HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
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TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	29	559	52	15	396	42
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	9	149	17	6	105	13
Hourly Flow Rate, HFR	35	594	66	25	421	53
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	29	8	18	40	3	17
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	9	3	7	13	2	7
Hourly Flow Rate, HFR	35	13	26	53	7	26
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	594	421
Shared ln volume, major rt vehicles:	66	53
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	3	3	3	3	3	3	3	3
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	474	660	1211	1221	627	1214	1228	448
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
?(x)								
/(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	627	448
Potential Capacity	482	608
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	482	608
Probability of Queue free St.	0.95	0.96
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	660	474
Potential Capacity	923	1083
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	923	1083
Probability of Queue free St.	0.97	0.97
Maj L-Shared Prob Q free St.	0.96	0.95
tep 3: TH from Minor St.	**8**	**11**
Conflicting Flows	1221	1228
Potential Capacity	179	177
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.91	0.91
Movement Capacity	164	162
Probability of Queue free St.	0.92	0.96
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows	1211	1214
Potential Capacity	159	157
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.84
Maj. L, Min T Adj. Imp Factor.	0.90	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	138	130

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
tential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1221	1228
Potential Capacity	179	177
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.91	0.91
Movement Capacity	164	162
Result for 2 stage process:		
a		
y		
C t	164	162
Probability of Queue free St.	0.92	0.96
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1211	1214
Potential Capacity	159	157
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.84
Maj. L, Min T Adj. Imp Factor.	0.90	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	138	130
Results for Two-stage process:		
a		
y		
C t	138	130

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	35	13	26	53	7	26
Movement Capacity (vph)	138	164	482	130	162	608
Shared Lane Capacity (vph)		191			174	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	138	164	482	130	162	608
Volume	35	13	26	53	7	26
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		191			174	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1083	923		191			174	
v/c	0.03	0.03		0.39			0.49	
95% queue length	0.10	0.08		1.70			2.41	
Control Delay	8.4	9.0		35.3			44.4	
LOS	A	A		E			E	
Approach Delay				35.3			44.4	
Approach LOS				E			E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.97
v(i1), Volume for stream 2 or 5	594	421
v(i2), Volume for stream 3 or 6	66	53
s(i1), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.95	0.96
d(M,LT), Delay for stream 1 or 4	8.4	9.0
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

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TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	21	554	31	10	376	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	28	636	49	14	432	24
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1100	904		191			200	
v/c	0.03	0.02		0.60			0.34	
95% queue length	0.08	0.05		3.31			1.39	
Control Delay	8.4	9.0		48.4			31.8	
LOS	A	A		E			D	
Approach Delay				48.4			31.8	
Approach LOS				E			D	

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TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
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Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
.olume	21	554	31	10	376	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	7	159	12	4	108	6
Hourly Flow Rate, HFR	28	636	49	14	432	24
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	18	1	10	9	1	7
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	636	432
Shared ln volume, major rt vehicles:	49	24
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
onstrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	456	685	1204	1200	660	1210	1213	444
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
I(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	660	444
Potential Capacity	462	612
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	462	612
Probability of Queue free St.	0.91	0.96
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	685	456
Potential Capacity	904	1100
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	904	1100
Probability of Queue free St.	0.98	0.97
Maj L-Shared Prob Q free St.	0.98	0.96
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows	1200	1213
Potential Capacity	185	181
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	174	170
Probability of Queue free St.	0.98	0.98
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows	1204	1210
Potential Capacity	161	158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	144	135

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1200	1213
Potential Capacity	185	181
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	174	170
Result for 2 stage process:		
a		
y		
C t	174	170
Probability of Queue free St.	0.98	0.98
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1204	1210
Potential Capacity	161	158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	144	135
Results for Two-stage process:		
a		
y		
C t	144	135

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	70	4	40	36	4	27
Movement Capacity (vph)	144	174	462	135	170	612
Shared Lane Capacity (vph)		191			200	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	144	174	462	135	170	612
Volume	70	4	40	36	4	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		191			200	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1100	904		191			200	
v/c	0.03	0.02		0.60			0.34	
95% queue length	0.08	0.05		3.31			1.39	
Control Delay	8.4	9.0		48.4			31.8	
LOS	A	A		E			D	
Approach Delay				48.4			31.8	
Approach LOS				E			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.98
v(i1), Volume for stream 2 or 5	636	432
v(i2), Volume for stream 3 or 6	49	24
s(i1), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.98
d(M,LT), Delay for stream 1 or 4	8.4	9.0
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2

APPENDIX 5

CAPACITY ANALYSIS
(2016 DEVELOPED CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		562	59	57	565	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR		610	78	79	620	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	56	0	63			
Peak Hour Factor, PHF	0.71	1.00	1.00			
Hourly Flow Rate, HFR	78	0	63			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		141				
C(m) (vph)		916		201				
v/c		0.09		0.70				
95% queue length		0.28		4.43				
Control Delay		9.3		56.6				
LOS		A		F				
Approach Delay				56.6				
Approach LOS				F				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		562	59	57	565	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		153	20	20	155	
Hourly Flow Rate, HFR		610	78	79	620	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	56	0	63			
Peak Hour Factor, PHF	0.71	1.00	1.00			
Peak-15 Minute Volume	20	0	16			
Hourly Flow Rate, HFR	78	0	63			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		620
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		688	1427	1427	649			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	649	
Potential Capacity	473	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	473	
Probability of Queue free St.	0.87	1.00
Step 2: LT from Major St.	4	1
Conflicting Flows	688	
Potential Capacity	916	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	916	
Probability of Queue free St.	0.91	1.00
Maj L-Shared Prob Q free St.	0.87	
Step 3: TH from Minor St.	8	11
Conflicting Flows	1427	
Potential Capacity	136	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	118	
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	1427	
Potential Capacity	150	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	137	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1427	
Potential Capacity	136	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	118	

Result for 2 stage process:		
a		
y		
C t	118	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1427	
Potential Capacity	150	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	137	

Results for Two-stage process:	
a	
y	
C t	137

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	78	0	63			
Movement Capacity (vph)	137	118	473			
Shared Lane Capacity (vph)		201				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	137	118	473			
Volume	78	0	63			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		201				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		141				
C(m) (vph)		916		201				
v/c		0.09		0.70				
95% queue length		0.28		4.43				
Control Delay		9.3		56.6				
LOS		A		F				
Approach Delay				56.6				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(i1), Volume for stream 2 or 5		620
v(i2), Volume for stream 3 or 6		0
s(i1), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.87
d(M,LT), Delay for stream 1 or 4		9.3
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.2

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		618	52	55	412	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		735	80	74	490	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	34	0	75			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Hourly Flow Rate, HFR	39	0	96			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		74		135				
C(m) (vph)		821		260				
v/c		0.09		0.52				
95% queue length		0.30		2.75				
Control Delay		9.8		32.9				
LOS		A		D				
Approach Delay				32.9				
Approach LOS				D				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		618	52	55	412	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		184	20	19	123	
Hourly Flow Rate, HFR		735	80	74	490	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	34	0	75			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Peak-15 Minute Volume	10	0	24			
Hourly Flow Rate, HFR	39	0	96			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		490
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x		815	1413	1413	775			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	775	
Potential Capacity	401	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	401	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	815	
Potential Capacity	821	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	821	
Probability of Queue free St.	0.91	1.00
Maj L-Shared Prob Q free St.	0.88	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1413	
Potential Capacity	139	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity	122	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1413	
Potential Capacity	153	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.91	0.69
Movement Capacity	139	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1413	
Potential Capacity	139	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity	122	
Result for 2 stage process:		
a		
y		
C t	122	
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1413	
Potential Capacity	153	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.91	0.69
Movement Capacity	139	
Results for Two-stage process:		
a		
y		
C t	139	

