

September 25, 2018

Mr. Jim Brennan
McKelvey Homes
218 Chesterfield Towne Centre
Chesterfield, Missouri 63005

RE: Traffic Engineering Services
Proposed Residential Development – Inverness
Dardenne Prairie, Missouri
CBB Job #63-18

Dear Mr. Brennan:

As requested, CBB has completed a traffic study for a proposed residential development, known as Inverness, in Dardenne Prairie, Missouri. The development site is in the northwest portion of the Bopp property which is located in the northwest quadrant of the intersection of Bryan Road and Feise Road. The location of the site in relation to the surrounding road system is depicted in **Figure 1**.

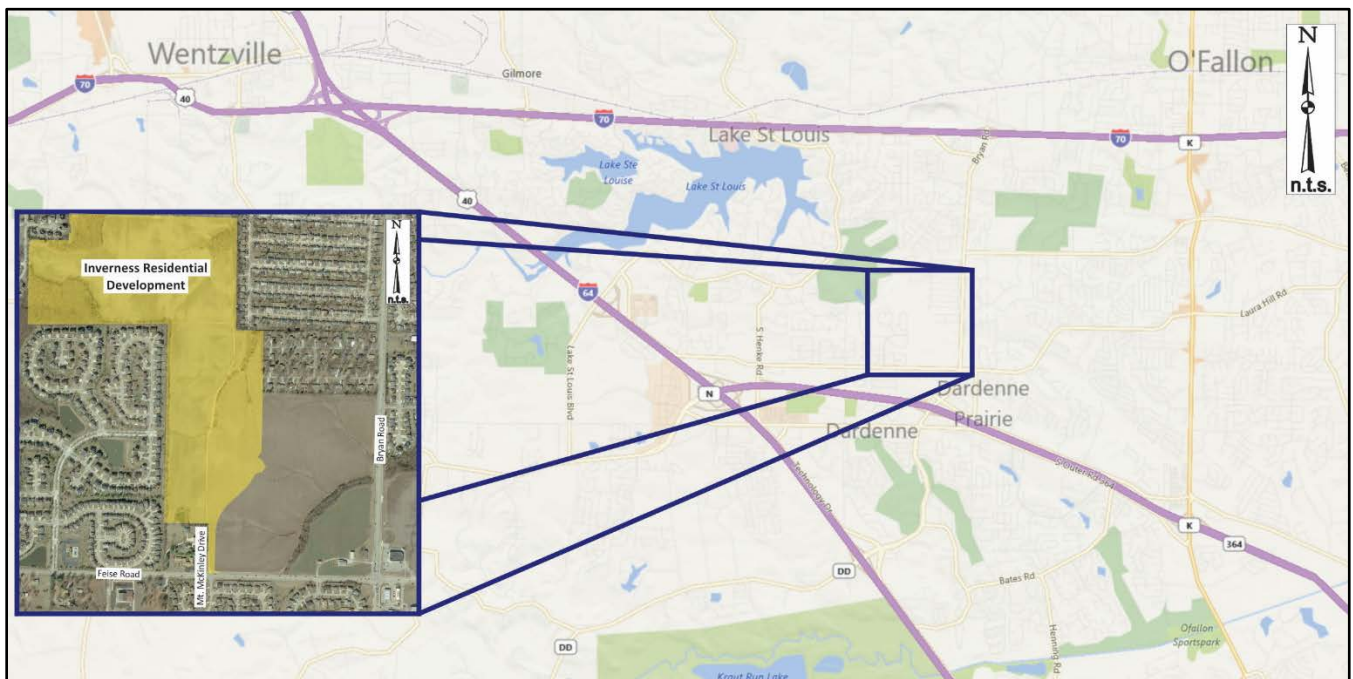


Figure 1: Project Location Map



Based on the concept plan provided at the commencement of this study, the proposed residential development would consist of 266 single-family homes. Access to the development site is proposed via a new roadway on Feise Road, opposite Mt. McKinley Drive. A schematic of the conceptual site plan is shown in **Figure 2**.



Figure 2: Iverness Preliminary Concept Plan (provided by others)



CBB previously prepared a Traffic Planning Study in September 2017 to address the overall area plan for the Bopp property. The Bopp property encompasses approximately 180 acres assumed to develop with a mix of retail, office and residential uses. As part of that prior process, we assisted the development team in addressing the associated transportation issues with the development of the overall Bopp property. The proposed residential development was designated as Zone 4 in the Traffic Planning Study.

