Manhard CONSULTING

Civil Engineering
Surveying
Water Resources Management
Water & Wastewater Engineering
Construction Management
Environmental Sciences

June 2, 2016

Mr. Tom Williams
Town of Parker
Director of Engineering
20120 E. Mainstreet
Parker, CO 80138

Re: Technical Criteria Variance Request
Roadway Design and Construction Criteria Manual Section 4.2.2.2 Spacing
Compark Village South Filing No.1 and No. 2

Dear Mr. Williams:

On behalf of Compark 470 LLC, in association with Compark Village South Filing No. 1 and No. 2, we are requesting a variance to the minimum intersection spacing on a major collector for full movement (non-signalized). The following details the variance requested:

Legal Description of Subject Property
Compark Village South Filing No. 1 and No. 2 located in the South Half of Section 6, Township 6 South, Range 66 West of the Sixth Principal Meridian, Town of Parker, County of Douglas, State of Colorado.

Variance Requested:

Code Section
Town of Parker Roadway Design and Construction Criteria Manual, dated July 2015, section 4.2.2.2 Spacing, a full movement (non-signalized) intersection must have a minimum spacing of **1,050 ft**.

Describe the Variance Requested
Requesting a variance for the minimum intersection spacing between Hummingbird Street and Sage Grouse Street (see figure 1). The site plan depicts the intersection spacing at approximately 900-ft, 150-ft less than the required 1,050-ft. The subject intersection spacing is a result of the following:

1. Cannot move Sage Grouse Street further to the east without negatively impacting/eliminating the future intersection to the east in PA-16. This future connection will be needed to provide access to the next phase(s) of the Compark Village development and continue the grid layout/view corridors.
2. Duplex lot and alley minimum spacing requirements established block length.
3. Intersection spacing addresses the Town's request for "view corridors". The view corridors commence from Belford and terminate at the landscape

buffer/park between the subject property and Grandview Estates. By moving the proposed intersections to accommodate minimal spacing, the view corridors are lost and the parks and open space become hidden at the south end of the community.

4. The location of Hummingbird Street provides a centralized location for the future Neighborhood Commercial parcel (PA-14).
5. Intersection spacing also resulted from the builder's requirement to separate single-family lots, duplexes, and future developments with right-of-way.

The attached *Traffic Compliance Analysis and Variance Request for Compark Village South Filing No. 1, dated May 27, 2016, by Felsburg, Holt & Ullevig*, analyzed the potential impacts of the requested variance. The Traffic Compliance Analysis did find that the requested variance will not diminish the safety or impact the traffic operations along Belford Avenue.

For the reasons noted above, we respectfully request a minimum standards variance from section 4.2.2.2 of the Town of Parker Roadway Design and Construction Criteria Manual.

Please call if you have any questions or require additional information.

Sincerely,

Manhard Consulting

Gary Iwata, PE

Submitted on behalf of 470 Compark, LLC
Michael Vickers

E-470

PA-13

PA-14

PA-15

PA-16

PA-17

BELFORD AVE.

1,050'

BELFORD AVE. (MAJOR COLLECTOR)

1,480'

900'

FUTURE INTERSECTION

DETENTION POND

GREEN ACRES TRIBUTARY

MEADOWLARK LANE

MEADOWLARK LANE

MEADOWLARK LANE

BALD EAGLE ST.

(VIEW CORRIDOR)

GOLDEN EAGLE ST.

HUMMINGBIRD ST.

(VIEW CORRIDOR)

SAGE GROUSE ST.

RED HAWK LANE

RED HAWK LANE

PARK

LANDSCAPE BUFFER

LANDSCAPE BUFFER

GRANDVIEW ESTATES

GRANDVIEW ESTATES

GRANDVIEW ESTATES

GRANDVIEW ESTATES

N

0 300 600 Feet

COMPARK VILLAGE SOUTH FILING NO. 2
INTERSECTION VARIANCE EXHIBIT
FIGURE 1

FELSBURG HOLT & ULLEVIG

connecting and enhancing communities

May 27, 2016

Mr. David Aden P.E.
Traffic Engineer
Town of Parker
20120 E. Mainstreet
Parker, CO 80138

Re: Traffic Compliance Analysis and Variance Request
Compark Village South Filing No. 1
FHU Reference No. 115360-01

Dear Mr. Aden:

KB Homes is proposing to develop a portion of Compark Village with approximately 192 residential units. The site is located south of E-470 between Peoria Street and Chambers Road in Parker, Colorado. Access to the site would be via Belford Avenue, a future Major Collector roadway that will parallel E-470 between Chambers Road and Peoria Street, bisecting the site. The attached **Figure 1** depicts the study area and primary roadway system.

The overall traffic impacts of this site were addressed in the report entitled *Chambers Crossing Transportation Impact Study*, Fehr & Peers, June 2012. While the Fehr & Peers analyses considered a mix of residential and commercial uses within the Chambers Crossing site, a site plan was not included, and internal roadway and access configurations were not addressed. More recently, the report entitled *Chambers High Point Traffic Impact Analysis*, Felsburg Holt & Ullevig, October, 2015 addressed a mixed-use development on the east side of Compark Village. Our report included traffic volume projections for Belford Avenue based in part on the Fehr & Peers study; however, traffic analyses of the KB Homes site accesses were not conducted.

Although the available documentation in this area does not directly address the traffic impacts specific to the KB Homes site, the Town of Parker has indicated that an abbreviated analysis, rather than a full Traffic Impact Study, may be sufficient for this submittal. Therefore, to address the Town's specific concerns, this brief letter report documents the projected future travel demand, intersection operational conditions, and access requirements associated with the current land use planning for Compark Village.

Land Use and Trip Generation

Figure 2 depicts the current site concept and land use projections for Compark Village. As indicated, the portion of Compark Village located south of Belford Avenue would consist of residential uses, with retail and office/flex uses located along the north side of Belford Avenue. Planning Area (PA) 18 is the first phase of development and consists of the KB Homes proposal for 120 duplex homes and 72 single family detached homes. The remainder of the planning areas within Compark Village would develop as follows:

6300 South Syracuse Way, Suite 600 Centennial, CO 80111 tel 303.721.1440 fax 303.721.0832
www.fhueng.com info@fhueng.com

- PA 13 – 404,082 square feet of office/flex uses.
- PA 14 – 72,868 square feet of neighborhood retail.
- PA 15 – 150,918 square feet of office/flex uses.
- PA 16 – 50 multi-family residential dwelling units.
- PA 17 – 80 multi-family residential dwelling units.