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	39	0	96			
Movement Capacity (vph)	139	122	401			
Shared Lane Capacity (vph)		260				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	139	122	401			
Volume	39	0	96			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		260				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		74		135				
C(m) (vph)		821		260				
v/c		0.09		0.52				
95% queue length		0.30		2.75				
Control Delay		9.8		32.9				
LOS		A		D				
Approach Delay				32.9				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(i1), Volume for stream 2 or 5		490
v(i2), Volume for stream 3 or 6		0
s(i1), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.88
d(M,LT), Delay for stream 1 or 4		9.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.2

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	67	558			569	19
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR	76	606			625	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				46	0	53
Peak Hour Factor, PHF				0.71	1.00	0.68
Hourly Flow Rate, HFR				64	0	77
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						141	
C(m) (vph)	948						234	
v/c	0.08						0.60	
95% queue length	0.26						3.50	
Control Delay	9.1						41.3	
LOS	A						E	
Approach Delay							41.3	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	67	558			569	19
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	19	152			156	6
Hourly Flow Rate, HFR	76	606			625	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				46	0	53
Peak Hour Factor, PHF				0.71	1.00	0.68
Peak-15 Minute Volume				16	0	19
Hourly Flow Rate, HFR				64	0	77
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	606	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	647					1394	1394	636
s								
Px								
V c,u,x								
r,x								
c plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		636
Potential Capacity		481
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		481
Probability of Queue free St.	1.00	0.84
Step 2: LT from Major St.	4	1
Conflicting Flows		647
Potential Capacity		948
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		948
Probability of Queue free St.	1.00	0.92
Maj L-Shared Prob Q free St.		0.88
Step 3: TH from Minor St.	8	11
Conflicting Flows		1394
Potential Capacity		143
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		126
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1394
Potential Capacity		158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0.91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		145

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1394
Potential Capacity		143
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		126
Result for 2 stage process:		
a		
y		
C t		126
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1394
Potential Capacity		158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0:91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		145
Results for Two-stage process:		
a		
y		
C t		145

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				64	0	77
Movement Capacity (vph)				145	126	481
Shared Lane Capacity (vph)					234	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				145	126	481
Volume				64	0	77
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					234	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						141	
C(m) (vph)	948						234	
v/c	0.08						0.60	
95% queue length	0.26						3.50	
Control Delay	9.1						41.3	
LOS	A						E	
Approach Delay							41.3	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.92	1.00
v(i1), Volume for stream 2 or 5	606	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.88	
d(M,LT), Delay for stream 1 or 4	9.1	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.1	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	89	604			413	62
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	97	719			491	79
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				44	0	54
Peak Hour Factor, PHF				0.70	1.00	0.77
Hourly Flow Rate, HFR				62	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						132	
C(m) (vph)	1013						223	
v/c	0.10						0.59	
95% queue length	0.32						3.36	
Control Delay	8.9						42.2	
LOS	A						E	
Approach Delay							42.2	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	89	604			413	62
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	24	180			123	20
Hourly Flow Rate, HFR	97	719			491	79
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				44	0	54
Peak Hour Factor, PHF				0.70	1.00	0.77
Peak-15 Minute Volume				16	0	18
Hourly Flow Rate, HFR				62	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	719	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	570					1443	1443	530
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		530
Potential Capacity		553
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		553
Probability of Queue free St.	1.00	0.87
Step 2: LT from Major St.	4	1
Conflicting Flows		570
Potential Capacity		1013
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1013
Probability of Queue free St.	1.00	0.90
Maj L-Shared Prob Q free St.		0.84
Step 3: TH from Minor St.	8	11
Conflicting Flows		1443
Potential Capacity		133
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		112
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1443
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.77	0.90
Movement Capacity		133

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1443
Potential Capacity		133
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		112
Result for 2 stage process:		
a		
y		
C t		112
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1443
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.77	0.90
Movement Capacity		133
Results for Two-stage process:		
a		
y		
C t		133

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				62	0	70
Movement Capacity (vph)				133	112	553
Shared Lane Capacity (vph)					223	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				133	112	553
Volume				62	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					223	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						132	
C(m) (vph)	1013						223	
v/c	0.10						0.59	
95% queue length	0.32						3.36	
Control Delay	8.9						42.2	
LOS	A						E	
Approach Delay							42.2	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.90	1.00
v(i1), Volume for stream 2 or 5	719	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.84	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	23	581			411	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	34	631			451	62
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	1.00	0.66
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/	No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1063						307	
v/c	0.03						0.44	
95% queue length	0.10						2.14	
Control Delay	8.5						25.6	
OS	A						D	
Approach Delay							25.6	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	23	581			411	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	9	158			113	16
Hourly Flow Rate, HFR	34	631			451	62
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	1.00	0.66
Peak-15 Minute Volume				17	0	17
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	631	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	513					1181	1181	482
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		482
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		588
Probability of Queue free St.	1.00	0.88
Step 2: LT from Major St.	4	1
Conflicting Flows		513
Potential Capacity		1063
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1063
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95
Step 3: TH from Minor St.	8	11
Conflicting Flows		1181
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		183
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1181
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		205

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1181
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		183

Result for 2 stage process:		
a		
y		
C t		183
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1181
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		205

Results for Two-stage process:	
a	
y	
C t	205

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				66	0	69
Movement Capacity (vph)				205	183	588
Shared Lane Capacity (vph)					307	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				205	183	588
Volume				66	0	69
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					307	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1063						307	
v/c	0.03						0.44	
95% queue length	0.10						2.14	
Control Delay	8.5						25.6	
LOS	A						D	
Approach Delay							25.6	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	631	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	28	649			400	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	35	772			476	39
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	1.00	0.58
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1061						253	
v/c	0.03						0.20	
95% queue length	0.10						0.74	
Control Delay	8.5						22.8	
LOS	A						C	
Approach Delay							22.8	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	28	649			400	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	9	193			119	10
Hourly Flow Rate, HFR	35	772			476	39
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	1.00	0.58
Peak-15 Minute Volume				7	0	6
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	772	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	515					1338	1338	496
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		496
Potential Capacity		578
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		578
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		515
Potential Capacity		1061
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1061
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.94

Step 3: TH from Minor St.	8	11
Conflicting Flows		1338
Potential Capacity		154
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		145
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1338
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		164

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1338
Potential Capacity		154
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		145
Result for 2 stage process:		
a		
y		
C t		145
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1338
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		164
Results for Two-stage process:		
a		
y		
C t		164

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				26	0	25
Movement Capacity (vph)				164	145	578
Shared Lane Capacity (vph)					253	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				164	145	578
Volume				26	0	25
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					253	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1061						253	
v/c	0.03						0.20	
95% queue length	0.10						0.74	
Control Delay	8.5						22.8	
LOS	A						C	
Approach Delay							22.8	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	772	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.94	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	31	591			427	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	34	656			474	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1084						359	
v/c	0.03						0.13	
95% queue length	0.10						0.44	
Control Delay	8.4						16.5	
LOS	A						C	
Approach Delay							16.5	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	31	591			427	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	164			119	4
Hourly Flow Rate, HFR	34	656			474	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	656	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	490					1206	1206	482
s								
Px								
V c,u,x								
r,x								
c plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		482
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		588
Probability of Queue free St.	1.00	0.95
Step 2: LT from Major St.	4	1
Conflicting Flows		490
Potential Capacity		1084
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1084
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95
Step 3: TH from Minor St.	8	11
Conflicting Flows		1206
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		176
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1206
Potential Capacity		205
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		199

