Traffic Signal Warrant Analysis

For the Intersection of FM 455 and Westfield Drive City of Anna, Texas

Prepared for:
City of Anna
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INTRODUCTION

The City of Anna has requested that an analysis be conducted for the intersection of FM 455 and Westfield Drive to determine if signalization is warranted. This report summarizes the results of the traffic signal warrant analysis conducted for this intersection.

The analysis was performed using existing turning movement volumes collected over a 24-hour period on Tuesday, November 16, 2021, which are summarized in **Table 1** with the raw data presented in the Appendix.

The traffic signal warrant analysis presented in this report is based on the traffic signal warrants contained in Chapter 4C, "Traffic Control Signal Needs Studies," of the *2011 Texas Manual on Uniform Traffic Control Devices*. Nine warrants are included in the manual for warranting a traffic signal installation. These warrants are:

Warrant 1 – Eight-Hour Vehicular Volume;
Warrant 2 – Four-Hour Vehicular Volume;
Warrant 3 – Peak Hour;
Warrant 4 – Pedestrian Volume;
Warrant 5 – School Crossing;
Warrant 6 – Coordinated Signal System;
Warrant 7 – Crash Experience;
Warrant 8 – Roadway Network;
Warrant 9 – Intersection Near a Grade Crossing

The current 2020 population estimate for the City of Anna is 16,896 (*Source: https://www.census.gov/quickfacts/annacitytexas*).

FM 455 (White Street) is a four-lane divided eastbound-westbound roadway with a posted speed limit of 45 miles per hour (mph) and a wide median (approximately 42-feet wide). At the study intersection, FM 455 has a left-turn lane in each direction. Westfield Drive is the northbound approach to the intersection, and is a two-lane undivided roadway with a posted speed limit of 25 mph. Westfield Drive widens to include a raised median approximately 320 feet south of FM 455. The northbound approach is striped to include two approach lanes. Willow Creek Drive is the southbound approach to the intersection, and is two-lane divided roadway.

The intersection of these two streets is currently stop-controlled on the Westfield Drive/Willow Creek Drive approaches. Based on the traffic volumes at this intersection, FM 455 is considered the *Major Roadway* for this analysis with multi-lane approaches. Westfield Drive will be considered a *Minor Roadway* with multi-lane approaches. While the southbound approach is only 18-feet wide, it may operate as a multi-lane approach as the median nose is pulled back approximately 40 feet from FM 455.

A vicinity map of the intersection is provided in **Figure 1** and an aerial photograph of the intersection is provided in **Figure 2**.

Table 1: Volume Summary

Hour Begin	FM 455			Westfield Drive		Willow Creek Drive		Total Minor Volume	Pedestrians Crossing Major Roadway
	EB Volume	WB Volume	Total Volume	NB Volume		SB Volume			
				Thru/LT	RT	Thru/LT	RT		
0:00	38	12	50	1	0	0	1	2	0
1:00	12	11	23	0	0	1	0	1	0
2:00	13	15	28	0	0	0	0	0	0
3:00	21	23	44	1	1	0	4	6	0
4:00	30	68	98	5	0	1	7	13	0
5:00	95	138	233	22	1	4	20	47	0
6:00	310	317	627	21	14	22	21	78	0
7:00	583	657	1,240	60	20	27	38	145	0
8:00	464	616	1,080	37	17	21	36	111	2
9:00	411	461	872	27	3	10	14	54	0
10:00	425	466	891	30	9	16	16	71	0
11:00	523	566	1,089	26	14	10	24	74	0
12:00	630	541	1,171	37	15	9	17	78	0
13:00	591	474	1,065	37	12	7	15	71	11
14:00	589	532	1,121	36	10	14	24	84	0
15:00	747	656	1,403	40	24	10	14	88	0
16:00	871	764	1,635	43	20	13	19	95	0
17:00	945	860	1,805	49	30	15	32	126	4
18:00	869	587	1,456	41	27	17	27	112	0
19:00	590	359	949	19	7	4	15	45	0
20:00	388	229	617	12	12	6	8	38	0
21:00	237	151	388	16	3	4	2	25	0
22:00	161	91	252	7	2	3	2	14	0
23:00	91	40	131	4	1	0	2	7	0
TOTAL	**9,634**	**8,634**	**18,268**	**571**	**242**	**214**	**358**	**1,385**	**17**

It should be noted that the collected volumes do not appear to need adjustment due to the COVID-19 pandemic. Historical TxDOT volumes on FM 455 just east of the study intersection for the past five years is identified in **Table 2**.

Table 2: Historic Daily Traffic Volumes

Year	FM 455 East of Westfield Dr
2015	9,604
2016	9,519
2017	10,577
2018	12,681
2019	-
2020	15,638
Average Annual Growth Rate	**10%**

Source: https://txdot.public.ms2soft.com/tcds/tsearch.asp?loc=Txdot&mod=TCDS

As shown, an average annual growth rate of 10% occurred on FM 455 east of the study intersection over the past five years. If this growth rate were applied to the above 2020 volume in Table 2 to obtain estimated 2021 data, the AADT would be 17,240 vehicles. However, the 2021 collected data (Table 1) results in 17,529 vehicles in a day on FM 455 east of Westfield Drive, which is higher. Thus, the collected volumes were not adjusted.

Figure 1: Vicinity Map

Figure 2: FM 455 at Westfield Drive

The Texas *MUTCD* recommends consideration of the effects of right turn volumes on the minor street approach if the movement enters the major street with minimal conflict, primarily with the presence of a right turn lane. For the purposes of this study, no reduction was utilized at this location. However, results would be similar if right-turn volumes were removed and the minor street was considered a single-lane approach. **Table 3** summarizes the volume warrant results, as discussed in the next section.

Table 3: Volume for Analysis and Warrant Summary

Hour Begin	FM 455			Westfield Drive/ Willow Creek Dr		Max Volume	Meets Warrants?				
	EB Volume	WB Volume	Total Volume	NB Volume	SB Volume		1A	1B	1-Combo A	1-Combo B	2
0:00	38	12	50	1	1	1	0	0	0	0	0
1:00	12	11	23	0	1	1	0	0	0	0	0
2:00	13	15	28	0	0	0	0	0	0	0	0
3:00	21	23	44	2	4	4	0	0	0	0	0
4:00	30	68	98	5	8	8	0	0	0	0	0
5:00	95	138	233	23	24	24	0	0	0	0	0
6:00	310	317	627	35	43	43	0	0	0	0	0
7:00	583	657	1,240	80	65	80	0	1	0	1	1
8:00	464	616	1,080	54	57	57	0	0	0	1	0
9:00	411	461	872	30	24	30	0	0	0	0	0
10:00	425	466	891	39	32	39	0	0	0	0	0
11:00	523	566	1,089	40	34	40	0	0	0	0	0
12:00	630	541	1,171	52	26	52	0	0	0	0	0
13:00	591	474	1,065	49	22	49	0	0	0	0	0
14:00	589	532	1,121	46	38	46	0	0	0	0	0
15:00	747	656	1,403	64	24	64	0	0	0	1	0
16:00	871	764	1,635	63	32	63	0	0	0	1	0
17:00	945	860	1,805	79	47	79	0	1	0	1	0
18:00	869	587	1,456	68	44	68	0	0	0	1	0
19:00	590	359	949	26	19	26	0	0	0	0	0
20:00	388	229	617	24	14	24	0	0	0	0	0
21:00	237	151	388	19	6	19	0	0	0	0	0
22:00	161	91	252	9	5	9	0	0	0	0	0
23:00	91	40	131	5	2	5	0	0	0	0	0
TOTAL	**9,634**	**8,634**	**18,268**	**813**	**572**	**831**	**0**	**2**	**0**	**6**	**1**
									0		

TRAFFIC SIGNAL WARRANT ANALYSIS

Warrant 1 – Eight-Hour Vehicular Volume

Warrant 1 is based on the volumes from both approaches on the major street and the higher approach volume on the minor street. It also uses the number of lanes for moving traffic on each approach. Either Condition A or Condition B of this warrant must be met for Warrant 1 to be satisfied.

The *Texas MUTCD* allows for the use of a reduced warranting threshold (70%) for intersections where the posted or 85th-percentile speed exceeds 40 mph or if the intersection is located in a community with a population under 10,000. Since the posted speed limit on the major street (FM 455) is greater than 40 mph (45 mph), the reduced warranting threshold was used for this warrant.

Condition A of Warrant 1 is met when, for each of any eight hours of an average day, the warranting volumes exist on the major street and on the higher-volume minor street approach to the intersection during the same eight hours. The warranting threshold for an approach with two or more lanes on the major street and an approach with two or more lanes on the minor street is:

Major Street: 420 vph (total for both directions)
Minor Street: 140 vph (higher volume approach)

Warrant 1A threshold volumes are not exceeded for any hours of the day. Eight (8) hours are required for this warrant condition. Warrant 1A is not satisfied at this location.

Condition B of Warrant 1 applies to operating conditions where the major street traffic is so heavy that it creates excessive delay or hazardous conditions for minor street traffic when entering or crossing the major street. The warrant condition is met when, for each of any eight hours of an average day, the warranting volumes exist on the major street and on the higher-volume minor street approach to an intersection. The warranting threshold for an approach with two or more lanes on the major street and an approach with two or more lanes on the minor street is:

Major Street: 630 vph (total for both directions)
Minor Street: 70 vph (higher volume approach)

Warrant 1B threshold volumes are exceeded for two (2) hours of the day. Eight (8) hours are required for this warrant condition. Warrant 1B is not satisfied at this location.

A combination of Conditions A and B may be applied at locations where Conditions A and B are not satisfied. The same eight hours of the day are not required to be used for meeting both conditions. Under the combination warrant, the warranting thresholds are:

Major Street: 336 vph and 504 vph for Conditions A and B, respectively
(total for both directions)
Minor Street: 112 vph and 56 vph for Conditions A and B, respectively
(higher volume approach)

Combination threshold volumes are not exceeded for any hours of the day. Eight (8) hours are required for this warrant condition. The combination warrant is not satisfied at this location.

