THOROUGHFARE PLAN

TOWN OF ST. JOHN

February, 2016

15-0012-04

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THOROUGHFARE PLAN

INTRODUCTION

The coordination of land use and thoroughfare development is critical to safe and efficient access to the residents of any community. Proper access planning for commercial areas, especially along a major corridor such as U.S. 41 affects quality of life issues for residents within a community, as well as those traversing through that community on their way to and from home.

The community of St. John is growing rapidly. Sound thoroughfare planning is needed to avoid the undesirable effects of congestion and to improve community cohesion. Thoroughfare planning will set the stage for the development of new roadways in the future as commercial and residential development outside of the present Town limits become absorbed into the community.

The Thoroughfare Plan will examine the present roadway conditions, traffic volumes and safety characteristics. Deficiencies will be noted and recommendations will be brought forth. As with any Plan, it should not be viewed in a static sense. Periodic updating will be necessary in future years to keep abreast of ever-changing conditions.

FUNCTIONAL CLASSIFICATION

Functional classification of the streets in a community is one of the main concepts in thoroughfare planning. It is extremely important that the community understand that there is a hierarchy to the streets within their community. This hierarchy will set expectations about traffic volumes, speed, access control, right-of-way widths and the presence of "foreign" traffic expected to use the individual streets.

The hierarchy is set by the streets functional classification. At the top of the list is the *principal arterial* classification. U.S. 41 is such a route. It is meant to carry large volumes, including semi-truck traffic, from community to community with linkage well beyond the adjacent community.

The next classification is that of *minor arterial*. Streets like West 93rd Avenue meet this classification in that they carry significant volumes of traffic and provide connection beyond the community's border into other areas. They also serve as feeder routes to the major arterials

The next classification is the *collector street*. The last classification is the local street, which is the typical sub-division street. The collector street collects traffic from the local street network and funnels it to the minor or major arterial streets. Keilman Street is an example of a collector street.

The following information should be used to guide the development of new roadways and re-development of existing roadways in the Town:

Functional Classification	*Right-of-Way*	*Roadway Widths*	*Access Control*
Principal Arterial	100'	4 lanes = 48'	No direct residential drives Minimize commercial drives
Minor Arterial	90'	2 lanes = 24'	No direct residential drives
Collector	70'	2 lanes = 22' min.	Minimize residential drives
Local	60'	2 lanes = 20' min.	Not controlled

Note that in areas of intense commercial development and added auxiliary lanes, the needed Right-of-Way width may be 120' or greater.

ADMINISTRATIVE JURISDICTION

Within Indiana, routes with the "U.S." or "State Route" designation come under the jurisdiction of the Indiana Department of Transportation (INDOT). This means that they have total control over the roadway and access thereto. Driveway location, speed limits, improvements and maintenance (including snow removal) come under INDOT's control. They often seek input from the communities that their route passes through, but the final decisions are theirs. U.S. 41 is such a route within St. John.

All routes other than U.S. 41 within the municipal boundary of St. John are the Town's responsibility, except those that are private and/or those not accepted by the Town. The jurisdictional responsibility is an important element in determining

who is responsible for maintenance work and what funding is available to the Town for maintenance and improvement. For example the Town gets no funding from the State for maintenance or improvements for U.S. 41. Likewise the State provides funds to the Town for its streets and does no maintenance on those streets.

TRAFFIC VOLUMES

Traffic volumes were obtained from the Northwestern Indiana Regional Planning Commission (NIRPC), INDOT, and the Town for selected roadways. The results are shown in the table that follows.

Parts of the West 93rd Avenue corridor through the Town of St. John have seen very high growth rates in recent years. Vacant land is still available adjacent to this corridor so it is likely that this high growth rate will continue in the short term. As the area matures, this growth rate will slow.

Considering the above, it is likely that West 93rd Avenue, which is two-lane presently, will have to be widened in the future. The volumes in 2002/2004 were in the range of 8,500 – 9,600 Average Annual Daily Traffic (AADT). The volumes in 2015 were about 12,000 AADT. This is about a 2% annual growth which shows that the growth rate is maturing. A two-lane road can handle up to about 15,000 AADT. From 15,000 - 19,000, a three-lane roadway will suffice. Beyond 19,000 AADT, a four-lane roadway should be considered. If the present rate continues, 93rd Avenue to the west of US 41 should be considered for widening to three (3) lanes in about twelve (12) years, 2027, and on to a four (4) lane road in about fifteen (15) years thereafter. Additional traffic counts should be taken every three (3) to five (5) years to monitor the growth in traffic volumes to determine if this growth rate continues. For the time being, it is recommended that all future development along West 93rd Avenue be platted with a 45' half right-of-way in order to provide the Town with sufficient width to widen to four lanes and have auxiliary left turn lanes.

The other area of concern is West 109th Avenue west of U.S. 41. In 1995, the AADT was 9,367. By the year 2011, the volumes have increased to 11,190 (That is about 1.2% to 1.3% increase per year). As development moves south, this roadway may increase in traffic flow as well. This road also serves traffic traveling west into Illinois. Consequently, to the extent that the Town can have

input in new developments along this route, a 50' half right-of-way should also be platted with those developments.

CRITICAL INTERSECTION ANALYSIS: U.S 41 AND 93RD AVENUE

The highest volume intersection in the Town is the intersection of West 93rd Avenue and U.S. 41. The intersection was mentioned by members of the audience in the Community outreach meeting for the Comprehensive Plan Update held in the summer of 2015 as an intersection with considerable delay.

The operating condition of that intersection can be described by its Level of Service. Level of Service is expressed as a letter grade of "A" through "F", with "A" being best and "F" being worst. The Level of Service is defined in terms of delay time. Level of Service "A" means that there is a minimum of delay experienced by most motorists using the intersection. The Level of Service "F" means that motorists are experiencing a great deal of delay (i.e. sitting through multiple signal cycles before making it through the intersection). For areas such as this location, Level of Service "C" is desirable and "D" is the generally accepted minimum allowable. Traffic counts were collected in September of 2015 for the morning and afternoon peak traffic periods. The intersection operates at a Level of Service C for both of those periods. There is an issue with the length of the left turn lane on the west approach. The morning left turn volume is so high that the left turn traffic spills out into the thru lane and blocks that traffic periodically from reaching the signal. It is approximately 170 feet in length and should be lengthened to about 320 feet.

