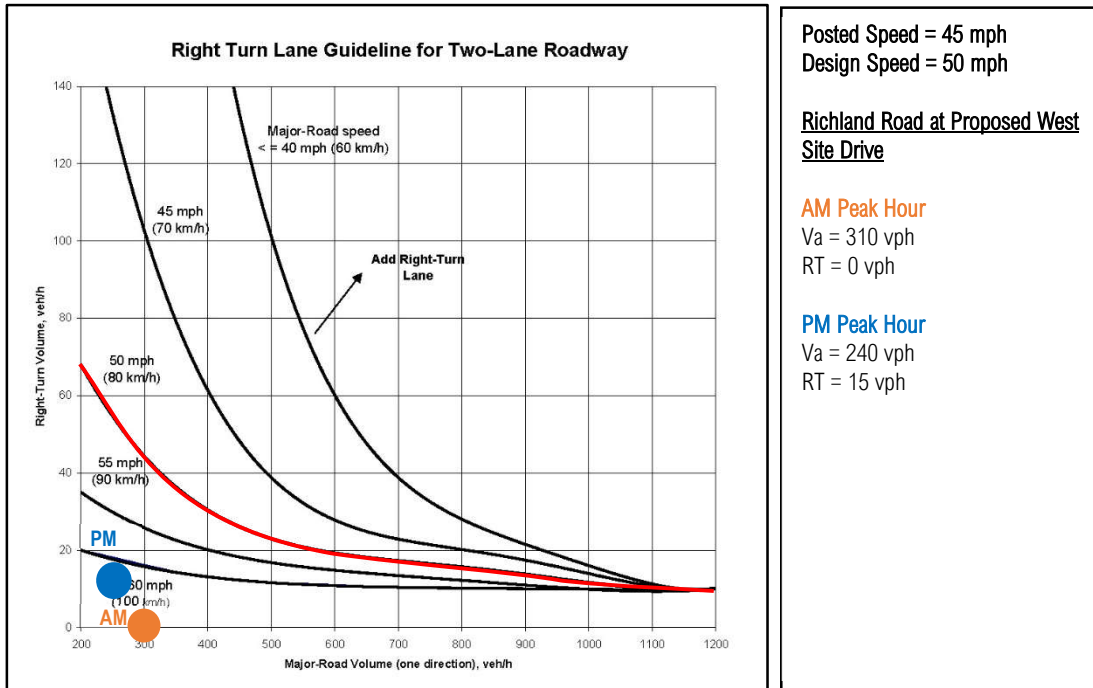


Figure 25: Westbound Richland Road Right-Turn Warrant at West Site Drive – 2021 Build Osburn Farm Alternate

