

ALLERA RESIDENTIAL DEVELOPMENT

MO ROUTE 150 AND PRYOR ROAD LEE'S SUMMIT, MO

Prepared for:

Summit Homes

Lee's Summit, Missouri



October 2018

Olsson Project No. 018-2503



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1. INTRODUCTION AND OBJECTIVE

This report studies traffic impacts associated with a proposed residential development located in the southwest quadrant of the intersection of Missouri Route 150 (MO Route 150) and Pryor Road in Lee's Summit, Missouri. The objective of this study is to evaluate operations at study intersections for the scenarios detailed below. The report will review roadway conditions and consider potential impacts of the proposed development regarding turn lanes, storage bays, and intersection control methods. Study intersections include:

- MO Route 150 and Pryor Road
- Proposed Site Drives

The two scenarios that were analyzed as a part of this study are as follows:

- Existing Conditions
- Existing Plus Development Conditions

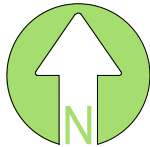
The approximate location of the proposed development is shown on the vicinity map in **Figure 1**.

City of Lee's Summit and Missouri Department of Transportation (MoDOT) staff provided guidance on study intersections and analysis periods to review. City staff indicated that there are no approved projects near the project area to consider in this traffic study.

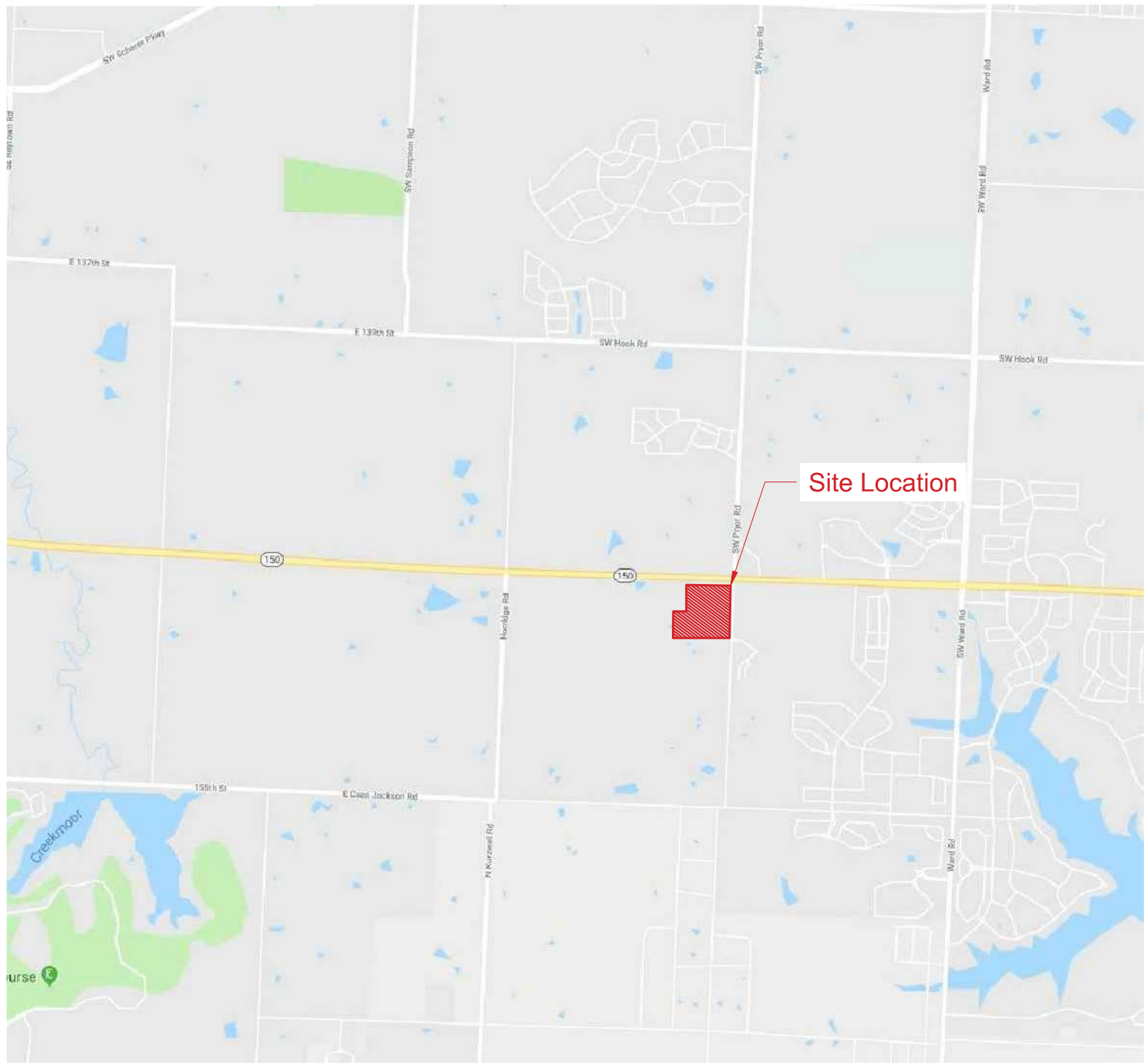
FIGURE 1

Vicinity Map

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— Site

Source: Google Maps

2. DATA COLLECTION

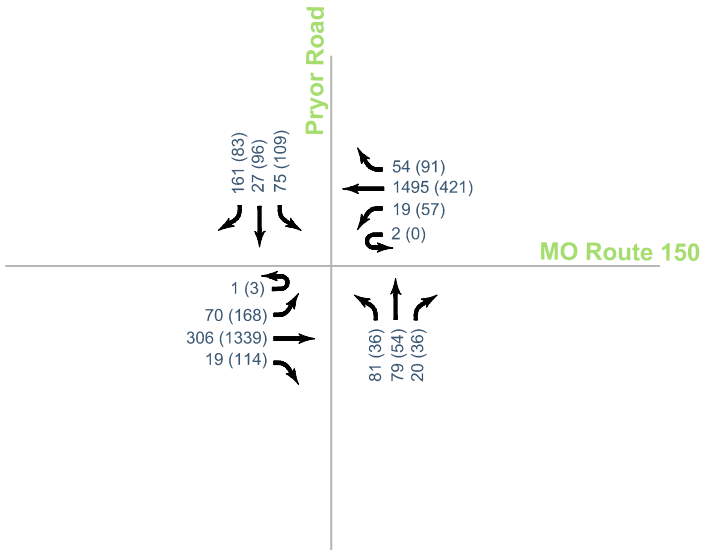
The data collection effort included acquiring AM and PM peak hour turning movement counts and documentation of current roadway geometrics. Intersection turning movement counts were conducted during the AM and PM peak hour periods on Thursday, August 16th, 2018 at the intersection of MO Route 150 and Pryor Road.

Based on the data collected, the peak hour periods for the study area were determined to be 7:00-8:00 AM and 5:00-6:00 PM. The existing peak hour volumes at the study intersections are illustrated in **Figure 2**. Count data collected for this study can be found in **Appendix A**.

Existing signal timing information for the signalized intersection of MO Route 150 and Pryor Road was provided by MoDOT.

FIGURE 2

Existing Conditions
Peak Hour Volumes
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AM (PM) Peak Hour Volume



3. EXISTING CONDITIONS

To provide a baseline for comparative purposes for the proposed development scenario, existing traffic operations were reviewed for the study intersections. This analysis considers existing conditions and does not include the consideration of any proposed development.

3.1. Network Characteristics

Two roadways within the study area were considered during analysis: MO Route 150 and Pryor Road. Current network characteristics are summarized in **Table 1** below. MO Route 150 is a roadway maintained by MoDOT. The functional classification for MO Route 150 was acquired from the MoDOT Functional Classification System Map. Pryor Road is a roadway maintained by the City of Lee's Summit. The functional classification for Pryor Road was acquired from the City of Lee's Summit, Missouri Existing Functional Classification Map. The intersection of MO Route 150 and Pryor Road is signalized and is maintained by MoDOT.

Table 1. Existing Network Summary

Roadway	Functional Classification	Section	Median Type	Posted Speed
MO Route 150	Other Principal Arterial	4-Lane	Raised	45 mph
Pryor Road	Major Arterial	2-Lane	n/a	45 mph north of MO Route 150; 35 mph south of MO Route 150

3.2. Existing Warrant Analysis

