Traffic Signal Design Study for Limekiln Pike (SR 0152) and Twining Road

Upper Dublin Township, Montgomery County, PA

Prepared by
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Prepared for
Upper Dublin Township
February 2019
McMahon Project 818353.2A

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Executive Summary

Upper Dublin School District is planning a full renovation of the Sandy Run Middle School located to the north of Twining Road and to the west of Limekiln Pike (S.R. 0152) in Upper Dublin Township, Montgomery County, PA. Access to the school will continue to be provided via two existing accesses along Twining Road and Audubon Drive.

As a result of the site redevelopment, some off site traffic improvements are proposed to add more capacity and provide safer vehicular and pedestrian accommodations. The following improvements are proposed for the intersection of Limekiln Pike (S.R. 0152) and Twining Road:

- Install a separate 10-foot left-turn lane along Twining Road
- Restripe the southbound Limekiln Pike (S.R. 0152) right-turn lane to extend the storage area from 110 to 150 feet
- Increase the size of the channelized island on the northeast corner to decrease pedestrian crossing times associated with the all-pedestrian phase
- Install video detection for all approaches and Wavetronix dilemma zone detection for both approaches of Limekiln Pike (S.R. 0152)
- Optimize signal timings during both peak hours, which will include the removal of the existing advance left-turn phase provided for the westbound approach of Twining Road
- Install new ADA compliant curb ramps for all affected existing crossings

The existing traffic signal permit plan for the intersection of Limekiln Pike (S.R. 0152) and Twining Road can be found in **Appendix B**.

Vehicle change and clearance interval and pedestrian interval calculations were conducted at the project intersection. The results of these calculations can be found in **Appendix C.**

An evaluation of the pedestrian needs and functionality of the existing facilities at the intersection was conducted. A Pedestrian Needs Accommodation at Signalized Intersection Study was prepared and the PennDOT TE-672 form, Pedestrian Accommodation at Intersections Checklist (*Publication 149, Chapter 4*), was completed for the project intersection. This study and completed form can be found in **Appendix D**.

Manual turning movement traffic counts were completed at the project intersection during the weekday morning peak period (6:30 AM to 8:30 AM) and the mid-afternoon peak period (1:30 PM to 3:30 PM) in May 2018. The results of these traffic counts are tabulated by 15-minute intervals and can be found in **Appendix E**.

The resultant peak hour traffic volumes were then subjected to detailed capacity/level-of-service and queuing analysis to assess the existing traffic conditions. The results of this analysis can be found in **Appendix F**.

Additionally, the peak hour traffic volumes were subjected to additional capacity/level-of-service and queuing analysis to assess the traffic conditions after the redevelopment has been completed. The results of this analysis can be found in **Appendix G**.

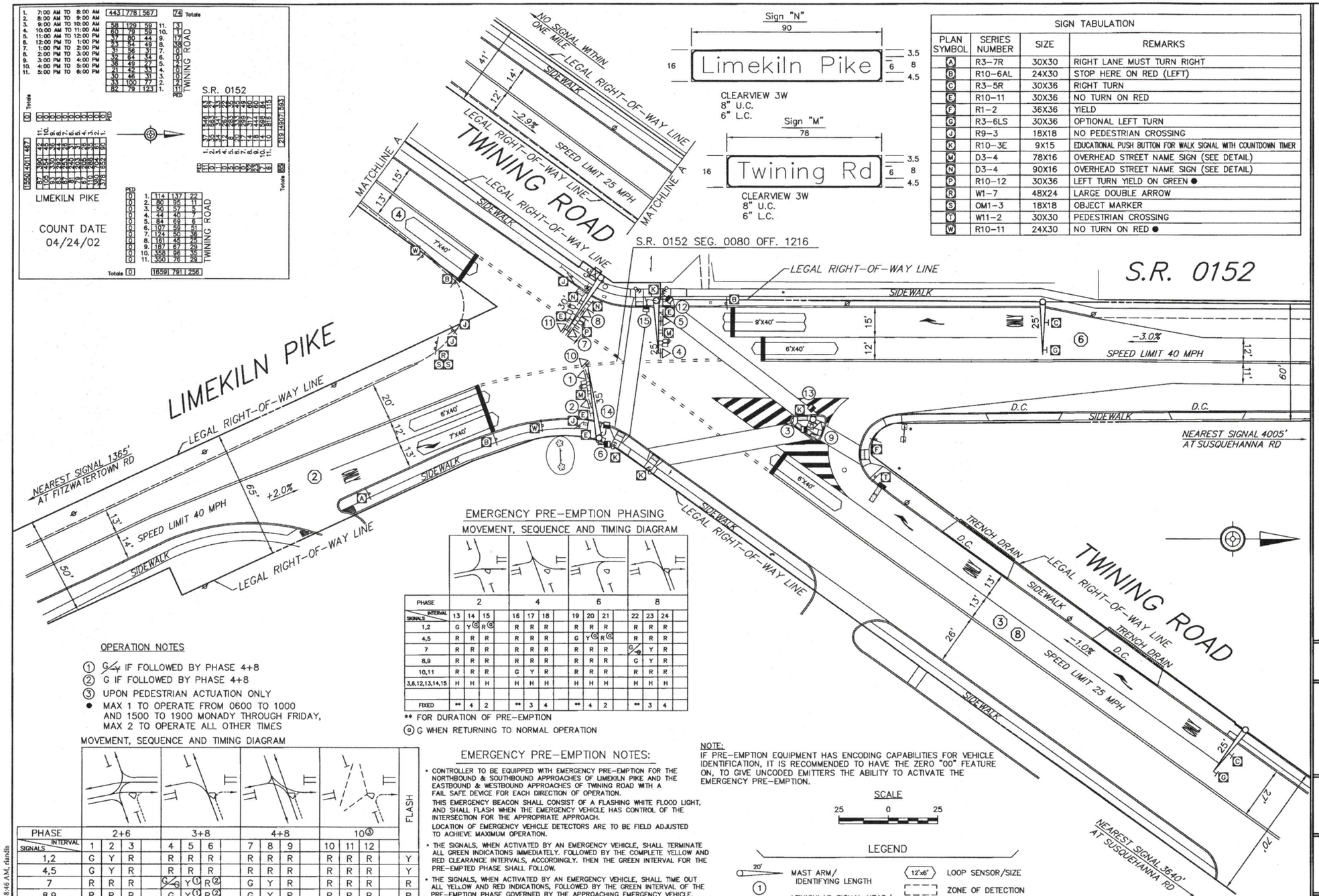
A left turn conflict factor worksheet was completed to evaluate the need for left turn phases at the project intersection. This worksheet and its results can be found in **Appendix H**.

APPENDIX A

Relevant Correspondence

APPENDIX B

Existing Traffic Signal Permit Plan



EMERGENCY PRE-EMPTION PHASING

MOVEMENT, SEQUENCE AND TIMING DIAGRAM

PHASE	2				4				6				8			
INTERVAL / SIGNALS	13	14	15		16	17	18		19	20	21		22	23	24	
1,2	G	Y ⓐ	R ⓐ		R	R	R		R	R	R		R	R	R	
4,5	R	R	R		R	R	R		G	Y ⓐ	R ⓐ		R	R	R	
7	R	R	R		R	R	R		R	R	R		G/4	Y	R	
8,9	R	R	R		R	R	R		R	R	R		G	Y	R	
10,11	R	R	R		G	Y	R		R	R	R		R	R	R	
3,6,12,13,14,15	H	H	H		H	H	H		H	H	H		H	H	H	
FIXED	**	4	2		**	3	4		**	4	2		**	3	4	

** FOR DURATION OF PRE-EMPTION

ⓐ G WHEN RETURNING TO NORMAL OPERATION

OPERATION NOTES

1. G/4 IF FOLLOWED BY PHASE 4+8
2. G IF FOLLOWED BY PHASE 4+8
3. UPON PEDESTRIAN ACTUATION ONLY

- MAX 1 TO OPERATE FROM 0600 TO 1000 AND 1500 TO 1900 MONADY THROUGH FRIDAY, MAX 2 TO OPERATE ALL OTHER TIMES

MOVEMENT, SEQUENCE AND TIMING DIAGRAM

PHASE	2+6				3+8				4+8				10③				FLASH
INTERVAL / SIGNALS	1	2	3		4	5	6		7	8	9		10	11	12		
1,2	G	Y	R		R	R	R		R	R	R		R	R	R		Y
4,5	G	Y	R		R	R	R		R	R	R		R	R	R		Y
7	R	R	R		G/6	Y①	R②		G	Y	R		R	R	R		R
8,9	R	R	R		G	Y①	R②		G	Y	R		R	R	R		R
10,11	R	R	R		R	R	R		G	Y	R		R	R	R		R
3,6,12,13,14,15	H	H	H		H	H	H		H	H	H		M	FH	H		OUT
FIXED		4	2			3	4			4	2						
MINIMUM	15				3				3								
PASSAGE	3				3				3								
MAXIMUM 1	62				10				17								
MAXIMUM 2	32				10				17								
PEDESTRIAN													7	25	3		
MEMORY	MN				L				L								

EMERGENCY PRE-EMPTION NOTES:

- CONTROLLER TO BE EQUIPPED WITH EMERGENCY PRE-EMPTION FOR THE NORTHBOUND & SOUTHBOUND APPROACHES OF LIMEKILN PIKE AND THE EASTBOUND & WESTBOUND APPROACHES OF TWINING ROAD WITH A FAIL SAFE DEVICE FOR EACH DIRECTION OF OPERATION.
  THIS EMERGENCY BEACON SHALL CONSIST OF A FLASHING WHITE FLOOD LIGHT, AND SHALL FLASH WHEN THE EMERGENCY VEHICLE HAS CONTROL OF THE INTERSECTION FOR THE APPROPRIATE APPROACH.
  LOCATION OF EMERGENCY VEHICLE DETECTORS ARE TO BE FIELD ADJUSTED TO ACHIEVE MAXIMUM OPERATION.
- THE SIGNALS, WHEN ACTIVATED BY AN EMERGENCY VEHICLE, SHALL TERMINATE ALL GREEN INDICATIONS IMMEDIATELY. FOLLOWED BY THE COMPLETE YELLOW AND RED CLEARANCE INTERVALS, ACCORDINGLY. THEN THE GREEN INTERVAL FOR THE PRE-EMPTED PHASE SHALL FOLLOW.
- THE SIGNALS, WHEN ACTIVATED BY AN EMERGENCY VEHICLE, SHALL TIME OUT ALL YELLOW AND RED INDICATIONS, FOLLOWED BY THE GREEN INTERVAL OF THE PRE-EMPTION PHASE GOVERNED BY THE APPROACHING EMERGENCY VEHICLE.
- IF SIGNALS HAVE BEEN ACTUATED BY PEDESTRIAN PUSH BUTTON AND THE SIGNAL IS PRE-EMPTED, THE PEDESTRIAN TIME SHALL BE SPLIT BETWEEN "PED WALK" AND "PED CLEAR". THE "PED WALK" INTERVAL SHALL TERMINATE IMMEDIATELY FOLLOWED BY THE "PED CLEAR" INTERVAL. THIS INTERVAL SHALL TIME OUT FOLLOWED BY THE APPROPRIATE SELECTIVE CLEARANCES BEFORE GOING INTO EMERGENCY PRE-EMPTION.
- IF THE SIGNALS, WHEN ACTIVATED BY AN EMERGENCY VEHICLE, ARE FLASHING ALL SIGNALS SHALL REMAIN FLASHING.
- IF ADDITIONAL PRE-EMPTION PHASES ARE ACTIVATED WHILE IN PRE-EMPTION, THE ORIGINAL PRE-EMPTION PHASE SHALL TIME OUT BEFORE PROCEEDING TO THE NEXT PRE-EMPTION PHASE.
- UPON COMPLETION OF PRE-EMPTION, PHASE 2,4,6 OR 8 IN RETURNING TO NORMAL OPERATION, PHASE 2+6 INTERVAL 1 SHALL FOLLOW.
- IN EMERGENCY PRE-EMPTION, NO PRIORITY SHALL BE ESTABLISHED, PRE-EMPTION SHALL BE A "FIRST COME, FIRST SERVE" OPERATION.

