Existing Conditions Report

City of

SPRING HILL

TENNESSEE

US ROUTE 31 SIGNAL TIMING OPTIMIZATION STUDY

Submitted By:

RPM Transportation Consultants, LLC.

In Cooperation With:

VOLKERT

U.S. ROUTE 31 (MAIN STREET)
SIGNAL TIMING OPTIMIZATION STUDY
EXISTING CONDITIONS REPORT
SPRING HILL, TENNESSEE

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1.0 Introduction

The principal purpose of this project is to develop optimized traffic signal timings for the US Route 31 (Main Street) corridor for immediate implementation. To accomplish this, the traffic simulation and modeling software Synchro and SimTraffic will be used to aid the development of signal timings and identification of needed improvements. To ensure that the traffic simulation model accurately reflects existing conditions it is calibrated with SimTraffic using field observations and existing travel time measurements. The following reports summarizes the data collection and analysis of existing conditions utilized for this purpose.

2.0 Roadway Network

The study area for the project includes a 4.3 mile arterial segment of US Route 31 extending from Thompson's Station Road on the northern end to Saturn Parkway on the southern end. The study focuses on the eleven intersections that have existing traffic signals or are planned to be signalized but also includes 15 unsignalized intersections along the corridor, as illustrated in Figure 1. Including unsignalized intersections helps account for side friction from minor driveways and streets and allows the development of a more accurate model. Auxiliary laneage at each intersection is illustrated in Figure 2, while the functional classification and speed limit of the study roadways can be found in Table 1. Two school zones are present within the study segment where the speed limit drops to 20 miles per hour, these include a 0.4 mile segment from south of Kedron Road to Ayers Street and a 0.25 mile segment from Spring Hill Circle / Traders Way to north of Buckner Road / Thompsons Ridge Road.

Table 1: Functional Classification and Speeds on Study Roadways Intersecting US-31.

No.	Intersecting Roadway	Functional Classification	Speed Limit (mph)
1	Crossings Boulevard	Local	20
2	Town Center Parkway	Local	35
3	Kedron Rd	Collector	35
4	Depot Street / McLemore Avenue	Collector	30/20
5	SR-247 (Beechcroft Road / Duplex Road)	Collector	30/35
6	Miles Johnson Parkway (planned signal)	Collector	35
7	Belshire Way / Commonwealth Drive	Local / Collector	20
8	Southern Walmart Entrance	Local	20
9	Campbell Station Parkway	Collector	20
10	Buckner Rd / Thompsons Ridge Rd	Collector	35
11	Thompson Station Rd	Collector	45
12	Access at Spring Hill Medical	Local	20
13	Home Depot Access	Local	20
14	Access at First Farmers Bank	Local	20
15	Maury Hill Street	Local	20
16	Ayers Street	Local	20
17	Locke Avenue	Local	20
18	Witt Hill Drive	Local	20
19	Bess Boulevard	Local	20
20	Nasdaq Street	Local	20
21	Publix Full Access	Local	20
22	Publix Partial Access	Local	20
23	Wilkes Lane	Collector	20
24	Spring Hill Circle	Local	20
25	Williford Court	Local	20
26	Spring Hill Circle / Traders Way	Local	20

1 US 31 and Crossings Boulevard
2 US 31 and Town Center Parkway
3 US 31 and Kedron Road / Kedron Parkway
4 US 31 and Depot Street / McLemore Avenue
5 US 31 and Beechcroft Road (SR 247) / Duplex Road (SR 247)
6 US 31 and Miles Johnson Parkway (Planned Signal)
7 US 31 and Belshire Way / Commonwealth Drive (Lowes Access)
8 US 31 and Southern Walmart Access
9 US 31 and Campbell Station Parkway
10 US 31 and Buckner Road / Thompsons Ridge Road
11 US 31 and Thompsons Station Road
12 US 31 and Spring Hill Medical
13 US 31 and Home Depot
14 US 31 and First Farmers Bank
15 US 31 and Maury Hills Street
16 US 31 and Ayers Street
17 US 31 and Locke Avenue
18 US 31 and Whitt Hill Drive
19 US 31 and Bess Boulevard
20 US 31 and Nasdaq Street
21 US 31 and Publix Full Access
22 US 31 and Publix Partial Access
23 US 31 and Wikes Lane / Spedale Court
24 US 31 and Spring Hill Circle
25 US 31 and Wilford Court
26 US 31 and Traders Way / Spring Hill Circle

(#) = Non-Signalized Intersection Number
(#) = Signalized Intersection Number

Study Area
(Not to Scale)

Figure 1: Study Area

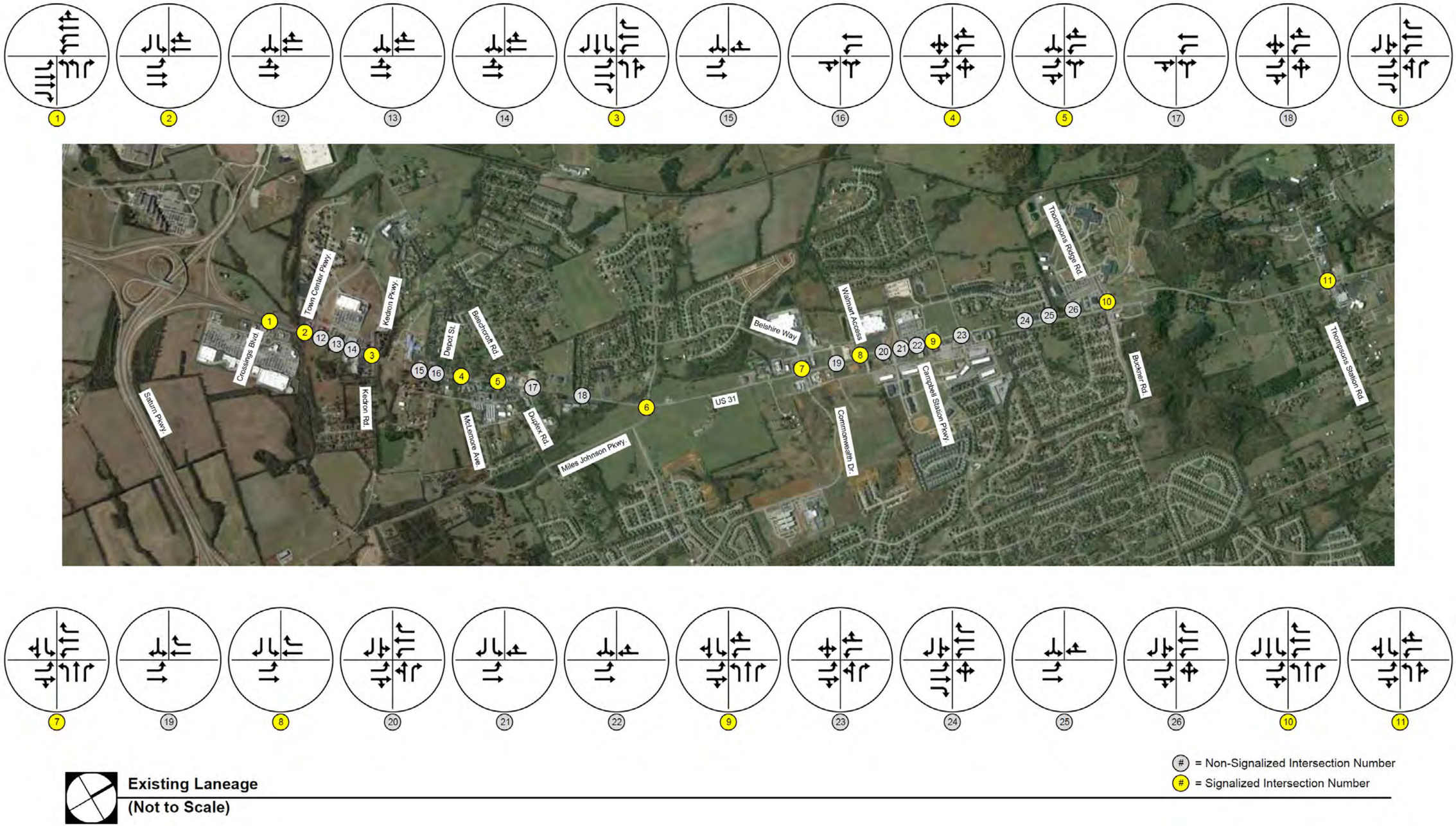

Figure 2: Existing Laneage at Study Area Intersections.