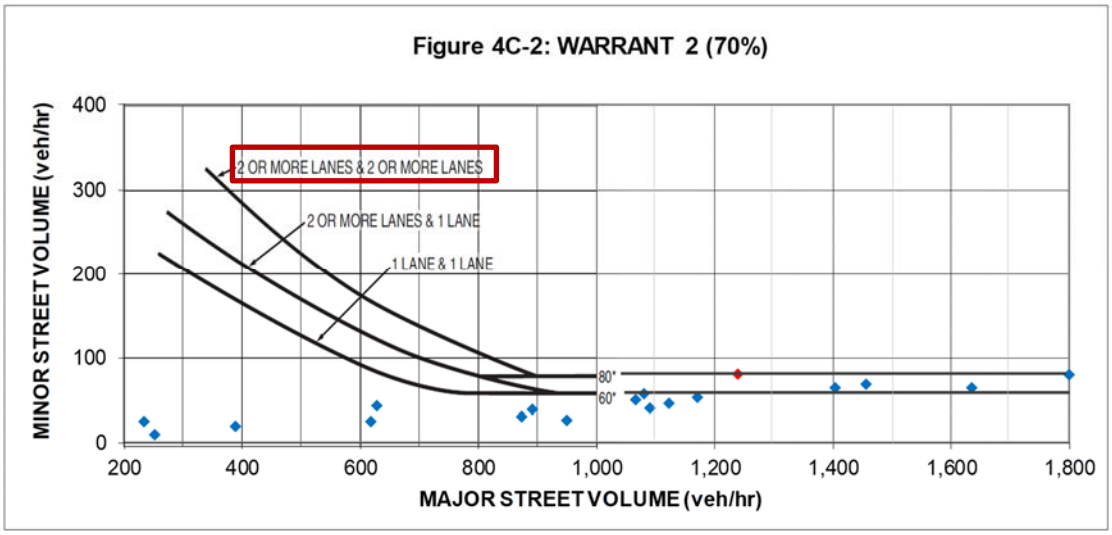
Based on these results and as shown in Table 2, **Warrant 1 is NOT MET for this intersection**.

Warrant 2 – Four-Hour Volumes

Warrant 2 is satisfied when the volumes for any four (4) hours of an average day, when plotted on Figure 4C-1 (or 4C-2 when applicable) of the *Texas MUTCD*, fall above the curve for the appropriate number of lanes. **Figure 3** shows the results of this analysis. Since the posted speed limit on the major street (FM 455) is greater than 40 mph (45 mph), the reduced warranting threshold was used for this warrant and Figure 4C-2 was used for this analysis.

Based on the traffic volumes presented in Table 2 and plotted in Figure 3, one (1) hour of the day falls above the curve for the appropriate number of lanes when plotted on Figure 4C-2 of the *Texas MUTCD* for this intersection. Four (4) hours are required for this warrant condition. Under these circumstances, **Warrant 2 is NOT MET for this intersection**.

Figure 3: Four-Hour Vehicular Volume Warrant (Warrant 2) – FM 455 and Westfield Drive



Warrant 3 – Peak Hour Volume

Warrant 3 is intended for application when traffic conditions are such that for at least one (1) hour of the day, the minor street traffic experiences undue delays entering or crossing the major street. Warrant 3 is satisfied when either of the following conditions is met:

1. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:
    a. The delay experienced by the traffic on the minor-street approach controlled by a STOP sign equals or exceeds 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach, and
    b. The volume on the same minor-street approach equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and
    c. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.
2. The plotted point 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) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 (or Figure 4C-4) for the existing combination of approach lanes.

As further specified in the *Texas MUTCD*:

> **"This signal warrant shall be applied only in unusual cases such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time."**

Traffic characteristics at this intersection do not fall under the unusual cases identified above. Therefore, **Warrant 3 is NOT APPLICABLE for this intersection and was not evaluated**.

Warrant 4 – Minimum Pedestrian Volume

Warrant 4 applies to conditions where the major street traffic is so heavy that pedestrians experience excessive delay in crossing the major street. It is intended for application at an intersection or midblock location and requires that one (1) of the following conditions be met:

1. 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 pedestrians per hour crossing the major street (total of all crossings) fall above the curve in Figure 4C-5 (or Figure 4C-6 for speeds greater than 35 mph); or
2. For one (1) hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) fall above the curve in Figure 4C-7 (or Figure 4C-8 for speeds greater than 35 mph).

This warrant applies only to those locations where the nearest traffic signal along the major street is greater than 300 feet away and where a new traffic signal at the study intersection would not unduly restrict platooned flow of traffic.

Based on the pedestrian volumes crossing FM 455, as shown in Table 1, relatively few pedestrians cross FM 455. The highest volume of pedestrians crossing the major roadway was 11 pedestrians between 1:00 and 2:00 PM. However, the threshold volumes (75 pedestrians during the 4th-highest hour or 93 pedestrians during the peak hour) are not met. **Warrant 4 was NOT MET at this intersection.**

Warrant 5 – School Crossing

This warrant applies at an established school crossing where a traffic engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at the school crossing shows that the number of adequate gaps in the traffic during the period when the children are using the crossing is less than the number of minutes in the same period.

Since this intersection is not an established school crossing, **Warrant 5 was NOT APPLICABLE.**

Warrant 6 – Coordinated Signal System

Progressive movement control sometimes requires traffic signal installations at intersections where they would not otherwise be warranted in order to maintain proper platooning of vehicles and effectively regulate group speed. This warrant is met when one (1) of the following requirements are met:

1. On a one-way street or a street which has predominantly unidirectional traffic, the adjacent signals are so far apart that they do not provide the required degree of platooning.
2. On a two-way street, adjacent signals do not provide the necessary degree of platooning and the proposed and adjacent signals could constitute a progressive signal system.

This warrant should not be applied where the ultimate signal spacing would be less than 1,000 feet. The nearest signalized intersections along FM 455 are located approximately 1,850 feet to the east (at SH 5) and approximately 2,950 feet to the west (at Ferguson Parkway). At this time, it is not clear whether a coordinated system is in place along FM 455. As a traffic signal at the intersection of FM 455 and Westfield Drive is not anticipated to be necessary for a progressive signal system, **Warrant 6 is NOT MET at this intersection.**

Warrant 7 – Crash Experience

The warrant is satisfied when:

1. Adequate trial of less restrictive remedies with satisfactory observance and enforcement has failed to reduce the crash frequency; and

2. Five or more reported crashes, of types susceptible to correction by traffic signal control, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and
3. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1, or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Lee Engineering obtained crash records from TxDOT's online Crash Records Information System (CRIS) for crashes that have occurred at the study intersections between 2017 and early 2021, as summarized below in **Table 3**. Additional data for each crash is included in the Appendix.

Based on this data, there were fourteen (14) reported crashes in the vicinity of this intersection between 2017 and 2021, with ten (10) of these crashes potentially susceptible to correction by traffic signal control. A maximum of six (6) crashes susceptible to correction by traffic signal control occurred within a 12-month period (August 2018 to July 2019).

However, vehicular volumes do meet the threshold volumes in the 56 percent columns in Table 4C-1 for Condition A or Condition B for eight hours of the day, as shown in Table 2. Based on the collected volumes, **Warrant 7 is NOT MET at this intersection.**

It should be noted that the vehicular volumes do meet the 56 percent threshold for Condition B for six hours of the day and are slightly below thresholds for two additional hours.

Table 4: Crash Data Summary – FM 455 at Oak Hollow Lane

Crash ID	Date	Vehicle Travel Directions	Crash Type	Contributing Factors	Potentially Correctable by Signal Control?
15947007	9/5/2017	South-East	Right Angle	Driver Inattention; Failed to Yield Right of Way - Stop Sign	YES
15986654	9/25/2017	North-East	Right Angle	Driver Inattention; Failed to Yield Right of Way - Open Intersection	YES
16178744	12/16/2017	East-East	Sideswipe	Vehicle Changing Lanes	No
16379162	4/27/2018	North-East	Right Angle	Failed to Yield Right of Way - Stop Sign	YES
16601181	8/28/2018	North-East	Right Angle	Driver Inattention; Failed to Yield Right of Way - Stop Sign	YES
16691028	10/19/2018	South-West	Right Angle	Driver Inattention; Failed to Yield Right of Way - Stop Sign	YES
16723901	10/27/2018	South-North	Left Turn	Driver Inattention; Failed to Yield Right of Way - Turning Left	YES
16938896	3/8/2019	North-West	Right Angle	None	YES
17049977	5/5/2019	North-West-West	Right Angle	Failed to Yield Right of Way - Open Intersection	YES
17201067	7/27/2019	West-East	Left Turn	Failed to Yield Right of Way - Turning Left	YES
17221607	8/7/2019	East-East	Non Intersection	Changed Lane When Unsafe; Driver Inattention; Failed to Control Speed; Failed to Yield Right of Way - Turning Left	No
17412619	11/18/2019	West-East-North	Left Turn	Failed to Yield Right of Way - Open Intersection	YES
18006980	12/8/2020	East-N/A	Fixed Object	Faulty Evasive Action	No
18266788	5/12/2021	East-North	Right Angle	Wrong Side - Approach or Intersection; Vehicle Leaving Driveway	No

Warrant 8 – Roadway Network

The systems warrant is intended to encourage concentration and organization of traffic flow networks. This warrant is applicable when the common intersection of two major routes:

1. Has a total existing, or immediately projected, entering volume of at least 1,000 vehicles during the peak hour of a typical weekday and has five-year projected traffic volumes, based on an engineering study, which meet one or more of Warrants 1, 2, and 3 during an average weekday; or
2. Has a total existing or immediately projected entering volume of at least 1,000 vehicles for each of any five hours of a Saturday and/or Sunday.

A major route as used in this signal warrant shall have one or more of the following characteristics:

1. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or

2. It includes rural or suburban highways outside, entering or traversing a City; or
3. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study; or
4. It connects areas of principal traffic generation; or
5. It has street freeway or expressway ramp terminals.

In the City of Anna *2045 Master Thoroughfare Plan*, FM 455 is classified as a Major Arterial (120' ROW). However, Westfield Drive is considered a local roadway in the thoroughfare plan and cannot be considered a major route. Therefore, **Warrant 8 is NOT MET at this intersection.**

Warrant 9 – Intersection Near a Grade Crossing

This signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:

1. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and
2. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13 of the Texas MUTCD.

A railroad grade crossing is not located within 140 feet of this intersection. **Warrant 9 is NOT APPLICABLE for this intersection**.

INTERSECTION SIGHT DISTANCE

As part of this study, sight distance on the minor street (Westfield Drive) approaches to the intersection was assessed. On the stop-controlled approaches, the motorist should be able to see if and when adequate gaps exist to perform their desired maneuver.

The sight distance required for the stop-controlled approaches was estimated using the procedures developed by the American Association of State Highway and Transportation Officials (AASHTO) and published in the 2018 edition of *A Policy on Geometric Design of Highways and Streets.* **Table 5** presents the required and available sight distance for vehicles turning onto FM 455 at Westfield Drive.

