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April 11, 2017

Mr. David A. Rinne, P.S.
Schlagel & Associates, P.A.
14920 W. 107th Street
Lenexa, Kansas 66215

**RE: Bowlin Road and Lakewood Way Traffic Impact Study
Lee's Summit, Missouri**

Dear Mr. Rinne:

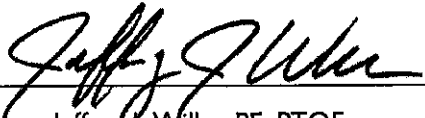
In response to your request and authorization, TranSystems has completed a traffic impact study for the proposed development to be located generally south and east of the Bowlin Road and Lakewood Way intersection in Lee's Summit, Missouri. The purpose of this study was to assess the impact of the proposed development on the surrounding transportation system.

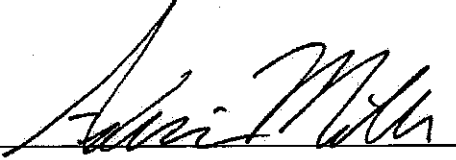
Included in this study is a discussion of the anticipated impacts of the proposed development on the adjacent street network for the following scenarios:

- ▶ Existing Conditions
- ▶ Existing plus Approved Development Conditions
- ▶ Existing plus Approved plus Proposed Development Conditions

We trust that the enclosed information proves beneficial to you and the City of Lee's Summit in this phase of the development process. We appreciate the opportunity to be of service to you and will be available to review this study at your convenience.

Sincerely,
TRANSYSTEMS

By: 
Jeffrey J. Wilke, PE, PTOE

By: 
Addison Miller, EIT

ARM:jjw/am/PI01170087
Enclosure

Enclosure

Introduction

TranSystems has completed a traffic impact study for the proposed development to be located generally south and east of the Bowlin Road and Lakewood Way intersection in Lee's Summit, Missouri. The purpose of this study was to assess the impact of the proposed development on the surrounding transportation system. The location of the development site relative to the major streets in the area is shown on *Figure A-1* in *Appendix A*. This study also contains a description of the proposed development and the surrounding transportation infrastructure along with trip generation estimates, trip distribution estimates, capacity analyses, and a summary of the findings.

Proposed Development Plan

The proposed development includes 10,000 square feet of office land uses and a 300 unit apartment complex. Access for the development will be provided from Jamestown Drive, which will be a new residential collector type street aligned somewhat diagonally through the site from southeast to northwest. At the south, the new street will connect through the Monticello development to other residential neighborhoods. At the north end, Jamestown Drive will intersect Bowlin Road approximately 500 feet east of Lakewood Way and 250 feet west of Campground Road. A copy of the proposed site plan showing the access points and the alignment of Jamestown Drive is included on *Figure A-2* in *Appendix A* for reference.

Study Area

To assess the impacts of the proposed development, the intersections listed below were identified for study during the A.M. and P.M. periods.

- ▶ Bowlin Road and I-470 Southbound Ramps
- ▶ Bowlin Road and I-470 Northbound Ramps
- ▶ Bowlin Road and Lakewood Way

Surrounding Land Uses and Street Network

The development site currently consists of undeveloped land used for agricultural purposes. There are several different land uses surrounding the site. To the north and east of the site the adjacent land is undeveloped. Much of this land is owned by the Corps of Engineers in the vicinity of Blue Springs Lake. To the south of the site are several existing neighborhoods of single-family homes as well as the Monticello development. To the west of the site are several small office buildings, which are accessed from Lakewood Way.

The existing alignment of Bowlin Road runs along the north and east sides of the development site. The north/south segment of Bowlin Road on the east side of the site is to be removed when Jamestown Drive is constructed. The east/west segment of Bowlin Road is a two-lane minor arterial street with a 22-foot asphalt surface with turf slopes to ditches. The posted speed limit is 35 m.p.h. West of the site, at the Lakewood Way intersection, Bowlin Road widens to include an eastbound left-turn lane. Bowlin Road is a four-lane undivided street with curbs and gutters and some turn lanes at intersections west of

Lakewood Way. West of I-470, the street name changes from Bowlin Road to Lakewood Boulevard.