3.0 Traffic

In order to provide data for the project, vehicle and pedestrian count data were collected for the corridor. Both manual and automated count data were collected. Manual turning movement counts were collected at each of the twenty-six (26) study area intersections for typical peak hour weekday and weekend conditions. For weekday conditions, manual turning movement counts were collected on a typical weekday in May 2014, from 7-10 AM, 11 AM – 1 PM, and 2-7PM. Weekend manual turning movement counts were collected on a typical Saturday in May 2014 from 11 AM – 3 PM. Peak hour turning movement counts for each study area intersection on US Route 31 can be found in Figure 3 – Figure 5.

From this data, the peak hour for each intersection under each condition was determined. For each condition, peak hours varied somewhat across intersections. There was also variation depending on if the peak hour for a particular direction or the total volume was under consideration. Midday peak hour conditions were the most consistent across all intersections, with the peak hour occurring at either 11:45 AM or 12:00 PM when considering total intersection volume. This segregated data is valuable in determining when traffic flows are conducive to coordination. The peak hour volume for each signalized intersection during AM, midday, and PM periods is presented below in Table 2 along with the time that it occurred.

Table 2: Variation in Peak Hour by Intersection.

US-31 Intersection	AM			Midday			PM		
	Total	NB	SB	Total	NB	SB	Total	NB	SB
Crossings Boulevard	1,422 (9:00)	635 (7:15)	577 (7:15)	2,012 (12:00)	473 (11:45)	521 (11:15)	2,394 (16:30)	734 (14:00)	680 (17:00)
Town Center Parkway	1,372 (7:15)	512 (8:00)	483 (7:15)	1,666 (12:00)	604 (12:00)	603 (12:00)	2,007 (15:45)	729 (14:00)	765 (17:00)
Kedron Road	1,459 (7:15)	513 (8:30)	470 (7:15)	1,792 (11:45)	564 (12:00)	581 (11:30)	2,098 (15:00)	630 (14:00)	728 (17:15)
Depot Street / McLemore Avenue	1,119 (8:30)	557 (8:45)	462 (9:00)	1,385 (12:00)	625 (12:00)	626 (11:30)	1,537 (16:30)	650 (14:15)	736 (17:00)
SR-247	1,279 (9:00)	570 (8:45)	427 (9:00)	1,567 (12:00)	639 (12:00)	626 (11:00)	1,756 (15:30)	640 (14:00)	716 (16:45)
Belshire Wy / Commonwealth Dr	1,725 (9:00)	611 (9:00)	484 (9:00)	1,934 (12:00)	591 (12:00)	595 (11:00)	2,035 (14:45)	646 (14:00)	716 (16:45)
Southern Walmart Entrance	1,450 (9:00)	696 (9:00)	542 (7:15)	1,570 (11:45)	644 (12:00)	636 (11:00)	1,714 (14:15)	704 (14:00)	736 (17:15)
Campbell Station Parkway	1,686 (8:45)	596 (8:45)	477 (7:15)	1,712 (12:00)	542 (12:00)	517 (11:00)	2,147 (16:45)	604 (14:00)	634 (15:00)
Buckner/Thompson Ridge Road	2,065 (8:45)	584 (9:00)	423 (8:30)	1,547 (11:45)	409 (12:00)	449 (11:00)	2,550 (16:45)	481 (14:00)	708 (15:45)
Thompson Station Road	1,961 (7:45)	974 (9:00)	489 (7:15)	1,359 (12:00)	497 (12:00)	466 (11:00)	1,923 (16:45)	620 (16:30)	815 (17:00)

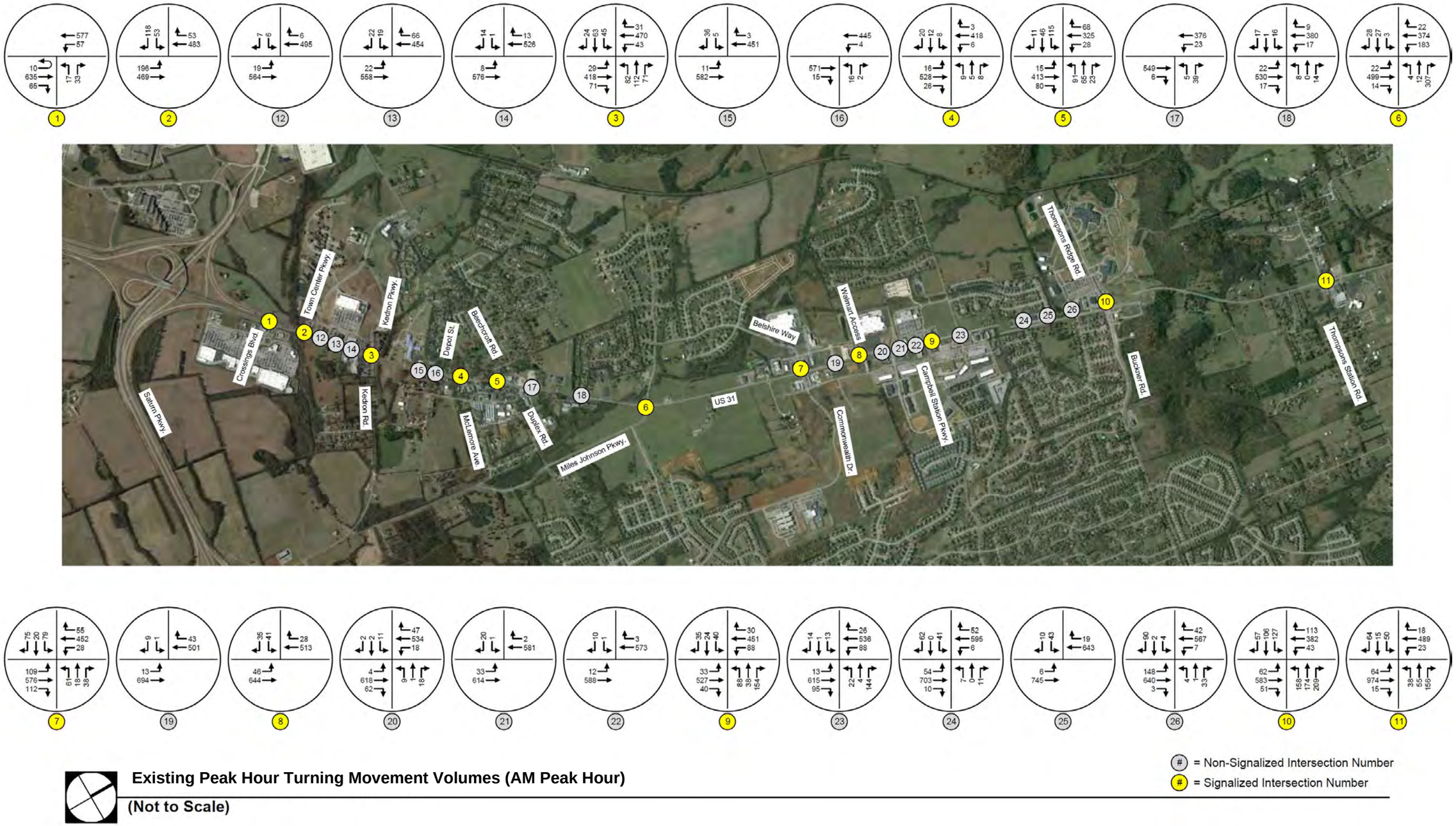

Figure 3: Weekday Peak Hour Turning Movement Volumes (AM Peak Hour).