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1206
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		176
Result for 2 stage process:		
a		
y		
C t		176
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1206
Potential Capacity		205
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		199
Results for Two-stage process:		
a		
y		
C t		199

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				15	0	31
Movement Capacity (vph)				199	176	588
Shared Lane Capacity (vph)					359	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				199	176	588
Volume				15	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					359	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1084						359	
v/c	0.03						0.13	
95% queue length	0.10						0.44	
Control Delay	8.4						16.5	
LOS	A						C	
Approach Delay							16.5	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	656	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	34	636			484	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	37	706			537	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1026						312	
v/c	0.04						0.16	
95% queue length	0.11						0.55	
Control Delay	8.6						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	34	636			484	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	177			134	5
Hourly Flow Rate, HFR	37	706			537	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	706	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	555					1326	1326	546
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		546
Potential Capacity		541
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		541
Probability of Queue free St.	1.00	0.94
Step 2: LT from Major St.	4	1
Conflicting Flows		555
Potential Capacity		1026
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1026
Probability of Queue free St.	1.00	0.96
Maj L-Shared Prob Q free St.		0.94
Step 3: TH from Minor St.	8	11
Conflicting Flows		1326
Potential Capacity		157
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		148
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1326
Potential Capacity		173
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.96
Movement Capacity		167

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1326
Potential Capacity		157
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		148
Result for 2 stage process:		
a		
y		
C t		148
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1326
Potential Capacity		173
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.96
Movement Capacity		167
Results for Two-stage process:		
a		
y		
C t		167

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				16	0	33
Movement Capacity (vph)				167	148	541
Shared Lane Capacity (vph)					312	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				167	148	541
Volume				16	0	33
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					312	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1026						312	
v/c	0.04						0.16	
95% queue length	0.11						0.55	
Control Delay	8.6						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.96	1.00
v(i1), Volume for stream 2 or 5	706	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.94	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS2000: Signalized Intersections Release 4.1e

Analyst: RHH
Agency: McMILLEN ENGINEERING
Date: 12/5/2005
Period: WEEKDAY PM PEAK DEVELOPED
Project ID: 2005-319
E/W St: ROUTE 40

Inter.: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisd:
Year : 2016
N/S St: MAIN DRIVE/MARKER ROAD

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	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Volume	62	546	9	7	383	47	3	0	11	42	0	56
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
EB Right					EB	Right				
WB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0	4.0					4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 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	171	1710	0.40	0.10	31.1	C		
TR	831	1762	0.74	0.47	18.6	B	19.8	B
Westbound								
L	171	1710	0.05	0.10	28.6	C		
TR	823	1745	0.57	0.47	14.2	B	14.5	B
Northbound								
LTR	265	1545	0.05	0.17	24.3	C	24.3	C
Southbound								
L	244	1424	0.19	0.17	25.2	C		
TR	262	1530	0.18	0.17	25.1	C	25.2	C

Intersection Delay = 18.3 (sec/veh) Intersection LOS = B

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2016
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	62	546	9	7	383	47	3	0	11	42	0	56
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	17	152	3	2	106	13	1	0	3	12	0	16
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14
Adj Flow	69	615		8	465			12		47	47	
%InSharedLn												
Prop LTs		0.000			0.000			0.250		1.000	0.000	
Prop RTs		0.013			0.084			0.750			1.000	
Peds Bikes	0			0			0			0		
Buses	0	0		0	0			0		0	0	
%InProtPhase												

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	
Priv. Type	3	3		3	3			3		3	3	
Unit Ext.	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	
Ext of g	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				NB Left	A		
Thru		A			Thru	A		
Right		A			Right	A		
Peds					Peds			
WB Left	A				SB Left	A		
Thru		A			Thru	A		
Right		A			Right	A		
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	7.0	33.0			12.0			
Yellow	4.0	4.0			4.0			
All Red	2.0	2.0			2.0			

Cycle Length: 70.0 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	62	546	9	7	383	47	3	0	11	42	0	56
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	69	607	8	8	426	39	3	0	9	47	0	47
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	69	615		8	465			12		47	47	
Prop LTs		0.000			0.000			0.250		1.000	0.000	
Prop RTs		0.013			0.084			0.750			1.000	

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

	Eastbound			Westbound				Northbound		Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.981		1.000	0.982			1.000		1.000	1.000	
fG	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	
fBB	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	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.998			0.987			0.899			0.850	
fLT	0.950	1.000		0.950	1.000			0.955		0.791	1.000	
Sec.												
fLpb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1710	1762		1710	1745			1545		1424	1530	
Sec.												

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							
Perm							
Left	L	69	1710	# 0.04	0.10	171	0.40
Prot							
Perm							
Thru	TR	615	1762	# 0.35	0.47	831	0.74
Right							
Westbound							
Prot							
Perm							
Left	L	8	1710	0.00	0.10	171	0.05
Prot							
Perm							
Thru	TR	465	1745	0.27	0.47	823	0.57
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	12	1545	0.01	0.17	265	0.05
Right							
Southbound							
Prot							
Perm							
Left	L	47	1424	# 0.03	0.17	244	0.19
Prot							
Perm							
Thru	TR	47	1530	0.03	0.17	262	0.18
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.42
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.57

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	0.40	0.10	29.5	1.000	171	0.11	1.6	0.0	31.1	C		
TR	0.74	0.47	15.0	1.000	831	0.30	3.6	0.0	18.6	B	19.8	B
Westbound												
L	0.05	0.10	28.5	1.000	171	0.11	0.1	0.0	28.6	C		
TR	0.57	0.47	13.3	1.000	823	0.16	0.9	0.0	14.2	B	14.5	B
Northbound												
LTR	0.05	0.17	24.2	1.000	265	0.11	0.1	0.0	24.3	C	24.3	C
Southbound												
L	0.19	0.17	24.8	1.000	244	0.11	0.4	0.0	25.2	C		

TR	0.18	0.17	24.8	1.000	262	0.11	0.3	0.0	25.1	C	25.2	C

Intersection delay = 18.3 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				S
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)				12.0
Effective permitted green time for LT lane group, g(s)				12.0
Opposing effective green time, go (s)				12.0
Number of lanes in LT lane group, N				1
Number of lanes in opposing approach, No				1
Adjusted LT flow rate, VLT (veh/h)				47
Proportion of LT in LT lane group, PLT				1.000
Proportion of LT in opposing flow, PLTo				0.25
Adjusted opposing flow rate, Vo (veh/h)				12
Lost time for LT lane group, tL				6.00
Computation				
LT volume per cycle, LTC=VLTC/3600				0.91
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				0.23
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				0.83
q, (see Exhibit C16-4,5,6,7,8)				0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf				12.00
n=Max(gq-gf)/2,0)				0.00
PTHo=1-PLTo				0.75
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				1.00
EL1 (refer to Exhibit C16-3)				1.26
EL2=Max((1-Ptho**n)/Plto, 1.0)				1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				0.33
gdiff=max(gq-gf,0)				0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				0.79
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				0.791

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			M	
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)			12.0	
Effective permitted green time for LT lane group, g(s)			12.0	
Opposing effective green time, go (s)			12.0	

