Aspen Business Park 414 South 17th Street, Suite 107 Ames, Iowa 50010

### Traffic Memorandum

DATE: March 6, 2014

TO: Damion Pregitzer, P.E.

FROM: Scott Williams, P.E.

RE: Left-Turn Lane Warrants

Quarry Estates Subdivision, Ames, IA

FOX P/N 5343-12A

### 1.0 BACKGROUND

This memorandum summarizes the results of a traffic analysis for the proposed Quarry Estates Subdivision located southeast of the intersection of W 190th Street and Grant Avenue in Ames, Iowa. A proposed layout of Quarry Estates Subdivision is included as Figure 1.

This study is based on a Traffic Impact Study completed for the Rose Prairie Subdivision by HWS Consulting Group in May 2008. That study evaluated future traffic impacts within the area bounded by GW Carver Avenue on the west, Grand Avenue (US 69) on the east, Bloomington Road on the south, and 190th Street on the north. The proposed Quarry Estates Subdivision is located within the boundary of the previous study area.

The purpose of this study is to evaluate whether dedicated left-turn lanes are warranted at entrances to the proposed subdivision. The approach of this study is to evaluate the intersections based on Year 2030 Full Build traffic volumes from the 2008 Rose Prairie Traffic Impact Study (which were modeled but not included in that earlier report). Synchro output from the earlier study is included as Appendix A. A previous Traffic Memorandum by FOX Engineering titled, "Trip Generation Rates, Quarry Estates Subdivision, Ames, IA, July 25, 2014", confirmed that trip generation rates estimated for Quarry Estates in the 2008 Rose Prairie Traffic Impact Study are similar to rates based on the current planned development.

Figure 1 - Quarry Estates Subdivision





### 2.0 FUTURE TRAFFIC CONDITIONS

### 2.1 Year 2030 Full Build - Traffic Volumes

This scenario includes not only the full build out of Quarry Estates Subdivision, but full build out of all development areas within the limits of the 2008 Rose Prairie Traffic Impact Study. Peak hour volumes for the W 190th Street and Grant Avenue intersection are shown in Appendix B. Year 2030 Full Build volumes were superimposed (in red) on the Year 2030 Base Traffic Volumes figure from the earlier study. Those peak hour turn volumes were used to estimate peak hour volumes on the roadway segments adjacent to the W 190th Street and Grant Avenue intersection, as shown on the figure. As the proposed entrances to the Quarry Estates Subdivision are all near this intersection, advancing and opposing volumes for each entrance were based on these peak hour volumes.

### 2.1 Year 2030 Full Build - Trip Distribution

Trip distribution for the Full Build scenario was included in the 2008 Rose Prairie Traffic Impact Study, and is included in Appendix C. At that time, it was estimated that 35% of the site generated traffic would enter the roadway network onto Grant Avenue, and 65% of the site generated traffic would enter the network onto W 190th Street. As currently planned, the development includes a single entrance to the subdivision from Grant Avenue and two entrances from W 190th Street. Based on the proposed site layout, this distribution seems reasonable. For purposes of this study, we've assumed a similar distribution:

Grant Avenue / Ada Hayden Road intersection - 34% W 190th Street / McFarland Avenue intersection - 33% W 190th Street / Ada Hayden Road intersection - 33%

**Table 1: Comparison of Peak Hour Trips** 

		Т	rips	
		AM	Р	М
	In	Out	In	Out
Quarry Estates Subdivision	32	105	113	64
(from Trip Generation - Quarry Estates Subdivision, Ames, IA, July 25, 2014)				
Intersection				
Grant Ave. / Ada Hayden Rd. intersection (34%)	11	36	38	22
W 190th St. / McFarland Ave. intersection (33%)	11	35	37	21
W 190th St. / Ada Hayden Rd. intersection (33%)	11	35	37	21



### 2.3 Left Turn Lane Warrants

Evaluation of whether dedicated left turn lanes are warranted at proposed entrances to the Quarry Estates Subdivision is based on Chapter 2 of "National Cooperative Highway Research Program (NCHRP) Report 457 - Evaluating Intersection Improvements: An Engineering Study Guide".

