

final report

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DESIGN SERVICES

March 6, 2018

# Traffic Impact Study

Oakland Hills  
11333 Bardstown Creek Road  
Louisville, KY

Prepared for

Louisville Metro Planning Commission  
Kentucky Transportation Cabinet



17 Zone 1081

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## INTRODUCTION

The subdivision plan for Oakland Hills on Bardstown Road in Louisville, KY shows 592 single family lots with a tract for multi-family of 348 units. Access to the subdivision will be from Bardstown Road and Broad Run Parkway. The original plan for this development had 736 single family lots with access only from Bardstown Road. **Figure 1** displays a map of the site. The purpose of this study is to examine the traffic impacts of the development upon the adjacent highway system. For this study, the impact area was defined to be the intersections of Bardstown Road with Oakland Hills Trail and Broad Run Parkway.

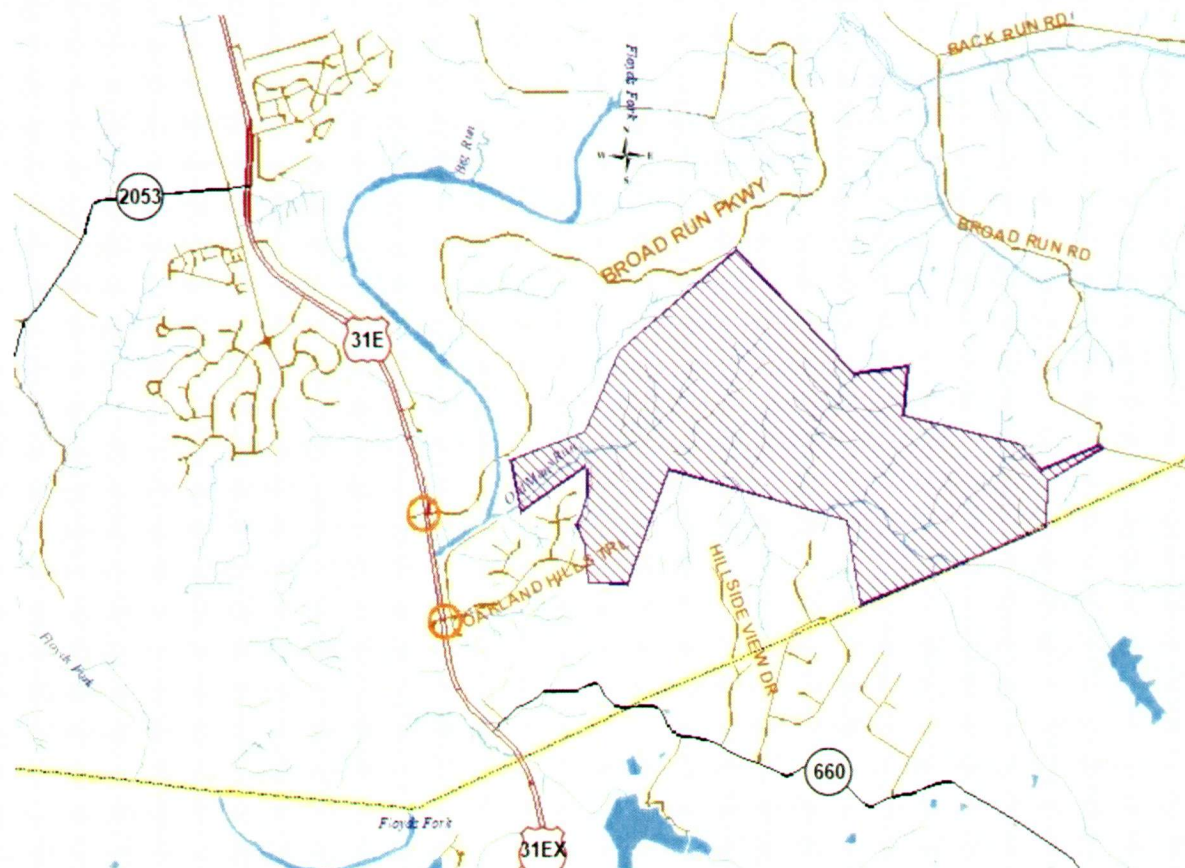


Figure 1. Site Map

## EXISTING CONDITIONS

Bardstown Road, US 31E, is maintained by the Kentucky Transportation Cabinet (KYTC) with an estimated 2018 Average Daily Traffic (ADT) volume of 35,100 vehicles per day between the Bullitt County line and Thixton Lane (KY 2053), as estimated from the KYTC 2013 count at station 257. The road is a four-lane highway with twelve-foot lanes, a depressed 32 foot median and ten-foot paved shoulders. The speed limit is 55 mph. There are no sidewalks. The intersection with Oakland Hills Trail has dedicated left turn lanes and is controlled with a stop sign on Oakland Hills Trail. The intersection with Broad Run Parkway has dedicated left turn lanes on all approaches and is controlled with a traffic signal.

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A.m. and p.m. peak hour traffic counts were collected on January 10, and 31, 2018 (see Appendix A). The a.m. peak hour occurred between 7:00 and 8:00 a.m. and the p.m. peak hour occurred between 5:00 and 6:00 p.m. Figure 2 illustrates the existing a.m. and p.m. peak hour traffic volumes.

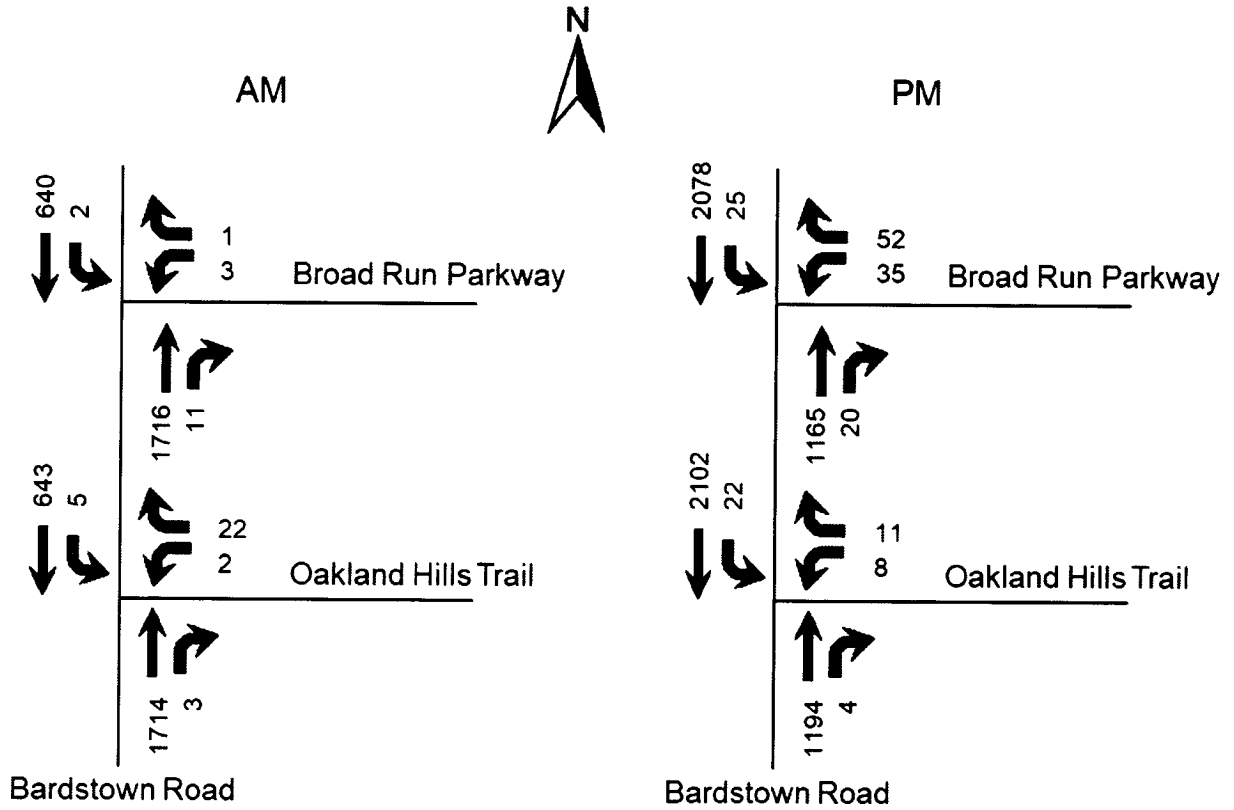


Figure 2. Existing Peak Hour Volumes

**FUTURE CONDITIONS**

The project completion date is 2030. An annual growth rate of 1.0 percent was applied to Bardstown Road and the park volumes. This is based upon historical growth at KYTC station C39 on US 31E in Bullitt County. The No Build volumes include full build-out of the original 736 lots. 57 lots currently have homes, so there are 679 remaining lots. The trip generation results are listed in Table 1. Figure 3 displays the 2030 No Build peak hour volumes.