Other Intersections Considered for Analysis:

There are a number of key intersection that should be considered for additional analysis, especially when large developments (i.e., greater than 95 homes) are being proposed in the immediate vicinity. These include:

1. Calumet Avenue and West 93rd Avenue
2. Calumet Avenue and 101st Street
3. White Oak Avenue and West 93rd Avenue
4. White Oak Avenue and 101st

TRAFFIC VOLUME

			AADT	Number Of lanes	Year of Count	AADT	Year of Count
1. Corridors							
	US 41	North of 93rd Avenue	18,850	4	1999	32,350	2011
		South of 93rd Avenue	16,520	4	1999	23,154	2011
		South of 97th Lane	13,500	4	1999	22,965	2011
		South of 109th	13,380	4	1999	22,111	2011
	West 93rd Avenue	West of White Oak	8,375	2	2004	9,525	2011
		East of White Oak	9,647	2	2004		
		West of US 41	8,034	2	2002	12,000	2015
		East of US 41	5,312	2	2004	9,700	2015
2. Other Locations							
	Parrish	South of Joliet	763	2	2004	6,025	2013
	Joliet Street	West of Parrish	2,727	2	2004	3,507	2013
	Joliet Street	East of US 41	2,321	2	2003	6,025	2011
	West 85th	East of US 41	4,949	2	2004	5,345	2013
	Patterson Street	North of 93rd Avenue	3,053	2	2003	6,025	2011
	109th	West of US 41	9,367	2	*1995	11,190	2011

ACCIDENT ANALYSIS

The intersection of U.S. 41 and Joliet Street was mentioned at the Community Outreach Meeting as a high accident area.

Accident reports for the years 2001 through 2003 and 2012 through 2014were provided by the St. John Police Department. The accidents occurring were as follows:

	Joliet Street
2001	3
2002	3
2003	11

	Joliet Street
2012	8
2013	13
2014	18

The numbers of accidents increased dramatically in the year 2003 and have continued to increase in recent years. There were construction activities occurring along U.S. 41 in 2003 which increased congestion and contributed to that increase. Since 2005, the Town has widening the Joliet Street approach at the intersection to provide two westbound lanes. This benefited the intersection by lessening the delay for those turning right; however the accidents have continued to increase. The Town is planning to extend 96th Place to Joliet Street as part of joint public/private development. The improvements will include a traffic signal at the intersection with 96th. The existing intersection of Joliet Street and U.S. 41 will be modified to only permit right turn in and right turn out movements. The remaining movements will be able to use the new connection from Joliet Street to 96th Place.

ACCESS ISSUES – RESIDENTIAL

From the field review of street conditions and a general review of the map of the Town streets, it is evident that residential development has occurred in such a manner as to result in neighborhoods that are isolated from one another and without a network of collector streets crossing the community. West 93rd Avenue and West 109th Street are the only two east/west streets that go all the way through Town. U.S. 41 is the only north/south street. The lack of through streets puts added traffic on these three streets for local trips that could be more easily handled if there were alternative options. This added traffic results in increased congestion and accelerates the need to widen these roadways. Additionally, the isolation of neighborhoods discourages pedestrian and bike movements between neighborhoods.

It is strongly recommended that new developments be connected to adjacent developments and further that multiple opportunities be provided in these new developments for connections to future adjacent development.

It is suggested that the following connections be provided within the Town as future developments take place:

1. East to West connections
   - A. West 90th Avenue from Franklin Drive to Olcott Avenue
   - B. West 105th Street from Bull Run Drive to US 41 (location is conceptual and may vary from the location shown on the map)

2. North to South connections
   - A. White Oak Avenue from West 93rd Ave. to West 85th Avenue
   - B. Monfort Drive from Hoffman Pl to West 93rd Avenue
   - C. Patterson Street – new connection. Extend Keilman Street to PattersonStreet at Wall Street.
   - D. US 41 Frontage Road. Connect Bailey Street and Schneider Place from 106th Lane to 108th Avenue
   - E. Extend Parish Street to connect with the intersection with Clarmonte Drive.
   - F. Extend Clarmonte Drive from 93rd Avenue to Parish Ave.

The following map (Figure 1) graphically depicts these connections.