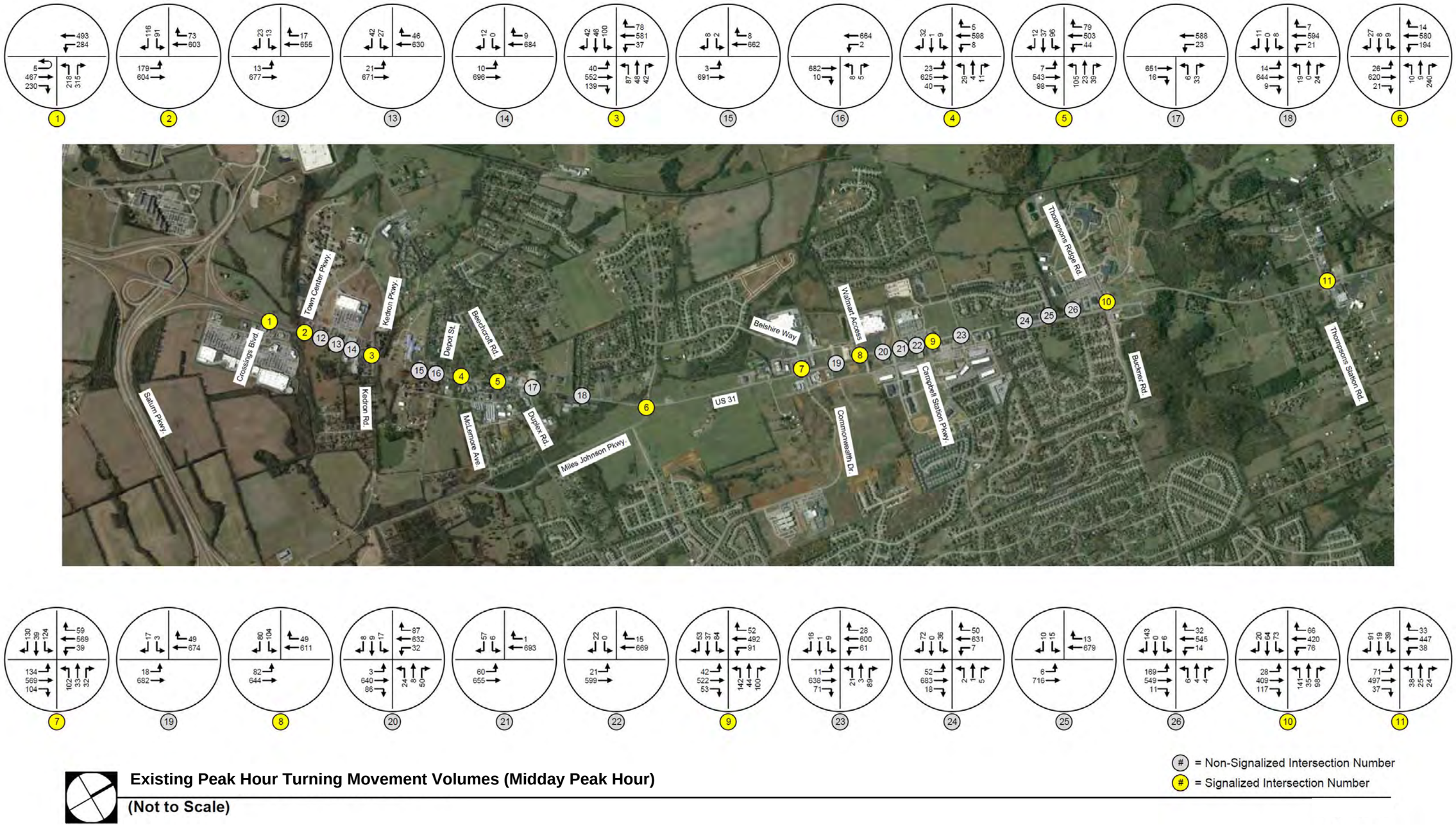

Figure 4: Weekday Peak Hour Turning Movement Volumes (Midday Peak Hour).

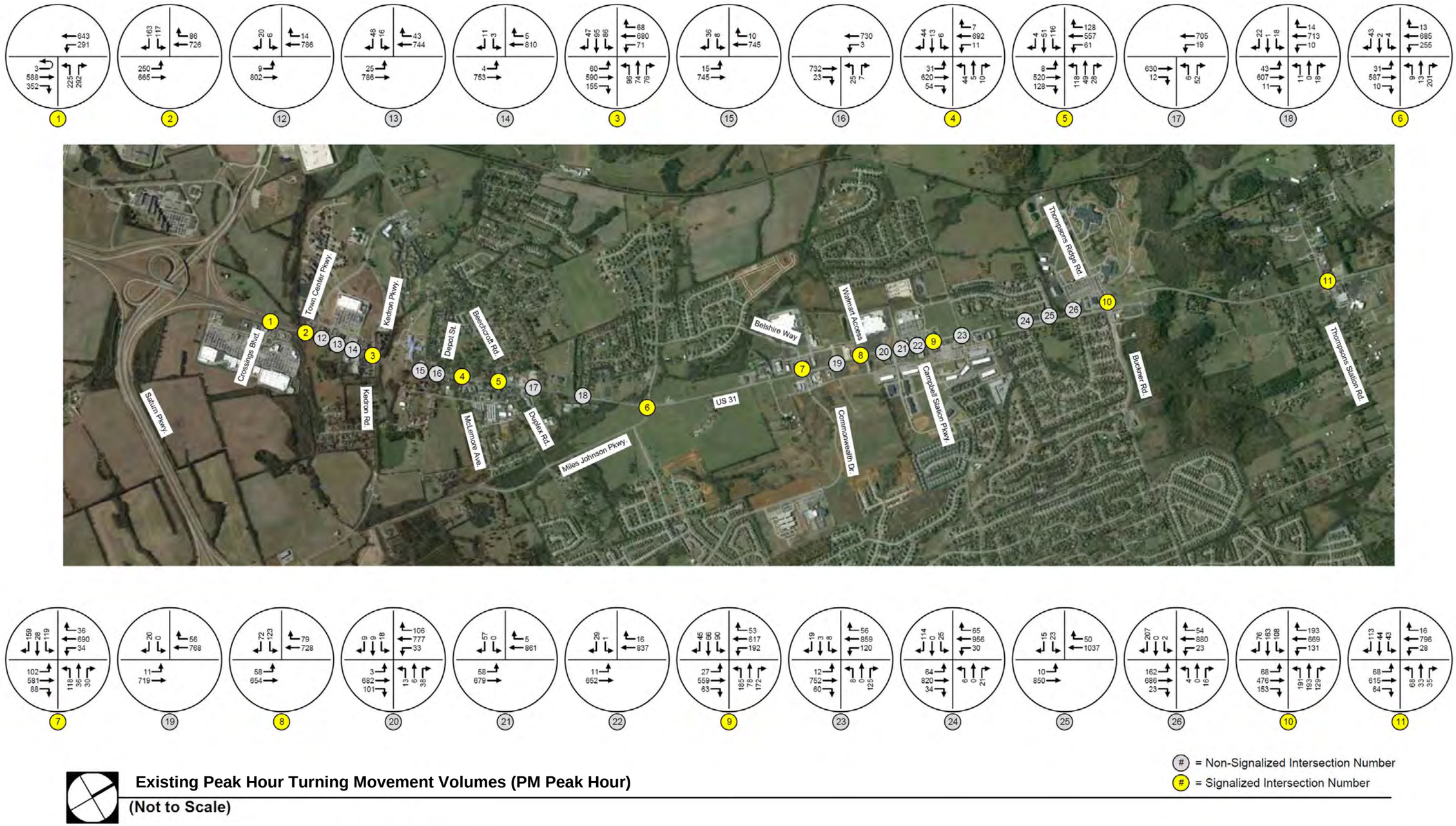

Figure 5: Weekday Peak Hour Turning Movement Volumes (PM Peak Hour).