NOTE:
IF PRE-EMPTION EQUIPMENT HAS ENCODING CAPABILITIES FOR VEHICLE IDENTIFICATION, IT IS RECOMMENDED TO HAVE THE ZERO "00" FEATURE ON, TO GIVE UNCODED EMITTERS THE ABILITY TO ACTIVATE THE EMERGENCY PRE-EMPTION.

SCALE

25 0 25

LEGEND

- 20' MAST ARM/ IDENTIFYING LENGTH
- ① VEHICULAR SIGNAL HEAD/ BACKPLATE/VISORS/ DIRECTIONAL ARROW/ IDENTIFYING NUMBER
- ① PEDESTRIAN SIGNAL HEAD/ IDENTIFYING NUMBER
- PEDESTRIAN PUSHBUTTON/ SIGN
- A SIGN/IDENTIFYING LETTER
- VIDEO DETECTOR
- C.C. CONTROLLER CABINET
- 12'x6' LOOP SENSOR/SIZE
- ZONE OF DETECTION
- MICROWAVE PRESENCE DETECTOR
- EMERGENCY PRE-EMPTION FLASHING BEACON
- EMERGENCY PRE-EMPTION DEVICE
- CURB RAMP
- UTILITY POLE
- ① PHASE NUMBER
- INLET

SIGNAL INDICATIONS

11" SYMBOLS — 3,6,12,13, 14,15

12" LENS — 7

12" LENS — 1,2,4,5 8,9,10,11

SIGNALS TO BE EQUIPPED WITH TUNNEL VISORS & LOUVERS 7 & 8

SIGN TABULATION			
PLAN SYMBOL	SERIES NUMBER	SIZE	REMARKS
A	R3-7R	30X30	RIGHT LANE MUST TURN RIGHT
B	R10-6AL	24X30	STOP HERE ON RED (LEFT)
C	R3-5R	30X36	RIGHT TURN
E	R10-11	30X36	NO TURN ON RED
F	R1-2	36X36	YIELD
G	R3-6LS	30X36	OPTIONAL LEFT TURN
J	R9-3	18X18	NO PEDESTRIAN CROSSING
K	R10-3E	9X15	EDUCATIONAL PUSH BUTTON FOR WALK SIGNAL WITH COUNTDOWN TIMER
M	D3-4	78X16	OVERHEAD STREET NAME SIGN (SEE DETAIL)
N	D3-4	90X16	OVERHEAD STREET NAME SIGN (SEE DETAIL)
P	R10-12	30X36	LEFT TURN YIELD ON GREEN ●
R	W1-7	48X24	LARGE DOUBLE ARROW
S	OM1-3	18X18	OBJECT MARKER
T	W11-2	30X30	PEDESTRIAN CROSSING
W	R10-11	24X30	NO TURN ON RED ●

GENERAL NOTES

NO MODIFICATIONS OF THIS INSTALLATION ARE PERMITTED UNLESS PRIOR APPROVAL IS GRANTED IN WRITING BY A REPRESENTATIVE OF THE DEPARTMENT OF TRANSPORTATION.

ALL MAINTENANCE WORK INCLUDING TRIMMING OF TREES, NECESSARY FOR PROPER VISIBILITY OF THE SIGNALS IS THE RESPONSIBILITY OF THE PERMITTEE.

ALL SIGNS AND PAVEMENT MARKINGS INDICATED ON THIS DRAWING ARE CONSIDERED PART OF THE PERMIT AND SHALL BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH PUBLICATION NO. 212.

POST MOUNTED SIGNALS SHALL BE INSTALLED WITH THE SIGNAL HEADS A MINIMUM OF 2 FEET BEHIND THE FACE OF CURB OR THE EDGE OF THE SHOULDER. SUPPORT POLES FOR OVERHEAD SIGNALS SHALL ALSO HAVE A MINIMUM CLEARANCE HORIZONTALLY OF 2 FEET.

SIGNALS ERECTED OVER THE ROADWAY SHALL HAVE A MINIMUM VERTICAL CLEARANCE OF 16 FT. ABOVE THE ROADWAY. POST MOUNTED SIGNALS SHALL BE A MINIMUM OF 8 FT. ABOVE THE SIDEWALK OR PAVEMENT.

ALL OVERHEAD SIGNALS MUST BE RIGIDLY MOUNTED, TOP AND BOTTOM, AND EQUIPPED WITH BACKPLATES.

THE MINIMUM HORIZONTAL DISTANCE BETWEEN SIGNALS MEASURED AT RIGHT ANGLES TO THE APPROACH SHALL BE 8 FEET.

EXACT LOCATION OF DETECTORS SHALL BE DETERMINED PRIOR TO INSTALLATION BY A REPRESENTATIVE OF PENNDOT.

CURBING TO BE INSTALLED BY MUNICIPALITY AND WHERE NOTED, SHALL BE PLAIN CEMENT CONCRETE CURB OR GRANITE CURB, INSTALLED IN ACCORDANCE WITH DEPARTMENT SPECIFICATIONS FORM 408.

PRIOR TO INSTALLATION THE CONTRACTOR SHALL CONSULT WITH THE LOCAL OFFICIALS AND UTILITY COMPANIES TO RESOLVE ANY PROBLEMS WHICH MAY BE CREATED DUE TO THE LOCATION OF UTILITIES.

THIS DRAWING CANNOT BE USED AS A CONSTRUCTION DRAWING UNLESS THE PERMITTEE COMPLIES WITH THE PROVISIONS OF THE LATEST AMENDMENT TO ACT 287, PREVENTION OF DAMAGE TO UNDERGROUND UTILITIES, DATED DECEMBER 20, 1974.

WHEN LIQUID FUELS MONEY IS USED, SIGNAL INSTALLATION MUST CONFORM TO FORM 408 AND A COPY OF THE PROPOSED SPECIFICATIONS MUST BE SUBMITTED TO THE DISTRICT TRAFFIC UNIT, FOR REVIEW, PRIOR TO BIDDING.

PERMITTEE SHALL OBTAIN A HIGHWAY OCCUPANCY PERMIT FOR ANY CHANGES IN INTERSECTION GEOMETRY REGARDING EXCAVATION.

CONDUIT INSTALLED IN BITUMINOUS ROADWAY LESS THAN 5 YEARS OLD, OR CONCRETE ROADWAY REGARDLESS OF AGE, MUST BE BORED OR JACKED UNDER THE ROADWAY. INSTALL IN ACCORDANCE WITH TRAFFIC SIGNAL STANDARDS TC-8800 SERIES.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
ENGINEERING DISTRICT 6-0

COUNTY: MONTGOMERY
MUNICIPALITY: UPPER DUBLIN TOWNSHIP
INTERSECTION: LIMEKILN PIKE (S.R. 0152) & TWINING ROAD

REVIEWED:
MUNICIPAL OFFICIAL — DATE 1/26/16

RECOMMENDED:
PAUL LUTZ 1/21/98
DOUGLAS MAY 1/21/98
DISTRICT TRAFFIC ENGINEER — DATE

NO.	REVISION	DES./ REVW.	DATE	REVW.	DATE	RECOM.	DATE
1	ADDED DOTTED LINES	BRB	7/23/99	MLK	7/26/99	DWM	8/3/99
2	ADDED EXCL PED PHASE, FULL ACT	PAI	10/9/02	MLK	10/19/02	DWM	10/19/02
3	TIMING CHANGE - MAX 1 AND MAX 2	JJS	11/17/03	MLK	11/19/03	LRB	11/20/03
4	ADDED EMERGENCY PRE-EMPTION	MCM	2/25/05	MLK	3/18/05	ABP	4/8/05
5	ADD CURB RAMPS UNDER ST-82, REL. PED BTNS (NW,NE,SE CORNERS), REV PED TIME	MCM		DLA	1/14/14	ABP	1/24/14
6	ADDED COUNTDOWN TIMERS	MCM		DLA	2/4/15		3/2/15
7							
8							

SHEET 2 OF 2 | PERMIT # 64-1064 | FILE # 1064

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APPENDIX C

Vehicle Change and Clearance Interval and Pedestrian Interval Calculations

STUDY LOCATION AND ANALYSIS INFORMATION

Municipality:	Upper Dublin Township	**Analysis Date:**	1/11/2019
County:	Montgomery County	**Conducted By:**	EJR
PennDOT Engineering District:	6	**Checked By:**	AKK
		Agency/Company Name:	McMahon Associates, Inc.

Intersection Description: Limekiln Pike (SR 0152) and Twining Road

VEHICLE AND PEDESTRIAN INTERVAL FINDINGS

Vehicle Change and Clearance Interval Findings

Approach Description	Direction	Calculated Yellow Change Interval, Y	User Defined Yellow Change Interval, Y	Calculated All-Red Clearance Interval, AR	User Defined All-Red Clearance Interval, AR	To Be Implemented	
						Y (s)	AR (s)
SR 0152 (Phase 2)	NB	3.6	4	2.3	3	**4**	**3**
SR 0152 (Phase 6)	SB	4.2	4	2.8	3	**4**	**3**
Twining Road (Phase 4)	EB	2.7	3	3.9	4	**3**	**4**
Twining Road (Phase 8)	WB	2.9	3	3.9	4	**3**	**4**

Additional Comments/Justifications:

** Note: This Traffic Signal Clearance Excel file provided by PennDOT has been altered from its original form so that the final output can be adjusted by the design engineer as needed to accommodate different PennDOT District preferences and based on engineering judgement.