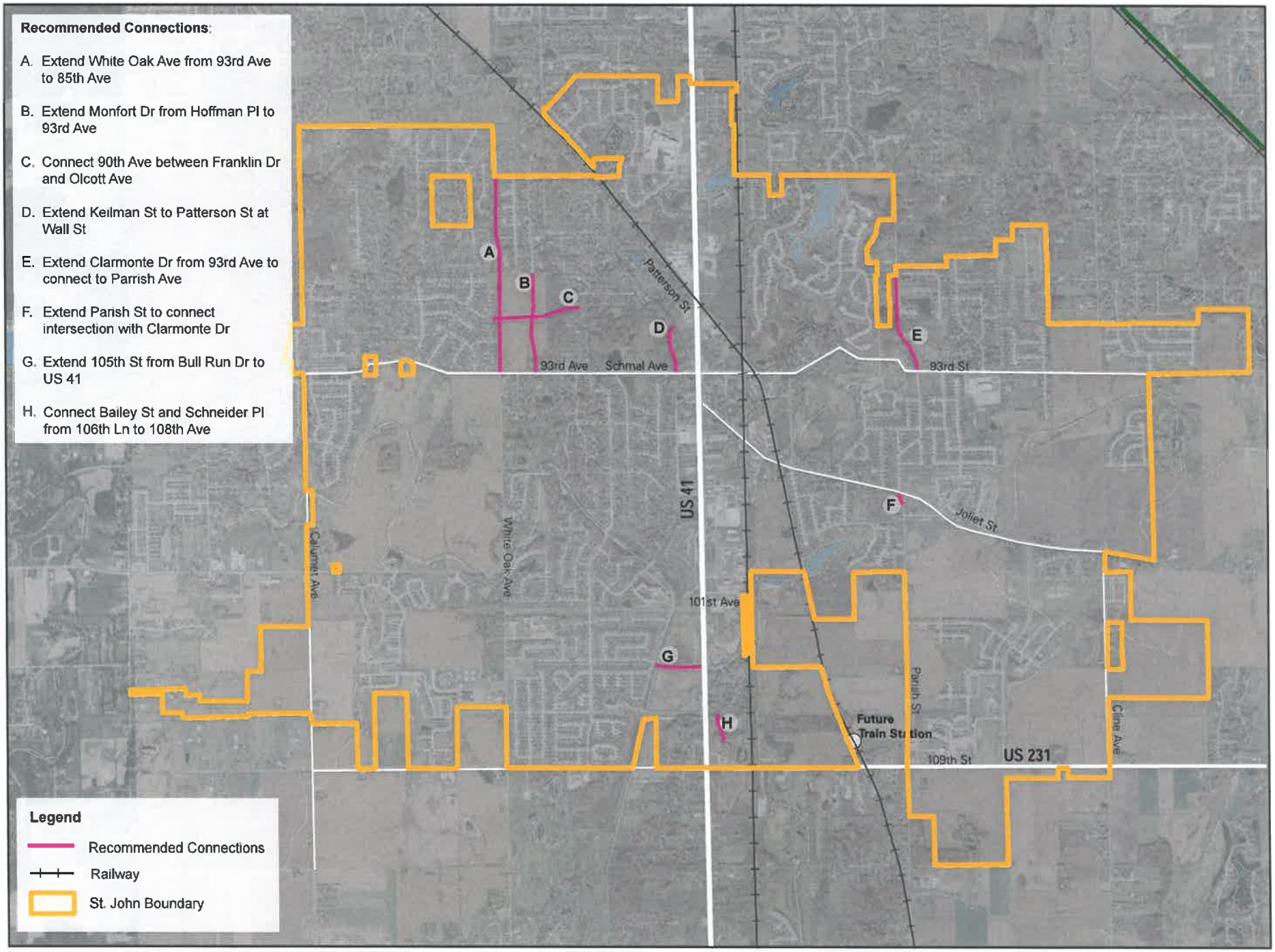

Figure 1: Recommended Roadway Connections

On the previous mentioned map, the street connections are recommended as collectors. It is strongly recommended that all new developments on arterial streets have only street access to other arterial streets. All lots on the arterial streets should have their access via the internal sub-division streets. This is recommended in order to reduce the number of conflict points along the arterial and to orient individual residential lot access onto local streets rather than arterial streets. This will also eliminate potential complaints by those living on the arterial streets about congestion, speeding and high traffic volumes.

New developments that are quite large on collector streets should also be oriented to provide lot access via the internal streets.

For large developments that encompass both sides of an arterial or a collector, the developer should consider a round-about or traffic circle if his Traffic Impact Study indicates that there is insufficient traffic volume to warrant a traffic signal and there is a poor Level of Service under two-way or four-way stop control.

ACCESS ISSUES – U.S. 41 COMMERCIAL

The U.S. 41 corridor is the primary commercial corridor for the Town of St. John. The Town has made efforts, with good success, at consolidating access to U.S. 41 for new developments. These efforts should continue as the greater the number of access points to U.S. 41, the more potential for congestion and accidents. New developments and redevelopment of existing lots should be required to have cross access agreements with adjacent parcels and connections between parking areas internal to the developments. Large-scale developments should also consider access connections to adjacent residential areas and frontage road connections.

Frontage roads can take the traditional form serving as a divider between the nearer outlot development and the larger development at the back of the lot. For lots that are not large enough for this type of development, back access roads are recommended. Also see the Comprehensive Plan for information concerning the future of Route 41. Care must be taken to design frontage roads at least 150' back from U.S. 41 to allow sufficient storage distance at signalized access points on U.S. 41. As the signalized access points are designed they should include right and left turn lanes on U.S. 41 and left turn lanes as a minimum on the side streets. Without the left turn lanes the signal will function less efficiently.

By interconnecting the commercial properties along U.S. 41, access can be controlled in a more organized manner. Consolidating access will likely mean signalized access control. Traffic signals work best if their spacing is 1000 feet or more. The Town should strive to achieve the spacing of major access points with that spacing in mind.
This may require that some lots be granted individual drives on a temporary basis until adjacent properties can be developed with the appropriate cross-access arrangements. Some type of covenant or condition of development approval should specifically and legally stipulate that these drives are temporary pending cross access to centralized signalized access points.

From a review of the development along U.S. 41, it is suggested that the Town attempt to direct future signalized access at or near the following locations:

1. Wall Street
2. 96th Avenue
3. 101st Avenue
4. 103rd Avenue
5. 105th Avenue

As stated earlier, INDOT has jurisdiction over U.S. 41. Consequently, the Town will need to work closely with INDOT, as they have in the past, to achieve the desired results concerning access to U.S. 41.

US 231 Corridor Discussion

The U.S. 231 corridor runs from U.S. 41 to the eastern Town Limits at Cline Avenue. The area between Parrish Avenue and Cline Avenue is rapidly developing into a commercial corridor with residential and office behind the corridor. The town has approved development plans that have minimized access onto U.S. 231 to keep from adding unnecessary access point along the route. The Town's vision for this corridor is for retail and/or office space fronting U.S. 231. A recent Traffic Study for the Mill Creek Subdivision included a corridor review of existing, approved and potential development in the vacant area between Parrish Avenue and Cline Avenue. Access for the vacant parcels along U.S. 231 was limited to the existing intersections and a single right-in/right-out drive between the intersections. Parrish Avenue and Cline Avenue are presently signalized. Park Place which is located between these two intersections will warrant a traffic signal in the future. Traffic volumes at full build-out will warrant

a 4-lane section with right turn lanes for the right-in/right-out drives and left turn lanes at the signalized intersections A raised 4 feet divided median is recommended throughout. Future development along U.S. 231 should provide a 60 foot half Right-of-Way order to provide the room for these improvements and utilities/sidewalks. The area between U.S. 41 and Parrish Avenue will be limited somewhat by the presence of the two rail lines. It is anticipated that the same 4 lane section will be needed in this area and the main entrance into the future proposed rail station development will be signalized. A secondary right-in/right-out drive may also be provided for additional access. The signalized intersection should have an eastbound left turn lane and a westbound right turn lane.

In the short term, the Town may consider the installation of left turn lanes on U.S. 231 at the intersections with Parrish Avenue and with Cline Avenue to provide left turning traffic a place to wait for the opposing gaps and not impede the thru movements.

RECOMMENDATIONS

The following are recommended actions resulting from this Thoroughfare Plan:

1. New developments on the various classifications of streets should have the required Right of Ways, as noted elsewhere in this plan, dedicated at the time of planning approval.

2. The west approach of 93rd Avenue to U.S.41 should be widened to lengthen the left turn lane to approximately 320 feet.

3. Access to U.S. 41 should be consolidated wherever and whenever the opportunity presents itself through re-development of existing properties. Frontage roads or cross access between properties should be required wherever possible to allow for traffic to move from development to development without having to use U.S. 41.

4. New residential sub-divisions should be linked to adjacent sub-divisions. Sub-divisions located on arterial or collector streets should not have direct driveway access to those streets but rather by way of the internal street system.

5. Specific linkages are recommended for improved circulation. These include:

   A. East to West connections
      1. West 90th Avenue from Franklin Drive to Olcott Avenue
      2. West 105th Street from Bull Run Drive to US 41 (location is conceptual and may vary from the location shown on the map)

   B. North to South connections
      1. White Oak Avenue from West 93rd Ave. to West 85th Avenue
      2. Monfort Drive from Hoffman Pl to West 93rd Avenue
      3. Patterson Street – new connection. Extend Keilman Street to PattersonStreet at Wall Street.
      4. US 41 Frontage Road. Connect Bailey Street and Schneider Place from 106th Lane to 108th Avenue
      5. Extend Parish Street to connect with the intersection with Clarmonte Drive.
      6. Extend Clarmonte Drive from 93rd Avenue to Parish Ave.

