

**APPENDIX A – TURNING MOVEMENT
ESTIMATE AND TRAFFIC FORECAST
TECHNICAL MEMO**

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File: US 127 Russell Springs Improvement Study

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Reference: Turning Movement Estimate and Traffic Forecasting Technical Memorandum

INTRODUCTION

As part of the US 127 Russell Springs Improvement Study, Stantec was tasked with collecting turning movement counts at major intersections along the study portion of US 127. However, in March 2020, COVID-19 caused the shutdown of businesses and schools across the state, including in Russell County. As a result, traffic patterns were significantly changed and collecting turning movement counts in the field was not a viable option. Instead, turning movement estimates were developed using available data including the Kentucky Statewide Model (KYSTM), Kentucky Transportation Cabinet (KYTC) station traffic counts, 2019 Streetlight origin-destination data, turning movement counts from previous projects, and drone footage of the afternoon release of students at the Russell County Middle and High Schools.

Additionally, Stantec was tasked with developing 2045 traffic forecasts for the study portion of US 127. Growth rates from the Kentucky Statewide Model (KYSTM) and historical Kentucky Transportation Cabinet (KYTC) traffic counts were used to develop the forecasts.

TURNING MOVEMENT ESTIMATES

The primary tool used to develop turning movement estimates was a project level “subarea” travel demand model extracted from the KYSTMv19 (version 20200514). Subarea models are smaller areas of the larger KYSTM network that are extracted and reformatted to provide a more detailed analysis of a defined study area. The subarea model extracted from the KYSTM, shown in **Figure 1**, includes the major intersections along the study portion of US 127 and other significant roadways such as the Cumberland Parkway, KY 80, KY 379, KY 430, KY 619, and KY 3280.

Also shown on Figure 1 are the ten intersections on US 127 where turning movements were estimated. These intersections included:

1. US 127 at KY 80
2. US 127 at Kroger/Steve Drive Connector
3. US 127 at KY 619
4. US 127 at the WB Cumberland Pkwy. ramp
5. US 127 at the EB Cumberland Pkwy. ramp
6. US 127 at Voils Road
7. US 127 at KY 430
8. US 127 at KY 3280
9. US 127 at Fruit of the Loom Drive
10. US 127 at US 127X

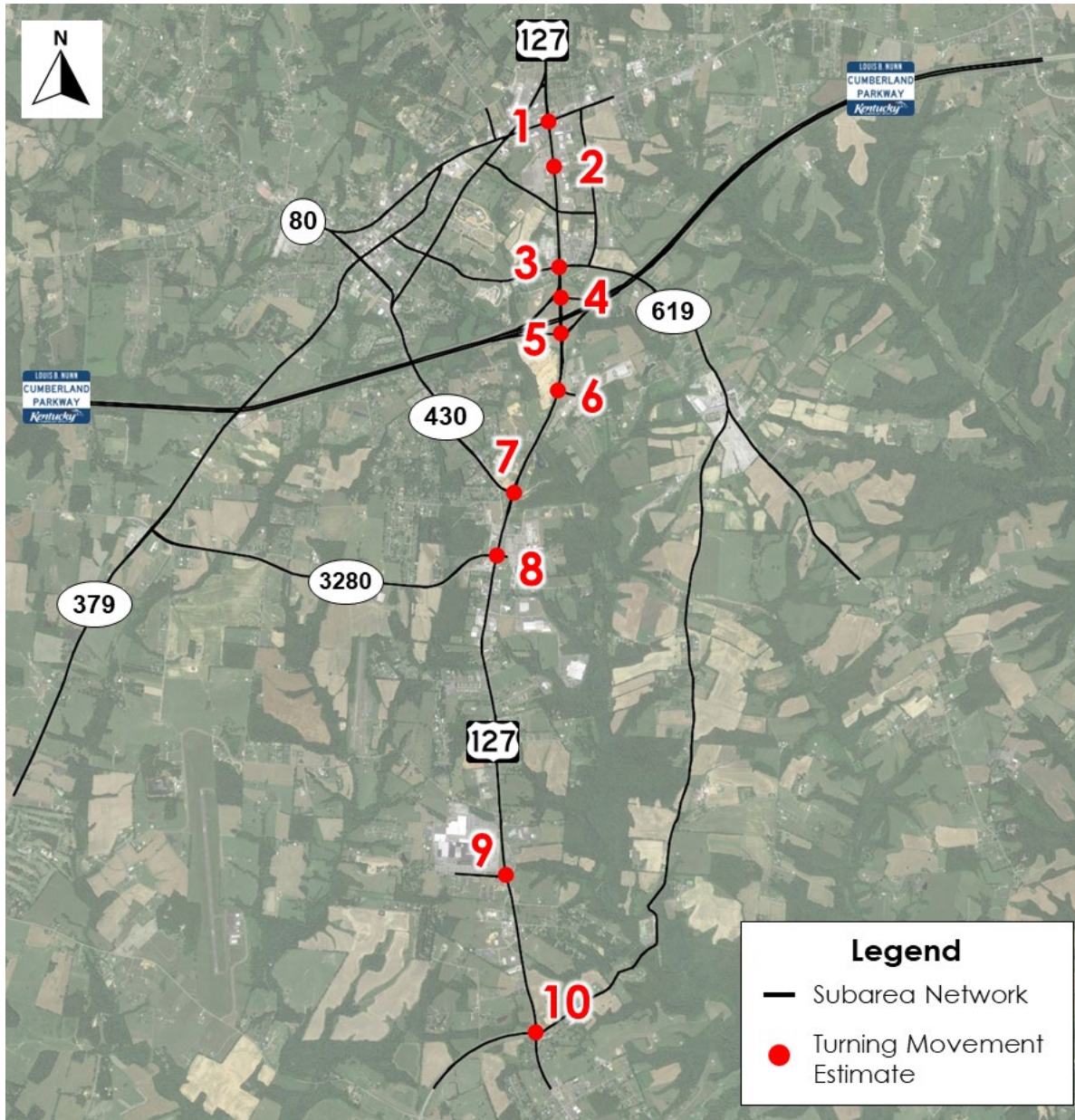


Figure 1: US 127 Subarea Model Network

As part of the calibration process, Stantec compared the extracted subarea daily trip table from the KYSTM with origin-destination data from Streetlight. Streetlight data from 2019 was queried to reflect similar origin and destination points as the subarea. The two data sets were compared on the basis of the relative proportionality between various individual and aggregate trip pairs that

Reference: US 127 Russell Springs Improvement Study

verify overall trip patterns within the study area. Overall, the Streetlight data confirmed that the extracted subarea trip table represents a reasonable approximation of existing trip patterns. A comparison of Streetlight data to subarea model trips is attached to this technical memorandum.

To ensure that the model assignments closely reflected existing traffic conditions in the study area, the most updated daily traffic counts from KYTC count stations were compared to model assignments. Network links with large discrepancies between count and assignment were initially identified and analyzed. Network corrections included moving the location of centroids to lengthen or shorten centroid connectors to ensure proper loading of trips onto the network and creating a turn prohibition file compatible with the subarea model. Once the network was updated, areas where the traffic was inconsistent with observed volumes were reexamined. Where necessary, trip values in the trip tables were adjusted for external nodes for which no count data was available. An iterative process of isolated and incremental adjustments to the trip table was used to ensure the overall balance of the trip table was maintained.

To validate the daily model, daily subarea model assignments were again compared to observed daily counts. For links with counts, the ratio of total assigned volumes to observed count volumes was 0.955, which was within the target range of less than five percent difference between total assigned volumes and observed volumes. Additionally, the root-mean-square error (RMSE) statistic, which reflects the relative error between model assignments and counts, was 19 percent, below the target threshold of 20 percent or lower. **Table 1** presents the calibration statistics for the daily subarea model.

Table 1: Daily Validation Statistics

	Daily
Sum of Counts	156,856
Sum of Assignments	149,776
Sum assignment-to-count ratio (Target: within 5%)	0.955
RMSE	19.0%

PEAK HOUR SUBAREA MODELS

Once the daily subarea model was validated, AM and PM peak hour subarea models were developed. While most network attributes remained unchanged, roadway capacities were changed to reflect hourly values.

The calibration process for the peak hour models was similar to the process for the daily model. Calibration data sources included the most recent available KYTC count station data, 2019 Streetlight peak hour data, US 127 drone footage, a 2019 turning movement count at the Voils Road intersection, and 2017 turning movement counts at the following intersections:

- US 127 at KY 80

Reference: US 127 Russell Springs Improvement Study

- US 127 at Kroger/Steve Drive Connector
- US 127 at KY 619
- US 127 at WB Cumberland Parkway ramps
- US 127 at EB Cumberland Parkway ramps

Since most of the hourly traffic volumes from KYTC count stations were taken during the summer when school is out of session, seasonal adjustment factors were used to better approximate traffic for these locations. Additionally, as turning movement counts were not available south of Voils Road, Streetlight data was used to calibrate the AM and PM subarea models. The peak hour Streetlight data was first compared to locations with available counts to ensure accuracy of the data. Once it was determined that the Streetlight data was a reasonable representation of the peak hour traffic, it was then used to calibrate model assignments south of Voils Road.

The calibration process for the peak hour models was similar to the process for the daily model. For links with counts, the ratio of total assigned volumes to observed count volumes was 1.01 for the AM peak and 1.035 for the PM peak, both well within the target range. Additionally, the RMSE was 9.1 percent for the AM and 8.8 percent for the PM. **Table 2** presents the calibration statistics for the peak hour subarea models.

Table 2: Peak Hour Validation Statistics

	AM Peak	PM Peak
Sum of Counts	20,345	22,512
Sum of Assignments	20,541	23,295
Sum assignment-to-count ratio (Target: within 5%)	1.010	1.035
RMSE	9.1%	8.8%

With the peak hour models sufficiently calibrated to within professional standards, turning movement estimates were developed using a TransCAD reporting function from its assignment procedure. As a comparative example, **Figure 2** presents the AM and PM turning movement estimates for the US 127 intersection with KY 619 while **Figure 3** presents the 2017 peak hour turning movement counts at the same location. 2020 turning movement estimates for all ten intersections are attached to this technical memorandum.

Reference: US 127 Russell Springs Improvement Study

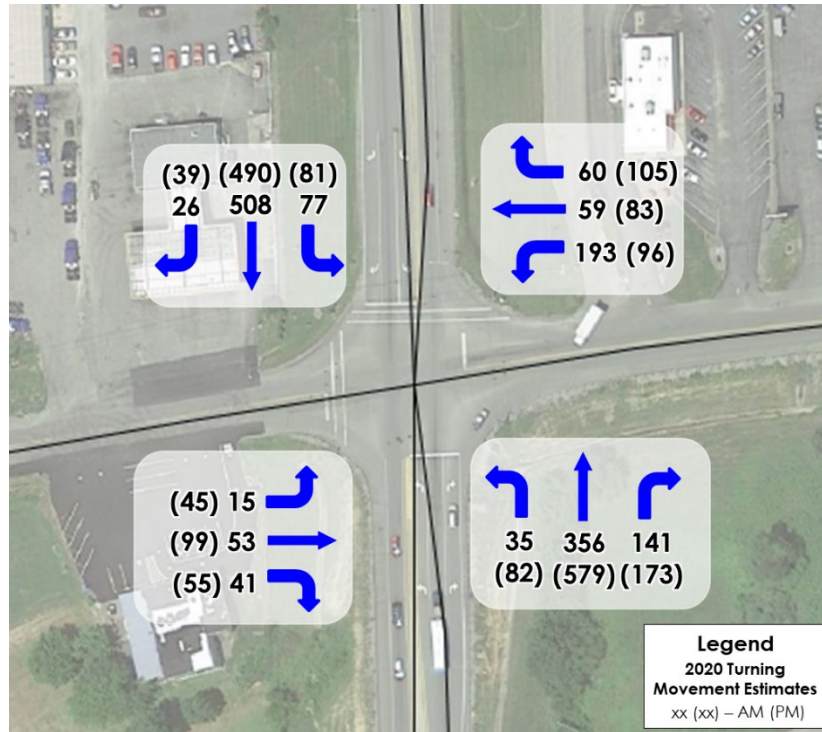


Figure 2: 2020 Turning Movement Estimate (US 127 at KY 619)

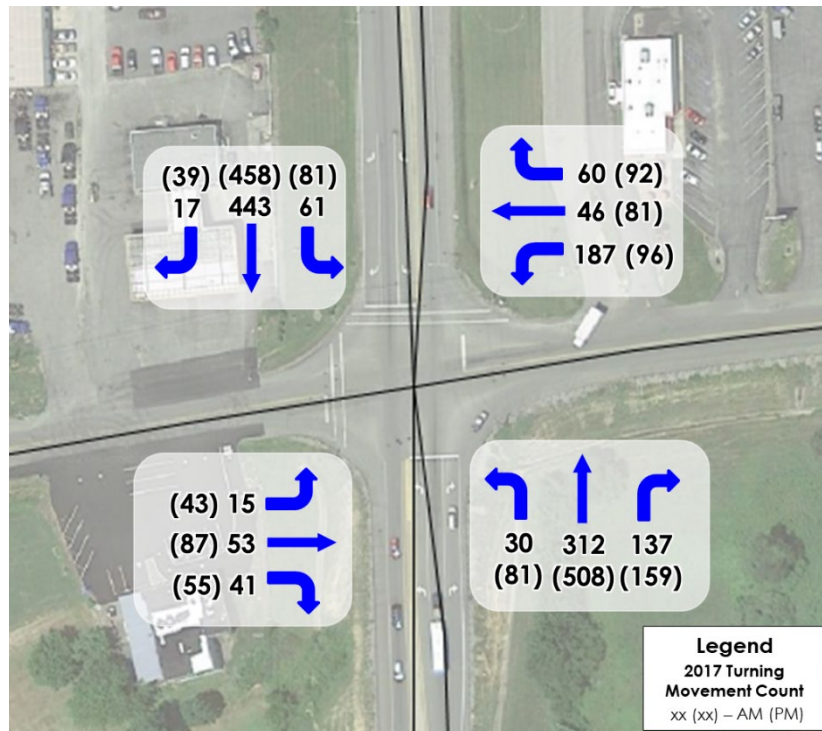


Figure 3: 2017 Turning Movement Count (US 127 at KY 619)

Reference: US 127 Russell Springs Improvement Study

TRAFFIC FORECASTS

Over the past 20 years, Russell County has experienced slight population growth. Based on projections from the Kentucky State Data Center, growth in Russell County is expected to remain modest, with an annual growth rate of 0.16 percent per year between 2010 and 2040.