Number of lanes in LT lane group, N			1	
Number of lanes in opposing approach, No			1	
Adjusted LT flow rate, VLT (veh/h)			3	
Proportion of LT in LT lane group, PLT	0.000	0.000	0.250	0.000
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			47	
Lost time for LT lane group, tL			6.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			0.06	
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			0.91	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			4.7	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.83	
gq, (see Exhibit C16-4,5,6,7,8)			0.00	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			7.30	
n=Max(gq-gf)/2,0)			0.00	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.25	
EL1 (refer to Exhibit C16-3)			1.32	
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.21	
gdiff=max(gq-gf,0)			0.00	
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.96	
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			0.955	

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	70.0	sec				
Adj. LT vol from Vol Adjustment Worksheet, v						
v/c ratio from Capacity Worksheet, X						
Protected phase effective green interval, g (s)						
Opposing queue effective green interval, gq						
Unopposed green interval, gu						
Red time r=(C-g-gq-gu)						
Arrival rate, qa=v/(3600(max[X,1.0]))						
Protected ph. departure rate, Sp=s/3600						
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)						
XPerm						
XProt						
Case						
Queue at beginning of green arrow, Qa						
Queue at beginning of unsaturated green, Qu						
Residual queue, Qr						
Uniform Delay, d1						

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								
Westbound								
Northbound								
Southbound								

Intersection Delay 18.3 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound		Westbound		Northbound	Southbound	
LaneGroup	L	TR	L	TR	LTR	L	TR
Init Queue	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	69	615	8	465	12	47	47
So	1800	1800	1800	1800	1800	1800	1800
No.Lanes	1	1 0	1	1 0	0 1 0	1	1 0
SL	1710	1762	1710	1745	1545	1424	1530
LnCapacity	171	831	171	823	265	244	262
Flow Ratio	0.04	0.35	0.00	0.27	0.01	0.03	0.03
v/c Ratio	0.40	0.74	0.05	0.57	0.05	0.19	0.18
Grn Ratio	0.10	0.47	0.10	0.47	0.17	0.17	0.17
I Factor		1.000		1.000	1.000		1.000
AT or PVG	3	3	3	3	3	3	3
Pltn Ratio	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
Q1	1.3	9.7	0.1	6.5	0.2	0.8	0.8
kB	0.2	0.5	0.2	0.5	0.3	0.3	0.3
Q2	0.1	1.4	0.0	0.7	0.0	0.1	0.1
Q Average	1.4	11.1	0.2	7.2	0.2	0.8	0.8
Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Q Storage	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
BOQ	1.7	13.1	0.2	8.5	0.2	1.0	1.0
QSRatio							
85th Percentile Output:							
fB%	1.6	1.5	1.6	1.5	1.6	1.6	1.6
BOQ	2.2	16.8	0.2	11.0	0.3	1.3	1.3
QSRatio							
90th Percentile Output:							
fB%	1.8	1.6	1.8	1.7	1.8	1.8	1.8
BOQ	2.5	18.2	0.3	12.1	0.4	1.5	1.5
QSRatio							
95th Percentile Output:							
fB%	2.1	1.8	2.1	1.9	2.1	2.1	2.1
BOQ	2.9	20.3	0.3	13.7	0.4	1.7	1.7
QSRatio							
98th Percentile Output:							
fB%	2.6	2.1	2.7	2.3	2.7	2.6	2.6
BOQ	3.6	23.7	0.4	16.4	0.6	2.2	2.2
QSRatio							

ERROR MESSAGES

No errors to report.

HCS2000: Signalized Intersections Release 4.1e

Analyst: RHH
Agency: McMILLEN ENGINEERING
Date: 12/5/2005
Period: SATURDAY AM PEAK DEVELOPED
Project ID: 2005-319
E/W St: ROUTE 40

Inter.: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisd:
Year : 2016

N/S St: MAIN DRIVE/MARKER ROAD

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	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Volume	68	498	3	6	346	51	4	0	6	45	0	60
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			1			13			2			15

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
EB Right					EB	Right				
WB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0	4.0					4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 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	171	1710	0.44	0.10	31.5	C		
TR	832	1764	0.67	0.47	16.3	B	18.1	B
Westbound								
L	171	1710	0.04	0.10	28.6	C		
TR	821	1742	0.52	0.47	13.5	B	13.8	B
Northbound								
LTR	263	1532	0.03	0.17	24.2	C	24.2	C
Southbound								
L	245	1430	0.20	0.17	25.3	C		
TR	262	1530	0.19	0.17	25.2	C	25.3	C

Intersection Delay = 17.2 (sec/veh) Intersection LOS = B

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: SATURDAY AM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2016
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	68	498	3	6	346	51	4	0	6	45	0	60
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	19	138	1	2	96	14	1	0	2	13	0	17
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			1			13			2			15
Adj Flow	76	555		7	426			8		50	50	
%InSharedLn												
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.099			0.500			1.000	
Peds Bikes	0			0			0			0		
Buses	0	0		0	0			0		0	0	
%InProtPhase												

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	
Priv. Type	3	3		3	3			3		3	3	
Unit Ext.	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	
Ext of g	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				NB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		7.0	33.0					12.0			
Yellow		4.0	4.0					4.0			
All Red		2.0	2.0					2.0			

Cycle Length: 70.0 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	68	498	3	6	346	51	4	0	6	45	0	60
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	76	553	2	7	384	42	4	0	4	50	0	50
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	76	555		7	426			8		50	50	
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.099			0.500			1.000	

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

	Eastbound			Westbound				Northbound		Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.980		1.000	0.982			1.000		1.000	1.000	
fG	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	
fBB	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	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.999			0.985			0.933			0.850	
fLT	0.950	1.000		0.950	1.000			0.912		0.794	1.000	
Sec.												
fpb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1710	1764		1710	1742			1532		1430	1530	
Sec.												

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							
Perm							
Left	L	76	1710	# 0.04	0.10	171	0.44
Prot							
Perm							
Thru	TR	555	1764	# 0.31	0.47	832	0.67
Right							
Westbound							
Prot							
Perm							
Left	L	7	1710	0.00	0.10	171	0.04
Prot							
Perm							
Thru	TR	426	1742	0.24	0.47	821	0.52
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	8	1532	0.01	0.17	263	0.03
Right							
Southbound							
Prot							
Perm							
Left	L	50	1430	# 0.03	0.17	245	0.20
Prot							
Perm							
Thru	TR	50	1530	0.03	0.17	262	0.19
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.39
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.53

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	0.44	0.10	29.7	1.000	171	0.11	1.8	0.0	31.5	C		
TR	0.67	0.47	14.3	1.000	832	0.24	2.1	0.0	16.3	B	18.1	B
Westbound												
L	0.04	0.10	28.5	1.000	171	0.11	0.1	0.0	28.6	C		
TR	0.52	0.47	12.9	1.000	821	0.12	0.6	0.0	13.5	B	13.8	B
Northbound												
LTR	0.03	0.17	24.2	1.000	263	0.11	0.0	0.0	24.2	C	24.2	C
Southbound												
L	0.20	0.17	24.9	1.000	245	0.11	0.4	0.0	25.3	C		

TR	0.19	0.17	24.8	1.000	262	0.11	0.4	0.0	25.2	C	25.3	C

Intersection delay = 17.2 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				S
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)				12.0
Effective permitted green time for LT lane group, g(s)				12.0
Opposing effective green time, go (s)				12.0
Number of lanes in LT lane group, N				1
Number of lanes in opposing approach, No				1
Adjusted LT flow rate, VLT (veh/h)				50
Proportion of LT in LT lane group, PLT				1.000
Proportion of LT in opposing flow, PLTo				0.50
Adjusted opposing flow rate, Vo (veh/h)				8
Lost time for LT lane group, tL				6.00
Computation				
LT volume per cycle, LTC=VLTC/3600				0.97
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				0.16
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				0.83
gq, (see Exhibit C16-4,5,6,7,8)				0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf				12.00
n=Max(gq-gf)/2,0)				0.00
PTHo=1-PLTo				0.50
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				1.00
EL1 (refer to Exhibit C16-3)				1.26
EL2=Max((1-Ptho**n)/Plto, 1.0)				1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				0.33
gdiff=max(gq-gf,0)				0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				0.79
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				0.794