Based on discussions with the City of Dardenne Prairie, a new traffic impact study will be required to address the impact of the 266 home development to determine if any roadway and/or traffic control improvements are necessary to support the currently proposed residential development.

Since the planning study evaluated the full build-out, or long-term impacts, of the Bopp property, the purpose of this study was to evaluate the near-term impact of the currently proposed residential development.

As requested by the City, the focus of this study was the AM and PM peak hours of a typical weekday and includes the following scenarios:

- Existing Conditions (2017 pre-development); and
- Forecasted Conditions (Existing plus Site)

The primary emphasis of this study was the intersection of Feise Road and the new North-South Road, opposite Mt. McKinley Drive, to serve the site, as well as the intersection of Feise Road and Bryan Road.

The following report presents the methodology and findings relative to the Existing and Forecasted conditions. The long-term impacts of the overall Bopp property are provided in the September 2017 Traffic Planning Study.



EXISTING CONDITIONS

Area Roadway System: **Bryan Road** is a north-south major arterial maintained by the City of O'Fallon. Bryan Road serves central St. Charles County providing a connection to I-70 approximately two miles to the north and to Route 364 (Page Avenue) approximately one half mile south and I-64 approximately two miles south of the subject site. The road provides five lanes, two in each direction with a center two-way left-turn lane (TWLTL) and has a posted speed limit of 40 miles per hour (mph). A sidewalk has been constructed along the west side of the road and a multi-use trail is located along the east side of the roadway.

Feise Road is an east-west roadway maintained by the City of Dardenne Prairie adjacent to the site. Based on MoDOT's Functional Classification System Map, to the west Feise Road serves as an urban collector roadway, while to the east it serves as a minor arterial roadway. The road provides three lanes, one in each direction with a center TWLTL and has a posted speed limit of 35 mph. Sidewalks are provided along both sides of Feise Road.

The intersection of Bryan Road and Feise Road is controlled by a traffic signal. The signal is part of a coordinated traffic signal system along Bryan Road from just south of I-70 to just north of I-64. Separate right- and left-turn lanes are provided on all approaches to the intersection. All approaches operate under protected plus permissive phasing with a flashing yellow arrow to indicate permissive left turns. In addition, a right-turn overlap phase is provided for northbound and southbound Bryan Road. Push-button activated pedestrian signals and crosswalks are provided for all approaches at the intersection. **Figure 3** provides an aerial view of the Bryan Road and Feise Road intersection.



Figure 3: Aerial View of Bryan Road and Feise Road Intersection



Mt. McKinley Drive is a local road maintained by the City of Dardenne Prairie which provides access to the Pinnacle Pointe subdivision from Feise Road. The road provides two lanes, one in each direction. The posted speed limit is 25 mph. Sidewalks are not provided along the roadway.

The intersection of Feise Road and Mt. McKinley Drive is controlled by a side-street stop with free-flow traffic along Feise Road. A pedestrian crosswalk is marked across the south leg (Mt. McKinley Drive). **Figure 4** provides an aerial view of the Feise Road and Mt. McKinley Drive intersection.



Figure 4: Aerial View of Feise Road and Mt. McKinley Drive Intersection

Existing Traffic Volumes: Based on discussions with the City, the traffic counts collected in the study area in March 2017 for the Bopp study were used for this analysis. The existing peak hour volumes for the two study intersections are summarized in **Exhibit 1**. Based on the traffic data collected, the morning peak hour occurred between 6:45 and 7:45 a.m. and the afternoon peak hour occurred between 4:45 and 5:45 p.m.

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 1: Existing Traffic Volumes



PROPOSED SITE

Proposed Land Use: As mentioned previously, approximately 266 single-family homes are proposed on the site, designated as Zone 4 in the Bopp Overall Traffic Planning Study.

Site Access: As shown on the concept plan in Figure 2, access to the development site is proposed via a new roadway, referred to as North-South Road, on Feise Road, opposite Mt. McKinley Drive. An emergency access only is being provided on the north side of the site via a gated connection to Little Big Horn Drive for emergency vehicles only.

Careful consideration should be given to sight distance obstructions when planning any future aesthetic enhancements, such as berms, fencing and landscaping, at the North-South roadway to ensure that these improvements do not obstruct the view of entering and exiting traffic at the intersection with the public road. 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 *Trip Generation Manual*, 10th Edition, published by the Institute of Transportation Engineers (ITE). This manual, which is a standard resource for transportation engineers, is based on a compilation of nationwide studies documenting the characteristics of various land uses. Estimates for the proposed 266 homes were based on Land Use: 210 – Single-Family homes.

