LUC-2-22.28-22.68 Safety Study

Navarre Avenue/SR 2 & Coy Road

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Prepared for:

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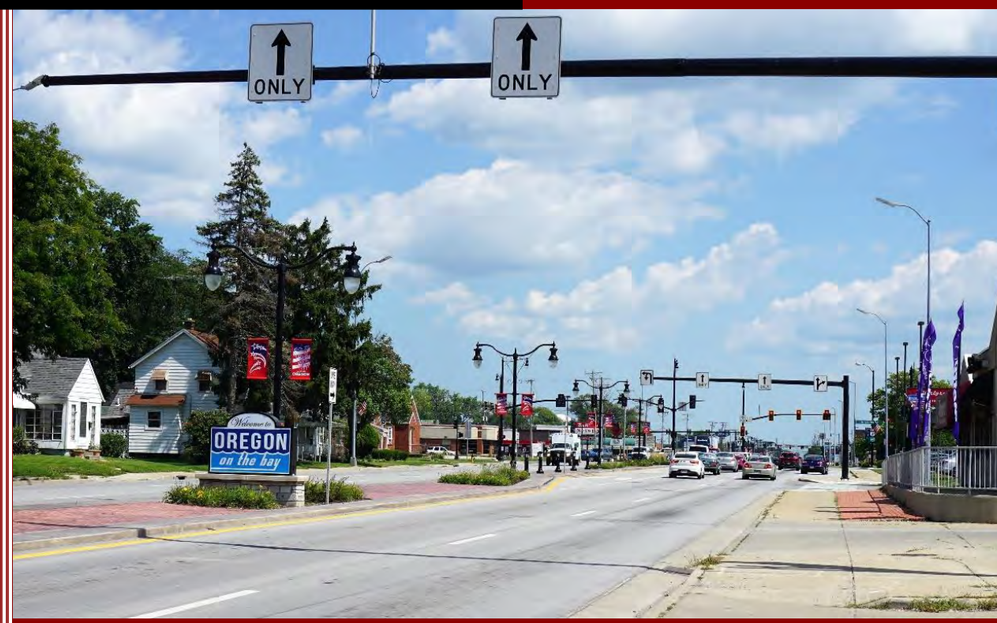

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SAFETY STUDY SUMMARY

LUC-2-22.28-22.69

Navarre Avenue/SR-2 and Coy Road

September 2018

Application Scoring	Score	
Crash Frequency	8.85	4
Ratio of Observed Total Crashes	0.01	1
% Improvement	69.30%	20
Relative Severity Index	$2,908,988	10
Equivalent Property Damage Only Index	3.75	3
Volume to Capacity Ratio	0.77	6
Benefit Cost Ratio	1.01	3
Safety Funding Request	80.00%	4
	Application Score:	**51**

Project Description

- Install right turn lanes on Coy Road to reduce congestion
- Install median along Navarre Avenue/SR 2
- Upgrade signalized intersection including pedestrian facilities
- Upgrade signing and traffic control
- Add median and decorative elements

Project Priority

The Navarre Avenue/SR 2 and Coy Road intersection is ranked 39th on the 2016 Urban Intersection Highway Safety Improvement Program List.

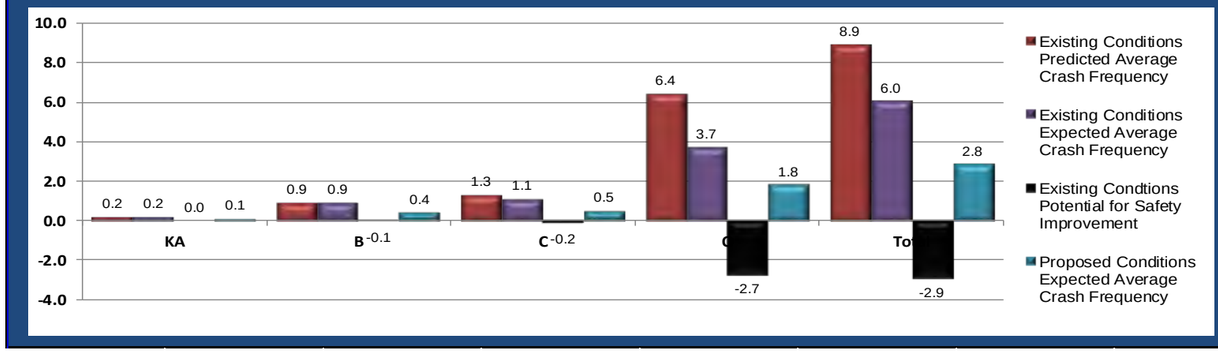
Strategic Highway Safety Plan

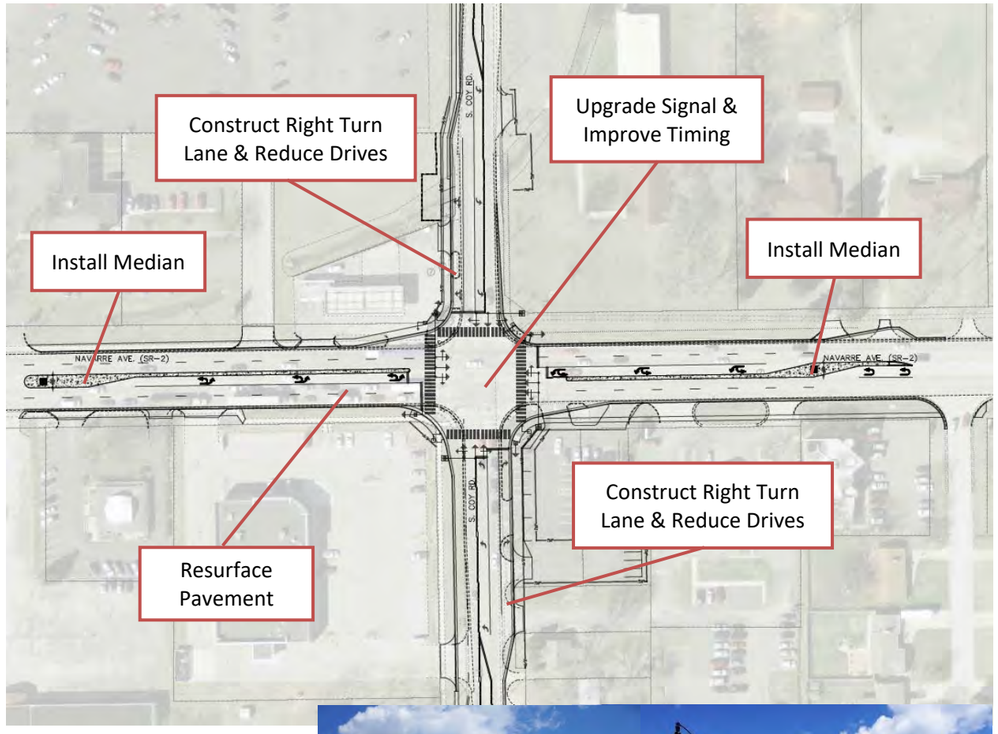
- Ohio Emphasis
  - Area I – Serious Crash Types
    - Intersection Crashes
    - Rear End Collisions
- FHWA Emphasis
  - Modify traffic signal timing
  - Improve design & operation of highway intersections

Types of Crashes

Rear End	77	51.0%
Left Turn	33	21.9%
Sideswipe - Passing	19	12.6%
Angle	11	7.3%
Right Turn	4	2.6%
Backing	2	1.3%
Pedestrian	1	0.7%
Other Non-Collision	1	0.7%
Fixed Object	1	0.7%
Head On	1	0.7%
Overturning	1	0.7%
Grand Total:	151	100.0%

Summary of Anticipated Safety Performance of the Project (average crashes/year)





OREGON on the bay

Traffic Crashes Per Year		
2015	54	35.8%
2016	53	35.1%
2017	44	29.1%
Grand Total:	151	100%

Proposed countermeasures anticipated to match LUC-2-21.24 PID 96295

Funding

Project Phase	Fiscal Year	Sponsor Funding	Previous Safety	New Safety	Total
Safety Study	2019	$25,000	-	-	$25,000
Environmental/PE	2019-2020	$25,000	-	-	$25,000
Detailed Design	2019-2020	-	-	$115,476	$115,476
ROW/Utilities	2020-2021	$300,000	-	$700,000	$1,000,000
Construction	2021	$167,600	-	$921,800	$1,089,400
	Total:	$517,600	-	$1,737,276	$2,254,876

EXECUTIVE SUMMARY

The Navarre Avenue/SR 2 and Coy Road intersection is ranked 39th on the 2016 Urban Intersection Highway Safety Improvement Program list for Ohio. This intersection is along the Navarre Avenue/SR 2 corridor, a main commercial corridor through Oregon Ohio in Lucas County. The corridor also experiences large volumes of summer tourist traffic volumes traveling from I-280 to the recreational areas along Lake Erie. The intersection has an average daily traffic entering volume of 28,800 vehicles. The Navarre Avenue/SR 2 corridor is the main commercial corridor for the City of Oregon. The study intersection is located approximately 1 ¼ miles from the I-280 and Navarre Avenue/SR 2 interchange. Throughout this 2-mile corridor there are 8 signalized intersections.

Crash data for the study area was collected between 2015 to 2017. During the three-year study period there were 151 crashes, where 128 of the crashes occurred within the influence of the Navarre Avenue/SR 2 and Coy Road intersection. Throughout the study area the top crashes were, 51% Rear End Crashes, 22% Left Turn, and 13% Sideswipe Passing crashes. Injury crashes make up 34% of the reported crashes.

Based on Statewide Crash Rates of accidents per million entering vehicles (MEV), the Navarre Avenue and Coy Road intersection experiences 4.5 times more crashes per million entering vehicles than the state average of 0.96 crashes per million entering vehicles. Using the Crash Modification Factors (CMF) Clearinghouse, the following Countermeasures were considered:

- o Replace Two-Way-Left-Turn-Lane with Raised Median
- o Replace Incandescent Traffic Signals with LEDs
- o Provide A Right-Turn Lane on One Major-Road Approach
- o Convert Signalized Intersection to Modern Roundabout
- o Add Signal (additional Primary Head)
- o Improve Visibility of Signal Heads
- o Provide Flashing Yellow Arrow
- o Install Overhead Lane-Use Signs
- o Install Right Turn Lane
- o Change Driveway Density
- o Increase Pavement Friction
- o Modify Clearance Intervals

The Ohio Department of Transportation (ODOT) Economic Crash Analysis Tool (ECAT) uses crash data and proposed countermeasures to estimate the predicted crashes expected from installing specific countermeasures while also calculating a benefit to cost analysis for the proposed design. While several countermeasures are proposed for the project area, ECAT does not allow analysis of them all, nor are all CMF's available. CMF's not located in the ECAT software were added manually through the data obtained from the CMF Clearinghouse.

Based on the available funding and Cost to Benefit analysis, it is recommended that an ODOT Safety Application be prepared for the Long Term Countermeasures and include both the Short Term countermeasures. No Medium Term countermeasures were identified.

Short Term Countermeasures

- $20,000.00
- Install backplates on existing signal heads
- Modify change plus clearance interval to ITE 1985 Proposed Recommended Practice
- Improve corridor timing along Navarre Avenue/SR 2
- Add additional signal heads to existing traffic signal

Long Term Countermeasures

- $2,038,219.00
- Increase pavement by resurfacing
- Install median along Navarre Avenue/SR 2 throughout study area
- Install Thru-Right turn lanes on Coy Road
- Extend Right turn lane from Coy Road onto Dustin Road to Navarre Avenue/SR 2
- Expand Coy Road culvert over Amolsch Ditch to accommodate additional pavement width and sidewalks
- Decrease drive density near intersection

PURPOSE AND NEED STATEMENT

The Navarre Avenue/SR 2 and Coy Road intersection is ranked 39th on the 2016 Urban Intersection Highway Safety Improvement Program list for Ohio. This intersection is along the Navarre Avenue/SR 2 corridor, a main commercial corridor through Oregon Ohio in Lucas County. The corridor also experiences large volumes of summer tourist traffic volumes traveling from I-280 to recreational areas along Lake Erie. The purpose of this study is to analyze crash trends and provide countermeasures that will improve the safety of the intersection.

STUDY LOCATION

The intersection and the area of influence is located along Navarre Avenue/SR 2 in Oregon, Ohio, an eastern suburb of Toledo. Oregon has a population of approximately 20,000 residents. The Navarre Avenue/SR 2 corridor is the main commercial corridor for the city of Oregon. The study intersection is located approximately 1 ¼ miles from the I-280 and Navarre Avenue/SR 2 interchange. Throughout this 2-mile corridor there are 8 signalized intersections. The study location is within the Navarre Avenue Signal System which extends two miles east of I-280.

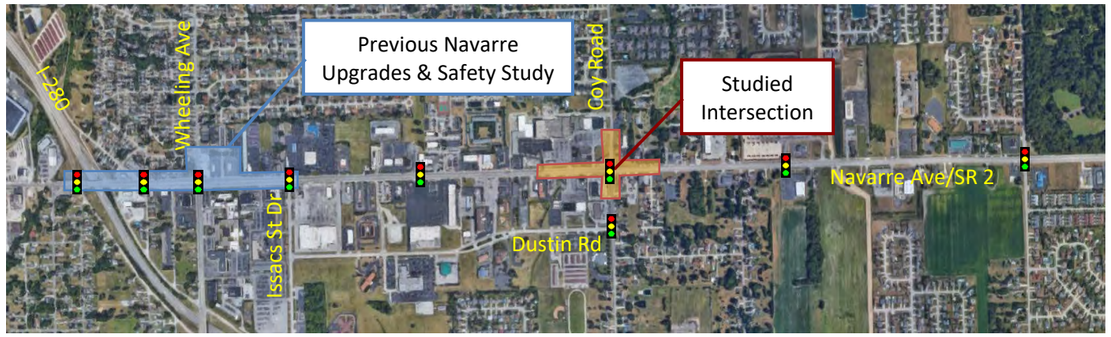


Figure 1 - Study Location

EXISTING CONDITIONS

Background

The Navarre Avenue/SR 2 and Coy Road intersection is located in Oregon, Lucas County, Ohio. Navarre Avenue/SR 2 runs east-west and is a five-lane facility with two lanes in either direction and a two-way-left-turn-lane (TWLTL) that transitions to left turn lanes at the Coy Road intersection. Navarre Avenue/SR 2 is classified as a Principal Arterial with a speed limit of 40 MPH. The Straight-Line Mileage for Navarre along the study area is from 22.28 to 22.68. The intersection located at 22.48 is signalized and coordinated with the other signals along Navarre Avenue. Coy Road is classified as a Major Collector south of Navarre Avenue/SR 2 and is classified as a Minor Arterial roadway north of Navarre. Coy is a two-lane facility with a left turn lane for each leg and has a speed limit of 35 MPH.