Thus, the total projected land use plan now includes about 555,000 square feet of office/flex, 72,868 square feet of retail, and approximately 322 residential units. The previous land use forecasts, as documented in the Fehr & Peers report, included 477,000 square feet of office/flex/ 45,000 square feet of retail, and 465 residential units. It can be seen that, although the current plan includes somewhat more commercial development than the previous concept, the residential component is now reduced by about 143 dwelling units.

A trip generation analysis of the current Compark Village concept was conducted using data contained in *Trip Generation*, 9th Edition, Institute of Transportation Engineers (ITE), 2012. **Table 1** summarizes the analysis in comparison to the trip generation results extracted from the Fehr & Peers study. Note that, because ITE does not have specific rates for duplexes, the single family rates have been applied for this use.

Table 1. Compark Village Trip Generation Comparison

Planning Area	Land Use	Quantity	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
June 2012 Fehr & Peers Report									
Retail		45.00 KSF	1,932	27	18	45	82	86	168
Single Family Homes		213 DU	2,038	40	120	160	136	80	216
Office/Flex		477 KSF	6,087	573	109	682	142	474	616
Apartments		252 DU	1,676	26	103	129	102	55	157
Total Trip Generation			11,733	666	350	1,016	462	695	1,157
Reduced for Internal Capture (1)			**10,912**	**666**	**350**	**1,016**	**439**	**660**	**1,099**
Current Site Concept									
PA 13	Office/Flex	404.08 KSF	5,030	480	85	565	130	380	510
PA 14	Retail	72.87 KSF	3,110	45	25	70	130	140	270
PA 15	Office/Flex	150.92 KSF	1,880	180	30	210	50	140	190
PA 16	Multi-Family	50 DU	330	5	20	25	20	10	30
PA 17	Multi-Family	80 DU	530	10	30	40	30	20	50
PA 18	SF/Duplex	192 DU	1,830	35	110	145	125	65	190
Total Trip Generation			12,710	755	300	1,055	485	755	1,240
Reduced for Internal Capture (1)			**11,820**	**755**	**300**	**1,055**	**460**	**720**	**1,180**
Percent Change from Previous Plan			**+8.3%**			**+3.8%**			**+7.4%**
1. Internal reductions of 7% daily and 5% PM peak hour applied per Fehr & Peers report.									

As can be seen, the current concept for Compark Village would represent a slight increase in trip generation in comparison to the previous plan. On a daily basis, the potential increase would be about 8.3 percent. Peak hour increases would range between about 3.8 and 7.4 percent.

Trip Distribution and Site Generated Traffic Assignment

The above site generated trips for the current site concept were assigned to the proposed site accesses along Belford Avenue based on the trip distribution documented in the Fehr & Peers report, with 55 percent oriented to/from the east and 45 percent oriented to/from the west. The trip distribution and resultant site generated traffic assignment is depicted on **Figure 3**. As shown, Compark Village would contribute approximately 6,500 vehicles per day (VPD) to Belford Avenue east of the site, and about 5,320 VPD to the west.

Background Traffic

Background traffic represent the component of roadway volumes that is unrelated to the site. For this analysis, year 2035 projections were based on our previous analyses for Chambers High Point. These volumes are depicted on the attached **Figure 4**. It can be seen that Belford Avenue would carry about 5,600 VPD in background volumes, with about 465 to 525 vehicles per hour (VPH) during the AM and PM peak hours.

Total Traffic Conditions

The site generated traffic volumes (**Figure 3**) were added to the 2035 background volumes (**Figure 4**) to obtain the total projected traffic volumes depicted on **Figure 5**. As shown, Belford Avenue within the study area would experience between about 10,920 and 12,100 VPD in 2035.

The peak hour traffic volumes were used as the basis for intersection level of service (LOS) computations, the results of which are also summarized on the figure. LOS is a qualitative measure of traffic operational conditions, based on roadway capacity and motorist delay. The 2010 *Highway Capacity Manual* defines six levels of service, ranging from A to F, with LOS A representing the best possible operating conditions and LOS F representing over-capacity, or congested conditions. In urbanized areas, LOS D is typically considered to be acceptable for peak hour traffic operations.

As indicated on **Figure 5**, the projected traffic operations at the study area intersections would be generally acceptable during the peak hours. One exception is the southbound left-turn movement from PA 14, which would experience near-capacity conditions (LOS E) and some delay during the PM peak hour. Note that, of the three accesses serving the commercial developments, only the westernmost (PA 13/18) would be expected to meet signal warrants. All other accesses would function as unsignalized intersections. The easternmost site access (PA 16) is projected to be restricted to right-in/right-out movements. LOS worksheets are included in the attachments to this letter.

Storage Requirements

The projected traffic volumes along Belford Avenue were evaluated relative to Town of Parker criteria for auxiliary lane requirements. Belford Avenue is classified as a Major Collector, with a posted speed limit of 35 miles per hour (MPH). Left-turn storage lanes are required where the associated movement is 25 VPH or more, with a minimum of 100 feet of storage plus 144 feet of transition taper. Right-turn deceleration lanes are required when the associated movement is 50 VPH or more, with 226 feet of deceleration length plus 144 feet of lead-in taper. As shown on

Figure 6, left-turn storage lanes are anticipated at the three full-movement site accesses. Right-turn deceleration lanes would be needed along westbound Belford Avenue entering the commercial site accesses only; traffic volumes entering the residential accesses from eastbound Belford Avenue would be insufficient to warrant right-turn deceleration lanes. At the westernmost site access (PA 13/18), the eastbound left-turn storage requirement would be increased to 215 feet based on the projected AM peak hour turning volume.

As a part of the LOS analyses, the 95th percentile maximum probable queue lengths are calculated. These projected queue lengths were extracted from the LOS worksheets (attached) and compared to the above storage requirements as summarized in **Table 2**.