This guidance document "suggests the following guidelines should be used to determine when to provide a left-turn bay on the major road of a two-way stop-controlled intersection:

- 1. A left-turn lane should be considered at any median crossover on a divided, high-speed road.
- 2. A left-turn lane should be provided on the unstopped approach of a high-speed rural highway when it intersects with other arterials or collectors.
- 3. A left-turn lane is recommended on the unstopped approach of any intersection when the combination of intersection volumes intersect above or to the right of the appropriate trend line shown in Figure 2-5".

Of the three guidelines described, only item 3 applies to the proposed entrances to Quarry Estates Subdivision. Use of Figure 2-5 requires determination of opposing volume, the advancing volume, and the operating speed. Advancing and opposing volumes for each entrance were based on calculations described in Section 2.1. Percentage of left-turning vehicles were based on calculations described in Section 2.2. It should be noted that 100% of AM and PM trips into the proposed development were assumed to be left-turns. This results in conservative results, as a portion of the trips into the development are likely not left-turns. 85th percentile speeds were assumed to be 5 mph above the posted speed limits for Grant Avenue and W 190th Street. Results of the analysis described in NCHRP 457 are included in Appendix D.

### 3.0 CONCLUSIONS

The results of this analysis indicate that dedicated left-turn lanes are not warranted on Grant Avenue or W 190th Street, at proposed entrances to Quarry Estates Subdivision.