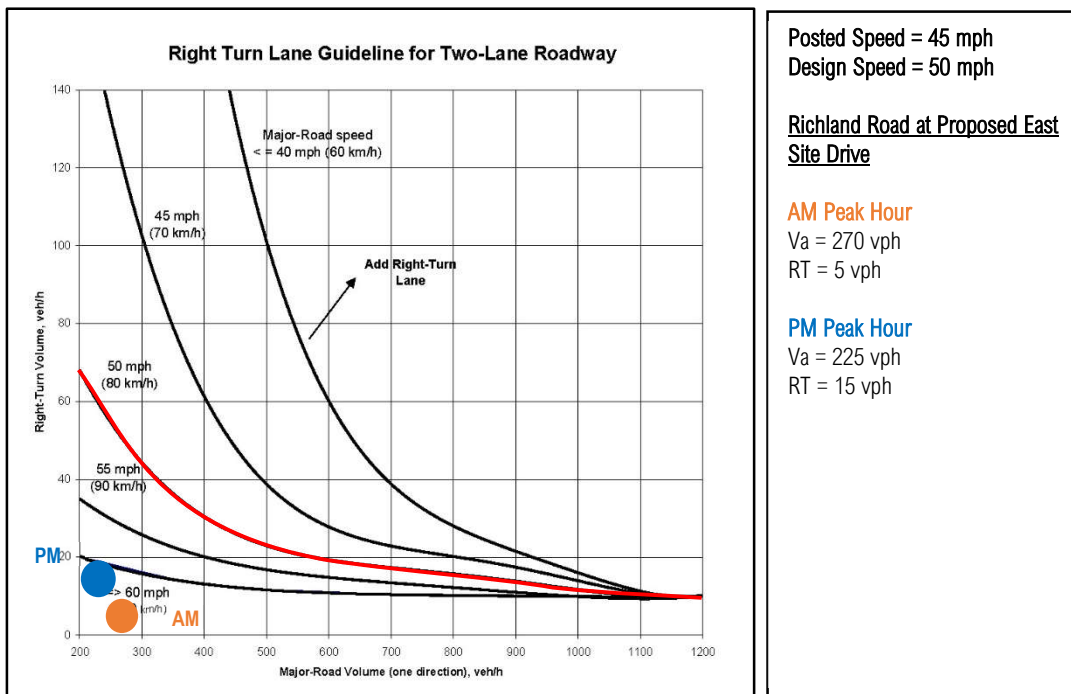


Figure 26: Westbound Richland Road Right-Turn at East Site Drive – 2021 Build Osburn Farm Alternate

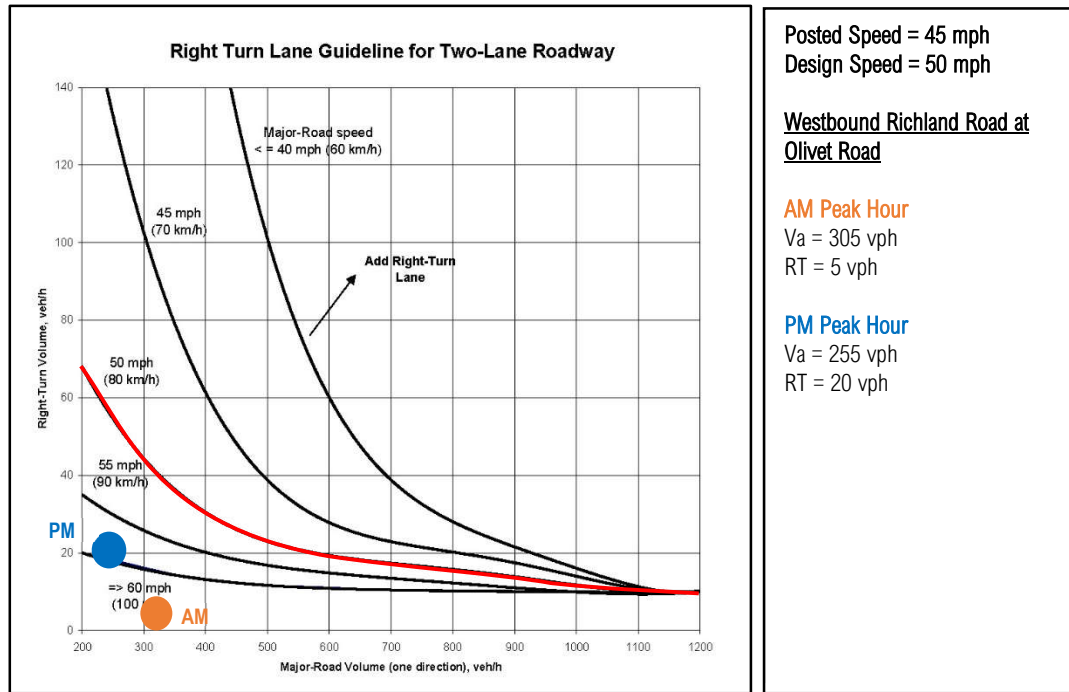


Figure 27: Westbound Richland Road Right-Turn Warrant at Olivet Road – 2021 Build Osburn Farm Alternate