Table 5: Sight Distance Evaluation

Major Roadway	FM 455	
Posted Speed Limit	45 mph	
Minor Roadway	Westfield Drive	Willow Creek Drive
Approach	Northbound	Southbound
Required Intersection Sight Distance	650’	
Available Sight Distance to the Left	700 feet	1,000 feet
Available Sight Distance to the Right	1,000 feet	750 feet
Sight Distance Available > Required		
To the Left	Yes	Yes
To the Right	Yes	Yes

As shown in Table 5 and based on a comparison of the field investigation results of the available sight distance to the required sight distance, adequate sight distance is available for both Westfield Drive and Willow Creek Drive at FM 455.

In addition, the stopping sight distance for vehicles on FM 455 was assessed. Motorists traveling along the major road should have adequate time to react and bring their vehicle to a stop after they see a vehicle enter the roadway from the minor street. The required stopping sight distance for a design speed of 45 mph is 360 feet, based on the 2018 edition of *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO). **Table 6** presents the available stopping sight distance for motorists on FM 455.

Table 6: Stopping Sight Distance Evaluation

Major Roadway	FM 455	
Posted Speed Limit	45 mph	
Minor Roadway	Westfield Drive	
Approach	Eastbound	Westbound
Required Stopping Sight Distance	350 feet	
Available Stopping Sight Distance	>700 feet	>700 feet
Sight Distance Available > Required	Yes	Yes

As shown in Table 6 and based on the field investigation results, available stopping sight distance is greater than the minimum required for the posted speed of 45 mph. Thus, a vehicle traveling on FM 455 at the posted speed should be able to stop if a vehicle enters the roadway from Westfield Drive or Willow Creek Drive, assuming typical perception-reaction time and deceleration.

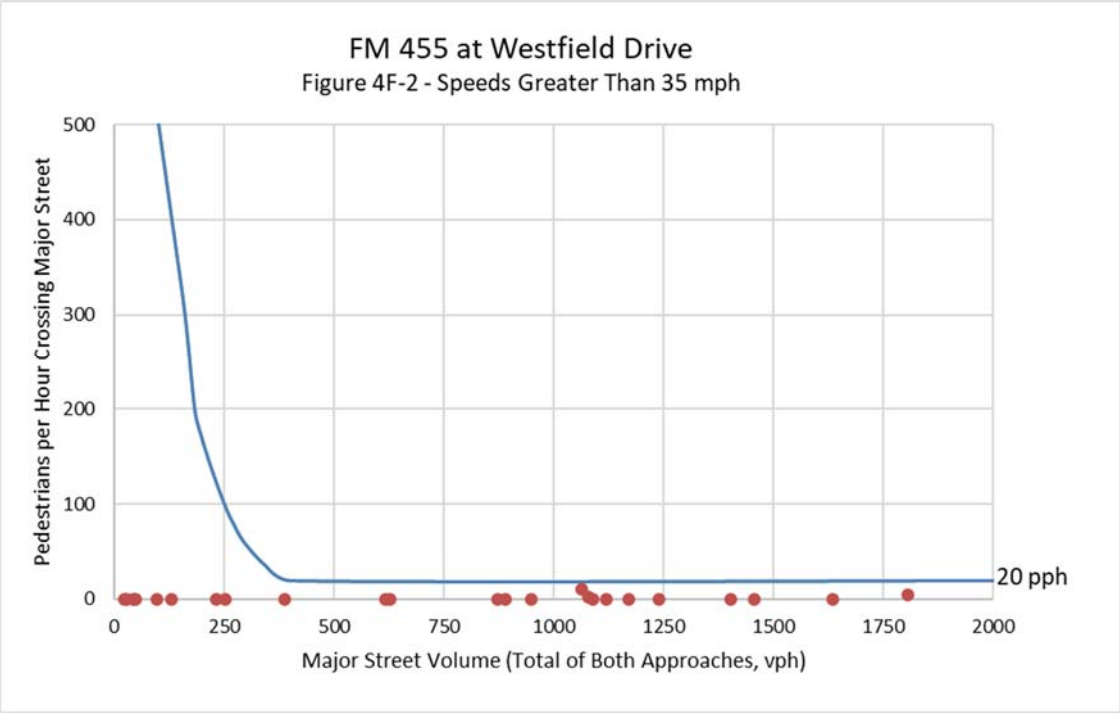
PEDESTRIAN HYBRID BEACON ANALYSIS

Warrants for installation of a pedestrian hybrid beacon were also evaluated, as a maximum of 11 pedestrians were observed to cross FM 455 in an hour. Crossing distance across FM 455 is approximately 100 feet ramp to ramp, although pedestrians may stop in the median. Note that there is currently no marked crosswalk at the intersection, but there are ramps in each corner. Sidewalk exists along both sides of FM 455 but not along either minor roadway near the intersection.

A pedestrian hybrid beacon is used to warn and control vehicular traffic at an unsignalized location to assist pedestrians crossing the roadway at a marked crosswalk. A pedestrian hybrid beacon may be considered at marked crosswalk locations that do not meet traffic signal warrants or where a decision is made to not install a traffic signal. The need for a pedestrian hybrid beacon should be considered when the point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street, when plotted on Figure 4F-1 (or 4F-2 when applicable) of the *Texas MUTCD*, falls above the curve for the appropriate length of crosswalk. Based on the posted speed limit on FM 455 (45 mph), the reduced warrant threshold was used for this warrant and Figure 4F-2 was used for this analysis. **Figure 4** shows the results of this analysis.

Based on the traffic volumes presented in Table 1 and plotted in Figure 4, no hours of the day fall above the curve for the appropriate crosswalk length when plotted on Figure 4F-2 of the *Texas MUTCD* for this intersection. Under these circumstances, **installation of a pedestrian hybrid beacon is not recommended at this time.**

Figure 4: Pedestrian Hybrid Beacon Analysis



ALTERNATIVE CROSSING ANALYSIS

FHWA Pedestrian Safety Worksheet

The Texas Transportation Institute developed guidelines for pedestrian treatments at unsignalized intersections and midblock locations for the National Cooperative Highway Research Program as part of NCHRP Report 562. Lee Engineering also utilized these guidelines in reviewing the study intersection.

The NCHRP guidelines present recommended levels of crossing treatments based on pedestrian crossing distance, pedestrian volume, vehicle speeds, and vehicle volumes. The recommended levels of crossing treatments resulting from the NCHRP analysis from least to most intensive are the following:

- Crosswalk: standard crosswalk markings and signs.
- Enhanced: enhanced crosswalk markings and signage.
- Active: devices designed to display a warning only when pedestrians are present.
- Red Beacon: devices that display a circular red indication to motorists at the pedestrian location such as a pedestrian hybrid beacon.
- Signal: full traffic signal.

Table 6 presents the volumes during the peak hour of the pedestrian activity at the study intersection and the peak hour of vehicular volumes on FM 455.

Table 7: Pedestrian and Vehicular Volumes

Time Period	Pedestrians Crossing FM 455 (ped/hr)	Vehicles on FM 455 (veh/hr)		
		EB	WB	Total
1:00 – 2:00 PM	11	591	474	1,065
5:00 – 6:00 PM	4	945	860	1,805

It should be noted that for the high-speed condition (35 mph or higher), methodology provided in NCHRP Report 562 requires a minimum of 14 pedestrians per hour for a crossing treatment to be considered as an alternative. Additionally, a minimum of 20 pedestrians per hour is required for consideration of a crosswalk as an alternative. However, a crosswalk alone is not identified as a possible alternative in the methodology based on the speed limit on FM 455.

As the maximum number of pedestrians crossing in an hour is currently eleven (between 1:00 PM and 2:00 PM), one of the above five crossing treatments is not currently recommended at the study intersection. Recommended treatment options include installation of a raised median island, curb extensions, or other traffic calming measures. The NCHRP worksheet results for each time period are included in the Appendix.

If the number of pedestrians crossing in an hour increased by three to 14 pedestrians in an hour, active or enhanced treatment would be recommended.

FHWA/TTI Pedestrian Crossing Guidelines for Texas

In December 2000, FHWA and Texas Transportation Institute (TTI) published a report entitled "*Pedestrian Crossing Guidelines for Texas*". The purpose of the publication was to recommend guidance and criteria on the provision of safe and effective pedestrian crossing. These guidelines are not intended to provide a specific pedestrian crossing treatment exclusive of conditions nor to recommend specific design dimensions. It should be noted that the study recommends a minimum volume of 20 pedestrians crossings per hour (or 15 pedestrians per hour for elderly and/or children) for installation of a crosswalk.

Table 7 below shows a table from the publication that recommends pedestrian improvements at uncontrolled locations.

Table 8: Pedestrian Treatment at Uncontrolled Location

Roadway Type	Vehicle ADT: ≤ 9,000			Vehicle ADT: 9,000 to 12,000			Vehicle ADT: 12,000 to 15,000			Vehicle ADT: > 15,000		
	Speed Limit**											
	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph
2-lane	C	C	P	C	C	P	C	C	N	C	P	N
3-lane	C	C	P	C	P	P	P	P	N	P	N	N
Multi-lane (4 or more lanes) with raised median	C	C	P	C	P	N	P	P	N	N	N	N
Multi-lane (4 or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

C = Candidate for marked crosswalks
P = Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancement
N = Marked crosswalks are not recommended, since pedestrian crash risk may be increased with marked crosswalks. Consider using other treatments, such as traffic signals with pedestrian signals to improve crossing safety for pedestrians.

Based on the existing lane configuration, count data collected and the speed limit FM 455 falls under the category of:

- Roadway type = multi-lane with raised median
- Vehicle ADT > 15,000
- Speed = >40 mph

With these characteristics and criteria provided in Table 7, installation of an uncontrolled marked crosswalk is not recommended on FM 455.

CONCLUSION

Based on the existing traffic volumes and this traffic signal warrant analysis, traffic signal warrants are not satisfied for the intersection of FM 455 and Westfield Drive. A summary of the traffic signal warrants is provided in **Table 9**.

Table 9: Warrant Summary – FM 455 and Westfield Drive

Warrant	Warrant Met?	Notes
1 – Eight-Hour Vehicular Volume	NO	Condition A – 0 hours met (8 required)
		Condition B – 2 hours met (8 required)
		Combination – 0 hours met (8 required)
2 – Four-Hour Vehicular Volume	NO	1 hour met (4 required)
3 – Peak Hour	N/A	Not a "special generator"
4 – Pedestrian Volume	NO	0 hours met for 4-hour and peak hour
5 – School Crossing	N/A	Not an established school crossing
6 – Coordinated Signal System	NO	Not needed for progressive signal system
7 – Crash Experience	NO	Crash history exceeds warrants; however, volume requirements are NOT met
8 – Roadway Network	NO	Not an intersection of two major routes
9 – Near a Grade Crossing	N/A	Not adjacent to a grade crossing

Based on the results of this traffic signal warrant analysis, the installation of a traffic signal is not recommended at this intersection at this time.

As shown above, crash history meets Warrant 7, but traffic volumes do not yet meet the Warrant 7 thresholds.