Pedestrian Interval Findings

WITH PEDESTRIAN SIGNALS Description of Pedestrian Crossing	Calculated Walk Interval, T_w	User Defined Walk Interval, T_w	Calculated Ped. Change Interval, T_{pc}	User Defined Ped. Change Interval, T_{pc}	Greater than $(T_w+T_{pc})_{min}$?	To Be Implemented	
						T_w (s)	T_{pc} (s)
Crossing of WB Twining Road (All Ped)	12.3	7	18.6	23	Yes	**7**	**23**
Crossing of NB SR 0152 (All Ped)	12.2	7	18.3	23	Yes	**7**	**23**
Crossing of SB SR 0152 (All Ped)	14.5	7	22.9	23	Yes	**7**	**23**

WITHOUT PEDESTRIAN SIGNALS Description of Pedestrian Crossing	Calculated Min. Green Interval, T_p

Additional Comments/Justifications:

VEHICLE CHANGE AND CLEARANCE INTERVALS

Assumptions and Calibration Inputs

Change and Clearance Intervals (CCI, seconds)

$$CCI = Y + AR$$

Yellow Change Interval (Y, seconds)

$$Y = t + \frac{1.47V}{2a \pm 64.4(g/100)}$$ (typ. 3-6 seconds)

t = Perception-reaction time, s (1 second) ← 1

V = Approach speed, MPH

a = Deceleration rate (10 ft/s^2) ← 10

g = Grade of approach, %

All-Red Clearance Interval (AR, seconds)

$$AR = \frac{(W + L)}{1.47V}$$

W = Width of the intersection, ft

(from the stop bar to the end of the farthest traveled lane)

L = Length of Vehicle (20 ft) ← 20

V = Approach speed, MPH

Calculations

Through Movement Phases								
Approach Description	**Direction**	**V**	**g (%)**	**W**	**Y**	**AR**	**CCI**	**Comments**
SR 0152 (Phase 2)	NB	40	4.8	113	3.6	2.3	5.9	
SR 0152 (Phase 6)	SB	40	-2.3	143	4.2	2.8	7.0	
Twining Road (Phase 4)	EB	25	4	122	2.7	3.9	6.6	
Twining Road (Phase 8)	WB	25	-0.5	120	2.9	3.9	6.8	
Left-Turn Movement Phases								
Approach Description	**Direction**	**V**	**g (%)**	**W**	**Y**	**AR**	**CCI**	**Comments**

PEDESTRIAN INTERVALS

Assumptions and Calibration Inputs

Walk Interval[1]

(T_w, seconds)

$$T_w = \frac{\left(\frac{1}{2}L\right)}{S_w} + 3$$

Pedestrian Change Interval

(T_{pc}, seconds)

$$T_{PC} = \frac{L}{S_w}$$

Minimum Duration

($(T_w+T_{pc})_{min}$, seconds)

$$(T_w + T_{pc})_{\min} = \frac{(L+6)}{3}$$

1) The walk interval should be at least 7 seconds, but where justified, a minimum 4 second interval may be used.

Pedestrian Interval Variables

L = Pedestrian walking distance from the curb or edge of shoulder to the far edge of the traveled way, ft

S_w = Walking Speed, ft/s (3.5 ft/s) ← 3.5

Minimum Green Interval[2]

(T_p, seconds)

$$T_p = \frac{L}{S_w} + 3$$

2) Minimum green interval when no pedestrian signals are present or proposed

Calculations

Description of Pedestrian Crossing	Ped Signal	L	T_w	T_{pc}	$(T_w+T_{pc})_{min}$	T_p	Comments
Crossing of WB Twining Road (All Ped)	Yes	65	12.3	18.6	23.7	N/A	
Crossing of NB SR 0152 (All Ped)	Yes	64	12.2	18.3	23.4	N/A	
Crossing of SB SR 0152 (All Ped)	Yes	80	14.5	22.9	28.7	N/A	

APPENDIX D

Pedestrian Needs Accommodation Checklist and Study

TE-672 (9-10)

PEDESTRIAN ACCOMMODATION AT INTERSECTIONS CHECKLIST

PLEASE TYPE OR PRINT ALL INFORMATION IN BLUE OR BLACK INK

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

As specified in the MUTCD, Section 4E, an engineering study shall be conducted to determine the need for pedestrian accommodation at signalized intersections and the related design and operational features. Based on the engineering study and engineering judgment, proper documentation shall be made at all new signalized intersections and modifications to existing signalized intersections. This documentation shall be provided with guidance from this checklist.

When pedestrian accommodations will not be provided at an intersection, signalized or not, proper justification must be documented. Below is a checklist of information that may be relevant in the determination of pedestrian needs and warranted accommodations at an intersection. Not all of the information below is required to make a determination. This form can be used to summarize the needs and accommodations of a corridor or a single intersection.

Intersection Background Information

DATE	DISTRICT	COUNTY
January 11, 2019	6-0	Montgomery

MUNICIPALITY	INTERSECTION
Upper Dublin Township	Limekiln Pike (SR 0152) and Twining Road

SUBMITTED BY	STREET ADDRESS
McMahon Associates, Inc.	425 Commerce Drive, Suite 200

CITY	STATE	ZIP	TELEPHONE NUMBER
Fort Washington	PA	19034	(215) 283-9444

Project Overview

Provide a Project Description and Scope of the Project. Refer to attached pedestrian study.

Bike/Ped Checklist Completed. ☐ Yes ☒ No

Existing Facility Description

Yes	No	
☒	☐	Are pedestrian facilities present (i.e., sidewalks, curb ramps, crosswalks, pedestrian signals, etc.)?
☒	☐	Are there descriptions of each quadrant of the existing intersection (photos are strongly recommended)?
☒	☐	Are near-by land uses documented?
☒	☐	Are pedestrian facilities near the intersection (i.e., sidewalks, bus stops, trails, etc.)?
☒	☐	Is there current evidence of pedestrians using the intersection (worn paths, observed activity)?
☒	☐	Were special accommodations made in the past for pedestrians at the intersection?
☒	☐	Are restrictions for pedestrians present? (No Ped signs, limited crossings)
☒	☐	Is this a defined walking route or safe route to school route?
☐	☒	Are physical restrictions or right-of-way restrictions present?
☒	☐	If pedestrian signals are present, is proper traffic signal timing designated for pedestrians at the intersection?

Proposed Facility Description

Yes	No	
☐	☒	Will the proposed improvements generate new or additional pedestrian traffic?
☐	☒	Does the proposed facility introduce possible additional restrictions for pedestrians?
☐	☒	Are new or existing pedestrian signals proposed at the intersection?
☒	☐	Are sidewalks proposed as part of the project?
☒	☐	Are detailed descriptions of changes to each quadrant documented?
☐	☒	Do near-by land uses change as part of the project?
☐	☒	Are additional pedestrian facilities proposed for the intersection?

Outreach Efforts

Has contact and discussion concerning pedestrian accommodations at the intersection been made with the following?

Yes	No	
☒	☐	Municipality (s)
☐	☐	Transit Organization (s)
☒	☐	School District (s)
☐	☐	Public Meeting (s)
☐	☐	Emergency Services
☐	☐	Advocacy Groups
☒	☐	Other (s) Refer to attached pedestrian study.

Intersection Details

(The information below may be useful in the determination of pedestrian needs and warranted accommodations at uncontrolled intersections. Not all of the information is required to make a determination. The minor roadway information may also be needed in some situations.)

Roadway classification: Minor Arterial

Roadway Typology: Community

Speed Limit (MPH): 40

Design Speed: _____

ADT: 8814

Percentage of Trucks: 4%

Travel lanes: 1 Right and 1 Left/Thru

Is there a sight distance deficiency? ☐ Yes ☒ No

If yes, explain. _____

Sidewalk: ☒ Yes ☐ No Shoulders: ☒ Yes ☐ No Curb: ☒ Yes ☐ No

Is parking permitted on the roadway? ☐ Yes ☒ No

Municipal recommendation: _____

Pedestrian generators? Refer to attached pedestrian study.

Distance to next available crossing: _____

Was a crash analysis completed? ☐ Yes ☒ No

Are there pedestrian crashes? ☐ Yes ☐ No

Has a pedestrian gap analysis been performed at the location? ☐ Yes ☒ No

ftp://ftp.dot.state.pa.us/transfer/Traffic Signals/Unsignalized Intersection Ped Calcs from HCS.xlsx

Are there other geometric concerns? If yes, explain: _____

Pedestrian Traffic Signals (if applicable)

Yes	No	
☒	☐	Is there proper pedestrian timing established at the intersection?
☒	☐	Is an all-pedestrian phase recommended in the study?
☒	☐	Are the crosswalks in alignment with curb ramps?
☒	☐	Are pedestrian signals visible from the proposed crosswalk/curb ramp locations?
☒	☐	Are countdown pedestrian signals present?
☒	☐	Has the need for Accessible Pedestrian Signals (APS) been determined from the study?
☒	☐	Are pushbuttons proposed to be within the current ADA criteria?
☒	☐	Are all pushbutton locations accessible to all pedestrians?
☒	☐	Do all features satisfy applicable state and federal requirements?

Recommendations/Justification
See attached pedestrian study.

District Traffic Engineer Approval	Assistant District Executive Approval
District Traffic Engineer Date	District ADE of Design, Maintenance or Services Date

Pedestrian Needs Accommodation at Signalized Intersection Study

Limekiln Pike (SR 0152) and Twining Road
Traffic Signal Modification

Upper Dublin Township
Montgomery County

February 2019

Prepared by: McMahon Associates, Inc.
425 Commerce Drive, Suite 200
Fort Washington, PA 19034

Project Description and Scope

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- Install video detection for all approaches and wavetronix dilemma zone detection for both approaches of Limekiln Pike (S.R. 0152)
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- Install new ADA compliant curb ramps for all affected existing crossings

Existing Facility Description

The existing intersection of Limekiln Pike (S.R. 0152) and Twining Road is located in Upper Dublin Township, Montgomery County, PA. This intersection is a four-leg signalized intersection. Within the vicinity of the project location Limekiln Pike (S.R. 0152) is a two-way community minor arterial running north-south. This road consists of one right turn lane and one thru/left turn lane in the northbound direction and one right turn lane and one thru/left turn lane in the southbound direction. Twining Road is a two-way community collector running east-west. This roadway consists of one left turn/thru/right turn lane in the eastbound direction and one right turn lane and one thru/left turn lane in the westbound direction. It should be noted that there is an existing all-pedestrian phase at this intersection.

<u>Northeast</u>: This corner of the intersection is a gas station with a small rock bed directly adjacent to the corner. There is curbing and sidewalk provided along both Limekiln Pike (S.R. 0152) and Twining Road. There is a small island on this corner creating a channelized right turn for westbound Twining Road onto northbound Limekiln Pike (S.R. 0152). There are ADA compliant curb ramps and a painted crosswalk provided for crossing the uncontrolled channelized right turn. There are ADA compliant curb ramps, pedestrian push buttons, countdown pedestrian signal heads and painted crosswalks for crossing the north leg of Limekiln Pike (S.R. 0152) and the west leg of Twining Road.