Existing Turn Lane Warrants: MoDOT's Access Management Guidelines, located in MoDOT Engineering Policy Guide (EPG) Section 940.9, were used to determine whether additional auxiliary turn lanes are currently warranted along MO Route 150 at the intersection with Pryor Road. Following the procedures outlined in the EPG, it was determined that the westbound right-turn movement at the intersection of MO Route 150 and Pryor Road warrants a right-turn lane based on existing AM and PM peak hour volumes. Capacity analysis will be reviewed to determine if a right-turn lane is necessary for this movement based on existing operations.

City of Lee's Summit Access Management Code guidelines were reviewed for turn lanes along Pryor Road at the intersection with MO Route 150. Northbound and southbound left-turn lanes are provided, meeting AMC guidelines; however, the turn bay lengths do not meet the recommended minimum turn bay length for an arterial intersecting an arterial.

Based on the AMC, a right-turn lane is required on major arterial streets with a right-turn movement of 30 vehicles in any hour. The southbound right-turn volume exceeds 30 vehicles during the AM and PM peak hour periods. A southbound right-turn lane is provided, although the length of the turn bay does not meet the recommended minimum length of 250 feet plus taper for an arterial intersecting another arterial.

Pryor Road south of MO Route 150 is a two-lane section and services a lower volume of vehicles. Based on review of the City of Lee's Summit Thoroughfare Master Plan, future capacity improvements are not planned. Based on the current and expected operations of Pryor Road south of MO Route 150, right-turn guidelines were reviewed considering Pryor Road as a minor arterial roadway. Based on the AMC, a right-turn lane is required on minor arterial streets with a right-turn volume of at least 60 vehicles in any hour. The northbound right-turn volume does not meet this criteria during the AM or PM peak hour periods. It should be noted that a northbound right-turn lane is currently provided, with a turn bay length of approximately 45 feet.

Existing conditions lane configurations and traffic control for the study network are illustrated in **Figure 3**. Turn lane warrant analysis sheets can be found in **Appendix B**.

3.3. Existing Capacity Analysis

Capacity analysis was performed for the study intersections utilizing the existing lane configurations and traffic control. Analysis was conducted using Synchro, Version 10, based on the Highway Capacity Manual (HCM) delay methodologies. In order to utilize the latest methodology, HCM 6th Edition, U-turn movements at the signalized intersection were coded as left-turn movements during analysis. Due to the low volume of U-turn movements at the study intersection, considering U-turn movements as a left-turn movement is expected to have minimal impact on results of capacity analysis. For simplicity, the amount of control delay is equated to a grade or Level of Service (LOS) based on thresholds of driver acceptance. The amount of delay is assigned a letter grade A through F, LOS A representing little or no delay and LOS F representing very high delay. **Table 2** shows the delays associated with each LOS grade for signalized and unsignalized intersections, respectively.

Table 2. Intersection LOS Criteria

Level-of-Service	Average Control Delay (seconds)	
	Signalized	Unsignalized
A	< 10	< 10
B	> 10-20	> 10-15
C	> 20-35	> 15-25
D	> 35-55	> 25-35
E	> 55-80	> 35-50
F	> 80	> 50
Highway Capacity Manual (HCM 6th Edition)		

The signalized study intersection of MO Route 150 and Pryor Road is operating at an overall LOS D and LOS C during both the AM and PM peak hour periods, respectively. All individual movements at the intersection are operating at a LOS D or better during the AM and PM peak hour periods except for the southbound right-turn movement, which operates at a LOS E during the AM peak hour.