Crash data was collected from the ODOT Transportation Information Mapping System (TIMS) website for the study area. The study area included the Kroger Drive to the West, Athens Drive to the East, Rite Aid Drive to the South, and the Plaza Drive to the North. The study area was determined by DGL and the City of Oregon at a preliminary meeting and includes many other driveways and access points to Navarre and Coy that have an influence on the Navarre Avenue/SR 2 and Coy Road intersection. Crash data was collected between 2015 to 2017. After scrubbing the data, 151 crashes were found to occur within the study area. Almost all of the crashes, 128 of 151, were within the influence of the Navarre Avenue/SR 2 and Coy Road intersection.

In 2012 an Access Management Study was conducted for ODOT District 2 by DLZ and TEC. The study reviewed Navarre Avenue/SR-2 from the I-280 Northbound Ramp to Coy Road. Crash data and Access Management issues were reviewed. The 2012 study recommended medians be installed to eliminate left turn movements and U-Turn lanes at intersections. Access Roads that combined multiple private drives into one location were also recommended. DLZ and TEC recommendations included substantial upgrades at both Wheeling Street and Coy Road.

Taking the 2012 Access Management Study further resulted in the 2013 LUC-2-21.24 Safety Study and Safety Application. The study looked to improve Navarre Avenue/SR 2 from I-280/Dearborn Avenue to Isaac Streets Drive. The upgrades included new signals, microsurfacing, installations of medians, and the construction of a service road near Wheeling Avenue. The safety study was submitted in April 2013 and construction was completed in Fall 2017. This safety study will analyze some of the same upgrades that occurred on the western side of the corridor for the Coy intersection including medians, u-turns, upgrading traffic signals and signage along with aesthetic elements. The construction was completed in 2017 and already shows a dramatic reduction in crashes.

Traffic Count

Traffic was collected in June 2018 at the Navarre Avenue/Coy Road intersection using video counters. Figure 2 illustrates the peak hour traffic volumes.

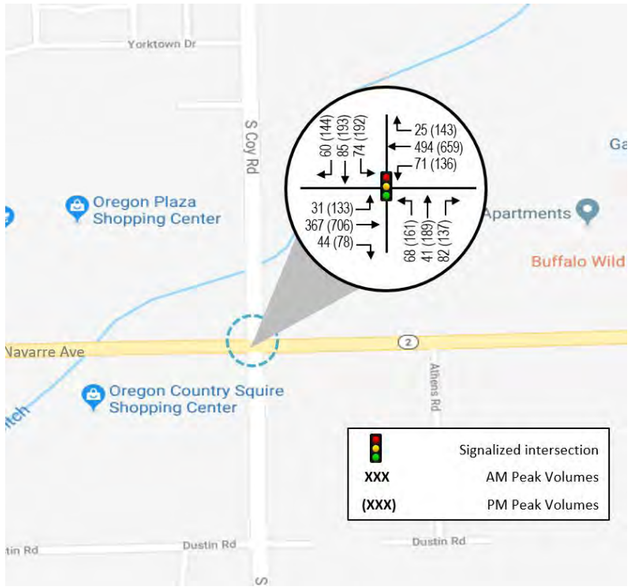


Figure 2 - 2018 Collected Traffic

Conditions Diagram
The existing condition diagrams for the study area are shown in Figure 3, Figure 4 and Figure 5, on pages 5-7.

Physical Conditions
The study area begins along Navarre Avenue/SR 2 at SLM 22.28, near the Kroger Drive of the shopping center that borders the north side of Navarre. The study area extends through the Coy Road intersection to Athens Road at SLM 22.68. Throughout the study area Navarre is a four-lane road with a TWLTL and a speed limit of 40 MPH. At the Coy Road intersection left turn lanes are provided. Within the study area there are 32 curb cuts, 24 on Navarre Avenue alone.

Along Coy Road, the study area extends south to the Rite Aid Drive, which is about 250 feet south of the northbound stop bar, to the Plaza Drive about 400 north of the southbound approach. In this area Coy Road is a two-lane road with left turn lanes at the intersection. Coy Road has a speed limit of 35 MPH. Located about 650 feet south of the Navarre, is the signalized Dustin Road and Coy Road intersection.

The signal for the intersection was constructed in 1999 with the LUC-2-21.24 project. Each has protected/permitted left turn phasing. The intersection has video detection for the left turn movements and crosswalks with pedestrian signals along all four legs. Sidewalks are not available on all sides of the roadways, but each leg has at least one sidewalk. See Figure 3 for illustration.

The following table outlines the Coy and Navarre intersection physical conditions. Note that the table includes data for the entire study area not just the Navarre Avenue and Coy Road intersection.

STUDY AREA CHARACTERISTICS				
	East Leg Navarre Avenue	West leg Navarre Avenue	North leg Coy Road	South leg Coy Road
Number of Lanes	4 Lanes	4 Lanes	2 Lanes	2 Lanes
Turn Lane Length	200’ + 50’ taper	300’ + 50’ taper	135’ + 100’ taper	175’ + 50’ taper
Sidewalk	5’ North No South walk	7’ North 5’ South	No East walk 5’ West	No East walk 5’ West
Number of Drives	6	17	4	4