6. Access to U.S. 231 between Parrish Avenue and Cline Avenue should be limited to full access at Park Place and right in/right out between intersections. 60 feet of half R/W should be required of all new developments in this area for future roadway improvements.

7. There are a number of key intersections that the Town should consider further investigation if new residential development (with 95 or more homes) is proposed in their vicinity. These would include:

   A. Calumet Avenue and West 93rd Avenue
   B. Calumet Avenue and 101st Street
   c. White Oak Avenue and West 93rd Avenue
   D. White Oak Avenue and 101st

APPENDIX

Traffic Counts: 93rd Avenue at U.S. 41 1
Traffic Counts: 93rd Avenue east of U.S. 41 2
Traffic Counts: 93rd Avenue west of U.S. 41 3
Highway Capacity Analysis: 93rd Avenue and U.S. 41 AM Peak 4
Highway Capacity Analysis: 93rd Avenue and U.S. 41 PM Peak 5

Traffic Counts:
93rd Avenue at U.S. 41

APPENDIX 1

TRAFFIC COUNT SUMMARY SHEET

LOCATION: US 41 and 93rd DATE: XXXXXXXX

TIME BEGIN	North Approach on US 41				East Approach on 93rd				South Approach on US 41				West Approach on 93rd				Total N/S	Total E/W	Total
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total			
6:00																			
7:00	58	569	73	700	78	149	104	331	57	1067	147	1271	92	147	256	495	1971	826	2797
8:00	75	594	67	736	105	127	108	340	64	1061	140	1265	71	121	198	390	2001	730	2731
9:00																			
10:00																			
11:00																			
12:00																			
1:00																			
2:00																			
3:00																			
4:00	62	1111	94	1267	72	172	145	389	88	702	189	979	116	171	182	469	2246	858	3104
5:00	82	1092	106	1280	61	184	146	391	99	671	178	948	139	179	153	471	2228	862	3090

Traffic Counts:
93rd Avenue east of U.S. 41

APPENDIX 2

First Group Engineering
VOLUME SUMMARY
Thu 9/17/2015

Page:

Site Reference: 000000000004
Site ID: 200000000001
Location: 93EAST410 EASTBOUND

93rd EAST OF 41

File: D0917002.prn
City:
County:

TIME	1 ~~NORTH~~ WB	2 ~~SOUTH~~ EB	Total
09:00	256	173	429
10:00	527	311	838
11:00	248	192	440
12:00	252	168	420
13:00	288	256	544
14:00	276	240	516
15:00	290	252	542
16:00	354	311	665
17:00	422	419	841
18:00	480	483	963
19:00	485	467	952
20:00	284	320	604
21:00	223	248	471
22:00	146	191	337
23:00	101	96	197
24:00	52	57	109
DAY TOTAL	4684	4184	8868
PERCENTS	52.9%	47.1%	100%
AM Times	10:00	10:00	
AM Peaks	527	311	
PM Times	19:00	18:00	
PM Peaks	485	483	

First Group Engineering
VOLUME SUMMARY
Fri 9/18/2015

Page:

Site Reference: 000000000004
Site ID: 200000000001
Location: 93EAST410 EASTBOUND

File: D0917002.prn
City:
County:

9340 EAST OF 41

TIME	1 ~~WB~~ WB	2 ~~EB~~ EB	Total
01:00	23	28	51
02:00	15	18	33
03:00	7	6	13
04:00	3	5	8
05:00	13	4	17
06:00	31	5	36
07:00	104	20	124
08:00	216	144	360
09:00	412	271	683
10:00	417	356	773
11:00	262	206	468
12:00	282	216	498
13:00	292	267	559
14:00	303	287	590
15:00	288	268	556
16:00	381	395	776
17:00	445	462	907
18:00	484	508	992
19:00	392	443	835
20:00	243	287	530
21:00	167	184	351
22:00	124	132	256
23:00	76	100	176
24:00	52	78	130
DAY TOTAL	5032	4690	9722
PERCENTS	51.8%	48.2%	100%
AM Times	10:00	10:00	
AM Peaks	417	356	
PM Times	18:00	18:00	
PM Peaks	484	508	

First Group Engineering
VOLUME SUMMARY
Sat 9/19/2015

Page:

Site Reference: 000000000004
Site ID: 200000000001
Location: 93EAST410 EASTHBOUND

File: D0917002.prn
City:
County:

93rd EAST OF 91

TIME	1 ~~NORTH~~ WB	2 ~~SOUTH~~ EB	Total
01:00	26	47	73
02:00	40	32	72
03:00	10	13	23
04:00	19	9	28
05:00	7	5	12
06:00	14	6	20
07:00	37	11	48
08:00	84	31	115
09:00	131	76	207
10:00	239	166	405
11:00	300	211	511
12:00	317	262	579
13:00	372	311	683
14:00	304	302	606
15:00	309	332	641
16:00	320	255	575
17:00	277	246	523
18:00	334	256	590
19:00	250	221	471
20:00	218	289	507
21:00	167	185	352
22:00	122	143	265
23:00	117	118	235
24:00	84	92	176
DAY TOTAL	4098	3619	7717
PERCENTS	53.2%	46.8%	100%
AM Times	12:00	12:00	
AM Peaks	317	262	
PM Times	13:00	15:00	
PM Peaks	372	332	

First Group Engineering
VOLUME SUMMARY
Sun 9/20/2015

Page:

Site Reference: 000000000004
Site ID: 200000000001
Location: 93EAST410 EASTHBOUND

File: D0917002.prn
City:
County:

93 EAST OF 41

TIME	1 ~~EASTBOUND~~ WB	2 ~~NORTH~~ EB	Total
01:00	62	65	127
02:00	31	38	69
03:00	27	15	42
04:00	15	11	26
05:00	10	8	18
06:00	14	3	17
07:00	24	8	32
08:00	44	21	65
09:00	116	53	169
10:00	179	109	288
11:00	254	147	401
12:00	298	257	555
13:00	299	301	600
14:00	231	257	488
15:00	240	252	492
16:00	247	239	486
17:00	274	224	498
18:00	261	257	518
19:00	211	220	431
20:00	185	166	351
21:00	134	189	323
22:00	88	124	212
23:00	53	60	113
24:00	25	28	53
DAY TOTAL	3322	3052	6374
PERCENTS	52.2%	47.8%	100%
AM Times	12:00	12:00	
AM Peaks	298	257	
PM Times	13:00	13:00	
PM Peaks	299	301	

Traffic Counts:

93rd Avenue west of U.S. 41

APPENDIX 3

First Group Engineering
VOLUME SUMMARY
Thu 9/24/2015

Page:

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.prn
City: ST. JOHN
County: LAKE

TIME	1 [redacted] W.B	2 [redacted] E.B	Total
11:00	0	0	0
12:00	30	58	88
13:00	314	290	604
14:00	285	285	570
15:00	424	386	810
16:00	464	408	872
17:00	510	565	1075
18:00	495	585	1080
19:00	446	421	867
20:00	426	326	752
21:00	354	182	536
22:00	204	133	337
23:00	78	74	152
24:00	45	27	72
DAY TOTAL	4075	3740	7815
PERCENTS	52.2%	47.8%	100%
AM Times	12:00	12:00	
AM Peaks	30	58	
PM Times	17:00	18:00	
PM Peaks	510	585	

First Group Engineering
VOLUME SUMMARY
Fri 9/25/2015

Page:

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.prn
City: ST JOHN
County: LAKE

TIME	1 [redacted] WB	2 [redacted] EB	Total
01:00	20	16	36
02:00	17	9	26
03:00	12	10	22
04:00	14	10	24
05:00	35	28	63
06:00	94	99	193
07:00	182	321	503
08:00	304	389	693
09:00	293	370	663
10:00	254	338	592
11:00	260	329	589
12:00	311	338	649
13:00	348	362	710
14:00	322	316	638
15:00	470	425	895
16:00	533	486	1019
17:00	529	564	1093
18:00	503	557	1060
19:00	446	502	948
20:00	406	299	705
21:00	317	205	522
22:00	298	220	518
23:00	227	156	383
24:00	101	69	170
DAY TOTAL	6296	6418	12714
PERCENTS	49.6%	50.4%	100%
AM Times	12:00	08:00	
AM Peaks	311	389	
PM Times	16:00	17:00	
PM Peaks	533	564	

First Group Engineering
VOLUME SUMMARY
Sat 9/26/2015

Page:

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.prn
City: ST 35TH
County: LAKE

TIME	1 [redacted] WB	2 [redacted] EB	Total
01:00	54	51	105
02:00	22	23	45
03:00	14	15	29
04:00	13	7	20
05:00	22	23	45
06:00	40	41	81
07:00	69	105	174
08:00	164	260	424
09:00	296	385	681
10:00	369	453	822
11:00	359	474	833
12:00	464	484	948
13:00	457	457	914
14:00	447	453	900
15:00	406	372	778
16:00	420	359	779
17:00	407	388	795
18:00	402	425	827
19:00	410	347	757
20:00	311	320	631
21:00	265	180	445
22:00	197	171	368
23:00	169	105	274
24:00	119	80	199
DAY TOTAL	5896	5978	11874
PERCENTS	49.7%	50.3%	100%
AM Times	12:00	12:00	
AM Peaks	464	484	
PM Times	13:00	13:00	
PM Peaks	457	457	

First Group Engineering
VOLUME SUMMARY
Sun 9/27/2015

Page:

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.PRN
City: ST JOHN
County: LAKE

TIME	1 [redacted]	2 [redacted]	Total
01:00	72	60	132
02:00	40	27	67
03:00	12	15	27
04:00	16	13	29
05:00	11	11	22
06:00	27	25	52
07:00	45	67	112
08:00	94	133	227
09:00	224	260	484
10:00	262	303	565
11:00	365	415	780
12:00	337	376	713
13:00	339	466	805
14:00	450	414	864
15:00	389	395	784
16:00	389	326	715
17:00	360	295	655
18:00	348	349	697
19:00	337	291	628
20:00	272	178	450
21:00	159	120	279
22:00	120	91	211
23:00	65	34	99
24:00	32	28	60
DAY TOTAL	4765	4692	9457
PERCENTS	50.4%	49.6%	100%
AM Times	11:00	11:00	
AM Peaks	365	415	
PM Times	14:00	13:00	
PM Peaks	450	466	

First Group Engineering
VOLUME SUMMARY
Mon 9/28/2015

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.prn
City: [redacted] ST. JOHN
County: LAKE

TIME	1 [redacted] WB	2 [redacted] EB	Total
01:00	14	21	35
02:00	4	10	14
03:00	13	6	19
04:00	12	12	24
05:00	29	29	58
06:00	122	112	234
07:00	211	310	521
08:00	281	414	695
09:00	307	341	648
10:00	243	322	565
11:00	251	312	563
12:00	264	296	560
13:00	260	270	530
14:00	306	309	615
15:00	431	418	849
16:00	486	433	919
17:00	556	514	1070
18:00	601	543	1144
19:00	449	333	782
20:00	353	303	656
21:00	237	143	380
22:00	139	108	247
23:00	69	42	111
24:00	28	36	64
DAY TOTAL	5666	5637	11303
PERCENTS	50.2%	49.8%	100%
AM Times	09:00	08:00	
AM Peaks	307	414	
PM Times	18:00	18:00	
PM Peaks	601	543	

First Group Engineering
VOLUME SUMMARY
Tue 9/29/2015

Site Reference: 000000000004
Site ID: 000000000093
Location: 93WEST410 [redacted]

File: D0924002.prn
City: ST JOHN
County: LAKE

TIME	1 [redacted] WB	2 [redacted] EB	Total
01:00	21	11	32
02:00	5	20	25
03:00	12	3	15
04:00	20	9	29
05:00	39	33	72
06:00	108	90	198
DAY TOTAL	205	166	371
PERCENTS	55.3%	44.7%	100%
AM Times	06:00	06:00	
AM Peaks	108	90	
PM Times			
PM Peaks			

Highway Capacity Analysis:
93rd Avenue and U.S. 41 AM Peak

APPENDIX 4

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency:
Date: 9/21/2015
Period: am peak
Project ID: US 41 and 93rd
E/W St: 93rd

Inter.:
Area Type: All other areas
Jurisd:
Year :

N/S St:

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	256	147	92	104	149	78	147	1067	57	73	569	58
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds						Peds				
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		10.0	20.0					9.0	35.0		
Yellow		3.0	3.0					3.0	3.0		
All Red		1.0	1.0					1.0	1.0		

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	358	1770	0.78	0.38	35.8	D		
TR	390	1755	0.67	0.22	36.3	D	36.0	D
Westbound								
L	348	1770	0.32	0.38	20.0+	C		
TR	393	1767	0.63	0.22	34.8	C	30.2	C
Northbound								
L	383	1770	0.42	0.53	12.8	B		
TR	1369	3520	0.89	0.39	33.6	C	31.2	C
Southbound								
L	260	1770	0.30	0.53	16.6	B		
TR	1360	3497	0.50	0.39	21.2	C	20.7	C