The data provided for Land Use 210 Peak Hour of the Adjacent Street was used for the traditional weekday AM and PM peak hour (one hour between 7:00 and 9:00 AM and one hour between 4:00 and 6:00 PM) forecasts.

Based on this data, the trip generation forecast for the proposed Iverness development is shown in **Table 1**. As shown, the proposed residential development would generate a total of 195 trips during the weekday AM peak hour and 260 trips during the weekday PM peak hour.

Table 1: Trip Generation Estimate

Land Use	Size	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	Total	In	Out	Total
Inverness Subdivision (ITE Land Use 210)	266 Homes	50	145	195	165	95	260
Total Trips*		50	145	195	165	95	260

*Trips rounded to the nearest 5 trips



Trip Distribution: The site-generated trips for the proposed residential development were then assigned into and out of the site based upon the previously approved trip distribution assumptions used for the Bopp Traffic Planning Study as summarized in **Table 2**.

Table 2: Trip Distribution Assumptions (Table 4 in the Bopp Traffic Planning Study)

Land Use	Trip Distribution Assumptions (Residential)
To/from the north on Bryan Road	37%
To/from the south on Bryan Road	36%
To/from the east on Feise Road	13%
To/from the west on Feise Road	14%

The resulting assignment of site-generated trips for the weekday AM and PM peak hours is summarized in **Exhibit 2**.

Forecasted Traffic Volumes (Existing plus Iverness): The assigned traffic volumes resulting from the trip distribution for the proposed Iverness residential development (Exhibit 2) were added to the Existing traffic volumes (Exhibit 1) to determine the total volumes in the forecasted scenario. The forecasted, near-term, traffic volumes for the weekday AM and PM peak hours are shown in **Exhibit 3**.



Exhibit 2: Site-Generated Traffic Volumes



Exhibit 3: Forecasted Traffic Volumes



TRAFFIC ANALYSIS

Study Procedures: The Existing and Forecasted 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 3** summarizes the thresholds used in the analysis for signalized and unsignalized intersections.

Table 3: 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 Turn Lane Needs: A separate left-turn lane is already provided on Feise Road at the proposed North-South Road. The need for a separate westbound right-turn lane on Feise Road at the proposed North-South Road was also considered. However, we are not aware of specific right-turn lane warrant guidelines followed by the City of Dardenne Prairie. A Policy for the Geometric Design of Highways and Streets, published by the American Association of State Highway and Transportation Officials (AASHTO), commonly referred to as the *Green Book* is often used to evaluate the need for turn lanes, but the *Green Book* does not provide specific criteria to determine whether a right-turn lane is ‘warranted’.

Outside other contributing factors that might necessitate the need for a separate right-turn lane, a general rule of thumb often used in the industry is to consider providing a separate right-turn lane when the right turn volume exceeds 100 vehicles per hour (vph) during the peak hour. The forecasted right-turn volume on Feise Road at the proposed North-South Road, opposite Mt. McKinley Drive, exceeds 100 vph during the weekday PM peak hour with a forecasted volume of 142 vph; as such, a separate right-turn lane should be considered given the general rule of thumb guideline in the *Green Book*.

Since the *Green Book* does not provide nomographs for the evaluation of right-turn lanes, the need for a right-turn lane on Feise Road at the proposed North-South Road was also evaluated using MoDOT’s Access Management Guidelines (AMG). These guidelines consider auxiliary lanes an asset in promoting safety and improved traffic flow at relatively high conflict locations. Separate turn lanes are intended to remove turning vehicles from the through lanes to reduce the potential number of rear-end collisions at intersections. The MoDOT method provides volume guidelines for the consideration of separate right-turn lanes by comparing the total advancing volume (which includes all turning traffic) to the number of right-turns during the design hour with respect to the major road speed.

The need for a westbound right-turn lane on Feise Road at the proposed North-South Road was evaluated using the MoDOT’s AMG - *Right Lane Warrant for Two-Lane Roadway*. **Figure 4** graphically illustrates the right-turn evaluation assuming the Forecasted Traffic Volumes during the AM and PM peak hours. A right-turn lane should be considered when the plotted point lies to the right of the line of the ≤ 40 mph line on the graph. As depicted, the forecasted traffic volumes for the weekday PM peak hour do meet the warrants for a separate westbound right-turn lane.

Since the forecasted right-turn volume on Feise Road at the proposed North-South Road exceeds 100 vph (the general rule of thumb guideline in the *Green Book*) during the weekday PM peak hour with a forecasted volume of 142 vph; and the fact the forecasted volumes also satisfy MoDOT’s AMG right-turn lane warrants, it is recommended that a separate westbound right-turn lane be provided on Feise Road at the proposed North-South Road.