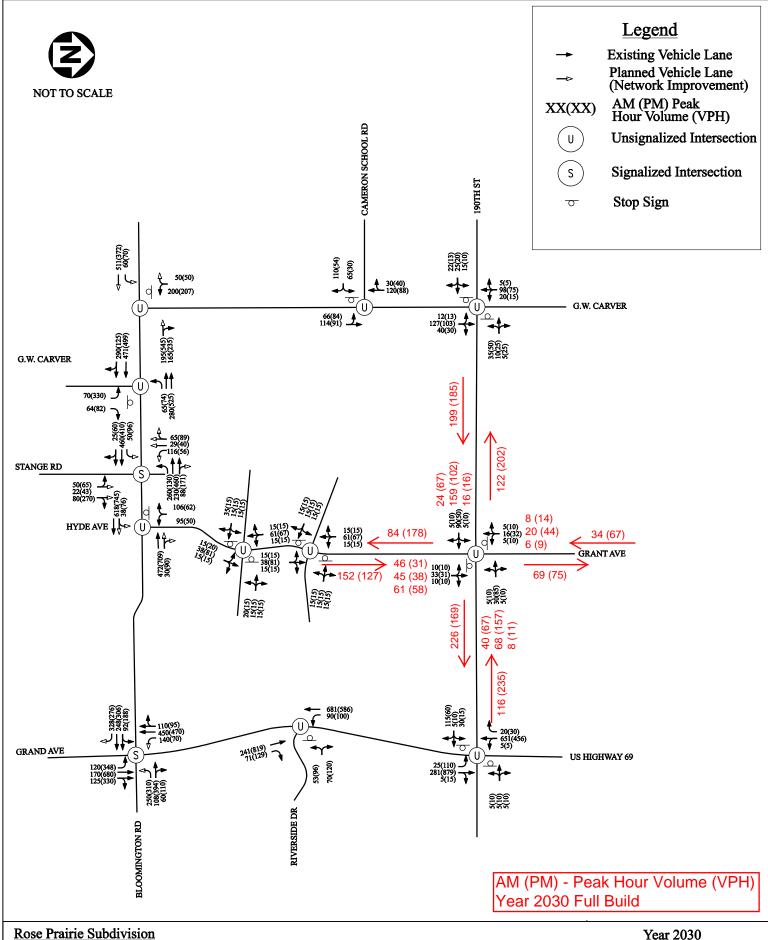


### Appendix A Synchro Output

	A.	<b>→</b>	*	-	4		4	<b>†</b>	1	-	Į.	4
Movement	T.BL	EBT	EBR	WBL	WBŢ	WBR	NBL	NBT	NBR	SBL	SBT	SBI
ane Configurations	estation tool k	ф separatelean	HARRISTER	- President	<b>ф</b>	en and a valence	RHERRY WEEK	4	MEKHRYKISHK	EKKEKKEME.	4	REHVERER
Sigh Control Grade	RESERVED S	Free 0%	195555555 1955555555 195555555 195555555 1955555 195555 1955	0.5248828	Free 0%		\$350US1 5030	Stop 0%	HERESEEN HEE	SERVICE SERVIC	Stöp 0%	8868688
orade /olume (veh/h)	2010	159	- KONE	40	68	u u u n	46	45	61	6	20	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.9
	7	173	26	43	74				66	7	22	THE SER
edestrians		Store State of			COLON DODGER	action of a manage	Example - Dam		1 To 20, Mars 2, 1994 11	A THE REST OF THE PARTY OF THE		
ane Width (ft)	PARROCKER PRO		LONG CORRECT					ARRIVA PRO				
Valking Speed (ft/s)	mannan.											
Percent Blöckage			12/25/25/21		ELSO BUNE					e je veze kara		
Right turn flare (veh)	**********	A STREET BEAUTIFUL A	en a damai manana	mulimi kitchini wito	NATION NAMES OF THE PARTY OF TH	NATIONAL PROPERTY.	PRESENTANT	KRERHKRANIAS:	NAMES AND ASSOCIATED BY	SHERRERES	KARAKARAKARA	CHRUSHA
(edian type	AND MARKET AND A	X NEW WORK PARTY OF THE PARTY O	NA STANKEN	X SECRETARY				None			None	1889,499
ledian storage veh)	X INTERNATION OF	STREET, DOLLAR	THE STREET WAS	a di la constancio			CHURN'N DI CHE	ERIOGACINATIVA II PORTOGRASIANI I A S	ARREST SE SE	HIMPERSKY HIMPERSKY	MARKET A	
lpstream signal (ft) X, platoon unblocked	ANNERS (ANNERS )		AND	KUURSEERER		nannan nan a	energa conso	REFERENCES	CERTER CARRE	ALEGGERARE	PARSONARROP	REAL SE
C, conflicting volume	83		20 200000	199	00.01.00000	251/11/11/12	405	×390	486	477	399	44444
C1, stage 1 conf vol	SPEEMON'S	Stricterentation	i .renkire	and the second	CONTRACTOR OF THE PROPERTY OF	Special systems	AND DESCRIPTION OF THE PERSON	Summer	I STATE OF THE STA	2000001	7.0	
C2, stage 2 conf.vol		E EXECUTE E		HUESESSES		AND A SERVICE AN		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	**************************************	1200000000	HE WEST WAR	
Cu, unblocked vol	83			199	000000000000000000000000000000000000000	*********	405	390	186	477	399	
C, single (s)	4.1	A KAKA		4.1			7.1	6,5	6,2	7.1	6,5	