A long 95th-percentile queue length was noted for westbound through traffic during the AM peak hour period and eastbound through traffic during the PM peak hour period. The 95th-percentile queue represents the queue length that has a 5 percent probability of being exceeded during the peak hour. A review of existing operations indicates that while longer queue lengths do occur during the AM and PM peak hour periods (directionally), the queues typically clear within one signal cycle length.

The existing capacity analysis summary is illustrated in **Figure 4**. Detailed results may be found in **Appendix B**.

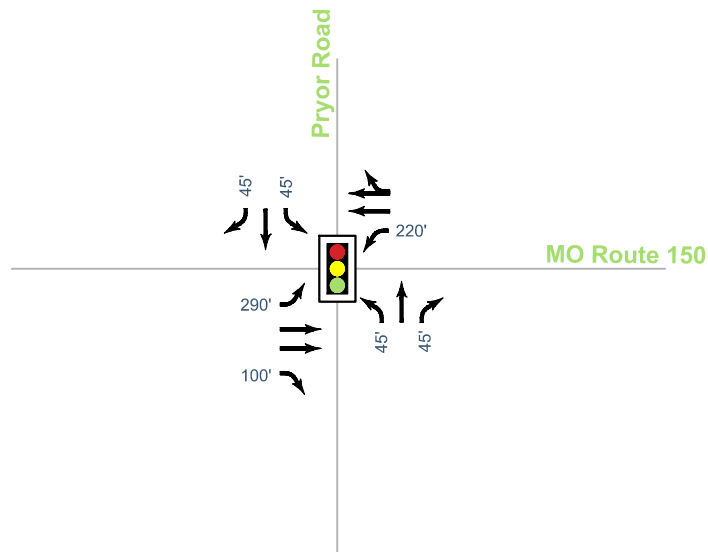
Existing operations were also reviewed to determine if a westbound right-turn lane, based on direction provided in the MoDOT EPG, should be provided at the intersection of MO Route 150 and Pryor Road. Level of service as well as 95th-percentile queue length were considered. While a westbound right-turn lane may improve operations and reduce delay for westbound right-turning traffic and westbound through traffic, construction of a westbound right-turn lane would impact an existing residential property in the northeast quadrant of the intersection. The addition of a westbound right-turn lane would also require relocation of an existing multi-use trail. To avoid impacting the existing properties driveway, only a short westbound right-turn lane could be provided. Considering the acceptable operations of the westbound movement and the

potential impact to existing residential property, it is not recommended to install a westbound right-turn lane at the intersection of MO Route 150 and Pryor Road at this time.

Existing operations were reviewed for the existing northbound and southbound left and right-turn movements. All movements are provided a dedicated turn bay; however, the turn bay lengths do not meet minimum guidelines set forth in the AMC. Reviewing existing operations, the northbound left-turn and southbound left-turn movements are exceeding available storage length for the respective turn movement. Additionally, the northbound and southbound through queues are extending beyond the provided turn bay during both the AM and PM peak hour periods.

FIGURE 3

Existing Conditions
Lane Configuration and Traffic Control
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xx' → Lane Configuration & Storage Length

 Signalized Intersection

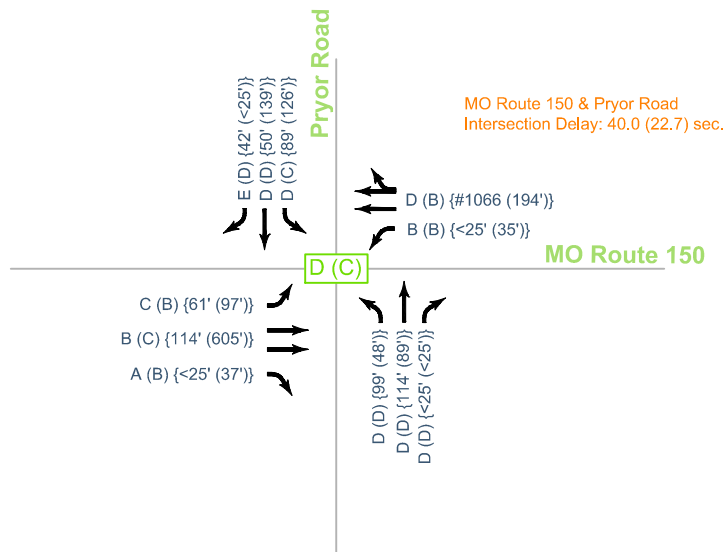


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FIGURE 4

Existing Conditions Capacity Analysis

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AM (PM) {AM (PM)} Movement LOS & {95th Percentile Queue}

AM (PM) Signalized Intersection LOS

→ Lane Geometry

95th Percentile Queue Exceeds Capacity



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4. SITE CHARACTERISTICS

The proposed residential development is located in the southwest quadrant of the intersection of MO Route 150 and Pryor Road. The proposed development consists of 160 single-family residential dwelling units. The site plan associated with this proposed development is illustrated in **Figure 5**.

Proposed Access Spacing

Access to the development is proposed via two new residential roadways. Access 1 is proposed as a right-in/right-out access along MO Route 150, located approximately 860 feet west of Pryor Road. Access 2 is proposed as a full access located along Pryor Road approximately 730 feet south of MO Route 150.

Existing signalized intersections along MO Route 150 are spaced approximately 1 mile apart. Limited access (right-in/right-out) intersections east of the site are spaced at approximately 600 feet from adjacent intersections. Full access unsignalized intersections east of the proposed site are spaced 1,400 to 1,800 feet apart. Intersection spacing is measured center to center of intersection.