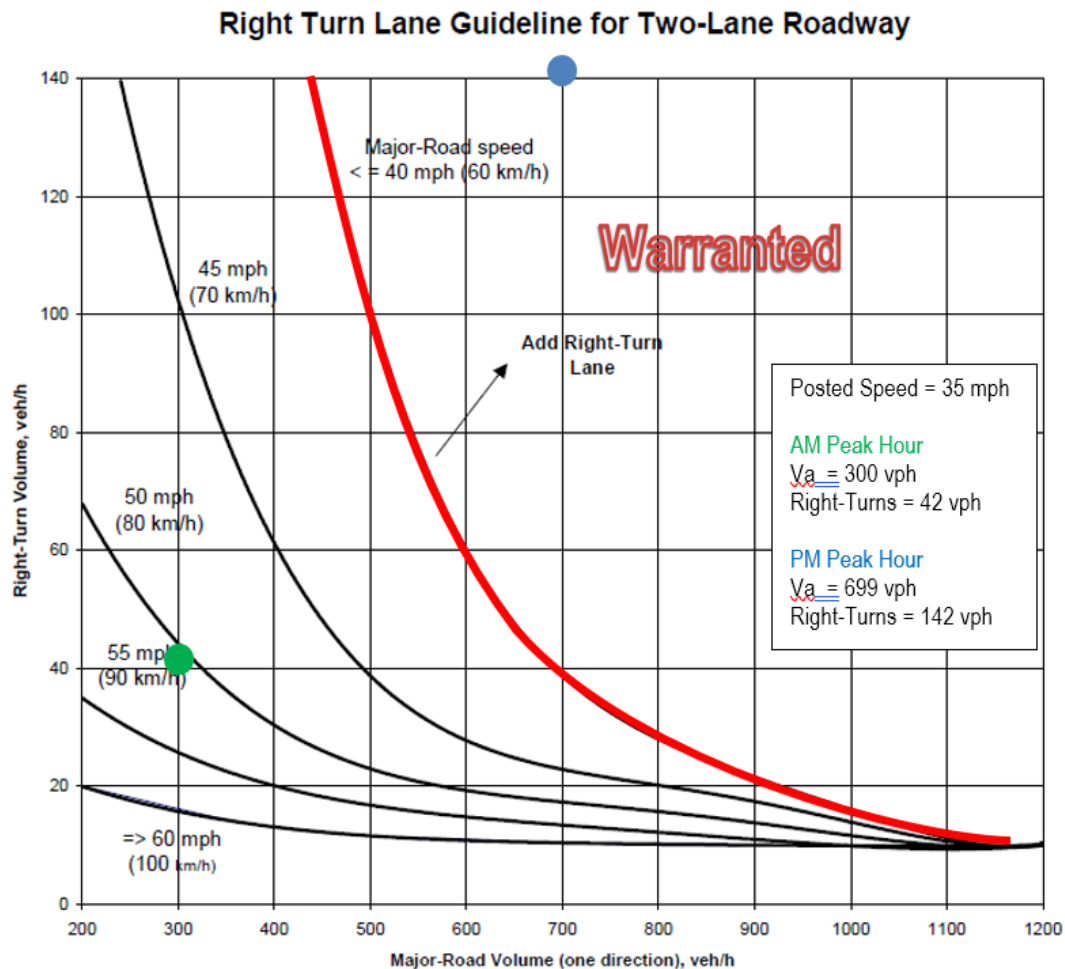


Figure 5: Right-Turn Lane Needs Evaluation - Westbound Feise Road at proposed North-South Road (MoDOT Access Management Guidelines - 2006)

Signal Warrants – Feise Road and North-South Road: The Bopp Traffic Planning Study identified the likely need to signalize the intersection of Feise Road and the proposed North South Road/Mt. McKinley Drive upon the full build-out of the Bopp property. Thus, a review of whether or not the residential development alone would trigger the need for a traffic signal was reviewed.

The need for a traffic signal at Feise Road and the proposed North-South Road/Mt. McKinley Drive 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.



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 5**.

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 6: MUTCD Warrant 1, Eight Hour Vehicular Volume

Warrant 1A requires approach volumes of at least 500 vph on major streets with one travel lane per direction and a minimum of 150 vph on the minor street assuming a single-lane approach. Warrant 1B requires approach volumes of at least 750 vph on major streets with one lane per direction and a minimum of 75 vph on the minor street assuming a one-lane approach. Even though two exit lanes are proposed on the North-South Road, a single-lane for the left-turn traffic was used for the analysis. The right-turn volume is often not considered in the signal warrant analysis if the right-turn movement is easy to make.