<u>Southeast</u>: This corner of the intersection is a commercial property occupied by a bank with a large grass area located directly adjacent to the back of sidewalk. There is curbing and sidewalk provided along both Limekiln Pike (S.R. 0152) and Twining Road. There are ADA compliant curb ramps, pedestrian push buttons, countdown pedestrians signal heads and painted crosswalks for crossing the west leg of Twining Road and from the southeast corner to the northwest corner. There is a "No Pedestrian Crossing" sign for the south leg of Limekiln Pike (S.R. 0152).

Northwest: This corner of the intersection is a middle school property with a large grass area directly adjacent to the back of sidewalk. There is curbing and sidewalk provided along both Limekiln Pike (S.R. 0152) and Twining Road. There are ADA compliant curb ramps, pedestrian push buttons, countdown pedestrian signal heads and painted crosswalks for crossing the north leg of Limekiln Pike (S.R. 0152) and from the northwest corner to the southeast corner. There is a "No Pedestrian Crossing" sign for the west leg of Twining Road.

Southwest: This corner of the intersection is a residential property with heavy trees and brush directly adjacent to the edge of road. There is no sidewalk or curbing provided on this corner of the intersection. There is shoulder provided along Limekiln Pike (S.R. 0152). There are "No Pedestrian Crossing" signs for crossing both the south leg of Limekiln Pike (S.R. 0152) and the west leg of Twining Road. There are no pedestrian accommodations on this corner.

Peak hour pedestrian counts were conducted in May 2018 at the project intersection from 7:30AM to 9:30AM and 1:30PM to 3:30PM. During the periods of observation 19 pedestrians were observed crossing the intersection.

For additional reference beyond the descriptions above, photographs of each corner of this intersection have been included with this study.

Pedestrian Determination Using Engineering Judgment

Based on an engineering judgement of this intersection, we have determined that all pedestrian crossings should be maintained. It has also been determined to install ADA compliant curb ramps, pedestrian push buttons and painted crosswalks on the northwest corner and the island on the northeast corner as the existing ramps in these locations will need to be removed as part of the proposed upgrades.

Additionally, through coordination with Upper Dublin Township it has been determined to install APS at this intersection.

Proposed Facility Description

Detailed descriptions of the improvements on each quadrant are identified below.

Northeast: Install three new ADA compliant curb ramps and painted crosswalks for crossing the channelized right turn, north leg of Limekiln Pike (S.R. 0152) and west leg of Twining Road. Install new pedestrian push buttons and countdown pedestrian signal heads for crossing the north leg of Limekiln Pike (S.R. 0152) and the west leg of Twining Road. Maintain existing ADA compliant curb ramp on the northeast corner for crossing the channelized right turn.

Southeast: Maintain existing pedestrian accommodations for crossing both the west leg of Twining Road and from the southeast corner to the northwest corner and existing "No Pedestrian Crossing" for crossing the south leg of Limekiln Pike (S.R. 0152)

Northwest: Install two new ADA compliant curb ramps, pedestrian push buttons and painted crosswalks for crossing the north leg of Limekiln Pike (S.R. 0152) and from the northwest corner to the southeast corner.

Southwest: Maintain existing "No Pedestrian Crossing" signs for crossing both Limekiln Pike (S.R. 0152) and Twining Road.

The Pedestrian Accommodation at Intersections Checklist (TE-672) has been completed for this intersection and is included with this study.

Northeast Corner

Northwest Corner

Southeast Corner

Southwest Corner

APPENDIX E

Manual Turning Movement Counts

McMahon Associates, Inc.

425 Commerce Drive, Suite 200
Fort Washington, PA 19034
Transportation Engineers and Planners

Municipality: Upper Dublin Township
Location: Limekiln Pike &
Twining Road
Counter: RS

File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
Page No : 1

Groups Printed- Passenger Vehicles - School Vehicles - Heavy Vehicles

	Limekiln Pk Southbound				Twining Rd Westbound				Limekiln Pk Northbound				Twining Rd Eastbound				
Start Time	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Int. Total
06:30	0	40	0	3	17	10	0	0	6	74	1	40	8	12	0	4	215
06:45	0	66	0	5	23	17	0	2	6	70	0	46	11	9	0	5	260
Total	0	106	0	8	40	27	0	2	12	144	1	86	19	21	0	9	475
07:00	0	69	0	14	28	15	0	4	6	122	0	31	6	17	0	5	317
07:15	1	88	0	22	38	22	0	5	18	124	0	49	8	24	0	9	408
07:30	4	70	0	35	41	25	0	13	12	128	0	75	35	29	0	14	481
07:45	3	82	0	12	37	11	0	6	8	134	0	97	6	31	0	11	438
Total	8	309	0	83	144	73	0	28	44	508	0	252	55	101	0	39	1644
08:00	1	83	0	6	28	22	1	3	8	119	0	96	8	24	0	7	406
08:15	4	80	0	7	40	19	0	4	8	113	0	86	7	25	0	5	398
*** BREAK ***																	
Total	5	163	0	13	68	41	1	7	16	232	0	182	15	49	0	12	804
*** BREAK ***																	
13:30	2	67	0	12	45	13	2	0	6	77	0	33	5	18	0	12	292
13:45	3	80	0	11	47	15	2	7	4	88	0	35	11	16	0	4	323
Total	5	147	0	23	92	28	4	7	10	165	0	68	16	34	0	16	615
14:00	3	83	1	13	51	18	0	5	4	82	0	39	10	21	0	5	335
14:15	2	75	2	13	50	20	0	7	3	83	0	39	8	24	0	5	331
14:30	8	83	2	11	44	18	0	2	9	70	0	32	19	30	0	5	333
14:45	8	71	4	26	50	28	1	10	11	89	0	32	10	23	0	4	367
Total	21	312	9	63	195	84	1	24	27	324	0	142	47	98	0	19	1366
15:00	7	113	2	21	48	21	0	1	11	98	0	43	19	26	0	16	426
15:15	9	122	0	12	53	18	0	5	8	100	0	52	19	16	0	8	422
Grand Total	55	1272	11	223	640	292	6	74	128	1571	1	825	190	345	0	119	5752
Apprch %	3.5	81.5	0.7	14.3	63.2	28.9	0.6	7.3	5.1	62.2	0	32.7	29.1	52.8	0	18.2	
Total %	1	22.1	0.2	3.9	11.1	5.1	0.1	1.3	2.2	27.3	0	14.3	3.3	6	0	2.1	
Passenger Vehicles	52	1208	0	192	613	281	6	70	112	1485	1	809	177	335	0	109	5450
% Passenger Vehicles	94.5	95	0	86.1	95.8	96.2	100	94.6	87.5	94.5	100	98.1	93.2	97.1	0	91.6	94.7
School Vehicles	0	2	11	28	0	0	0	0	0	19	0	0	7	0	0	6	73
% School Vehicles	0	0.2	100	12.6	0	0	0	0	0	1.2	0	0	3.7	0	0	5	1.3
Heavy Vehicles	3	62	0	3	27	11	0	4	16	67	0	16	6	10	0	4	229
% Heavy Vehicles	5.5	4.9	0	1.3	4.2	3.8	0	5.4	12.5	4.3	0	1.9	3.2	2.9	0	3.4	4

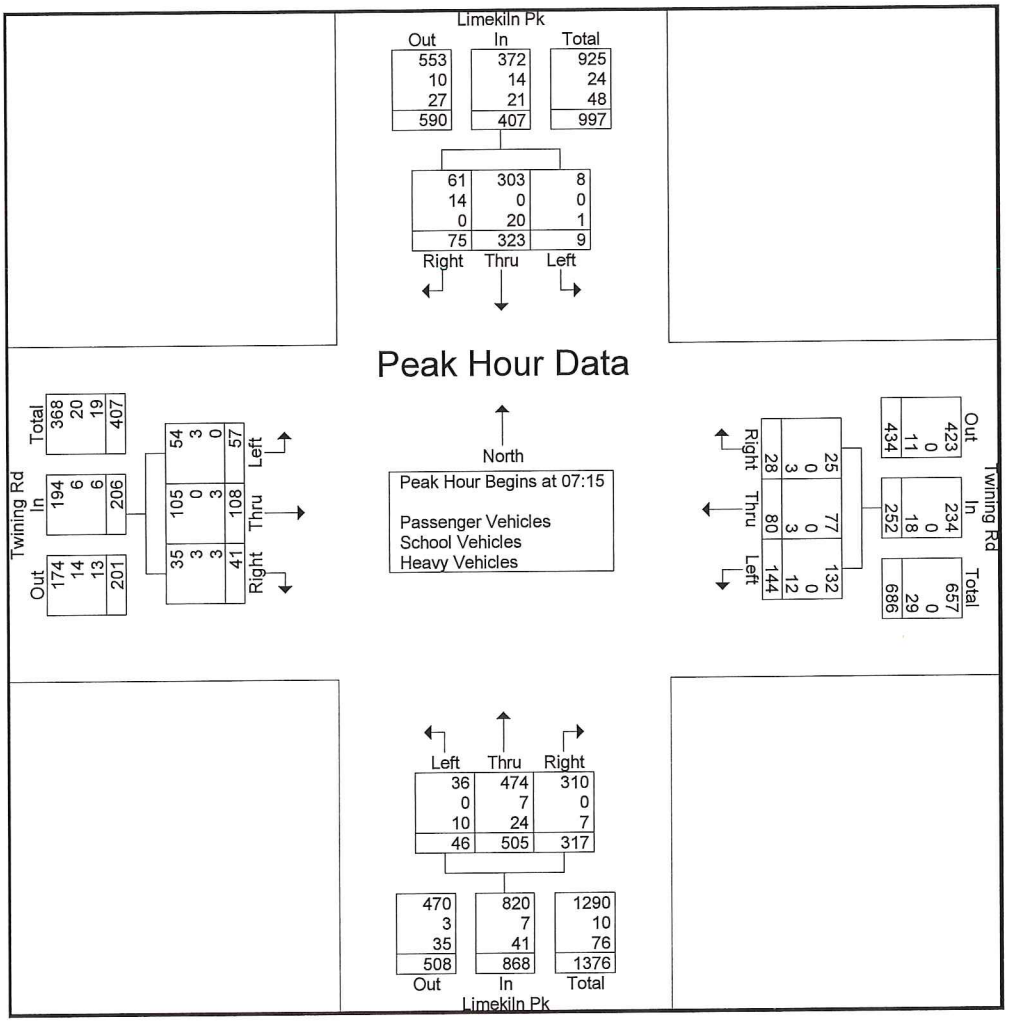
McMahon Associates, Inc.