The I-470 southbound exit ramp is a single 18-foot wide lane with paved shoulders on each side. Drivers utilize the ramp as two-lanes. At the Bowlin Road intersection, the southbound left-turn movement is stop sign controlled and the right-turn movement is channelized and controlled with a yield sign. The northbound I-470 exit ramp measures 28 feet between edge lines with paved shoulders on each side. The ramp has separate left-turn and right-turn lanes at the intersection with Bowlin Road.

Lakewood Way serves as a frontage road along the east side of I-470. It is classified as a commercial/industrial collector with a posted speed limit of 45 m.p.h. At the Bowlin Road intersection, Lakewood Way is three lanes with a raised median and curbs and gutters on both the north and south side. The northbound lanes are a shared right-through lane and left-turn lane. The southbound lanes are a right-turn lane and a shared left-through lane.

Traffic signals control the Bowlin Road and I-470 northbound ramps intersection and the Bowlin Road and Lakewood Way intersection. While not a study intersection for the purposes of this study, there is also a traffic signal on Bowlin Road/Lakewood Boulevard at Anderson Drive, which is approximately 350 feet west of the I-470 southbound ramps.

Traffic Counts

Turning-movement traffic volume counts were collected at the study intersections on Wednesday, March 8, 2017; Thursday, March 9, 2017 and Tuesday, March 14, 2017. The turning movement counts were collected at each intersection from 7:00 to 9:00 A.M. and from 4:00 to 6:00 P.M. The A.M. peak hour for all intersections occurred between 7:15 and 8:15 A.M., while the P.M. peak hour occurred between 5:00 and 6:00 P.M. The existing lane configurations, traffic control devices, and peak hour traffic volumes have been illustrated on **Figure A-3**.

Approved Development

The Monticello residential development was approved in 2015. It is currently under construction immediately to the south of the proposed development site. Monticello includes 160 lots for single-family homes. A traffic impact study was prepared for this development by TranSystems in 2015. Since this approved development will add traffic to the study intersections when completed, the development trips from Monticello are included in the analysis of for several of the study scenarios.

Analysis

The scope of analysis for the assessment of the proposed development's impact on the surrounding transportation system is based in large part on the recommended practices of the Institute of Transportation Engineers (ITE), as outlined in their Traffic Engineering Handbook. ITE is a nationally-recognized organization of transportation professionals with members from both private and public sectors. The analysis of the proposed development's impact included development of trip generation and trip distribution estimates as well as a traffic operations assessment for each study scenario. Each of the analysis methodologies and findings are described in the subsequent sections.

Trip Generation

Trip generation estimates were prepared using the Institute of Transportation Engineer's Trip Generation, 9th Edition. **Table 1** shows the expected trips to be generated by the proposed development.

Land Use	Intensity	ITE Code	Average Weekday	A.M. Peak Hour			P.M. Peak Hour		
				Total	In	Out	Total	In	Out
Apartments	300 du	220	1,942	151	31	120	183	119	64
General Office Building	10,000 sf	710	111	16	15	1	15	3	12
Total New Development Trips			2,053	167	46	121	198	122	76

Trip Distribution

The estimated trips generated by the proposed development were distributed onto the street system based on the trip distributions summarized in **Table 2**. These distributions are based on existing traffic patterns and engineering judgment. The detailed distribution patterns through the study intersections are shown in **Appendix B**.

Direction To/From	Percentage
West on Bowlin Road/Lakewood Blvd.	10%
South on I-470	25%
North on I-470	35%
South on Lakewood Way	15%
North on Lakewood Way	15%
Total	100%

Traffic Operation Assessment

An assessment of traffic operations was made for the scenarios listed below. These scenarios allowed for comparison of the before and after impacts of the proposed development on the street network.