Table 1. Peak Hour Trips Generated by Original Plan

Land Use	A.M. Peak Hour			P.M. Peak Hour		
	Trips	In	Out	Trips	In	Out
Single-Family Detached (679 lots)	487	122	365	639	403	236

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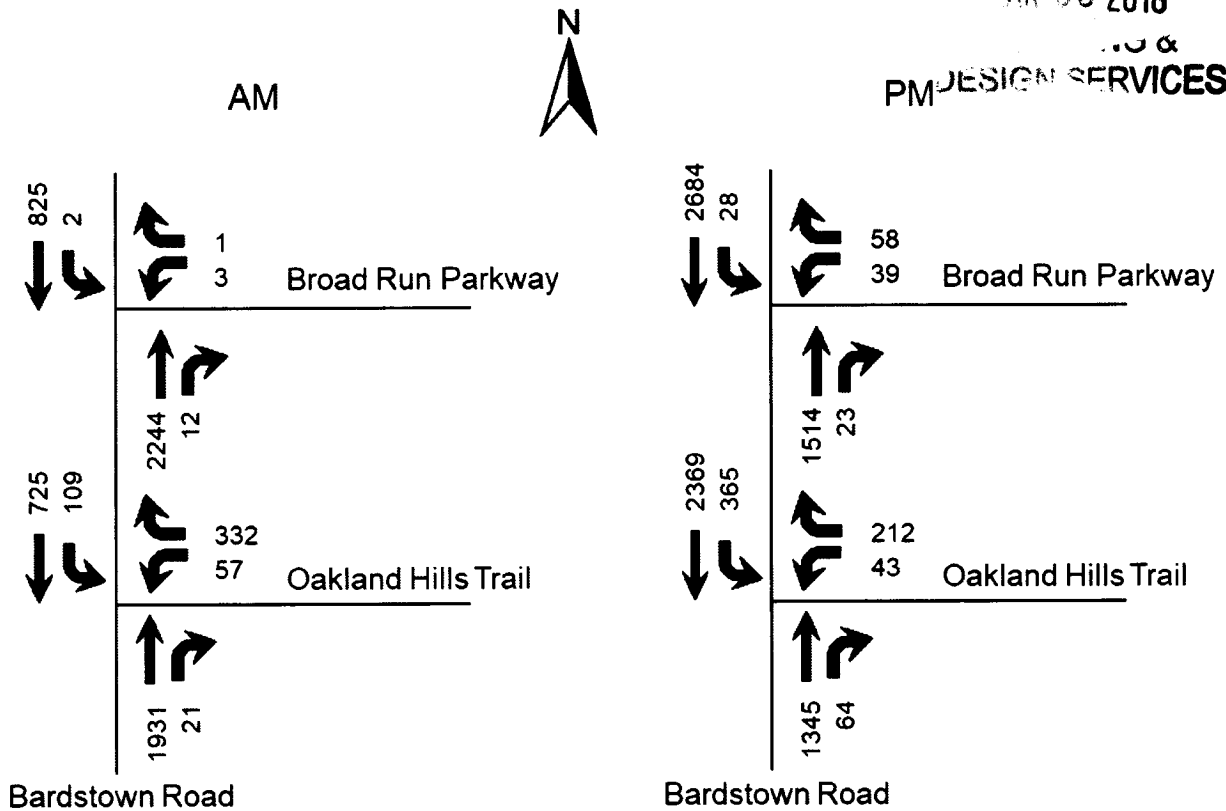


Figure 3. No Build (Original Plan) Peak Hour Volumes

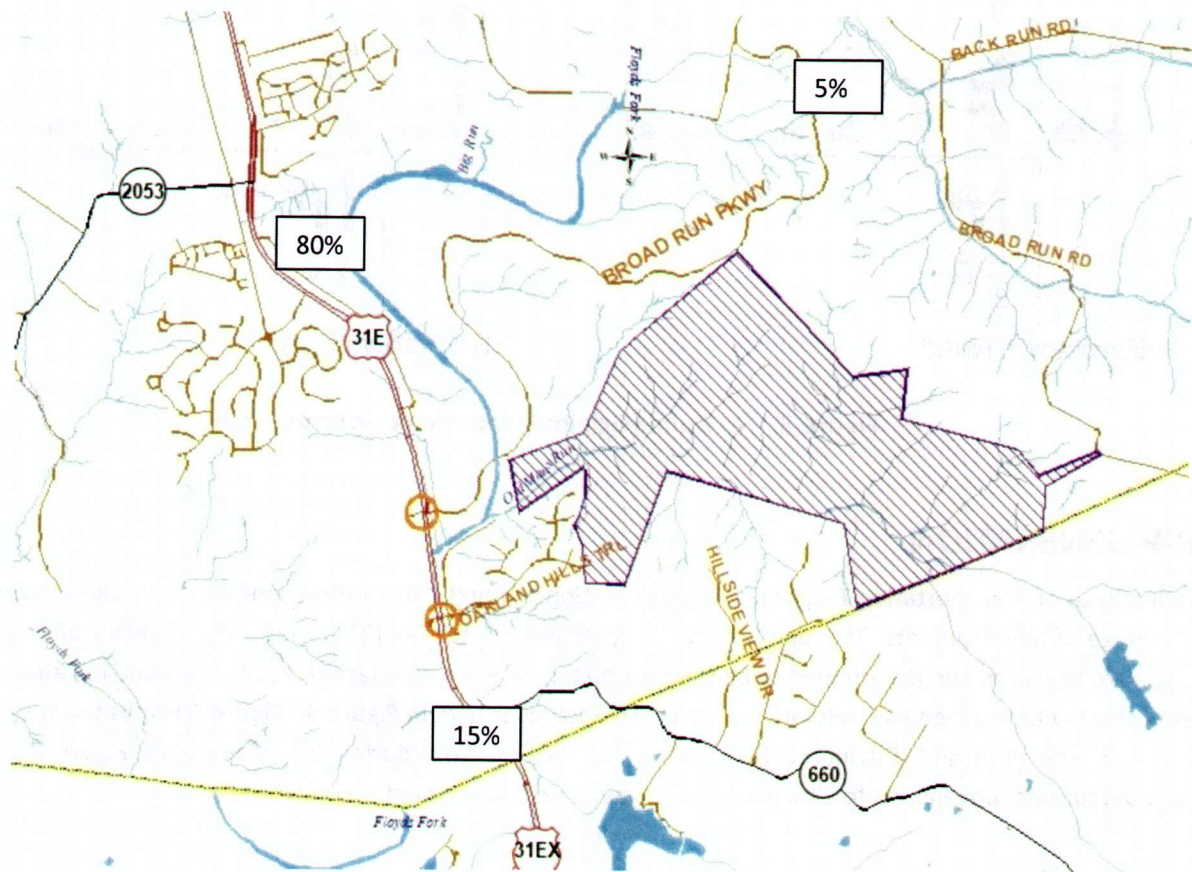
### TRIP GENERATION

The Institute of Transportation Engineers Trip Generation Manual, 10<sup>th</sup> Edition contains trip generation rates for a wide range of developments. The land uses of "Single-Family Detached (210)" and "Multifamily Housing (Mid-Rise) (221)" were reviewed and determined to be the best match. The trip generation results are listed in **Table 2**. The trips were assigned to the highway network with the percentages shown in **Figure 4**. **Figure 5** shows the trips generated by this development and distributed throughout the road network during the peak hours. **Figure 6** displays the individual turning movements for the peak hours when the development is completed.