Automated counts were collected at four locations along the corridor for typical weekday and weekend conditions. Typical conditions included the collection of bi-directional count data for seven (7) consecutive 24-hour periods, from May 5th through May 11th, 2014. Figure 6 illustrates the weekday hourly variation in traffic flow for reference purposes at one of the four automated bi-directional count locations Figure 6 also includes the time of day plan transition times and associated cycle length with each coordination plan.

In addition to the above information, annual average daily traffic (AADT) volumes were obtained from the Tennessee Department of Transportation (TDOT). There are three TDOT count stations on US Route 31 in or near the study area. Station # 7 is just south of Crossings Boulevard, Station #9 is just north of Duplex Road, and Station #67 is just north of Thompsons Station Road. The TDOT AADT counts for the year 2013 are shown in
Table 3 below.

Table 3: TDOT Count Station Data.

Location	County	Station No.	2013 AADT
185' South of Crossings Boulevard	Maury	7	19,490
0.22 miles north of SR-247	Maury	9	15,726
0.48 miles north of Thompsons Station Road	Williamson	67	19,666

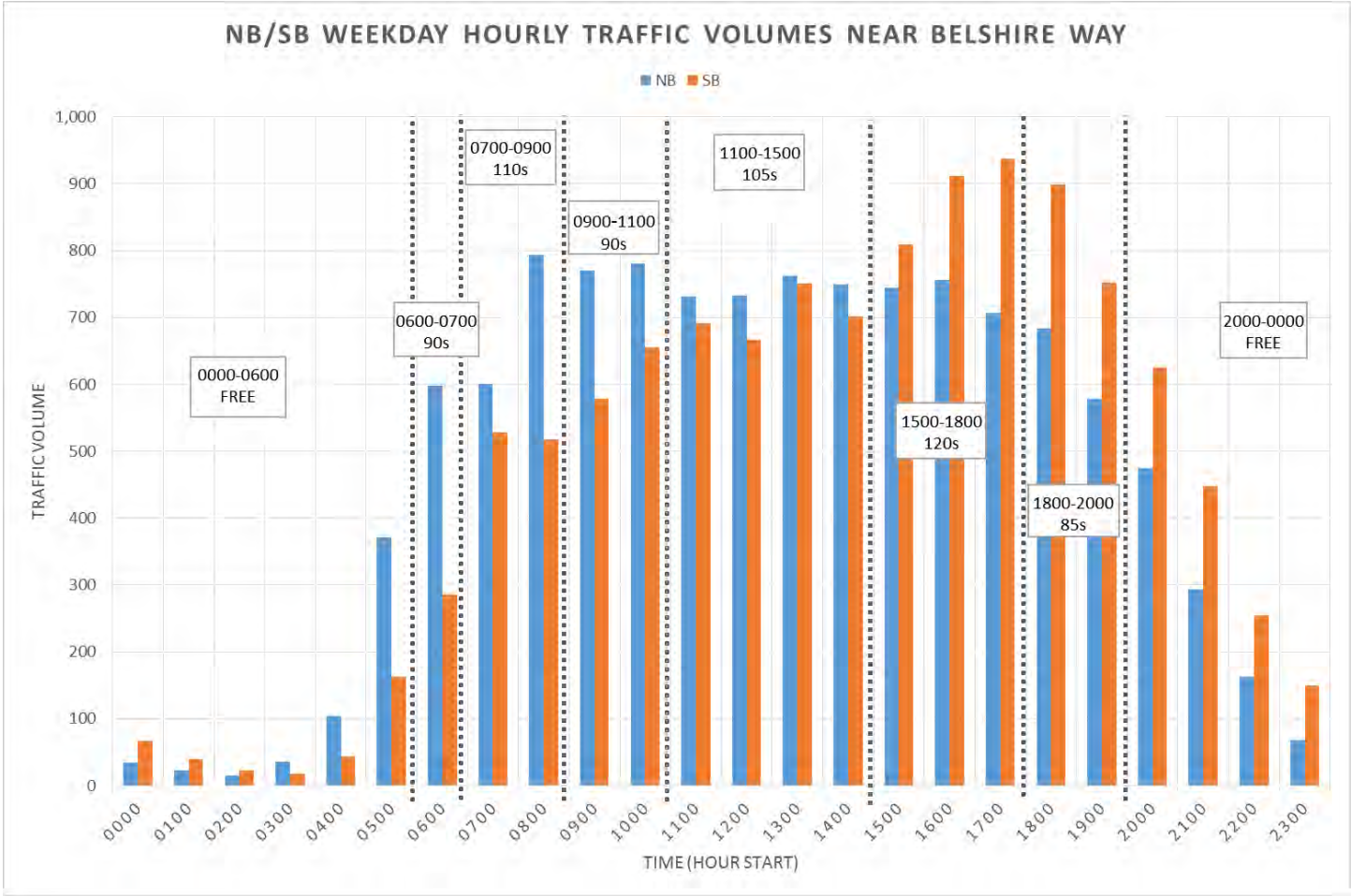

Figure 6: Northbound/Southbound Hourly Traffic Volumes near Belshire Way (Typical Weekday).

4.0 Signal System Timing

As part of the detailed field inventory the current signal timings were obtained from each local traffic signal controller along the project corridor. Based on the existing signal timing, two segments of the study corridor currently operate as coordinated signal systems. The signals from Crossings Boulevard to SR-247 are one coordinated zone, with the signals from Belshire Way / Commonwealth Drive to Campbell Station Parkway being the other coordinated segment. There are four cycle lengths being used for coordination, ranging from 90 seconds to 120 seconds. Table 4 below includes the beginning and ending time of each time of day (TOD) plan and its associated cycle length in each zone. The two northernmost intersections (Buckner Road / Thompson Ridge Road and Thompsons Station Road) currently operate free, with base max times increased using TOD plans during peak periods. Detailed phasing and timing plan data from each intersection can be found in **Error! Reference source not found.**.

Table 4: Existing Weekday TOD Plans and Cycle Length.