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			M	
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)			12.0	
Effective permitted green time for LT lane group, g(s)			12.0	
Opposing effective green time, go (s)			12.0	

Number of lanes in LT lane group, N			1	
Number of lanes in opposing approach, No			1	
Adjusted LT flow rate, VLT (veh/h)			4	
Proportion of LT in LT lane group, PLT	0.000	0.000	0.500	0.000
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			50	
Lost time for LT lane group, tL			6.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			0.08	
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			0.97	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			4.4	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.83	
gq, (see Exhibit C16-4,5,6,7,8)			0.00	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			7.58	
n=Max(gq-gf)/2,0)			0.00	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.50	
EL1 (refer to Exhibit C16-3)			1.32	
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.25	
gdiff=max(gq-gf,0)			0.00	
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.91	
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			0.912	

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	70.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v					
v/c ratio from Capacity Worksheet, X					
Protected phase effective green interval, g (s)					
Opposing queue effective green interval, gq					
Unopposed green interval, gu					
Red time r=(C-g-gq-gu)					
Arrival rate, qa=v/(3600(max{X,1.0}))					
Protected ph. departure rate, Sp=s/3600					
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)					
XPerm					
XProt					
Case					
Queue at beginning of green arrow, Qa					
Queue at beginning of unsaturated green, Qu					
Residual queue, Qr					
Uniform Delay, d1					

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								
Westbound								
Northbound								
Southbound								

Intersection Delay 17.2 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR		L	TR	
Init Queue	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Flow Rate	76	555		7	426			8		50	50	
So	1800	1800		1800	1800			1800		1800	1800	
No.Lanes	1	1	0	1	1	0	0	1	0	1	1	0
SL	1710	1764		1710	1742			1532		1430	1530	
LnCapacity	171	832		171	821			263		245	262	
Flow Ratio	0.04	0.31		0.00	0.24			0.01		0.03	0.03	
v/c Ratio	0.44	0.67		0.04	0.52			0.03		0.20	0.19	
Grn Ratio	0.10	0.47		0.10	0.47			0.17		0.17	0.17	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3			3		3	3	
Pltn Ratio	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	
Q1	1.4	8.3		0.1	5.8			0.1		0.8	0.8	
kB	0.2	0.5		0.2	0.5			0.3		0.3	0.3	
Q2	0.2	1.0		0.0	0.6			0.0		0.1	0.1	
Q Average	1.6	9.4		0.1	6.4			0.1		0.9	0.9	
Q Spacing	25.0	25.0		25.0	25.0			25.0		25.0	25.0	
Q Storage	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	
BOQ	1.9	11.0		0.2	7.5			0.2		1.1	1.1	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5			1.6		1.6	1.6	
BOQ	2.5	14.2		0.2	9.8			0.2		1.4	1.4	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.7		1.8	1.7			1.8		1.8	1.8	
BOQ	2.8	15.4		0.2	10.8			0.2		1.6	1.6	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.9		2.1	1.9			2.1		2.1	2.1	
BOQ	3.2	17.4		0.3	12.2			0.3		1.9	1.9	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.2		2.7	2.3			2.7		2.6	2.6	
BOQ	4.0	20.5		0.4	14.7			0.4		2.4	2.4	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	18	610			435	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	26	648			462	13
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.90	0.93
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1098						363	
v/c	0.02						0.13	
95% queue length	0.07						0.45	
Control Delay	8.4						16.4	
LOS	A						C	
Approach Delay							16.4	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	18	610			435	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	7	162			116	3
Hourly Flow Rate, HFR	26	648			462	13
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.90	0.93
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	648	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	475					1168	1168	468
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		468
Potential Capacity		599
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		599
Probability of Queue free St.	1.00	0.95
Step 2: LT from Major St.	4	1
Conflicting Flows		475
Potential Capacity		1098
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1098
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.96
Step 3: TH from Minor St.	8	11
Conflicting Flows		1168
Potential Capacity		195
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		188
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1168
Potential Capacity		216
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		211

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1168
Potential Capacity		195
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		188
Result for 2 stage process:		
a		
y		
C t		188
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1168
Potential Capacity		216
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		211
Results for Two-stage process:		
a		
y		
C t		211

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				17	0	31
Movement Capacity (vph)				211	188	599
Shared Lane Capacity (vph)					363	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				211	188	599
Volume				17	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					363	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1098						363	
v/c	0.02						0.13	
95% queue length	0.07						0.45	
Control Delay	8.4						16.4	
LOS	A						C	
Approach Delay							16.4	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(i1), Volume for stream 2 or 5	648	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	15	534			426	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	30	613			489	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.90	0.60
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1065						302	
v/c	0.03						0.14	
95% queue length	0.09						0.49	
Control Delay	8.5						18.9	
LOS	A						C	
Approach Delay							18.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	15	534			426	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	8	153			122	6
Hourly Flow Rate, HFR	30	613			489	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.90	0.60
Peak-15 Minute Volume				6	0	5
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	613	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	511					1173	1173	500
s								
Px								
V c,u,x								
r,x								
c plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
J(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		500
Potential Capacity		575
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		575
Probability of Queue free St.	1.00	0.96
Step 2: LT from Major St.	4	1
Conflicting Flows		511
Potential Capacity		1065
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1065
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96
Step 3: TH from Minor St.	8	11
Conflicting Flows		1173
Potential Capacity		194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		186
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1173
Potential Capacity		214
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		208

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1173
Potential Capacity		194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		186
Result for 2 stage process:		
a		
y		
C t		186
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1173
Potential Capacity		214
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		208
Results for Two-stage process:		
a		
y		
C t		208

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				22	0	21
Movement Capacity (vph)				208	186	575
Shared Lane Capacity (vph)					302	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				208	186	575
Volume				22	0	21
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					302	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1065						302	
v/c	0.03						0.14	
95% queue length	0.09						0.49	
Control Delay	8.5						18.9	
LOS	A						C	
Approach Delay							18.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	613	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	555	52	15	398	42
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR	35	590	66	25	423	53
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	29	8	18	40	3	17
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR	35	13	26	53	7	26
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1097	941		194			178	
v/c	0.03	0.03		0.38			0.48	
95% queue length	0.10	0.08		1.67			2.33	
Control Delay	8.4	8.9		34.6			42.8	
LOS	A	A		D			E	
Approach Delay				34.6			42.8	
Approach LOS				D			E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	555	52	15	398	42
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	9	148	17	6	106	13
Hourly Flow Rate, HFR	35	590	66	25	423	53
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	29	8	18	40	3	17
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	9	3	7	13	2	7
Hourly Flow Rate, HFR	35	13	26	53	7	26
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	590	423
Shared ln volume, major rt vehicles:	66	53
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	476	656	1209	1219	623	1212	1226	450
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	623	450
Potential Capacity	490	613
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	490	613
Probability of Queue free St.	0.95	0.96
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	656	476
Potential Capacity	941	1097
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	941	1097
Probability of Queue free St.	0.97	0.97
Maj L-Shared Prob Q free St.	0.96	0.95
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows	1219	1226
Potential Capacity	182	180
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	167	165
Probability of Queue free St.	0.92	0.96
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows	1209	1212
Potential Capacity	161	160
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	0.84
Maj. L, Min T Adj. Imp Factor.	0.91	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	140	133