It is recommended to monitor traffic volumes and pedestrian activity at this intersection, particularly if the northeast corner or adjacent parcels south of FM 455 develop, and reevaluate signal warrants as needed. If pedestrian activity increases, the City should consider installing an enhanced crossing with a median refuge on FM 455.

If you have any comments or questions regarding this study, please feel free to contact us at your convenience.

APPENDIX

DRAFT - RELEASED FOR REVIEW PURPOSES ONLY (12-21-2021)
KRISTEN NOVAK, P.E. (131727), LEE ENGINEERING (F-450)

GRAM Traffic NTX Inc.

1120 W. Lovers Lane

Arlington, Texas, United States 76013
817.265.8968

Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021
Page No: 1

Turning Movement Data

Start Time	WESTFIELD DR Southbound						FM 455 Westbound						WESTFIELD DR Northbound						FM 455 Eastbound						Int. Total
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	
12:00 AM	0	0	0	0	0	0	0	4	0	0	0	4	1	0	0	0	0	1	1	10	1	0	0	12	17
12:15 AM	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	8	1	0	0	9	13
12:30 AM	0	0	1	0	0	1	0	3	0	1	0	4	0	0	0	0	0	0	0	7	1	0	0	8	13
12:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	9	9
Hourly Total	0	0	1	0	0	1	0	11	0	1	0	12	1	0	0	0	0	1	1	34	3	0	0	38	52
1:00 AM	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
1:15 AM	0	0	0	0	0	0	0	5	0	0	0	5	0	0	0	0	0	0	1	4	0	0	0	5	10
1:30 AM	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	6	7
1:45 AM	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	3
Hourly Total	1	0	0	0	0	1	0	11	0	0	0	11	0	0	0	0	0	0	1	11	0	0	0	12	24
2:00 AM	0	0	0	0	0	0	0	2	1	0	0	3	0	0	0	0	0	0	0	4	0	0	0	4	7
2:15 AM	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	4	6
2:30 AM	0	0	0	0	0	0	0	6	0	0	0	6	0	0	0	0	0	0	0	3	0	0	0	3	9
2:45 AM	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	1	0	1	0	2	6
Hourly Total	0	0	0	0	0	0	0	14	1	0	0	15	0	0	0	0	0	0	0	12	0	1	0	13	28
3:00 AM	0	0	0	0	0	0	0	5	0	0	0	5	1	0	1	0	0	2	0	1	0	0	0	1	8
3:15 AM	0	0	1	0	0	1	0	2	0	0	0	2	0	0	0	0	0	0	0	9	0	0	0	9	12
3:30 AM	0	0	2	0	0	2	0	10	0	0	0	10	0	0	0	0	0	0	0	4	2	0	0	6	18
3:45 AM	0	0	1	0	0	1	0	6	0	0	0	6	0	0	0	0	0	0	0	5	0	0	0	5	12
Hourly Total	0	0	4	0	0	4	0	23	0	0	0	23	1	0	1	0	0	2	0	19	2	0	0	21	50
4:00 AM	0	0	1	0	0	1	0	7	0	0	0	7	1	0	0	0	0	1	0	5	0	0	0	5	14
4:15 AM	1	0	1	0	0	2	0	14	0	0	0	14	1	0	0	0	0	1	1	7	2	0	0	10	27
4:30 AM	0	0	3	0	0	3	0	15	0	0	0	15	1	0	0	0	0	1	3	2	1	0	0	6	25
4:45 AM	0	0	2	0	0	2	0	32	0	0	0	32	2	0	0	0	0	2	1	8	0	0	0	9	45
Hourly Total	1	0	7	0	0	8	0	68	0	0	0	68	5	0	0	0	0	5	5	22	3	0	0	30	111
5:00 AM	0	0	1	0	0	1	1	31	0	0	0	32	3	0	0	0	0	3	2	8	0	0	0	10	46
5:15 AM	2	0	5	0	0	7	0	27	0	0	0	27	2	0	0	0	0	2	1	16	0	0	0	17	53
5:30 AM	0	0	7	0	0	7	0	25	1	0	0	26	6	0	1	0	0	7	0	20	0	0	0	20	60
5:45 AM	2	0	7	0	0	9	0	52	1	0	0	53	11	0	0	0	0	11	1	47	0	0	0	48	121
Hourly Total	4	0	20	0	0	24	1	135	2	0	0	138	22	0	1	0	0	23	4	91	0	0	0	95	280
6:00 AM	1	0	4	0	0	5	0	55	1	0	0	56	3	0	2	0	0	5	0	33	1	1	0	35	101
6:15 AM	3	0	6	0	0	9	0	60	2	0	0	62	3	0	0	0	0	3	3	54	1	2	0	60	134
6:30 AM	6	1	4	0	0	11	0	85	1	0	0	86	5	0	4	0	0	9	6	86	3	3	0	98	204
6:45 AM	11	0	7	0	0	18	2	109	2	0	0	113	10	0	8	0	0	18	6	110	0	1	0	117	266
Hourly Total	21	1	21	0	0	43	2	309	6	0	0	317	21	0	14	0	0	35	15	283	5	7	0	310	705
7:00 AM	10	0	13	0	0	23	3	107	3	1	0	114	22	0	5	0	0	27	7	120	5	1	0	133	297
7:15 AM	5	0	2	0	0	7	1	176	6	2	0	185	14	0	6	0	0	20	5	114	8	2	0	129	341
7:30 AM	6	0	14	0	0	20	2	166	4	2	0	174	13	0	4	0	0	17	7	126	7	3	0	143	354
7:45 AM	6	0	9	0	0	15	5	173	6	0	0	184	11	0	5	0	0	16	12	155	8	3	0	178	393
Hourly Total	27	0	38	0	0	65	11	622	19	5	0	657	60	0	20	0	0	80	31	515	28	9	0	583	1385
8:00 AM	10	0	11	0	0	21	4	171	3	1	2	179	7	2	8	0	0	17	6	135	5	3	0	149	366
8:15 AM	2	1	10	0	0	13	6	165	10	0	0	181	12	0	2	0	0	14	2	109	3	4	0	118	326
8:30 AM	4	0	8	0	0	12	1	119	5	2	0	127	7	0	5	0	0	12	1	92	2	1	0	96	247
8:45 AM	4	0	7	0	0	11	2	123	3	1	0	129	9	0	2	0	0	11	6	90	3	2	0	101	252
Hourly Total	20	1	36	0	0	57	13	578	21	4	2	616	35	2	17	0	0	54	15	426	13	10	0	464	1191
9:00 AM	3	1	6	0	0	10	4	117	2	2	0	125	6	0	1	0	0	7	11	79	3	3	0	96	238
9:15 AM	1	0	5	0	0	6	3	100	2	1	0	106	10	0	0	0	0	10	2	87	4	4	0	97	219
9:30 AM	3	0	2	0	0	5	3	103	2	3	0	111	5	1	0	0	0	6	2	95	4	1	0	102	224
9:45 AM	2	0	1	0	0	3	6	109	2	2	0	119	4	1	2	0	0	7	3	109	2	2	0	116	245
Hourly Total	9	1	14	0	0	24	16	429	8	8	0	461	25	2	3	0	0	30	18	370	13	10	0	411	926
10:00 AM	2	1	4	0	0	7	2	106	1	0	0	109	8	0	2	0	0	10	2	98	4	2	0	106	232
10:15 AM	5	0	4	0	0	9	5	106	2	0	0	113	8	1	2	0	0	11	6	83	9	5	0	103	236
10:30 AM	6	0	4	0	0	10	7	111	2	0	0	120	1	1	1	0	0	3	5	87	8	3	0	103	236
10:45 AM	2	0	4	0	0	6	4	117	1	2	0	124	11	0	4	0	0	15	5	100	4	4	0	113	258
Hourly Total	15	1	16	0	0	32	18	440	6	2	0	466	28	2	9	0	0	39	18	368	25	14	0	425	962
11:00 AM	1	0	7	0	0	8	4	133	1	1	0	139	3	0	2	0	0	5	15	91	7	6	0	119	271
11:15 AM	2	0	6	0	0	8	4	116	3	2	0	125	9	0	5	0	1	14	1	106	7	5	0	119	266
11:30 AM	3	0	8	0	0	11	1	146	1	1	0	149	8	0	2	0	0	10	6	114	4	4	0	128	298
11:45 AM	4	0	3	0	0	7	7	137	5	4	0	153	6	0	5	0	0	11	9	138	4	6	0	157	328
Hourly Total	10	0	24	0	0	34	16	532	10	8	0	566	26	0	14	0	1	40	31	449	22	21	0	523	1163
12:00 PM	5	0	4	0	0	9	3	139	3	2	0	147	11	0	7	0	1	18	10	152	9	10	0	181	355
12:15 PM	3	0	4	0	0	7	4	148	3	2	0	157	7	0	1	0	0	8	3	137	3	3	0	146	318

DRAFT - RELEASED FOR REVIEW PURPOSES ONLY (12-21-2021)
KRISTEN NOVAK, P.E. (131727), LEE ENGINEERING (F-450)