425 Commerce Drive, Suite 200
Fort Washington, PA 19034
Transportation Engineers and Planners

Municipality: Upper Dublin Township
Location: Limekiln Pike &
Twining Road
Counter: RS

File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
Page No : 2

	Limekiln Pk Southbound					Twining Rd Westbound					Limekiln Pk Northbound					Twining Rd Eastbound					
Start Time	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Int. Total
Peak Hour Analysis From 06:30 to 11:45 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15																					
07:15	1	**88**	0	22	**111**	38	22	0	5	65	**18**	124	0	49	191	8	24	0	9	41	408
07:30	**4**	70	0	**35**	109	**41**	**25**	0	**13**	**79**	12	128	0	75	215	**35**	29	0	**14**	**78**	**481**
07:45	3	82	0	12	97	37	11	0	6	54	8	**134**	0	**97**	**239**	6	**31**	0	11	48	438
08:00	1	83	0	6	90	28	22	**1**	3	54	8	119	0	96	223	8	24	0	7	39	406
Total Volume	9	323	0	75	407	144	80	1	27	252	46	505	0	317	868	57	108	0	41	206	1733
% App. Total	2.2	79.4	0	18.4		57.1	31.7	0.4	10.7		5.3	58.2	0	36.5		27.7	52.4	0	19.9		
PHF	.563	.918	.000	.536	.917	.878	.800	.250	.519	.797	.639	.942	.000	.817	.908	.407	.871	.000	.732	.660	.901
Passenger Vehicles																					
% Passenger Vehicles	88.9	93.8	0	81.3	91.4	91.7	96.3	100	88.9	92.9	78.3	93.9	0	97.8	94.5	94.7	97.2	0	85.4	94.2	93.5
School Vehicles																					
% School Vehicles	0	0	0	18.7	3.4	0	0	0	0	0	0	1.4	0	0	0.8	5.3	0	0	7.3	2.9	1.6
Heavy Vehicles																					
% Heavy Vehicles	11.1	6.2	0	0	5.2	8.3	3.8	0	11.1	7.1	21.7	4.8	0	2.2	4.7	0	2.8	0	7.3	2.9	5.0



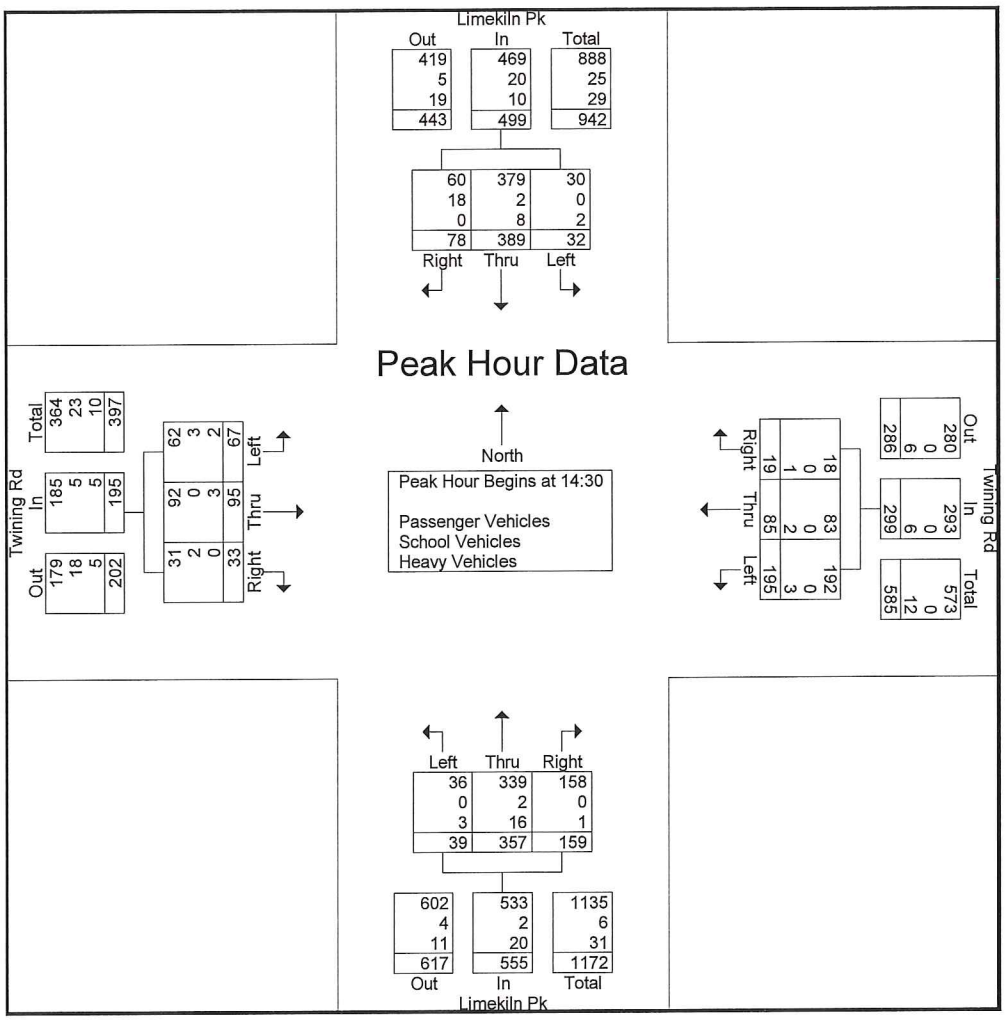
McMahon Associates, Inc.

425 Commerce Drive, Suite 200
Fort Washington, PA 19034
Transportation Engineers and Planners

Municipality: Upper Dublin Township
Location: Limekiln Pike &
Twining Road
Counter: RS

File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
Page No : 3

	Limekiln Pk Southbound					Twining Rd Westbound					Limekiln Pk Northbound					Twining Rd Eastbound					
Start Time	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Left	Thru	ROR	Right	App. Total	Int. Total
Peak Hour Analysis From 12:00 to 15:15 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 14:30																					
14:30	8	83	2	11	104	44	18	0	2	64	9	70	0	32	111	**19**	**30**	0	5	54	333
14:45	8	71	**4**	**26**	109	50	**28**	**1**	**10**	**89**	**11**	89	0	32	132	10	23	0	4	37	367
15:00	7	113	2	21	**143**	48	21	0	1	70	11	98	0	43	152	19	26	0	**16**	**61**	**426**
15:15	**9**	**122**	0	12	143	**53**	18	0	5	76	8	**100**	0	**52**	**160**	19	16	0	8	43	422
Total Volume	32	389	8	70	499	195	85	1	18	299	39	357	0	159	555	67	95	0	33	195	1548
% App. Total	6.4	78	1.6	14		65.2	28.4	0.3	6		7	64.3	0	28.6		34.4	48.7	0	16.9		
PHF	.889	.797	.500	.673	.872	.920	.759	.250	.450	.840	.886	.893	.000	.764	.867	.882	.792	.000	.516	.799	.908
Passenger Vehicles																					
% Passenger Vehicles	93.8	97.4	0	85.7	94.0	98.5	97.6	100	94.4	98.0	92.3	95.0	0	99.4	96.0	92.5	96.8	0	93.9	94.9	95.6
School Vehicles																					
% School Vehicles	0	0.5	100	14.3	4.0	0	0	0	0	0	0	0.6	0	0	0.4	4.5	0	0	6.1	2.6	1.7
Heavy Vehicles																					
% Heavy Vehicles	6.3	2.1	0	0	2.0	1.5	2.4	0	5.6	2.0	7.7	4.5	0	0.6	3.6	3.0	3.2	0	0	2.6	2.6



McMahon Associates, Inc.

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Transportation Engineers and Planners

Municipality: Upper Dublin Township
Location: Limekiln Pike &
Twining Road
Counter: RS

File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
Page No : 1

Groups Printed- Passenger Vehicles

	Limekiln Pk Southbound				Twining Rd Westbound				Limekiln Pk Northbound				Twining Rd Eastbound				
Start Time	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Int. Total
06:30	0	39	0	2	17	9	0	0	6	73	1	39	7	11	0	4	208
06:45	0	61	0	5	23	16	0	2	6	64	0	45	10	9	0	4	245
Total	0	100	0	7	40	25	0	2	12	137	1	84	17	20	0	8	453
07:00	0	62	0	12	27	14	0	4	6	117	0	31	6	17	0	5	301
07:15	1	82	0	19	37	22	0	5	15	116	0	49	6	24	0	9	385
07:30	3	67	0	31	37	22	0	11	9	120	0	74	35	28	0	12	449
07:45	3	78	0	7	36	11	0	6	8	126	0	96	6	29	0	9	415
Total	7	289	0	69	137	69	0	26	38	479	0	250	53	98	0	35	1550
08:00	1	76	0	4	22	22	1	2	4	112	0	91	7	24	0	5	371
08:15	4	78	0	7	36	18	0	4	6	109	0	84	7	24	0	4	381
*** BREAK ***																	
Total	5	154	0	11	58	40	1	6	10	221	0	175	14	48	0	9	752
*** BREAK ***																	
13:30	2	64	0	12	44	13	2	0	6	75	0	33	3	18	0	12	284
13:45	3	73	0	11	45	15	2	7	4	87	0	34	11	16	0	4	312
Total	5	137	0	23	89	28	4	7	10	162	0	67	14	34	0	16	596
14:00	3	78	0	11	51	18	0	5	4	70	0	36	10	19	0	5	310
14:15	2	71	0	11	46	18	0	7	2	77	0	39	7	24	0	5	309
14:30	8	82	0	9	44	18	0	2	9	64	0	32	16	30	0	4	318
14:45	8	70	0	21	48	27	1	10	10	83	0	32	9	23	0	4	346
Total	21	301	0	52	189	81	1	24	25	294	0	139	42	96	0	18	1283
15:00	7	106	0	18	48	21	0	0	10	95	0	42	19	24	0	15	405
15:15	7	121	0	12	52	17	0	5	7	97	0	52	18	15	0	8	411
Grand Total	52	1208	0	192	613	281	6	70	112	1485	1	809	177	335	0	109	5450
Apprch %	3.6	83.2	0	13.2	63.2	29	0.6	7.2	4.7	61.7	0	33.6	28.5	53.9	0	17.6	
Total %	1	22.2	0	3.5	11.2	5.2	0.1	1.3	2.1	27.2	0	14.8	3.2	6.1	0	2	

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File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
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Groups Printed- School Vehicles