Table 2. Queues

Access	Movement	95% Max Queue (ft)		Storage (ft)
		AM Peak Hour	PM Peak Hour	
PA 13/18	EB Left	90	30	215
	WB Left	9	21	100
	WB Right	0	0	226
PA 14/17/18	EB Left	3	5	100
	WB Left	0	3	100
	WB Right	0	0	226
PA 15/16/17	EB Left	8	3	100
	WB Left	0	3	100
	WB Right	0	0	226

As indicated, the proposed storage lengths would be sufficient to accommodate the anticipated vehicle queues.

Access Spacing

Per Town of Parker standards, the minimum spacing along Major Collectors is 1,320 feet between full-movement signalized intersections and 1,050 feet between full-movement unsignalized intersections. The minimum spacing for restricted movement intersections is 305 feet.

The approximate distances between the proposed site accesses are included on **Figure 6**. As indicated, the westernmost two accesses exceed the minimum spacing of 1,320 feet for full-movement signalized intersections. The next access to the east would be spaced at 900 feet, which is about 150 feet less than the Town standard of 1,050 feet, and would, therefore, require a variance. The proposed right-in/right-out access could be spaced at about 1,050 feet to maintain flexibility in future planning efforts.

As noted above, the proposed spacing of 900 feet between the middle two accesses (PA 14/18/17 and PA 15/16/17) is somewhat less than required per Town standards. However, the back-to back left-turn storage requirements for these accesses is only 200 feet total, plus 288 feet of taper, which can easily be accommodated within the proposed spacing. As previously discussed, the projected queue lengths would be well within the storage requirements, and traffic operations along Belford Avenue would not be impacted as a result of the proposed spacing. Based on this, a variance from the Town of Parker spacing criteria could be supported.

Summary and Conclusions

KB Homes is proposing to develop a portion of Compark Village with approximately 192 residential units. Access to the site would be via Belford Avenue, a future Major Collector bisecting the site. The current buildout plan for Compark Village includes about 555,000 square feet of office/flex, 72,868 square feet of retail, and approximately 322 residential units, which represents somewhat more commercial development than previously considered. However, the residential component has been reduced from 465 dwelling units to 322 units. Due to the increase in potential commercial uses, the current concept for Compark Village would represent increases in trip generation of between about 3.8 and 8.3 percent, as compared to the previous plan.

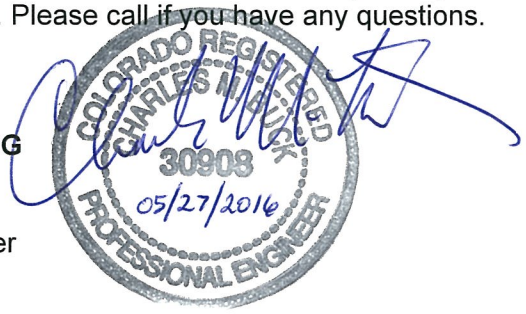
The projected traffic operations at the site accesses along Belford Avenue would be generally acceptable through 2035. Relative to this, the following access improvements are anticipated:

- **PA 13/18.** Full-movement access. Signalize when warranted. Provide left-turn lanes on the eastbound and westbound approaches on Belford Avenue. Eastbound left-turn storage of 215 feet plus 144 feet of taper required. Westbound left-turn storage of 100 feet plus 144 feet of taper required. Provide a westbound right-turn deceleration lane of 226 feet deceleration length plus 144 feet transition taper.
- **PA 14/17/18.** Full-movement access. STOP sign control on the northbound and southbound approaches to Belford Avenue. Provide left-turn storage lanes on the eastbound and westbound approaches on Belford Avenue. Left-turn storage of 100 feet plus 144 feet of taper required for each. Provide a westbound right-turn deceleration lane of 226 feet deceleration length plus 144 feet transition taper.
- **PA 15/16/17.** Full-movement access. STOP sign control on the northbound and southbound approaches to Belford Avenue. Provide left-turn storage on eastbound and westbound approaches on Belford Avenue. Left-turn storage of 100 feet plus 144 feet of taper required for each. Provide a westbound right-turn deceleration lane of 226 feet deceleration length plus 144 feet of taper.
- **PA 16.** Right-in/right-out access. STOP sign control on the northbound approach to Belford Avenue. Auxiliary lanes not required at this access.

The proposed spacing of approximately 900 feet between the middle two site accesses is about 150 feet less than required per the Town's standard of 1,050 feet. However, the back-to back left-turn lane requirement for these accesses is only 200 feet of storage plus 288 feet of taper, which can be accommodated within the proposed spacing. Because the projected queue lengths would be well within the storage requirements, and because traffic operations along Belford Avenue would not be impacted as a result, a variance from the Town of Parker's spacing requirements is respectfully requested.

We trust the analyses documented in this letter will assist you in your review of the Compark Village development proposal. Please call if you have any questions.