C, 2 stage (s)	SESSIBILITIES WILL	a Processors was an	MINIST DE ROMANIA (C.	DER COMMENSAGE SER	- SAKH HENNER	RESERVE OF FRANKS	MENURAL WELLS	SANCHARITA ES	HERRICANIES	янгония <u>м</u> ия <u>е</u> го	HICHESTRANCE	MENADES
<del>)</del> (s)	2.2	XXY XX		2.2		Maranin in	3.5	4.0	3.3	3.5	40	
O queue free %	99	#299 <b>200</b>	9049999999	97	99999999999	29000000000000000000000000000000000000	90	91	92	98	96 516	9
Micapacity (veh/h)	1515	i quertar		13/4	KINNENNENNE		910	11244	111099			
Direction Lane#	EB1	WB1	MB 1	SB1					122			
/olume Total	216	126		37		CENTA CHEST	***********	PROPERTY OF	XXXXXXXX	HANNERS OF THE STATE OF THE STA		NAME OF
/olume Left	17	43	50	7	RESPECTATION	esense legrad	***********	(8888288) EKY	CERCUSEEEEE	1152341856	enernsmades:	SEEKEENT
/olume Right	26	1070		9				PERMIT	STEER STREET	100000000000000000000000000000000000000	PARTAGERES	
SH	1515	1373	616 0:27	554 0.07	88868888888	98498385423	18888886.15.8	:55666666665	1008888890E	8988888888	988998 <b>288</b> 98	16988831
Volume te Capacity Queue Length 95th (fl)	-0.01 1	0.03 2	27	5	E688668868	868983888KS	888888888888888888888888888888888888888	88888888888	000000000000000000000000000000000000000	81866888668	60536665555	saetaeu:
Control Delay (s)	<b>D.</b> 7	2.8	13.0	12,0			CONTROL CONTROL	3,556	XXXXXXX	1 277	A CONTROL OF	
ane LOS	A	A	В	В	1909x1 1 2200	REZMAUN MOSS	6324X2	A SON SECTION ASSESSMENT	IZEEEEEEEEEE	RECERCIE	STREET	HENSWITH.
Approach Delay (s)	0.7		13,0		XXNEXX HANX	HENRY SHERRY	KYXKNKUPKKAN KYXKKYKAP KYXKKYK	MANAKAN ANA	SECREPH S		HICKSTRANCE NO. CARROLL SERVICE NO. CARROLL SE	
Approach LOS	SITTEMENT		В	В								
ntersection Summary						1   f   1   1   1   1   2   1   1   2   1   1						
Average Delay			5.7							, ,,,,,,,,	. 1 744414 ***	
ntersection Capacity U	tilizatior	)	38.1%	A STANKE	CU Lev	el of Se	rvice	ANGERER ANGERS	A Min	**************************************	Transaria.	270,000
Analysis Period (min)	RESERVED	es-mermanan	15.	REMEMBERS	RESHEREKER	SERRE PERRE	RESERVENCE	KRESKKERRKER	APPRESENTE	HENNERSHE	18668888888	*****
	P. X R X X X X X X X X X X X X X X X X X				KKARAGERAKA PARISARA PARISA	E STATE OF STATE	**************************************	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	************	**************************************	CARACTER SERVICE	XXXXX