- ▶ Existing Conditions
- ▶ Existing plus Approved Development Conditions
- ▶ Existing plus Approved plus Proposed Development Conditions

The study intersections were evaluated using the Synchro traffic analysis software package. Calculations were performed based on the methodologies outlined in the Highway Capacity Manual (HCM), 2000 Edition, which is published by the Transportation Research Board. The operating conditions at an intersection are graded by the "level of service" experienced by drivers. Level of service (LOS) describes the quality of traffic operating conditions and is rated from "A" to "F". LOS A represents the least congested condition with free-flow movement of traffic and minimal delays. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in the average delay per stopped vehicle. Delay is measured in seconds per vehicle. **Table 3** shows the upper limit of delay associated with each level of service for signalized and unsignalized intersections.

Level of Service (LOS)	Signalized	Unsignalized
A	≤ 10 Seconds	≤ 10 Seconds
B	≤ 20 Seconds	≤ 15 Seconds
C	≤ 35 Seconds	≤ 25 Seconds
D	≤ 55 Seconds	≤ 35 Seconds
E	≤ 80 Seconds	≤ 50 Seconds
F	> 80 Seconds	> 50 Seconds

While LOS measurements apply to both signalized and unsignalized intersections, there are significant differences between how these intersections operate and how they are evaluated. LOS for signalized intersections reflects the operation of the intersection as a whole.

Unsignalized intersections, in contrast, are evaluated based on the movement groupings which are required to yield to other traffic. Typically, these are the left turns off of the major street and the side-street approaches for two-way stop-controlled intersections. At unsignalized intersections lower LOS ratings (D, E and F) do not, in themselves, indicate the need for additional improvements. Many times there are convenient alternative paths to avoid the longer delays. Other times the volumes on the unsignalized approaches are relatively minor when compared to the major street traffic, and traffic signal installation may increase the average delay to all users of the intersection.

The LOS rating deemed acceptable varies by community, facility type and traffic control device. In Lee's Summit, LOS C has been identified as the minimum desirable goal for signalized intersections. At unsignalized intersections LOS C and above are often accepted for low to moderate traffic volumes where the installation of a traffic signal is not warranted by the conditions at the intersection or location has been deemed undesirable for signalization for other reasons, e.g. the close proximity of an existing traffic signal or the presence of a convenient alternative path.

Existing Conditions

The results of the Existing Conditions intersection analyses are summarized in **Table 4**. The study intersections were evaluated with the lane configurations, traffic volumes, and traffic control devices shown on **Figure A-3**. The Synchro output files are included in **Appendix C**.

Intersection	Movement	A.M. Peak Hour		P.M. Peak Hour	
		LOS ¹	Delay ²	LOS ¹	Delay ²
Bowlin Road and I-470 SB Ramps					
	Westbound Left-Turn	B	10.7	B	11.1
	Southbound Right-Turn	B	10.4	C	21.6
	Southbound Left-Turn	F	>100	F	>100
Bowlin Road and I-470 NB Ramps					
	Traffic Signal	B	10.7	B	16.1
Bowlin Road and Lakewood Way					
	Traffic Signal	C	23.7	C	27.6

1 – Level of Service

2 – Delay in seconds per vehicle

As shown in the table, most movements at the study intersections currently operate within acceptable levels of service during the peak hours. The one exception is the southbound left-turn movement at the Bowlin Road and I-470 southbound ramps. The analysis indicates that this movement operates at LOS F during both peak hours. Due to lengthy delays, a stop delay study was performed for this movement to compare the analysis results to actual conditions. The study was performed during the P.M. peak hour (5:00 to 6:00 P.M.) on March 21, 2017. The results of the delay study are shown in **Table 5**.

Time Period	Movement	Average Delay per Vehicle	Average Queue	Maximum Queue
P.M. Peak Hour	Southbound Left-Turn	24.4 seconds	2 Vehicles	7 Vehicles

Based on the results of the stop delay study, the southbound left-turn movement at the Bowlin Road and I-470 southbound ramps intersection currently operates with an average stop delay of 24.4 seconds per vehicle which corresponds to LOS C conditions.