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1219	1226
Potential Capacity	182	180
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	167	165
Result for 2 stage process:		
a		
y		
C t	167	165
Probability of Queue free St.	0.92	0.96
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1209	1212
Potential Capacity	161	160
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	0.84
Maj. L, Min T Adj. Imp Factor.	0.91	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	140	133
Results for Two-stage process:		
a		
y		
C t	140	133

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	35	13	26	53	7	26
Movement Capacity (vph)	140	167	490	133	165	613
Shared Lane Capacity (vph)		194			178	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	140	167	490	133	165	613
Volume	35	13	26	53	7	26
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		194			178	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1097	941		194			178	
v/c	0.03	0.03		0.38			0.48	
95% queue length	0.10	0.08		1.67			2.33	
Control Delay	8.4	8.9		34.6			42.8	
LOS	A	A		D			E	
Approach Delay				34.6			42.8	
Approach LOS				D			E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.97
v(i1), Volume for stream 2 or 5	590	423
v(i2), Volume for stream 3 or 6	66	53
s(i1), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.95	0.96
d(M,LT), Delay for stream 1 or 4	8.4	8.9
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	21	534	31	10	360	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	28	613	49	14	413	24
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1134	936		207			218	
v/c	0.02	0.01		0.55			0.31	
95% queue length	0.08	0.05		2.94			1.25	
Control Delay	8.3	8.9		41.8			28.7	
LOS	A	A		E			D	
Approach Delay				41.8			28.7	
Approach LOS				E			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	534	31	10	360	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	7	153	12	4	103	6
Hourly Flow Rate, HFR	28	613	49	14	413	24
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	18	1	10	9	1	7
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	613	413
Shared ln volume, major rt vehicles:	49	24
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	437	662	1162	1159	638	1169	1171	425
s								
Px								
V c,u,x								
r,x								
c plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	638	425
Potential Capacity	480	634
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	480	634
Probability of Queue free St.	0.92	0.96
Step 2: LT from Major St.	4	1
Conflicting Flows	662	437
Potential Capacity	936	1134
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	936	1134
Probability of Queue free St.	0.99	0.98
Maj L-Shared Prob Q free St.	0.98	0.96
Step 3: TH from Minor St.	8	11
Conflicting Flows	1159	1171
Potential Capacity	197	194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	186	183
Probability of Queue free St.	0.98	0.98
Step 4: LT from Minor St.	7	10
Conflicting Flows	1162	1169
Potential Capacity	174	172
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	157	148

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1159	1171
Potential Capacity	197	194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	186	183
Result for 2 stage process:		
a		
y		
C t	186	183
Probability of Queue free St.	0.98	0.98
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1162	1169
Potential Capacity	174	172
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	157	148
Results for Two-stage process:		
a		
y		
C t	157	148

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	70	4	40	36	4	27
Movement Capacity (vph)	157	186	480	148	183	634
Shared Lane Capacity (vph)		207			218	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	157	186	480	148	183	634
Volume	70	4	40	36	4	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		207			218	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1134	936		207			218	
v/c	0.02	0.01		0.55			0.31	
95% queue length	0.08	0.05		2.94			1.25	
Control Delay	8.3	8.9		41.8			28.7	
LOS	A	A		E			D	
Approach Delay				41.8			28.7	
Approach LOS				E			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	0.99
v(i1), Volume for stream 2 or 5	613	413
v(i2), Volume for stream 3 or 6	49	24
s(i1), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
p*(oj)	0.96	0.98
d(M,LT), Delay for stream 1 or 4	8.3	8.9
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2

APPENDIX 6

PEAK HOUR FACTOR CALCULATIONS

Route 40/Route 381

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	13	13	17	17	60	**0.88**
Through	112	129	126	136	503	**0.92**
Right Turn	11	18	18	7	54	**0.75**
Route 40 West Bound						
Left Turn	11	10	18	13	52	**0.72**
Through	133	142	107	133	515	**0.91**
Right Turn	3	5	4	5	17	**0.85**
Route 381 North Bound						
Left Turn	18	7	13	13	51	**0.71**
Through						**N/A**
Right Turn	14	14	14	14	56	**1**
Route 381 South Bound						
Left Turn	6	9	16	17	48	**0.71**
Through						**N/A**
Right Turn	15	13	10	3	41	**0.68**

Route 40/Route 381

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	16	26	16	22	80	**0.91**
Through	142	120	140	171	573	**0.84**
Right Turn	12	8	9	18	47	**0.65**
Route 40 West Bound						
Left Turn	12	9	18	14	53	**0.74**
Through	114	118	80	85	397	**0.84**
Right Turn	16	19	14	10	59	**0.78**
Route 381 North Bound						
Left Turn	4	9	9	9	31	**0.86**
Through						**N/A**
Right Turn	14	21	12	22	69	**0.78**
Route 381 South Bound						
Left Turn	8	15	11	8	42	**0.70**
Through						**N/A**
Right Turn	13	11	9	16	49	**0.77**

Route 40/Hawes Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	8	5	5	3	21	0.66
Through						0.92
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through						0.91
Right Turn	4	11	14	8	37	0.66
Hawes Road South Bound						
Left Turn	8	15	7	7	37	0.62
Through						N/A
Right Turn	11	16	10	5	42	0.66

Route 40/Hawes Road

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	8	2	7	8	25	0.78
Through						0.84
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through						0.84
Right Turn	9	1	6	5	21	0.58
Hawes Road South Bound						
Left Turn	5	5	6	3	19	0.79
Through						N/A
Right Turn	2	6	4	2	14	0.58

Route 40/Secondary Driveway

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						0.90
Through						0.90
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through						0.90
Right Turn						0.90
Secondary Driveway South Bound						
Left Turn						0.90
Through						N/A
Right Turn						0.90

Route 40/Secondeary Driveway

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						0.90
Through						0.90
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through						0.90
Right Turn						0.90
Secondary Driveway South Bound						
Left Turn						0.90
Through						N/A
Right Turn						0.90

Route 40/Marker Road - Main Driveway

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						0.90
Through	127	138	145	148	558	0.94
Right Turn	2	1	3	2	8	0.67
Route 40 West Bound						
Left Turn	1	2	3	0	6	0.50
Through						0.94
Right Turn						0.9
Marker Road North Bound						
Left Turn	1	0	1	1	3	0.75
Through						0.90
Right Turn	2	4	1	3	10	0.63
Main Driveway South Bound						
Left Turn						0.90
Through						0.90
Right Turn						0.90

Route 40/Marker Road - Main Driveway

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						0.90
Through	129	111	137	170	547	0.80
Right Turn	1	0	1	1	3	0.75
Route 40 West Bound						
Left Turn	0	2	2	1	5	0.63
Through						0.87
Right Turn						0.90
Marker Road North Bound						
Left Turn	1	1	1	1	4	1.00
Through						0.90
Right Turn	0	1	1	3	5	0.42
Main Driveway South Bound						
Left Turn						0.90
Through						0.90
Right Turn						0.90

Route 40/Smith School House Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	4	5	6	16	0.67
Through						0.94
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through	104	89	101	96	390	0.94
Right Turn	2	2	1	3	8	0.67
Smith School House Road South Bound						
Left Turn	3	2	3	4	12	0.75
Through						N/A
Right Turn	7	6	6	7	26	0.93