Sincerely,



FELSBURG HOLT & ULLEVIG

Charles M. Buck, P.E., PTOE
Senior Transportation Engineer

Attachments

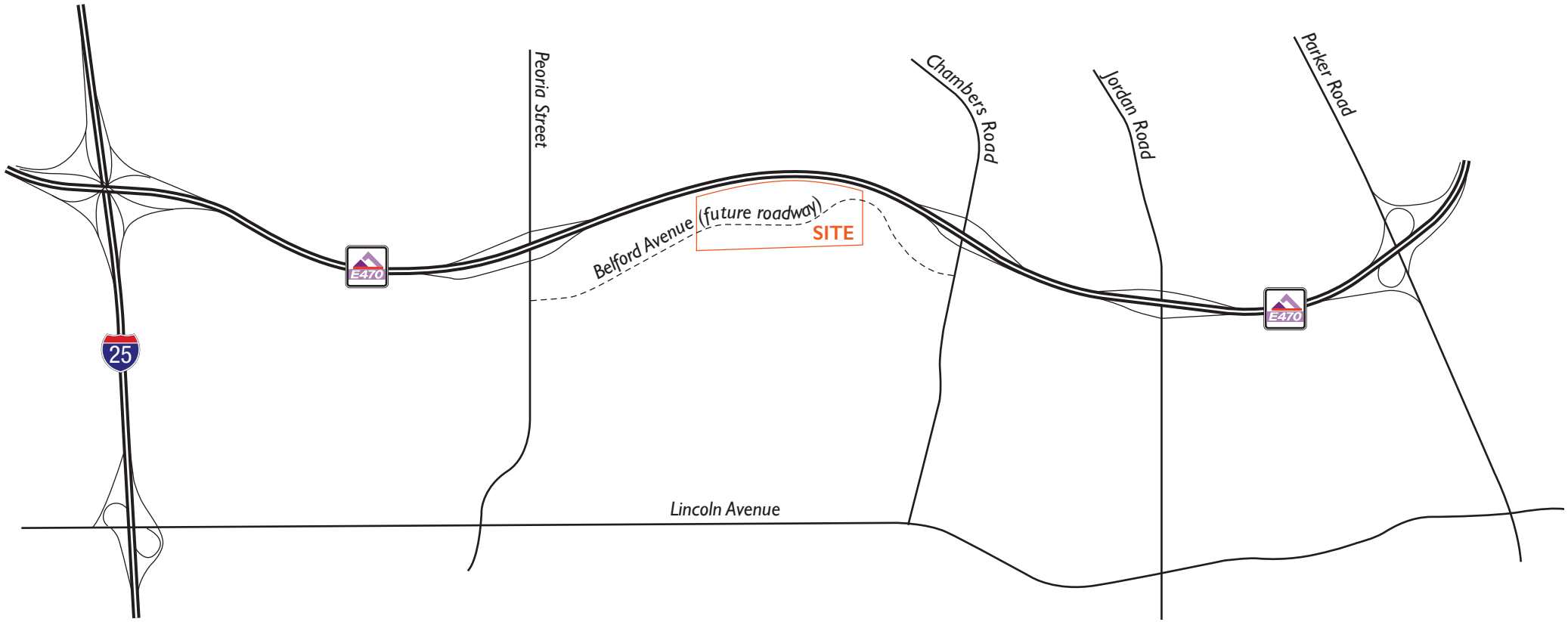


Figure 1
Vicinity Map

FELSBURG HOLT & ULLEVIG

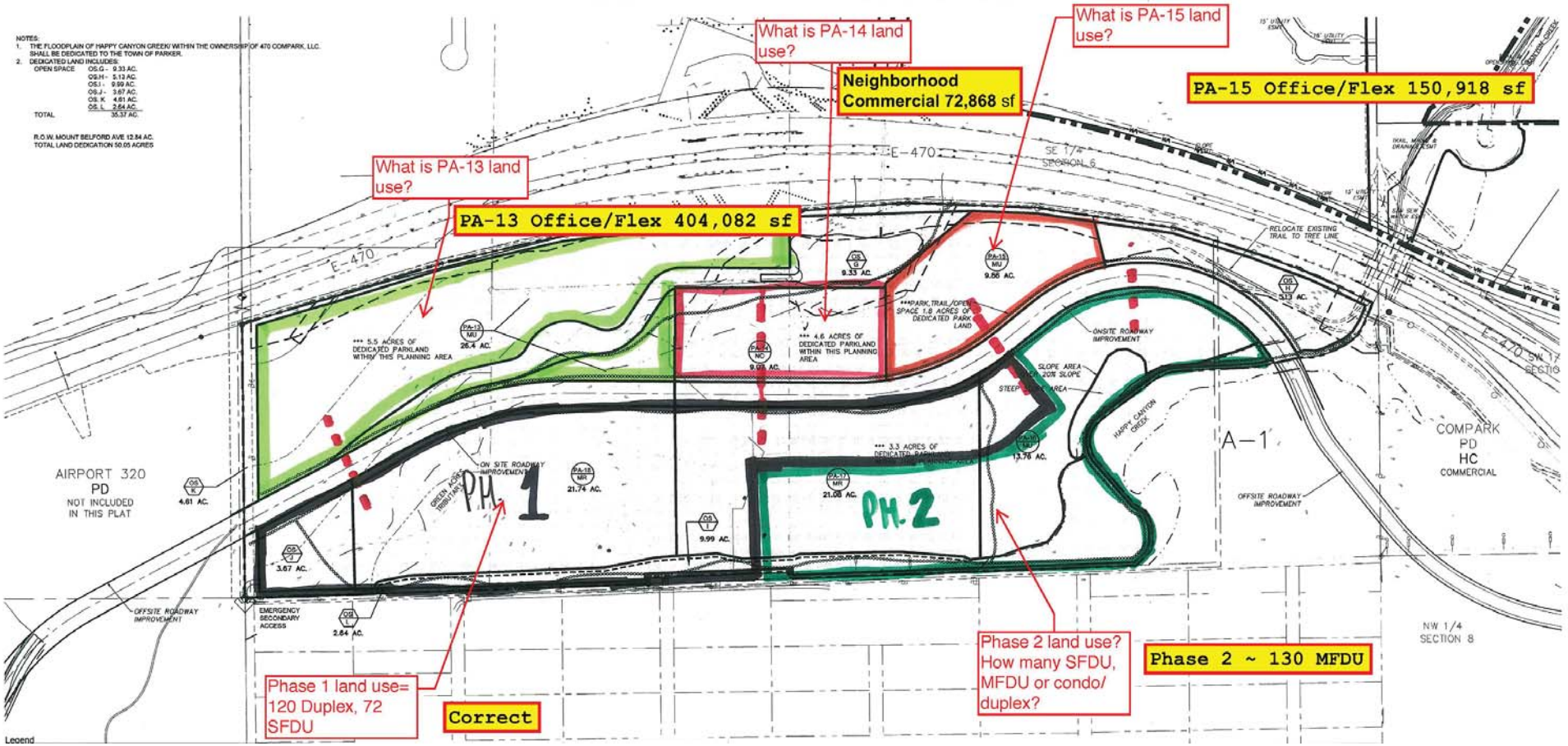
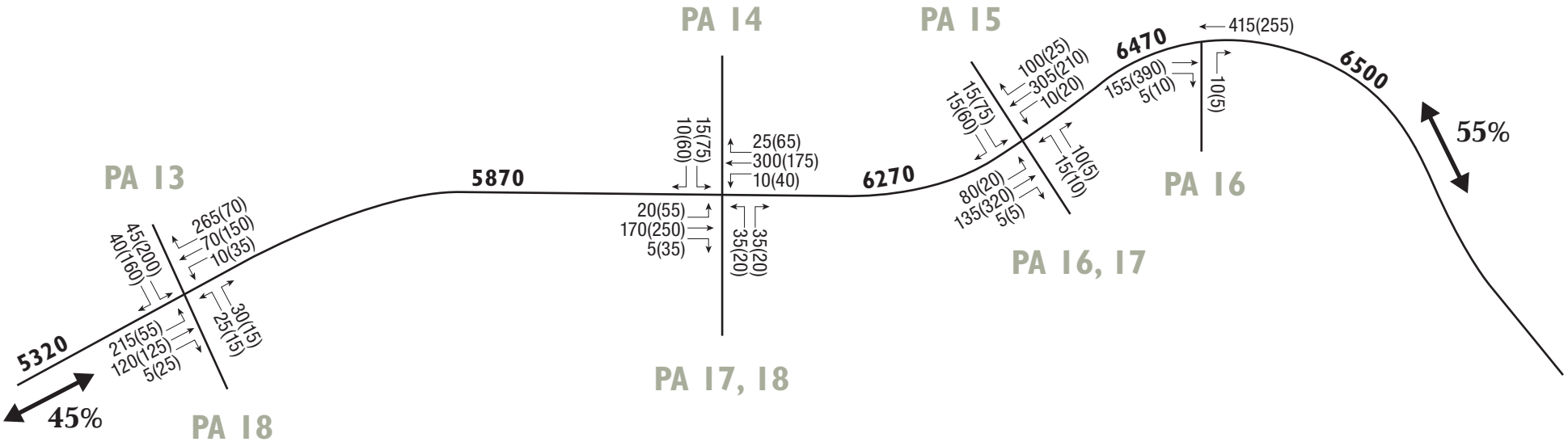