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**Table 2. Peak Hour Trips Generated by Site**

Land Use	A.M. Peak Hour			P.M. Peak Hour		
	Trips	In	Out	Trips	In	Out
Single-Family Detached (592 lots)	425	106	319	560	353	207
Multifamily (Mid-Rise) (348 units)	116	30	86	147	89	58
<b>TOTAL</b>	<b>541</b>	<b>136</b>	<b>405</b>	<b>707</b>	<b>442</b>	<b>265</b>



**Figure 4. Trip Distribution Percentages**

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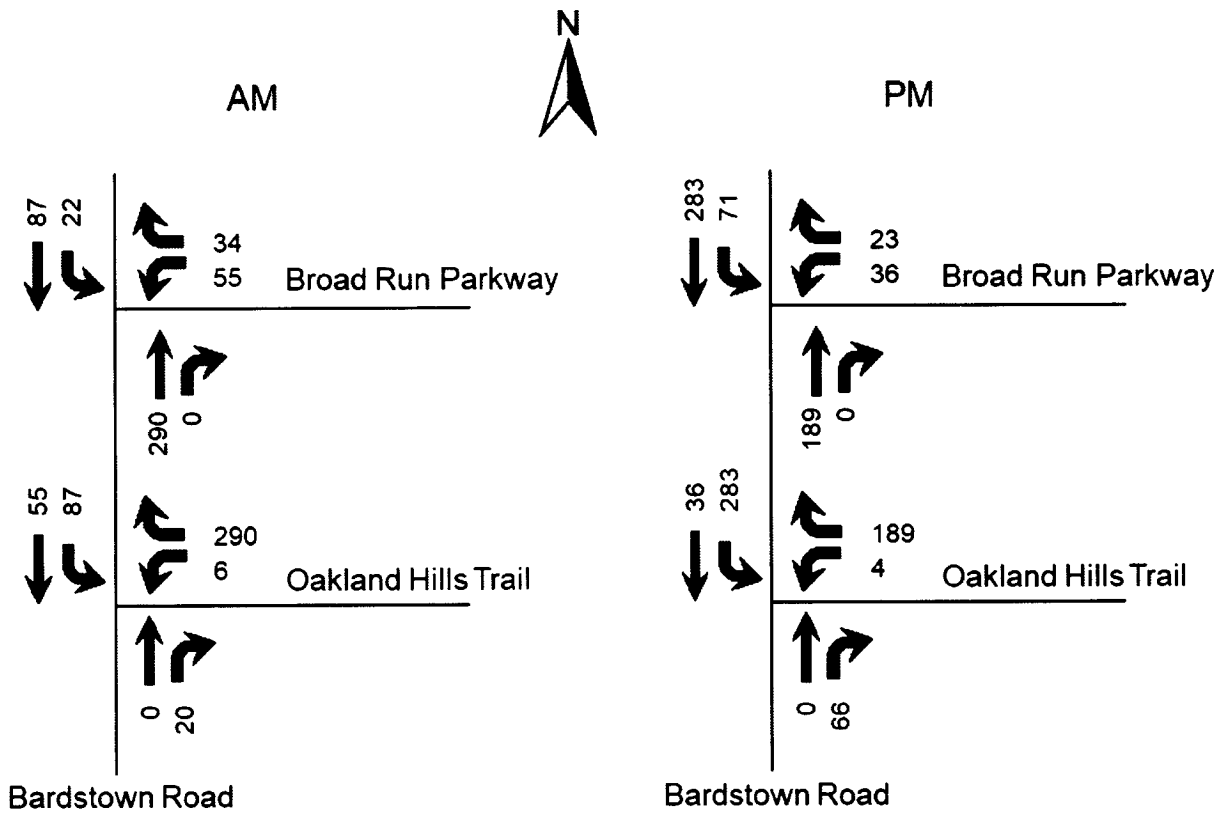


Figure 5. Peak Hour Trips Generated by Site

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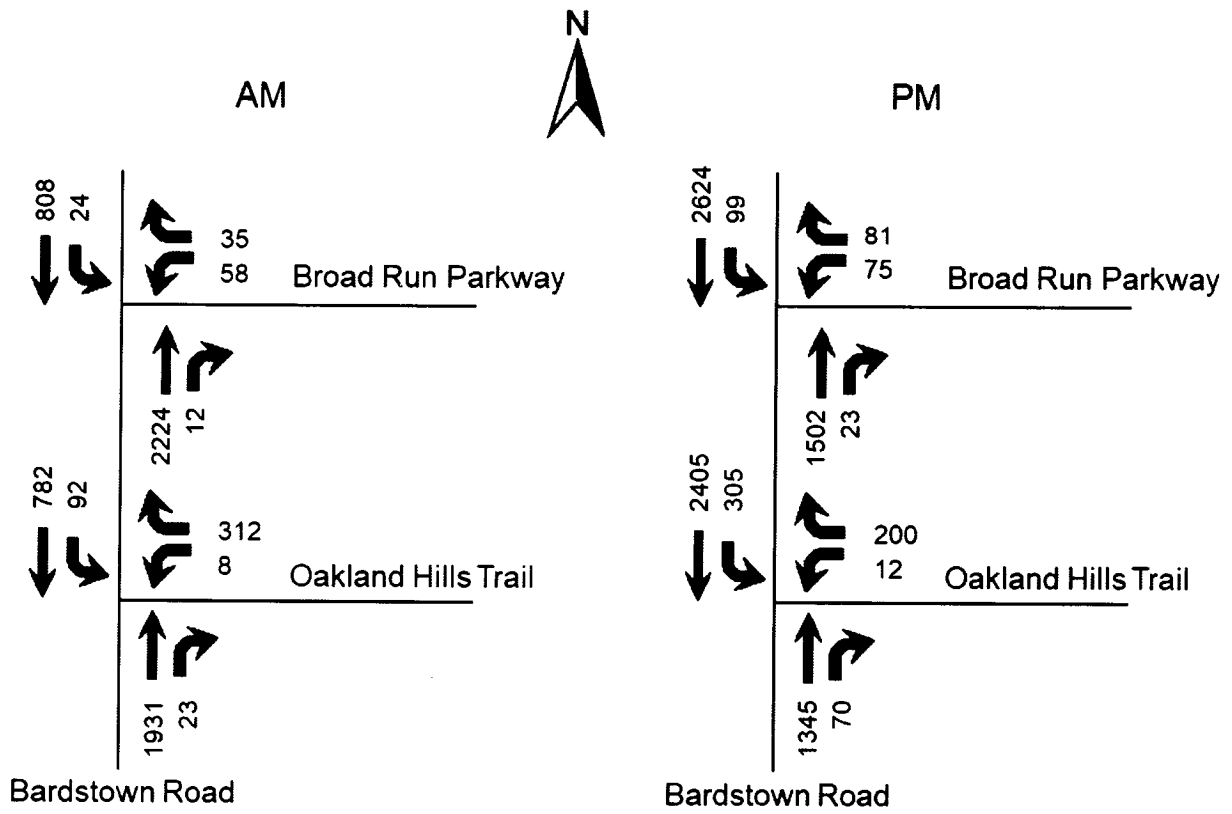


Figure 6. Build Peak Hour Volumes

## ANALYSIS

The qualitative measure of operation for a roadway facility or intersection is evaluated by assigning a "Level of Service". Level of Service is a ranking scale from A through F, "A" is the best operating condition and "F" is the worst. Level of Service results depend upon the facility that is analyzed. In this case, the Level of Service is based upon the total delay experienced at an intersection.

To evaluate the impact of the proposed development, the vehicle delays at the intersections were determined using procedures detailed in the Highway Capacity Manual, 6<sup>th</sup> edition. Future delays and Level of Service were determined for the intersections using the HCS Streets (version 7.4) software. The delays and Level of Service are summarized in **Table 3**.



**Table 3. Peak Hour Level of Service**

Approach	A.M.			P.M.		
	2018 Existing	2030 No Build	2030 Build	2018 Existing	2030 No Build	2030 Build
<b>Bardstown Road at Oakland Hills Trail</b>						
Oakland Hills Trail Westbound	C 20.5	F 252.9	C 18.0	C 23.8	F 174.8	C 21.2
Bardstown Road Southbound (left)	C 18.1	D 37.2	D 30.6	B 11.9	D 26.9	C 21.5
<b>Bardstown Road at Broad Run Parkway</b>						
Broad Run Parkway Westbound	D 43.2	E 60.3	E 55.3	D 49.6	E 56.3	E 57.3
Bardstown Road Northbound	A 2.8	A 4.6	A 7.7	A 3.1	A 3.5	A 4.0
Bardstown Road Southbound	A 1.7	A 1.4	A 4.0	A 5.8	B 16.2	B 16.7

*Key: Level of Service, Delay in seconds per vehicle*

The Oakland Hills Trail intersection was evaluated for turn lanes using the Kentucky Transportation Cabinet Highway Design Guidance Manual dated March, 2017. Using the volumes in Figure 5, a northbound right turn lane will be required on Bardstown Road at the Oakland Hills Trail intersection.