Table 2 – Study Area Characteristics

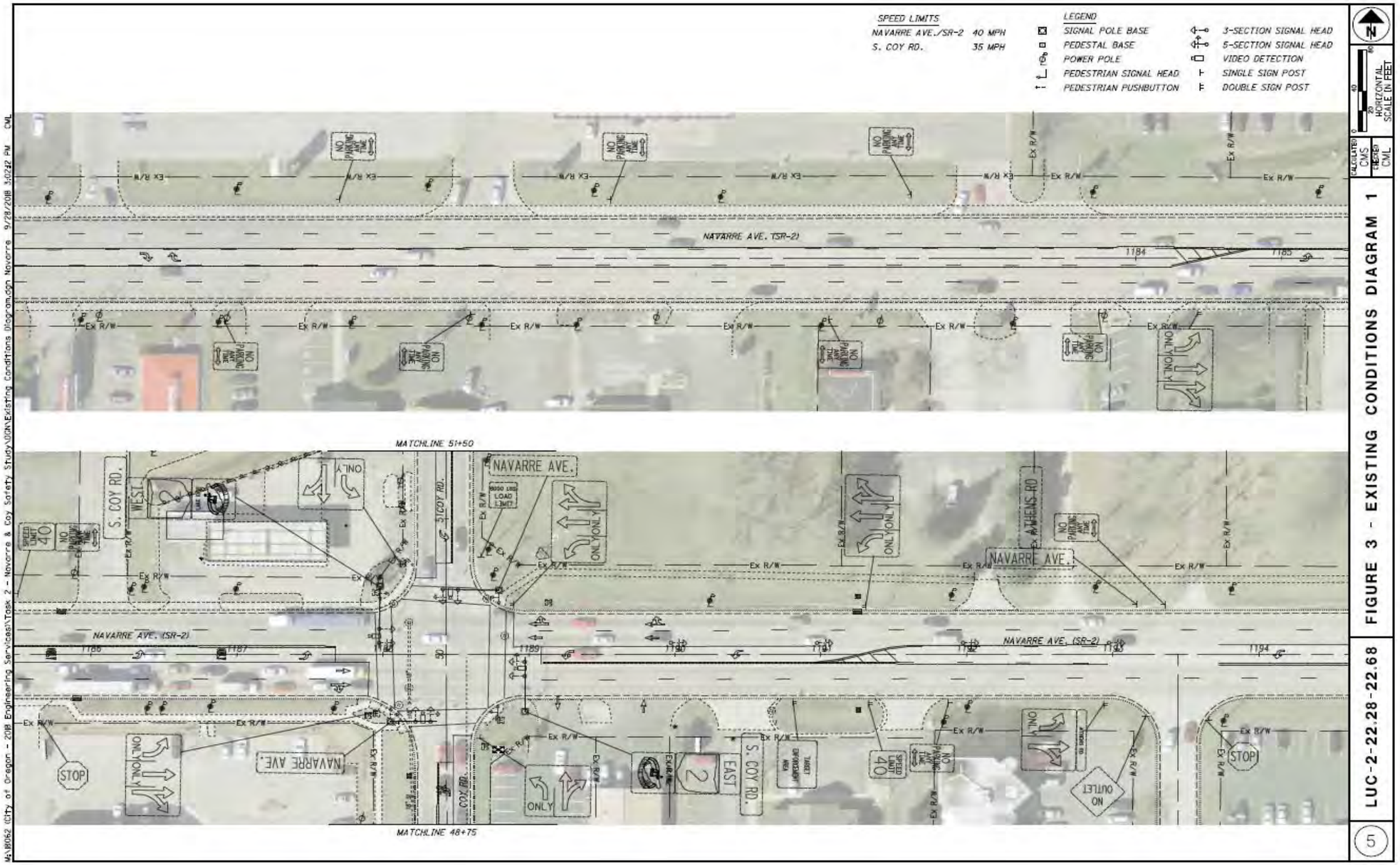


Figure 3 - Existing Conditions Diagram 1

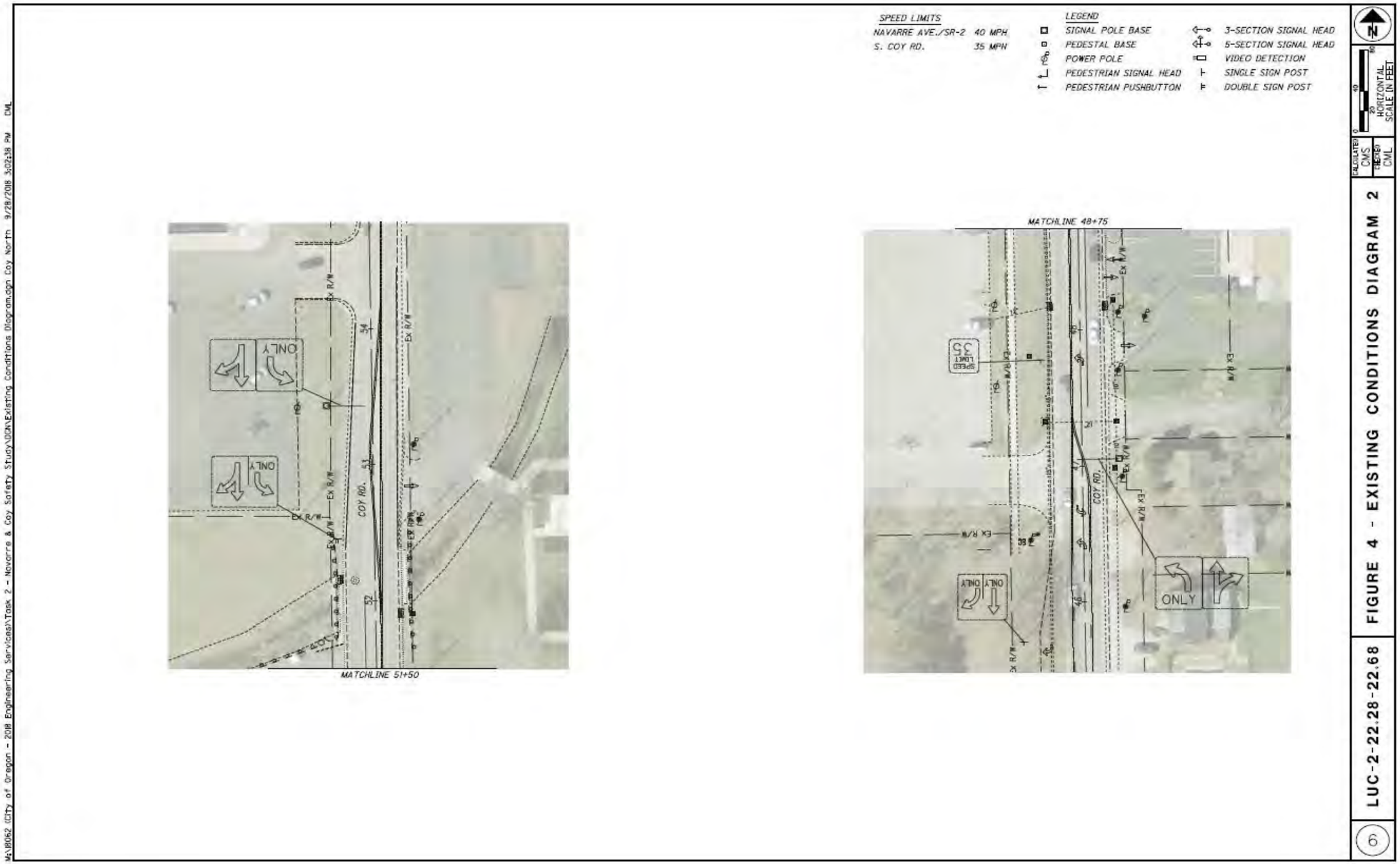


Figure 4 - Existing Conditions Diagram 2

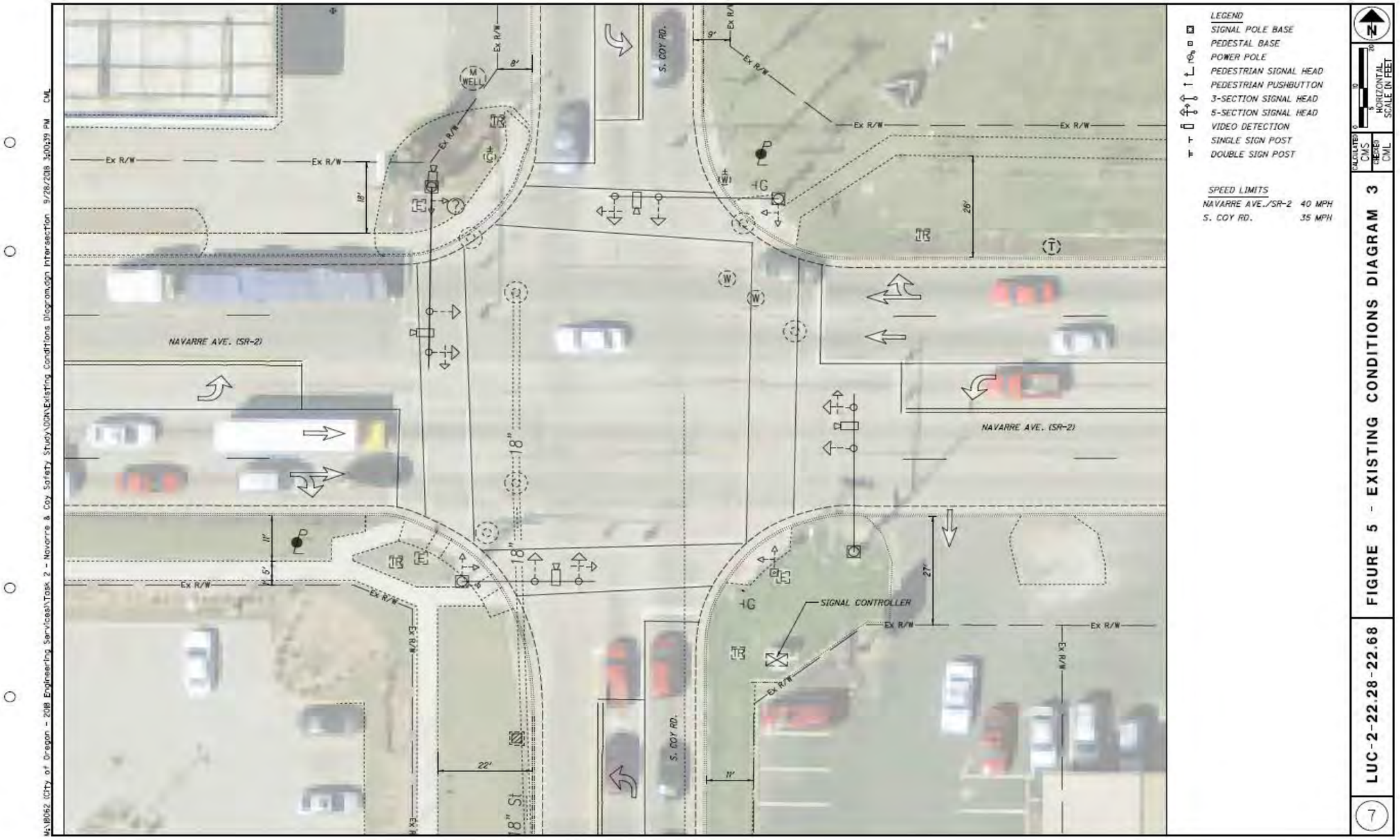


Figure 5 – Existing Conditions Diagram 3

Other Issues and Data

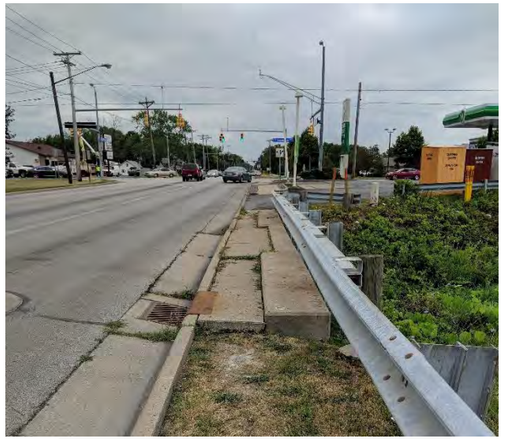
During the field review of the study there were a few "near miss" crashes observed. In one instance a vehicle traveling southbound Coy Road had to stop abruptly while a northbound driver made a left turn. As a bystander it appeared that the left turning driver did not see the southbound traveling vehicle.

Another concern for this project is Amolsch Ditch. The ditch is located around 150' north of the intersection on Coy Road. The BP gas station on the northwest corner of the intersection backs up to the ditch. According to the Lucas County Auditors website, the BP property extends from Navarre Avenue to the parking lot for Auto Zone. See Figure 6 for the location. The ditch runs through the middle of the property, with the fuel pumps and convenience market on the south side of the parcel. If right-of-way is required for the proposed intersection design, the current BP site configuration will be greatly impacted.

Figure 6 – BP Property Location

DGL completed a bridge inspection of the Coy Road bridge over Amolsch Ditch in November 2017. The bridge has a sufficiency rating of 99.8, but a few issues were noted in the report including issues with longitudinal cracking, exposing and rusting the beam, abutment wall horizontal and vertical cracking, and scouring of the soil around the bridge footing. It should also be noted that the bridge does not provide a walkway for pedestrians on the bridge, and there is no sidewalk to or from the bridge. There is an abutment wall that is used by pedestrians, but the wall is uneven, and not ADA compliant or ADA accessible. It is anticipated that the bridge will need to be widened on both sides or replaced to provide the necessary pedestrian amenities. Based on current United States Army Corp of Engineers requirements, the ditch may be enclosed up to 150 feet without additional environmental study.

The structure that carries Coy Road over Amolsch Ditch is a 10 wide by 8-foot rise box culvert built in 1917. In 1986, the culvert was extended to the east to construct a southbound left turn lane at Navarre Avenue. The culvert will require another widening, or a new structure properly sized to accommodate the proposed Coy Road configuration. Due to the structure age and the fact that the second rehabilitation still would not address the deficiencies with the original 1917 structure, rehabilitation is not advised. A new bridge would address all structural deficiencies currently found within the original and rehabilitated portions of the existing bridge, as well as provide a bridge of uniform material properties and construction age.



Coy Road – Looking Southbound, Bridge over the Amolsch Ditch abutment wall.

Note the absence of sidewalk at the bridge. There is no accessible pedestrian route across the bridge.

Coy Road – Looking Southbound, 200' North of the intersection.

Note the absence of sidewalk north of the bridge.

Underside of the Coy Road Bridge.

Figure 7 - Amolsch Ditch Bridge, Coy Road

CRASH DATA AND ANALYSIS

Crash data for the study area was collected between 2015 to 2017. During the study period there were 151 crashes with 128 of the crashes occurring within the influence of the Navarre Avenue/SR 2 and Coy Road intersection. Crash reports were reviewed to ensure that the data presented from the ODOT TIMS was as accurate as possible. Throughout the study area the top crashes were, 51% Rear End Crashes, 22% Left Turn, and 13% Sideswipe Passing crashes. Injury crashes make up 34% of the reported crashes. Crashes trends did not indicate a significant pattern for specific day crashes, but an increase in crash occurrences was seen in the summer between May to August. This increase in crashes could be a result of SR 2 being a main route to the recreational areas along Lake Erie to the east. The following section further details the crash data. Collision Diagrams can be found in Table 4 to Table 9.

%	Crash Type
51	Rear End
22	Left Turn
13	Sideswipe - Passing

%	Location
87	Intersection
11	Driveway
2	T-Intersection

%	Severity
66	Property Damage
34	Injury Crash
0	Fatality

%	Pavement Conditions
71	Dry
29	Wet/Snow/Ice

Table 3 – Study Area Crash Data Summary

Crash Data Graphical Analysis

The following charts show the crash data in greater detail. Crashes are classified by log point in some graphs to show the location of the crash in relation to the center of the intersection and to illustrate what road the crashes occurred on. The study area for Navarre extended from log point 22.30-22.7, while the Navarre Avenue and Coy Road intersection is located between 22.42-22.6.