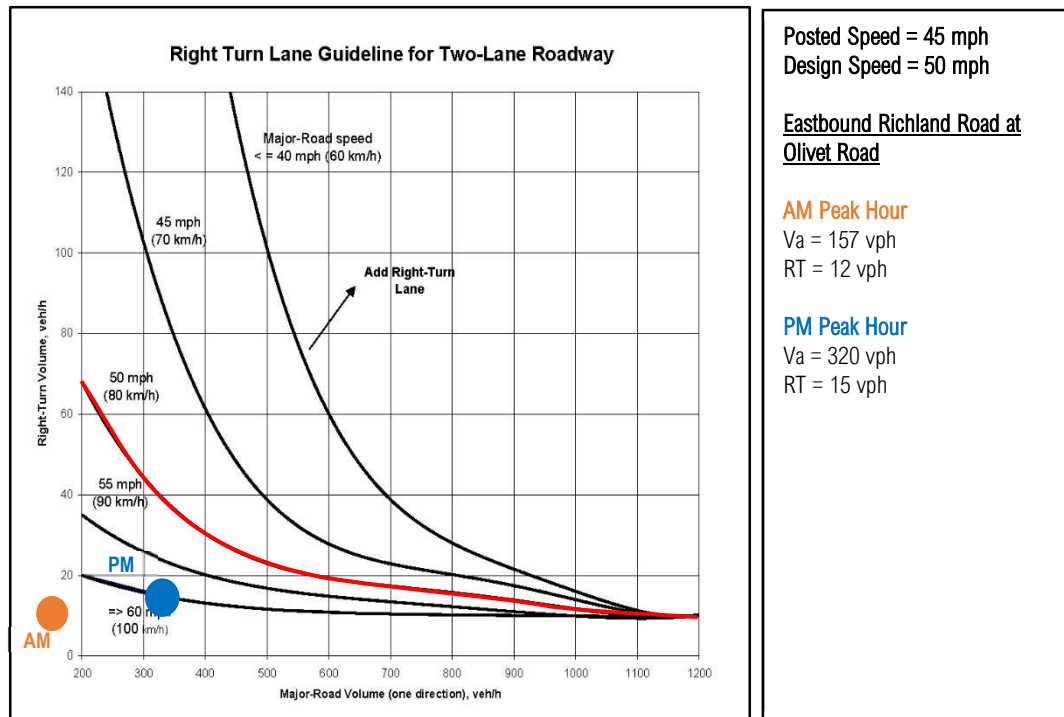


Figure 28: Eastbound Richland Road Right-Turn Warrant at Olivet Road – 2021 Build Osburn Farm Alternate



Operating Conditions – Osburn Farms Alternate: The study intersections were reevaluated using the methodologies described previously. The existing lane configurations and traffic control were used in the analysis (i.e., no roadway or traffic control improvements). The proposed site drives were all assumed to have one lane exiting and one lane entering.

Table 9 summarizes the results of these analyses, which reflect the 2021 Build Osburn Farms Alternate operating conditions and average delay for each of the study intersections during the weekday AM and PM peak hours. The (v/c) is also noted in the table to better understand the available capacity of the intersection and the impact of the additional Osburn Farms trips on the overall capacity.

As shown in the table, the comparison of the v/c ratio between the 2021 Build (Silver Lakes trips Only) and 2021 Build Osburn Farms Alternate (adding the Osburn Farms trips) show that the trips associated with the proposed Osburn Farms only utilize about five to ten percent of the intersection capacity with the exception of the Richland Road and Rolling Hills Road intersection. In the AM peak hour, the v/c ratio increase from 0.69 in the 2021 Build condition to 0.91 in the 2021 Build Alternate conditions with the Osburn Farms trips utilizing about 20 percent of the intersection capacity. In the PM peak hour, the v/c ratio increase from 0.98 in the 2021 Build condition to 1.14 in the 2021 Build Alternate conditions with the Osburn Farms trips utilizing about 16 percent of the intersection capacity. More importantly, in the PM peak hour, the v/c ratio at the intersection of Richland Road and Rolling Hills Road is 1.14 which is over capacity and will likely result in long delays and queues without roadway and/or traffic control improvements.