Proposed access along MO Route 150 was reviewed in accordance with MoDOT EPG Section 940.5 'At Grade Intersection Spacing' and Section 940.15 'Spacing and Clearance for Right-in, Right-out Driveways'. MO Route 150 was considered a major, non-freeway roadway based on its location within a developing, suburban area. Based on guidance provided in the EPG Section 940.5, intersections along major, non-freeway roadways should be spaced at $\frac{1}{2}$ - 1 mile. Based on the proposed limited access of Access 1 (right-in/right-out), characteristics of this segment of MO Route 150, and the suburban/developing characteristics of the area, a reduction in this recommended spacing was considered. Access 1 is proposed 860 feet west of Pryor Road. This exceeds recommended right-in/right-out driveway spacing provided in Section 940.15 of the MoDOT EPG. While this access does not meet access spacing for a full intersection as recommended in the EPG, a reduction in spacing from $\frac{1}{2}$ - 1 mile was considered due to the limited movements of the access. Operations of the proposed roadway in relation to surrounding intersections will be considered.

Three curb cuts are currently provided along the segment of MO Route 150 where the development is proposed. Two curb cuts are not currently used, and one serves as access to residential property. These three curb cuts are proposed to be consolidated into one access point, providing access to the proposed development along MO Route 150.

The City of Lee's Summit Access Management Code (AMC) was referenced to evaluate the proposed Access 2 located along Pryor Road. Referencing Section 15.1, 'Connection Spacing Standards' of the AMC, connection spacing must be outside the intersection functional area of adjacent intersections and accommodate warranted or required turn lanes. Minimum recommended connection spacing is 660 feet along a major arterial roadway. Two intersections are adjacent to the proposed access location. The intersection of MO Route 150 with Pryor Road is located to the north, and the intersection of Pryor Road with Napa Valley is located to the south. Access 2 is outside the intersection functional area of both existing intersections and meets or exceeds the recommended minimum connection spacing.

Access Throat Length and Driveway Width

Throat length of an access point refers to the length of approach provided within the development site approaching the intersection with the public roadway. The proposed throat length for each development access point is provided in **Table 3**. Each access is proposed with one entering and one exiting lane of traffic.

Table 3. Proposed Access Characteristics

Proposed Access	Public Roadway Intersected	Access Type	Proposed Throat Length	Median Divided
Access 1	MO Route 150	Right-in/ Right-out	80 feet*	No
Access 2	Pryor Road	Full Access	180 feet**	Yes

*Throat length was measured from the intersection with MO Route 150 to the first residential property line.

**Throat length was measured from the intersection with Pryor Road to the first internal roadway. It is assumed access to the corner property will be provided via an internal roadway.

Accesses 1 and 2 are proposed as public, residential roadways which will be maintained by the City of Lee's Summit. The MoDOT EPG and City of Lee's Summit AMC were referenced for driveway geometric requirements for Access 1. Access 1 is anticipated to be maintained by the City of Lee's Summit, with the roadway associated with Access 1 intersecting a MoDOT route. Access 2 will be evaluated using only the City of Lee's Summit AMC due to the accesses location along a City maintained roadway.

Access 1: Both MoDOT and Lee's Summit driveway width criteria are based on projected peak hour and daily traffic volumes. Trip generation completed in **Section 4.1** of this report anticipates that Access 1 will service 68 vehicles during the highest peak hour period. Access 1 has a proposed driveway width of 28 feet, measured back of curb to back of curb. Referencing *Table 18-1* of the AMC and *Section 940.16.4* of the EPG, driveways servicing less than 150 vph during the peak hour period should have a driveway width of 28 feet to 42 feet for two-way access. Access 1 meets City and MoDOT standards.

Throat length standards for a proposed access is set forth by the City of Lee's Summit and MoDOT and is based on projected peak hour traffic volumes. Access 1 has a proposed driveway throat length of 80 feet. Referencing *Table 18-2* of the *AMC*, driveways servicing between 50 to 100 vph during the peak hour period should have a minimum driveway throat length of 100 feet adjacent to an arterial roadway. Access 1 does not meet City standards. Referencing *Section 940.16.8* of the MoDOT *EPG*, driveways servicing less than 150 vph during the peak hour period should have a minimum driveway throat length of 20 feet. Access 1 meets MoDOT standards. Capacity analysis will be reviewed to determine if adequate throat length is provided to accommodate expected vehicular queuing.