Plan	Southern Zone (1-5)	Northern Zone (7-9)	Cycle Length
Free	12:00 AM – 6:30 AM	12:00 AM – 6:00 AM	Variable
Off Peak	6:30 AM – 7:00 AM	6:00 AM – 7:00 AM	90 seconds
AM Peak	7:00 AM – 9:00 AM	7:00 AM – 9:00 AM	110 seconds
Off Peak	9:00 AM – 10:00 AM	9:00 AM – 11:00 AM	90 seconds
Mid Peak	10:00 AM – 2:00 PM	11:00 AM – 3:00 PM	105 seconds
PM Peak	2:00 PM – 6:15 PM	3:00 PM – 6:00 PM	120 seconds
Off Peak	6:15 PM – 8:30 PM	6:00 PM – 8:00 PM	105 seconds
Free	8:30 PM – 12:00 AM	8:00 PM – 12:00 AM	Variable

Existing timings at each signalized intersection were compared to recommendations from the TDOT Traffic Design Manual and the Institute of Transportation Engineers (ITE) Manual of Traffic Signal Design, which includes minimum parameters for signal timing. The following includes detailed evaluations for minimum vehicular green time, yellow and all-red vehicular clearance intervals, and pedestrian clearance intervals.

4.1 Minimum Vehicular Green Time

The TDOT Traffic Design Manual states that a minimum vehicular green of 6.0 seconds shall be used for through movements on side streets and any turn lane. Some existing timings have only 5.0 seconds of minimum vehicular green time. This will be adjusted to at least 6.0 seconds for the new timing plans. The existing minimum vehicular green time for each signalized intersection can be found in the table titled "TIME BY PHASE (SEC) & FUNCTIONS" in the appendix.

4.2 Yellow and All-Red Clearance Intervals

Yellow and all-red clearance intervals were calculated for all phases at each intersection using the methodology from the ITE Manual of Traffic Signal Design, which is also the methodology specified by the Tennessee Department of Transportation. The clearance interval calculation includes a reaction time, a deceleration time and an intersection clearance time. This method is intended to eliminate the "dilemma zone" in which a driver has difficulty deciding to stop or continue through the intersection. The existing and recommended yellow and all-red clearance intervals are shown in Table 6. In developing proposed signal timing in the next project task, yellow and all-red clearance intervals will be modified to match these recommended values where they differ.

4.3 Pedestrian Clearance Intervals

Pedestrian clearance intervals were calculated at each intersection for all legs of the intersection that had crosswalks or for which pedestrians were likely to cross (Table 5). Where pedestrian signals exist, the Walk Interval provides the pedestrian time to leave the curb and begin crossing the street. The Manual on Uniform Traffic Control Devices (MUTCD) recommends a Walk Interval of seven (7) seconds followed by the Flashing Don't Walk (FDW) clearance interval long enough to allow a pedestrian to cross the roadway walking at a speed of 3.5 feet per second. Some signalized intersections without pedestrian signals have pedestrian phasing entered under the current timing plans. Where there is no pedestrian signal, the pedestrian phasing will be removed from the controller settings. Where the Walk or FDW interval differs from the duration recommended by the MUTCD the value will be changed in the proposed timing plans.

Table 5: Pedestrian Clearance Intervals

Intersection	Side	Width (ft)	PED CLR (s)	Existing		Recommended	
				WALK (s)	FDW (s)	WALK (s)	FDW (s)
Crossings Boulevard	E	95	27	–	—	—	—
Mclemore Avenue Depot Street	E	32	9	–	—	—	—
	W	28	8	–	—	—	—
Duplex Rd (SR-247) Beechcroft Rd (SR-247)	E	40	11	–	—	—	—
	W	35	10	–	—	—	—
Miles Johnson Parkway	N*	70	20	–	—	—	—
	E*	75	21	–	—	—	—
Belshire Way / Commonwealth Drive	N*	91	26	–	—	—	—
	W	82	23	7	15	7	19
Southern Walmart Access	W*	54	15	5**	5**	—	—
Campbell Station Parkway	N	67	19	8	15	7	15
	E	64	18	5**	0**	—	—
Buckner Road / Thompson Ridge Road	S	68	19	–	—	—	—

*No crosswalk **No pedestrian signals

Table 6: Existing & Recommended Vehicular Clearance Intervals.

US-31 Intersection	Phase	Dir.	Speed (mph)	Speed (ft/s)	w (ft)	Existing Clearance (s)			TDOT Calculated Clearance (s)			Recommended Clearance (s)		
						Yellow	Red	Total	Yellow	Red	Total	Yellow	Red	Total
Crossings Boulevard	2	SBT	45	66.0	95.3	4.5	2.0	6.5	4.3	1.7	6.0	4.5	2.0	6.5
	4	WB	20	29.3	95.3	4.0	2.0	6.0	2.5	3.9	6.4	3.0	2.5	5.5
	5	SBL	15	22.0	92	4.5	2.0	6.5	2.1	5.1	7.2	3.0	2.5	5.5
	6	NB	45	66.0	65	4.5	2.0	6.5	4.3	1.3	5.6	4.5	1.5	6.0
Town Center Parkway	1	NBL	15	22.0	85	4.0	2.0	6.0	2.1	4.8	6.9	3.0	2.5	5.5
	2	NB/SB	35	51.3	87	4.5	2.0	6.5	3.6	2.1	5.7	4.0	1.5	5.5
	4	EB	20	29.3	89	4.0	2.0	6.0	2.5	3.7	6.2	3.0	2.5	5.5
Kedron Road	1	SBL	15	22.0	38	4.0	2.0	6.0	2.1	2.6	4.7	3.0	2.5	5.5
	2	NB	35	51.3	85	4.5	2.0	6.5	3.6	2.0	5.6	4.0	1.5	5.5
	3	WBL	15	22.0	81	4.0	2.0	6.0	2.1	4.6	6.7	3.0	2.5	5.5
	4	EB	35	51.3	101	4.0	2.0	6.0	3.6	2.4	5.9	4.0	2.0	6.0
	5	NBL	15	22.0	61	4.5	2.0	6.5	2.1	3.7	5.8	3.0	2.5	5.5
	6	SB	15	22.0	89	4.5	2.0	6.5	2.1	5.0	7.1	3.0	2.5	5.5
	7	EBL	15	22.0	95	4.0	2.0	6.0	2.1	5.2	7.3	3.0	2.5	5.5
	8	WB	35	51.3	93	4.0	2.0	6.0	3.6	2.2	5.8	4.0	1.5	5.5
Depot Street / McLemore Avenue	1	NBL	15	22.0	47	4.0	2.0	6.0	2.1	3.0	5.1	3.0	2.5	5.5
	2	SB	35	51.3	98	4.5	2.0	6.5	3.6	2.3	5.9	4.0	2.0	6.0
	3	EB	15	22.0	77	4.0	2.0	6.0	2.1	4.4	6.5	3.0	2.5	5.5
	4	WB	15	22.0	75	4.0	2.0	6.0	2.1	4.3	6.4	3.0	2.5	5.5
	5	SBL	15	22.0	75	4.5	2.0	6.5	2.1	4.3	6.4	3.0	2.5	5.5
	6	NB	35	51.3	75	4.5	2.0	6.5	3.6	1.9	5.4	4.0	1.5	5.5
SR-247	1	SBL	15	22.0	42	4.0	2.0	6.0	2.1	2.8	4.9	3.0	2.5	5.5
	2	NBT	35	51.3	110	4.5	2.0	6.5	3.6	2.5	6.1	4.0	2.0	6.0
	3	WB	15	22.0	73	4.0	2.0	6.0	2.1	4.2	6.3	3.0	2.5	5.5
	4	EB	15	22.0	79	4.0	2.0	6.0	2.1	4.5	6.6	3.0	2.5	5.5
	5	NBL	15	22.0	65	4.5	2.0	6.5	2.1	3.9	6.0	3.0	2.5	5.5
	6	SBT	35	51.3	79	4.5	2.0	6.5	3.6	1.9	5.5	4.0	1.5	5.5