Intersection Delay = 29.3 (sec/veh) Intersection LOS = C

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 9/21/2015
Analysis Time Period: am peak
Intersection:
Area Type: All other areas
Jurisdiction:
Analysis Year:
Project ID: US 41 and 93rd
E/W St: 93rd N/S St:

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	256	147	92	104	149	78	147	1067	57	73	569	58
% Heavy Veh	2	2	2	2	2	2	2	2	2	2	2	2
PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
PK 15 Vol	70	40	25	28	40	21	40	290	15	20	155	16
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	278	260		113	247		160	1222		79	681	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs	0.385			0.344			0.051			0.093		
Peds Bikes	0			0			0			0		
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Arriv. Type	3	3		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.2			3.2			3.2			3.2	

PHASE DATA

Phase Combination		1	2	3	4	5	6	7	8
EB	Left	A	A			NB Left	A	A	
	Thru		A			Thru		A	
	Right		A			Right		A	
	Peds					Peds			
WB	Left	A	A			SB Left	A	A	
	Thru		A			Thru		A	
	Right		A			Right		A	
	Peds					Peds			
NB	Right					EB Right			
SB	Right					WB Right			
Green		10.0	20.0				9.0	35.0	
Yellow		3.0	3.0				3.0	3.0	
All Red		1.0	1.0				1.0	1.0	

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	256	147	92	104	149	78	147	1067	57	73	569	58
PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj flow	278	160	100	113	162	85	160	1160	62	79	618	63
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	278	260		113	247		160	1222		79	681	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs	0.385			0.344			0.051			0.093		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	1	0	1	1	0	1	2	0	1	2	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.980	0.980		0.980	0.980		0.980	0.980		0.980	0.980	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000		1.000	0.952		1.000	0.952	
fRT		0.942			0.948			0.992			0.986	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.325			0.304			0.256			0.103		
fLpb	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1770	1755		1770	1767		1770	3520		1770	3497	
Sec.	605			566			476			191		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot		197	1770	# 0.11	0.111	197	1.00
Perm		81	605	0.13	0.267	161	0.50
Left	L	278			0.38	358	0.78
Prot							
Perm							
Thru	TR	260	1755	# 0.15	0.22	390	0.67
Right							
Westbound							
Prot		113	1770	0.06	0.111	197	0.57
Perm		0	566	0.00	0.267	151	0.00
Left	L	113			0.38	348	0.32
Prot							
Perm							
Thru	TR	247	1767	0.14	0.22	393	0.63
Right							
Northbound							
Prot		160	1770	# 0.09	0.100	177	0.90
Perm		0	476	0.00	0.433	206	0.00
Left	L	160			0.53	383	0.42
Prot							
Perm							
Thru	TR	1222	3520	# 0.35	0.39	1369	0.89
Right							
Southbound							
Prot		79	1770	0.04	0.100	177	0.45
Perm		0	191	0.00	0.433	83	0.00
Left	L	79			0.53	260	0.30
Prot							
Perm							
Thru	TR	681	3497	0.19	0.39	1360	0.50
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.70
Total lost time per cycle, L = 16.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.85

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.78	0.38	25.5	1.000	358	0.33	10.3	0.0	35.8	D		
TR	0.67	0.22	32.0	1.000	390	0.24	4.3	0.0	36.3	D	36.0	D
Westbound												
L	0.32	0.38	19.5	1.000	348	0.11	0.5	0.0	20.0+	C		
TR	0.63	0.22	31.6	1.000	393	0.21	3.2	0.0	34.8	C	30.2	C
Northbound												
L	0.42	0.53	12.1	1.000	383	0.11	0.7	0.0	12.8	B		
TR	0.89	0.39	25.7	1.000	1369	0.42	7.8	0.0	33.6	C	31.2	C
Southbound												
L	0.30	0.53	15.9	1.000	260	0.11	0.7	0.0	16.6	B		
TR	0.50	0.39	20.9	1.000	1360	0.11	0.3	0.0	21.2	C	20.7	C

Intersection delay = 29.3 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 90.0 sec				
Total actual green time for LT lane group, G (s)	34.0	34.0	48.0	48.0
Effective permitted green time for LT lane group, g(s)	24.0	24.0	39.0	39.0
Opposing effective green time, go (s)	20.0	20.0	35.0	35.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	1	1	2	2
Adjusted LT flow rate, VLT (veh/h)	278	113	160	79
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	247	260	681	1222
Lost time for LT lane group, tL	4.00	4.00	4.00	4.00
Computation				
LT volume per cycle, LTC=VLTC/3600	6.95	2.83	4.00	1.98
Opposing lane util. factor, fLUo	1.000	1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	6.18	6.50	8.94	16.05
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.78	0.78	0.61	0.61
gq, (see Exhibit C16-4,5,6,7,8)	11.13	11.82	13.64	30.48
gu=g-gq if gq>=gf, or = g-gf if gq<gf	12.87	12.18	25.36	8.52
n=Max(gq-gf)/2,0)	5.57	5.91	6.82	15.24
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	1.65	1.67	2.54	4.34
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.17	0.17	0.10	0.10
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.32	0.30	0.26	0.10
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.325	0.304	0.256	0.103

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 90.0 sec				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	0.000	0.000	0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000	1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		278	113	160	79
v/c ratio from Capacity Worksheet, X		0.78	0.32	0.42	0.30
Protected phase effective green interval, g (s)		10.0	10.0	9.0	9.0
Opposing queue effective green interval, gq		11.13	11.82	13.64	30.48
Unopposed green interval, gu		12.87	12.18	25.36	8.52
Red time r=(C-g-gq-gu)		56.0	56.0	42.0	42.0
Arrival rate, qa=v/(3600(max[X,1.0]))		0.08	0.03	0.04	0.02
Protected ph. departure rate, Sp=s/3600		0.492	0.492	0.492	0.492
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.31	0.31	0.20	0.24
XPerm		0.46	0.20	0.34	0.41
XProt		1.04	0.42	0.51	0.25
Case		2	1	1	1
Queue at beginning of green arrow, Qa		4.32	1.76	1.87	0.92
Queue at beginning of unsaturated green, Qu		2.82	0.37	0.61	0.67
Residual queue, Qr		0.18	0.00	0.00	0.00
Uniform Delay, d1		25.5	19.5	12.1	15.9

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		25.5	0.00	0.0	0.0	35.8
TR	0.0	0.00	35.0	32.0	0.00	0.0	0.0	36.3
	0.0						0.0	
Westbound								
L	0.0	0.00		19.5	0.00	0.0	0.0	20.0+
TR	0.0	0.00	35.0	31.6	0.00	0.0	0.0	34.8
	0.0						0.0	
Northbound								
L	0.0	0.00		12.1	0.00	0.0	0.0	12.8
TR	0.0	0.00	27.5	25.7	0.00	0.0	0.0	33.6
	0.0						0.0	
Southbound								
L	0.0	0.00		15.9	0.00	0.0	0.0	16.6
TR	0.0	0.00	27.5	20.9	0.00	0.0	0.0	21.2
	0.0						0.0	