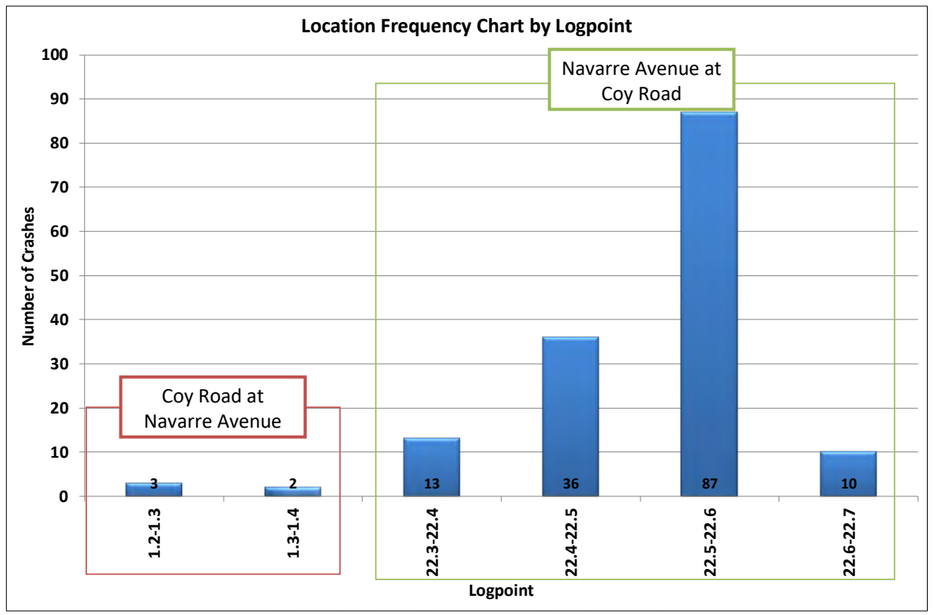


Table 4 – Crash Location Frequency Chart by Logpoint

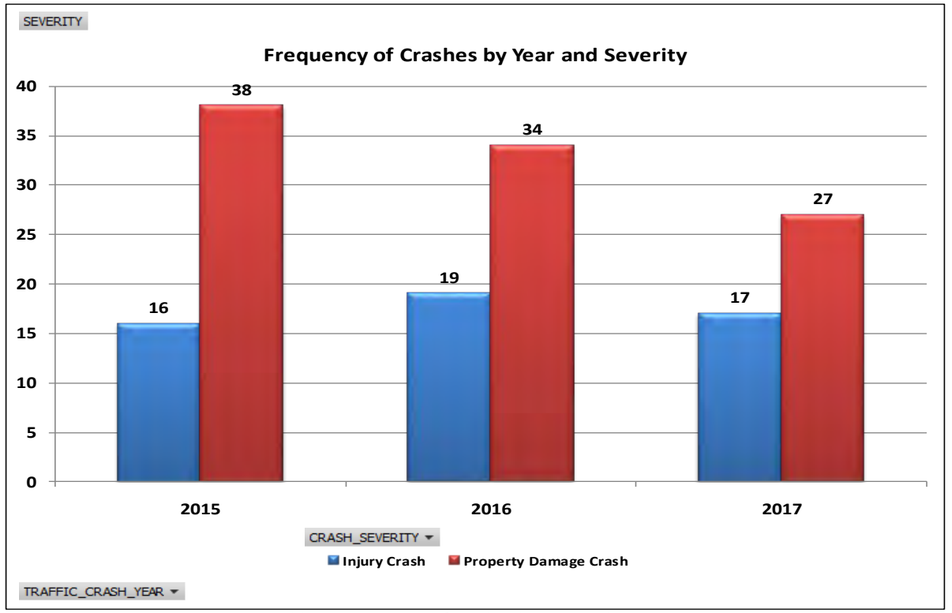


Table 5 – Frequency of Crashes by Year and Severity

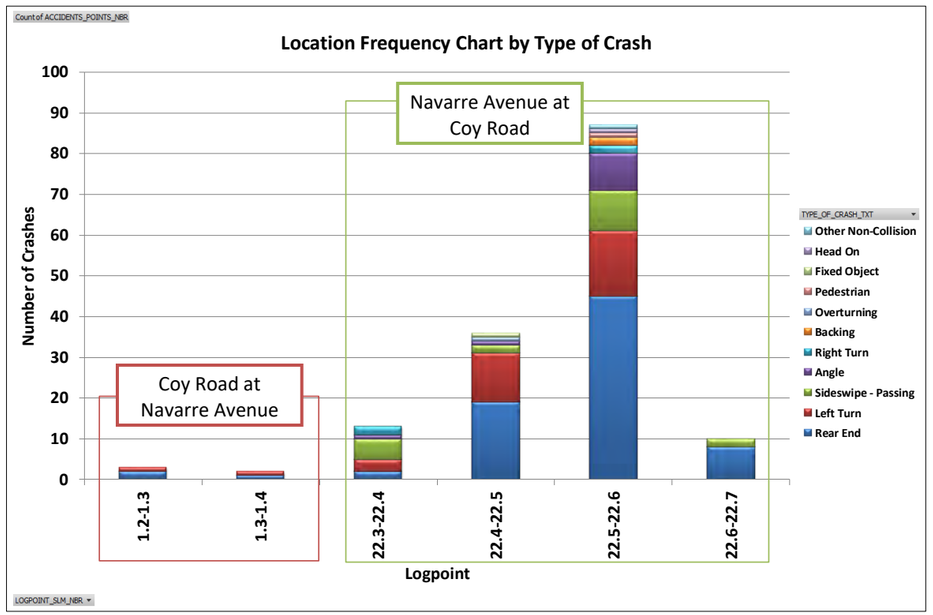


Table 6 – Crash Location Frequency by Type

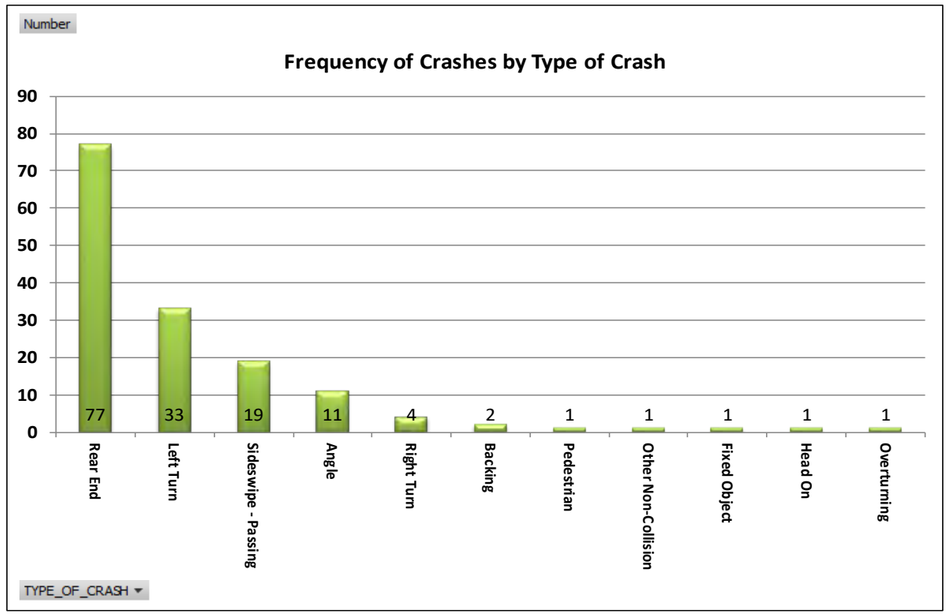


Table 7 – Frequency of Crash Type

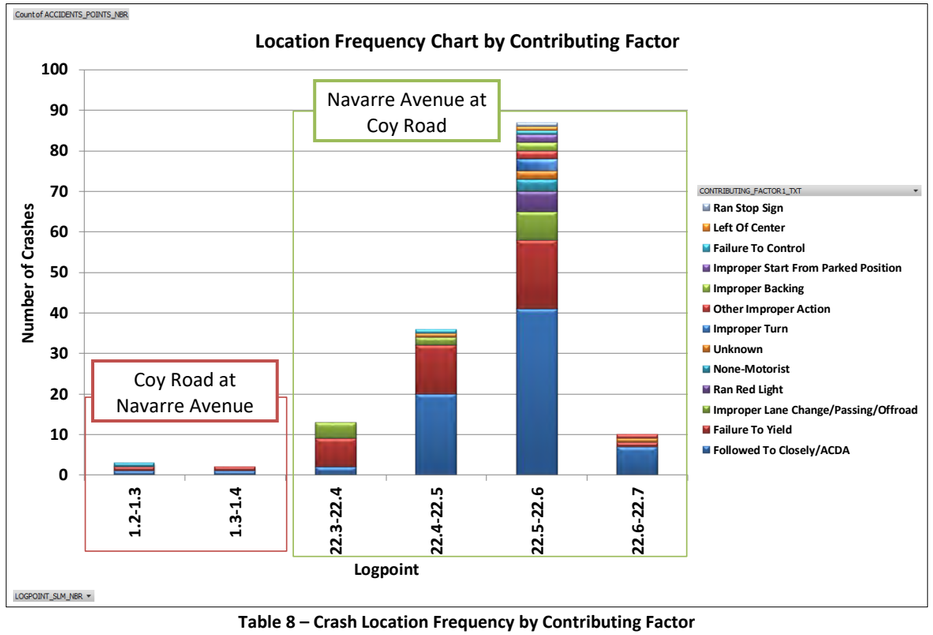


Table 8 – Crash Location Frequency by Contributing Factor

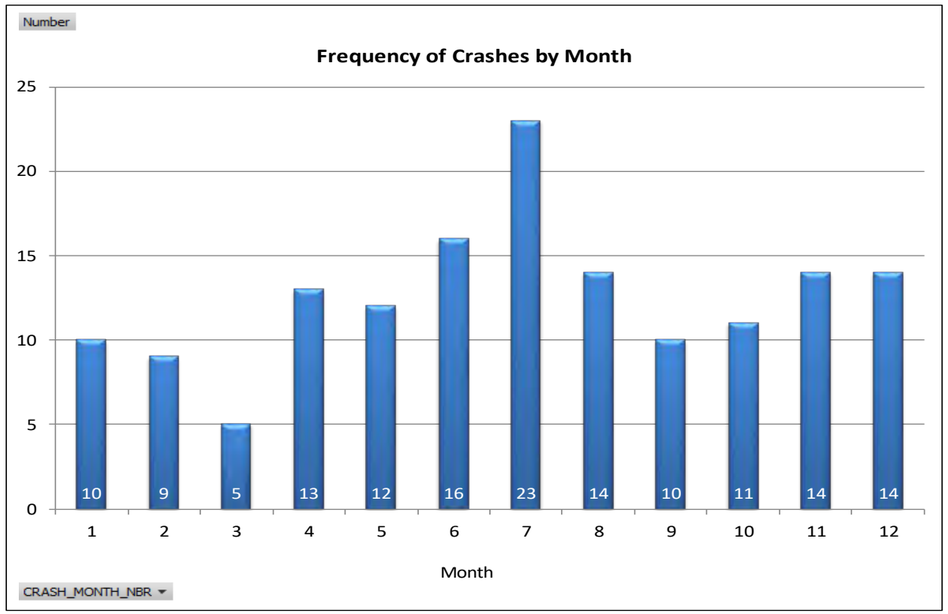


Table 9 – Crashes by Month

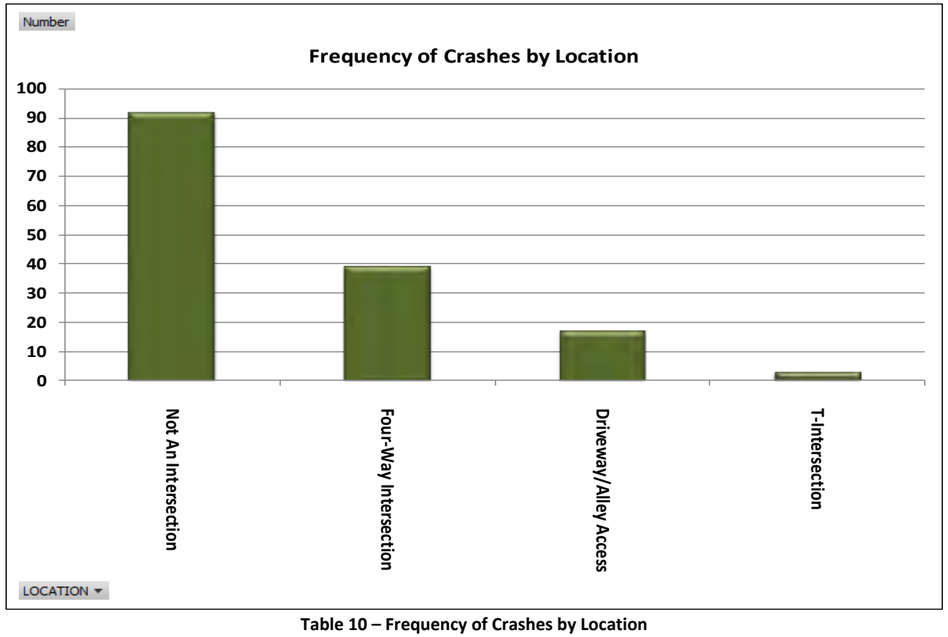
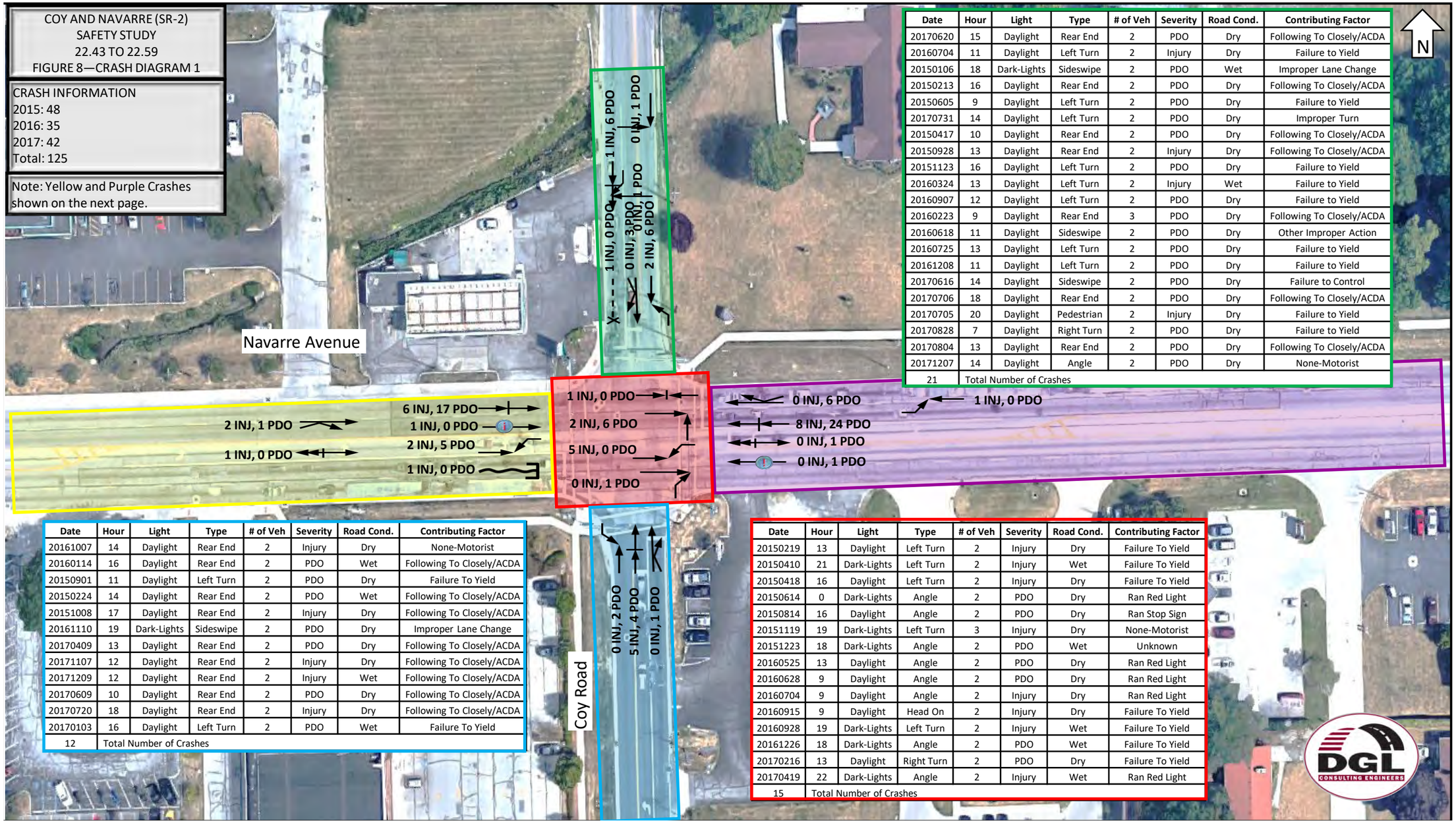