US-31 Intersection	Phase	Dir.	Speed (mph)	Speed (ft/s)	w (ft)	Existing Clearance (s)			TDOT Calculated Clearance (s)			Recommended Clearance (s)		
						Yellow	Red	Total	Yellow	Red	Total	Yellow	Red	Total
Belshire Way / Commonwealth Drive	1	SBL	15	22.0	59	4.0	2.0	6.0	2.1	3.6	5.7	3.0	2.5	5.5
	2	NBT	45	66.0	70	4.5	2.0	6.5	4.3	1.4	5.7	4.5	1.5	6.0
	3	WBL	15	22.0	90	4.0	2.0	6.0	2.1	5.0	7.1	3.0	2.5	5.5
	4	EBT	20	29.3	68	4.0	2.0	6.0	2.5	3.0	5.5	3.0	2.5	5.5
	5	NBL	15	22.0	54	4.5	2.0	6.5	2.1	3.4	5.5	3.0	2.5	5.5
	6	SBT	45	66.0	88	4.5	2.0	6.5	4.3	1.6	5.9	4.5	1.5	6.0
	7	EBL	15	22.0	71	4.0	2.0	6.0	2.1	4.1	6.2	3.0	2.5	5.5
	8	WBT	20	29.3	87	4.0	2.0	6.0	2.5	3.6	6.1	3.0	2.5	5.5
Southern Walmart Entrance	2	NBT	45	66.0	103	4.5	2.0	6.5	4.3	1.9	6.2	4.5	2.0	6.5
	4	EB	15	22.0	39	4.0	2.0	6.0	2.1	2.7	4.8	3.0	2.5	5.5
	5	NBL	15	22.0	74	4.5	2.0	6.5	2.1	4.3	6.4	3.0	2.5	5.5
	6	SB	45	66.0	71	4.5	2.0	6.5	4.3	1.4	5.7	4.5	1.5	6.0
Campbell Station Parkway	1	SBL	15	22.0	54	4.0	2.0	6.0	2.1	3.4	5.5	3.0	2.5	5.5
	2	NBT	45	66.0	78	4.5	2.0	6.5	4.3	1.5	5.8	4.5	1.5	6.0
	3	EBL	15	22.0	37	4.0	2.0	6.0	2.1	2.6	4.7	3.0	2.5	5.5
	4	WBT	20	29.3	69	4.0	2.0	6.0	2.5	3.0	5.5	3.0	2.5	5.5
	5	NBL	15	22.0	49	4.5	2.0	6.5	2.1	3.1	5.2	3.0	2.5	5.5
	6	SBT	45	66.0	69	4.5	2.0	6.5	4.3	1.3	5.6	4.5	1.5	6.0
	7	WBL	15	22.0	56	4.0	2.0	6.0	2.1	3.5	5.6	3.0	2.5	5.5
	8	EBT	20	29.3	49	4.0	2.0	6.0	2.5	2.4	4.8	3.0	2.5	5.5
Buckner Road / Thompson Ridge Road	1	SBL	15	22.0	67	4.0	1.0	5.0	2.1	4.0	6.1	3.0	2.5	5.5
	2	NBT	45	66.0	90	4.0	2.0	6.0	4.3	1.7	6.0	4.5	1.5	6.0
	3	EBL	15	22.0	70	4.0	1.0	5.0	2.1	4.1	6.2	3.0	2.5	5.5
	4	WBT	35	51.3	80	4.0	2.0	6.0	3.6	1.9	5.5	4.0	1.5	5.5
	5	NBL	15	22.0	51	4.0	1.0	5.0	2.1	3.2	5.3	3.0	2.5	5.5
	6	SBT	45	66.0	97	4.0	2.0	6.0	4.3	1.8	6.1	4.5	2.0	6.5
	7	WBL	15	22.0	51	4.0	1.0	5.0	2.1	3.2	5.3	3.0	2.5	5.5
	8	EBT	35	51.3	62	4.0	2.0	6.0	3.6	1.6	5.2	4.0	1.5	5.5

5.0 Signal System Infrastructure

In order to develop a calibrated model of the US Route 31 corridor a detailed inventory of the existing signal system was performed using data obtained from the City of Spring Hill and field observations performed by the project team. Each traffic signal currently includes similar equipment. All ten existing traffic signals include Peek 3000 or 3000E local controllers, conflict monitors from EDI or Peek, and either Sonem 2000 or EPS-II emergency vehicle preemption (if present). Table 7 summarizes the equipment type for each intersection. All vehicle detection is accomplished by loop detectors, with a mix of models from EDI, IDC, Northstar, and Sarasota in use. Time synchronization for signal coordination is accomplished by TR-4 Global Positioning System (GPS) time sync units from RTC Manufacturing, Inc, at each signalized intersection.

Field investigation revealed the US Route 31 intersections with the Southern Walmart Access and Crossings Boulevard each included equipment that was not currently in use. Each included a Peek M3000E master controller, as well as equipment for single-mode fiber optic interconnect, such as modems and fiber media converters. This equipment was removed and taken by City staff for safe storage until future use.

Table 7: Signal controller, conflict monitor, and EVP types by intersection.

No.	US-31 Intersection	Controller Model	Conflict Monitor	EVP System
1	Crossings Blvd	Peek 3000E & M3000E*	Peek Double Diamond	None
2	Town Center Pkwy	Peek 3000	Peek Transyt 12ELRA	Sonem 2000
3	Kedron Rd	Peek 3000	EDI SSM-12LE	Sonem 2000
4	Depot St / McLemore Ave	Peek 3000E	Peek Double Diamond	EPS-II
5	SR-247	Peek 3000E	EDI SSM-12LE	Sonem 2000
6	Miles Johnson Pkwy	N/A - Future Signal	N/A	N/A
7	Belshire Wy / Commonwealth Dr	Peek 3000E	Peek Double Diamond	Sonem 2000
8	Southern Walmart Entrance	Peek 3000E & M3000E*	Peek Double Diamond	Sonem 2000
9	Campbell Station Pkwy	Peek 3000E	Peek Double Diamond	Sonem 2000
10	Buckner Rd / Thompsons Ridge Rd	Peek 3000	Peek Transyt 12ELRA	EPS-II
11	Thompson Station Rd	Peek 3000E	Peek Transyt 12ELRA	EPS-II

*Peek M300E master controller not in use; removed and taken by City staff for storage.

During the field inventory it was noted that certain signal system infrastructure items were not operating properly. At this point the City of Spring Hill contracted with Quality Traffic Systems to perform a complete signal system diagnostic. The diagnostic inspection found that many of the intersections were not receiving the time clock sync reference from the GPS time reference module. There were also problems with the emergency vehicle preemption equipment in some locations. Following are specific details of the findings and modifications made by Quality Traffic to date can be found below.

5.1 Crossings Boulevard

The local signal controller was not receiving the time clock sync reference from the GPS time reference module. The TR-4 GPS clock constantly displays “Acquiring Sats”. This is the result of a faulty GPS receiver. Based on field observations the issue could be the result of corrosion of the GPS receiver connecting pins

due to failure of the seal between the GPS receiver body and the exterior of the cabinet. The local controller time was reset manually.

This intersection also had a master controller (Peek M3000E) and was interconnected with Town Center Parkway by fiber optic cable. This equipment was not in use since the installation of the GPS time reference module so it was removed and given to City staff for safe storage until needed in the future.

5.2 Town Center Parkway

At this intersection the GPS time reference module appeared to be operating correctly, but the local controller was not responding to the time clock sync reference signal. The project team determined that the wire on the preemption harness was not terminated on the preemption panel. After connecting the wire to the proper terminal the unit was tested and the time sync operation was confirmed.

The emergency vehicle preemption unit was not working at this intersection. Power was confirmed to be present at the connection to the Sonem 2000 unit, but the system would not turn on. This does not affect normal signal operation.