## CONCLUSIONS

Based upon the volume of traffic generated by the development and the amount of traffic forecasted for the year 2030, there will be a manageable impact to the existing highway network, with Levels of Service remaining within acceptable limits. A northbound right turn lane is required on Bardstown Road at the Oakland Hills Trail intersection. The proposed plan improves the traffic operations as compared to the existing plan for the site. The improvement is due to the access to the park road system, especially the signal at Broad Run Parkway intersection with Bardstown Road.

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**APPENDIX**

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Leg	Direction	Start Time	US 31E			Oakland Hills Trail			US 31E			Int Total
			Left	Thru	U-Turn	Left	Right	U-Turn	Left	Right	U-Turn	
	Southbound	7:00:00	0	118	0	0	0	8	0	1	0	618
		7:15:00	0	174	0	0	0	7	0	0	0	605
		7:30:00	3	178	0	0	1	2	0	0	0	606
		7:45:00	2	173	0	0	1	5	0	0	0	560
		8:00:00	2	147	0	0	1	7	0	4	0	566
		8:15:00	2	165	0	0	2	6	0	1	0	547
		8:30:00	0	139	0	0	5	0	0	1	0	519
		8:45:00	2	141	0	0	5	0	0	3	0	429
		16:00:00	4	439	0	0	2	2	0	2	0	713
		16:15:00	5	436	0	0	1	6	0	1	0	709
		16:30:00	8	514	0	0	1	2	0	1	0	807
		16:45:00	5	511	0	0	2	5	0	1	0	807
		17:00:00	3	549	0	0	5	3	0	1	0	901
		17:15:00	6	528	0	0	0	1	0	1	0	826
		17:30:00	2	510	0	0	3	3	0	2	0	766
		17:45:00	7	454	0	0	2	2	0	1	1	687
		Grand Total	51	5176	0	0	19	69	0	22	1	10666
	% Approach		1.0%	99.0%	0.0%	0.0%	21.6%	78.4%	0.0%	0.4%	0.0%	
	% Total		0.5%	48.5%	0.0%	0.2%	0.6%	50.0%	0.0%	0.2%	0.0%	
	Lights and M		50	5070	0	19	67	0	5237	21	1	10465
	% Lights and		98.0%	98.0%	0.0%	100%	97.1%	0.0%	98.3%	95.5%	100%	98.1%
	Heavy		1	106	0	0	2	0	91	1	0	201
	% Heavy		2.0%	2.0%	0.0%	0.0%	2.9%	0.0%	1.7%	4.5%	0.0%	1.9%
	AM TOTAL		5	643	0	2	22	0	1714	3	0	2389
	16:30:00		8	514	0	1	2	0	281	1	0	807
	16:45:00		5	511	0	2	5	0	283	1	0	807
	17:00:00		3	549	0	5	3	0	340	1	0	901
	17:15:00		6	528	0	0	1	0	290	1	0	826
	17:30:00		2	510	0	3	3	0	246	2	0	766
	17:45:00		7	454	0	2	2	0	220	1	1	687
	PM TOTAL		22	2102	0	8	11	0	1194	4	0	3341

groundbreaking by Design



Traffic Counts  
Bardstown Road (US 31E) at Oakland Hills Trail  
1/10/2018

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Groundbreaking by Design

Leg	Bardstown Rd			Broad Run Pkwy			Bardstown Rd		
	Southbound	Westbound	Northbound	U-Turn	Right	Left	U-Turn	Right	Left
Start Time	Left	Thru	U-Turn	Left	Thru	U-Turn	Left	Thru	U-Turn
Direction	Southbound			Westbound			Northbound		
Int Total									
7:00:00	0	100	0	1	0	0	468	3	0
7:15:00	0	160	0	0	0	0	451	2	0
7:30:00	1	172	0	0	1	0	392	6	0
7:45:00	1	208	0	2	0	0	405	0	0
8:00:00	0	172	0	0	1	0	337	2	0
8:15:00	2	158	0	1	0	0	349	0	0
8:30:00	1	149	0	1	0	0	358	1	0
8:45:00	0	156	0	0	0	0	306	0	0
16:00:00	12	404	1	6	10	0	257	8	0
16:15:00	8	447	0	5	9	0	243	6	0
16:30:00	10	526	0	9	8	0	274	8	0
16:45:00	4	510	0	2	5	0	252	3	0
17:00:00	6	511	0	11	11	0	308	2	0
17:15:00	10	511	0	5	13	0	344	7	0
17:30:00	3	519	0	10	15	0	286	5	0
17:45:00	6	537	0	9	13	0	227	6	0
<b>Grand Total</b>	<b>64</b>	<b>5240</b>	<b>1</b>	<b>62</b>	<b>86</b>	<b>0</b>	<b>5257</b>	<b>59</b>	<b>0</b>
<b>% Approach</b>	<b>1.2%</b>	<b>98.8%</b>	<b>0.0%</b>	<b>41.9%</b>	<b>58.1%</b>	<b>0.0%</b>	<b>98.9%</b>	<b>1.1%</b>	<b>0.0%</b>
<b>% Total</b>	<b>0.6%</b>	<b>48.7%</b>	<b>0.0%</b>	<b>0.6%</b>	<b>0.8%</b>	<b>0.0%</b>	<b>48.8%</b>	<b>0.5%</b>	<b>0.0%</b>
<b>Lights and M</b>	<b>63</b>	<b>5151</b>	<b>1</b>	<b>61</b>	<b>86</b>	<b>0</b>	<b>5159</b>	<b>58</b>	<b>0</b>
<b>% Lights and</b>	<b>98.4%</b>	<b>98.3%</b>	<b>100%</b>	<b>98.4%</b>	<b>100%</b>	<b>0.0%</b>	<b>98.1%</b>	<b>98.3%</b>	<b>0.0%</b>
<b>Heavy</b>	<b>1</b>	<b>89</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>98</b>	<b>1</b>	<b>0</b>
<b>% Heavy</b>	<b>1.6%</b>	<b>1.7%</b>	<b>0.0%</b>	<b>1.6%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>1.9%</b>	<b>1.7%</b>	<b>0.0%</b>
<b>PM TOTAL</b>	<b>25</b>	<b>2078</b>	<b>0</b>	<b>35</b>	<b>52</b>	<b>0</b>	<b>1165</b>	<b>20</b>	<b>0</b>
<b>AM TOTAL</b>	<b>2</b>	<b>640</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>1716</b>	<b>11</b>	<b>0</b>
7:00:00	0	100	0	1	0	0	468	3	0
7:15:00	0	160	0	0	0	0	451	2	0
7:30:00	1	172	0	0	1	0	392	6	0
7:45:00	1	208	0	2	0	0	405	0	0
8:00:00	0	172	0	0	1	0	337	2	0
8:15:00	2	158	0	1	0	0	349	0	0
8:30:00	1	149	0	1	0	0	358	1	0
8:45:00	0	156	0	0	0	0	306	0	0
16:00:00	12	404	1	6	10	0	257	8	0
16:15:00	8	447	0	5	9	0	243	6	0
16:30:00	10	526	0	9	8	0	274	8	0
16:45:00	4	510	0	2	5	0	252	3	0
17:00:00	6	511	0	11	11	0	308	2	0
17:15:00	10	511	0	5	13	0	344	7	0
17:30:00	3	519	0	10	15	0	286	5	0
17:45:00	6	537	0	9	13	0	227	6	0
<b>Grand Total</b>	<b>64</b>	<b>5240</b>	<b>1</b>	<b>62</b>	<b>86</b>	<b>0</b>	<b>5257</b>	<b>59</b>	<b>0</b>
<b>% Approach</b>	<b>1.2%</b>	<b>98.8%</b>	<b>0.0%</b>	<b>41.9%</b>	<b>58.1%</b>	<b>0.0%</b>	<b>98.9%</b>	<b>1.1%</b>	<b>0.0%</b>
<b>% Total</b>	<b>0.6%</b>	<b>48.7%</b>	<b>0.0%</b>	<b>0.6%</b>	<b>0.8%</b>	<b>0.0%</b>	<b>48.8%</b>	<b>0.5%</b>	<b>0.0%</b>
<b>Lights and M</b>	<b>63</b>	<b>5151</b>	<b>1</b>	<b>61</b>	<b>86</b>	<b>0</b>	<b>5159</b>	<b>58</b>	<b>0</b>
<b>% Lights and</b>	<b>98.4%</b>	<b>98.3%</b>	<b>100%</b>	<b>98.4%</b>	<b>100%</b>	<b>0.0%</b>	<b>98.1%</b>	<b>98.3%</b>	<b>0.0%</b>
<b>Heavy</b>	<b>1</b>	<b>89</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>98</b>	<b>1</b>	<b>0</b>
<b>% Heavy</b>	<b>1.6%</b>	<b>1.7%</b>	<b>0.0%</b>	<b>1.6%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>1.9%</b>	<b>1.7%</b>	<b>0.0%</b>