Intersection Delay 29.3 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound		Westbound		Northbound		Southbound	
LaneGroup	L	TR	L	TR	L	TR	L	TR
Init Queue	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	278	260	113	247	160	641	79	357
So	1900	1900	1900	1900	1900	1900	1900	1900
No.Lanes	1	1 0	1	1 0	1	2 0	1	2 0
SL	948	1755	920	1767	719	1848	487	1836
LnCapacity	358	390	348	393	383	719	260	714
Flow Ratio	0.3	0.1	0.1	0.1	0.2	0.3	0.2	0.2
v/c Ratio	0.78	0.67	0.32	0.63	0.42	0.89	0.30	0.50
Grn Ratio	0.38	0.22	0.38	0.22	0.53	0.39	0.53	0.39
I Factor		1.000		1.000		1.000		1.000
AT or PVG	3	3	3	3	3	3	3	3
Pltn Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Q1	4.7	5.9	1.8	5.6	1.9	15.0	1.0	6.8
kB	0.4	0.4	0.4	0.4	0.4	0.6	0.3	0.6
Q2	1.2	0.7	0.2	0.6	0.3	3.4	0.1	0.6
Q Average	5.9	6.7	2.0	6.2	2.2	18.4	1.1	7.3
Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	0	0	0	0	0	0	0	0
Q S Ratio								
70th Percentile Output:								
fB%	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	7.0	7.9	2.4	7.4	2.7	21.4	1.3	8.7
QSRatio								
85th Percentile Output:								
fB%	1.5	1.5	1.6	1.5	1.6	1.5	1.6	1.5
BOQ	9.1	10.3	3.2	9.6	3.5	26.9	1.7	11.2
QSRatio								
90th Percentile Output:								
fB%	1.7	1.7	1.8	1.7	1.8	1.6	1.8	1.7
BOQ	10.0	11.3	3.5	10.5	3.9	28.7	1.9	12.3
QSRatio								
95th Percentile Output:								
fB%	1.9	1.9	2.0	1.9	2.0	1.7	2.1	1.9
BOQ	11.4	12.8	4.1	12.0	4.5	31.6	2.2	13.9
QSRatio								
98th Percentile Output:								
fB%	2.3	2.3	2.6	2.3	2.5	1.9	2.6	2.3
BOQ	13.8	15.4	5.1	14.4	5.7	35.8	2.8	16.6
QSRatio								

ERROR MESSAGES

No errors to report.

Highway Capacity Analysis:
93rd Avenue and U.S. 41 PM Peak

APPENDIX 5

HCS+: Signalized Intersections Release 5.4

Analyst:
Agency:
Date: 9/21/2015
Period: pm peak
Project ID: US 41 and 93rd
E/W St: 93rd

Inter.:
Area Type: All other areas
Jurisd:
Year :

N/S St:

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	182	171	116	145	172	72	189	702	88	94	1111	62
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4	5	6	7	8
EB	Left	A	A			NB Left	A	A	
	Thru		A			Thru		A	
	Right		A			Right		A	
	Peds					Peds			
WB	Left	A	A			SB Left	A	A	
	Thru		A			Thru		A	
	Right		A			Right		A	
	Peds					Peds			
NB	Right					EB Right			
SB	Right					WB Right			
Green		10.0	20.0				9.0	35.0	
Yellow		3.0	3.0				3.0	3.0	
All Red		1.0	1.0				1.0	1.0	

Cycle Length: 90.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	344	1770	0.58	0.38	23.0	C		
TR	389	1750	0.80	0.22	44.6	D	36.2	D
Westbound								
L	307	1770	0.51	0.38	22.0	C		
TR	396	1781	0.67	0.22	36.3	D	31.0	C
Northbound								
L	260	1770	0.79	0.53	34.6	C		
TR	1356	3487	0.63	0.39	23.3	C	25.5	C
Southbound								
L	318	1770	0.32	0.53	13.2	B		
TR	1369	3519	0.93	0.39	37.9	D	36.1	D

Intersection Delay = 32.1 (sec/veh) Intersection LOS = C

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 9/21/2015
Analysis Time Period: pm peak
Intersection:
Area Type: All other areas
Jurisdiction:
Analysis Year:
Project ID: US 41 and 93rd
E/W St: 93rd N/S St:

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	182	171	116	145	172	72	189	702	88	94	1111	62
% Heavy Veh	2	2	2	2	2	2	2	2	2	2	2	2
PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
PK 15 Vol	49	46	32	39	47	20	51	191	24	26	302	17
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	198	312		158	265		205	859		102	1275	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs	0.404			0.294			0.112			0.053		
Peds Bikes	0			0			0			0		
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Arriv. Type	3	3		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.2			3.2			3.2			3.2	

PHASE DATA

Phase Combination		1	2	3	4		5	6	7	8
EB	Left	A	A			NB	Left A	A		
	Thru		A				Thru	A		
	Right		A				Right	A		
	Peds						Peds			
WB	Left	A	A			SB	Left A	A		
	Thru		A				Thru	A		
	Right		A				Right	A		
	Peds						Peds			
NB	Right					EB	Right			
SB	Right					WB	Right			
Green		10.0	20.0				9.0	35.0		
Yellow		3.0	3.0				3.0	3.0		
All Red		1.0	1.0				1.0	1.0		

Cycle Length: 90.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	182	171	116	145	172	72	189	702	88	94	1111	62
PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj flow	198	186	126	158	187	78	205	763	96	102	1208	67
No. Lanes	1	1	0	1	1	0	1	2	0	1	2	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	198	312		158	265		205	859		102	1275	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs	0.404			0.294			0.112			0.053		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	1	0	1	1	0	1	2	0	1	2	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.980	0.980		0.980	0.980		0.980	0.980		0.980	0.980	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000		1.000	0.952		1.000	0.952	
fRT		0.939			0.956			0.983			0.992	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.296			0.222			0.103			0.174		
fLpb	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1770	1750		1770	1781		1770	3487		1770	3519	
Sec.	551			413			191			325		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot		197	1770	# 0.11	0.111	197	1.00
Perm		1	551	0.00	0.267	147	0.01
Left	L	198			0.38	344	0.58
Prot							
Perm							
Thru	TR	312	1750	# 0.18	0.22	389	0.80
Right							
Westbound							
Prot		158	1770	0.09	0.111	197	0.80
Perm		0	413	0.00	0.267	110	0.00
Left	L	158			0.38	307	0.51
Prot							
Perm							
Thru	TR	265	1781	0.15	0.22	396	0.67
Right							
Northbound							
Prot		177	1770	# 0.10	0.100	177	1.00
Perm		28	191	0.15	0.433	83	0.34
Left	L	205			0.53	260	0.79
Prot							
Perm							
Thru	TR	859	3487	0.25	0.39	1356	0.63
Right							
Southbound							
Prot		102	1770	0.06	0.100	177	0.58
Perm		0	325	0.00	0.433	141	0.00
Left	L	102			0.53	318	0.32
Prot							
Perm							
Thru	TR	1275	3519	# 0.36	0.39	1369	0.93
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.75
Total lost time per cycle, L = 16.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.91