Unused equipment, including a single-mode fiber modem, was removed from the cabinet and taken by City staff for storage.

5.3 Kedron Road

The local signal controller was not receiving the time clock sync reference from the GPS time reference module. The TR-4 GPS clock constantly displays "Acquiring Sats". This is the result of a faulty GPS receiver. Based on field observations the issue could be the result of corrosion of the GPS receiver connecting pins due to failure of the seal between the GPS receiver body and the exterior of the cabinet. The local controller time was reset manually.

5.4 Depot Street / McLemore Avenue

The local signal controller was not receiving the time clock sync reference from the GPS time reference module. The TR-4 GPS clock constantly displays "Acquiring Sats". This is the result of a faulty GPS receiver. Based on field observations the issue could be the result of corrosion of the GPS receiver connecting pins due to failure of the seal between the GPS receiver body and the exterior of the cabinet. The local controller time was reset manually.

5.5 SR-247

The local signal controller was not receiving the time clock sync reference from the GPS time reference module. When the GPS receiver is connected to the face of the TR-4 the unit shuts off. This is the result of a faulty GPS receiver. Based on field observations the issue could be the result of corrosion of the GPS receiver connecting pins due to failure of the seal between the GPS receiver body and the exterior of the cabinet. The local controller time was reset manually.

5.6 Belshire Way / Commonwealth Drive

At this intersection the GPS time reference module appeared to be operating correctly, but the local controller was not responding to the time clock sync reference signal. The local controller was replaced with the spare controller provided by the City, which was confirmed to respond appropriately to the time reset signal. It was determined later that the issue was with the firmware version in the original traffic controller. Quality Traffic updated the firmware, confirmed that the unit functioned appropriately, and returned the controller to the City on August 7, 2014.

Field observations also uncovered a broken advance loop detector in the northbound through lane (Phase 2). The detector card indicates a fault and there is not continuity between each end of the loop wire. The result is a constant call placed to that controller phase. During coordination this is not an issue because the loop is for northbound through traffic on US Route 31, but in off peak times the side street traffic will have to wait until the US Route 31 phase time maxes out.

5.7 Southern Walmart Access

This intersection had a master controller (Peek M3000E) and was interconnected with Campbell Station Parkway by fiber optic cable. This equipment was not in use since the installation of the GPS time reference module so it was removed and given to City staff for safe storage until needed in the future.

5.8 Campbell Station Parkway

This intersection was interconnected with the Southern Walmart Access by fiber optic cable. However, this equipment was not in use since the installation of the GPS time sync unit so it was removed and given to City staff for safe storage until needed in the future.

There are issues with the emergency vehicle preemption at this intersection. The acoustic preemption receivers for the northbound and westbound directions need to be adjusted. The acoustic preemption receiver for the southbound direction needs to be reinstalled (currently in signal cabinet). These issues do not affect normal signal operations.

5.9 Buckner Road / Thompsons Ridge Road

Field observations at this intersections indicated that the northbound left turn protected phase received an amount of phase time (green arrow), even with no left turning traffic present. Further investigation revealed that the Phase 2 (northbound through movement) loop detector input was terminated on Phase 5 (northbound left turn) and vice versa. Therefore the northbound through traffic was placing a constant call for the left turn. Quality Traffic switched the detector wiring to correct the problem.

5.10 Thompsons Station Road

At this intersection the GPS time reference module appeared to be operating correctly, but the local controller was not responding to the time clock sync reference signal. The project team determined that the wire on the preemption harness was not terminated on the correct terminal on preemption panel. After connecting the wire to the proper terminal the time sync was still not working. The local controller was replaced with the spare controller provided by Quality Traffic, which was confirmed to respond appropriately to the time reset signal. It was determined later that the issue was with the firmware version in the original traffic controller. Quality Traffic updated the firmware, confirmed that the unit responded to the time clock sync reference signal and reinstalled the controller on August 7, 2014.

Quality Traffic received a call from the town of Thompsons Station on 8/7/2014 stating that traffic was backing up at this intersection on US-31. Quality Traffic responded and found that that the timing had not transferred to back to the controller properly. The passage time on US Route 31 was 3.0 seconds and the initial green time was 15 seconds. Quality Traffic increased these settings to 5.0 seconds for passage time and 30 seconds for initial green interval time.

6.0 Travel Time

Travel time and delay data is used to validate the base condition traffic simulation model of existing traffic on US Route 31. The project team collected this travel data on a typical weekday in May 2014 during the AM, midday, and PM peak periods using the average vehicle method. The travel-time and delay study included two routes: 1) northbound US Route 31 (Main Street) between Crossings Boulevard and Thompsons Station Road; 2) southbound US Route 31 (Main Street) between Thompsons Station Road and Crossings Boulevard. The average weekday peak hour travel time summary can be found in Table 8 – Table 10.

Table 8: Results from Northbound US Route 31 Travel Time Runs.

From	To	Average Travel Time (sec)			Average Travel Speed (mph)			Average Delay (sec)		
		AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Crossings Boulevard	Town Center Parkway	15	16	17	38	35	33	12.0	0.0	21.0
Town Center Parkway	Kedron Road	43	24	49	21.2	37.2	18.6	10.5	0.0	0.0
Kedron Road	Depot Street / McLemore Avenue	54	46	50	25	30	28	0.0	20.0	23.0
Depot Street / McLemore Avenue	SR-247	44	62	53	12	9	10	22.0	12.5	0.0
SR-247	Belshire Way / Commonwealth Drive	157	160	131	30	28	34	32.3	13.8	19.3
Belshire Way / Commonwealth Drive	Southern Walmart Entrance	29	42	43	27	19	18	0.1	29.5	18.0
Southern Walmart Entrance	Campbell Station Parkway	69	73	70	15	15	15	20.7	0.0	16.0
Campbell Station Parkway	Buckner Road / Thompsons Ridge Road	426	73	100	6	36	26	130.5	0.0	10.5
Buckner Road / Thompsons Ridge Road	Thompsons Station Road	224	79	113	15	41	29	0.0	0.0	4.8

Table 9: Results from Souhtbound US Route 31 Travel Time Runs.

From	To	Average Travel Time (sec)			Average Travel Speed (mph)			Average Delay (sec)		
		AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Thompsons Station Road	Buckner Road / Thompsons Ridge Road	107	118	432	32	33	14	36.0	32.1	166.7
Buckner Road / Thompsons Ridge Road	Campbell Station Parkway	84	104	107	38	38	34	10.4	11.0	17.1
Campbell Station Parkway	Southern Walmart Entrance	28	32	49	26	23	21	13.8	18.9	22.2
Southern Walmart Entrance	Belshire Way / Commonwealth Drive	35	45	47	36	31	24	3.7	6.5	12.1
Belshire Way / Commonwealth Drive	SR-247	133	154	143	38	37	36	23.7	35.3	38.9
SR-247	Depot Street / McLemore Avenue	16	18	18	28	27	24	15.6	19.6	30.9
Depot Street / McLemore Avenue	Kedron Road	58	53	58	30	29	28	6.3	7.6	10.6
Kedron Road	Town Center Parkway	35	26	25	29	28	27	15.5	18.2	20.9
Town Center Parkway	Crossings Boulevard	22	14	14	41	36	38	1.4	3.5	2.3

Table 10: Travel Time Runs Total Route Summary.