	<i>&gt;</i> _	. >		4	4	•	<u>†</u>	<i>p</i> =	1	Ţ	4
vlovement			ivvigi	Wei	Wer	NEL S		, MBR	(SBL-)		SER
Lane Configurations	€	3		4		Carl China Specia . 1	4	Control of particular		Ф	A STATE OF S
Sign Cöntrö	Fre	é	## '##!################################	Frée		****	Stop	**************************************	######################################	Stop	SCHEUCKSK SCHEUC
Grade	0,			0%			0%	MINNAME CONT.	. I where wight to	0%	es a strategray
Volume (yeh/h)	16 10		67	157	1.4.1	31	38	58	9.	44	114
Peak Hour Factor	0.92 0.9 17 11		0.92 73	0.92	0.92	0.92	0.92 41	0.92 63	0.92	0.92	0.92
Hourly flow rate (vph) Pedestrians	r IV	de mente (10 m	1,3,5,6	M I M ARME	KANG LENE	34	e e e e e e e e e e e e e e e e e e e	::::O3	ENERGIE		THE STATE OF
Lane Width (ft)	000000000000000000000000000000000000000	\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$		EES4382838	182988888888888888888888888888888888888	18882E2018E2	99999999		\$6298959696 \$6298959666		PEGEORÓS PA
Walking Speed (ft/s)	THE TAXABLE OF THE PARTY OF THE	SUDAGERASSASSASSASSASSASSASSASSASSASSASSASSASS	rulinar asaani c	·samman	managenen	mentraem			HACEMBER IN THE	(Leginore) pro-	(10.1111.111111111111111111111111111111
Percent Blockage			10 28 20 20 20 Ex			iki Sasaute - 1868	**************************************	erini Kundan	1.2888£138-9		E HIJAKA
Right turn flare (veh)	THE RESERVE THE PROPERTY.	*************	THE WARRANT OF THE PERSON OF T	MURRANARA	ennur huhunn	**********	erenninees.	CHRESTER	STIFFINGERS	намвиниями	CHRHHHHHER
Median type	SERVICE SERVICE SERVICES	Managara ang kanang ka Kanang kanang kanang ka Kanang kanang kanang Kanang kanang	AN AN ANNA AN		Carlle Mary	**************************************	None	AXXXXIIII	CONTRACTOR OF STREET	None	
Median storage veh) Upstream signal (ff)	PERSONAL PROPERTY OF THE PROPE	5057855 15558555 5057855 15558555	EN ENEXHOLES	**************************************		######################################	2880315 1535 2880315 1535	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	CARINARIAN	HANNEY OF	
pX, platoon unblocked	99999999999999999999999999999999999999	NERCHARDARGARGA	AURTON PROPERTY	REPRESENTE	RARGERREINE	ZHURRUFI NYK	NI KAKKAKAKA	KKKKKKKEHESK	KKKKKKKKKKK	HHEHHHMANNEN	KREMERHERR
VC, conflicting volume	183	00111111111111111111111111111111111111	184			543	510	147	588	541	177
vC1, stage 1 conf vol	The second second second second				territories de la constante de	A PROPERTY OF A STANDARD OF				(August) transfers	***************************************
vG2, stage 2 conf vol	**************************************	NEWS STREET	***************************************								
vCu, unblocked vol	183	DEPOS T SACTIMISTA	184 41	ar esteres	KSON LUMBE	543	510 6.5	147 6.2	588	541 6.5	177 6 2
tC, single (s)	<b>X</b> Ph					ere ( Lei		Q,Z	id and oxidate	0.0	
tH (s)	200	CHTROTISK THERESE	200	***********	XXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	3.5	40	### B	1385	40	3.3
p0 queue free %	99	SPORT IN STANKING	95	AND A PERSONAL	NEW NOW WILLIAM	91	91	93	97	89	98
oM capacity (ven/h)	1392		1391	<u>Qoʻxaggan</u>	COCHECE PORCE	384	436	11900	345	419	866
Direction Lane		ara ne is								T (I	
Volume Total	201 2	55 138	73			en in the		XXXXXX		-	
Volume Left	17	73 34	10	HANNEY SAF	CCCS SHE HALLS	***********	nanaga ganaa		NA HEADONDON	10000000000	
Volume Right	73(1	Section of Property and Applications	16		NAME OF STREET			XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	**************************************		
csH	1392 139		455	000000000000000000000000000000000000000	000000000000000000000000000000000000000	100000000000000000000000000000000000000	620600000000000000000000000000000000000	100000000000000000000000000000000000000	92290224004	0000000000	000001900000
Volume te Capacity	0.04: 0	MAAAAAAAAAAAAAA	0.16				************	######################################	3665556656	16696888888	12581112525
Queue Length 95th (ft) Control Delay (s)	0.8 5	4 25 5 13.8	14 14.4	WXXX			EXECUTE 17	XXXXXX	THE RESERVE	: XXXXXXXXXX	
Lane LOS	A	A B	В		544.1444428	227.11.1.123	22692.12 ×2°1	(2828894EE	01,002,002,000	0; 200032233	herriali
Approach Delay (s)		5 13.8	144	HERRHPRAN CONTRACTOR			CENTRACKAN CENTRACKAN CENTRACKAN	HERKENSKY HERKESKY HE	##  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	NHAMMANA NAMED NAMED NA	**************************************
Approach LOS	Idanasan kan tanan ka	В	В	nancine anne		**********					.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Įnterseoil <b>o</b> ni Skim <b>ma</b> nvi				15121							
Average Delay		5.6						V111104001111		W. Josephan	
Intersection Capacity U	Itilization	45.3%		U Leve	of Se	rvice	XXXXXXX AND	A.	APRICAL SECTION OF THE SECTION OF TH		Y VIEW X
Analysis Period (min)	KERINGENKARAN KEKAN	15	PESSERVEN NEWS	######################################	HAN TANKANAN	***********	CERNERHERE SECONDO SE	*********	**********	**************************************	XX38K"8KXXXX
BARRES I IZBAZARREZ ELBERGEZERA IA	KEKINENENENENENENENENENEN	CANAL MANAGEMENT	PHARYXXXXXXXX	RESERVED	ergengeneig Ergengeneig	MAKKAMAI LAM	HANNENHANN	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	**************************************		MAN MANUAREN