As shown, all of the study intersections would continue to operate at overall favorable levels of service during the peak hours for the 2021 Build Alternate conditions with the exception of the Richland Road and Rolling Hills Road intersection. In fact, most of the study intersections and the respective approaches to those intersections are forecasted to continue to operate at highly desirable LOS B or better.

As shown, during the PM peak hour, the Richland Road and Rolling Hills Road intersection is forecasted to further decline to LOS F with approximately 75 seconds of delay per vehicle on average.



Table 9: 2021 Build Osburn Farms Alternate – Operating Conditions Summary

Intersection / Approach	AM Peak Hour	PM Peak Hour
St. Charles Road and Keene Street (Signalized)		
Eastbound St. Charles Road Approach	B (19.0)	C (23.8)
Westbound St. Charles Road Approach	E (66.6)	D (54.8)
Northbound Keene Street Approach	C (28.1)	C (27.5)
Southbound Keene Street Approach	C (20.8)	C (21.3)
Overall	D (39.0) v/c: 0.95	C (30.4) v/c: 0.83
St. Charles Road and Richland Road (Side-Street STOP)		
Eastbound St. Charles Road Approach	Free Flow	Free Flow
Westbound Richland Road Approach (Stop)	B (12.6)	B (13.4)
Southbound St. Charles Road Approach	A (<1.0)	A (<1.0)
Overall	A (6.4) v/c: 0.37	A (2.7) v/c: 0.28
Richland Road and Rolling Hills Road/Grace Lane (All-Way STOP)		
Eastbound Richland Road Approach	B (11.3)	C (20.8)
Westbound Richland Road Approach	E (46.7)	E (43.8)
Northbound Rolling Hills Road Approach	C (23.5)	F (84.8)
Southbound Grace Lane Approach	C (22.2)	F (116.3)
Overall	D (31.1) v/c: 0.91	F (74.5) v/c: 1.14
Richland Road and Olivet Road (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (<1.0)
Westbound Richland Road Approach	A (1.9)	A (1.7)
Northbound Olivet Road Approach	B (11.1)	B (13.0)
Southbound Olivet Road Approach	B (12.4)	B (12.0)
Overall	A (3.0) v/c: 0.09	A (3.1) v/c: 0.16



Intersection / Approach	AM Peak Hour	PM Peak Hour
Richland Road and Proposed Osburn West Driveway/Tradewinds Parkway (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (<1.0)
Westbound Richland Road Approach	A (<1.0)	A (<1.0)
Northbound Proposed Osburn West Driveway Approach	B (12.8)	B (14.4)
Southbound Tradewinds Parkway Approach	B (10.4)	B (10.6)
Overall	A (3.4) v/c: 0.18	A (2.4) v/c: 0.15
Richland Road and Rangeline Road (Side-Street STOP)		
Eastbound Richland Road Approach	A (7.1)	A (6.6)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Rangeline Road Approach	B (10.3)	B (13.4)
Overall	A (6.8) v/c: 0.18	A (8.9) v/c: 0.45
St. Charles Road and Grace Lane (Side-Street STOP)		
Eastbound St. Charles Road Approach	Free Flow	Free Flow
Westbound St. Charles Road Approach	A (6.1)	A (8.5)
Northbound Grace Lane Approach	C (16.8)	D (34.8)
Overall	B (10.7) v/c: 0.66	C (15.5) v/c: 0.82
Highway WW and Rolling Hills Road (Roundabout)		
Eastbound Highway WW Approach	A (8.2)	B (11.0)
Westbound Highway WW Approach	A (9.2)	A (8.0)
Northbound Rolling Hills Road Approach	A (5.1)	A (9.0)
Southbound Rolling Hills Road Approach	B (11.9)	A (7.0)
Overall	A (8.6)	A (9.2)
Highway WW and Olivet Road (Side-Street STOP)		
Eastbound Highway WW Approach	A (1.1)	A (1.0)
Westbound Highway WW Approach	A (<1.0)	A (<1.0)
Northbound Olivet Road Approach	B (13.0)	B (13.9)
Southbound Olivet Road Approach	B (12.9)	B (12.6)
Overall	A (3.5) v/c: 0.19	A (3.6) v/c: 0.14