In addition to population growth, the US 127 corridor in Russell County is also expected to experience employment growth, with several developments expected in the study area, including:

- Dollar General on Apache Avenue
 - This facility is approximately 9,100 sqft.
- Davis Distributing Metal Fabrication Facility on Airport Road
 - 50 employees are expected in this 50,000 - 100,000 sqft facility.
- Development in the NE quadrant of the parkway interchange
 - Four small restaurants are expected on this 5-acre parcel.
- Lake Cumberland Regional College and Workforce Center
 - This 58,000 sqft facility is not expected to add any additional students or staff on the school property during normal hours. Students and staff will shift from the current vocational school on the property to the new building.

Jobs created by these developments were added to the socioeconomic data of the KYSTM. **Table 3** presents the distribution of employment in the study area traffic analysis zones (TAZs).

Table 3: KYSTM Socioeconomic Updates

TAZ ID	Development	F_emp	Jobs added	Updated F_emp
3104151	Dollar General	303	10	363
	Davis Distributing		50	
3104131	NE Quadrant of Parkway	722	60	782

GROWTH RATES

Upon completion of travel demand runs with the updated socioeconomic data, annual growth rates were calculated using outputs from the KYSTM and annual growth rates from historical KYTC traffic count station data. Based on growth rates from these sources, an annual growth rate of 0.75 percent per year is projected for US 127, as shown in **Table 4**.

Reference: US 127 Russell Springs Improvement Study

Table 4: US 127 Study Area Annual Growth Rates

Route	Location	Beg MP	End MP	KYTC Station GR	KYSTM GR	US 127 GR
US 127	US 127X to KY 3280	14.142	16.618	0.77%	0.71%	0.75%
	KY 3280 to KY 430	16.618	16.921	1.12%	0.71%	
	KY 430 to Cumberland Pkwy.	16.921	17.891	1.48%	0.80%	
	Cumberland Pkwy. to KY 619	17.891	18.154	1.41%	0.81%	
	KY 619 to KY 80	18.154	18.902	-0.16%	0.60%	
	KY 80 to KY 379	18.902	19.09	-0.32%	0.51%	

A review of the KYSTM and KYTC count station growth rates for the entire study area revealed that 0.75 percent growth per year accurately captures the growth on most roadways in the study area. An exception is the Cumberland Parkway, where growth is expected to be 1.5 percent per year. Trips going to and coming from the parkway were grown at this higher rate.

Another exception is the growth at the Russell County Middle and High Schools. Enrollment at the schools is likely to mirror population growth, so trips coming from and going to the schools were grown at the expected Russell County annual growth rate of 0.16 percent per year.

2045 TRAFFIC VOLUMES

The annual growth rates were then used to forecast the 2020 daily traffic estimates to the future year 2045, as shown in **Table 5** and **Figure 4**.

Table 5: 2045 Daily Traffic Forecasts

Route	Location	Beg MP	End MP	Annual GR	2020 ADT	2045 ADT
US 127	US 127X to KY 3280	14.142	16.618	0.75%	11,900	14,400
	KY 3280 to KY 430	16.618	16.921		15,600	18,800
	KY 430 to Cumberland Pkwy.	16.921	17.891		14,000	16,900
	Cumberland Pkwy. to KY 619	17.891	18.154		14,800	17,900
	KY 619 to KY 80	18.154	18.902		11,700	14,100
	KY 80 to KY 379	18.902	19.09		6,900	8,300

AM and PM peak hour turning movement forecasts were also developed using the annual growth rate. As an illustrative example, **Figure 5** presents the 2045 turning movement forecasts at the US 127 intersection with French Valley Road/Russell County Schools. 2045 turning movement forecasts for all ten intersections are attached to this technical memorandum.

Reference: US 127 Russell Springs Improvement Study

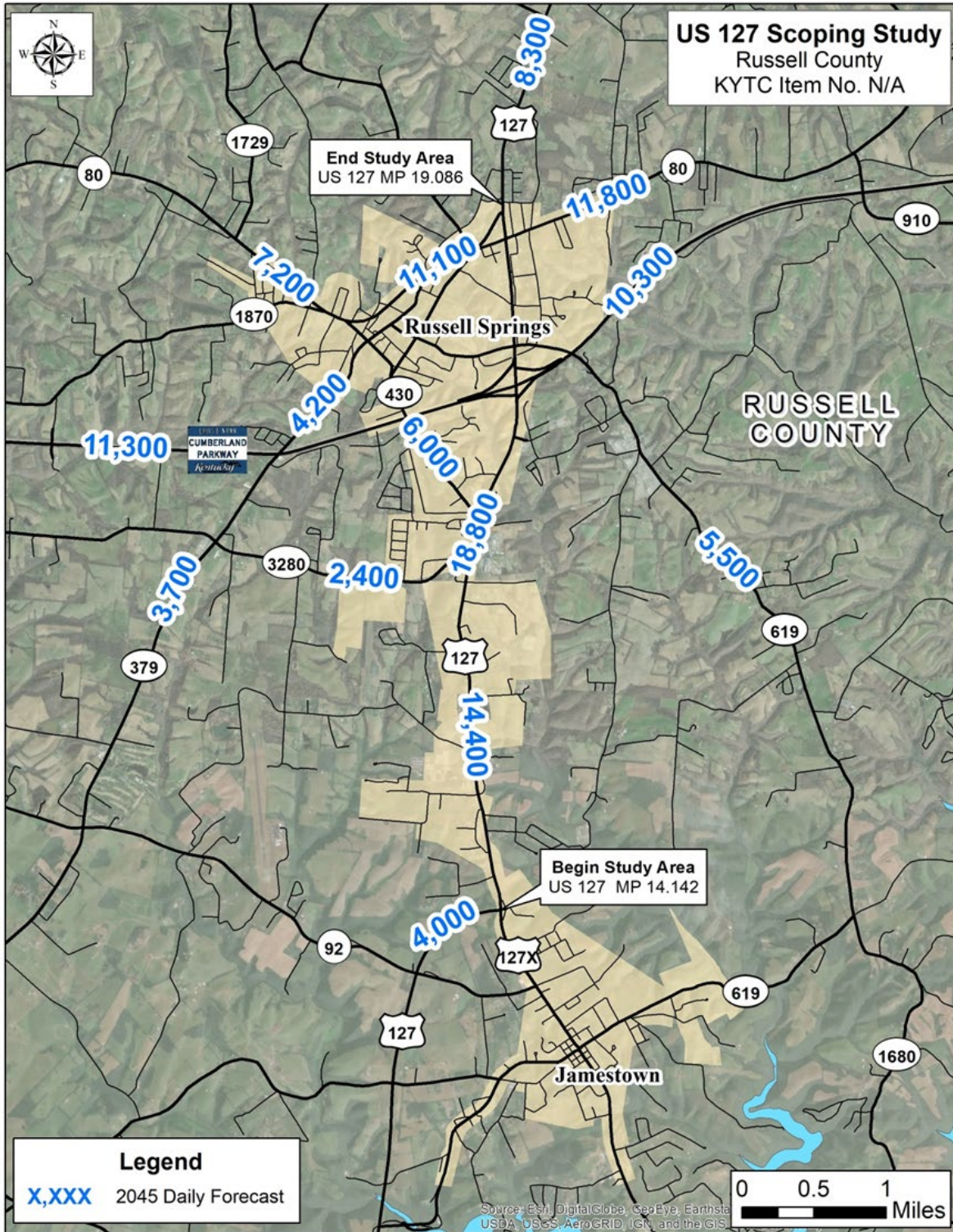


Figure 4: 2045 Daily Traffic Forecasts

Reference: US 127 Russell Springs Improvement Study

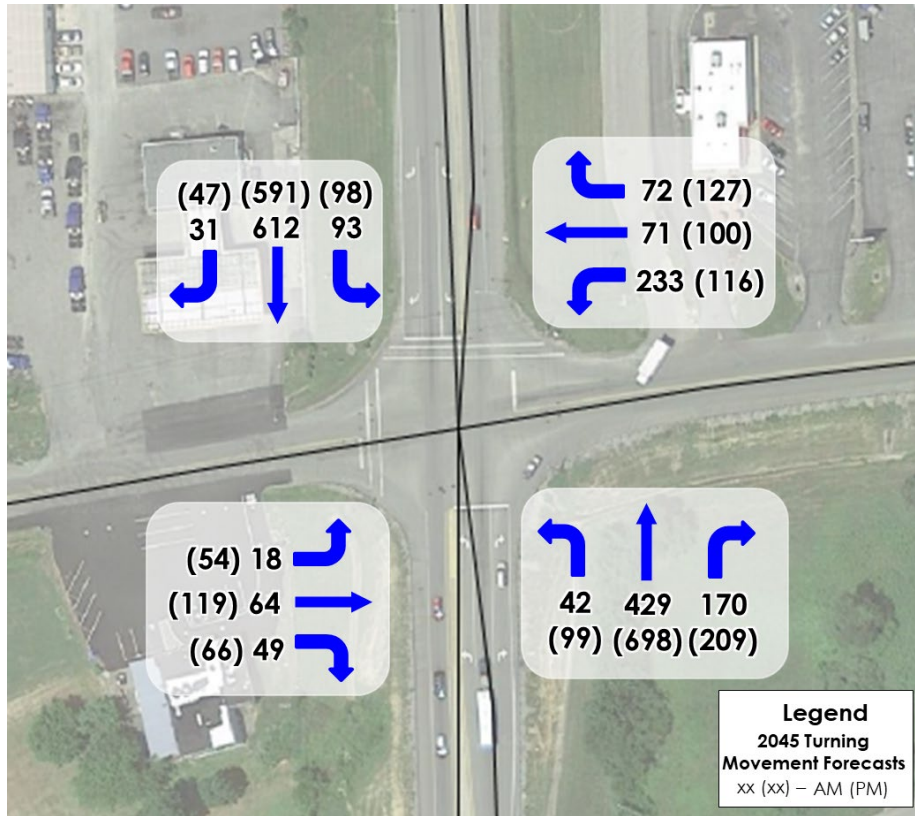


Figure 5: 2045 Turning Movement Estimate (US 127 at KY 619)