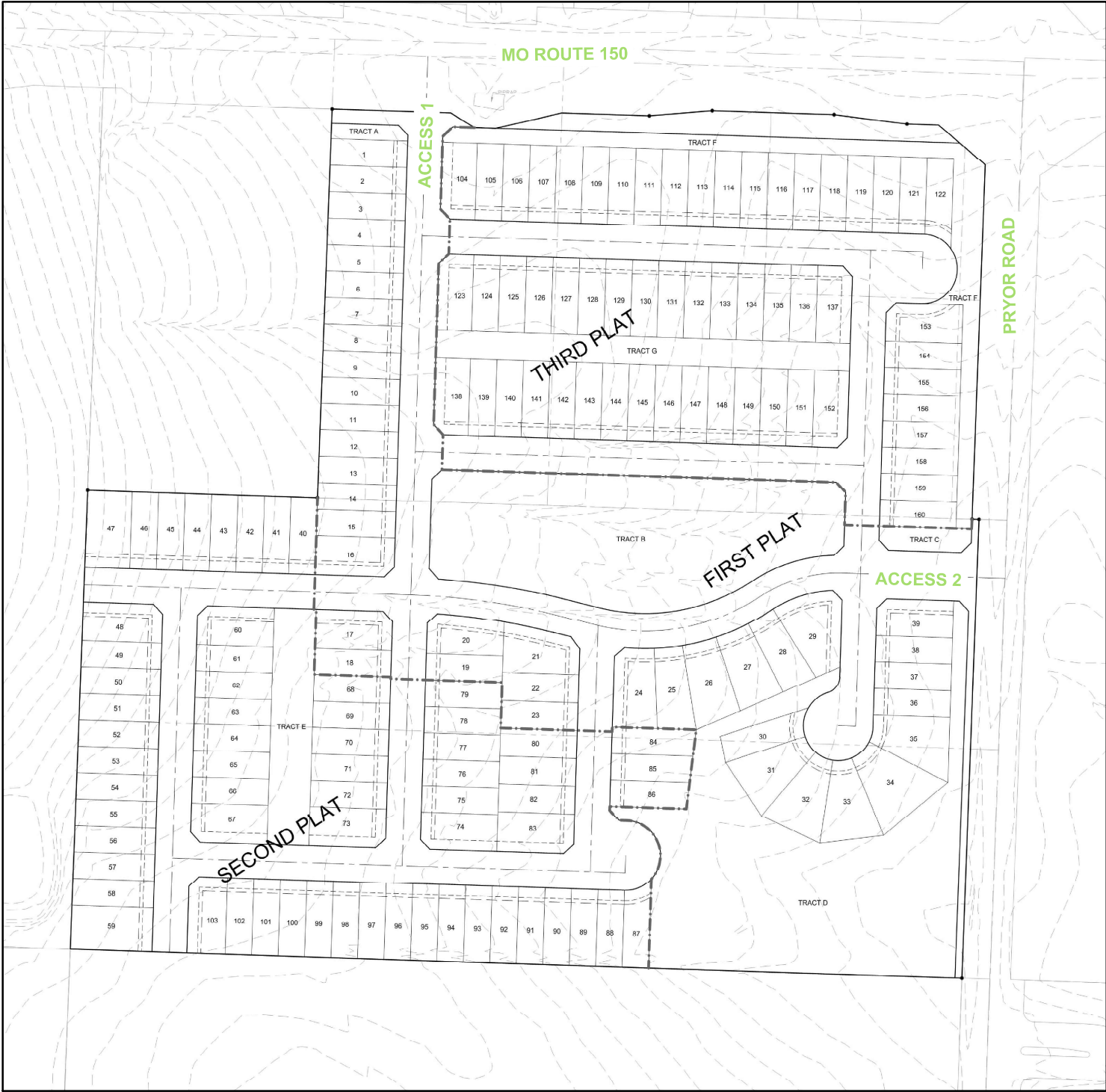
Access 2: City of Lee's Summit criteria were used to evaluate driveway width and throat length for Access 2. Access 2 is expected to service 93 vehicles during the highest peak hour period. Access 2 has a proposed driveway width of 48 feet (includes an 8-foot median), measured back of curb to back of curb. Access 2, including the median width, is wider than City standards.

Access 2 has a proposed driveway throat length of 180 feet. Access 2 meets the minimum recommended driveway throat length. Capacity analysis will be reviewed to determine if adequate throat length is provided to accommodate expected vehicular queuing.

To maintain the provided throat length at the roadway approach to MO Route 150 or Pryor Road, it is recommended to restrict parking within the provided throat length.

FIGURE 5

Site Plan
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4.1. Proposed Development Trip Generation and Distribution

To determine the impact of potential site traffic on the roadway network, expected trips associated with the proposed site were generated and applied to the study network. The Institute of Transportation Engineers (ITE) provides methods for estimating traffic volumes of common land uses in the Trip Generation Manual (10th Edition). The land use that most resembles that which is planned for this site is Land Use Code 210 (Single-Family Detached Housing).

Based on the ITE Trip Generation Manual, trip generation characteristics were developed for the proposed site. Trip generation characteristics expected for the site are shown in **Table 4**. Detailed ITE trip generation information can be found in **Appendix C**.

Table 4. Proposed Development Trip Generation

Land Use	Size	Average Weekday	AM Peak Hour			PM Peak Hour		
			Total	Enter	Exit	Total	Enter	Exit
Single-Family Detached Housing	160 DU	1,603	119	30	89	160	101	59

Trips were distributed based on the anticipated land use, discussions with City staff, as well as a review of existing traffic behavior within the study area. **Table 5** illustrates general trip distribution for the site.