Intersection / Approach	AM Peak Hour	PM Peak Hour
Richland Road and Proposed Silver Lakes West Driveway (Side-Street STOP)		
Eastbound Richland Road Approach	A (1.4)	A (1.8)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Proposed Silver Lakes Driveway Approach	B (11.6)	B (11.9)
Richland Road and Proposed Silver Lakes East Driveway (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (1.4)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Proposed Silver Lakes Driveway Approach	B (10.8)	B (11.0)
Olivet Road Extension and Proposed Silver Lakes South Driveway (Side-Street STOP)		
Eastbound Proposed Silver Lakes Driveway Approach	A (8.5)	A (8.4)
Northbound Olivet Road Extension Approach	A (3.7)	A (4.3)
Southbound Olivet Road Extension Approach	Free Flow	Free Flow
Richland Road and Proposed Silver Lakes Center Driveway (Side-Street STOP)		
Eastbound Proposed Silver Lakes Driveway	A (8.4)	A (8.4)
Northbound Olivet Road Extension Approach	A (3.6)	A (5.9)
Southbound Olivet Road Extension Approach	Free Flow	Free Flow
Richland Road and Proposed Silver Lakes North Driveway (Side-Street STOP)		
Eastbound Proposed Silver Lakes Driveway	A (8.3)	A (8.3)
Northbound Olivet Road Extension Approach	A (7.2)	A (7.2)
Richland Road and Proposed Osburn Farms East Driveway (Side-Street STOP)		
Eastbound Richland Road Approach	Free Flow	Free Flow
Westbound Richland Road Approach	A (1.4)	A (2.5)
Northbound Proposed Osburn Farms East Driveway Approach	B (10.4)	B (10.9)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)

As discussed previously, several improvement alternatives were considered for the 2021 Build conditions at the intersection of Richland Road and Rolling Hills Road/Grace Lane as follows:

- Maintain All-Way Stop control with the addition of a southbound left-turn lane on Grace Lane and a westbound left-turn lane on Richland Road;



- Construct a traffic signal at the intersection with the addition of a southbound left-turn lane on Grace Lane and a westbound left-turn lane on Richland Road;
- Construct a single-lane roundabout at the intersection.

Table 10 summarizes the analysis results of the various improvement alternatives for the intersection of Richland Road and Rolling Hills Road/Grace Lane during the weekday AM and PM peak hours for the 2021 Build Osburn Farms Alternate conditions.

Table 10: 2021 Build Osburn Farms Alternate- Richland Road and Rolling Hills Road/Grace Lane Improvement Alternatives

Intersection / Approach	AM Peak Hour			PM Peak Hour		
	All-Way Stop w/Left Turns on all Approaches	Signal w/Left Turns on all Approaches	Single lane Roundabout	All-Way Stop w/Left Turns on all Approaches	Signal w/Left Turns on all Approaches	Single lane Roundabout
Richland Road and Rolling Hills Road/Grace Lane						
Eastbound Richland Road Approach	B (10.0)	B (18.2)	A (5.0)	C (16.5)	C (29.9)	A (9.5)
Westbound Richland Road Approach	B (13.7)	B (16.3)	A (9.3)	B (14.7)	C (22.2)	A (7.4)
Northbound Rolling Hills Road Approach	C (18.1)	C (20.2)	A (6.0)	E (48.2)	C (29.3)	B (11.3)
Southbound Grace Lane Approach	B (13.7)	B (17.1)	A (7.5)	C (19.2)	B (16.4)	A (8.7)
Overall	B (14.8) v/c: 0.64	B (17.9) v/c: 0.61	A (7.5) v/c: 0.47	D (26.9) v/c: 0.93	C (24.0) v/c: 0.79	A (9.4) v/c: 0.54