Table 10 – Frequency of Crashes by Location

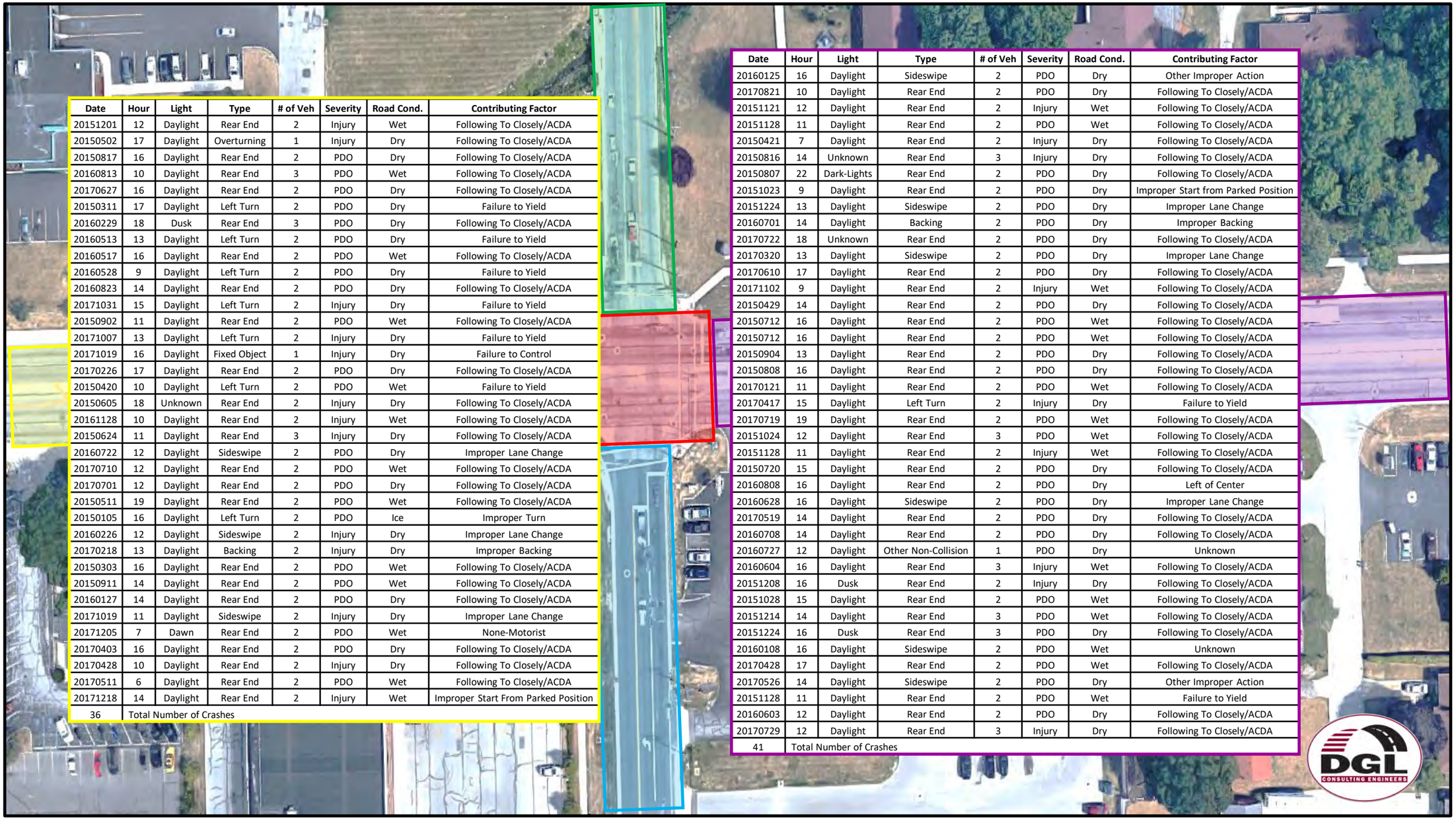


Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20170620	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160704	11	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20150106	18	Dark-Lights	Sideswipe	2	PDO	Wet	Improper Lane Change
20150213	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150605	9	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20170731	14	Daylight	Left Turn	2	PDO	Dry	Improper Turn
20150417	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150928	13	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20151123	16	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160324	13	Daylight	Left Turn	2	Injury	Wet	Failure to Yield
20160907	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160223	9	Daylight	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160618	11	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20160725	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20161208	11	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20170616	14	Daylight	Sideswipe	2	PDO	Dry	Failure to Control
20170706	18	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170705	20	Daylight	Pedestrian	2	Injury	Dry	Failure to Yield
20170828	7	Daylight	Right Turn	2	PDO	Dry	Failure to Yield
20170804	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171207	14	Daylight	Angle	2	PDO	Dry	None-Motorist
21	Total Number of Crashes						

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20161007	14	Daylight	Rear End	2	Injury	Dry	None-Motorist
20160114	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150901	11	Daylight	Left Turn	2	PDO	Dry	Failure To Yield
20150224	14	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151008	17	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20161110	19	Dark-Lights	Sideswipe	2	PDO	Dry	Improper Lane Change
20170409	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171107	12	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20171209	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20170609	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170720	18	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170103	16	Daylight	Left Turn	2	PDO	Wet	Failure To Yield
12	Total Number of Crashes						

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20150219	13	Daylight	Left Turn	2	Injury	Dry	Failure To Yield
20150410	21	Dark-Lights	Left Turn	2	Injury	Wet	Failure To Yield
20150418	16	Daylight	Left Turn	2	Injury	Dry	Failure To Yield
20150614	0	Dark-Lights	Angle	2	PDO	Dry	Ran Red Light
20150814	16	Daylight	Angle	2	PDO	Dry	Ran Stop Sign
20151119	19	Dark-Lights	Left Turn	3	Injury	Dry	None-Motorist
20151223	18	Dark-Lights	Angle	2	PDO	Wet	Unknown
20160525	13	Daylight	Angle	2	PDO	Dry	Ran Red Light
20160628	9	Daylight	Angle	2	PDO	Dry	Ran Red Light
20160704	9	Daylight	Angle	2	Injury	Dry	Ran Red Light
20160915	9	Daylight	Head On	2	Injury	Dry	Failure To Yield
20160928	19	Dark-Lights	Left Turn	2	Injury	Wet	Failure To Yield
20161226	18	Dark-Lights	Angle	2	PDO	Wet	Failure To Yield
20170216	13	Daylight	Right Turn	2	PDO	Dry	Failure To Yield
20170419	22	Dark-Lights	Angle	2	Injury	Wet	Ran Red Light
15	Total Number of Crashes						

Figure 8 – Collision Diagram 1



Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20151201	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150502	17	Daylight	Overturning	1	Injury	Dry	Following To Closely/ACDA
20150817	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160813	10	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20170627	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150311	17	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160229	18	Dusk	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160513	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160517	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20160528	9	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160823	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171031	15	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20150902	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20171007	13	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20171019	16	Daylight	Fixed Object	1	Injury	Dry	Failure to Control
20170226	17	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150420	10	Daylight	Left Turn	2	PDO	Wet	Failure to Yield
20150605	18	Unknown	Rear End	2	Injury	Dry	Following To Closely/ACDA
20161128	10	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150624	11	Daylight	Rear End	3	Injury	Dry	Following To Closely/ACDA
20160722	12	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170710	12	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170701	12	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150511	19	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150105	16	Daylight	Left Turn	2	PDO	Ice	Improper Turn
20160226	12	Daylight	Sideswipe	2	Injury	Dry	Improper Lane Change
20170218	13	Daylight	Backing	2	Injury	Dry	Improper Backing
20150303	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150911	14	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20160127	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171019	11	Daylight	Sideswipe	2	Injury	Dry	Improper Lane Change
20171205	7	Dawn	Rear End	2	PDO	Wet	None-Motorist
20170403	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170428	10	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170511	6	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20171218	14	Daylight	Rear End	2	Injury	Wet	Improper Start From Parked Position
36	Total Number of Crashes						

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20160125	16	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20170821	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20151121	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20151128	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150421	7	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20150816	14	Unknown	Rear End	3	Injury	Dry	Following To Closely/ACDA
20150807	22	Dark-Lights	Rear End	2	PDO	Dry	Following To Closely/ACDA
20151023	9	Daylight	Rear End	2	PDO	Dry	Improper Start from Parked Position
20151224	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160701	14	Daylight	Backing	2	PDO	Dry	Improper Backing
20170722	18	Unknown	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170320	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170610	17	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171102	9	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150429	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150712	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150712	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150904	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150808	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170121	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170417	15	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20170719	19	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151024	12	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20151128	11	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150720	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160808	16	Daylight	Rear End	2	PDO	Dry	Left of Center
20160628	16	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170519	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160708	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160727	12	Daylight	Other Non-Collision	1	PDO	Dry	Unknown
20160604	16	Daylight	Rear End	3	Injury	Wet	Following To Closely/ACDA
20151208	16	Dusk	Rear End	2	Injury	Dry	Following To Closely/ACDA
20151028	15	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151214	14	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20151224	16	Dusk	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160108	16	Daylight	Sideswipe	2	PDO	Wet	Unknown
20170428	17	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170526	14	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20151128	11	Daylight	Rear End	2	PDO	Wet	Failure to Yield
20160603	12	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170729	12	Daylight	Rear End	3	Injury	Dry	Following To Closely/ACDA
41	Total Number of Crashes						

Figure 9 – Collision Diagram 2

COY AND NAVARRE (SR-2)
SAFETY STUDY
22.28 TO 22.42
FIGURE 9—CRASH DIAGRAM 2

CRASH INFORMATION
2015: 4
2016: 18
2017: 3
Total: 25

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20150117	13	Daylight	Right Turn	2	PDO	Dry	Failure to Yield
20150428	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20150523	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20151025	12	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20160904	14	Daylight	Sideswipe	3	Injury	Dry	Improper Lane Change
20161114	16	Daylight	Sideswipe	2	PDO	Dry	Failure to Yield
20160129	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160508	9	Daylight	Angle	2	Injury	Dry	Failure to Yield
20160629	16	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160629	16	Daylight	Right Turn	2	Injury	Dry	Failure to Yield
20160713	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160730	13	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20160819	12	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20160831	10	Daylight	Left Turn	2	PDO	Dry	Unknown
20160830	12	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20160925	14	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20161026	16	Daylight	Sideswipe	4	Injury	Wet	Improper Lane Change
20161102	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20161110	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20161209	18	Dark-Lights	Angle	2	PDO	Dry	Failure to Yield
20161224	10	Daylight	Rear End	3	Injury	Wet	Following To Closely/ACDA
20161117	18	Dark-Lights	Left Turn	2	Injury	Dry	Failure to Yield
20170709	15	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170504	11	Daylight	Left Turn	2	PDO	Wet	Failure to Yield
20170707	17	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
25	Total Number of Crashes						

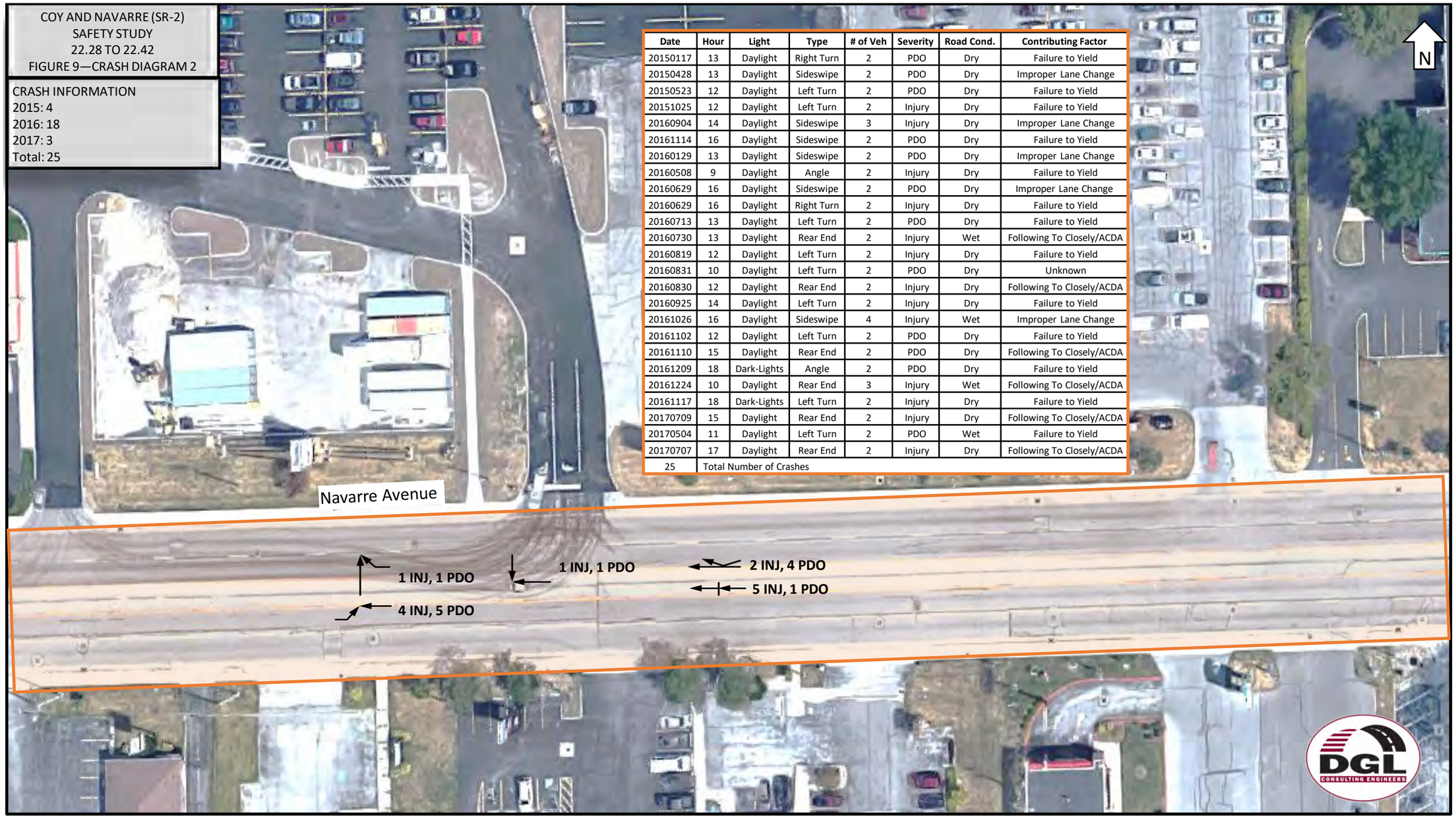


Figure 10 – Collision Diagram 3

Crash Summary Narrative

Segment Crash Rates were calculated and compared to statewide averages. Additionally, the ODOT ECAT Software was utilized to determine predicted and expected crashes, as well as the potential for safety improvement. Crash Rates for the segments within the study area are shown in Table 7. Crashes along Coy Road were analyzed in part with the intersection data, due to the crashes being within the influence of the intersection.

Seg. ID	Segment	Classification	# of Crashes	ADT	Crash Rate (ACC/MVMT)	Statewide Average
1	Navarre (SR-2) 22.30-22.41	Urban Principal Arterial	25	24,780	4.79	2.71
2	Navarre (SR-2) 22.60-22.68	Urban Principal Arterial	2	16,260	1.12	2.71

Table 11 – Segment Crash Rates

The segment west of Coy Road has a crash rate above the statewide average. While Navarre Avenue is a straight and flat roadway there are many access points. In this segment, Navarre is a four-lane roadway with a TWLTL in the center. Backups from the Navarre and Coy intersection also extend into this segment. Most of the crashes occurred at drives throughout this area.

The segment east of Coy Road has a crash rate below the statewide average. Only 2 crashes were observed in the collected data. Both crashes occurred at the Navarre Avenue/SR 2 and Athens intersection. This section of Navarre has far less driveways than the west leg.