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HCS Reports

HCS7 Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	Diane Zimmerman							Intersection	Bardstown Rd at Oakland H							
Agency/Co.	Diane B Zimmerman Traffic Engineering							Jurisdiction								
Date Performed	2/8/2018							East/West Street	Oakland Hills							
Analysis Year	2018							North/South Street	Bardstown Road							
Time Analyzed	AM Peak							Peak Hour Factor	0.97							
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25							
Project Description	Oakland Hills															
Lanes																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		1	0	1	0	0	2	0	0	1	2	0
Configuration						L		R			T	TR		L	T	
Volume, V (veh/h)						2		22			1714	3		5	643	
Percent Heavy Vehicles (%)						0		4						20		
Proportion Time Blocked																
Percent Grade (%)							0									
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						
Critical and Follow-up Headways																
Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						2		23						5		
Capacity, c (veh/h)						106		284						280		
v/c Ratio						0.02		0.08						0.02		
95% Queue Length, Q <sub>95</sub> (veh)						0.1		0.3						0.1		
Control Delay (s/veh)						39.8		18.8						18.1		
Level of Service, LOS						E		C						C		
Approach Delay (s/veh)						20.5								0.1		
Approach LOS						C										

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HCS7 Two-Way Stop-Control Report																	
General Information								Site Information									
Analyst	Diane Zimmerman							Intersection	Bardstown Rd at Oakland H								
Agency/Co.	Diane B Zimmerman Traffic Engineering							Jurisdiction									
Date Performed	3/6/18							East/West Street	Oakland Hills								
Analysis Year	2030							North/South Street	Bardstown Road								
Time Analyzed	AM Peak No Build							Peak Hour Factor	0.97								
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25								
Project Description	Oakland Hills																
Lanes																	
<p style="text-align: center;">Major Street: North-South</p>																	
Vehicle Volumes and Adjustments																	
Approach	Eastbound				Westbound				Northbound				Southbound				
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6	
Number of Lanes		0	0	0		1	0	1	0	0	2	0	0	1	2	0	
Configuration						L		R			T	TR		L	T		
Volume, V (veh/h)						57		332			1931	21		109	725		
Percent Heavy Vehicles (%)						0		4						20			
Proportion Time Blocked																	
Percent Grade (%)						0											
Right Turn Channelized		No				No				No				No			
Median Type/Storage		Left Only										1					
Critical and Follow-up Headways																	
Base Critical Headway (sec)																	
Critical Headway (sec)																	
Base Follow-Up Headway (sec)																	
Follow-Up Headway (sec)																	
Delay, Queue Length, and Level of Service																	
Flow Rate, v (veh/h)						59		342						112			
Capacity, c (veh/h)						66		236						220			
v/c Ratio						0.90		1.45						0.51			
95% Queue Length, Q <sub>95</sub> (veh)						4.3		19.8						2.6			
Control Delay (s/veh)						186.9		264.2						37.2			
Level of Service, LOS						F		F						E			
Approach Delay (s/veh)						252.9								4.9			
Approach LOS						F											

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HCS7 Two-Way Stop-Control Report												
General Information						Site Information						
Analyst	Diane Zimmerman					Intersection	Bardstown Rd at Oakland H					
Agency/Co.	Diane B Zimmerman Traffic Engineering					Jurisdiction						
Date Performed	3/6/2018					East/West Street	Oakland Hills					
Analysis Year	2030					North/South Street	Bardstown Road					
Time Analyzed	AM Peak Build					Peak Hour Factor	0.97					
Intersection Orientation	North-South					Analysis Time Period (hrs)	0.25					
Project Description	Oakland Hills											
Lanes												
Vehicle Volumes and Adjustments												
Approach	Eastbound			Westbound			Northbound			Southbound		
Movement	U	L	T	R	L	T	U	L	T	R	L	T
Priority	10	11	12	7	8	9	1U	1	2	3	4U	5
Number of Lanes	0	0	0	1	0	1	0	0	0	2	1	0
Configuration				L		R	T		R	L		T
Volume, V (veh/h)				8		312			1931	23		92
Percent Heavy Vehicles (%)				0		4						20
Proportion Time Blocked				0.300		0.300			0.000	0.000		0.300
Percent Grade (%)	0											
Right Turn Channelized	No											
Median Type/Storage	Left Only											
Approach LOS	C			C			C			D		
Approach Delay (s/veh)	18.0			17.0			30.6			3.2		
Level of Service, LOS	F			C			D			D		
Control Delay (s/veh)	55.2			17.0			30.6			3.2		
95% Queue Length, Q <sub>95</sub> (veh)	0.3			3.0			1.9			0.41		
v/c Ratio	0.10			0.52			0.41			0.41		
Capacity, c (veh/h)	80			617			233			95		
Flow Rate, v (veh/h)	8			322			617			233		
Critical and Follow-up Headways												
Base Critical Headway (sec)												
Critical Headway (sec)												
Base Follow-Up Headway (sec)												
Follow-Up Headway (sec)												
Delay, Queue Length, and Level of Service												
Flow Rate, v (veh/h)												
Capacity, c (veh/h)												
v/c Ratio												
95% Queue Length, Q <sub>95</sub> (veh)												
Control Delay (s/veh)												
Level of Service, LOS												
Approach Delay (s/veh)												
Approach LOS												

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Oakland Hills  
Traffic Impact Study

HCS7 Two-Way Stop-Control Report																
General Information								Site Information								
Analyst	Diane Zimmerman							Intersection	Bardstown Rd at Oakland H							
Agency/Co.	Diane B Zimmerman Traffic Engineering							Jurisdiction								
Date Performed	2/8/2018							East/West Street	Oakland Hills							
Analysis Year	2018							North/South Street	Bardstown Road							
Time Analyzed	PM Peak							Peak Hour Factor	0.93							
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25							
Project Description	Oakland Hills															
Lanes																
<p style="text-align: center;">Major Street: North-South</p>																
Vehicle Volumes and Adjustments																
Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		1	0	1	0	0	2	0	0	1	2	0
Configuration						L		R			T	TR		L	T	
Volume, V (veh/h)						8		11			1194	4		22	2102	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked						0.000		0.000			0.000	0.000		0.000	0.000	
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						
Critical and Follow-up Headways																
Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																
Delay, Queue Length, and Level of Service																
Flow Rate, v (veh/h)						9		12							24	
Capacity, c (veh/h)						119		420							545	
v/c Ratio						0.07		0.03							0.04	
95% Queue Length, Q <sub>95</sub> (veh)						0.2		0.1							0.1	
Control Delay (s/veh)						37.5		13.8							11.9	
Level of Service, LOS						E		B							B	
Approach Delay (s/veh)		23.8								0.1						
Approach LOS		C														