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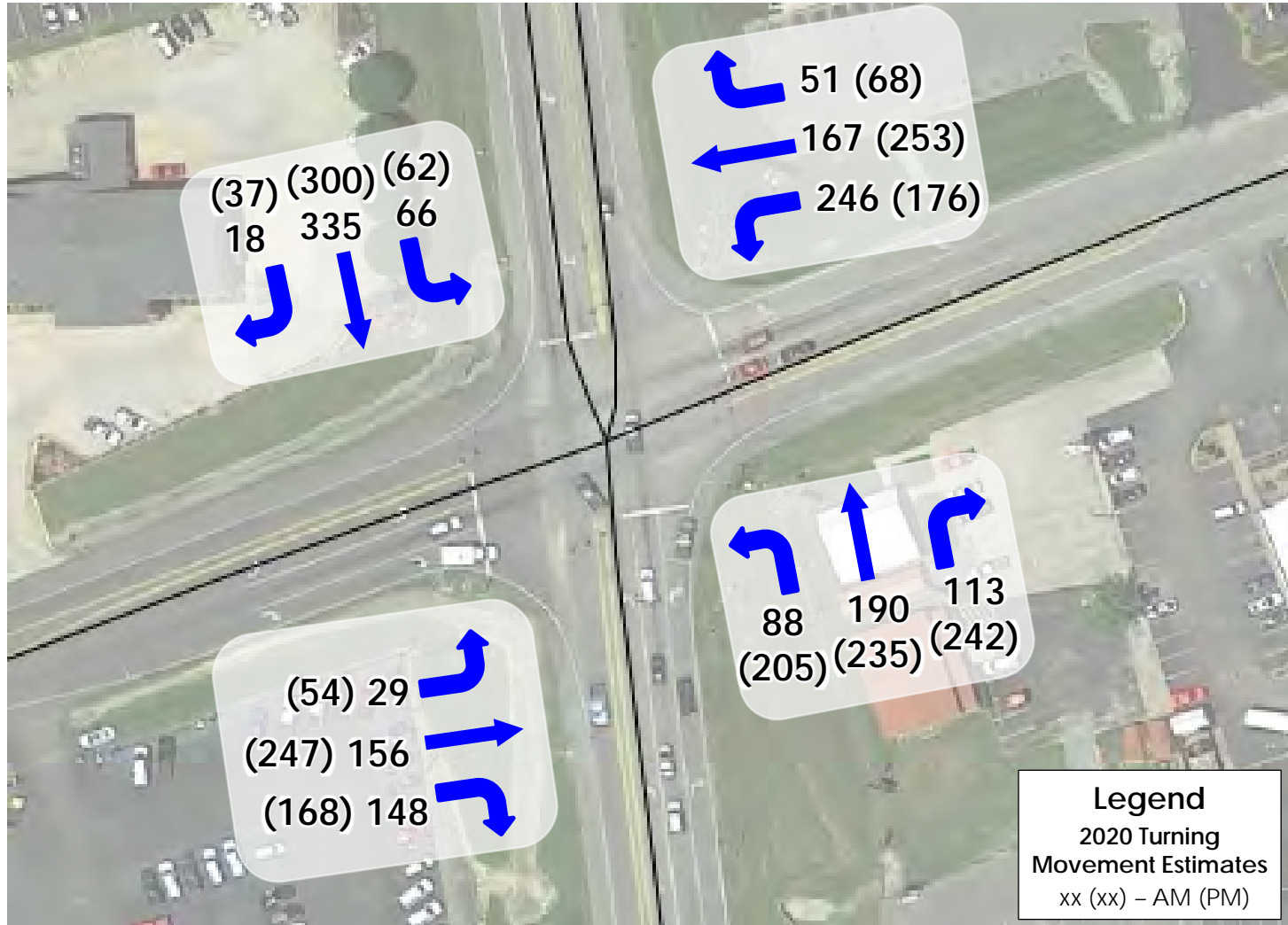
Streetlight Comparison

Location	Daily Origins		Daily Destinations		AM Origins		AM Destinations		PM Origins		PM Destinations	
	Subarea	Streetlight	Subarea	Streetlight	Subarea	Streetlight	Subarea	Streetlight	Subarea	Streetlight	Subarea	Streetlight
Cumberland Pkwy E	10.1%	10.0%	9.3%	10.5%	10.5%	12.0%	8.4%	8.8%	8.4%	11.1%	9.3%	12.1%
Cumberland Pkwy W	10.2%	9.6%	9.1%	10.4%	8.8%	9.8%	7.9%	7.7%	8.4%	10.6%	8.3%	10.8%
Fruit of the Loom	2.3%	1.3%	1.3%	1.3%	1.6%	2.9%	0.6%	0.8%	4.6%	2.8%	1.1%	1.9%
Kroger	9.3%	8.8%	10.6%	8.8%	9.0%	10.6%	6.0%	5.5%	8.8%	9.7%	8.3%	9.0%
KY 1545	2.2%	1.3%	2.2%	1.2%	2.8%	1.8%	3.7%	3.1%	7.8%	5.8%	7.0%	4.1%
KY 379 South	4.0%	5.5%	7.0%	5.9%	2.7%	1.8%	8.4%	10.2%	4.4%	5.6%	3.7%	2.3%
KY 619 South	4.3%	3.8%	5.1%	3.7%	5.5%	4.1%	7.7%	6.4%	7.8%	5.0%	5.9%	4.0%
KY 80 E	10.5%	11.4%	12.0%	13.6%	10.8%	11.7%	13.9%	15.6%	13.4%	13.9%	12.1%	14.4%
KY 80 W Boundary	14.2%	12.0%	12.8%	11.8%	7.8%	5.4%	9.1%	11.4%	11.6%	10.6%	10.2%	9.1%
Russell Co. Schools	7.0%	8.0%	6.1%	6.2%	18.5%	21.7%	4.4%	3.3%	2.1%	3.2%	8.0%	5.7%
US 127 N	9.3%	10.0%	10.0%	10.5%	8.8%	9.7%	12.6%	11.2%	8.8%	9.6%	9.9%	11.8%
US 127 W	3.9%	4.8%	4.2%	5.0%	5.3%	3.4%	5.0%	3.7%	3.8%	3.3%	5.6%	4.4%
US 127B	10.0%	11.7%	9.3%	9.4%	5.9%	3.8%	10.5%	12.3%	8.4%	7.5%	7.9%	8.6%
Voils Rd	2.7%	1.8%	1.2%	1.7%	1.8%	1.4%	1.8%	0.2%	1.6%	1.2%	2.7%	1.9%

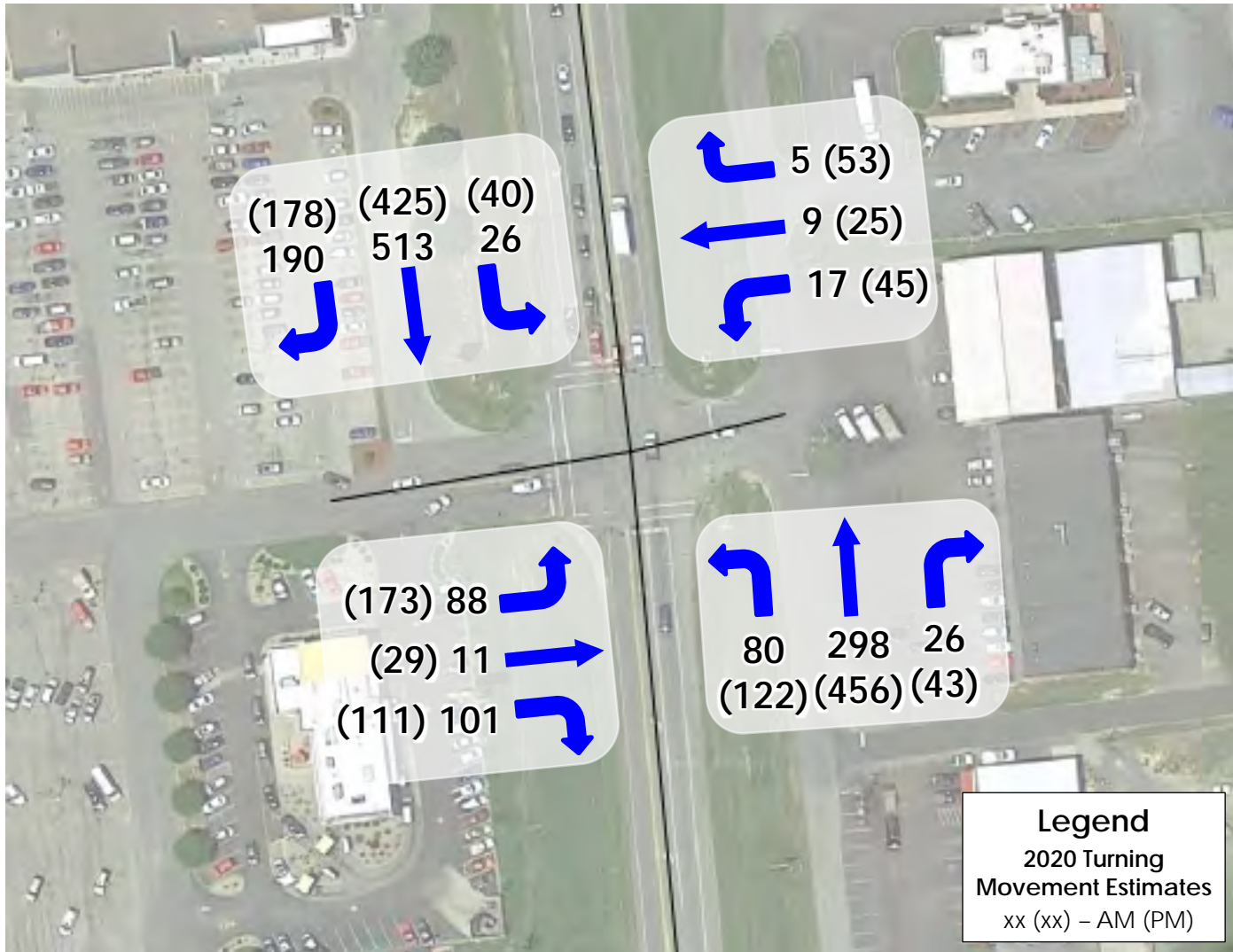
The table above provides a comparison of Streetlight origin-destination proportionality to US 127 Subarea model trip proportionality. Where possible, subarea model centroids were combined for a better comparison with the Streetlight zones.