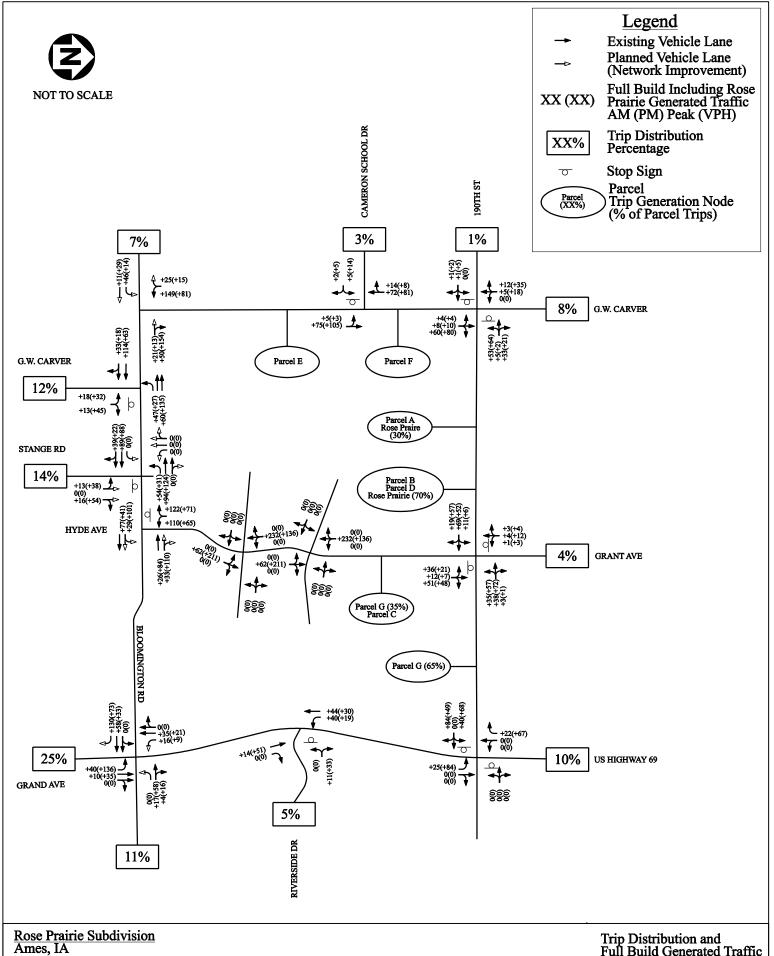
### Appendix B Peak Hour Volumes



Ames, IA

AMES OFFICE 223 S. Walnut Ave., Ste D Ames, Iowa 50010 (515) 232-1103 www.hws.com Year 2030 Base Traffic Volumes

### Appendix C Trip Distribution



Full Build Generated Traffic

Appendix D
Left-Turn Warrants
(from NCHRP 457)

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

### 2-lane roadway (English) INPUT

Value	008 41/1	10% <b>e</b> 700	116	22e (V	<b>amu</b>	Value 300		in 200 Leit-tum	0 100 warranted.
Variable	85 <sup>th</sup> percentile speed, mph:	Percent of left-turns in advancing volume (V <sub>A</sub> ), %:	Advancing volume $(V_A)$ , veh/h:	Opposing volume (V <sub>O</sub> ), veh/h:	OUTPUT	Variable	Limiting advancing volume $(V_A)$ , veh/h:	Guidance for determining the need for a major-road left-turn bay:	Left-turn treatment NOT warranted.