Int. ID	Intersection	Classification	# of Crashes	Intersection Entering Vehicles	Crash Rate (ACC/MEV)	I-J-K Statewide Average
1	Navarre Ave (SR 2) & Coy Road 22.51	4-Lane Urban Signalized	128	28,800	4.53	0.369

Table 12 – Intersection Crash Rates

The Navarre Avenue/SR 2 and Coy Road intersection has a crash rate much higher than the Statewide average. This high crash rate puts the intersection at number 39 on the 2016 Urban Intersection Highway Safety Improvement Program list. Of the 123 crashes at the Navarre/SR 2 and Coy Road intersection, 69 crashes were Rear End Crashes, accounting for 55.6% of all incidents at the intersection. There were 24 Left turn Crashes (19.4%) and 13 Sideswipe – Passing crashes (10.5%) were present at the intersection. The Rear End crashes occurred on all legs of the intersection, many crashes were observed near the Rite Aid drive on Navarre. There were also several Left Turn crashes that occurred at one of the many drives near the intersection, nine Left Turn crashes occurred at the BP and Coy Drive alone. Of the 123 crashes, 85 occurred on dry pavement with 39 crashes occurring when the road was wet or icy, and 86% of crashes occurred during daylight hours.

Site Diagnosis and Identification of Potential Countermeasures

Based on Statewide Crash Rates of accidents per million entering vehicles, the Navarre Avenue and Coy Road intersection experiences 4.5 times more crashes per million entering vehicles than the state average of 0.96 crashes per million vehicles. Using the Crash Modification Factors (CMF) Clearinghouse the following Countermeasures were considered:

Countermeasure	CMF	Affected Crash Types	Affect Crash Severity	Studied
Replace Two-Way-Left-Turn-Lane with Raised Median	0.77	Angle, Fixed Object, Head On, Rear End, Run Off Road, Sideswipe, Single Vehicle	All	Yes. Continue Navarre corridor aesthetic.
Replace Incandescent Traffic Signals with LEDs	0.827	Rear End	All	No. Traffic signals currently LED.
Provide A Right-Turn Lane on One Major-Road Approach	0.75	All	All	Yes. Turn lane for WB Navarre.
Convert Signalized Intersection to Modern Roundabout	0.52	All	All	Yes. Greatly reduces crashes at intersections.
Add Signal (additional Primary Head)	0.72	Rear End	All	Yes. Supplemental signals on all approaches.
Improve Visibility of Signal Heads	0.93	All	All	Yes. Backplates recommended.
Change from 5-Section Signal Head to Flashing Yellow Arrow	0.838	All	All	No. Not present in other corridor intersections.
Install Overhead Lane-Use Signs	0.9	Rear End/Sideswipe	All	No. Currently present along Navarre in study area.
Install Right Turn Lane	0.7	Rear End	All	Yes. Provide turn lanes for NB & SB Coy.
Change Driveway Density	Equation	All	All	Yes. Consider Consolidation of drives.
Resurface Pavement	0.766	All	All	Yes.
Modify Clearance Intervals	0.88	Rear End	All	Yes.

Table 13 – Potential Crash Countermeasures

Replace Two-Way-Left-Turn-Lane with Raised Median: Changing the TWLTL to a median with turnarounds or access points would reduce the number of driveway crashes along the corridor. All legs of the intersection have several driveways that can access the roadway within a very close proximity of the signal. Constructing a median would reduce the allowable movements in and out of the drives to rights, thus reducing the potential conflict points at the drive.

Install Right Turn Lane/Provide Right-Turn Lane on One Major Lane Approach: The installation of a right turn lane on both approaches of Navarre Avenue and both approaches Coy Road was also examined. The right turn lanes on Navarre could reduce the number or rear end crashes while making the signal more efficient. Right turn lanes on Coy Road would also improve the efficiency of the signal. The installation of right turn lanes would also allow for more green time on Navarre. Allowing a right-turn overlap from Coy Road while left turn phasing is on along Navarre Avenue will move vehicles from Coy road to Navarre, thus increasing the signal efficiency. However, the cost of constructing right turn lanes along Navarre Avenue/SR 2 versus the intersection capacity gains did not show a favorable return on investment.

Convert Signalized Intersection to Modern Roundabout: Converting the signalized Navarre Road and Coy intersection to a roundabout was also considered. A dual lane roundabout would require significant right of way acquisition on all quadrants. It should also be noted that signalized intersections are present within 600 feet south of the study intersection and could potentially create problems with the flow of the roundabout. While roundabouts have significantly lower crash rates, the Navarre Road and Coy intersection is not the ideal location for a roundabout.

Add Signal (additional Primary Head): The Navarre Avenue/SR 2 and Coy Road intersection currently has two signal heads per through approach. The addition of an additional signal head for each approach could also help reduce crash rates at the intersection. The installation of additional signal heads has the potential to be a lower cost option to improve crash rates at the intersection.

Improve Visibility of Signal Heads: Low visibility of the signal heads may contribute to the high number of crashes at the intersection. The Navarre Avenue/SR 2 corridor runs East-West and the lack of backplates on the signal heads could be a contributing factor of crashes. Drivers may not be able to easily see the signal heads due to the position of the sun and direction of travel. The existing signals were installed in 1999, do not have backplates, and the early LED equipment are not as bright as the currently manufactured LED signals.

Install Overhead Lane-Use Signs: Navarre currently has overhead lane control signs for both directions of Navarre Avenue/SR 2 at Coy Road, so this countermeasure is not recommended.

Change Driveway Density: Changing the driveway density throughout the corridor is also a potential countermeasure. Within the study area there are 32 driveways. Reducing the number of driveways would greatly increase the safety of the roadway. Two driveways at the BP Gas Station and one Third Base Carryout drive are recommended to be removed.

Resurface Pavement: Resurfacing the pavement within the study area will improve skid resistance while reducing crashes that occur during wet weather. According to the ODOT TIMS website the Pavement Condition Rating along Navarre Avenue is currently fair but is anticipated to become in need of repair by 2021. The City of Oregon noted that rutting and longitudinal cracking are occurring around the intersection area and should be resurfaced. The LUC-2-21.24 Safety project used Microsurfacing as a countermeasure. The City would prefer milling and resurfacing for this project.

Modify Change Plus Clearance Interval to ITE 1985 Proposed Recommended Practice: Alternatively, the modification of the signal clearance intervals and red times could also reduce the number of rear end crashes at the intersection. In many other cases the cost to retime the signal, or the entire corridor, has an extremely high rate of return. When retiming and improving clearance times, the cost to do so is relatively low. It can be more effective than the installation of new facilities. With this countermeasure the pedestrian clearance intervals were also evaluated and updated.

The following countermeasures were studied at the Navarre Avenue/SR 2 and Coy Road intersection

- Signal Upgrades
  - Improve the visibility of new signal heads by installing include backplates.
  - Add a signal head on all approaches so that each thru lane has a signal and separate the left turn arrow.
  - Modify change plus clearance interval to ITE 1985 Proposed Recommended Practice.
- Intersection Geometrics
  - Add a 250-foot right lane for Northbound Coy Road with corresponding taper before bridge on North leg.
  - Add a 250-foot thru-right lane for Southbound Coy Road that extends to the right turn only lane at Dustin Road.
  - Add a sidewalk along North Leg on west side of Coy Road.
  - Add a 265-foot right turn lane for Eastbound Navarre Avenue/SR 2.
  - Add a 315-foot right turn lane for Westbound Navarre Avenue/SR 2.
  - Replace Two-Way-Left-Turn-Lane with a raised median on the west leg of Navarre Avenue/SR 2.
  - Relocate drives within 50 feet of the intersection.
  - Convert Signalized Intersection to two-lane roundabout.

Table 13 depicts the studied countermeasures and their potential crash reduction. Additional analyses follow including highway capacity, countermeasure costs and return on investment.

Countermeasure	Location	% Crash Reduction
Install Backplates (new signal heads)	All Signal Heads	7%
Add Additional Signal Heads	All Approaches	28%
Add Right Lane for NB Coy Road	NB Coy	30%
Add Thru-Right Lane for SB Coy Road	SB Coy	30%
Add Right lane for EB Navarre Avenue/SR 2	EB Navarre	25%
Add Right lane for WB Navarre Avenue/SR 2	WB Navarre	25%
Replace TWLTL with raised Median	Navarre	23%
Relocate Drives within 50 feet of intersection	Coy & Navarre	3%
Convert intersection to Roundabout	Intersection	48%
Resurface Pavement	Study Area	24%
Modify Clearance Intervals	Intersection	12%

Table 14 – Proposed Countermeasures

Design Evaluation

HCS analysis was conducted for the proposed geometric changes to the intersection. A thru-right lane on Northbound and Southbound Coy, along with a right turn lane on Eastbound Navarre. Some upgrades did not affect the HCS Analysis of the intersection including, a median along Navarre, installation of backplates, and adding signal heads.

Further evaluation of the proposed countermeasures is shown in the table below. Synchro 9 analysis of the signalized intersection was used to improve the signal timing, while Sidra 8 software was used to evaluate the potential roundabout.

The level of service (LOS) is a way to classify the intersection on a scale of A to F, from a functional standpoint. Intersections and approaches are assigned an overall grade based on traffic volumes, capacity, and overall delay experienced by drivers.

Intersection Level of Service and Delay (in seconds)								
Signalized Intersection			**Unsignalized Intersection**			**Roundabout Intersection**		
A	<=	10s	A	<=	10s	A	<=	10s
B	>	10-20s	B	>	10-15s	B	>	10-15s
C	>	20-35s	C	>	15-25s	C	>	15-25s
D	>	35-55s	D	>	25-35s	D	>	25-35s
E	>	55-80s	E	>	35-50s	E	>	35-50s
F	>	80s	F	>	50s	F	>	50s

Table 15 – Intersection Level of Service

Several of the proposed countermeasures do not influence the level of service or queue length of vehicles within the intersection. These countermeasures were not included on the table.

Proposed Countermeasure Evaluation					
Scenario	**Approach**	**LOS & Delay**	**Max Queue (Lane)**		**v/c**
			Left Lane	**Thru Lane**	
Existing Condition	Intersection	D (36.5)	-	-	-
	EB Navarre	C (28.1)	87’	324’	0.68
	WB Navarre	C (28.0)	88’	340’	0.69
	NB Coy	D (47.3)	154’	195’	0.81
	SB Coy	D (54.8)	222’	368’	0.89
Add Thru-Right lane for Northbound Coy Road + Timing Changes	Intersection	C (31.3)	-	-	-
	EB Navarre	C (26.7)	81’	318’	0.66
	WB Navarre	C (26.7)	82’	334’	0.68
	NB Coy	C (25.7)	158’	72’	0.77
	SB Coy	D (52.4)	163	400’	0.89
Add Thru-Right Lane for Southbound Coy Road + Timing Changes	Intersection	C (32.1)	-	-	-
	EB Navarre	C (26.7)	81’	318’	0.66
	WB Navarre	C (26.8)	82’	334’	0.68
	NB Coy	D (48.8)	102’	281’	0.90
	SB Coy	C (34.6)	227’	105’	0.89
Add Right Lane for Eastbound Navarre Avenue + Timing Changes	Intersection	D (37.0)	-	-	-
	EB Navarre	C (23.5)	81’	282’	0.59
	WB Navarre	C (26.6)	82’	334’	0.68
	NB Coy	D (54.4)	159’	281’	0.90
	SB Coy	E (61.4)	227’	400’	0.89
Add Right Lane for Westbound Navarre Avenue + Timing Changes	Intersection	D (36.2)	-	-	-
	EB Navarre	C (26.4)	81’	318’	0.66
	WB Navarre	C (21.2)	82’	259’	0.54
	NB Coy	D (54.4)	159’	281’	0.90
	SB Coy	E (61.4)	227’	400’	0.88
Add Thru-Right Lane for Northbound and Southbound Coy Road + Timing Changes	**Intersection**	**C (25.5)**	**-**	**-**	**-**
	EB Navarre	**C (22.3)**	**81’**	**318’**	**0.58**
	WB Navarre	**C (22.3)**	**82’**	**334’**	**0.60**
	NB Coy	**C (31.3)**	**102’**	**172’**	**0.69**
	SB Coy	**C (30.9)**	**163’**	**105’**	**0.76**
Modify Clearance Intervals + Timing Changes	Intersection	D (38.8)	-	-	-
	EB Navarre	C (27.1)	82’	318’	0.67
	WB Navarre	C (27.1)	83’	334’	0.68
	NB Coy	E (56.4)	164’	389’	0.90
	SB Coy	E (62.5)	232’	396’	0.88
Convert Signalized Intersection to Roundabout	Intersection	C (16.3)	-	-	0.63
	EB Navarre	C (15.2)	142.6’	145.9	0.76
	WB Navarre	B (14.4)	142.4	145.2	0.74
	NB Coy	C (19.6)	74.7	46.5	0.80
	SB Coy	C (18.6)	79.0	80.9	0.78

Table 16 – Proposed Countermeasure Evaluation

Although the roundabout had the best LOS and delay improvement, the roundabout option requires a large 2 lane roundabout and significant right of way acquisition. Significant damage to the BP Gas Station and Third Base Carry out properties is expected. Both businesses may require relocation of a business. In addition, a future signal is located

with 1,200 feet west and existing signals are located 2,200' east and 600' south. The addition of a single roundabout in this corridor is not recommended due to poor LOS.

The best solution for the Navarre Avenue/SR 2 and Coy Road intersection is a combination of several countermeasures. LOS and delay analysis indicate that the Northbound and Southbound Coy Road Thru-Right Lanes with timing changes yields the best result for the intersection. Combining these changes with the addition of medians, resurfacing the pavement, increasing visibility of the signals, and installing additional signal heads can result in a much lower crash rating for the intersection.

A cost breakdown for the countermeasures shown above can be found in Appendix C – Calculations. The cost listed for the modification to clearance intervals is the estimated cost for a full corridor signal timing study. The construction costs were estimated using unit costs from the LUC-2-21.24 (PID 96295) bid tabulation. A contingency of 30%, engineering design cost of 12%, and an inflation cost was used to calculate the final project cost. Inflation costs were calculated using the ODOT Fiscal Year 2019-2023 Business Plan Inflation Calculator. Using the Total Project Cost of $838,000 the calculator gave an estimated inflation cost of 7.7% for construction in 2020 dollars. Following the ECAT Cost and Benefit analysis, the additional cost for construction inspection and testing were not included. DGL has estimated this inspection and testing cost to be 10% of the contingency and inflation total cost at $122,000. The estimate also includes $32,000 to add on to the existing structure over Amolsch Ditch. A full bridge replacement is estimated to cost between $150,000 to $220,000. Aesthetic upgrade costs were not included in the estimate. The City intends to continue the aesthetic treatments as constructed in the LUC-2-21.24 project at their own cost.