2020 Turning Movement Estimates

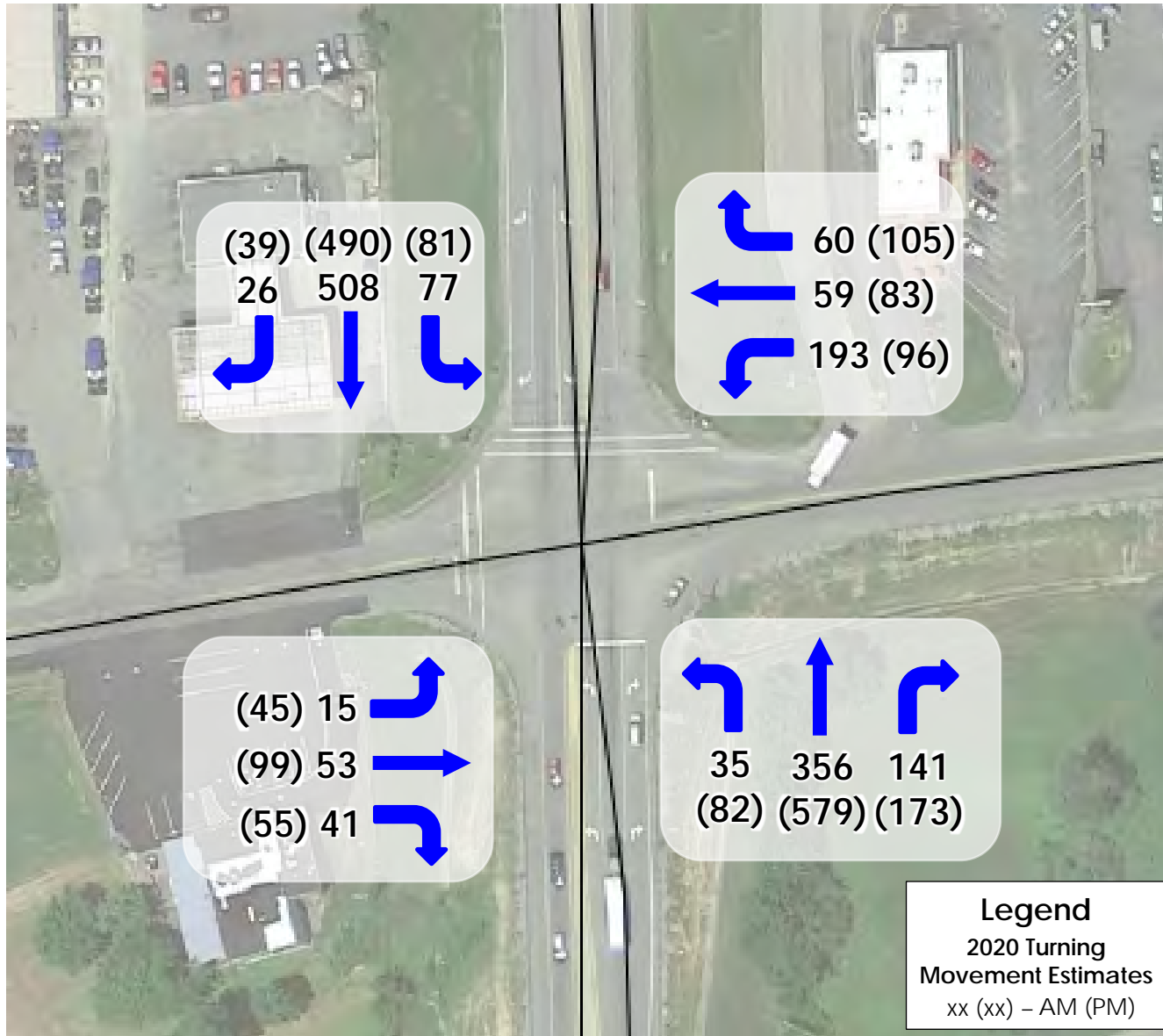
US 127 at KY 80



US 127 at Kroger

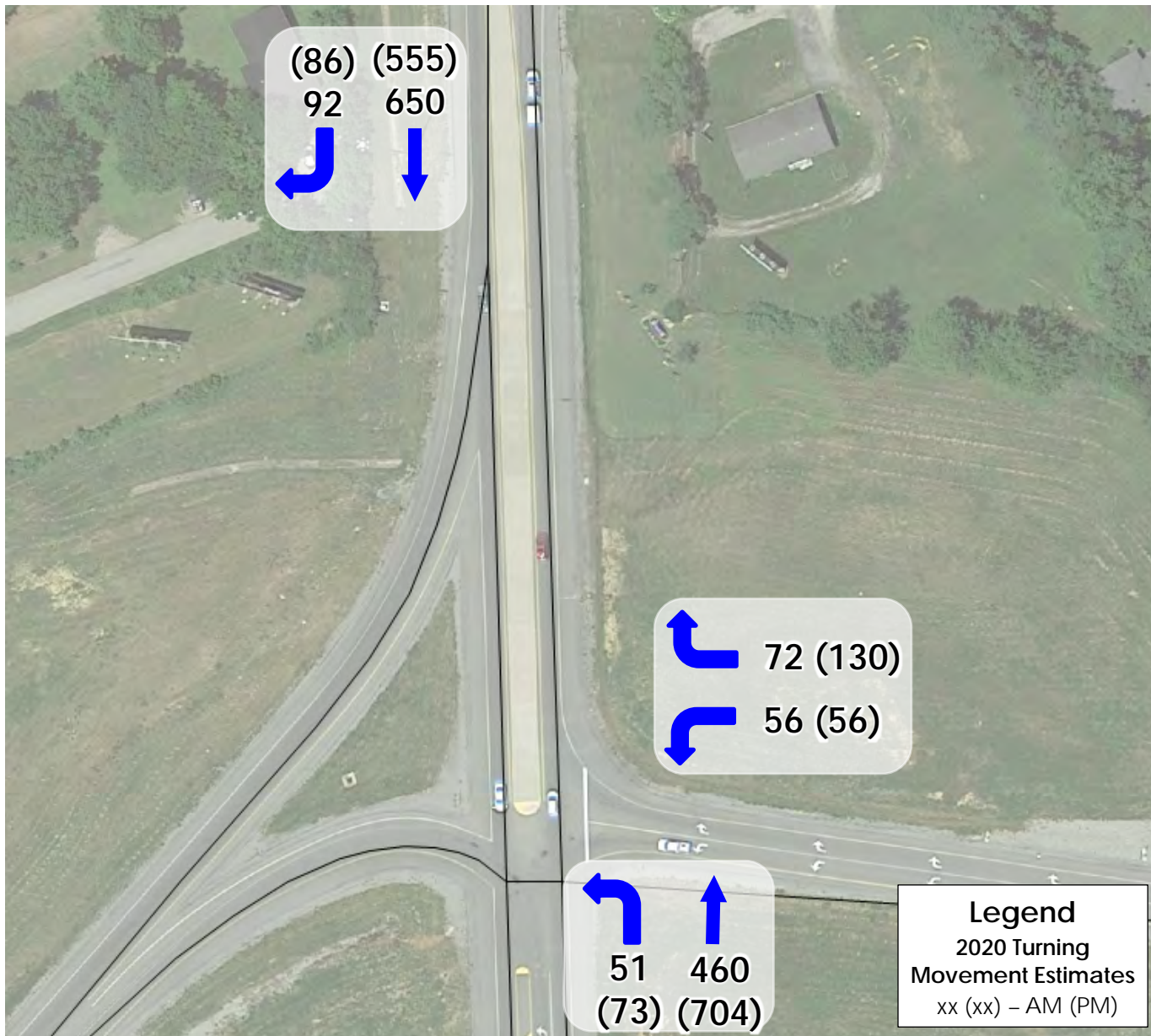


US 127 at KY 619

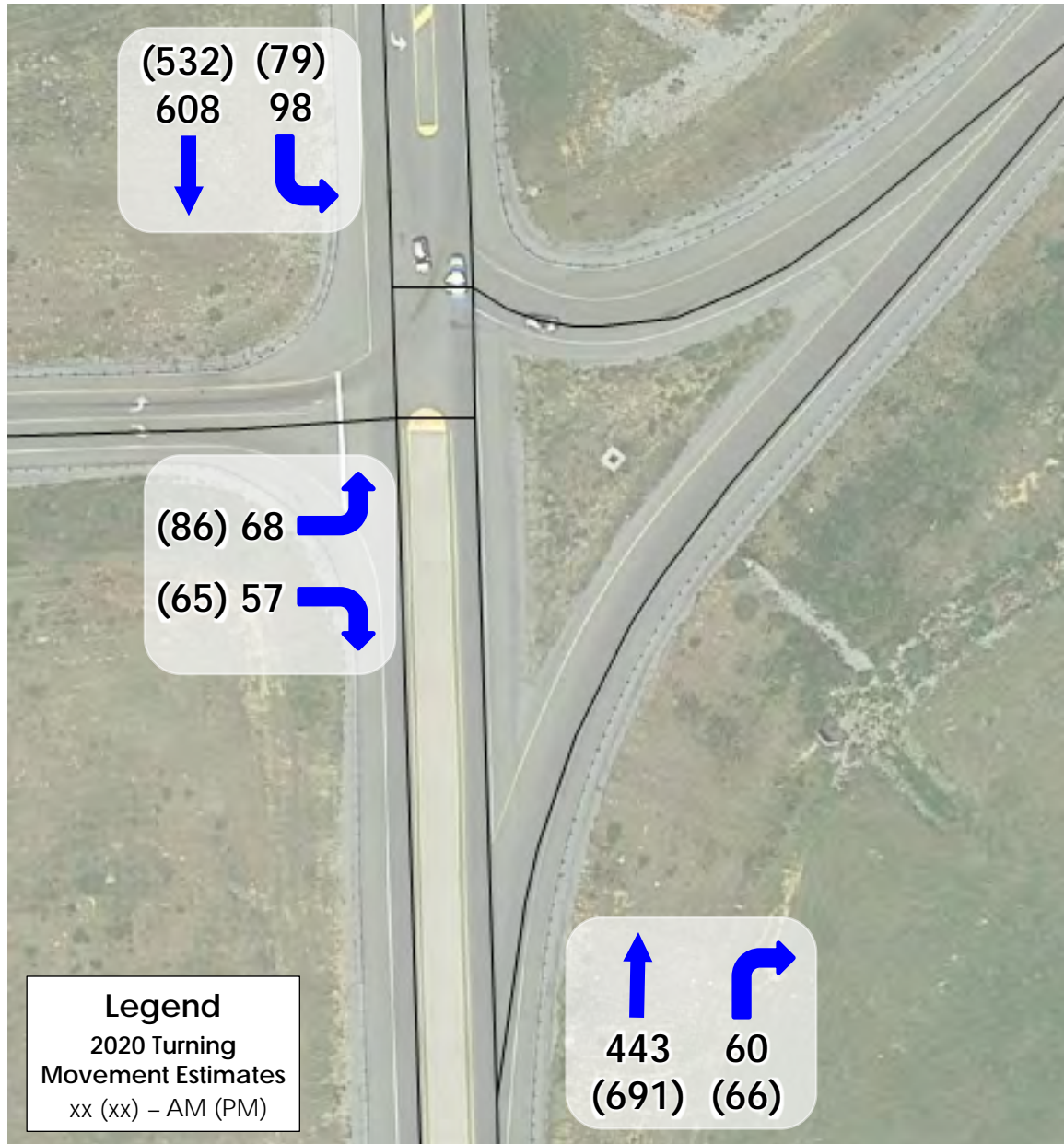


Legend
 2020 Turning
 Movement Estimates
 xx (xx) – AM (PM)