Figure 2
Site Plan Concept



LEGEND

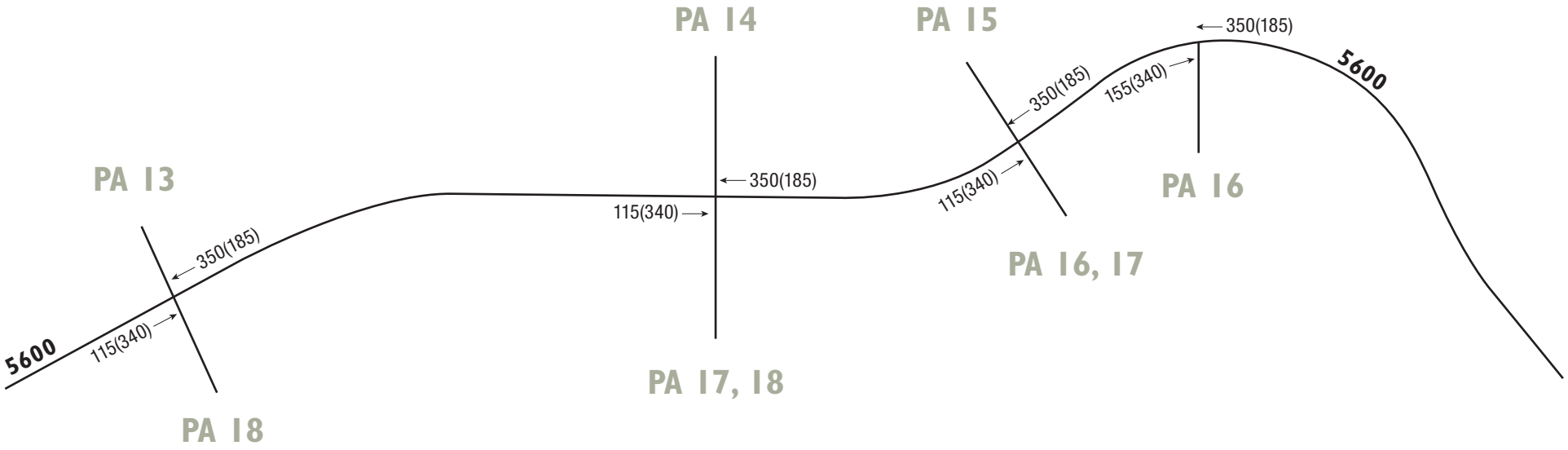
XXX(XXX) = AM(PM) Peak Hour Traffic Volumes