Several factors could explain the difference between the analysis results and observed conditions. One factor is the close proximity of the signalized Anderson Drive intersection to the west, which creates gaps and platoons in the flow of traffic that are not accounted for in the Synchro analysis. Another factor is the gap time that southbound left-turn drivers are accepting to complete their maneuvers. The Synchro analysis program uses the Highway Capacity Manual default values for critical gaps. The critical

gap is the minimum length of time between vehicles traveling on the major street that allows entry for drivers on the minor street approach. The default critical gap time for a left-turn onto a four-lane major street is 7.5 seconds. During the stop delay study it appeared that drivers routinely accept gaps smaller than the default critical gap time.

Calibrating the Synchro models to actual conditions for the southbound left-turn movement results in a critical gap time of 3.0 seconds. Adjusting the critical gap time in the Synchro analysis to reflect observed conditions reduces delays for the southbound left-turn movement. During the A.M. peak hour, the movement operates at LOS B with 14.8 seconds of delay, and during the P.M. peak hour the movement operates at LOS C with 24.5 seconds of delay with the critical gap time adjustment.

Given the potential concerns about operations at the Bowlin Road and I-470 southbound ramps intersection, the traffic volumes were compared to the thresholds for the peak hour traffic signal warrant. The peak hour traffic signal warrant analysis is shown in **Appendix C**. Southbound right-turn volumes were excluded from the minor street volumes in the analysis because right-turn traffic is not delayed by left-turning vehicles. The Manual on Uniform Traffic Control Devices (MUTCD) states that the right-turn volume should not be included if the movement enters the major street with minimal conflict. The eastbound right-turn volume is also excluded from the analysis, as it does not conflict with southbound left-turn movement. Existing traffic volumes for the A.M. and P.M. peak hours are below the minimum traffic volumes thresholds for the peak hour warrant. As such, it is unlikely that a traffic signal is warranted at the Bowlin Road and I-470 southbound ramps intersection.

Existing plus Approved Development Conditions

The development trips generated by the unbuilt approved development adjacent to the site were compiled to determine the effects of traffic from the approved development that is yet to be completed. The results of the Existing plus Approved Development Conditions intersection analyses are summarized on the following page in **Table 6**. The study intersections were evaluated with the lane configurations, traffic volumes, and traffic control devices shown on **Figure A-4**. The Synchro output files are included in **Appendix C**. The critical gap time at the Bowlin Road and I-470 Southbound ramps intersection was adjusted to the calibration from the stop delay study.

As shown in **Table 6**, the addition of traffic from the approved development has a nominal effect of the levels of service at the study intersections. The southbound left-turn movement at the Bowlin Road and I-470 southbound ramps is projected to operate at LOS D during the P.M. peak hour with the addition of traffic from the Monticello subdivision. The peak hour signal warrant analysis in **Appendix C** indicates that traffic volumes are projected to be below the warranting thresholds in this scenario as well.

Table 6
Intersection Operational Analysis
Existing plus Approved Development Conditions

Intersection	Movement	A.M. Peak Hour		P.M. Peak Hour	
		LOS ¹	Delay ²	LOS ¹	Delay ²
Bowlin Road and I-470 SB Ramps					
	Westbound Left-Turn	A	9.3	A	9.8
	Southbound Right-Turn	A	9.2	B	13.1
	Southbound Left-Turn	C	15.9	D	29.2
Bowlin Road and I-470 NB Ramps					
	Traffic Signal	B	10.7	B	16.1
Bowlin Road and Lakewood Way					
	Traffic Signal	C	23.8	C	30.5

1 – Level of Service

2 – Delay in seconds per vehicle

Existing plus Approved plus Proposed Development Conditions

The results of the Existing plus Approved plus Proposed Development conditions intersection analyses are summarized in **Table 7**. This study scenario assessed the street system with the additional traffic generated by the proposed development. The study intersections were evaluated with the lane configurations, traffic volumes, and traffic control devices shown on **Figure A-5**. The Synchro output files are included in **Appendix C**. The critical gap time at the Bowlin Road and I-470 Southbound ramps intersection was adjusted to the calibration from the stop delay study.