Right-of-Way costs were estimated by West Erie Realty in September 2018. The final cost of $1,358,800 represents a worst-case scenario, which would include total acquisition of the BP Gas Station site. Potential right-of-way acquisition for the Third Base Carryout as well as Rite Aid, St. Paul's Church, and First Federal Bank were also evaluated. The worst-case Right-of-Way estimate includes consulting fees for appraisal and relocation review. For the estimate shown below, a less severe Right-of-Way cost was provided. This estimate reduced the impact to BP Gast Station, Third Base Carryout and St. Paul's Church.

LUC-2-22.42 Safety Study Proposed Conditions Estimated Costs		
Roadway Improvements	$	74,000.00
Erosion Control	$	2,000.00
Drainage	$	71,000.00
Pavement	$	324,000.00
Structure Addition	$	32,000.00
Traffic Control	$	60,000.00
Traffic Signal	$	150,000.00
Maintainance of Traffic	$	50,000.00
Incidentals	$	80,000.00
Total Project Cost:	**$**	**843,000.00**
Contingency (30%):	$	252,900.00
Inflation (7%)	$	133,342.00
Total:	**$**	**1,229,242.00**
Engineering (10%):	$	115,477.00
Right of Way	$	700,000.00
Grand Total:	**$**	**2,044,719.00**

Table 17 – Proposed Conditions Estimated Cost

Proposed Countermeasure Evaluation

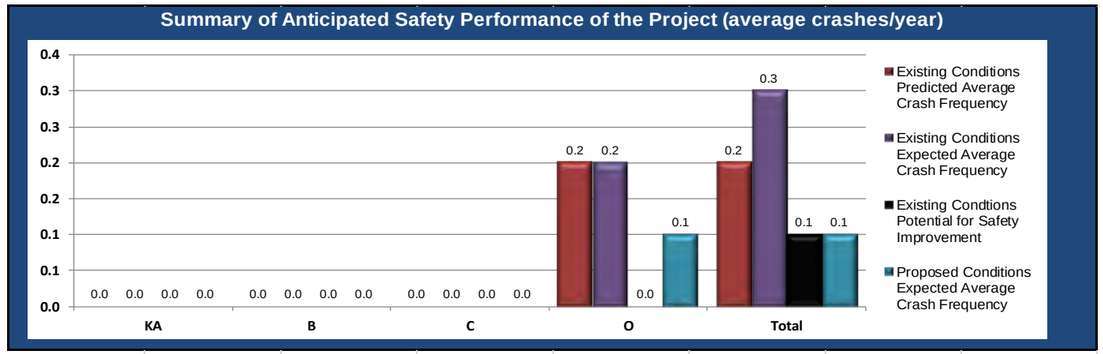
ODOT's Economic Crash Analysis Tool (ECAT) uses the crash data and proposed countermeasures to estimate the predicted crashes expected from installing specific countermeasures while also calculating a benefit to cost analysis for the proposed design. CMF's not located in the ECAT software were added manually through the data obtained from the CMF Clearinghouse.

For Navarre Avenue/SR 2 ECAT analysis was conducted for the study area in three parts. The first analysis reviewed the western study area of Navarre SLM 22.28-22.42. Next the Navarre and Coy intersection influence area, SLM 22.42-22.60 was analyzed. Last the eastern edge of the study area was analyzed along Navarre SLM 22.60-22.68.

ECAT Analysis Study Area 1 – Navarre Avenue/SR 2 – SLM 22.28 to 22.42

Using the collected crash data and the applicable countermeasures the following safety performance for Navarre Avenue/SR 2 was estimated. For the western section of the study area the following countermeasures were applied; Resurfacing Pavement and Installation of a Median. The median would have a u-turn allowing some left turn movements along Navarre, similar to the safety project recently completed.

With the stated countermeasures, ECAT predicted a crash reduction rate along Navarre Avenue/SR 2 in this section. The calculated ECAT analysis is shown in Figure 11.

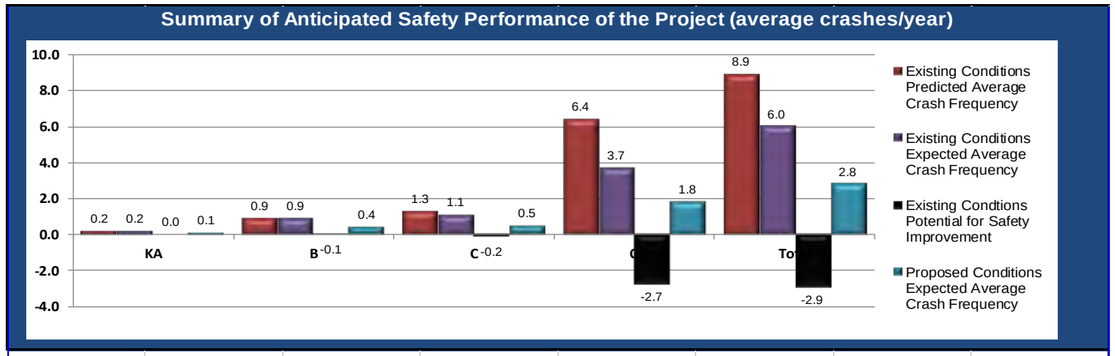


Project Summary Results (Without Animal Crashes)	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.0071	0.0332	0.0305	0.1573	0.2281
$N_{expected}$ - Existing Conditions	0.0070	0.0386	0.0380	0.2032	0.2868
$N_{potential\ for\ improvement}$ - Existing Conditions	-0.0001	**0.0054**	**0.0075**	**0.0459**	**0.0587**
$N_{expected}$ - Proposed Conditions	0.0019	0.0104	0.0107	0.0574	0.0804

Figure 11 – Navarre Avenue/SR 2 SLM 22.28-22.42 ECAT

ECAT Analysis Study Area 2 – Navarre Avenue/SR 2 & Coy Road Intersection – SLM 22.42-22.60

The intersection of Navarre Avenue/SR 2 and Coy Road had the highest amount of crashes throughout the study area. Crashes due to the influence of the intersection occurred to around 250 feet from the center of the intersection. For this section several countermeasures were proposed including; Resurfacing Pavement, Addition of a Median, Installation of a Right Turn Lane, and Improving the visibility of Signal Heads. Analysis showed significant decrease in crashes with the proposed countermeasures.



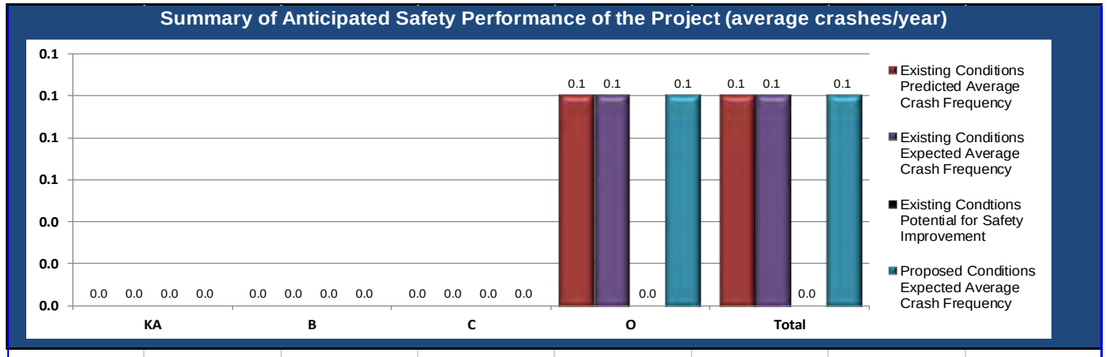
Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.2030	0.9310	1.3080	6.4115	8.8535
$N_{expected}$ - Existing Conditions	0.1994	0.8632	1.1490	3.7465	5.9581
$N_{potential\ for\ improvement}$ - Existing Conditions	-0.0036	-0.0678	-0.1590	-2.6650	-2.8954
$N_{expected}$ - Proposed Conditions	0.0868	0.3889	0.5432	1.7928	2.8117

Figure 12 – Navarre Avenue/SR 2 & Coy Road Intersection ECAT SLM 22.42-22.60

ECAT Analysis Study Area 3 – Navarre Avenue/SR 2 – SLM 22.60 to 22.68

The eastern section of the study area along Navarre Avenue/SR 2 did not have many crashes in the existing conditions. The same countermeasures that were applied in study area 1 were applied to this location, resurface pavement and install median. With the countermeasures ECAT predicted a slight reduction in the crash rate within this section.



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.0035	0.0154	0.0146	0.0767	0.1102
$N_{expected}$ - Existing Conditions	0.0033	0.0152	0.0143	0.1098	0.1426
$N_{potential\ for\ improvement}$ - Existing Conditions	-0.0002	-0.0002	-0.0003	**0.0331**	**0.0324**
$N_{expected}$ - Proposed Conditions	0.0028	0.0072	0.0096	0.0772	0.0968

Figure 13 – Navarre Avenue/SR 2 SLM 22.60-22.68 ECAT

Conclusions

A review of the ECAT analysis reports reveal that the Expected Average Crash Frequency exceeds the Predicted Average Crash Frequency, thus there is a Potential for Safety Improvement for all locations. Crash patterns at the locations can be attributed to the geometric design of the study area.

While the minor modifications may help the reduce crashes within the study area, the CMF's do not show a large improvement in conditions.

The study area should be treated as a whole, although combining the ECAT study areas into one project is not possible with the software. Therefore, to figure a Benefit Cost Analysis, only the ECAT for the intersection was used with all the proposed improvements. A full improvement to the Navarre Avenue/SR 2 and Coy Road intersection and study area with right turn lanes, medians, and repaving indicate a positive return on investment. This ROI includes $700,000 for Right-of-Way acquisition and only an addition onto the Coy Road bridge. With these factors, a positive ROI is anticipated to occur in 2036, 18 years after construction.

SUMMARY OF SUPPLEMENTAL TRAFFIC STUDIES

The Navarre Avenue/SR 2 corridor has been studied several times since 2010. In 2010 a Traffic Analyses was conducted by DGL for Coy Road between Navarre Avenue to Dustin Road. The study reviewed the unsignalized Dustin Road and Coy Road intersection for potential improvements. The study resulted in the Coy/Dustin intersection being converted to a signalized intersection which was constructed in 2014. Other analyses looked at potential upgrades to the Coy/Navarre intersection. The results include northbound and southbound right turn lanes on Coy Road.

In June 2012, DLZ and TEC prepared an Access Management Study for ODOT District 2 for the Navarre Avenue Corridor between I-280 to Coy Road. The study recommended medians be installed to eliminate left turn movements and U-Turn lanes at intersections. Access Roads that combined multiple private drives into one location were also recommended. DLZ and TEC recommendations extended through the limits of the Navarre Avenue/SR 2 & Coy Road intersection. The study also recommended the addition of a northbound Coy right turn lane.

RECOMMENDATIONS AND PRIORITIZATION

Geometric modifications are recommended for the study area, to include medians, turn lanes and signal upgrades. Additional countermeasures are also available that may provide some relief until the long-term solutions can be constructed.

Countermeasure Recommendations and Implementation Plan

Short Term Countermeasures

- $20,000.00
- Install backplates on existing signal heads
- Modify change plus clearance interval to ITE 1985 Proposed Recommended Practice
- Improve corridor timing along Navarre Avenue/SR 2
- Add additional signal heads to existing traffic signal

Long Term Countermeasures

- $2,038,219.00
- Increase pavement by resurfacing
- Install median along Navarre Avenue/SR 2 throughout study area
- Install Thru-Right turn lanes on Coy Road
- Extend Right turn lane from Coy Road onto Dustin Road to Navarre Avenue/SR 2
- Expand Coy Road culvert over Amolsch Ditch to accommodate additional pavement width and sidewalks
- Decrease drive density near intersection

Using the ECAT software a Benefit Cost Analysis was conducted. Decorative elements were not included In the analysis, nor was the total bridge replacement cost. The City of Oregon will fund the aesthetic treatments as it did in LC-2-2.21.24, and is intending to pursue funding to have the Coy Road bridge replaced. Using the described countermeasures, Right-of-Way Costs, estimated annual maintenance costs, and the salvage value of the proposed design a Net Benefit of the project was calculated. The final benefit to cost ratio for the entire project is 1.01.

Benefit - Cost Calculator	
Net Present Value of Project	$1,919,254.40
Net Present Value of Safety Benefits	$1,929,750.96
Net Benefit	$10,496.56
Benefit / Cost Ratio	1.01

Figure 14 – Benefit and Cost Calculator

Using the estimated construction costs, a return on investment has also been calculated. According to the ECAT analysis and a service life of 30 years, a positive return on investment will be observed in 2036, 18 years after the project has be constructed.