12:30 PM	1	0	4	0	0	5	8	98	4	0	0	110	14	0	4	0	0	18	4	144	4	1	0	153	286
12:45 PM	0	0	5	0	0	5	6	117	1	3	0	127	5	0	3	0	0	8	5	131	5	9	0	150	290
Hourly Total	9	0	17	0	0	26	21	502	11	7	0	541	37	0	15	0	1	52	22	564	21	23	0	630	1249
1:00 PM	2	0	2	0	0	4	2	100	2	1	0	105	6	1	2	0	0	9	5	135	9	2	0	151	269
1:15 PM	0	1	9	0	0	10	3	120	6	3	0	132	9	1	2	0	0	12	4	145	8	4	3	161	315
1:30 PM	3	0	2	0	3	5	4	118	0	3	7	125	10	3	4	0	0	17	4	131	3	3	0	141	288
1:45 PM	1	0	2	0	0	3	4	106	1	1	1	112	7	0	4	0	0	11	3	122	7	6	0	138	264
Hourly Total	6	1	15	0	3	22	13	444	9	8	8	474	32	5	12	0	0	49	16	533	27	15	3	591	1136
2:00 PM	6	1	6	0	0	13	9	107	2	1	0	119	4	0	4	0	0	8	6	130	6	1	0	143	283
2:15 PM	1	0	2	0	0	3	2	128	2	2	0	134	7	0	3	0	1	10	7	100	5	5	0	117	264
2:30 PM	0	0	12	0	0	12	4	135	1	1	0	141	11	0	1	0	0	12	9	153	12	4	0	178	343
2:45 PM	6	0	4	0	0	10	5	130	1	2	0	138	14	0	2	0	0	16	5	134	7	5	0	151	315
Hourly Total	13	1	24	0	0	38	20	500	6	6	0	532	36	0	10	0	1	46	27	517	30	15	0	589	1205
3:00 PM	0	0	4	0	0	4	7	119	5	3	0	134	5	0	3	0	0	8	11	133	19	5	0	168	314
3:15 PM	1	0	3	0	0	4	8	137	7	3	0	155	13	0	6	0	3	19	4	163	18	7	0	192	370
3:30 PM	4	0	6	0	0	10	12	182	3	3	0	200	11	1	6	0	0	18	5	166	11	7	0	189	417
3:45 PM	5	0	1	0	0	6	12	147	5	3	0	167	10	0	9	0	1	19	5	176	14	3	0	198	390
Hourly Total	10	0	14	0	0	24	39	585	20	12	0	656	39	1	24	0	4	64	25	638	62	22	0	747	1491
4:00 PM	1	0	2	0	0	3	8	141	5	1	0	155	13	0	7	0	1	20	4	170	10	4	0	188	366
4:15 PM	4	0	6	0	0	10	11	209	5	0	0	225	8	0	2	0	0	10	5	198	20	7	0	230	475
4:30 PM	4	1	3	0	0	8	9	160	6	1	0	176	7	0	6	0	1	13	14	189	6	5	0	214	411
4:45 PM	3	0	8	0	0	11	12	185	7	4	0	208	14	1	5	0	0	20	11	211	13	4	0	239	478
Hourly Total	12	1	19	0	0	32	40	695	23	6	0	764	42	1	20	0	2	63	34	768	49	20	0	871	1730
5:00 PM	1	0	12	0	0	13	6	205	6	2	0	219	7	2	7	0	0	16	9	205	14	5	3	233	481
5:15 PM	4	0	6	0	0	10	17	193	4	4	0	218	10	2	8	0	0	20	22	207	14	6	0	249	497
5:30 PM	0	1	6	0	1	7	12	179	8	2	1	201	12	0	8	0	0	20	9	211	13	9	0	242	470
5:45 PM	9	0	8	0	0	17	17	196	3	6	0	222	16	0	7	0	0	23	13	178	24	6	0	221	483
Hourly Total	14	1	32	0	1	47	52	773	21	14	1	860	45	4	30	0	0	79	53	801	65	26	3	945	1931
6:00 PM	3	0	8	0	0	11	8	143	7	2	0	160	9	0	7	0	0	16	9	221	19	9	0	258	445
6:15 PM	6	1	10	0	0	17	4	122	5	0	0	131	11	0	6	0	0	17	10	200	18	7	0	235	400
6:30 PM	4	1	4	0	0	9	6	139	7	2	0	154	8	1	5	0	0	14	8	176	12	3	0	199	376
6:45 PM	2	0	5	0	1	7	11	125	3	3	0	142	12	0	9	0	0	21	9	147	19	2	0	177	347
Hourly Total	15	2	27	0	1	44	29	529	22	7	0	587	40	1	27	0	0	68	36	744	68	21	0	869	1568
7:00 PM	2	0	4	0	0	6	8	95	2	1	0	106	5	0	2	0	0	7	8	137	9	1	0	155	274
7:15 PM	1	0	4	0	0	5	8	79	3	0	0	90	3	0	3	0	0	6	7	139	10	2	0	158	259
7:30 PM	0	0	5	0	0	5	2	66	2	3	0	73	3	0	0	0	0	3	10	134	5	2	0	151	232
7:45 PM	1	0	2	0	0	3	7	81	1	1	0	90	8	0	2	0	0	10	13	104	7	2	0	126	229
Hourly Total	4	0	15	0	0	19	25	321	8	5	0	359	19	0	7	0	0	26	38	514	31	7	0	590	994
8:00 PM	1	0	3	0	0	4	1	75	2	3	0	81	3	0	5	0	0	8	6	113	8	3	0	130	223
8:15 PM	3	0	3	0	0	6	3	52	0	0	0	55	3	1	5	0	0	9	4	89	5	2	0	100	170
8:30 PM	0	0	1	0	0	1	2	49	0	1	0	52	4	1	2	0	0	7	4	76	3	0	0	83	143
8:45 PM	2	0	1	0	0	3	1	37	3	0	0	41	0	0	0	0	0	0	3	68	4	0	0	75	119
Hourly Total	6	0	8	0	0	14	7	213	5	4	0	229	10	2	12	0	0	24	17	346	20	5	0	388	655
9:00 PM	2	0	0	0	0	2	3	44	0	2	0	49	4	1	0	0	0	5	1	64	5	0	0	70	126
9:15 PM	1	0	0	0	0	1	2	25	0	0	0	27	3	1	2	0	0	6	2	52	7	0	0	61	95
9:30 PM	1	0	1	0	0	2	2	34	2	1	0	39	3	0	1	0	0	4	5	45	4	1	0	55	100
9:45 PM	0	0	1	0	0	1	3	32	1	0	0	36	4	0	0	0	1	4	2	48	0	1	0	51	92
Hourly Total	4	0	2	0	0	6	10	135	3	3	0	151	14	2	3	0	1	19	10	209	16	2	0	237	413
10:00 PM	0	0	0	0	1	0	1	29	0	0	0	30	2	0	1	0	0	3	3	41	3	0	0	47	80
10:15 PM	1	0	0	0	0	1	0	26	1	0	0	27	1	0	0	0	0	1	0	41	3	0	0	44	73
10:30 PM	1	0	1	0	0	2	1	15	1	0	0	17	1	0	1	0	0	2	1	38	3	0	0	42	63
10:45 PM	1	0	1	0	0	2	1	16	0	0	0	17	3	0	0	0	0	3	0	25	3	0	0	28	50
Hourly Total	3	0	2	0	1	5	3	86	2	0	0	91	7	0	2	0	0	9	4	145	12	0	0	161	266
11:00 PM	0	0	0	0	0	0	0	13	0	0	0	13	2	0	0	0	0	2	5	29	3	1	0	38	53
11:15 PM	0	0	2	0	0	2	1	6	0	0	0	7	0	0	0	0	0	0	3	18	0	0	0	21	30
11:30 PM	0	0	0	0	0	0	2	12	0	0	0	14	1	0	1	0	0	2	3	12	3	0	0	18	34
11:45 PM	0	0	0	0	0	0	1	5	0	0	0	6	1	0	0	0	0	1	0	11	3	0	0	14	21
Hourly Total	0	0	2	0	0	2	4	36	0	0	0	40	4	0	1	0	0	5	11	70	9	1	0	91	138
Grand Total	204	10	358	0	6	572	340	7991	203	100	11	8634	549	22	242	0	10	813	432	8449	524	229	6	9634	19653
Approach %	35.7	1.7	62.6	0.0	-	-	3.9	92.6	2.4	1.2	-	-	67.5	2.7	29.8	0.0	-	-	4.5	87.7	5.4	2.4	-	-	-
Total %	1.0	0.1	1.8	0.0	-	2.9	1.7	40.7	1.0	0.5	-	43.9	2.8	0.1	1.2	0.0	-	4.1	2.2	43.0	2.7	1.2	-	49.0	-
Lights	201	10	349	0	-	560	336	7834	195	98	-	8463	545	21	233	0	-	799	427	8335	512	226	-	9500	19322
% Lights	98.5	100.0	97.5	-	-	97.9	98.8	98.0	96.1	98.0	-	98.0	99.3	95.5	96.3	-	-	98.3	98.8	98.7	97.7	98.7	-	98.6	98.3
Mediums	3	0	9	0	-	12	4	123	8	2	-	137	3	1	9	0	-	13	5	77	12	3	-	97	259
% Mediums	1.5	0.0	2.5	-	-	2.1	1.2	1.5	3.9	2.0	-	1.6	0.5	4.5	3.7	-	-	1.6	1.2	0.9	2.3	1.3	-	1.0	1.3
Articulated Trucks	0	0	0	0	-	0	0	34	0	0	-	34	1	0	0	0	-	1	0	37	0	0	-	37	72
% Articulated Trucks	0.0	0.0	0.0	-	-	0.0	0.0	0.4	0.0	0.0	-	0.4	0.2	0.0	0.0	-	-	0.1	0.0	0.4	0.0	0.0	-	0.4	0.4
Bicycles on Crosswalk	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	16.7	-	-	-	-	-	18.2	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	5	-	-	-	-	-	9	-	-	-	-	-	10	-	-	-	-	-	6	-	-
% Pedestrians	-	-	-	-	83.3	-	-	-	-	-	81.8	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

GRAM Traffic NTX Inc.
1120 W. Lovers Lane

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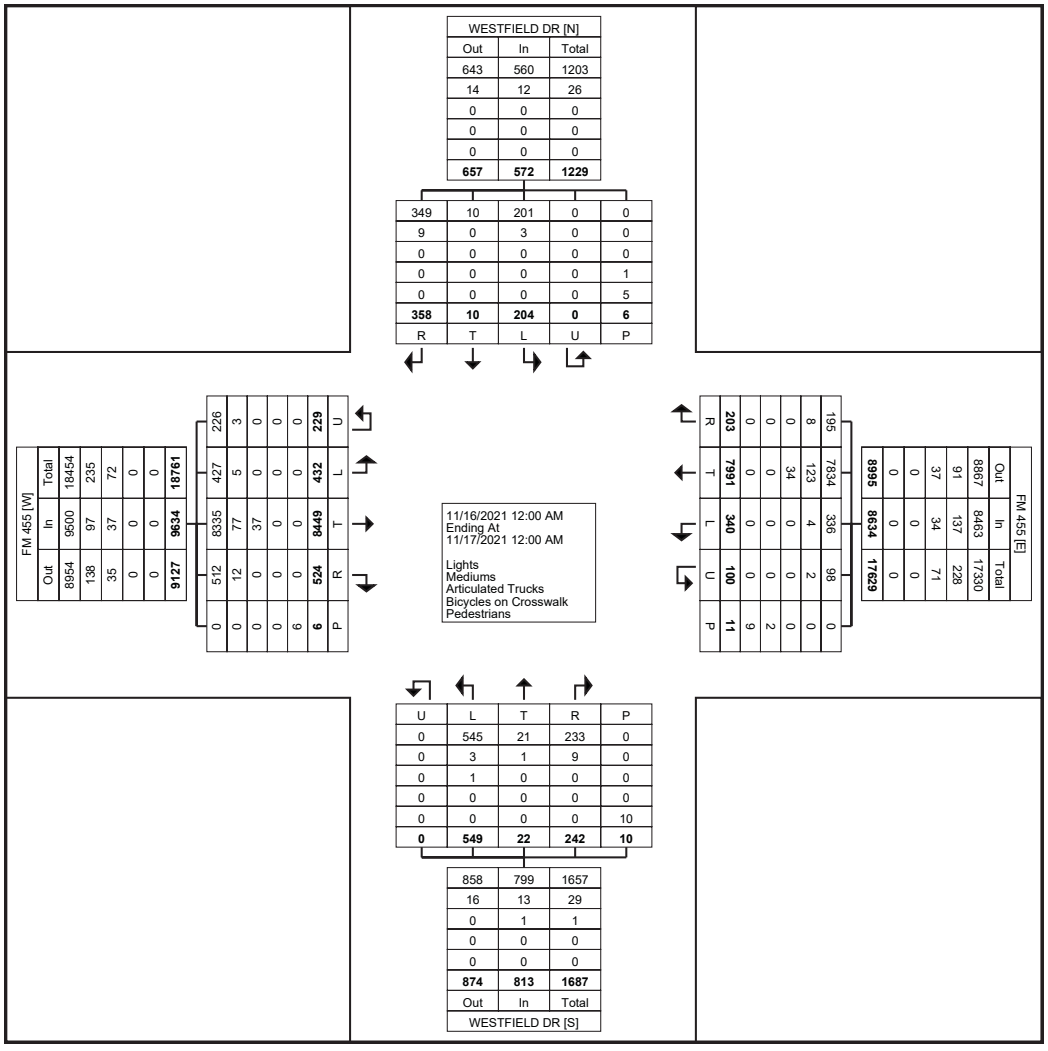
Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021
Page No: 3