Table 5. Proposed Development Trip Distribution

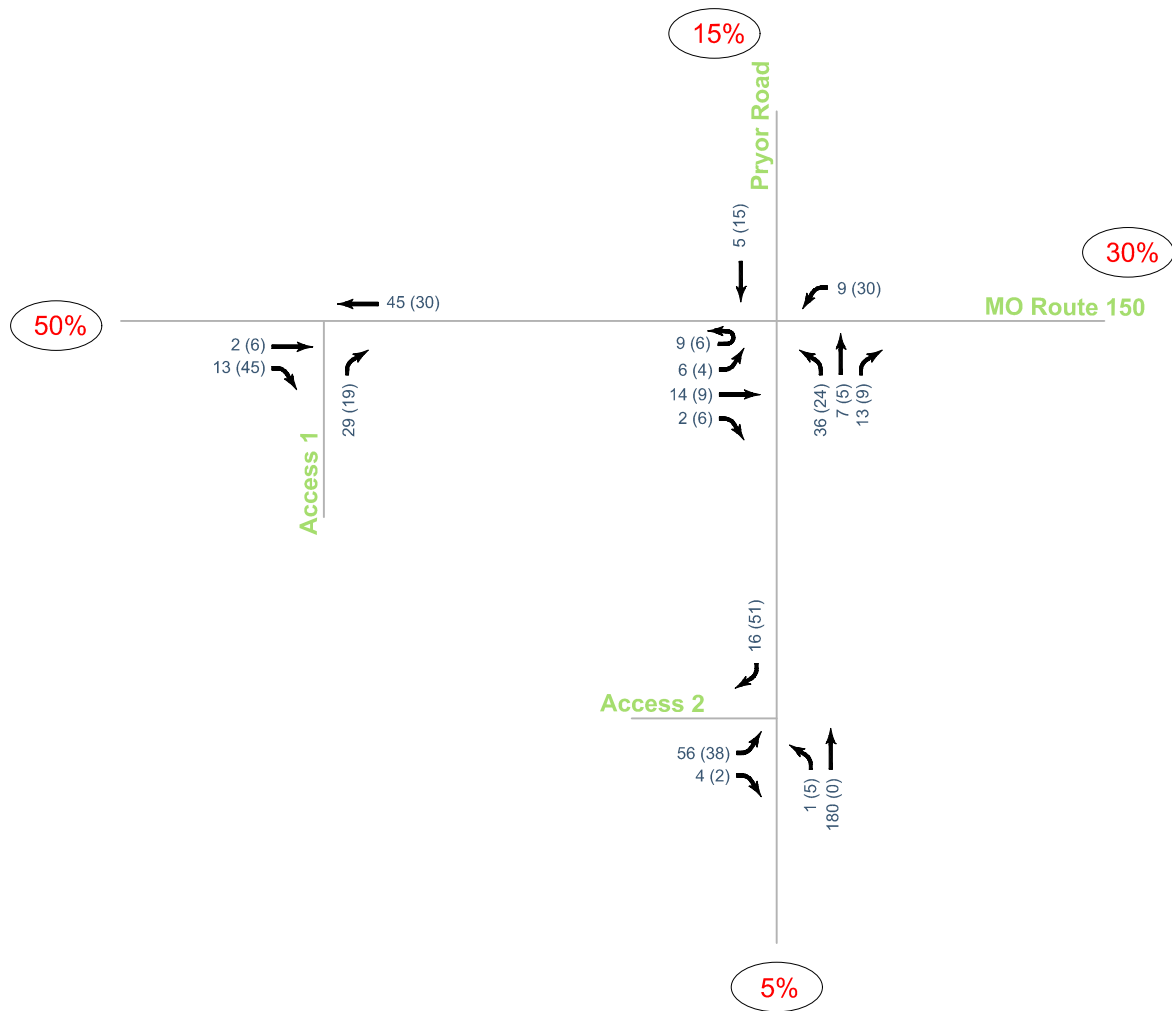
Route	Percent Distribution
Pryor Road (north)	15%
Pryor Road (south)	5%
MO Route 150 (west)	50%
MO Route 150 (east)	30%

The trip distribution for the proposed development is shown in **Figure 6**. Existing plus development volumes are illustrated in **Figure 7**.

FIGURE 6

Proposed Development Trip Distribution

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AM (PM) AM (PM) Peak Hour Development Trips

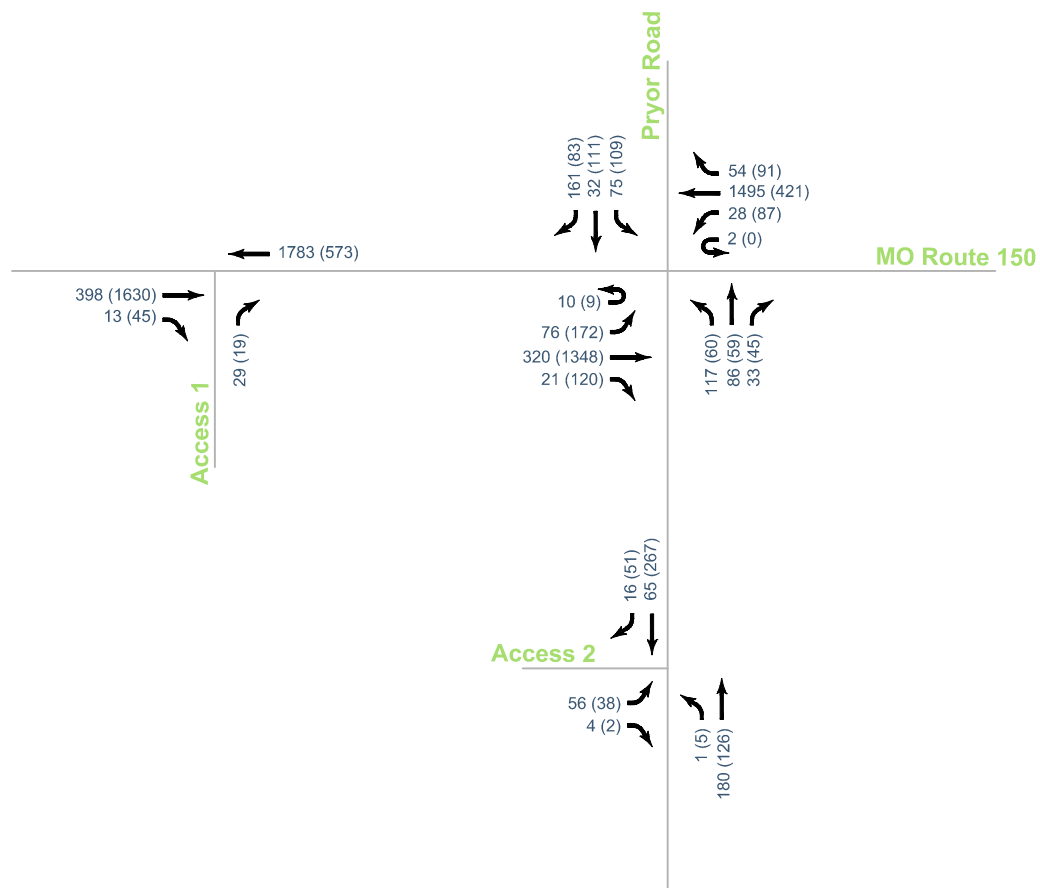
XX% To/From Trip Distribution Percentages



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FIGURE 7

Existing + Development
Conditions
Peak Hour Volumes
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Lee's Summit, MO



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AM (PM) Peak Hour Volume



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5. EXISTING PLUS DEVELOPMENT CONDITIONS

Traffic conditions were reviewed to identify any potential geometric improvements that could be attributed to additional traffic associated with the proposed development.