	700
warranted.	009
Left-turn tr	500 veh/h
	200 300 400 500 Advancing Volume (V <sub>A</sub> ), veh/h
	300 <b>ng Volu</b>
	200 <b>4dvanci</b>
Left-turn treatment not warranted.	100
800 700 600 500 300 Left trea 100 wan	0
hpposing Volume (V <sub>O</sub> ), veh/h	0

## CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane, s:	1.9

# Guidelines from NCHRP 457

W 190th St. intersections with McFarland AM Peak Hour Volume (VPH) Year 2030 Full Build Ave. and Ada Hayden Rd.

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

## 2-lane roadway (English)

Variable	Value		
85 <sup>th</sup> percentile speed, mph:	09		
Percent of left-turns in advancing volume $(V_A)$ , %:	16%	<b>190</b>	
Advancing volume $(V_A)$ , veh/h:	235	, <b>, (</b> ,	
Opposing volume (V <sub>O</sub> ), veh/h:	169	β (Λ	
		200 200	
OUTPUT		<b>un</b>	
Variable	Value	<b>O</b> /	
Limiting advancing volume $(V_A)$ , veh/h:	274		
Guidance for determining the need for a major-road left-turn bay:		<b>uis</b>	Left-tu treatm

Left-turn treatment NOT warranted.

	200
warranted.	009
Left-turn tr	500 , <b>veh/h</b>
-	400 me (V <sub>A</sub> ),
	200 300 400 500 Advancing Volume (V <sub>A</sub> ), veh/h
	200 <b>Advanc</b> i
Leff-tum treatment not warranted.	100
8000 7000 6000 8000 3000 1000 4 tu	0
h/həv ,(oV) əmuloV gnisoqq0	0

## CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane, s:	1.9

# **Guidelines from NCHRP 457**

W 190th St. intersections with McFarland PM Peak Hour Volume (VPH) Ave. and Ada Hayden Rd. Year 2030 Full Build

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

## 2-lane roadway (English)

Variable	Value		
85 <sup>th</sup> percentile speed, mph:	50	ų/ι	800
Percent of left-turns in advancing volume (V <sub>A</sub> ), %:	13%	lθν	700
Advancing volume $(V_A)$ , veh/h:	84		800
Opposing volume (V <sub>O</sub> ), veh/h:	152	<sup>2</sup> Λ)	3
		əu	200

OUTPUT

Variable	Value
Limiting advancing volume $(V_A)$ , veh/h:	374
Guidance for determining the need for a major-road left-turn bay:	
Left-turn treatment NOT warranted.	

700 Left-turn treatment warranted. 009 Advancing Volume (V<sub>A</sub>), veh/h 200 300 200 Left-turn treatment not warranted. 100 0 200 100 300 0 2 2 400 nuloV gnisoqqO

## CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane, s:	1.9

# **Guidelines from NCHRP 457**

Grant Ave. intersection with Ada Hayden AM Peak Hour Volume (VPH) Year 2030 Full Build

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

### 2-lane roadway (English) INPUT

Variable	Value		
85 <sup>th</sup> percentile speed, mph:	20	008 <b>4/</b> L	
Percent of left-turns in advancing volume (V <sub>A</sub> ), %:	21%	100 ×	
Advancing volume $(V_A)$ , veh/h:	178	, <b>'(</b> °	
Opposing volume (V <sub>O</sub> ), veh/h:	127	β (Λ	
		200	
OUTPUT		<b>un</b> 400	
Variable	Value	)O/	
Limiting advancing volume $(V_A)$ , veh/h:	318	3 A 6	
Guidance for determining the need for a major-road left-turn bay:	ıy:	ui <b>s</b>	Lett-tu treatn

Left-turn treatment NOT warranted.

	200
warranted.	009
Left-turn tre	500 , veh/h
	400 I <b>me (V<sub>A</sub>)</b>
	200 300 400 500 Advancing Volume (V <sub>A</sub> ), veh/h
	200 <b>Advanc</b> i
Left-tum treatment not warranted.	100
	0
800 700 600 500 400 300 200 100	>
ηγον '(οV) əmuloV gnisoqq	0

## CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane, s:	1.9

# **Guidelines from NCHRP 457**

Grant Ave. intersection with Ada Hayden PM Peak Hour Volume (VPH) Year 2030 Full Build