	Limekiln Pk Southbound				Twining Rd Westbound				Limekiln Pk Northbound				Twining Rd Eastbound				
Start Time	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Int. Total
*** BREAK ***																	
07:00	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3
07:15	0	0	0	3	0	0	0	0	0	2	0	0	2	0	0	0	7
07:30	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	1	6
07:45	0	0	0	5	0	0	0	0	0	3	0	0	0	0	0	2	10
Total	0	0	0	12	0	0	0	0	0	9	0	0	2	0	0	3	26
08:00	0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	4
08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
*** BREAK ***																	
Total	0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	1	5
*** BREAK ***																	
14:00	0	0	1	2	0	0	0	0	0	4	0	0	0	0	0	0	7
14:15	0	0	2	2	0	0	0	0	0	3	0	0	1	0	0	0	8
14:30	0	0	2	2	0	0	0	0	0	1	0	0	2	0	0	1	8
14:45	0	0	4	5	0	0	0	0	0	0	0	0	1	0	0	0	10
Total	0	0	9	11	0	0	0	0	0	8	0	0	4	0	0	1	33
15:00	0	2	2	3	0	0	0	0	0	1	0	0	0	0	0	1	9
*** BREAK ***																	
Grand Total	0	2	11	28	0	0	0	0	0	19	0	0	7	0	0	6	73
Apprch %	0	4.9	26.8	68.3	0	0	0	0	0	100	0	0	53.8	0	0	46.2	
Total %	0	2.7	15.1	38.4	0	0	0	0	0	26	0	0	9.6	0	0	8.2	

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Location: Limekiln Pike &
Twining Road
Counter: RS

File Name : sandyrun04w
Site Code : 81835304
Start Date : 5/10/2018
Page No : 1

Groups Printed- Heavy Vehicles

	Limekiln Pk Southbound				Twining Rd Westbound				Limekiln Pk Northbound				Twining Rd Eastbound				
Start Time	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Left	Thru	ROR	Right	Int. Total
06:30	0	1	0	1	0	1	0	0	0	1	0	1	1	1	0	0	7
06:45	0	5	0	0	0	1	0	0	0	6	0	1	1	0	0	1	15
Total	0	6	0	1	0	2	0	0	0	7	0	2	2	1	0	1	22
07:00	0	7	0	2	1	1	0	0	0	2	0	0	0	0	0	0	13
07:15	0	6	0	0	1	0	0	0	3	6	0	0	0	0	0	0	16
07:30	1	3	0	0	4	3	0	2	3	7	0	1	0	1	0	1	26
07:45	0	4	0	0	1	0	0	0	0	5	0	1	0	2	0	0	13
Total	1	20	0	2	7	4	0	2	6	20	0	2	0	3	0	1	68
08:00	0	7	0	0	6	0	0	1	4	6	0	5	0	0	0	2	31
08:15	0	2	0	0	4	1	0	0	2	4	0	2	0	1	0	0	16
*** BREAK ***																	
Total	0	9	0	0	10	1	0	1	6	10	0	7	0	1	0	2	47
*** BREAK ***																	
13:30	0	3	0	0	1	0	0	0	0	2	0	0	2	0	0	0	8
13:45	0	7	0	0	2	0	0	0	0	1	0	1	0	0	0	0	11
Total	0	10	0	0	3	0	0	0	0	3	0	1	2	0	0	0	19
14:00	0	5	0	0	0	0	0	0	0	8	0	3	0	2	0	0	18
14:15	0	4	0	0	4	2	0	0	1	3	0	0	0	0	0	0	14
14:30	0	1	0	0	0	0	0	0	0	5	0	0	1	0	0	0	7
14:45	0	1	0	0	2	1	0	0	1	6	0	0	0	0	0	0	11
Total	0	11	0	0	6	3	0	0	2	22	0	3	1	2	0	0	50
15:00	0	5	0	0	0	0	0	1	1	2	0	1	0	2	0	0	12
15:15	2	1	0	0	1	1	0	0	1	3	0	0	1	1	0	0	11
Grand Total	3	62	0	3	27	11	0	4	16	67	0	16	6	10	0	4	229
Apprch %	4.4	91.2	0	4.4	64.3	26.2	0	9.5	16.2	67.7	0	16.2	30	50	0	20	
Total %	1.3	27.1	0	1.3	11.8	4.8	0	1.7	7	29.3	0	7	2.6	4.4	0	1.7	

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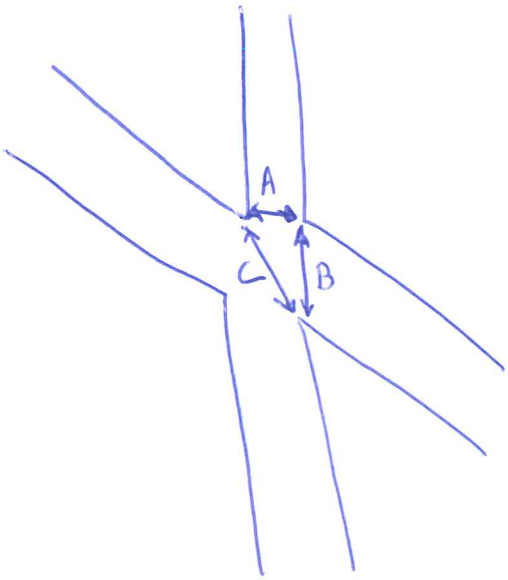
Start Date : 5/10/2018
Page No : 1

Groups Printed- Pedestrians

	Limekiln Pk Southbound	Twining Rd Westbound	Limekiln Pk Northbound		Twining Rd Eastbound	
Start Time	E/W	N/S	E/W	Diagonal Crossing	N/S	Int. Total
*** BREAK ***	A	B		C		
07:30	0	0	0	6	0	6
07:45	0	0	0	5	0	5
Total	0	0	0	11	0	11
08:00	1	0	0	1	0	2
08:15	2	0	0	0	0	2
*** BREAK ***						
Total	3	0	0	1	0	4
*** BREAK ***						
14:30	2	0	0	1	0	3
14:45	0	0	0	5	0	5
Total	2	0	0	6	0	8
15:00	0	0	0	4	0	4
15:15	1	0	0	2	0	3
Grand Total	6	0	0	24	0	30
Apprch %	100	0	0	100	0	
Total %	20	0	0	80	0	



	AM	(PM)
A	1	(3)
B	0	(0)
C	12	(12)
Total	13	(15)

AM = 7:15 to 8:15
PM = 14:30 to 3:30

APPENDIX F

2018 Existing Capacity Analysis

Lanes, Volumes, Timings
2: Limekiln Pike & Twining Road

02/01/2019

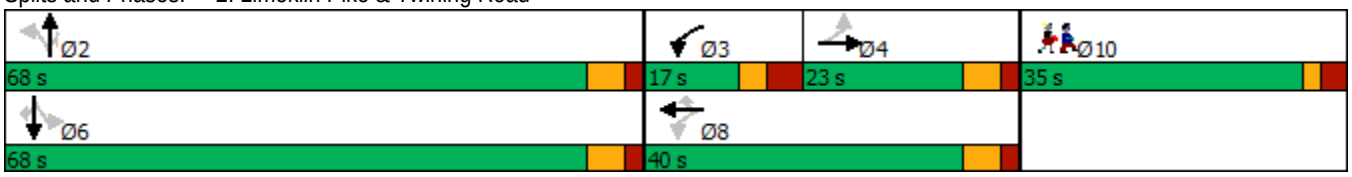
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	63	121	46	144	93	28	53	505	317	9	323	86
Future Volume (vph)	63	121	46	144	93	28	53	505	317	9	323	86
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	13	13	13	13	13	13	12	12	13	12	15	15
Grade (%)		4%			0%			5%			-2%	
Storage Length (ft)	0		0	0		275	0		85	0		110
Storage Lanes	0		0	0		1	0		1	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.973				0.850			0.850			0.850
Flt Protected		0.986			0.970			0.995			0.999	
Satd. Flow (prot)	0	1651	0	0	1695	1424	0	1624	1511	0	1882	1428
Flt Permitted		0.818			0.408			0.927			0.982	
Satd. Flow (perm)	0	1369	0	0	713	1424	0	1513	1511	0	1850	1428
Right Turn on Red			No			Yes			No			No
Satd. Flow (RTOR)						61						
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		1191			640			635			460	
Travel Time (s)		32.5			17.5			10.8			7.8	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	5%	3%	15%	8%	4%	11%	22%	6%	2%	11%	6%	19%
Adj. Flow (vph)	70	134	51	160	103	31	59	561	352	10	359	96
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	255	0	0	263	31	0	620	352	0	369	96
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			0			0	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.06	1.06	1.06	1.03	1.03	1.03	1.11	1.11	1.06	1.06	0.94	0.94
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1	0	1	1	1	1	1	1
Detector Template	Left			Left			Left			Left		
Leading Detector (ft)	20	37		20	37	0	20	37	37	20	37	37
Trailing Detector (ft)	0	-3		0	-3	0	0	-3	-3	0	-3	-3
Detector 1 Position(ft)	0	-3		0	-3	0	0	-3	-3	0	-3	-3
Detector 1 Size(ft)	20	40		20	40	20	20	40	40	20	40	40
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turn Type	Perm	NA		pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	4	4		3	8	8	2	2	2	6	6	6
Switch Phase												

Lane Group	Ø10
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Grade (%)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Enter Blocked Intersection	
Lane Alignment	
Median Width(ft)	
Link Offset(ft)	
Crosswalk Width(ft)	
Two way Left Turn Lane	
Headway Factor	
Turning Speed (mph)	
Number of Detectors	
Detector Template	
Leading Detector (ft)	
Trailing Detector (ft)	
Detector 1 Position(ft)	
Detector 1 Size(ft)	
Detector 1 Type	
Detector 1 Channel	
Detector 1 Extend (s)	
Detector 1 Queue (s)	
Detector 1 Delay (s)	
Turn Type	
Protected Phases	10
Permitted Phases	
Detector Phase	
Switch Phase	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Initial (s)	3.0	3.0		3.0	3.0	3.0	15.0	15.0	15.0	15.0	15.0	15.0
Minimum Split (s)	9.0	9.0		10.0	9.0	9.0	21.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	23.0	23.0		17.0	40.0	40.0	68.0	68.0	68.0	68.0	68.0	68.0
Total Split (%)	16.1%	16.1%		11.9%	28.0%	28.0%	47.6%	47.6%	47.6%	47.6%	47.6%	47.6%
Maximum Green (s)	17.0	17.0		10.0	34.0	34.0	62.0	62.0	62.0	62.0	62.0	62.0
Yellow Time (s)	4.0	4.0		3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0		4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-1.0			-1.0	-1.0		-1.0	-1.0		-1.0	-1.0
Total Lost Time (s)		5.0			5.0	5.0		5.0	5.0		5.0	5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None		Max	None	None	Min	Min	Min	Min	Min	Min
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		18.3			35.7	35.7		64.2	64.2		64.2	64.2
Actuated g/C Ratio		0.15			0.29	0.29		0.53	0.53		0.53	0.53
v/c Ratio		1.24			0.86	0.07		0.78	0.44		0.38	0.13
Control Delay		185.4			66.4	1.9		35.1	23.5		21.7	19.3
Queue Delay		0.0			0.0	0.0		0.0	0.0		0.0	0.0
Total Delay		185.4			66.4	1.9		35.1	23.5		21.7	19.3
LOS		F			E	A		D	C		C	B
Approach Delay		185.4			59.6			30.9			21.2	
Approach LOS		F			E			C			C	