5.1. Existing plus Development Warrants

Existing plus Development Signal Warrants: A traffic signal may be justified if traffic conditions meet any of the applicable nine signal warrants described in the 2009 Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD provides criteria for conducting an engineering study to determine whether a traffic signal is appropriate at any intersection.

Considering existing plus development volumes, the intersection of Pryor Road and Access 2 is not expected to meet the criteria for signalization during either peak hour period based on Warrant 3 (peak hour warrant). Signal warrant analysis sheets can be found in **Appendix C**.

Existing plus Development Turn Lane Warrants: The MoDOT *EPG* was used to determine if turn lanes are required for Access 1. **Section 3.2** discussed the procedure used for evaluation of turn lanes. Following the procedures outlined in the *EPG*, an eastbound right-turn lane is warranted at the intersection of MO Route 150 and Access 1 during the PM peak hour period. It is recommended to provide an eastbound right-turn lane at this access location to remove turning traffic from the through lane. Based on MoDOT deceleration guidance, the right-turn lane should have a minimum storage of 150 feet plus taper.

The westbound right-turn movement at the intersection of MO Route 150 and Pryor Road warranted a right-turn lane under existing conditions. Capacity analysis will be reviewed to determine if a right-turn lane is necessary for this movement based on existing plus development operations.

The City of Lee's Summit *AMC* was used to determine if turn lanes may be required for Access 2. The *AMC* provides direction on when turn lanes should be provided based on intersection control, roadway classification and traffic volumes.

Left-Turn Lane: The Lee's Summit *AMC* was referenced in evaluating left-turn lane recommendations for the intersection of Pryor Road and Access 2. Based on the *AMC*, left-turn lanes should be provided on all major arterial streets at the intersection with a connector. Left-turn lanes should be provided on minor arterial streets intersecting an arterial or collector roadway. At other connector locations along a minor arterial, left-turn volume is considered when determining if a left-turn lane should be provided. As stated in **Section 3.1**, Pryor Road is currently classified as a Major Arterial. However, based on the current traffic volumes of Pryor Road (south of MO Route 150) and the provided roadway surface (two-lane roadway), this segment of Pryor Road was evaluated using turn lane criteria for a minor arterial. Referencing

these criteria, a left-turn lane is required on minor arterial streets at the intersection with a local street when the left-turn volume is at least 20 vehicles in any hour. Based on the low volume of traffic expected to access the development from the south, a northbound left-turn lane is not recommended at Access 2. Referencing the City of Lee's Summit *Thoroughfare Plan*, the segment of Pryor Road south of MO Route 150 is expected to operate at acceptable levels of service in the future and planned capacity improvements are not noted. If growth occurs along this segment of roadway and capacity improvements are made, at that time a re-evaluation of providing a northbound left-turn lane at Access 2 may be appropriate.

Right-Turn Lane: The Lee's Summit *AMC* was referenced in evaluating right-turn lane recommendations for the intersection of Pryor Road and Access 2. Based on the *AMC*, right-turn lanes are required on all major arterial streets at an intersecting street when the right-turn volume is at least 30 vehicles in any hour. For a minor arterial roadway, a right-turn lane is required when the right-turn volume is at least 60 vehicles in any hour. As with the left-turn lane analysis, this segment of Pryor Road was evaluated using minor arterial criteria due to the low volume of vehicular traffic along the roadway and the two-lane roadway section. The highest expected right-turn volume is during the PM peak hour period, in which 51 southbound right-turning vehicles are expected. Considering the roadway volume, roadway conditions, and posted speed limit of 35 mph, a southbound right-turn lane is not recommended at Access 2. As discussed previously for the left-turn lane, this segment of Pryor Road is expected to operate at acceptable levels of service in the future and planned capacity improvements are not noted. If growth occurs along this segment of roadway and capacity improvements are made, at that time a re-evaluation of providing a southbound right-turn lane at Access 2 may be appropriate.

Existing plus development conditions lane configurations and traffic control for the study network are illustrated in **Figure 8**.

5.2. Existing plus Development Capacity Analysis

Capacity analysis was performed for existing plus development conditions using the methodologies described previously. Results of the capacity analysis indicate similar operations to existing conditions. The overall signalized study intersection and associated individual movements are expected to operate at LOS D or better during both the AM and PM peak hour periods. As with existing conditions, long 95th-percentile queue lengths are expected for eastbound and westbound traffic during the peak hour periods. Development traffic is not expected to significantly impact the queue length or operations of the intersection. As with existing conditions, the eastbound and westbound through movement queues would be expected to typically clear within one signal cycle.

Expected 95th-percentile queue lengths at Access 1 and Access 2 are not expected to exceed the provided throat length.

As discussed in **Section 3.3**, the northbound left-turn movement exceeds available turn bay storage considering existing traffic volumes. With the proposed development traffic, the northbound left-turn movement 95th-percentile queue at the intersection of MO Route 150 and Pryor Road is expected to increase by approximately 1.5 vehicles during the AM peak hour period and 1 vehicle during the PM peak hour period. To accommodate the expected queue after development, the northbound left-turn lane is recommended to be extended 105 feet to provide a total turn bay length of 150 feet plus taper. While the recommended turn bay length does not meet the required length as detailed in the *AMC*, the turn bay length is adequate to accommodate expected traffic volumes for existing plus development conditions. Referencing the *Thoroughfare Master Plan*, minimal traffic growth is expected along this segment of the corridor in the future.

As discussed in **Section 3.3**, the southbound left-turn movement is exceeding available turn bay storage considering existing traffic volumes. Additionally, the southbound and northbound right-turn lanes will be blocked during a portion of the peak hour period by the through movement queue, although the 95th-percentile queue for the right-turn movements is contained within the provided storage. With the addition of development traffic to the roadway network, slight increases in vehicular queuing for the movements are expected. The expected impact to the movements is minimal considering the low volume of trips expected to be added to the roadway network due to the proposed development.