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)

As shown in Table 10, all three improvement alternatives at the intersection of Richland Road and Rolling Hills Road/Grace Lane would provide overall acceptable operations (i.e., LOS D or better). However, the All-Way Stop alternative has an estimated v/c ratio of 0.93 in the PM peak hour which is approaching the capacity of the intersection.

Considering the combined impact of the full build out of The Brooks, The Vineyards, the Zumwalt Tract, the proposed Silver Lakes development and the proposed Osburn Farms development, it is recommended that either a traffic signal or a roundabout be pursued as the ultimate configuration for the Richland Road and Rolling Hills Road/Grace Lane intersection.



Sunrise Estates Access on Richland Road: As requested by the County, the study also reviewed the impact of the trips for the proposed Silver Lakes and Osburn Farms developments on the roadways off Richland Road serving the Sunrise Estates subdivision (i.e., Rainbow Drive, Broadview Court and Sunshine Drive).

Table 11 summarizes the results of these analyses, which reflect the 2021 Build Osburn Farms Alternate operating conditions and average delay for each of the study intersections during the weekday AM and PM peak hours. This scenario includes all approved developments (i.e., The Vineyards, The Brooks Phase 1 and 2, Crescent Ridge, and Zumwalt Tract) as well as the proposed Silver Lakes and Osburn Farms developments.

Table 11: 2021 Build Osburn Farms Alternate Operating Conditions Summary - Sunrise Estates Drives

Intersection / Approach	AM Peak Hour	PM Peak Hour
Richland Road and Rainbow Drive (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (1.4)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Rainbow Drive Approach	B (10.6)	B (10.9)
Overall	A (1.3) v/c: 0.17	A (1.3) v/c: 0.16
Richland Road and Broadview Court (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (1.7)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Broadview Court Approach	B (10.3)	B (10.7)
Overall	A (1.6) v/c: 0.14	A (1.6) v/c: 0.16
Richland Road and Sunshine Drive (Side-Street STOP)		
Eastbound Richland Road Approach	A (<1.0)	A (<1.0)
Westbound Richland Road Approach	Free Flow	Free Flow
Southbound Sunshine Drive Approach	A (9.9)	B (10.1)
Overall	A (<1.0) v/c: 0.14	A (<1.0) v/c: 0.15

As shown in Table 11, the drives serving the Sunrise Estates subdivision on Richland Road are forecasted to operate at highly favorable levels of service during the peak hours for the 2021 Build Alternate conditions with all movements forecasted to operate at LOS A or B.



SUMMARY

CBB completed the preceding study to address the anticipated traffic impacts associated with the proposed Silver Lakes development located on the north side of Richland Road just west of Olivet Road, in Columbia, Missouri.

In summary, the following findings and improvements should be considered in conjunction with the proposed Silver Lakes development:

- The proposed Silver Lakes development is expected to add about 255 trips during the weekday AM peak hour and 335 trips during the weekday PM peak hour to the adjacent roadways.
- The proposed Silver Lakes development will have the greatest traffic volume increase on Richland Road between Rolling Hills Road and the Silver Lakes development site with an estimated increase of 70 percent (i.e., 2,360 ADT) over the 2021 Base traffic volumes.
- A traffic signal at the intersection of Rolling Hills Road and Richland Road is not warranted in the 2021 Base or 2021 Build conditions.
- Based on the 2021 Build volumes, a separate eastbound left-turn lane is warranted on Richland Road at the proposed Silver Lakes west drive.
- All of the study intersections operate at overall favorable levels of service (i.e., LOS D or better) in the 2021 Base conditions and would continue to operate at overall favorable levels of service during the peak hours for the 2021 Build conditions with the exception of the Richland Road and Rolling Hills Road intersection. In fact, most of the study intersections and the respective approaches to those intersections are forecasted to operate at highly desirable LOS B or better.
- Several improvement alternatives were considered at the intersection of Richland Road and Rolling Hills Road/Grace Lane including maintaining All-Way Stop control with the addition of southbound and westbound left-turn lanes, constructing a traffic signal with the addition of southbound and westbound left-turn lanes, and constructing a single-lane roundabout.