Intersection Summary	
Area Type: Other	
Cycle Length: 143	
Actuated Cycle Length: 122	
Natural Cycle: 150	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 1.24	
Intersection Signal Delay: 52.7	Intersection LOS: D
Intersection Capacity Utilization 89.5%	ICU Level of Service E
Analysis Period (min) 15	

Splits and Phases: 2: Limekiln Pike & Twining Road



Lanes, Volumes, Timings
2: Limekiln Pike & Twining Road

02/01/2019

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	95	33	195	85	19	39	357	159	32	389	78
Future Volume (vph)	67	95	33	195	85	19	39	357	159	32	389	78
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	13	13	13	13	13	13	12	12	13	12	15	15
Grade (%)		4%			0%			5%			-2%	
Storage Length (ft)	0		0	0		275	0		85	0		110
Storage Lanes	0		0	0		1	0		1	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.977				0.850			0.850			0.850
Flt Protected		0.983			0.966			0.995			0.996	
Satd. Flow (prot)	0	1664	0	0	1762	1506	0	1658	1526	0	1930	1382
Flt Permitted		0.765			0.532			0.747			0.848	
Satd. Flow (perm)	0	1295	0	0	970	1506	0	1245	1526	0	1643	1382
Right Turn on Red			No			Yes			No			No
Satd. Flow (RTOR)						61						
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		1191			640			635			460	
Travel Time (s)		32.5			17.5			10.8			7.8	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Heavy Vehicles (%)	8%	3%	6%	2%	2%	5%	8%	5%	1%	6%	3%	23%
Adj. Flow (vph)	74	104	36	214	93	21	43	392	175	35	427	86
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	214	0	0	307	21	0	435	175	0	462	86
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		0			0			0			0	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.06	1.06	1.06	1.03	1.03	1.03	1.11	1.11	1.06	1.06	0.94	0.94
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1	0	1	1	1	1	1	1
Detector Template	Left			Left			Left			Left		
Leading Detector (ft)	20	37		20	37	0	20	37	37	20	37	37
Trailing Detector (ft)	0	-3		0	-3	0	0	-3	-3	0	-3	-3
Detector 1 Position(ft)	0	-3		0	-3	0	0	-3	-3	0	-3	-3
Detector 1 Size(ft)	20	40		20	40	0	20	40	40	20	40	40
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turn Type	Perm	NA		pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	4	4		3	8	8	2	2	2	6	6	6
Switch Phase												

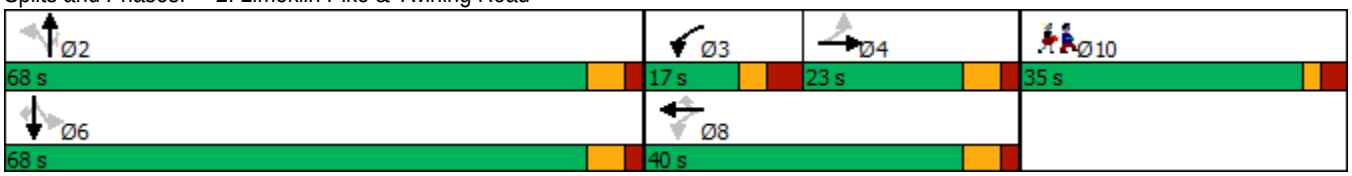
Lane Group	Ø10
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Grade (%)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Enter Blocked Intersection	
Lane Alignment	
Median Width(ft)	
Link Offset(ft)	
Crosswalk Width(ft)	
Two way Left Turn Lane	
Headway Factor	
Turning Speed (mph)	
Number of Detectors	
Detector Template	
Leading Detector (ft)	
Trailing Detector (ft)	
Detector 1 Position(ft)	
Detector 1 Size(ft)	
Detector 1 Type	
Detector 1 Channel	
Detector 1 Extend (s)	
Detector 1 Queue (s)	
Detector 1 Delay (s)	
Turn Type	
Protected Phases	10
Permitted Phases	
Detector Phase	
Switch Phase	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Initial (s)	3.0	3.0		3.0	3.0	3.0	15.0	15.0	15.0	15.0	15.0	15.0
Minimum Split (s)	9.0	9.0		10.0	9.0	9.0	21.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	23.0	23.0		17.0	40.0	40.0	68.0	68.0	68.0	68.0	68.0	68.0
Total Split (%)	16.1%	16.1%		11.9%	28.0%	28.0%	47.6%	47.6%	47.6%	47.6%	47.6%	47.6%
Yellow Time (s)	4.0	4.0		3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0		4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-1.0			-1.0	-1.0		-1.0	-1.0		-1.0	-1.0
Total Lost Time (s)		5.0			5.0	5.0		5.0	5.0		5.0	5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?												
Recall Mode	None	None		Max	None	None	Min	Min	Min	Min	Min	Min
Act Effct Green (s)		20.1			39.1	39.1		38.4	38.4		38.4	38.4
Actuated g/C Ratio		0.20			0.40	0.40		0.39	0.39		0.39	0.39
v/c Ratio		0.81			0.62	0.03		0.90	0.29		0.72	0.16
Control Delay		67.3			38.6	0.1		51.9	23.3		33.6	22.1
Queue Delay		0.0			0.0	0.0		0.0	0.0		0.0	0.0
Total Delay		67.3			38.6	0.1		51.9	23.3		33.6	22.1
LOS		E			D	A		D	C		C	C
Approach Delay		67.3			36.2			43.7			31.8	
Approach LOS		E			D			D			C	
Queue Length 50th (ft)		92			89	0		181	54		174	25
Queue Length 95th (ft)		#426			#493	0		500	158		455	85
Internal Link Dist (ft)		1111			560			555			380	
Turn Bay Length (ft)						275			85			110
Base Capacity (vph)		264			492	634		889	1089		1173	987
Starvation Cap Reductn		0			0	0		0	0		0	0
Spillback Cap Reductn		0			0	0		0	0		0	0
Storage Cap Reductn		0			0	0		0	0		0	0
Reduced v/c Ratio		0.81			0.62	0.03		0.49	0.16		0.39	0.09

Intersection Summary	
Area Type:	Other
Cycle Length: 143	
Actuated Cycle Length: 98.6	
Natural Cycle: 130	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.90	
Intersection Signal Delay: 41.4	Intersection LOS: D
Intersection Capacity Utilization 88.6%	ICU Level of Service E
Analysis Period (min) 15	

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Limekiln Pike & Twining Road



APPENDIX G

2023 Proposed Capacity Analysis

Lanes, Volumes, Timings
2: Limekiln Pike & Twining Road

02/01/2019

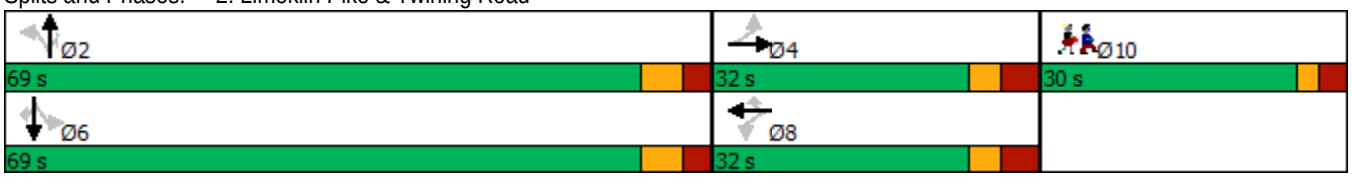
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	100	128	66	147	102	26	100	471	324	8	312	154
Future Volume (vph)	100	128	66	147	102	26	100	471	324	8	312	154
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	10	13	13	10	11	13	12	12	14	11	15	15
Grade (%)		4%			0%			5%			-2%	
Storage Length (ft)	185		0	300		275	0		85	0		150
Storage Lanes	1		0	1		1	0		1	0		1
Taper Length (ft)	75			75			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.949				0.850			0.850			0.850
Flt Protected	0.950			0.950				0.991			0.999	
Satd. Flow (prot)	1533	1674	0	1478	1689	1412	0	1617	1560	0	1864	1634
Flt Permitted	0.684			0.481				0.817			0.983	
Satd. Flow (perm)	1104	1674	0	748	1689	1412	0	1333	1560	0	1835	1634
Right Turn on Red			No			Yes			No			No
Satd. Flow (RTOR)						75						
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		1191			640			635			460	
Travel Time (s)		32.5			17.5			10.8			7.8	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	2%	2%	6%	8%	3%	12%	10%	7%	2%	13%	7%	4%
Adj. Flow (vph)	111	142	73	163	113	29	111	523	360	9	347	171
Shared Lane Traffic (%)												
Lane Group Flow (vph)	111	215	0	163	113	29	0	634	360	0	356	171
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		10			10			0			0	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.20	1.06	1.06	1.17	1.12	1.03	1.11	1.11	1.02	1.11	0.94	0.94
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1	0	1	1	1	1	1	1
Detector Template	Left						Left			Left		
Leading Detector (ft)	37	37		37	37	0	20	37	37	20	37	37
Trailing Detector (ft)	-3	-3		-3	-3	0	0	-3	-3	0	-3	-3
Detector 1 Position(ft)	-3	-3		-3	-3	0	0	-3	-3	0	-3	-3
Detector 1 Size(ft)	40	40		40	40	20	20	40	40	20	40	40
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	4	4		8	8	8	2	2	2	6	6	6
Switch Phase												

Lane Group	Ø10
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Grade (%)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Enter Blocked Intersection	
Lane Alignment	
Median Width(ft)	
Link Offset(ft)	
Crosswalk Width(ft)	
Two way Left Turn Lane	
Headway Factor	
Turning Speed (mph)	
Number of Detectors	
Detector Template	
Leading Detector (ft)	
Trailing Detector (ft)	
Detector 1 Position(ft)	
Detector 1 Size(ft)	
Detector 1 Type	
Detector 1 Channel	
Detector 1 Extend (s)	
Detector 1 Queue (s)	
Detector 1 Delay (s)	
Turn Type	
Protected Phases	10
Permitted Phases	
Detector Phase	
Switch Phase	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Initial (s)	3.0	3.0		3.0	3.0	3.0	15.0	15.0	15.0	15.0	15.0	15.0
Minimum Split (s)	10.0	10.0		10.0	10.0	10.0	22.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	32.0	32.0		32.0	32.0	32.0	69.0	69.0	69.0	69.0	69.0	69.0
Total Split (%)	24.4%	24.4%		24.4%	24.4%	24.4%	52.7%	52.7%	52.7%	52.7%	52.7%	52.7%
Maximum Green (s)	25.0	25.0		25.0	25.0	25.0	62.0	62.0	62.0	62.0	62.0	62.0
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	4.0	4.0		4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	-1.0	-1.0		-1.0	-1.0	-1.0		-1.0	-1.0		-1.0	-1.0
Total Lost Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0		6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Minimum Gap (s)	3.0	3.0		3.0	3.0	3.0	2.7	2.7	2.7	2.7	2.7	2.7
Time Before Reduce (s)	0.0	0.0		0.0	0.0	0.0	30.0	30.0	30.0	30.0	30.0	30.0
Time To Reduce (s)	0.0	0.0		0.0	0.0	0.0	15.0	15.0	15.0	15.0	15.0	15.0
Recall Mode	None	None		None	None	None	Min	Min	Min	Min	Min	Min
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)	26.4	26.4		26.4	26.4	26.4		63.9	63.9		63.9	63.9
Actuated g/C Ratio	0.24	0.24		0.24	0.24	0.24		0.57	0.57		0.57	0.57
v/c Ratio	0.43	0.55		0.93	0.28	0.07		0.83	0.40		0.34	0.18
Control Delay	45.8	46.2		96.3	40.5	0.4		34.1	17.6		16.2	14.6
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0	0.0
Total Delay	45.8	46.2		96.3	40.5	0.4		34.1	17.6		16.2	14.6
LOS	D	D		F	D	A		C	B		B	B
Approach Delay		46.0			66.5			28.1			15.7	
Approach LOS		D			E			C			B	