Table 7
Intersection Operational Analysis
Existing plus Approved plus Proposed Development Conditions

Intersection	Movement	A.M. Peak Hour		P.M. Peak Hour	
		LOS ¹	Delay ²	LOS ¹	Delay ²
Bowlin Road and I-470 SB Ramps					
	Westbound Left-Turn	A	9.5	B	10.0
	Southbound Right-Turn	A	9.2	B	13.1
	Southbound Left-Turn	C	18.3	E	44.8
Bowlin Road and I-470 NB Ramps					
	Traffic Signal	B	10.9	B	16.6
Bowlin Road and Lakewood Way					
	Traffic Signal	C	23.9	C	34.3
Bowlin Road and Jamestown Drive					
	Northbound Left-Turn	B	10.3	B	10.4

1 – Level of Service

2 – Delay in seconds per vehicle

The table indicates that delays are projected to slightly increase at the study intersections with the addition of development traffic. The southbound left-turn movement at the Bowlin Road and I-470 southbound ramps is projected to operate at LOS E with 44.8 seconds of delay during the P.M. peak

hour. All other movements and intersections are projected to operate within acceptable levels of service. All projected queues can be contained within the storage length of the existing turn lanes.

The traffic volumes projections at the Bowlin Road and I-470 southbound ramps intersection exceed the minimum threshold for the peak hour traffic signal warrant. Typically, the peak hour signal warrant is used to justify a traffic signal installation in unusual cases such as at facilities that attract or discharge a large number of vehicles over a short time. As such, the peak hour warrant is likely not applicable at this location. However, the peak hour warrant does provide an indication of the potential need for future signalization or other improvements to the intersections.

Given the close spacing to the intersection with Anderson Drive the Bowlin Road and I-470 southbound ramps intersection is not a desirable location for a traffic signal installation. Generally signals are to be spaced at least one-quarter mile apart to provide adequate room for queuing, lane changing maneuvers, and signal coordination. As a signalized intersection there is potential for queues to extend through the two closely spaced intersections. There is also potential for drivers on Bowlin Road/Lakewood Boulevard to observe signal indications that are intended for the upstream intersection. In light of these safety and operational concerns, other traffic control or geometric improvement alternatives should be considered for this intersection as development continues in the area.

Access Management Code

The City's Access Management Code provides guidance for traffic elements including turn lanes, connection spacings, and throat lengths of driveways, based on a roadway's classification. According to the City's classification map, Bowlin Road is a minor arterial roadway. Given the low volume of traffic on Bowlin Road and the fact that it will never be a through street to the east of the development site, we would consider Bowlin Road to the east of Lakewood Way to function as a residential collector street.

As a residential collector type street, the Access Management Code suggests several improvements at the new intersection of Bowlin Road and Jamestown Drive. The access management code indicates that a westbound left-turn lane and an eastbound right-turn lane should be constructed at the intersection. However, there does not appear to be a need for a westbound left-turn lane since the volume for that movement is projected to be nominal. Likewise, there does not appear to be a need for an eastbound right-turn lane, given that the vast majority of the eastbound traffic volume on Bowlin Road will be making the right-turn maneuver. As such right-turn maneuvers will not impede the minimal volume of through traffic.

Summary

TranSystems has completed a traffic impact study for the proposed development to be located generally south and east of the Bowlin Road and Lakewood Way intersection in Lee's Summit, Missouri. The purpose of this study was to assess the impact of the proposed development on the surrounding transportation system.

The proposed development is projected to generate 167 new trips during the A.M. peak hour and 198 new trips during the P.M. peak hour. Development traffic will be distributed to a new residential collector street, Jamestown Drive, which will be constructed through the development site.

No improvements are identified to mitigate the addition of development traffic to the street network. All intersections are projected to operate at an acceptable level of service, except for the Bowlin Road and I-470 southbound ramps intersection. The southbound left-turn movement at the intersection is projected to operate at LOS E. There may be a need for a traffic signal installation at the intersection, however, there is a short distance to the existing traffic signal at the intersection with Anderson Drive. Closely spaced signalized intersections can result in operational and safety concerns. Therefore, other traffic control or geometric improvement alternatives should be considered for this intersection as development continues in the area.