Turning Movement Data Plot

GRAM Traffic NTX Inc.
1120 W. Lovers Lane

Arlington, Texas, United States 76013
817.265.8968

Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021

Turning Movement Peak Hour Data (7:15 AM)

Start Time	WESTFIELD DR Southbound						FM 455 Westbound						WESTFIELD DR Northbound						FM 455 Eastbound						Int. Total
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	
7:15 AM	5	0	2	0	0	7	1	176	6	2	0	185	14	0	6	0	0	20	5	114	8	2	0	129	341
7:30 AM	6	0	14	0	0	20	2	166	4	2	0	174	13	0	4	0	0	17	7	126	7	3	0	143	354
7:45 AM	6	0	9	0	0	15	5	173	6	0	0	184	11	0	5	0	0	16	12	155	8	3	0	178	393
8:00 AM	10	0	11	0	0	21	4	171	3	1	2	179	7	2	8	0	0	17	6	135	5	3	0	149	366
Total	27	0	36	0	0	63	12	686	19	5	2	722	45	2	23	0	0	70	30	530	28	11	0	599	1454
Approach %	42.9	0.0	57.1	0.0	-	-	1.7	95.0	2.6	0.7	-	-	64.3	2.9	32.9	0.0	-	-	5.0	88.5	4.7	1.8	-	-	-
Total %	1.9	0.0	2.5	0.0	-	4.3	0.8	47.2	1.3	0.3	-	49.7	3.1	0.1	1.6	0.0	-	4.8	2.1	36.5	1.9	0.8	-	41.2	-
PHF	0.675	0.000	0.643	0.000	-	0.750	0.600	0.974	0.792	0.625	-	0.976	0.804	0.250	0.719	0.000	-	0.875	0.625	0.855	0.875	0.917	-	0.841	0.925
Lights	27	0	36	0	-	63	12	670	18	5	-	705	45	2	22	0	-	69	30	518	26	11	-	585	1422
% Lights	100.0	-	100.0	-	-	100.0	100.0	97.7	94.7	100.0	-	97.6	100.0	100.0	95.7	-	-	98.6	100.0	97.7	92.9	100.0	-	97.7	97.8
Mediums	0	0	0	0	-	0	0	8	1	0	-	9	0	0	1	0	-	1	0	7	2	0	-	9	19
% Mediums	0.0	-	0.0	-	-	0.0	0.0	1.2	5.3	0.0	-	1.2	0.0	0.0	4.3	-	-	1.4	0.0	1.3	7.1	0.0	-	1.5	1.3
Articulated Trucks	0	0	0	0	-	0	0	8	0	0	-	8	0	0	0	0	-	0	0	5	0	0	-	5	13
% Articulated Trucks	0.0	-	0.0	-	-	0.0	0.0	1.2	0.0	0.0	-	1.1	0.0	0.0	0.0	-	-	0.0	0.0	0.9	0.0	0.0	-	0.8	0.9
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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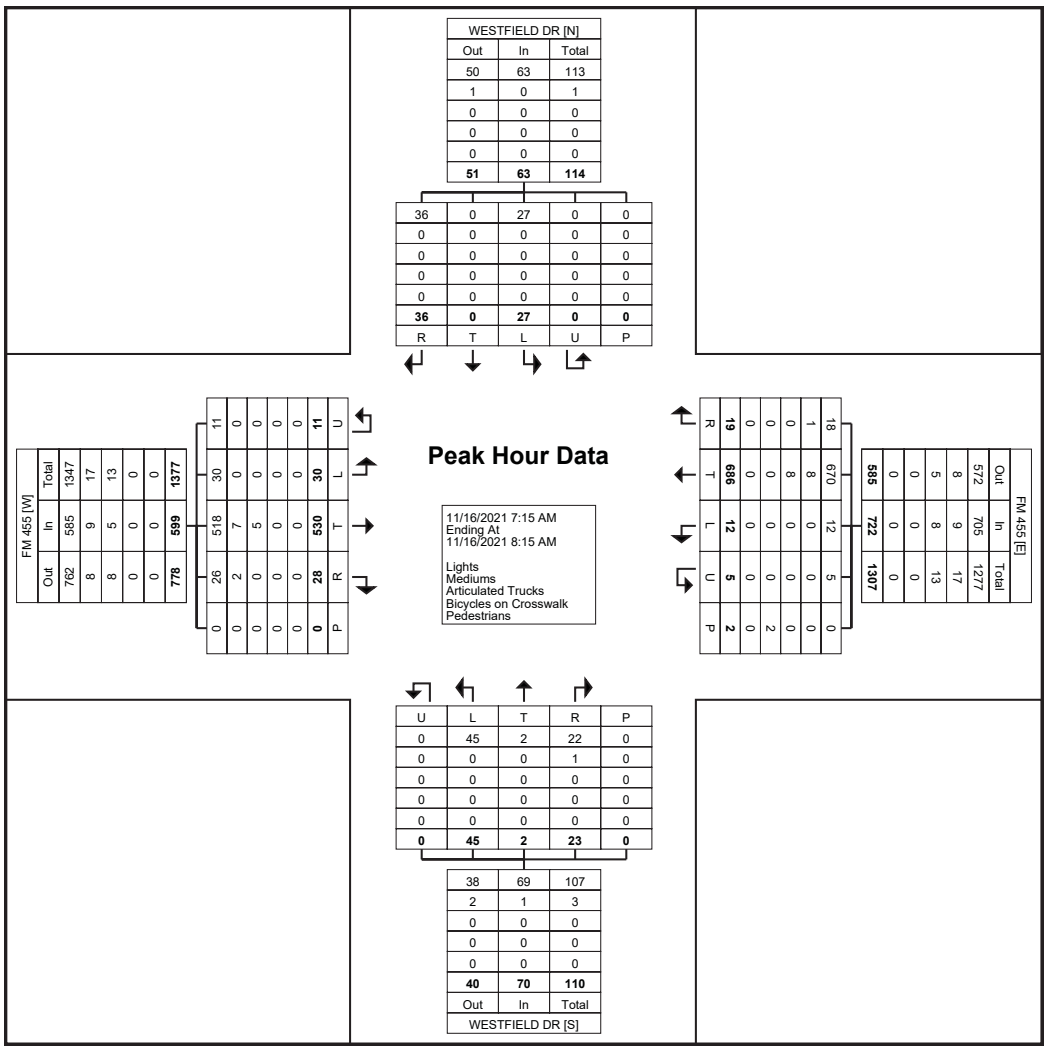
Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021
Page No: 5



Turning Movement Peak Hour Data Plot (7:15 AM)

GRAM Traffic NTX Inc.
1120 W. Lovers Lane

Arlington, Texas, United States 76013
817.265.8968

Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021

Turning Movement Peak Hour Data (5:00 PM)

Start Time	WESTFIELD DR Southbound						FM 455 Westbound						WESTFIELD DR Northbound						FM 455 Eastbound						Int. Total
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	
5:00 PM	1	0	12	0	0	13	6	205	6	2	0	219	7	2	7	0	0	16	9	205	14	5	3	233	481
5:15 PM	4	0	6	0	0	10	17	193	4	4	0	218	10	2	8	0	0	20	22	207	14	6	0	249	497
5:30 PM	0	1	6	0	1	7	12	179	8	2	1	201	12	0	8	0	0	20	9	211	13	9	0	242	470
5:45 PM	9	0	8	0	0	17	17	196	3	6	0	222	16	0	7	0	0	23	13	178	24	6	0	221	483
Total	14	1	32	0	1	47	52	773	21	14	1	860	45	4	30	0	0	79	53	801	65	26	3	945	1931
Approach %	29.8	2.1	68.1	0.0	-	-	6.0	89.9	2.4	1.6	-	-	57.0	5.1	38.0	0.0	-	-	5.6	84.8	6.9	2.8	-	-	-
Total %	0.7	0.1	1.7	0.0	-	2.4	2.7	40.0	1.1	0.7	-	44.5	2.3	0.2	1.6	0.0	-	4.1	2.7	41.5	3.4	1.3	-	48.9	-
PHF	0.389	0.250	0.667	0.000	-	0.691	0.765	0.943	0.656	0.583	-	0.968	0.703	0.500	0.938	0.000	-	0.859	0.602	0.949	0.677	0.722	-	0.949	0.971
Lights	14	1	31	0	-	46	52	762	20	14	-	848	45	4	28	0	-	77	53	792	63	26	-	934	1905
% Lights	100.0	100.0	96.9	-	-	97.9	100.0	98.6	95.2	100.0	-	98.6	100.0	100.0	93.3	-	-	97.5	100.0	98.9	96.9	100.0	-	98.8	98.7
Mediums	0	0	1	0	-	1	0	11	1	0	-	12	0	0	2	0	-	2	0	7	2	0	-	9	24
% Mediums	0.0	0.0	3.1	-	-	2.1	0.0	1.4	4.8	0.0	-	1.4	0.0	0.0	6.7	-	-	2.5	0.0	0.9	3.1	0.0	-	1.0	1.2
Articulated Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	2	0	0	-	2	2
% Articulated Trucks	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	3	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	100.0	-	-