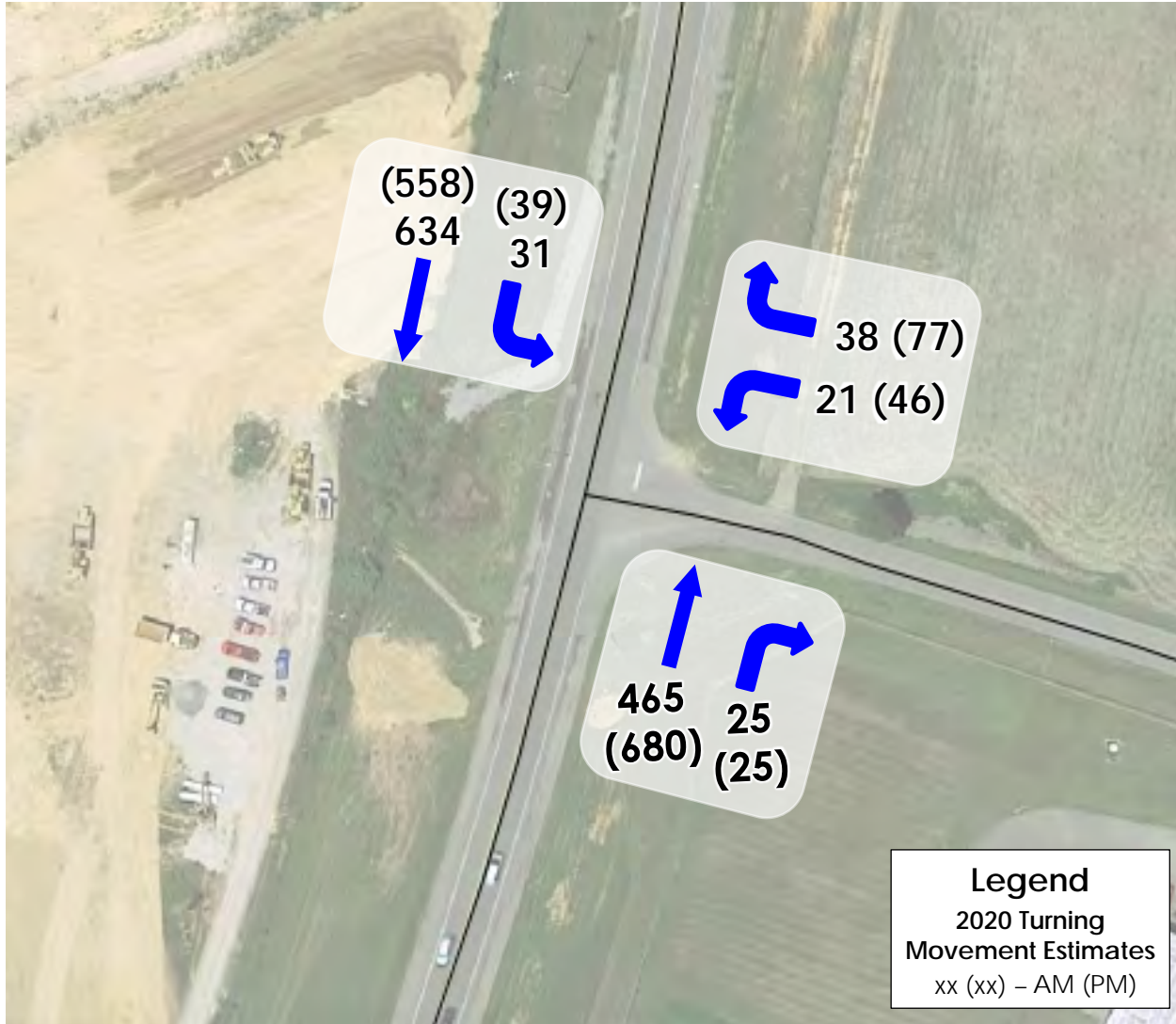
US 127 at WB Ramps



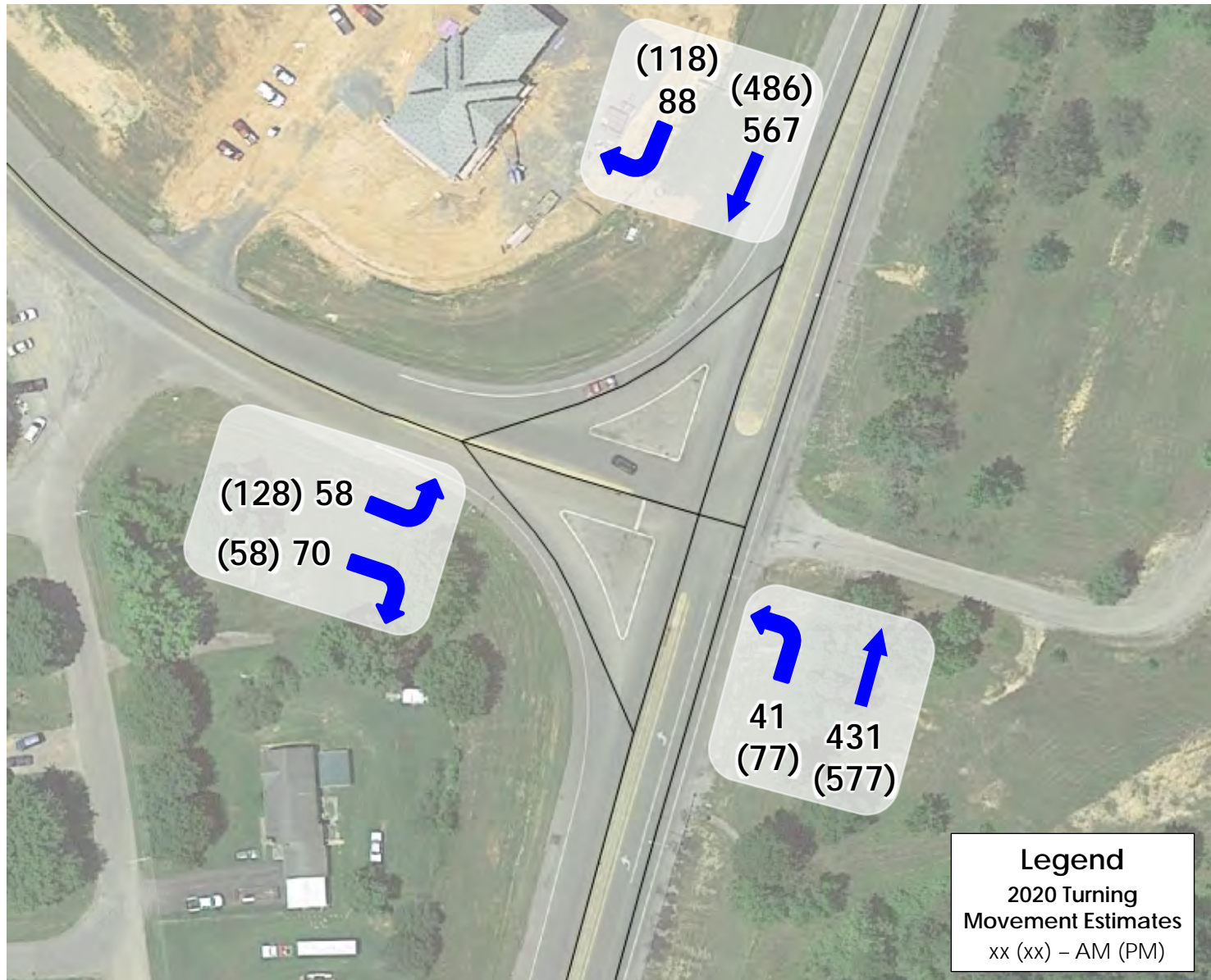
US 127 at EB Ramps



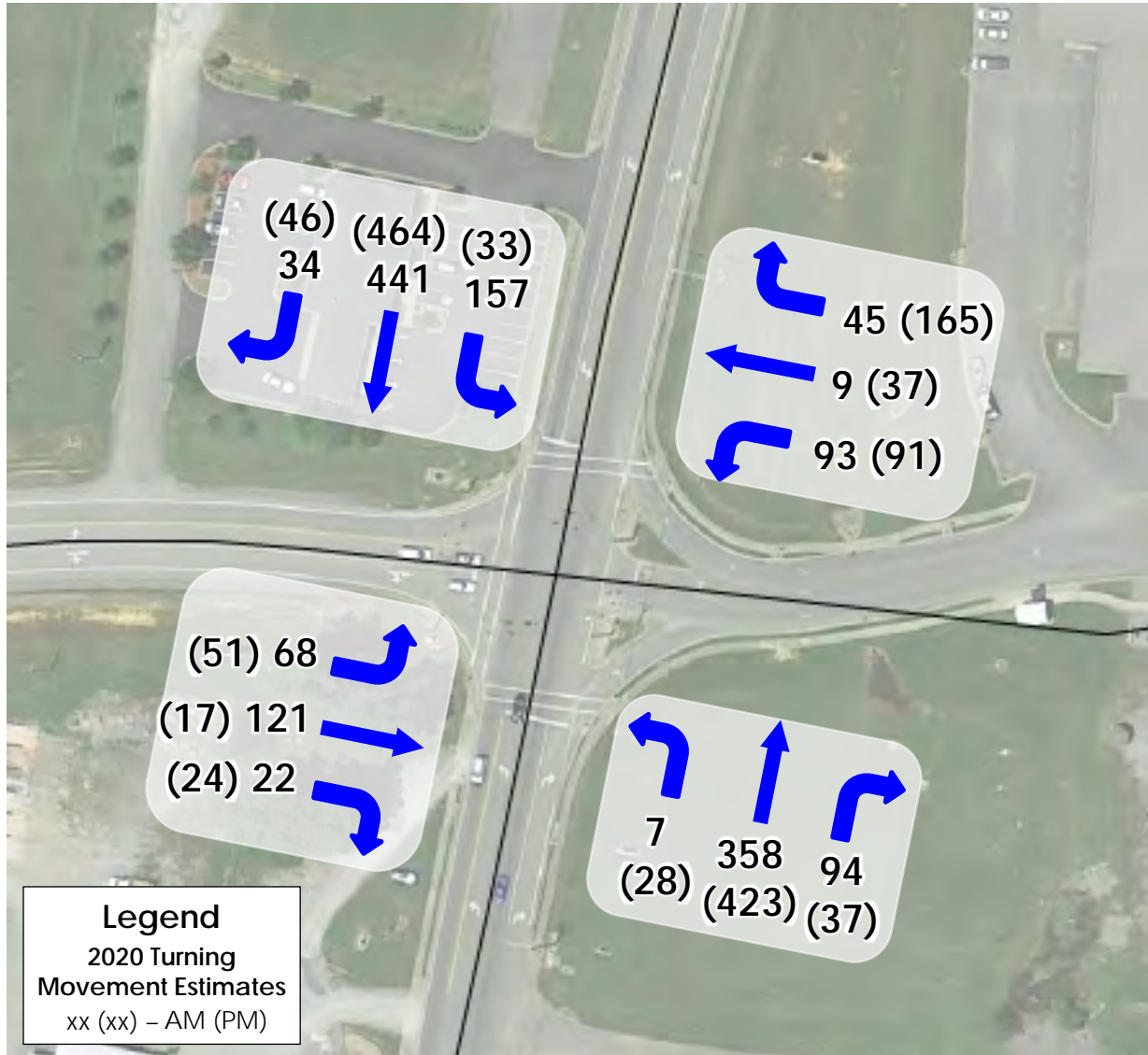
US 127 at Voils Rd.



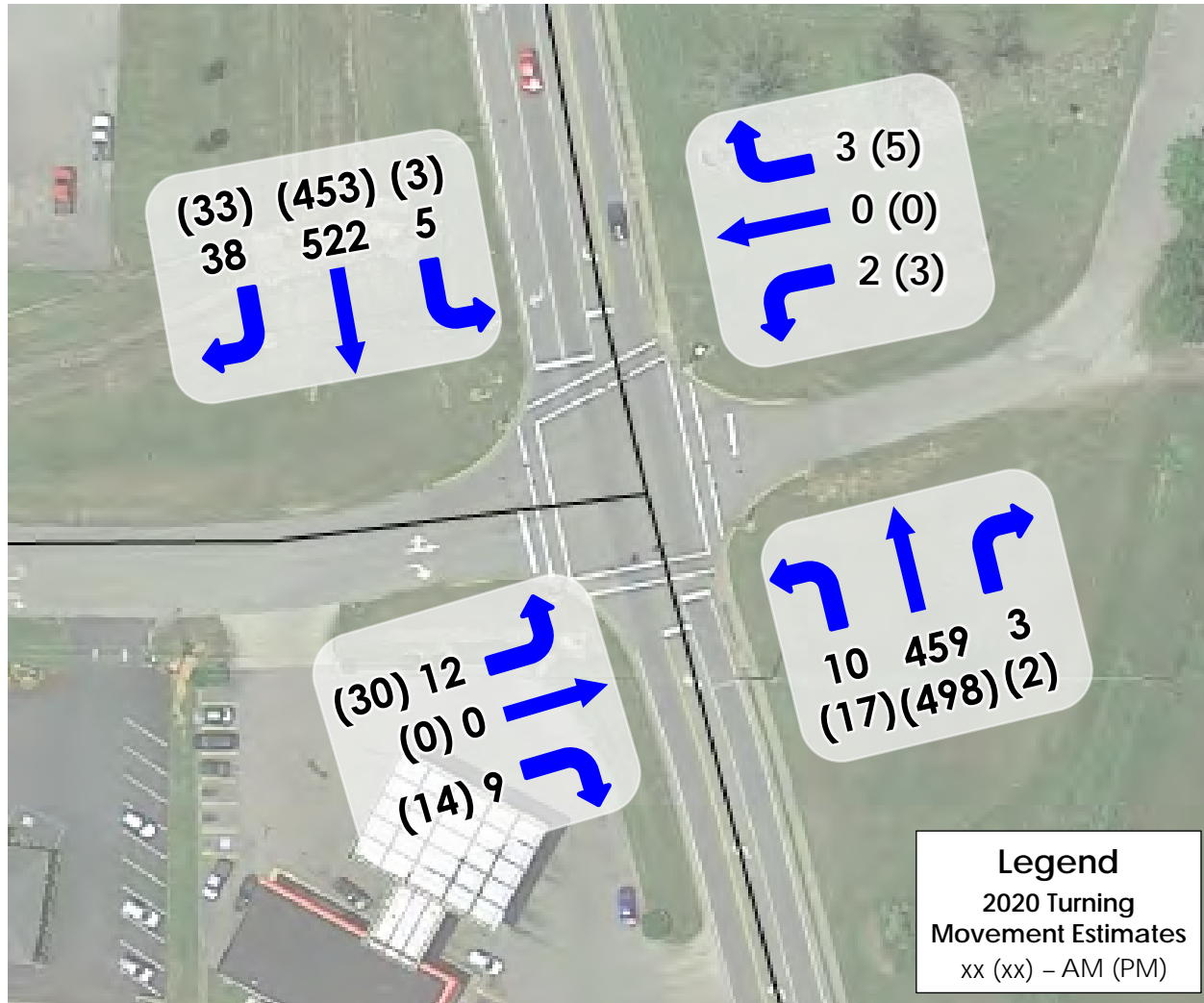
US 127 at Lake Way Dr.



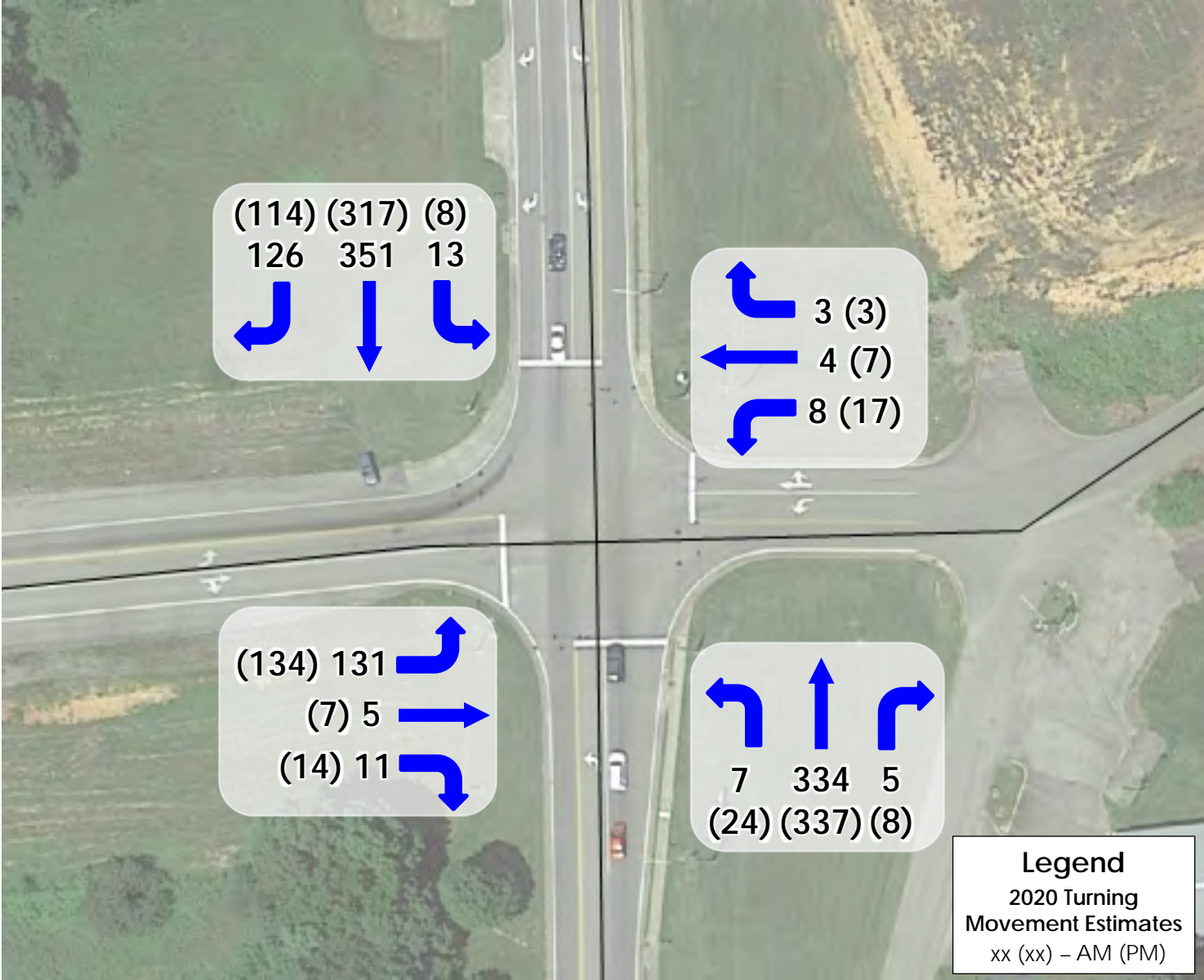
US 127 at French Valley Rd./Russell Co. Schools