Route 40/Smith School House Raod

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	2	4	7	14	0.50
Through						0.87
Right Turn						N/A
Route 40 West Bound						
Left Turn						N/A
Through	114	109	89	86	398	0.87
Right Turn	2	2	1	5	10	0.50
Smith School House Road South Bound						
Left Turn	3	5	0	0	8	0.40
Through						N/A
Right Turn	5	1	3	3	12	0.60

Route 40/Dinner Bell Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	6	8	5	7	26	**0.81**
Through						**0.94**
Right Turn	7	14	15	11	47	**0.78**
Route 40 West Bound						
Left Turn	2	6	2	4	14	**0.58**
Through						**0.94**
Right Turn	11	10	5	12	38	**0.79**
Dinner Bell Road North Bound						
Left Turn	3	8	7	8	26	**0.81**
Through	3	1	1	2	7	**0.58**
Right Turn	5	2	6	3	16	**0.67**
Dinner Bell Road South Bound						
Left Turn	9	7	12	8	36	**0.75**
Through	0	0	1	2	3	**0.38**
Right Turn	6	2	6	1	15	**0.63**

Route 40/Dinner Bell Road

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	3	3	2	9	**0.75**
Through						**0.87**
Right Turn	1	6	5	3	15	**0.63**
Route 40 West Bound						
Left Turn	7	3	2	7	19	**0.68**
Through						**0.87**
Right Turn	10	6	5	7	28	**0.70**
Dinner Bell Road North Bound						
Left Turn	16	11	13	14	54	**0.84**
Through	0	1	0	1	2	**0.50**
Right Turn	2	0	4	9	15	**0.42**
Dinner Bell Road South Bound						
Left Turn	3	2	3	8	16	**0.50**
Through	1	1	1	0	3	**0.75**
Right Turn	6	6	0	3	15	**0.63**

APPENDIX 7

QUEUE ANALYSIS

QUEUE ANALYSIS –

Route 40 / Main Driveway – Marker Road
Eastbound Left Turn Lane

Turning Volume V = 68
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'

Route 40 / Main Driveway – Marker Road
Westbound Left Turn Lane

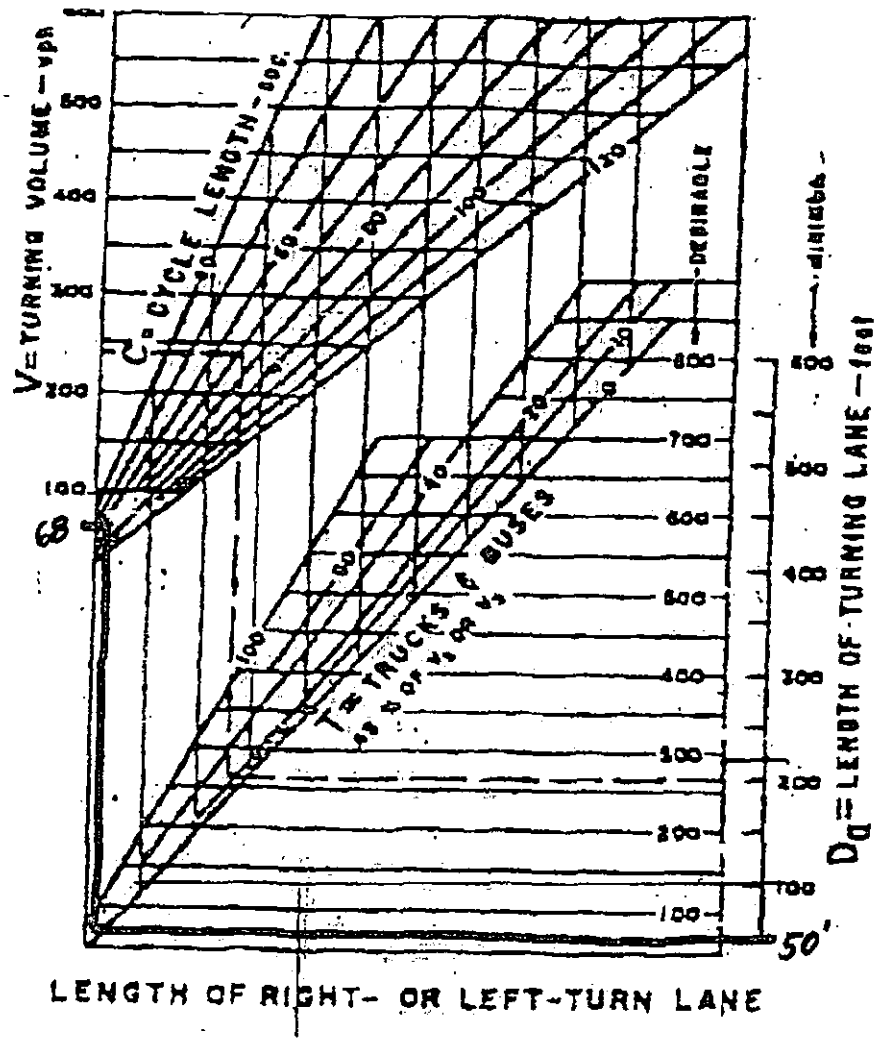
Turning Volume V = 6
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'

Route 40 / Main Driveway – Marker Road
Southbound Left Turn Lane

Turning Volume V = 45
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'