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PLANNING & DESIGN SERVICES

Oakland Hills  
Traffic Impact Study

HCS7 Two-Way Stop-Control Report																	
General Information								Site Information									
Analyst	Diane Zimmerman							Intersection	Bardstown Rd at Oakland H								
Agency/Co.	Diane B Zimmerman Traffic Engineering							Jurisdiction									
Date Performed	3/6/18							East/West Street	Oakland Hills								
Analysis Year	2030							North/South Street	Bardstown Road								
Time Analyzed	PM Peak No Build							Peak Hour Factor	0.93								
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25								
Project Description	Oakland Hills Original																
<b>Lanes</b>																	
<p>Major Street: North-South</p>																	
<b>Vehicle Volumes and Adjustments</b>																	
Approach	Eastbound				Westbound				Northbound				Southbound				
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6	
Number of Lanes		0	0	0		1	0	1	0	0	2	1	0	1	2	0	
Configuration						L		R			T	R		L	T		
Volume, V (veh/h)						43		212			1345	64		365	2369		
Percent Heavy Vehicles (%)						0		0						0			
Proportion Time Blocked						0.300		0.300			0.000	0.000		0.300	0.000		
Percent Grade (%)	0																
Right Turn Channelized	No				No				No				No				
Median Type/Storage	Left Only								1								
<b>Critical and Follow-up Headways</b>																	
Base Critical Headway (sec)																	
Critical Headway (sec)																	
Base Follow-Up Headway (sec)																	
Follow-Up Headway (sec)																	
<b>Delay, Queue Length, and Level of Service</b>																	
Flow Rate, v (veh/h)						46		228						392			
Capacity, c (veh/h)						20		764						544			
v/c Ratio						2.27		0.30						0.72			
95% Queue Length, Q <sub>95</sub> (veh)						6.1		1.3						5.9			
Control Delay (s/veh)						978.8		11.7						26.9			
Level of Service, LOS						F		B						D			
Approach Delay (s/veh)					174.8								3.6				
Approach LOS					F												

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Oakland Hills  
Traffic Impact Study

HCS7 Two-Way Stop-Control Report																	
General Information								Site Information									
Analyst	Diane Zimmerman							Intersection	Bardstown Rd at Oakland H								
Agency/Co.	Diane B Zimmerman Traffic Engineering							Jurisdiction									
Date Performed	3/6/2018							East/West Street	Oakland Hills								
Analysis Year	2030							North/South Street	Bardstown Road								
Time Analyzed	PM Peak Build							Peak Hour Factor	0.93								
Intersection Orientation	North-South							Analysis Time Period (hrs)	0.25								
Project Description	Oakland Hills																
<b>Lanes</b>																	
<p style="text-align: center;">Major Street North-South</p>																	
<b>Vehicle Volumes and Adjustments</b>																	
Approach	Eastbound				Westbound				Northbound				Southbound				
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6	
Number of Lanes		0	0	0		1	0	1	0	0	2	1	0	1	2	0	
Configuration						L		R			T	R		L	T		
Volume, V (veh/h)						12		200			1345	70		305	2405		
Percent Heavy Vehicles (%)						0		0						0			
Proportion Time Blocked						0.300		0.300			0.000	0.000		0.300	0.000		
Percent Grade (%)						0											
Right Turn Channelized		No				No				No				No			
Median Type/Storage		Left Only										1					
<b>Critical and Follow-up Headways</b>																	
Base Critical Headway (sec)																	
Critical Headway (sec)																	
Base Follow-Up Headway (sec)																	
Follow-Up Headway (sec)																	
<b>Delay, Queue Length, and Level of Service</b>																	
Flow Rate, v (veh/h)						13		215							328		
Capacity, c (veh/h)						32		764							539		
v/c Ratio						0.41		0.28							0.61		
95% Queue Length, Q <sub>95</sub> (veh)						1.3		1.2							4.0		
Control Delay (s/veh)						182.5		11.6							21.5		
Level of Service, LOS						F		B							C		
Approach Delay (s/veh)						21.2								2.4			
Approach LOS						C											

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HCS7 Signalized Intersection Results Summary

General Information															
Agency	Diane B. Zimmerman Traffic Engineering														
Analyst	DBZ														
Jurisdiction	AM Peak														
Urban Street	Bardstown Road														
Intersection	Bardstown Road														
Project Description	Oakland Hills														
Demand Information															
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v, veh/h)				3	0	1	3	0	1	1716	11	2	640		
Signal Information															
Cycle, s	69.9														
Reference Phase	2														
Offset, s	0														
Reference Point	End														
Uncoordinated	Yes														
Simult. Gap E/W	On														
Force Mode	Fixed														
Simult. Gap N/S	On														
Green Extension Time (g <sub>e</sub> ), s	0.0														
Queue Clearance Time (g <sub>s</sub> ), s	2.1														
Max Allow Headway (MAH), s	5.0														
Change Period, (Y+R <sub>c</sub> ), s	6.6														
Phase Duration, s	7.2														
Case Number	11.0														
Assigned Phase	8														
Assigned Movement	L	T	R	L	T	R	L	T	R	L	T	R	L	T	R
Adjusted Flow Rate (v), veh/h	3	8	18	3	8	18	3	8	18	939	938	2	696		
Adjusted Saturation Flow Rate (s), veh/h/in	1810	1610	1900	1896	247	1809									
Queue Service Time (g <sub>s</sub> ), s	0.1														
Cycle Queue Clearance Time (g <sub>c</sub> ), s	0.1														
Green Ratio (g/C)	0.01														
Capacity (c), veh/h	15														
Volume-to-Capacity Ratio (X)	0.222														
Back of Queue (Q), ft/in (90 th percentile)	4.2														
Back of Queue (Q), veh/in (90 th percentile)	0.2														
Queue Storage Ratio (RQ) (90 th percentile)	0.00														
Uniform Delay (d <sub>1</sub> ), s/veh	34.4														
Incremental Delay (d <sub>2</sub> ), s/veh	10.4														
Initial Queue Delay (d <sub>3</sub> ), s/veh	0.0														
Control Delay (d), s/veh	44.9														
Level of Service (LOS)	D														
Approach Delay, s/veh / LOS	0.0	43.2			2.8			1.7			A				
Intersection Delay, s/veh / LOS	2.5														
Multimodal Results															
Bicycle LOS Score / LOS	EB			WB			NB			SB					
Pedestrian LOS Score / LOS	B			B			B			A					
Bicycle LOS Score / LOS	2.14			2.31			2.04			1.06					

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HCS7 Signalized Intersection Results Summary

General Information											
Agency	Diane B. Zimmerman Traffic Engineering										
Analyst	DBZ										
Analysis Date	Mar 6, 2018										
Area Type	Other										
Time Period	AM Peak										
Analysis Year	2030 No Build										
File Name	Broad Run AM 30 NB Org Plan.xus										
Project Description	Oakland Hills Original Plan										
Demand Information											
Approach Movement	L	T	R	L	T	R	L	T	R	L	T
Demand (v), veh/h				3			1			2244	12
Signal Information											
Cycle, s	103.8										
Reference Phase	2										
Reference Point	End										
Offset, s	0										
Uncoordinated	Yes										
Force Mode	Fixed										
Simult. Gap N/S	On										
Simult. Gap E/W	On										
Green	90.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow	5.1	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red	1.3	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Timer Results											
Assigned Phase	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT			
Case Number	8										
Phase Duration, s	96.4										
Change Period (Y+Rc), s	6.4										
Max Allow Headway (MAH), s	4.9										
Queue Clearance Time (g <sub>s</sub> ), s	91.2										
Green Extension Time (g <sub>e</sub> ), s	0.0										
Phase Call Probability	1.00										
Max Out Probability	1.00										
Movement Group Results											
Approach Movement	L	T	R	L	T	R	L	T	R	L	T
Assigned Movement				18			2			12	1
Adjusted Flow Rate (V), veh/h	3			1			1226			2	897
Adjusted Saturation Flow Rate (s), veh/h/in	1810			1610			1900			1896	140
Queue Service Time (g <sub>s</sub> ), s	0.2			0.1			87.6			25.3	1.6
Cycle Queue Clearance Time (g <sub>c</sub> ), s	0.2			0.1			87.6			25.3	89.2
Green Ratio (g/C)	0.01			0.01			0.87			0.87	0.87
Capacity (c), veh/h	14			13			1647			1644	73
Volume-to-Capacity Ratio (X)	0.226			0.085			0.744			0.746	0.030
Back of Queue (Q), ft/in (90th percentile)	5.6			1.8			41.6			42.1	2.6
Back of Queue (Q), veh/in (90th percentile)	0.2			0.1			1.7			1.7	0.1
Queue Storage Ratio (RQ) (90th percentile)	0.00			0.00			0.00			0.00	0.00
Uniform Delay (d <sub>1</sub> ), s/veh	51.2			51.1			2.6			2.6	50.3
Incremental Delay (d <sub>2</sub> ), s/veh	10.9			4.0			2.0			2.0	0.1
Initial Queue Delay (d <sub>3</sub> ), s/veh	0.0			0.0			0.0			0.0	0.0
Control Delay (d), s/veh	62.1			55.1			4.6			4.7	50.5
Level of Service (LOS)	E			E			A			A	A
Approach Delay, s/veh / LOS	0.0			60.3			4.6			A	1.4
Intersection Delay, s/veh / LOS	3.8										
Multimodal Results											
EB	WB	NB	SB								
Pedestrian LOS Score / LOS	2.15	B	2.32	B	1.79	B	0.60	A			
Bicycle LOS Score / LOS							2.51	C	1.23	A	