US 127 at Fruit of the Loom

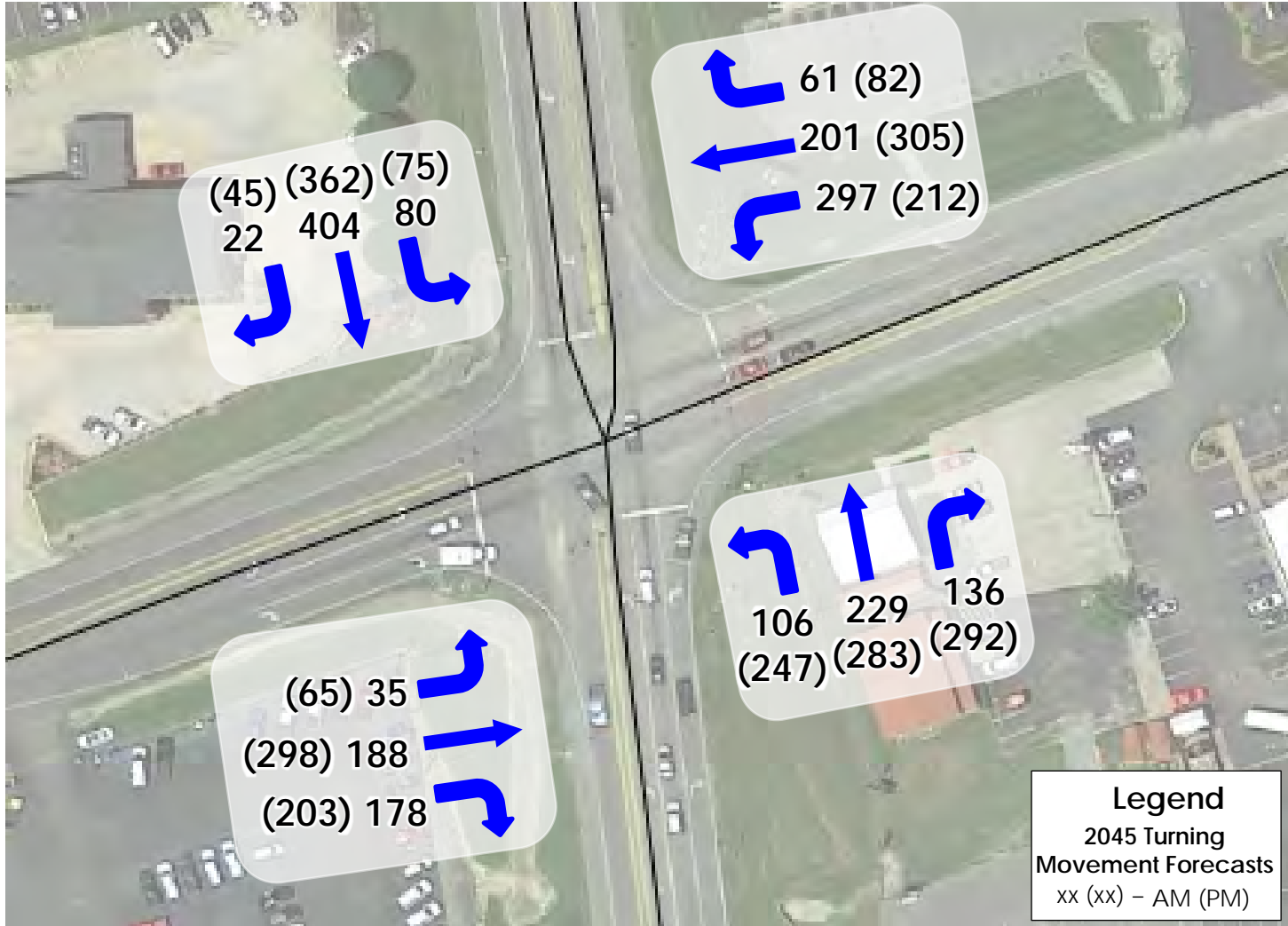


US 127 at US 127 Bypass

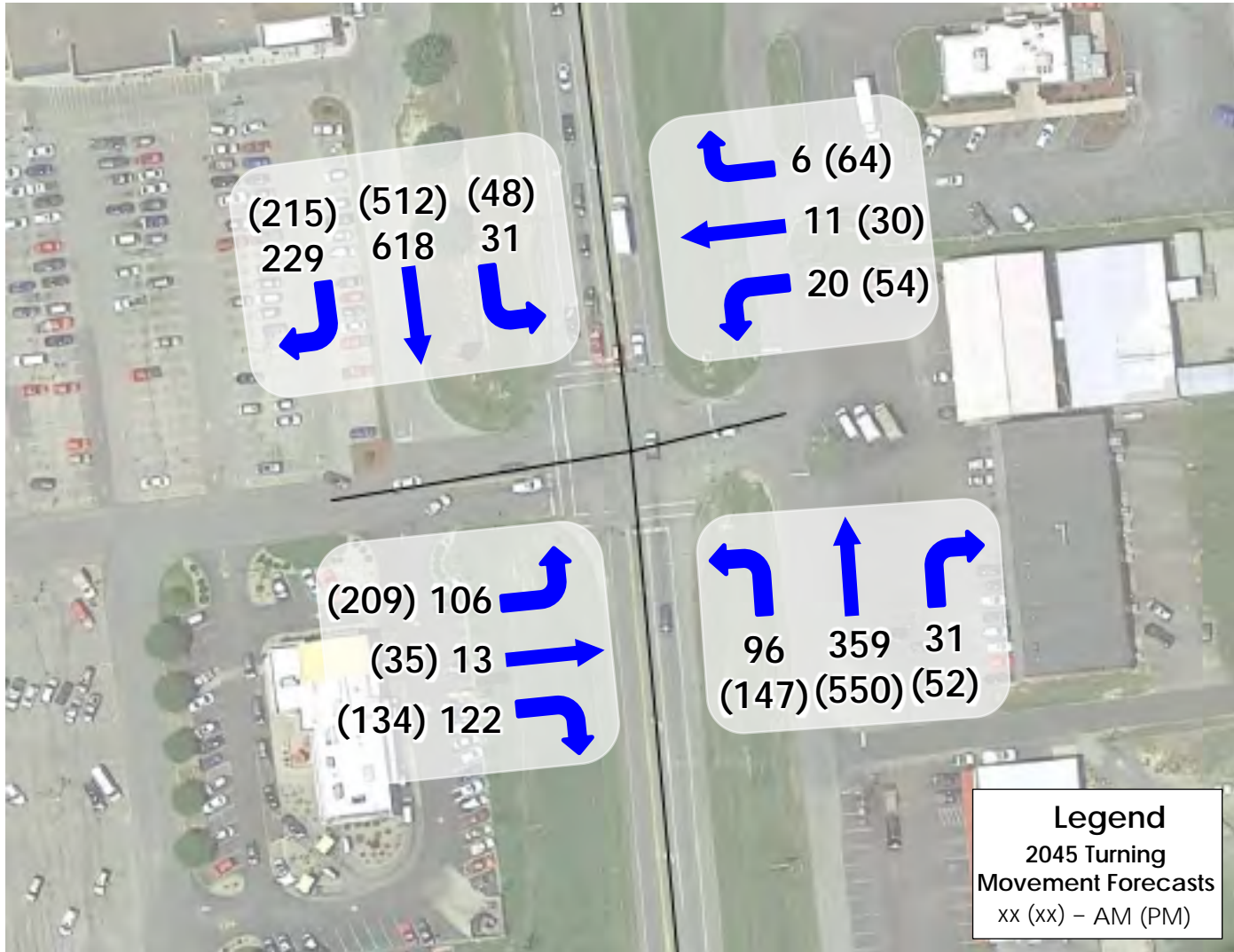


2045
Turning Movement
Forecasts

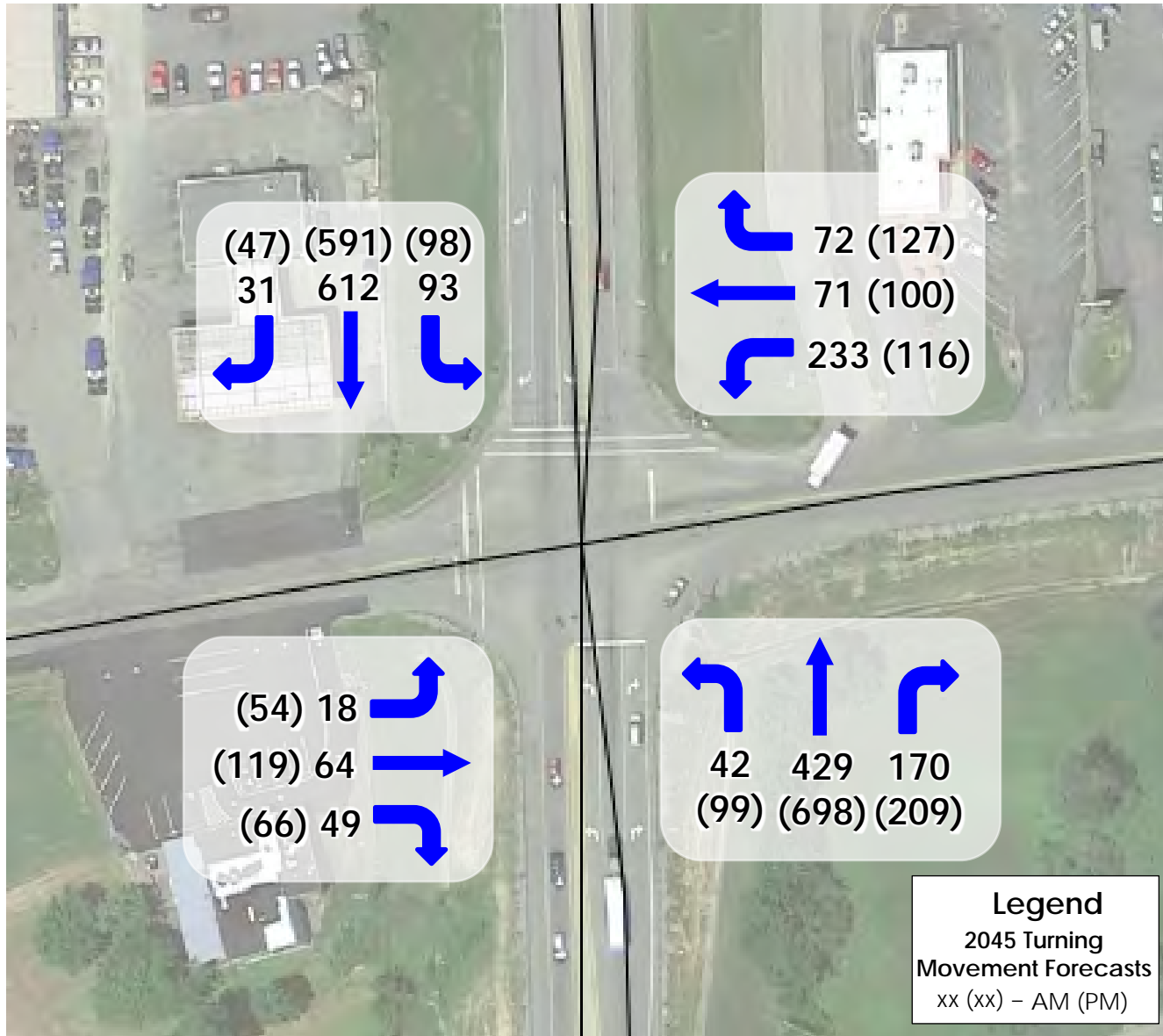
US 127 at KY 80



US 127 at Kroger

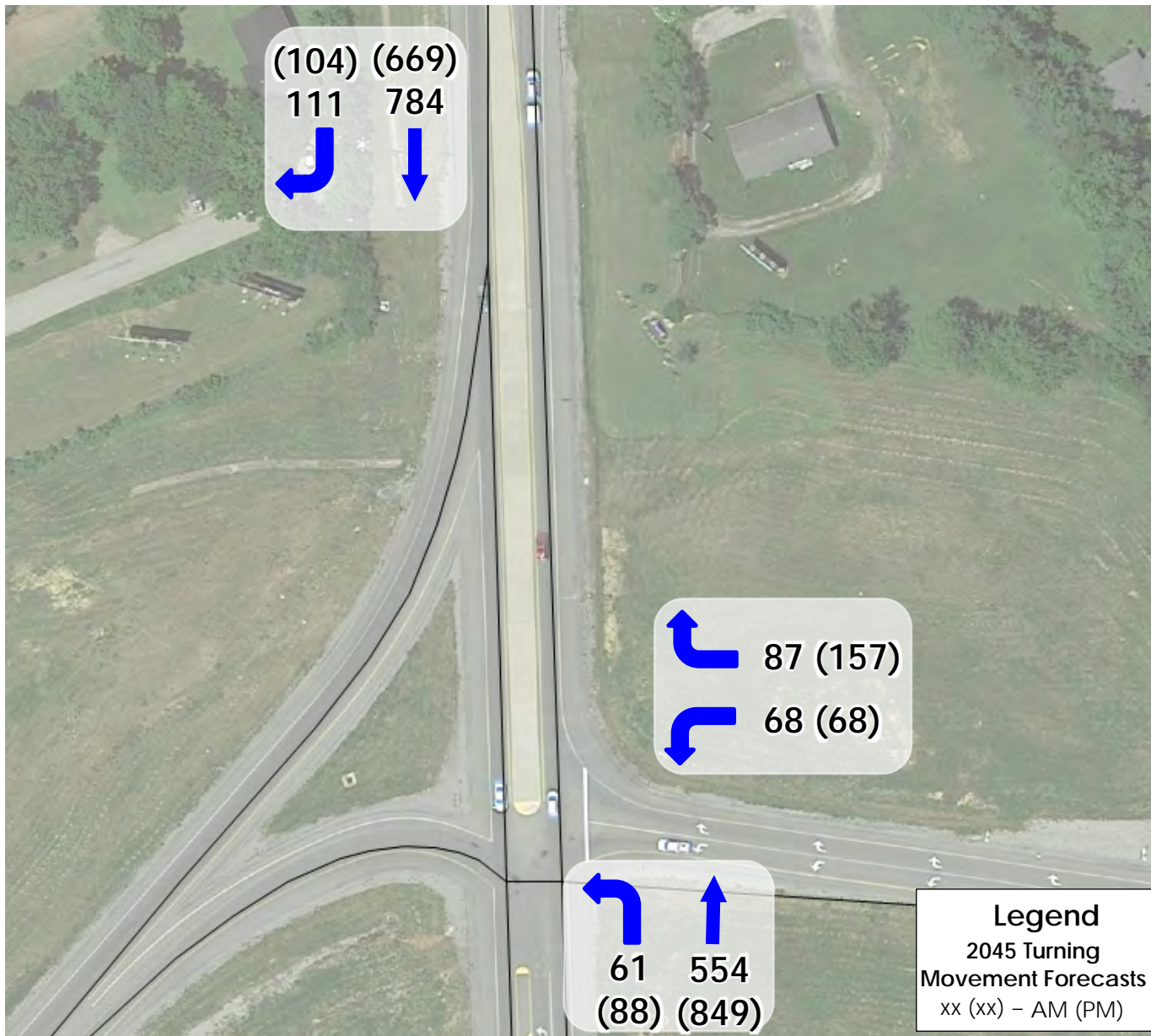


US 127 at KY 619

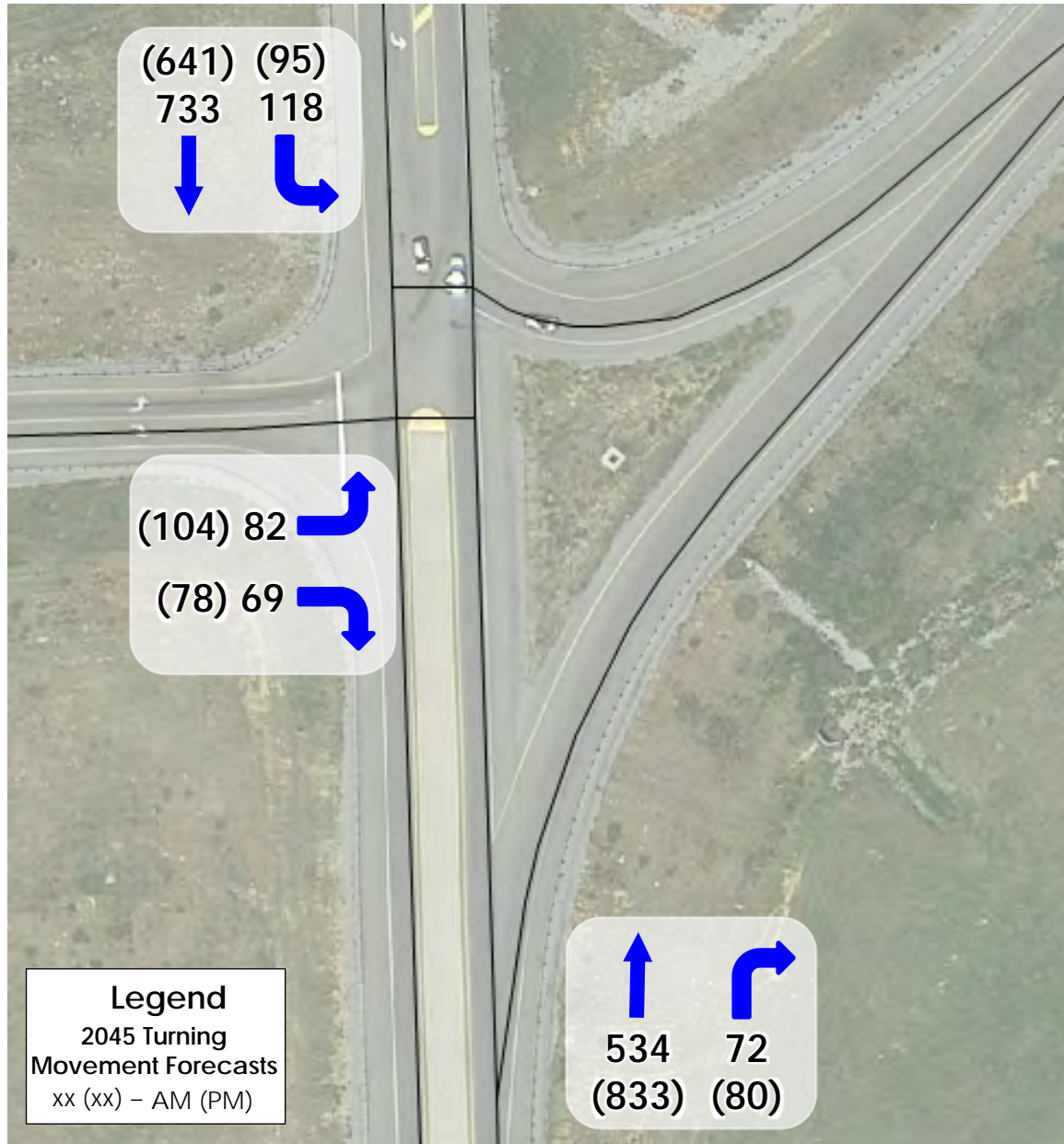


Legend
 2045 Turning
 Movement Forecasts
 xx (xx) – AM (PM)