XXXX = Daily Traffic Volumes

XX% = Site Trip Distribution

Figure 3

Site Generated Traffic Assignment

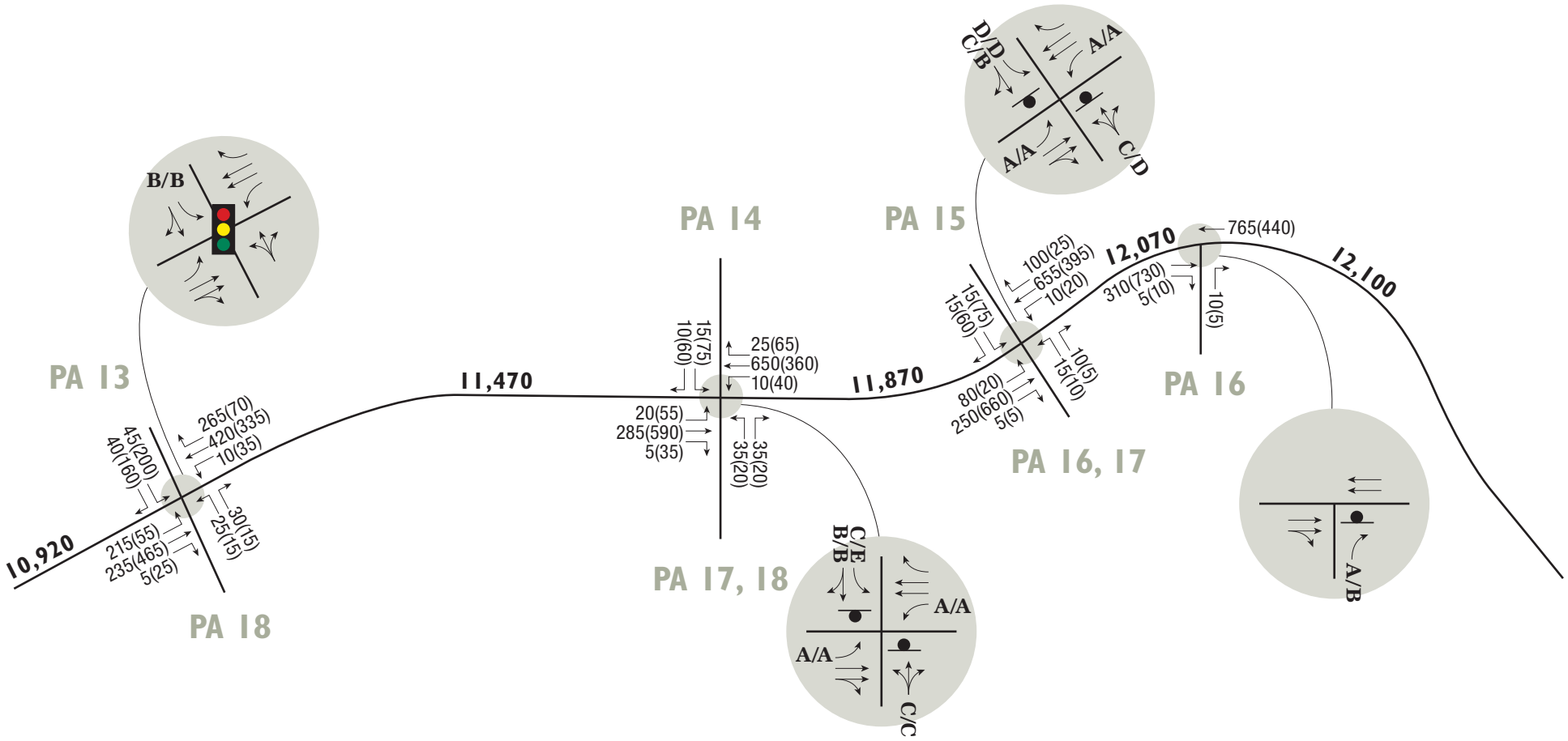


LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes

XXXX = Daily Traffic Volumes

Figure 4
Long Range Future
Background Traffic Volumes



LEGEND

XXX(XXX)	=	AM(PM) Peak Hour Traffic Volumes
XXXX	=	Daily Traffic Volumes
X/X	=	AM/PM Peak Hour Level of Service
	=	Stop Sign
	=	Traffic Signal

Figure 5
Total Traffic Conditions

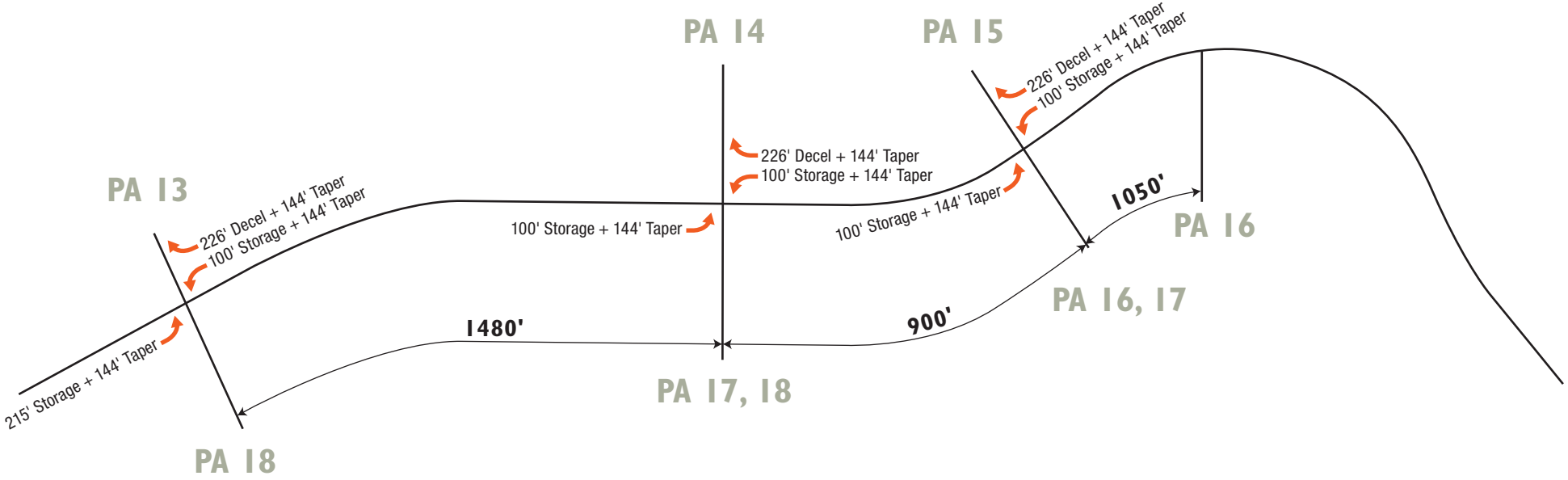


Figure 6
Auxiliary Lane Requirements

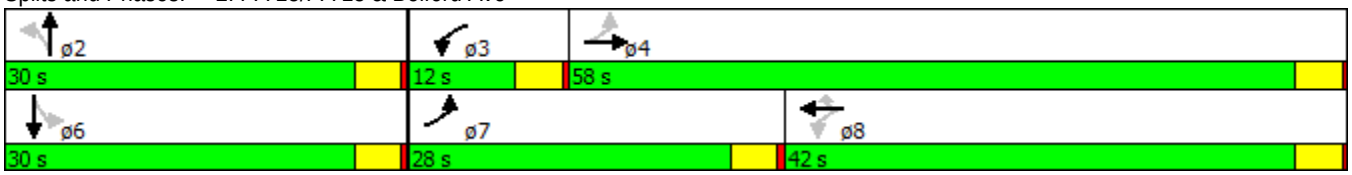
NOT TO SCALE

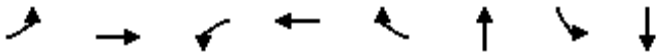
FELSBURG HOLT & ULLEVIG

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	215	235	10	420	265	25	5	45	5
Turn Type	pm+pt	NA	pm+pt	NA	Perm	Perm	NA	Perm	NA
Protected Phases	7	4	3	8			2		6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	2	2	6	6
Switch Phase									
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.0	20.0	8.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	28.0	58.0	12.0	42.0	42.0	30.0	30.0	30.0	30.0
Total Split (%)	28.0%	58.0%	12.0%	42.0%	42.0%	30.0%	30.0%	30.0%	30.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes				
Recall Mode	None	None	None	None	None	Max	Max	Max	Max
Act Effct Green (s)	32.7	30.9	20.6	14.8	14.8		26.3	26.3	26.3
Actuated g/C Ratio	0.49	0.46	0.31	0.22	0.22		0.39	0.39	0.39
v/c Ratio	0.44	0.16	0.03	0.59	0.50		0.10	0.09	0.07
Control Delay	12.5	11.0	9.7	27.0	6.6		10.1	16.3	7.0
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Total Delay	12.5	11.0	9.7	27.0	6.6		10.1	16.3	7.0
LOS	B	B	A	C	A		B	B	A
Approach Delay		11.7		19.0			10.1		11.7
Approach LOS		B		B			B		B