Intersection Summary	
Area Type:	Other
Cycle Length: 131	
Actuated Cycle Length: 111.8	
Natural Cycle: 150	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.93	
Intersection Signal Delay: 33.2	Intersection LOS: C
Intersection Capacity Utilization 89.8%	ICU Level of Service E
Analysis Period (min) 15	

Splits and Phases: 2: Limekiln Pike & Twining Road



Lanes, Volumes, Timings
2: Limekiln Pike & Twining Road

02/01/2019

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	127	102	54	199	90	18	52	352	162	31	377	89
Future Volume (vph)	127	102	54	199	90	18	52	352	162	31	377	89
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	10	13	13	10	11	13	12	12	14	11	15	15
Grade (%)		4%			0%			5%			-2%	
Storage Length (ft)	185		0	300		275	0		85	0		150
Storage Lanes	1		0	1		1	0		1	0		1
Taper Length (ft)	75			75			25			25		
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.952				0.850			0.850			0.850
Flt Protected	0.950	0.996		0.950				0.994			0.996	
Satd. Flow (prot)	1402	1605	0	1565	1706	1492	0	1659	1575	0	1930	1589
Flt Permitted	0.693	0.978		0.614				0.750			0.904	
Satd. Flow (perm)	1023	1576	0	1011	1706	1492	0	1252	1575	0	1751	1589
Right Turn on Red			No			Yes			No			No
Satd. Flow (RTOR)						75						
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		1191			640			635			460	
Travel Time (s)		32.5			17.5			10.8			7.8	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Heavy Vehicles (%)	6%	3%	0%	2%	2%	6%	6%	5%	1%	6%	3%	7%
Adj. Flow (vph)	140	112	59	219	99	20	57	387	178	34	414	98
Shared Lane Traffic (%)	10%											
Lane Group Flow (vph)	126	185	0	219	99	20	0	444	178	0	448	98
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		10			10			0			0	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.20	1.06	1.06	1.17	1.12	1.03	1.11	1.11	1.02	1.11	0.94	0.94
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	1		1	1	0	1	1	1	1	1	1
Detector Template	Left			Left			Left			Left		
Leading Detector (ft)	37	37		37	37	0	20	37	37	20	37	37
Trailing Detector (ft)	-3	-3		-3	-3	0	0	-3	-3	0	-3	-3
Detector 1 Position(ft)	-3	-3		-3	-3	0	0	-3	-3	0	-3	-3
Detector 1 Size(ft)	40	40		40	40	20	20	40	40	20	40	40
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	4	4		8	8	8	2	2	2	6	6	6
Switch Phase												

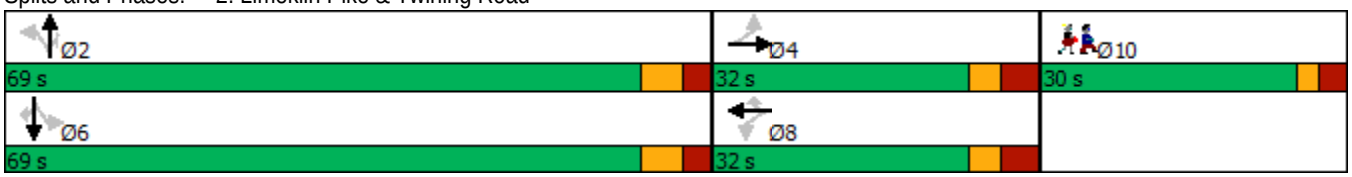
Lane Group	Ø10
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Grade (%)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Enter Blocked Intersection	
Lane Alignment	
Median Width(ft)	
Link Offset(ft)	
Crosswalk Width(ft)	
Two way Left Turn Lane	
Headway Factor	
Turning Speed (mph)	
Number of Detectors	
Detector Template	
Leading Detector (ft)	
Trailing Detector (ft)	
Detector 1 Position(ft)	
Detector 1 Size(ft)	
Detector 1 Type	
Detector 1 Channel	
Detector 1 Extend (s)	
Detector 1 Queue (s)	
Detector 1 Delay (s)	
Turn Type	
Protected Phases	10
Permitted Phases	
Detector Phase	
Switch Phase	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Minimum Initial (s)	3.0	3.0		3.0	3.0	3.0	15.0	15.0	15.0	15.0	15.0	15.0
Minimum Split (s)	10.0	10.0		10.0	10.0	10.0	22.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	32.0	32.0		32.0	32.0	32.0	69.0	69.0	69.0	69.0	69.0	69.0
Total Split (%)	24.4%	24.4%		24.4%	24.4%	24.4%	52.7%	52.7%	52.7%	52.7%	52.7%	52.7%
Maximum Green (s)	25.0	25.0		25.0	25.0	25.0	62.0	62.0	62.0	62.0	62.0	62.0
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	4.0	4.0		4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	-1.0	-1.0		-1.0	-1.0	-1.0		-1.0	-1.0		-1.0	-1.0
Total Lost Time (s)	6.0	6.0		6.0	6.0	6.0		6.0	6.0		6.0	6.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Minimum Gap (s)	3.0	3.0		3.0	3.0	3.0	2.7	2.7	2.7	2.7	2.7	2.7
Time Before Reduce (s)	0.0	0.0		0.0	0.0	0.0	30.0	30.0	30.0	30.0	30.0	30.0
Time To Reduce (s)	0.0	0.0		0.0	0.0	0.0	15.0	15.0	15.0	15.0	15.0	15.0
Recall Mode	None	None		None	None	None	Min	Min	Min	Min	Min	Min
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)	29.0	29.0		29.0	29.0	29.0		34.5	34.5		34.5	34.5
Actuated g/C Ratio	0.34	0.34		0.34	0.34	0.34		0.41	0.41		0.41	0.41
v/c Ratio	0.36	0.34		0.63	0.17	0.04		0.87	0.28		0.63	0.15
Control Delay	35.8	32.5		42.4	31.3	0.1		42.2	18.5		24.6	17.3
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0	0.0
Total Delay	35.8	32.5		42.4	31.3	0.1		42.2	18.5		24.6	17.3
LOS	D	C		D	C	A		D	B		C	B
Approach Delay		33.8			36.7			35.4			23.3	
Approach LOS		C			D			D			C	

Intersection Summary

Area Type: Other
Cycle Length: 131
Actuated Cycle Length: 84.6
Natural Cycle: 110
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 31.7 Intersection LOS: C
Intersection Capacity Utilization 85.3% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 2: Limekiln Pike & Twining Road



APPENDIX H

Left Turn Conflict Factor Worksheet

Left Turn Conflict Worksheet

Intersection: Limekiln Pike (SR 0152) and Twining Road

McMAHON TRANSPORTATION ENGINEERS & PLANNERS

County: Montgomery **Municipality:** Upper Dublin Township

Count Date: 5/10/2018 **File Number:** 1064

NB Approach: **Limekiln Pike (SR 0152)**

Exclusive Left-Turn Lane	N
Number of Opposing Lanes	1
Include Right Turns	Y
Required C.F. (Protected/Permitted)	35000
Required C.F. (Protected/Prohibited)	Not Applicable

Hour	NB Left	SB Through	Cycle Length	Turns Per Cycle	NB Conflict Factor	L.T.P. Justified
7:00 AM						
8:00 AM						
9:00 AM						
10:00 AM						
11:00 AM						
12:00 PM						
1:00 PM						
2:00 PM						
3:00 PM						
4:00 PM						
5:00 PM						
AM Peak	45	398	108	1.35	17910	No
MID Peak	39	467	78	0.845	18213	No
PM Peak						

SB Approach: **Limekiln Pike (SR 0152)**

Exclusive Lane	N
Number of Opposing Lanes	1
Include Right Turns	Y
Required C.F. (Protected/Permitted)	35000
Required C.F. (Protected/Prohibited)	Not Applicable

Hour	SB Left	NB Through	Cycle Length	Turns Per Cycle	SB Conflict Factor	L.T.P. Justified
7:00 AM						
8:00 AM						
9:00 AM						
10:00 AM						
11:00 AM						
12:00 PM						
1:00 PM						
2:00 PM						
3:00 PM						
4:00 PM						
5:00 PM						
AM Peak	9	822	108	0.27	7398	No
MID Peak	32	516	78	0.6933	16512	No
PM Peak						

EB Approach: **Twining Road**

Exclusive Lane	N
Number of Opposing Lanes	1
Include Right Turns	N
Requried C.F. (Protected/Permitted)	35000
Required C.F. (Protected/Prohibited)	Not Applicable

Hour	EB Left	WB Through	Cycle Length	Turns Per Cycle	EB Conflict Factor	L.T.P. Justified
7:00 AM						
8:00 AM						
9:00 AM						
10:00 AM						
11:00 AM						
12:00 PM						
1:00 PM						
2:00 PM						
3:00 PM						
4:00 PM						
5:00 PM						
AM Peak	57	80	108	1.71	4560	No
MID Peak	67	85	78	1.4517	5695	No
PM Peak						

WB Approach: **Twining Road**

Exclusive Lane	N
Number of Opposing Lanes	1
Include Right Turns	Y
Requried C.F. (Protected/Permitted)	35000
Required C.F. (Protected/Prohibited)	Not Applicable

Hour	WB Left	EB Through	Cycle Length	Turns Per Cycle	WB Conflict Factor	L.T.P. Justified
7:00 AM						
8:00 AM						
9:00 AM						
10:00 AM						
11:00 AM						
12:00 PM						
1:00 PM						
2:00 PM						
3:00 PM						
4:00 PM						
5:00 PM						
AM Peak	144	149	108	4.32	21456	No
MID Peak	195	128	78	4.225	24960	No
PM Peak						

Remarks:

Compiled By EJR
Checked By: AKK
Date: January 31, 2019