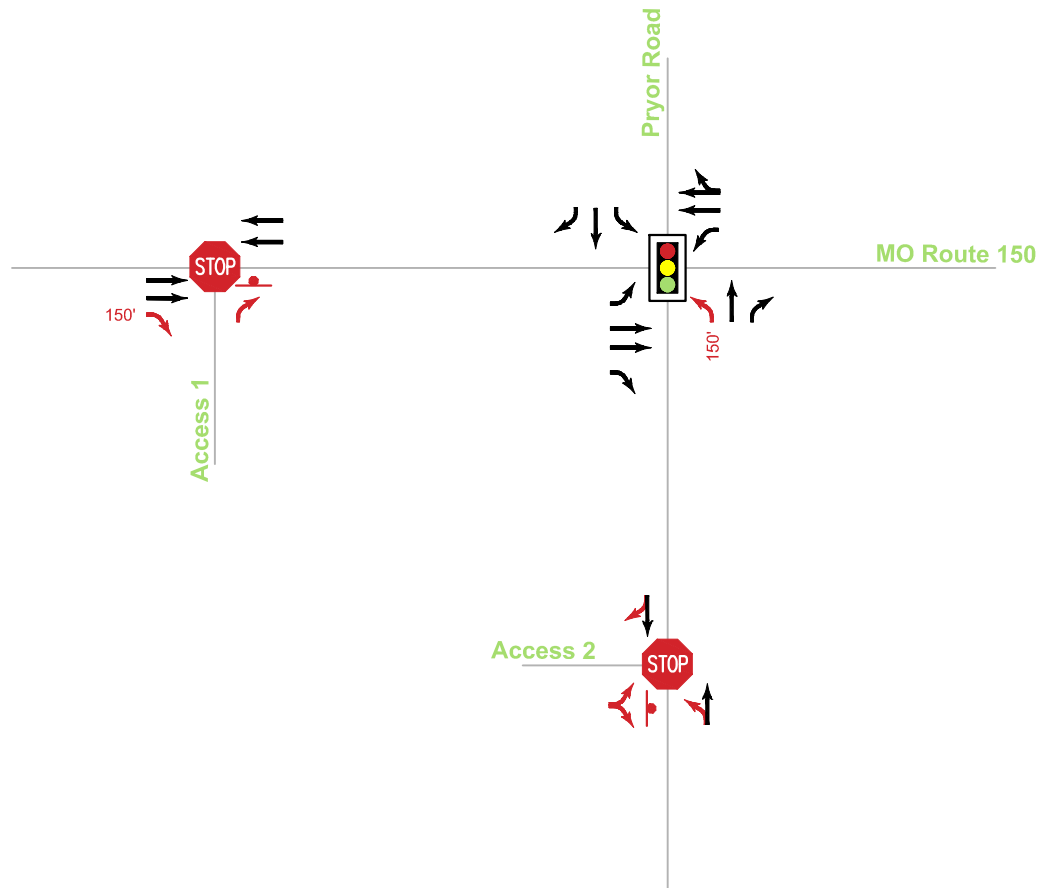
The existing plus development capacity analysis summary is illustrated in **Figure 9**. Detailed results may be found in **Appendix C**.

As discussed previously, a westbound right-turn lane is warranted at the intersection of MO Route 150 and Pryor Road based on existing conditions. Reviewing expected operations for this intersection based on existing plus development conditions, operations are expected to be similar to the existing conditions. Considering the acceptable operations of the westbound movement and the potential impact to existing residential property, it is not recommended to install a westbound right-turn lane at the intersection of MO Route 150 and Pryor Road.

FIGURE 8

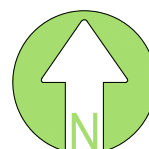
Existing + Development Conditions Lane Configuration and Traffic Control

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Lee's Summit, MO



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- Lane Configuration
- Proposed Lane Configuration & Storage Length
- Stop Controlled Intersection
- Stop Sign
- Signalized Intersection



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6. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to summarize the traffic impacts regarding a proposed residential development located in the southwest quadrant of the intersection of MO Route 150 and Pryor Road in Lee's Summit, Missouri. Based on this evaluation, the following conclusions and recommendations are made for the study area.

6.1. Conclusions

The general findings of this traffic impact study are summarized as:

1. In general, traffic operations after development of the proposed site are expected to be acceptable and be similar to existing conditions.
2. A westbound right-turn lane is warranted at the intersection of MO Route 150 and Pryor Road based on MoDOT EPG criteria under existing conditions. Due to acceptable operations and the impact construction of a right-turn lane would have on existing residential property and an existing multi-use trail, it is not recommended to install a westbound right-turn lane at the intersection.
3. Access 1 meets MoDOT recommended minimum throat length (20 feet) but does not meet City of Lee's Summit recommended minimum throat length (100 feet). Based on capacity analysis, adequate throat is provided (80 feet) to accommodate queuing associated with the northbound movement.
4. Due to the low volume of traffic serviced along this segment of Pryor Road and the two-lane roadway section, turn lanes are not recommended at the intersection of Pryor Road and Access 2. Referencing the City of Lee's Summit Thoroughfare Master Plan, capacity improvements to the roadway segment are not anticipated in the future. If the roadway is improved, at that time consideration may be given to providing a southbound right-turn lane and northbound left-turn lane at Access 2.

6.2. Recommendations

Given the review of information, list of conclusions and intersection specific capacity analysis, the following items are recommended for the study area:

1. An eastbound right-turn lane with a storage length of 150 feet plus taper is recommended at the intersection of MO Route 150 and Access 1.
2. It is recommended to provide 'No Parking' signage along the throat lengths of Access 1 and Access 2 to protect the approach to the intersection.
3. Extend the existing northbound left-turn lane at the intersection of MO Route 150 and Pryor Road 105 feet to provide a total storage length of 150 feet plus taper.

APPENDIX A

Data Collection