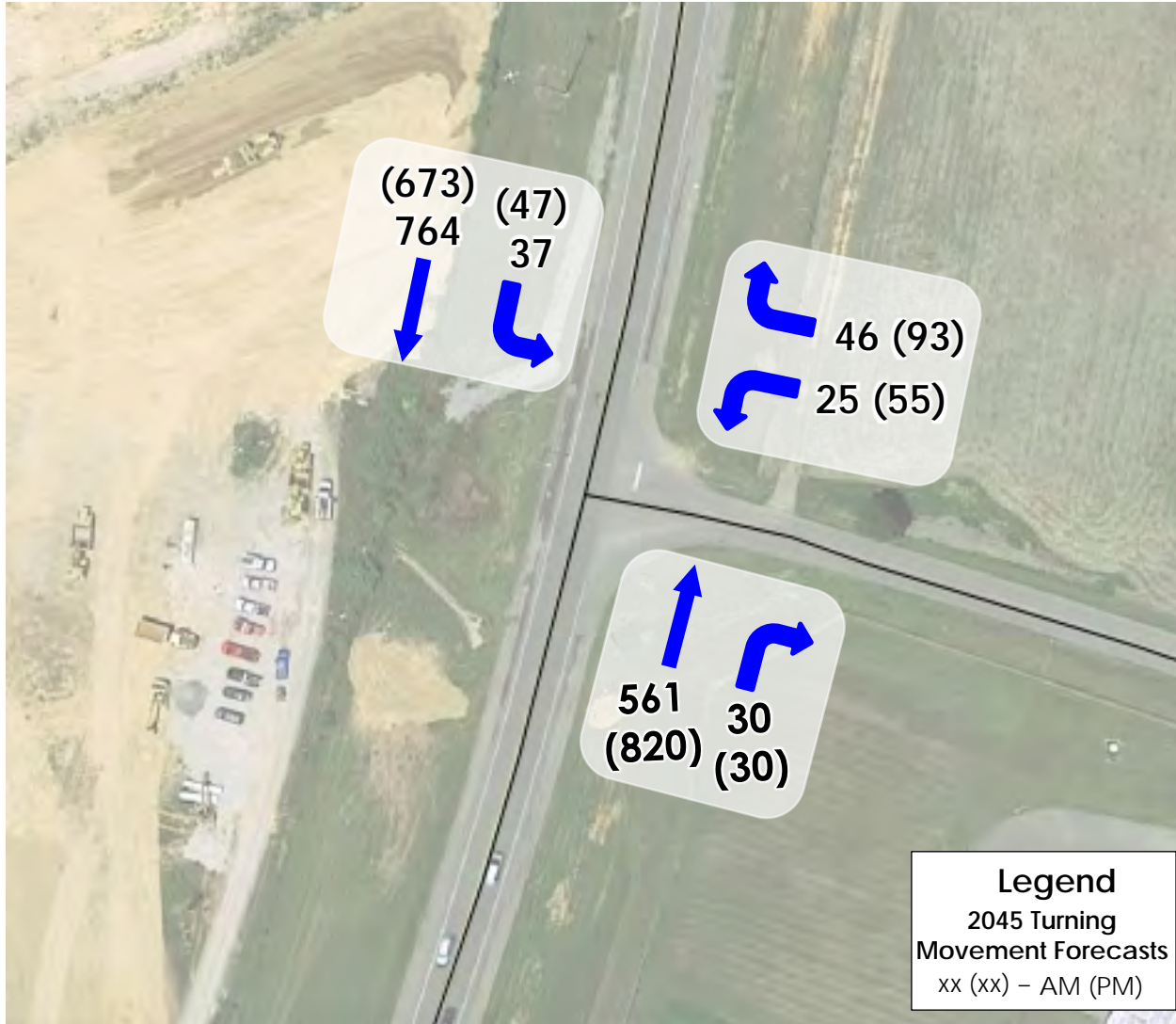
US 127 at WB Ramps



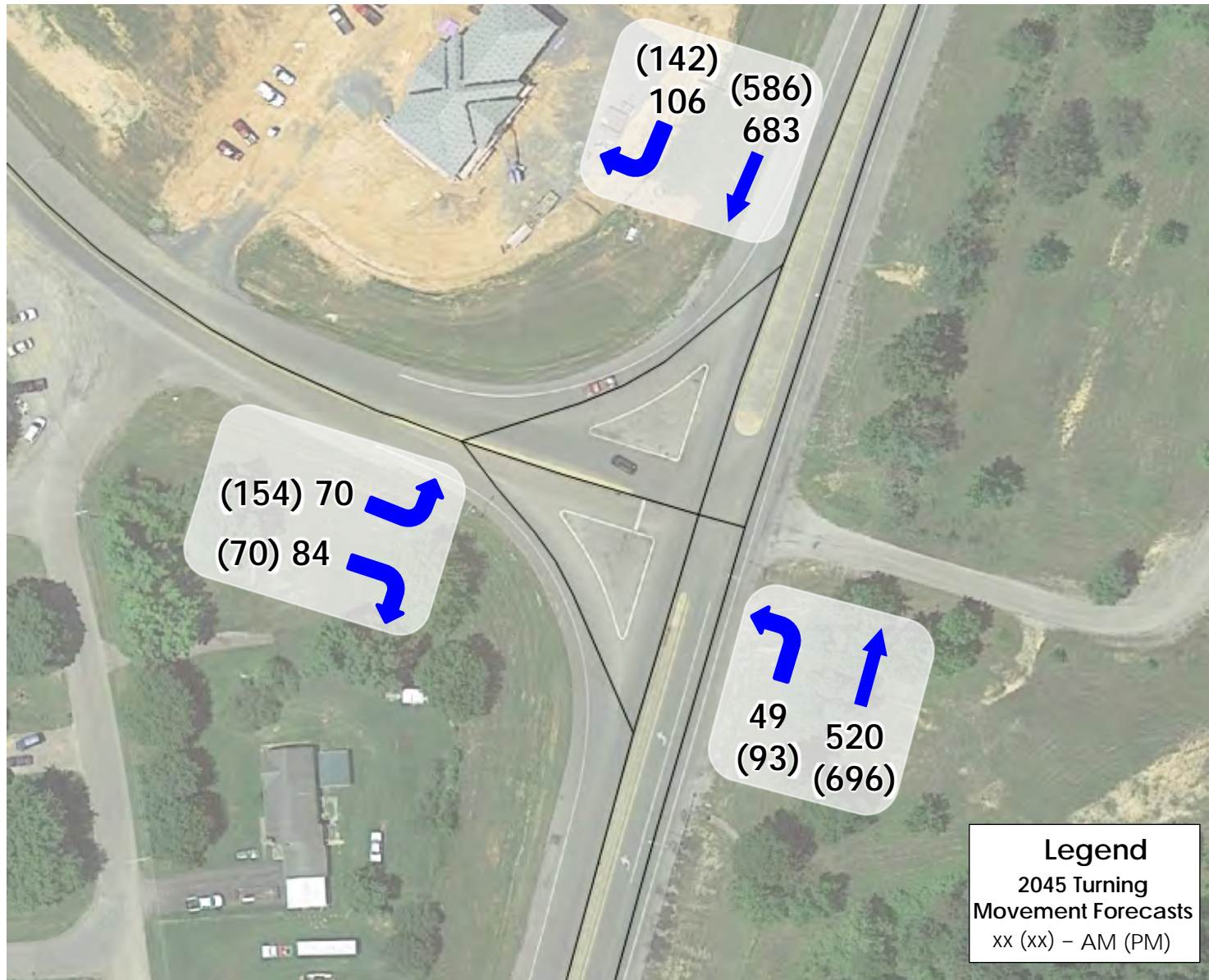
US 127 at EB Ramps



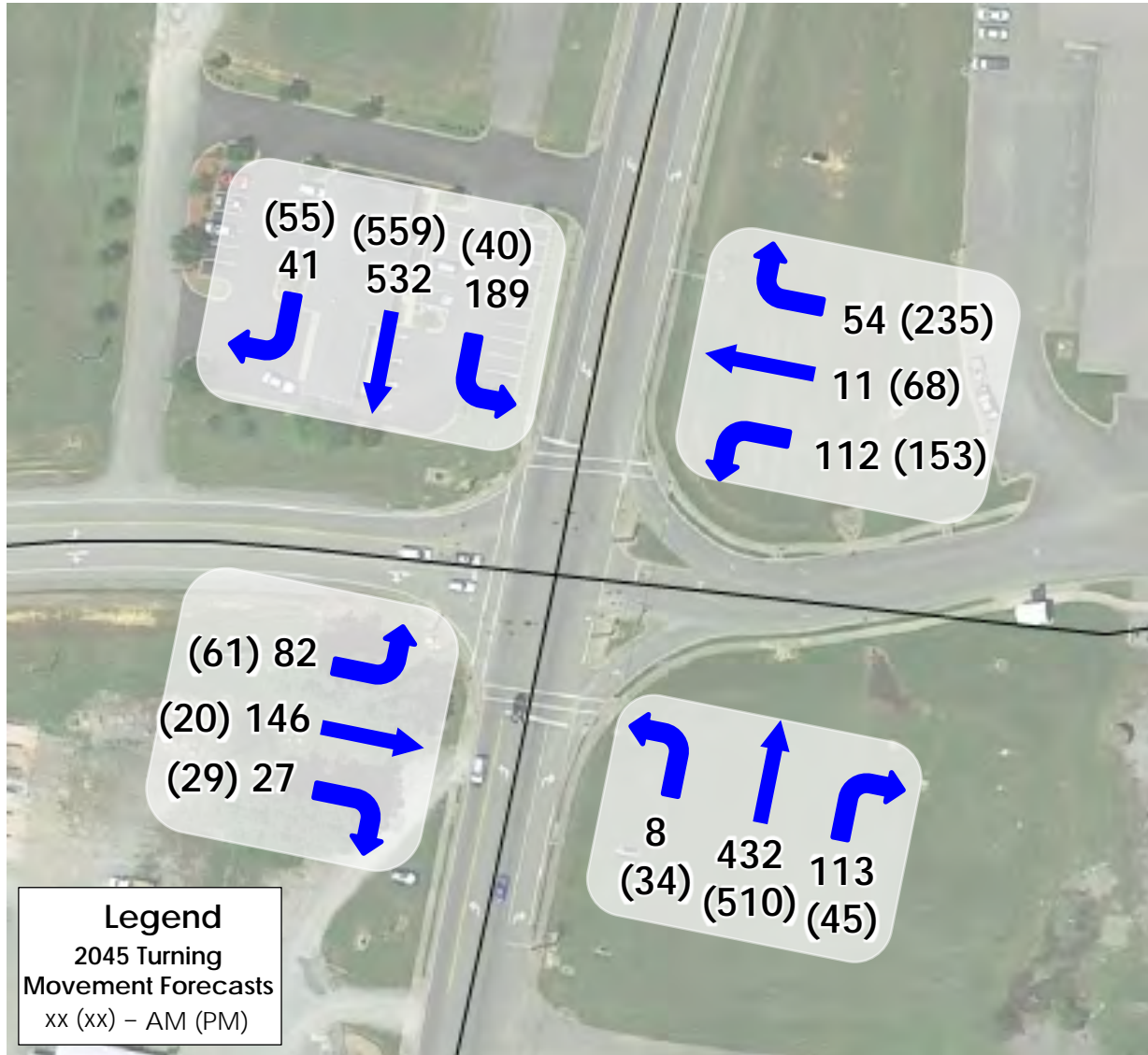
US 127 at Voils Rd.



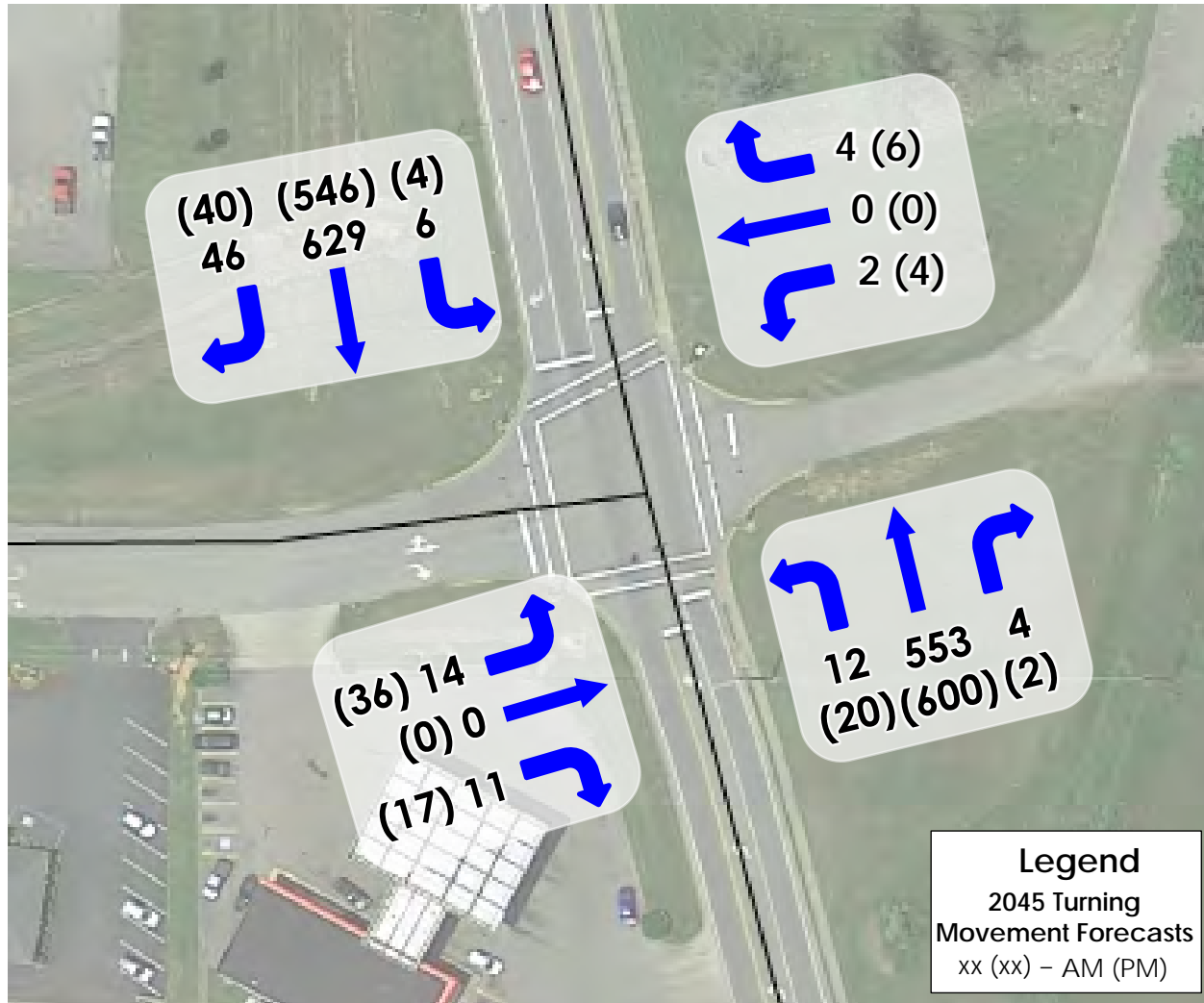