Intersection Summary	
Cycle Length: 100	
Actuated Cycle Length: 67.1	
Natural Cycle: 50	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.59	
Intersection Signal Delay: 15.5	Intersection LOS: B
Intersection Capacity Utilization 43.7%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 2: PA 18/PA 13 & Belford Ave





Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT
Lane Group Flow (vph)	234	260	11	457	288	65	49	48
v/c Ratio	0.44	0.16	0.03	0.59	0.50	0.10	0.09	0.07
Control Delay	12.5	11.0	9.7	27.0	6.6	10.1	16.3	7.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.5	11.0	9.7	27.0	6.6	10.1	16.3	7.0
Queue Length 50th (ft)	52	28	2	88	0	8	12	1
Queue Length 95th (ft)	90	62	9	141	55	37	40	23
Internal Link Dist (ft)		324		1383		38		32
Turn Bay Length (ft)	215		100		226		100	
Base Capacity (vph)	715	2874	455	2027	1030	637	522	658
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.33	0.09	0.02	0.23	0.28	0.10	0.09	0.07

Intersection Summary

Intersection	
Int Delay, s/veh	1.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	20	285	5	10	650	25	35	5	35	15	5	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	226	100	-	226	-	-	-	100	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	22	310	5	11	707	27	38	5	38	16	5	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	707	0	0	310	0	0	731	1081	155	929	1081	353
Stage 1	-	-	-	-	-	-	353	353	-	728	728	-
Stage 2	-	-	-	-	-	-	378	728	-	201	353	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	887	-	-	1247	-	-	310	216	863	222	216	643
Stage 1	-	-	-	-	-	-	637	629	-	381	427	-
Stage 2	-	-	-	-	-	-	616	427	-	782	629	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	887	-	-	1247	-	-	291	209	863	203	209	643
Mov Cap-2 Maneuver	-	-	-	-	-	-	291	209	-	203	209	-
Stage 1	-	-	-	-	-	-	621	613	-	372	423	-
Stage 2	-	-	-	-	-	-	593	423	-	723	613	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.6	0.1	16.1	19.6
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	406	887	-	-	1247	-	-	203	380
HCM Lane V/C Ratio	0.201	0.025	-	-	0.009	-	-	0.08	0.043
HCM Control Delay (s)	16.1	9.2	-	-	7.9	-	-	24.3	14.9
HCM Lane LOS	C	A	-	-	A	-	-	C	B
HCM 95th %tile Q(veh)	0.7	0.1	-	-	0	-	-	0.3	0.1

Intersection	
Int Delay, s/veh	1.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	80	250	5	10	655	100	15	5	10	15	5	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	100	-	226	-	-	-	100	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	87	272	5	11	712	109	16	5	11	16	5	16

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	712	0	0	277	0	0	828	1182	139	1047	1185	356
Stage 1	-	-	-	-	-	-	448	448	-	734	734	-
Stage 2	-	-	-	-	-	-	380	734	-	313	451	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	884	-	-	1283	-	-	263	188	884	182	188	640
Stage 1	-	-	-	-	-	-	560	571	-	378	424	-
Stage 2	-	-	-	-	-	-	614	424	-	672	569	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	884	-	-	1283	-	-	230	168	884	161	168	640
Mov Cap-2 Maneuver	-	-	-	-	-	-	230	168	-	161	168	-
Stage 1	-	-	-	-	-	-	505	515	-	341	420	-
Stage 2	-	-	-	-	-	-	586	420	-	592	513	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.3	0.1	19.4	21.5
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	282	884	-	-	1283	-	-	161	376
HCM Lane V/C Ratio	0.116	0.098	-	-	0.008	-	-	0.101	0.058
HCM Control Delay (s)	19.4	9.5	-	-	7.8	-	-	29.9	15.2
HCM Lane LOS	C	A	-	-	A	-	-	D	C
HCM 95th %tile Q(veh)	0.4	0.3	-	-	0	-	-	0.3	0.2

Intersection	
Int Delay, s/veh	0.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	310	5	0	765	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	337	5	0	832	0	11

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	342	0	756	171
Stage 1	-	-	-	-	340	-
Stage 2	-	-	-	-	416	-
Critical Hdwy	-	-	4.14	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	-	-	2.22	-	3.52	3.32
Pot Cap-1 Maneuver	-	-	1214	-	344	843
Stage 1	-	-	-	-	692	-
Stage 2	-	-	-	-	634	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1214	-	344	843
Mov Cap-2 Maneuver	-	-	-	-	344	-
Stage 1	-	-	-	-	692	-
Stage 2	-	-	-	-	634	-

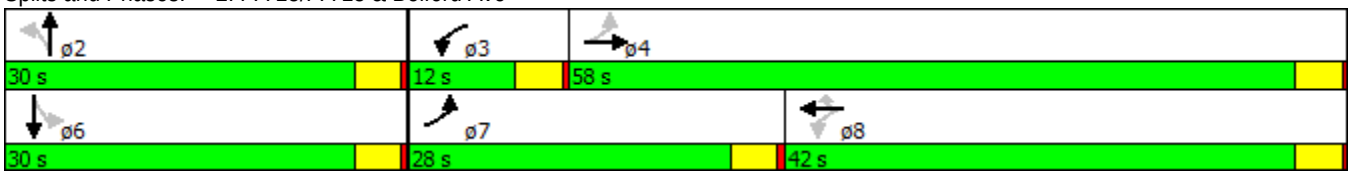
Approach	EB	WB	NB
HCM Control Delay, s	0	0	9.3
HCM LOS			A