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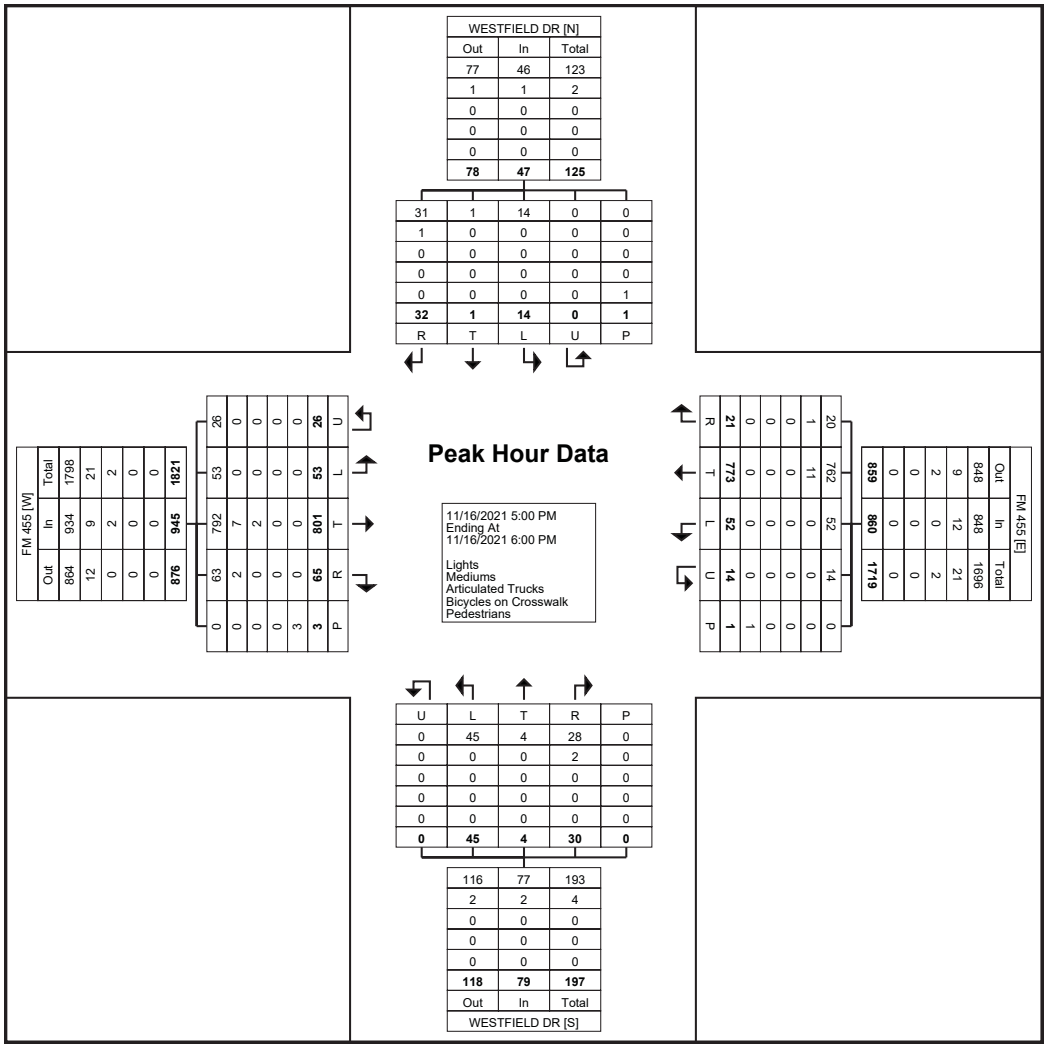
Count Name: FM 455 @ WESTFIELD DR
Site Code:
Start Date: 11/16/2021
Page No: 7



Turning Movement Peak Hour Data Plot (5:00 PM)

Crash ID	Street Name	Intersecting Street Name	Crash Date	Day of Week	Crash Time	Intersection Related	Crash Severity	Manner of Collision	First Harmful Event	Object Struck	Contributing Factors	Other Factor	Vehicle Travel Direction 1	Vehicle Travel Direction 2	Vehicle Travel Direction 3
15947007	FM0455	WILLOW CREEK DR	9/5/2017	TUESDAY	1135	INTERSECTION	N - NOT INJURED	ANGLE - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	DRIVER INATTENTION;FAILED TO YIELD RIGHT OF WAY - STOP SIGN	ATTENTION DIVERTED FROM DRIVING	S - SOUTH	E - EAST	
15986654	FM0455	WESTFIELD DR	9/25/2017	MONDAY	621	INTERSECTION	N - NOT INJURED	ANGLE - BOTH GOING STRAIGHT	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	DRIVER INATTENTION;FAILED TO YIELD RIGHT OF WAY - OPEN INTERSECTION	ATTENTION DIVERTED FROM DRIVING	N - NORTH	E - EAST	
16178744	FM0455	WILLOW CREEK DR	12/16/2017	SATURDAY	2054	INTERSECTION RELATED	N - NOT INJURED	SAME DIRECTION - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	NONE	VEHICLE CHANGING LANES	E - EAST	E - EAST	
16379162	FM0455	WESTFIELD DR	4/27/2018	FRIDAY	730	INTERSECTION	N - NOT INJURED	ANGLE - BOTH GOING STRAIGHT	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	FAILED TO YIELD RIGHT OF WAY - STOP SIGN	NOT APPLICABLE	N - NORTH	E - EAST	
16601181	FM0455	WESTFIELD DR	8/28/2018	TUESDAY	1610	INTERSECTION	C - POSSIBLE INJURY	ANGLE - BOTH GOING STRAIGHT	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	DRIVER INATTENTION;FAILED TO YIELD RIGHT OF WAY - STOP SIGN	ATTENTION DIVERTED FROM DRIVING	N - NORTH	E - EAST	
16691028	FM0455	WILLOW CREEK DR	10/19/2018	FRIDAY	1920	INTERSECTION	C - POSSIBLE INJURY	ANGLE - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	DRIVER INATTENTION;FAILED TO YIELD RIGHT OF WAY - STOP SIGN	ATTENTION DIVERTED FROM DRIVING	S - SOUTH	W - WEST	
16723901	FM0455	WESTFIELD DR	10/27/2018	SATURDAY	1030	INTERSECTION	N - NOT INJURED	OPPOSITE DIRECTION - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	DRIVER INATTENTION;FAILED TO YIELD RIGHT OF WAY - TURNING LEFT	ATTENTION DIVERTED FROM DRIVING	S - SOUTH	N - NORTH	
16938896	W WHITE ST	WESTFIELD DR	3/8/2019	FRIDAY	1036	INTERSECTION	N - NOT INJURED	ANGLE - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	NONE	NOT APPLICABLE	N - NORTH	W - WEST	
17049977	FM0455	WILLOW CREEK DR	5/5/2019	SUNDAY	1100	INTERSECTION	B - SUSPECTED MINOR INJURY	ANGLE - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	FAILED TO YIELD RIGHT OF WAY - OPEN INTERSECTION	NOT APPLICABLE	N - NORTH	W - WEST	W - WEST
17201067	FM0455	WESTFIELD DR	7/27/2019	SATURDAY	1529	INTERSECTION	N - NOT INJURED	OPPOSITE DIRECTION - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	FAILED TO YIELD RIGHT OF WAY - TURNING LEFT	NOT APPLICABLE	W - WEST	E - EAST	
17221607	W WHITE ST	N/A	8/7/2019	WEDNESDAY	1715	NON INTERSECTION	C - POSSIBLE INJURY	SAME DIRECTION - BOTH GOING STRAIGHT-REAR END	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	CHANGED LANE WHEN UNSAFE;DRIVER INATTENTION;FAILED TO CONTROL SPEED;FAILED TO YIELD RIGHT OF WAY - TURNING LEFT	VEHICLE CHANGING LANES	E - EAST	E - EAST	
17412619	FM0455	WESTFIELD DR	11/18/2019	MONDAY	1704	INTERSECTION	C - POSSIBLE INJURY	OPPOSITE DIRECTION - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	FAILED TO YIELD RIGHT OF WAY - OPEN INTERSECTION	NOT APPLICABLE	W - WEST	E - EAST	N - NORTH
18006980	W WHITE ST	WESTFIELD DR	12/8/2020	TUESDAY	1925	INTERSECTION RELATED	N - NOT INJURED	ONE MOTOR VEHICLE - TURNING RIGHT	FIXED OBJECT	FIRE HYDRANT	FAULTY EVASIVE ACTION	NOT APPLICABLE	E - EAST	NA - NOT APPLICABLE	
18266788	FM0455	WESTFIELD DR	5/12/2021	WEDNESDAY	946	INTERSECTION	B - SUSPECTED MINOR INJURY	ANGLE - ONE STRAIGHT-ONE LEFT TURN	MOTOR VEHICLE IN TRANSPORT	NOT APPLICABLE	WRONG SIDE - APPROACH OR INTERSECTION	ONE VEHICLE LEAVING DRIVEWAY	E - EAST	N - NORTH	

GUIDELINES FOR PEDESTRIAN CROSSING TREATMENTS

This spreadsheet combines Worksheet 1 and Worksheet 2 (Appendix A, pages 69-70) of TCRP Report 112/NCHRP Report 562 (*Improving Pedestrian Safety at Unsignalized Intersections*) into an electronic format. This spreadsheet should be used in conjunction with, and not independent of, Appendix A documentation.

This spreadsheet is still under development, please inform TTI if errors are identified.

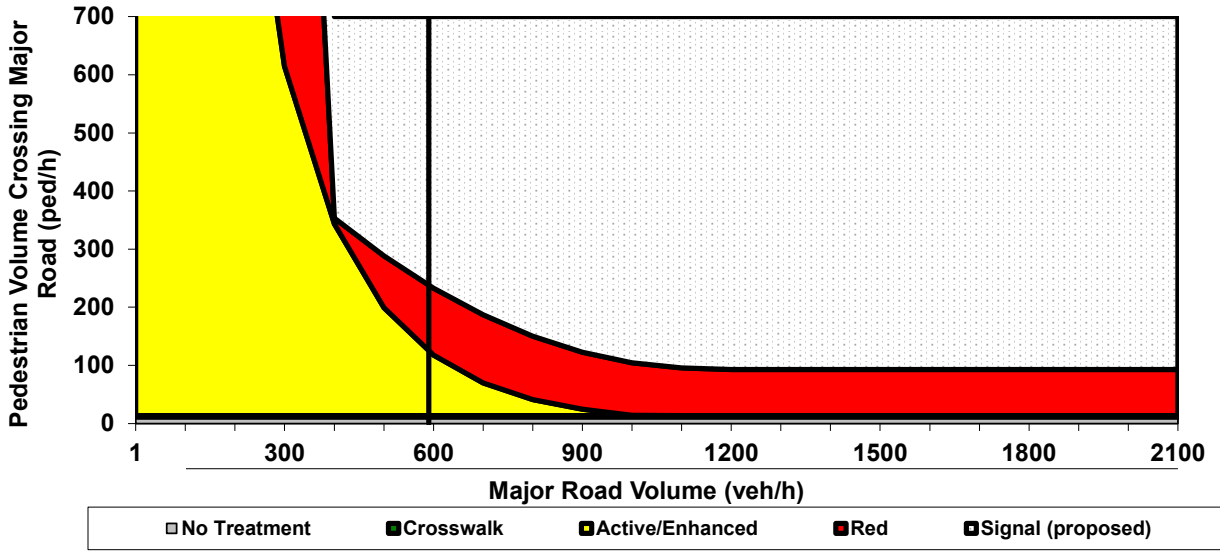
Key

Blue fields contain descriptive information.
Green fields are required and must be completed.
Tan fields are adjustments that are filled out only under certain conditions (follow instructions to the left of the cell).
Gray fields are automatically calculated and should not be edited.