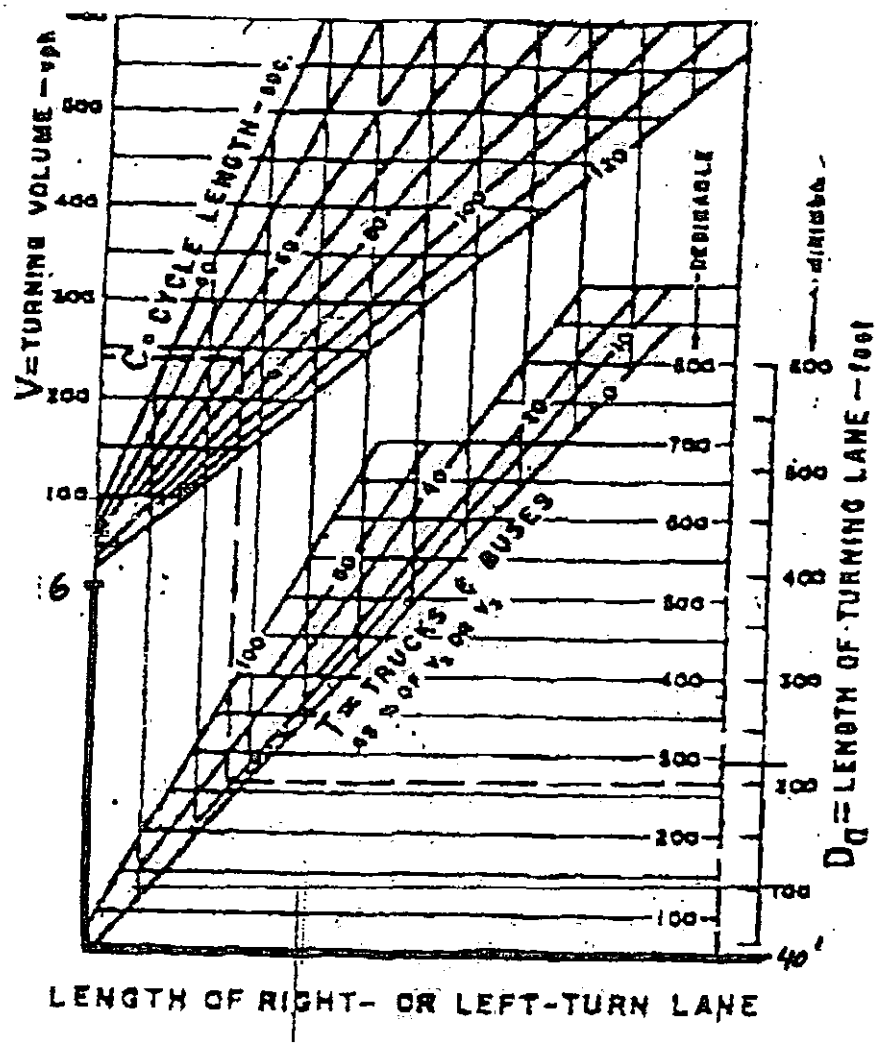
Note: 100' min. Required

FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

Route 40 / Main Driveway - Market Road

Eastbound Left Turn Lane



Note: 100' min. Required

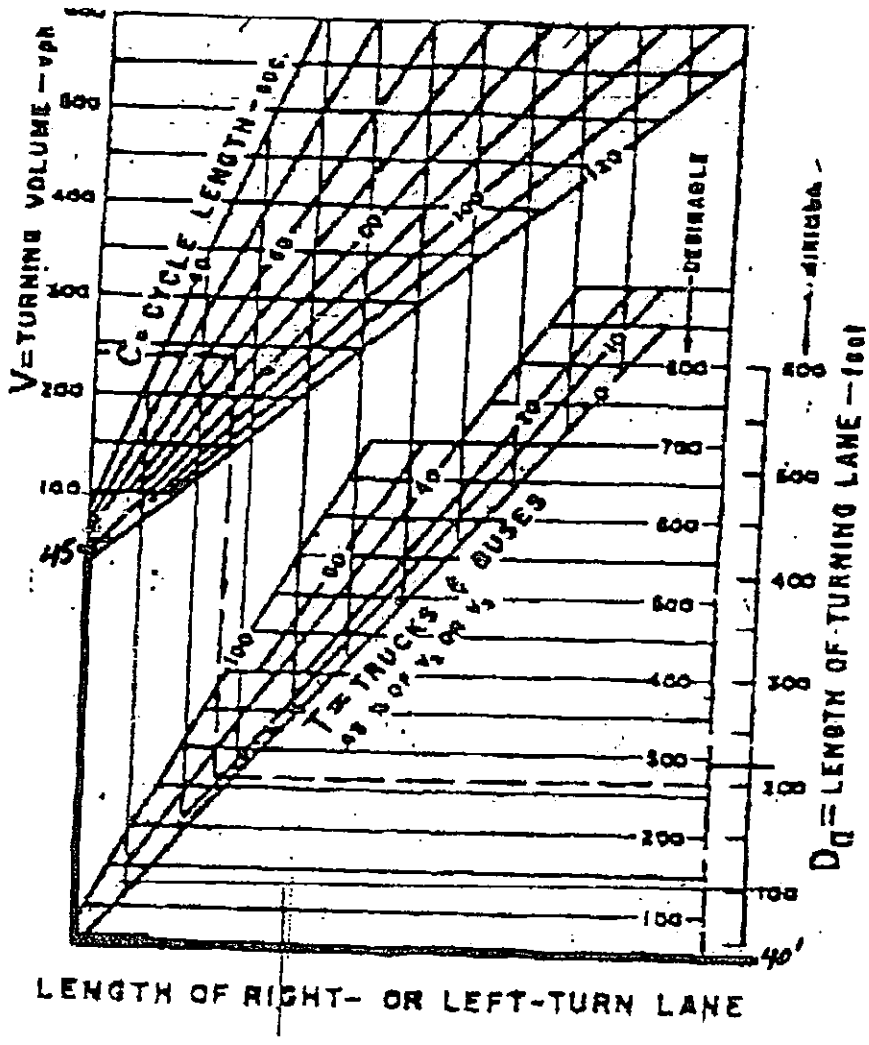
FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

---END---

Route 40 / Main Driveway - Marker Road

Westbound Left Turn Lane



Note: 100' min. Required

FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

---END---

Route 40 / Main Driveway - Mackor Road

South Bound Left Turn Lane

APPENDIX 8

SIGNAL WARRANT ANALYSIS

SIGNAL WARRANT ANALYSIS

Route 40 / Main Driveway – Marker Road
2016 Developed Conditions

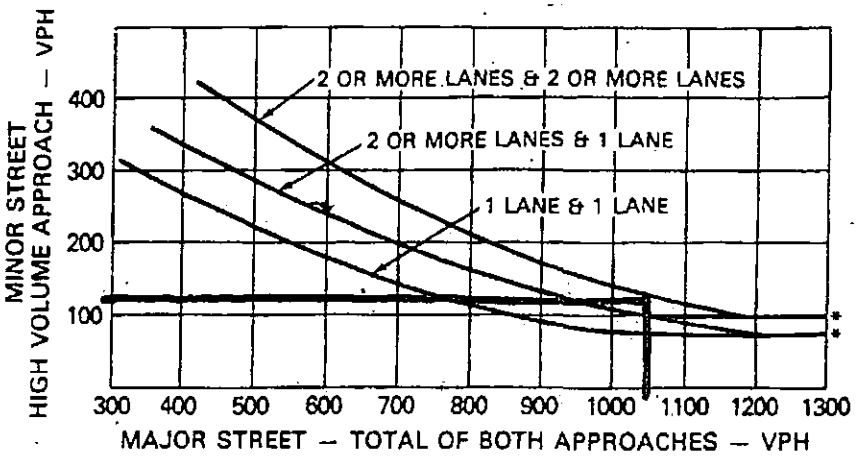
xi. Peak Hour Volumes - meets

	Major	Minor
2016	1054	112

*see attached warrant chart

PEAK HOUR VOLUME WARRANT

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)

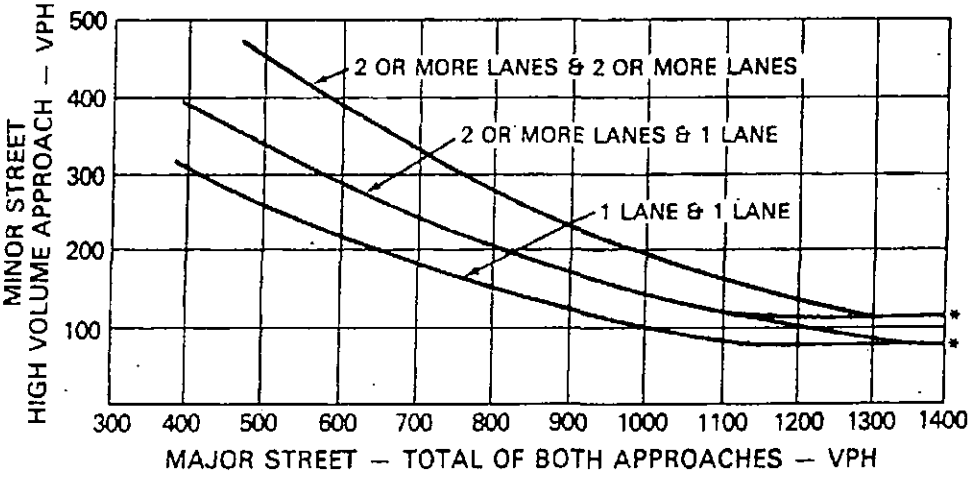


*NOTE: 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 75 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

(xii) Four-hour volume. This warrant is satisfied when the following requirements exist:

(A) For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only), all fall above the curve in the following graph for the existing combination of approach lanes:

FOUR HOUR VOLUME WARRANT



*NOTE: 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.