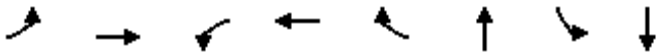
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	843	-	-	1214	-
HCM Lane V/C Ratio	0.013	-	-	-	-
HCM Control Delay (s)	9.3	-	-	0	-
HCM Lane LOS	A	-	-	A	-
HCM 95th %tile Q(veh)	0	-	-	0	-

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	55	465	35	335	70	15	5	200	5
Turn Type	pm+pt	NA	pm+pt	NA	Perm	Perm	NA	Perm	NA
Protected Phases	7	4	3	8			2		6
Permitted Phases	4		8		8	2		6	
Detector Phase	7	4	3	8	8	2	2	6	6
Switch Phase									
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.0	20.0	8.0	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	28.0	58.0	12.0	42.0	42.0	30.0	30.0	30.0	30.0
Total Split (%)	28.0%	58.0%	12.0%	42.0%	42.0%	30.0%	30.0%	30.0%	30.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes				
Recall Mode	None	None	None	None	None	Max	Max	Max	Max
Act Effct Green (s)	17.7	15.1	16.3	12.7	12.7		26.6	26.6	26.6
Actuated g/C Ratio	0.33	0.28	0.30	0.24	0.24		0.50	0.50	0.50
v/c Ratio	0.15	0.54	0.11	0.43	0.17		0.05	0.32	0.20
Control Delay	11.2	18.9	10.8	19.9	4.2		7.9	12.5	3.2
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Total Delay	11.2	18.9	10.8	19.9	4.2		7.9	12.5	3.2
LOS	B	B	B	B	A		A	B	A
Approach Delay		18.1		16.7			7.9		8.3
Approach LOS		B		B			A		A

Intersection Summary	
Cycle Length: 100	
Actuated Cycle Length: 53.7	
Natural Cycle: 50	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.54	
Intersection Signal Delay: 14.8	Intersection LOS: B
Intersection Capacity Utilization 44.7%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 2: PA 18/PA 13 & Belford Ave





Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT
Lane Group Flow (vph)	60	532	38	364	76	37	217	179
v/c Ratio	0.15	0.54	0.11	0.43	0.17	0.05	0.32	0.20
Control Delay	11.2	18.9	10.8	19.9	4.2	7.9	12.5	3.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.2	18.9	10.8	19.9	4.2	7.9	12.5	3.2
Queue Length 50th (ft)	12	63	8	57	0	4	43	1
Queue Length 95th (ft)	30	131	21	92	20	20	107	33
Internal Link Dist (ft)		324		1383		38		32
Turn Bay Length (ft)	215		100		226		100	
Base Capacity (vph)	832	3305	389	2566	1175	790	677	877
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.07	0.16	0.10	0.14	0.06	0.05	0.32	0.20

Intersection Summary

Intersection	
Int Delay, s/veh	4.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	55	590	35	40	360	65	20	5	20	75	5	60
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	100	-	226	-	-	-	100	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	60	641	38	43	391	71	22	5	22	82	5	65

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	391	0	0	679	0	0	1065	1258	340	921	1277	196
Stage 1	-	-	-	-	-	-	780	780	-	478	478	-
Stage 2	-	-	-	-	-	-	285	478	-	443	799	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	1164	-	-	909	-	-	177	170	656	225	165	812
Stage 1	-	-	-	-	-	-	354	404	-	537	554	-
Stage 2	-	-	-	-	-	-	698	554	-	564	396	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1164	-	-	909	-	-	147	154	656	196	149	812
Mov Cap-2 Maneuver	-	-	-	-	-	-	147	154	-	196	149	-
Stage 1	-	-	-	-	-	-	336	383	-	509	528	-
Stage 2	-	-	-	-	-	-	605	528	-	510	376	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.7	0.8	25.3	24.7
HCM LOS			D	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	226	1164	-	-	909	-	-	196	605
HCM Lane V/C Ratio	0.216	0.051	-	-	0.048	-	-	0.416	0.117
HCM Control Delay (s)	25.3	8.3	-	-	9.2	-	-	35.9	11.7
HCM Lane LOS	D	A	-	-	A	-	-	E	B
HCM 95th %tile Q(veh)	0.8	0.2	-	-	0.1	-	-	1.9	0.4

Intersection	
Int Delay, s/veh	3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	20	660	5	20	395	25	10	5	5	75	5	60
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	100	-	226	-	-	-	100	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	22	717	5	22	429	27	11	5	5	82	5	65

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	429	0	0	723	0	0	1025	1237	361	878	1239	215
Stage 1	-	-	-	-	-	-	764	764	-	473	473	-
Stage 2	-	-	-	-	-	-	261	473	-	405	766	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	1127	-	-	875	-	-	189	175	636	242	174	790
Stage 1	-	-	-	-	-	-	362	411	-	541	557	-
Stage 2	-	-	-	-	-	-	721	557	-	593	410	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1127	-	-	875	-	-	163	167	636	226	166	790
Mov Cap-2 Maneuver	-	-	-	-	-	-	163	167	-	226	166	-
Stage 1	-	-	-	-	-	-	355	403	-	530	543	-
Stage 2	-	-	-	-	-	-	638	543	-	569	402	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0.4	25	21.3
HCM LOS			D	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	202	1127	-	-	875	-	-	226	613
HCM Lane V/C Ratio	0.108	0.019	-	-	0.025	-	-	0.361	0.115
HCM Control Delay (s)	25	8.3	-	-	9.2	-	-	29.7	11.6
HCM Lane LOS	D	A	-	-	A	-	-	D	B
HCM 95th %tile Q(veh)	0.4	0.1	-	-	0.1	-	-	1.6	0.4

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	730	10	0	440	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	793	11	0	478	0	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	804	0	1038	402
Stage 1	-	-	-	-	799	-
Stage 2	-	-	-	-	239	-
Critical Hdwy	-	-	4.14	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	-	-	2.22	-	3.52	3.32
Pot Cap-1 Maneuver	-	-	816	-	227	598
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	778	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	816	-	227	598
Mov Cap-2 Maneuver	-	-	-	-	227	-
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	778	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	11.1
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	598	-	-	816	-
HCM Lane V/C Ratio	0.009	-	-	-	-
HCM Control Delay (s)	11.1	-	-	0	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0	-	-	0	-