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Incremental Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.58	0.38	20.6	1.000	344	0.17	2.4	0.0	23.0	C		
TR	0.80	0.22	33.1	1.000	389	0.35	11.5	0.0	44.6	D	36.2	D
Westbound												
L	0.51	0.38	20.5	1.000	307	0.12	1.5	0.0	22.0	C		
TR	0.67	0.22	32.0	1.000	396	0.24	4.3	0.0	36.3	D	31.0	C
Northbound												
L	0.79	0.53	19.6	1.000	260	0.34	14.9	0.0	34.6	C		
TR	0.63	0.39	22.3	1.000	1356	0.21	1.0	0.0	23.3	C	25.5	C
Southbound												
L	0.32	0.53	12.7	1.000	318	0.11	0.6	0.0	13.2	B		
TR	0.93	0.39	26.3	1.000	1369	0.45	11.6	0.0	37.9	D	36.1	D

Intersection delay = 32.1 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 90.0 sec				
Total actual green time for LT lane group, G (s)	34.0	34.0	48.0	48.0
Effective permitted green time for LT lane group, g(s)	24.0	24.0	39.0	39.0
Opposing effective green time, go (s)	20.0	20.0	35.0	35.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	1	1	2	2
Adjusted LT flow rate, VLT (veh/h)	198	158	205	102
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	265	312	1275	859
Lost time for LT lane group, tL	4.00	4.00	4.00	4.00
Computation				
LT volume per cycle, LTC=VLTC/3600	4.95	3.95	5.13	2.55
Opposing lane util. factor, fLUo	1.000	1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	6.63	7.80	16.74	11.28
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.78	0.78	0.61	0.61
gq, (see Exhibit C16-4,5,6,7,8)	12.08	14.68	32.58	18.40
gu=g-gq if gq>=gf, or = g-gf if gq<gf	11.92	9.32	6.42	20.60
n=Max(gq-gf)/2,0)	6.04	7.34	16.29	9.20
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	1.68	1.75	4.58	3.03
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.17	0.17	0.10	0.10
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.30	0.22	0.10	0.17
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00) or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.296	0.222	0.103	0.174

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 90.0 sec				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				

Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	0.000	0.000	0.000	0.000
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000	1.000	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	90.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		198	158	205	102
v/c ratio from Capacity Worksheet, X		0.58	0.51	0.79	0.32
Protected phase effective green interval, g (s)		10.0	10.0	9.0	9.0
Opposing queue effective green interval, gq		12.08	14.68	32.58	18.40
Unopposed green interval, gu		11.92	9.32	6.42	20.60
Red time r=(C-g-gq-gu)		56.0	56.0	42.0	42.0
Arrival rate, qa=v/(3600(max[X,1.0]))		0.05	0.04	0.06	0.03
Protected ph. departure rate, Sp=s/3600		0.492	0.492	0.492	0.492
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.31	0.30	0.32	0.17
XPerm		0.36	0.38	1.07	0.31
XProt		0.74	0.59	0.66	0.33
Case		1	1	3	1
Queue at beginning of green arrow, Qa		3.08	2.46	2.54	1.19
Queue at beginning of unsaturated green, Qu		0.66	0.64	1.86	0.52
Residual queue, Qr		0.00	0.00	0.15	0.00
Uniform Delay, d1		20.6	20.5	19.6	12.7

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		20.6	0.00	0.0	0.0	23.0
TR	0.0	0.00	35.0	33.1	0.00	0.0	0.0	44.6
	0.0						0.0	
Westbound								
L	0.0	0.00		20.5	0.00	0.0	0.0	22.0
TR	0.0	0.00	35.0	32.0	0.00	0.0	0.0	36.3
	0.0						0.0	
Northbound								
L	0.0	0.00		19.6	0.00	0.0	0.0	34.6
TR	0.0	0.00	27.5	22.3	0.00	0.0	0.0	23.3
	0.0						0.0	
Southbound								
L	0.0	0.00		12.7	0.00	0.0	0.0	13.2
TR	0.0	0.00	27.5	26.3	0.00	0.0	0.0	37.9
	0.0						0.0	

Intersection Delay 32.1 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	198	312		158	265		205	451		102	669	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	1	0	1	1	0	1	2	0	1	2	0
SL	910	1750		812	1781		487	1831		596	1848	
LnCapacity	344	389		307	396		260	712		318	719	
Flow Ratio	0.2	0.2		0.2	0.1		0.4	0.2		0.2	0.4	
v/c Ratio	0.58	0.80		0.51	0.67		0.79	0.63		0.32	0.93	
Grn Ratio	0.38	0.22		0.38	0.22		0.53	0.39		0.53	0.39	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3		3	3		3	3	
Pltn Ratio	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
PF2	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Q1	3.3	7.4		2.6	6.1		2.6	9.1		1.2	16.0	
kB	0.4	0.4		0.3	0.4		0.3	0.6		0.3	0.6	
Q2	0.5	1.4		0.4	0.8		1.0	0.9		0.2	4.4	
Q Average	3.8	8.8		3.0	6.8		3.6	10.1		1.4	20.4	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	4.5	10.4		3.5	8.1		4.3	11.9		1.7	23.7	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5		1.6	1.5		1.6	1.5	
BOQ	5.9	13.4		4.7	10.5		5.6	15.3		2.2	29.7	
QSRatio												
90th Percentile Output:												
fB%	1.7	1.7		1.7	1.7		1.7	1.6		1.8	1.5	
BOQ	6.5	14.5		5.2	11.5		6.2	16.6		2.5	31.6	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.9		2.0	1.9		2.0	1.8		2.1	1.7	
BOQ	7.5	16.4		5.9	13.0		7.2	18.6		2.9	34.6	
QSRatio												
98th Percentile Output:												
fB%	2.4	2.2		2.5	2.3		2.5	2.2		2.6	1.9	
BOQ	9.2	19.4		7.4	15.6		8.8	21.8		3.6	39.0	
QSRatio												

ERROR MESSAGES

No errors to report.