In the absence of eight-hour traffic counts, the 8th highest hourly volumes are commonly estimated as 55% of peak hour traffic. As indicated by the Forecasted traffic volumes (Exhibit 3), the total approach volume on Feise Road is forecasted at 1,124 vph during the weekday PM peak hour, while the approach volume on the North-South Road (discounting the right-turn volume) is forecasted at 82 vph. At 55% of the peak hour, the 8th highest hourly volume is estimated to be approximately 618 vph on Feise Road and 45 vph on North-South Road which would not meet the signal warrant thresholds. As such, a traffic signal at the intersection of



Feise Road and the proposed North-South Road/Mt. McKinley Drive is not justified with the residential portion alone of the Bopp property.

Forecasted (Near-Term) Operating Conditions: The study intersections were evaluated for the Existing and Forecasted scenarios using the methodologies previously described. The Forecasted scenario reflects the recommended westbound right-turn lane on Feise Road at the proposed North-South Road. **Table 4** summarizes the results of this analysis, which reflects the Existing and Forecasted operating conditions and average delays during the weekday AM and PM peak hours. The Synchro estimated 95th percentile queue lengths for the signalized intersection of Bryan Road and Feise Road are shown in the table.

Table 4: Capacity Analysis Summary

Intersection / Approach	Weekday AM Peak Hour		Weekday PM Peak Hour	
	Existing	Forecasted	Existing	Forecasted
<i>Bryan Road and Feise Road (Signalized)</i>				
Eastbound Feise Road Approach	C (26.8) 95 th Q: 170' L	C (27.8) 95 th Q: 220' L	D (36.3) 95 th Q: 190' L	D (40.9) 95 th Q: 250' L
Westbound Feise Road Approach	C (30.2) 95 th Q: 200' L	C (28.4) 95 th Q: 200' L	C (30.9) 95 th Q: 160' L	C (32.0) 95 th Q: 160' L
Northbound Bryan Road Approach	C (33.0) 95 th Q: 440' T 95 th Q: >25' LT	C (34.5) 95 th Q: 440' T 95 th Q: 45' LT	C (21.0) 95 th Q: 530' T 95 th Q: 35' LT	C (24.0) 95 th Q: 530' T 95 th Q: 60' LT
Southbound Bryan Road Approach	C (27.4) 95 th Q: 535' T	C (29.4) 95 th Q: 535' T	C (34.3) 95 th Q: 480' T	C (34.1) 95 th Q: 480' T
Overall	C (29.5)	C (30.7)	C (28.9)	C (30.8)
<i>Feise Road and Mt. McKinley Drive/Proposed North-South Road (Side-Street Stop Control)</i>				
Eastbound Feise Road Approach	A (<1.0)	A (<1.0)	A (<1.0)	A (<1.0)
Westbound Feise Road Approach	A (<1.0)	A (<1.0)	A (<1.0)	A (<1.0)
Northbound Mt. McKinley Drive Approach	B (11.0)	B (11.2)	B (11.7)	B (12.2)
Southbound North-South Road Approach		B (14.1)		B (17.1)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)
95th percentile queue for the critical movement of the approach and lane (L-Left, T-Thru, R-Right)

As shown in the table, the study intersections currently operate at overall acceptable levels of service (LOS C or better) during both peak periods and would continue to operate at overall acceptable levels of service upon the build-out of the proposed subdivision with negligible changes in delay as a result of the proposed development. The additional trips associated with the proposed 266 homes would not warrant any capacity improvements at the signalized intersection to accommodate the proposed homes.



SUMMARY

CBB completed the preceding study to address the traffic impacts associated with the proposed residential development, known as Iverness, generally located in the northwest quadrant of the intersection of Bryan Road and Feise Road in Dardenne Prairie, Missouri.

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

- It is recommended that a separate westbound right-turn lane be provided on Feise Road at the proposed North-South Road.
- A traffic signal at the intersection of Feise Road and the proposed North-South Road/Mt. McKinley Drive is not justified with the residential portion alone of the Bopp property.
- The study intersections currently operate at overall acceptable levels of service (LOS C or better) during both the AM and PM peak periods and would continue to operate at overall acceptable levels of service upon the build-out of the proposed subdivision.

We trust that this traffic study adequately describes the forecasted traffic conditions that should be expected as a result of the proposed Iverness residential development in Dardenne Prairie, Missouri. 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