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Oakland Hills Traffic Impact Study

HCS7 Signalized Intersection Results Summary

<b>General Information</b>		Agency: Diane B. Zimmerman Traffic Engineering	Duration, h: 0.25
Analyst: DBZ	Analysis Date: Mar 6, 2018	Area Type: Other	
Jurisdiction:	Time Period: AM Peak	PHF: 0.92	
Urban Street: Bardstown Road	Analysis Year: 2030 Build	Analysis Period: 1 > 7:00	
Intersection: Broad Run Parkway	File Name: Broad Run AM 30 B Oak xus		
Project Description: Oakland Hills			

<b>Demand Information</b>		Approach Movement: L T R	Demand (v, veh/h): L 58 T 35 R 24
		Approach Movement: EB WB NB SB	

<b>Signal Information</b>		Cycle, s: 109.7	Reference Phase: 2
Offset, s: 0	Reference Point: End	Green: 90.0	Yellow: 5.1
Uncoordinated: Yes	Simult. Gap E/W: On	Red: 1.3	3.0
Force Mode: Fixed	Simult. Gap N/S: On		

<b>Timer Results</b>		EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase: 6	Case Number: 8.0	9.0	9.0	13.3	96.4	96.4	6.4	6.4	96.4
Phase Duration, s: 6.0	Change Period, (Y+R+c), s: 6.4	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (MAH), s: 92.0	Queue Clearance Time (g+s), s: 2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Green Extension Time (g+e), s: 1.00	Phase Call Probability: 1.00	0.00	0.00	0.95	1.00	1.00	1.00	1.00	1.00
Max Out Probability: 1.00									

<b>Movement Group Results</b>		EB	WB	NB	SB
Approach Movement: L T R	Assigned Movement: L T R	18	12	1	6
Adjusted Flow Rate (v), veh/h: 63	Adjusted Saturation Flow Rate (s), veh/h/in: 1810	38	1215	26	878
Adjusted Saturation Flow Rate (s), veh/h/in: 1810	Queue Service Time (g+s), s: 3.7	2.5	85.4	35.1	6.3
Cycle Queue Clearance Time (g+c), s: 3.7	Green Ratio (g/c): 0.06	0.06	0.82	0.82	0.82
Capacity (c), veh/h: 110	Capacity (c), veh/h: 98	1559	1556	72	2968
Volume-to-Capacity Ratio (X): 0.572	Volume-to-Capacity Ratio (X): 0.779	0.779	0.781	0.364	0.296
Back of Queue (Q), ft/in (90 th percentile): 81.3	Back of Queue (Q), ft/in (90 th percentile): 47.5	232.3	232.7	34.9	38.8
Back of Queue (Q), veh/in (90 th percentile): 3.3	Back of Queue (Q), veh/in (90 th percentile): 1.9	9.3	9.3	1.4	1.6
Queue Storage Ratio (RQ) (90 th percentile): 0.00	Queue Storage Ratio (RQ) (90 th percentile): 0.00	0.00	0.00	0.00	0.00
Uniform Delay (d), s/veh: 50.1	Uniform Delay (d), s/veh: 49.5	4.9	4.9	54.3	2.3
Incremental Delay (d2), s/veh: 6.5	Incremental Delay (d2), s/veh: 3.5	2.8	2.8	4.4	0.1
Initial Queue Delay (d3), s/veh: 0.0	Initial Queue Delay (d3), s/veh: 0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh: 56.6	Control Delay (d), s/veh: 53.1	7.7	7.7	58.7	2.4
Level of Service (LOS): E	Level of Service (LOS): D	E	A	E	A
Approach Delay, s/veh / LOS: 0.0	Approach Delay, s/veh / LOS: 55.3	7.7	7.7	4.0	A
Intersection Delay, s/veh / LOS: 8.1	Intersection Delay, s/veh / LOS: 8.1				

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HCS7 Signalized Intersection Results Summary

General Information															
Agency	Diane B. Zimmerman Traffic Engineering														
Analyst	DBZ														
Jurisdiction	2/8/2018														
Urban Street	Bardstown Road														
Intersection	Broad Run Parkway														
Project Description	Oakland Hills														
Intersection Information															
Duration, h	0.25														
Area Type	Other														
PHF	0.95														
Analysis Period	1 > 5:00														
Analysis Year	2018														
File Name	Broad Run PM 18.xus														
Demand Information															
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				35			52			1165	20	25	2078		
Signal Information															
Cycle, s	100.3														
Reference Phase	2														
Reference Point	End														
Offset, s	0														
Uncoordinated	Yes														
Simult. Gap E/W	On														
Simult. Gap N/S	On														
Force Mode	Fixed														
Green Extension Time (g <sub>e</sub> ), s	49.1														
Queue Clearance Time (g <sub>c</sub> ), s	31.8														
Max Allow Headway (MAH), s	4.9														
Change Period, (Y+R <sub>c</sub> ), s	6.4														
Phase Duration, s	87.3														
Case Number	6.0														
Assigned Phase	SBT														
Timer Results															
Assigned Phase	EBL	EBS	EBT	WBL	WBS	WBT	NBL	NBS	NBT	SBL	SBS	SBT			
Phase Duration, s													6.0		
Change Period, (Y+R <sub>c</sub> ), s													6.4		
Max Allow Headway (MAH), s													4.9		
Queue Clearance Time (g <sub>c</sub> ), s													31.8		
Green Extension Time (g <sub>e</sub> ), s													49.1		
Phase Call Probability													1.00		
Max Out Probability													0.79		
Movement Group Results															
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement															
Adjusted Flow Rate (v), veh/h															
Adjusted Saturation Flow Rate (s), veh/h/in															
Queue Service Time (g <sub>s</sub> ), s															
Cycle Queue Clearance Time (g <sub>c</sub> ), s															
Green Ratio (g/c)															
Capacity (c), veh/h															
Volume-to-Capacity Ratio (X)															
Back of Queue (Q), ft/in (90 th percentile)															
Back of Queue (Q), veh/in (90 th percentile)															
Queue Storage Ratio (R <sub>Q</sub> ) (90 th percentile)															
Uniform Delay (d <sub>i</sub> ), s/veh															
Incremental Delay (d <sub>2</sub> ), s/veh															
Initial Queue Delay (d <sub>3</sub> ), s/veh															
Control Delay (d <sub>i</sub> ), s/veh															
Level of Service (LOS)															
Approach Delay, s/veh / LOS															
Intersection Delay, s/veh / LOS															
Multimodal Results															
Bicycle LOS Score / LOS															
Pedestrian LOS Score / LOS															
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Oakland Hills Traffic Impact Study