Route	Total Average Travel Time (min:sec)			Total Average Travel Speed (mph)			Total Average Delay (sec)		
	AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Northbound US Route 31 (Main Street)	17:41	09:35	10:26	20.4	20.4	27.2	228.2	228.2	112.5
Southbound US Route 31 (Main Street)	08:38	09:24	14:53	31.4	28.8	24.2	34.3	82.0	86.8

In order to evaluate projected conditions as well as identify needed improvements, a base model representing existing conditions has been established through the development and calibration of a simulation model of the roadway network. This base model of the roadway network was constructed using the traffic simulation and modeling software Synchro and SimTraffic. Base model calibration to simulate the existing conditions of the roadway network was based on field observations, existing signal timings and field-run travel times. The base model was coded with the existing geometric, volume, phasing and timing information collected as part of the field inventory. The base traffic operations are then calibrated for each time-period studied (AM, midday, and PM) to establish a point of reference to which future modifications will be compared. Since the existing-conditions travel time runs were made before the project team have made intermediate signal timing modifications at the southern Walmart Access (and adjacent signals on US-31), the original signal timings are being used in the base model. The base model average weekday travel time data can be found in Table 11 Table 13.

Table 11: Base Model Northbound US Route 31 Travel Time

From	To	Average Travel Time (sec)			Average Travel Speed (mph)			Average Delay (sec)		
		AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Crossings Boulevard	Town Center Parkway	20.9	22.9	23.5	27	25	24	4.5	6.4	7.5
Town Center Parkway	Kedron Road	34.3	42.0	47.8	28	25	23	9.3	16.2	22.0
Kedron Road	Depot Street / McLemore Avenue	43.8	47.7	49.7	31	29	28	6.0	8.0	10.3
Depot Street / McLemore Avenue	SR-247	29.9	35.5	40.3	18	15	13	15.2	20.3	25.1
SR-247	Belshire Way / Commonwealth Drive	124.5	128.1	135.8	36	35	33	21.3	26.5	32.7
Belshire Way / Commonwealth Drive	Southern Walmart Entrance	23.7	24.0	26.8	33	33	29	6.3	6.9	9.3
Southern Walmart Entrance	Campbell Station Parkway	44.2	51.7	59.5	26	25	23	20.5	28.0	35.8
Campbell Station Parkway	Buckner Road / Thompsons Ridge Road	89.4	86.3	101.7	35	36	34	31.6	28.7	44.1
Buckner Road / Thompsons Ridge Road	Thompsons Station Road	95.6	86.9	92.0	34	38	36	31.0	17.9	23.4

Table 12: Base Model Southbound US Route 31 Travel Time

From	To	Average Travel Time (sec)			Average Travel Speed (mph)			Average Delay (sec)		
		AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Thompsons Station Road	Buckner Road / Thompsons Ridge Road	102.5	100.5	233.5	32	33	14	36.0	32.1	166.7
Buckner Road / Thompsons Ridge Road	Campbell Station Parkway	57.4	57.8	63.7	38	38	34	10.4	11.0	17.1
Campbell Station Parkway	Southern Walmart Entrance	32.3	37.6	40.9	26	23	21	13.8	18.9	22.2
Southern Walmart Entrance	Belshire Way / Commonwealth Drive	19.5	22.3	27.9	36	31	24	3.7	6.5	12.1
Belshire Way / Commonwealth Drive	SR-247	112.1	123.7	126.6	38	37	36	23.7	35.3	38.9
SR-247	Depot Street / McLemore Avenue	47.9	52.2	64.4	28	27	24	15.6	19.6	30.9
Depot Street / McLemore Avenue	Kedron Road	35.6	37.0	39.5	30	29	28	6.3	7.6	10.6
Kedron Road	Town Center Parkway	64.9	69.2	71.8	29	28	27	15.5	18.2	20.9
Town Center Parkway	Crossings Boulevard	13.9	15.9	15.0	41	36	38	1.4	3.5	2.3

Table 13: Base Model Total Route Summary

Route	Total Average Travel Time (min:sec)			Total Average Travel Speed (mph)			Total Average Delay (sec)		
	AM	Midday	PM	AM	Midday	PM	AM	Midday	PM
Northbound US Route 31 (Main Street)	08:26	08:45	09:37	32.7	32.6	30.8	145.7	158.9	210.2
Southbound US Route 31 (Main Street)	08:06	08:36	11:23	34.0	32.9	27.5	126.4	152.7	321.7

7.0 Level of Service

To determine the current operation of the area intersections, capacity analyses were performed for the peak hours at the signal timing project intersections. The capacity calculations were performed according to the methods outlined in the *Highway Capacity Manual*, TRB 2000. Capacity analyses result in the determination of a Level of Service (LOS) for an intersection. The LOS is a concept used to describe how well an intersection or roadway operates. LOS A is the best, while LOS F is the worst. Table 14 presents the descriptions of LOS for signalized intersections.

Table 14: Level of Service Descriptions.

LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY (sec/veh)
A	Operations with very low delay. This occurs when progression is extremely favorable. Most vehicles do not stop at all.	≤ 10
B	Operations with stable flows. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.	>10 and ≤ 20
C	Operations with stable flow. Occurs with fair progression and/or longer cycle lengths. The number of vehicles stopping is significant, although many still pass through the intersection without stopping.	>20 and ≤ 35
D	Approaching unstable flow. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop.	>35 and ≤ 55
E	Unstable flow. This is considered to be the limit for acceptable delay. These high delays generally indicate poor progression, long cycle lengths, and high V/C ratios.	>55 and ≤ 80
F	Unacceptable delay. This condition often occurs with over saturation or with high V/C ratios. Poor progression and long cycle lengths may also cause such delay levels.	>80.0

The results of capacity analyses for base conditions at the study area signalized intersections are presented in Table 15. Analysis indicates that each signalized intersection on the study segment of Route 31 operates at LOS D or better during the weekday AM, midday, and PM peak hours. This evaluation establishes the base condition to which all future modifications will be compared. In addition, these capacity analyses will be used to evaluate the need for roadway and traffic control improvements at the project area intersections.

It should be noted that the actual LOS on US Route 31 is likely worse than estimated by the model. The traffic simulation model shows substantially better performance than the field measurements would indicate, as evidenced by comparing the actual travel time runs (Table 8 –Table 10) to the travel time predicted by the traffic simulation model (Table 11 – Table 13). This discrepancy is largely due to the signal system problems discussed in Section 5.0 Signal System Infrastructure. The problems many of the signals had regarding the controller not receiving input from GPS time reference module cannot be accounted for in the model.

Table 15: Base Intersection Peak Hour Levels of Service.

No.	INTERSECTION	TURNING MOVEMENT	LEVEL OF SERVICE					
			AM PEAK HOUR	Average Delay (sec/veh)	MIDDAY PEAK HOUR	Average Delay (sec/veh)	PM PEAK HOUR	Average Delay (sec/veh)
1	Crossings Blvd	Overall Intersection	A	8.3	B	19.5	B	19.4
2	Town Center Pkwy	Overall Intersection	B	10.8	B	10.6	B	14.1
3	Kedron Rd	Overall Intersection	C	24.7	C	22.8	C	27.9
4	Depot St / McLemore Ave	Overall Intersection	B	11.5	A	9.7	B	15.1
5	SR-247	Overall Intersection	B	17.9	B	19.2	C	22.5
7	Belshire Wy / Commonwealth Dr	Overall Intersection	C	25.7	D	36.0	C	31.7
8	Southern Walmart Entrance	Overall Intersection	A	6.7	B	10.4	B	19.9
9	Campbell Station Pkwy	Overall Intersection	C	23.6	C	31.9	D	41.3
10	Buckner Rd / Thompsons Ridge Rd	Overall Intersection	D	37.6	C	28.5	D	53.8
11	Thompson Station Rd	Overall Intersection	D	41.0	C	25.6	D	37.0