Analyst and Site Information			
Analyst	KWN	Major Street	FM 455
Analysis Date	December 1, 2021	Minor Street or Location	Westfield Drive
Data Collection Date	November 16, 2021	Peak Hour	1:00 PM - Peak of Peds

Step 1: Select worksheet:		
Posted or statutory speed limit (or 85th percentile speed) on the major street (mph)	*1a*	45
Is the population of the surrounding area <10,000? (enter ***YES*** or ***NO***)	*1b*	NO
Step 2: Does the crossing meet minimum pedestrian volumes to be considered for a traffic control device?		
Peak-hour pedestrian volume (ped/h), V_p	*2a*	11
Result: Consider raised median islands, curb extensions, traffic calming, etc. as feasible.		
Step 3: Does the crossing meet the pedestrian warrant for a traffic signal?		
Major road volume, total of both approaches during peak hour (veh/h), $V_{maj\text{-}s}$	*3a*	1065
[Calculated automatically] Preliminary (before min. threshold) peak hour pedestrian volume to meet warrant	*3b*	93
[Calculated automatically] Minimum required peak hour pedestrian volume to meet traffic signal warrant	*3c*	93
Is 15th percentile crossing speed of pedestrians less than 3.5 ft/s (1.1 m/s)? (enter ***YES*** or ***NO***)	*3d*	NO
If 15th percentile crossing speed of pedestrians is less than 3.5 ft/s (1.1 m/s), then reduce *3c* by up to 50%. — % rate of reduction for *3c* (up to 50%)	*3e*	
If 15th percentile crossing speed of pedestrians is less than 3.5 ft/s (1.1 m/s), then reduce *3c* by up to 50%. — Reduced value or *3c*	*3f*	93
Result:		
Step 4: Estimate pedestrian delay.		
Pedestrian crossing distance, curb to curb (ft), L	*4a*	45
Pedestrian walking speed (ft/s), S_p (suggested speed = 3.5 ft/s)	*4b*	3.5
Pedestrian start-up time and end clearance time (s), t_s (suggested start-up time = 3 sec)	*4c*	3
[Calculated automatically] Critical gap required for crossing pedestrian (s), t_c	*4d*	16
Major road volume, total both approaches OR approach being crossed if raised median island is present, during peak hour (veh/h), $V_{maj\text{-}d}$	*4e*	591
Major road flow rate (veh/s), v	*4f*	0.23
Average pedestrian delay (s/person), d_p	*4g*	147
Total pedestrian delay (h), D_p The value in 4h is the calculated estimated delay for all pedestrians crossing the major roadway without a crossing treatment (assumes 0% compliance). If the actual total pedestrian delay has been measured at the site, that value can be entered in 4i to replace the calculated value in 4h.	*4h*	0.4
	4i	
Step 5: Select treatment based up on total pedestrian delay and expected motorist compliance.		
Expected motorist compliance at pedestrian crossings in region: enter ***HIGH for High Compliance*** or ***LOW for Low Compliance***	*5a*	LOW

Treatment Category:	**Consider raised median islands, curb extensions, traffic calming, etc. as feasible.**



Because the volume in Step 4e is different from the volume in Step 3a, the graph may show a different result than the Treatment Category above.

This worksheet provides general recommendations on pedestrian crossing treatments to consider at unsignalized intersections; in all cases, engineering judgment should be used in selecting a specific treatment for installation. This worksheet does not apply to school crossings. In addition to the results provided by this worksheet, users should consider whether a pedestrian treatment could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex geometrics, or nearby traffic signals.

GUIDELINES FOR PEDESTRIAN CROSSING TREATMENTS

This spreadsheet combines Worksheet 1 and Worksheet 2 (Appendix A, pages 69-70) of TCRP Report 112/NCHRP Report 562 (*Improving Pedestrian Safety at Unsignalized Intersections*) into an electronic format. This spreadsheet should be used in conjunction with, and not independent of, Appendix A documentation.

This spreadsheet is still under development, please inform TTI if errors are identified.

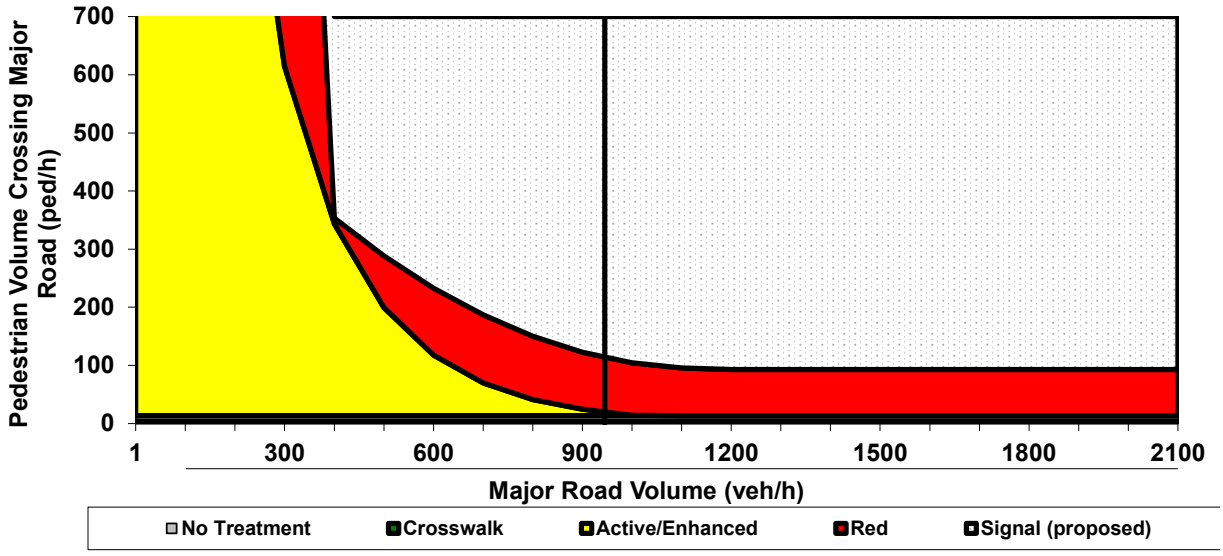
Key

Blue fields contain descriptive information.
Green fields are required and must be completed.
Tan fields are adjustments that are filled out only under certain conditions (follow instructions to the left of the cell).
Gray fields are automatically calculated and should not be edited.

Analyst and Site Information			
Analyst	KWN	Major Street	FM 455
Analysis Date	December 1, 2021	Minor Street or Location	Westfield Drive
Data Collection Date	November 16, 2021	Peak Hour	5:00 PM - Peak of Vehicles

Step 1: Select worksheet:		
Posted or statutory speed limit (or 85th percentile speed) on the major street (mph)	*1a*	45
Is the population of the surrounding area <10,000? (enter ***YES*** or ***NO***)	*1b*	NO
Step 2: Does the crossing meet minimum pedestrian volumes to be considered for a traffic control device?		
Peak-hour pedestrian volume (ped/h), V_p	*2a*	4
Result: Consider raised median islands, curb extensions, traffic calming, etc. as feasible.		
Step 3: Does the crossing meet the pedestrian warrant for a traffic signal?		
Major road volume, total of both approaches during peak hour (veh/h), $V_{maj\text{-}s}$	*3a*	1805
[Calculated automatically] Preliminary (before min. threshold) peak hour pedestrian volume to meet warrant	*3b*	93
[Calculated automatically] Minimum required peak hour pedestrian volume to meet traffic signal warrant	*3c*	93
Is 15th percentile crossing speed of pedestrians less than 3.5 ft/s (1.1 m/s)? (enter ***YES*** or ***NO***)	*3d*	NO
If 15th percentile crossing speed of pedestrians is less than 3.5 ft/s (1.1 m/s), then reduce *3c* by up to 50%. — % rate of reduction for *3c* (up to 50%)	*3e*	
If 15th percentile crossing speed of pedestrians is less than 3.5 ft/s (1.1 m/s), then reduce *3c* by up to 50%. — Reduced value or *3c*	*3f*	93
Result:		
Step 4: Estimate pedestrian delay.		
Pedestrian crossing distance, curb to curb (ft), L	*4a*	45
Pedestrian walking speed (ft/s), S_p (suggested speed = 3.5 ft/s)	*4b*	3.5
Pedestrian start-up time and end clearance time (s), t_s (suggested start-up time = 3 sec)	*4c*	3
[Calculated automatically] Critical gap required for crossing pedestrian (s), t_c	*4d*	16
Major road volume, total both approaches OR approach being crossed if raised median island is present, during peak hour (veh/h), $V_{maj\text{-}d}$	*4e*	945
Major road flow rate (veh/s), v	*4f*	0.38
Average pedestrian delay (s/person), d_p	*4g*	1071
Total pedestrian delay (h), D_p The value in 4h is the calculated estimated delay for all pedestrians crossing the major roadway without a crossing treatment (assumes 0% compliance). If the actual total pedestrian delay has been measured at the site, that value can be entered in 4i to replace the calculated value in 4h.	*4h*	1.2
	4i	
Step 5: Select treatment based up on total pedestrian delay and expected motorist compliance.		
Expected motorist compliance at pedestrian crossings in region: enter ***HIGH for High Compliance*** or ***LOW for Low Compliance***	*5a*	LOW

Treatment Category:	**Consider raised median islands, curb extensions, traffic calming, etc. as feasible.**



Because the volume in Step 4e is different from the volume in Step 3a, the graph may show a different result than the Treatment Category above.

This worksheet provides general recommendations on pedestrian crossing treatments to consider at unsignalized intersections; in all cases, engineering judgment should be used in selecting a specific treatment for installation. This worksheet does not apply to school crossings. In addition to the results provided by this worksheet, users should consider whether a pedestrian treatment could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex geometrics, or nearby traffic signals.