All three improvement alternatives at the intersection of Richland Road and Rolling Hills Road/Grace Lane would provide favorable operations. Since it will likely be several years before the 2021 Build traffic volumes are realized, since they account for the full build out of The Brooks, The Vineyards, the Zumwalt Tract and the proposed Silver Lakes development or about 1,200 homes in the area, the improvement alternative of adding the southbound and westbound left-turns lanes at the intersection and maintaining All-Way Stop control is reasonable.

- It is recommended the site design engineer verify adequate sight distance is provided at the proposed site drives on both Richland Road and Olivet Road.



- Careful consideration should be given to sight distance obstructions when planning any future aesthetic enhancements, such as berms, fencing and landscaping, at any of the subdivision entrances to ensure that these improvements do not obstruct the view of entering and exiting traffic at the site intersections with the public roads. It is generally recommended that all improvements wider than two inches (posts, tree trunks, etc.) and higher than 3.5 feet above the elevation of the nearest pavement edge be held back at least 20 feet from the traveled roadway.

The following findings and improvements should be considered in conjunction with the combined impact of the proposed Silver Lakes and Osburn Farms developments:

- The proposed Osburn Farms development is expected to add an additional 265 trips during the weekday AM peak hour and 355 trips during the weekday PM peak hour to the adjacent roadways.
- Based on the 2021 Build Osburn Farms Alternate volumes, a separate eastbound left-turn lane is warranted on Richland Road at the proposed Silver Lakes west drive and east drive.
- Based on the 2021 Build Osburn Farms Alternate volumes, separate eastbound and westbound left-turn lanes are not warranted on Richland Road at Olivet Road. However, with approximately 50 to 100 additional through trips on Richland Road, the left-turns at the Olivet Road intersection will meet warrants. As such, it is recommended that consideration be given to constructing the eastbound and westbound left-turn lanes on Richland Road at Olivet Road in conjunction with the proposed Silver Lakes and Osburn Farms developments.
- All of the study intersections would continue to operate at overall favorable levels of service in the 2021 Build Osburn Farms Alternate conditions with the exception of the Richland Road and Rolling Hills Road intersection. In fact, most of the study intersections and the respective approaches to those intersections are forecasted to operate at highly desirable LOS B or better.
- Again, several improvement alternatives were considered at the intersection of Richland Road and Rolling Hills Road/Grace Lane including maintaining All-Way Stop control with the addition of southbound and westbound left-turn lanes, constructing a traffic signal with the addition of southbound and westbound left-turn lanes, and constructing a single-lane roundabout.

Both the traffic signal and roundabout improvement alternatives at the intersection of Richland Road and Rolling Hills Road/Grace Lane would provide favorable operations. With continued development in the area, the All-Way Stop control will eventually fail. Considering the combined impact of the full build out of The Brooks, The Vineyards, the Zumwalt Tract, the proposed Silver Lakes development and the proposed Osburn Farms development, it is recommended that either a traffic signal or a roundabout be pursued



as the ultimate configuration for the Richland Road and Rolling Hills Road/Grace Lane intersection.

We trust this traffic impact study adequately describes the forecasted traffic conditions that should be expected as a result of the proposed Silver Lakes residential development. If additional information is desired, please feel free to contact me at 314-449-9572 or swhite@cbbtraffic.com.

Sincerely,

Shawn Lerai White, P.E., PTOE
Associate - Senior Traffic Engineer