HCS7 Signalized Intersection Results Summary

General Information											
Agency	Diane B. Zimmerman Traffic Engineering										
Analyst	DBZ										
Jurisdiction	Mar 6, 2018										
Urban Street	Bardstown Road										
Intersection	Broad Run Parkway										
Project Description	Oakland Hills Original Plan										
Demand Information											
Approach Movement	L	T	R	L	T	R	L	T	R	L	T
Demand (v), veh/h				39			58			1514	23
Signal Information											
Cycle, s	109.5										
Reference Phase	2										
Reference Point	End	Green	89.8	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Offset, s	0	Reference Point	Green	89.8	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	5.1	3.6	0.0	0.0	0.0	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.3	3.0	0.0	0.0	0.0	0.0	0.0
Timer Results											
Assigned Phase	EBL	EBS	EBT	WBL	WBT	NBL	NBT	SBL	SBT		
Case Number	6.0										
Phase Duration, s	96.2										
Change Period, (Y+Rc), s	6.4										
Max Allow Headway (MAH), s	4.9										
Queue Clearance Time (g*), s	72.2										
Green Extension Time (g*), s	17.6										
Phase Call Probability	1.00										
Max Out Probability	0.99										
Movement Group Results											
Approach Movement	L	T	R	L	T	R	L	T	R	L	T
Assigned Movement				18			2			12	1
Adjusted Flow Rate (v), veh/h	41		61	18		810	808	29	2825	1890	317
Adjusted Saturation Flow Rate (s), veh/h	1810		1610	1810		1900	1890	317	1809	1900	317
Queue Service Time (g*), s	2.4		4.1	2.4		35.8	14.7	5.7	70.2	35.8	14.7
Cycle Queue Clearance Time (g*), s	2.4		4.1	2.4		35.8	14.7	5.7	70.2	35.8	14.7
Green Ratio (g/C)	0.06		0.06	0.06		0.82	0.82	0.82	0.82	0.82	0.82
Capacity (c), veh/h	111		98	111		1558	1550	222	2967	1558	222
Volume-to-Capacity Ratio (X)	0.371		0.621	0.371		0.520	0.521	0.133	0.952	0.520	0.133
Back of Queue (Q), ft/h (90 th percentile)	50.4		80.8	50.4		100.3	100.1	17.7	433.8	100.3	17.7
Back of Queue (Q), veh/h (90 th percentile)	2.0		3.2	2.0		4.0	4.0	0.7	17.4	4.0	0.7
Queue Storage Ratio (RQ) (90 th percentile)	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Uniform Delay (d), s/veh	49.4		50.2	49.4		3.1	3.1	15.5	8.1	3.1	15.5
Incremental Delay (d2), s/veh	2.9		8.8	2.9		0.4	0.4	0.4	8.2	0.4	0.4
Initial Queue Delay (d3), s/veh	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	52.3		59.0	52.3		3.5	3.5	15.8	16.2	3.5	15.8
Level of Service (LOS)	D		E	D		A	A	B	B	A	B
Approach Delay, s/veh / LOS	0.0		56.3	0.0		3.5	3.5	16.2	16.2	3.5	16.2
Intersection Delay, s/veh / LOS	12.6										
Multimodal Results											
Approach	EB	WB	NB	SB							
Pedestrian LOS Score / LOS	2.15	B	2.32	B	1.82	B	0.62	A			
Bicycle LOS Score / LOS							2.84	C			

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**HCS7 Signalized Intersection Results Summary**

General Information										
Agency	Diane B. Zimmerman Traffic Engineering									
Analyst	DBZ									
Jurisdiction	Mar 6, 2018									
Time Period	PM Peak									
Analysis Year	2030 Build									
File Name	Broad Run PM 30 B Oak.xus									
Project Description	Oakland Hills									
Intersection Information										
Intersection	Broad Run Parkway									
Urban Street	Bardstown Road									
Area Type	Other									
Duration, h	0.25									
Analysis Date	Mar 6, 2018									
Area Type	Other									
PHF	0.95									
Analysis Period	1 > 5:00									
File Name	Broad Run PM 30 B Oak.xus									
Project Description	Oakland Hills									
Demand Information										
Demand (V), veh/h	L		T		R		L		R	
Approach Movement	L		T		R		L		R	
Assigned Phase	EBL		EBT		WBL		WBT		NBL	
Case Number	6		8		9		8		2	
Phase Duration, s	96.2		15.1		96.2		96.2		8.0	
Change Period, (Y+Rc), s	6.4		6.6		6.4		6.4		5.0	
Max Allow Headway (MAH), s	5.0		5.1		5.0		5.0		37.3	
Queue Clearance Time (g+), s	71.5		7.7		71.5		71.5		18.4	
Green Extension Time (g+), s	18.4		0.8		18.4		18.4		1.00	
Phase Call Probability	1.00		0.99		1.00		1.00		0.97	
Max Out Probability	0.99		0.00		0.99		0.00		0.00	
Timer Results										
Assigned Phase	EBL		EBT		WBL		WBT		NBL	
Case Number	6		8		9		8		2	
Phase Duration, s	96.2		15.1		96.2		96.2		8.0	
Change Period, (Y+Rc), s	6.4		6.6		6.4		6.4		5.0	
Max Allow Headway (MAH), s	5.0		5.1		5.0		5.0		37.3	
Queue Clearance Time (g+), s	71.5		7.7		71.5		71.5		18.4	
Green Extension Time (g+), s	18.4		0.8		18.4		18.4		1.00	
Phase Call Probability	1.00		0.99		1.00		1.00		0.97	
Max Out Probability	0.99		0.00		0.99		0.00		0.00	
Movement Group Results										
Approach Movement	L		T		R		L		R	
Assigned Movement	L		T		R		L		R	
Adjusted Flow Rate (V), veh/h	79		1810		85		1610		804	
Adjusted Saturation Flow Rate (s), veh/h/in	1810		1610		85		1610		804	
Queue Service Time (g+), s	4.7		5.7		4.7		5.7		35.3	
Cycle Queue Clearance Time (g+), s	4.7		5.7		4.7		5.7		35.3	
Green Ratio (g/c)	0.08		0.08		0.08		0.08		0.81	
Capacity (c), veh/h	138		123		1533		1525		222	
Volume-to-Capacity Ratio (X)	0.570		0.692		0.524		0.526		0.469	
Back of Queue (Q), ft/in (90th percentile)	100.1		114		128.2		128.7		87.6	
Back of Queue (Q), veh/in (90th percentile)	4.0		4.6		5.1		5.1		3.5	
Queue Storage Ratio (Rq) (90th percentile)	0.00		0.00		0.00		0.00		0.00	
Uniform Delay (d), s/veh	49.7		50.1		3.6		3.6		21.4	
Incremental Delay (d2), s/veh	5.2		9.5		0.4		0.4		2.2	
Initial Queue Delay (d3), s/veh	0.0		0.0		0.0		0.0		0.0	
Control Delay (d), s/veh	54.8		59.6		4.0		4.1		23.6	
Level of Service (LOS)	D		E		A		A		C	
Approach Delay, s/veh / LOS	0.0		57.3		4.0		4.0		16.7	
Intersection Delay, s/veh / LOS	13.8		13.8		4.0		4.0		16.7	
Multimodal Results										
Pedestrian LOS Score / LOS	B		B		B		B		B	
Bicycle LOS Score / LOS	2.15		2.32		1.83		1.83		2.85	

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# MEMO

**To:** Lee Hasken  
**From:** Mark O'Hara, HOK  
**Client:** LCFC  
**Project:** LCFC Stadium  
**Project #:** 17.70079.00

**Date:** 7 March 2018  
**Copies To:** Gus Drosos/Brian Ashworth/Rashed Singaby/Steven Holt, HOK  
Bart Miller/Erin Kueht, WPM  
Dan Almond, MST  
Mark Sites/Kent Gootee, Mindel Scott

## RE: Pitch and Concourse Elevation Investigation

As requested, HOK is providing this memo to investigate lowering the pitch and concourse elevations to aid in understanding the potential savings in fill material.

The design team arrived at the current pitch (444.0') and concourse (453.0') elevations with the knowledge of the 100-year floodplain (449.8') and using Slugger Field (approximately 443.5') as a local precedent. It is HOK's understanding that Slugger Field has not been adversely affected by flood waters since its construction.

The relationship between the pitch and concourse elevations are a result of the seating bowl capacity and sight lines, among others. The pitch, concourse and seating bowl should be thought of as a system. This system can move as a whole.

With the pitch elevation at 444.0' the subsurface drainage invert elevation is assumed to be 438.50'. The invert shown on the field subdrainage plan (see sheet PF 1-2) that ties into the storm sewer manhole (see MSD plans) is well above the high water table elevation of 420'. We suggest installing a back water valve at this location in the event that water table does exceed 420'. The fields' subdrainage piping system can also intercept rising water table, and hold for a time in the piping and gravel layer until the water recedes.

With this knowledge, HOK does not oppose investigating the saving to be had in fill material with lowering the pitch and concourse elevations.

The options, in 6" increments are the following:

**Option A: Lower by 0.5'**

Pitch - 443.5'  
Concourse - 452.5'

**Option B: Lower by 1.0'**

Pitch - 443.0'  
Concourse - 452.0'

**Option C: Lower by 1.5'**

Pitch - 442.5'  
Concourse - 451.5'

All options keep the concourse above the 100-year floodplain elevation.

While the field tunnel, dock and service yard are lower than the 100-year flood elevation, this areas is protected by elevations above the 100-year flood elevation.

At this time, these options do not appear to require any significant structural modifications.

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