US 127 at Lake Way Dr.



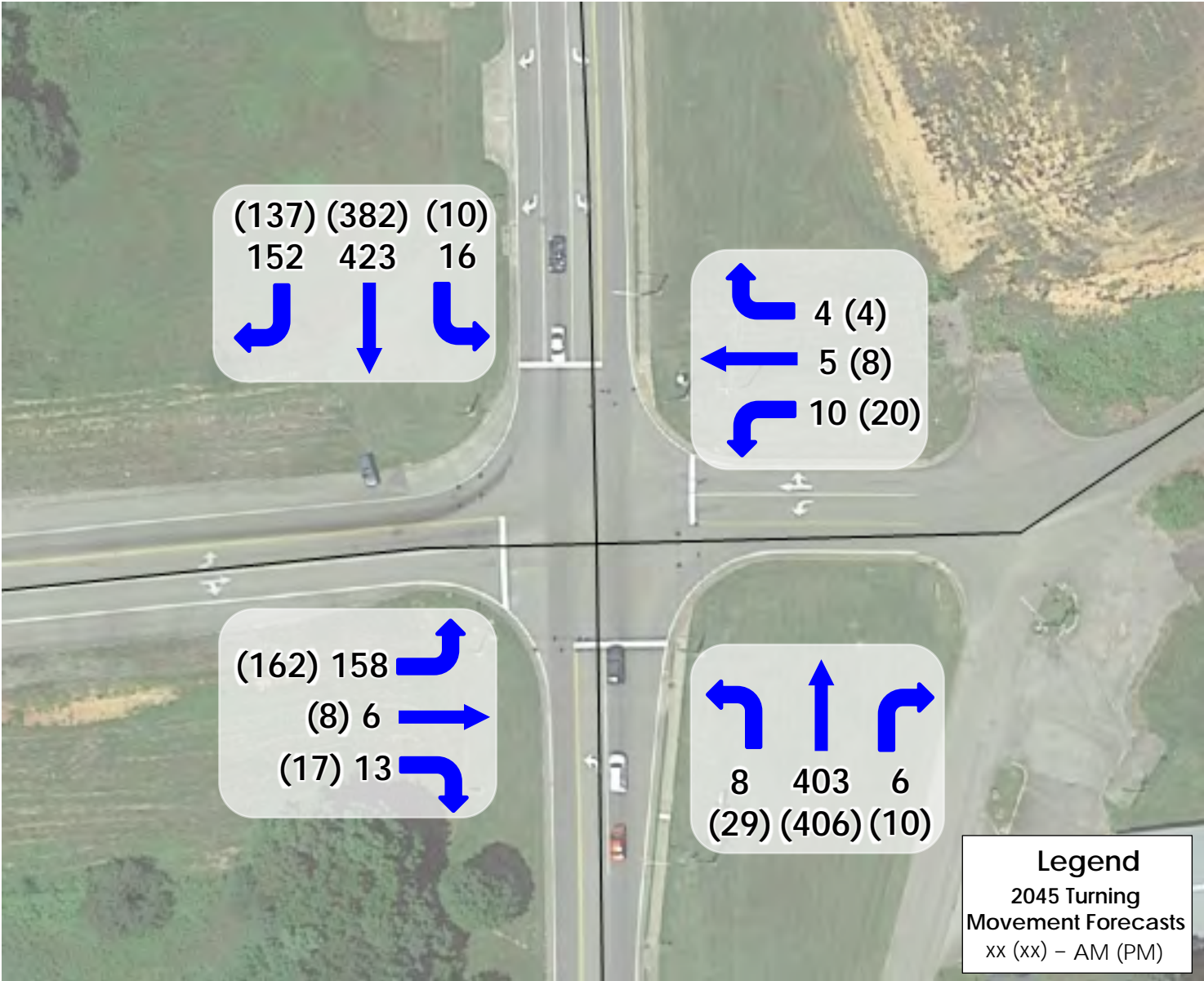
US 127 at French Valley Rd./Russell Co. Schools



US 127 at Fruit of the Loom



US 127 at US 127 Bypass



Legend
 2045 Turning
 Movement Forecasts
 xx (xx) - AM (PM)