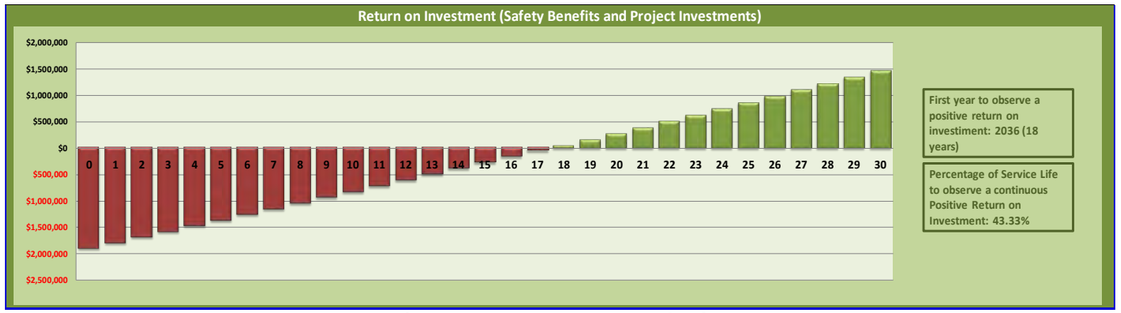


Figure 15 – Return on Investment Graph

Based on the available funding and Cost to Benefit analysis, it is recommended that an ODOT Safety Application be prepared for the Long Term Countermeasures and include both the Short Term and Medium Term countermeasures. The Navarre Avenue/SR 2 and Coy Road intersection is ranked 39th on the 2016 Urban Intersection Highway Safety Improvement Program list for Ohio. This intersection is along the Navarre Avenue/SR 2 corridor, a main commercial corridor through Oregon Ohio in Lucas County. Improvements to this intersection would greatly improve the safety of the intersection.

Proposed Condition Diagrams

The following figures show the proposed improvements to the Navarre Avenue/SR 2 and Coy Road intersection study area.

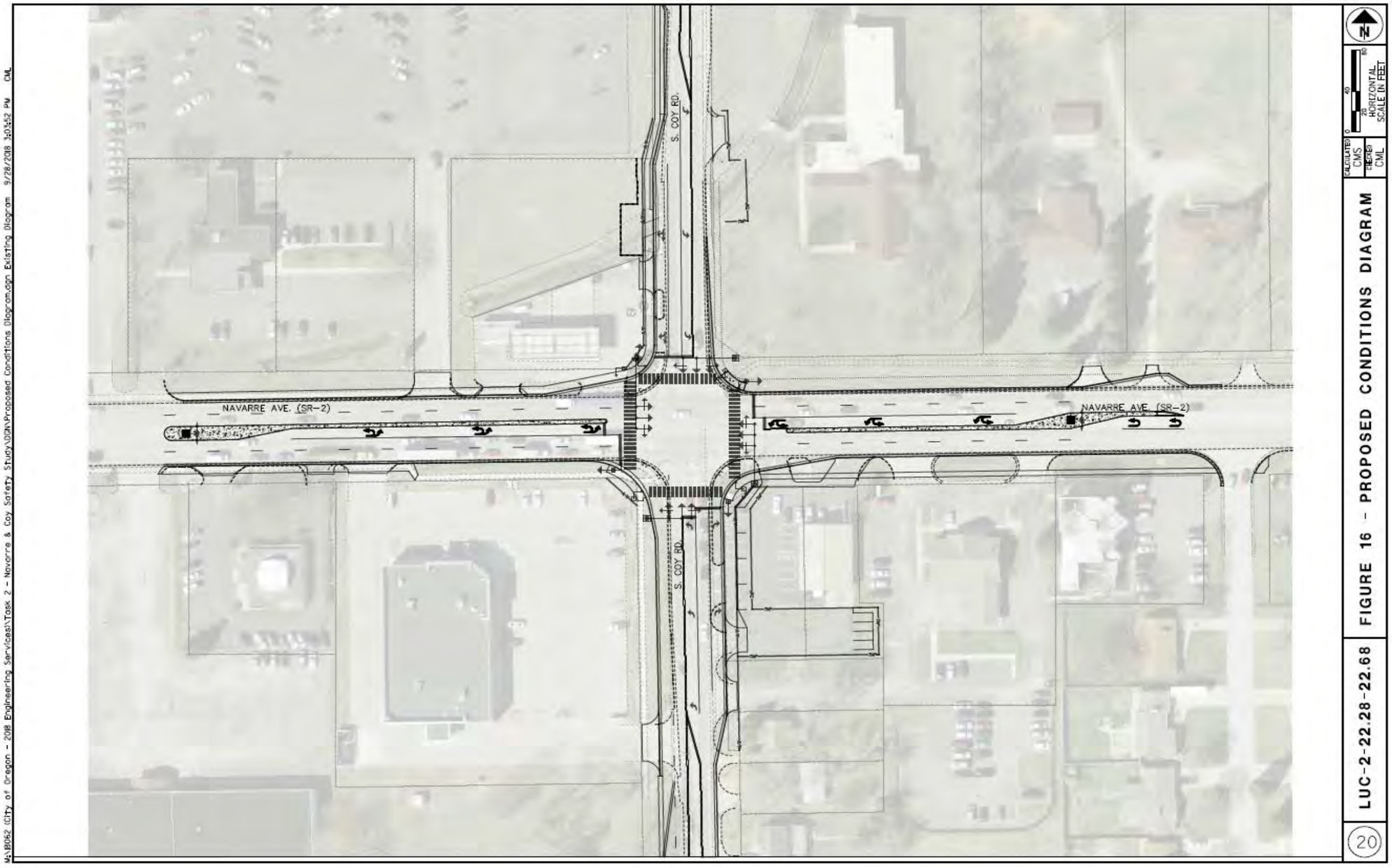


Figure 16 - Proposed Conditions Diagram

APPENDIX A

Turn Movement Counts

Study Name 18062 Navarre and Coy Safety Study

Start Date 2018

Site Code 18062

Project Traffic from DGL Count

2018 Navarre and Coy

	Westbound				Eastbound				Southbound				Northbound				
Start Time	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Peak Period
7:45 AM	71	494	25	0	31	367	44	0	74	85	60	0	68	41	82	0	AM
11:30 AM	169	734	103	0	83	598	70	0	151	141	132	0	169	121	135	0	Mid-Day
4:45 PM	136	659	143	0	133	706	78	0	192	193	144	0	161	189	137	0	PM

Growth Rate: 0.50% Years until Opening Day: 3

2021 Navarre and Coy

	Westbound				Eastbound				Southbound				Northbound				
Start Time	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Peak Period
7:45 AM	72	501	25	0	31	373	45	0	75	86	61	0	69	42	83	0	
11:30 AM	172	745	105	0	84	607	71	0	153	143	134	0	172	123	137	0	
4:45 PM	138	669	145	0	135	717	79	0	195	196	146	0	163	192	139	0	

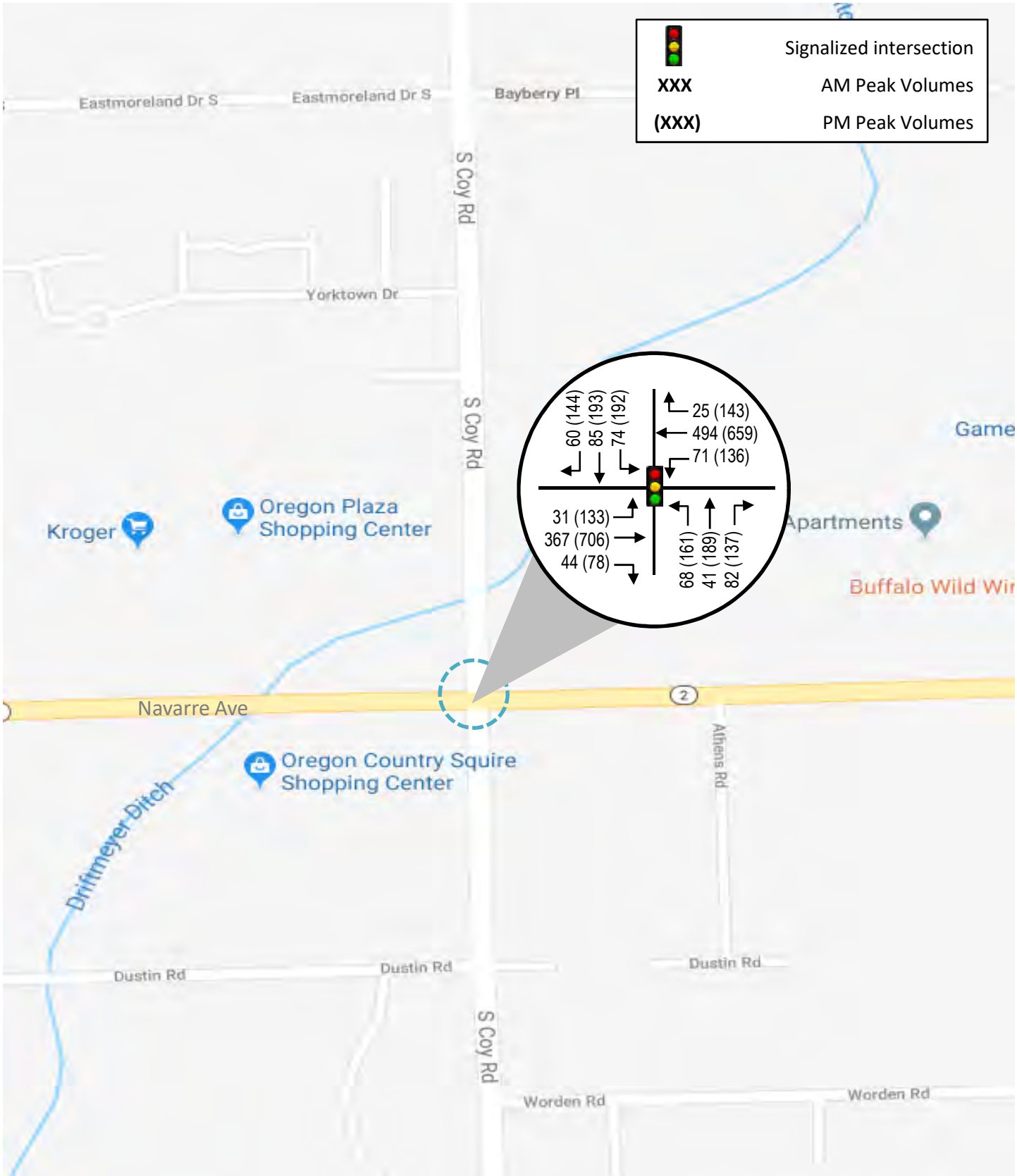
Growth Rate: 0.50% Years until Opening Day: 23

2041 Navarre and Coy

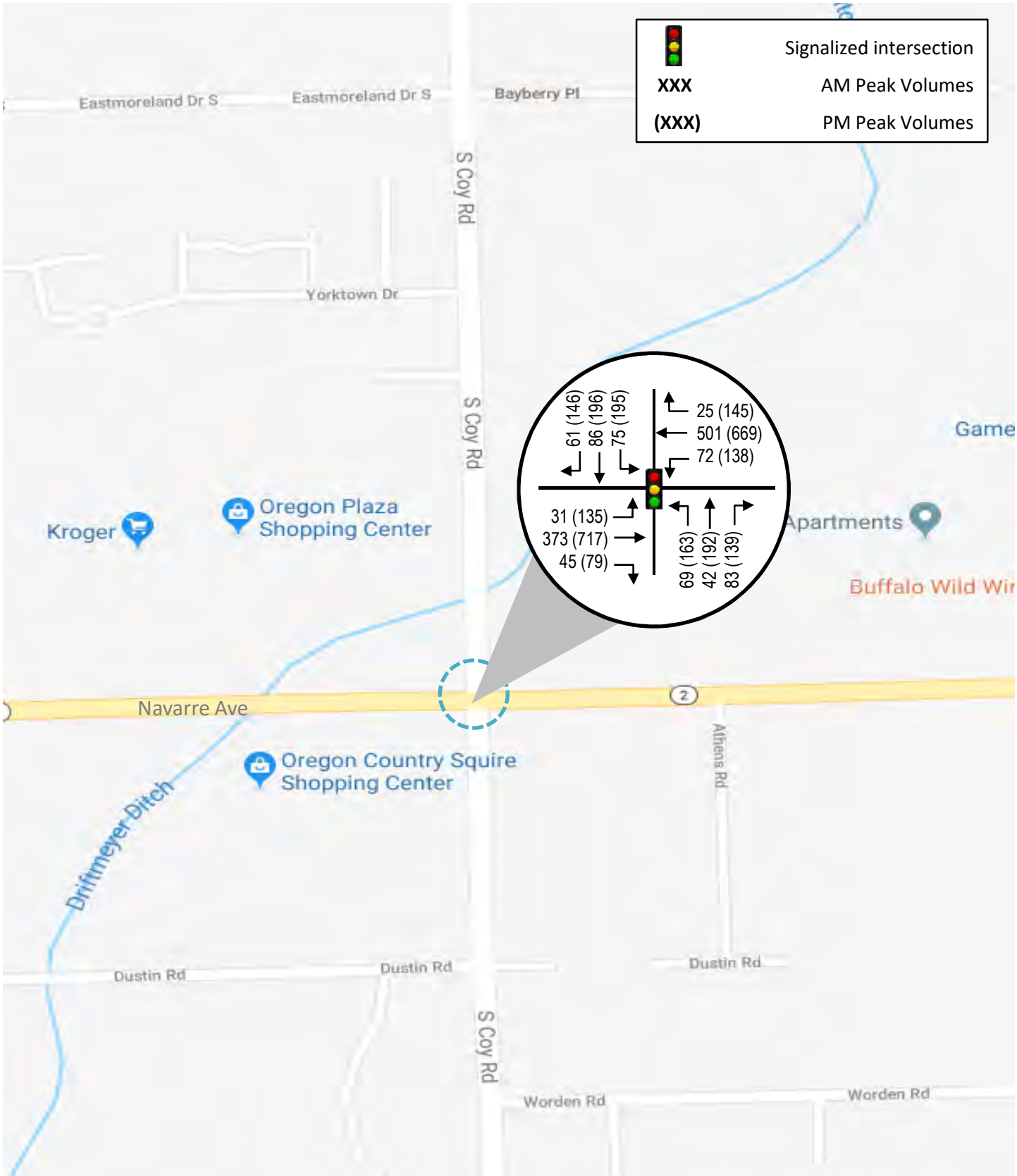
	Westbound				Eastbound				Southbound				Northbound				
Start Time	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Peak Period
7:45 AM	81	562	28	0	35	418	50	0	84	96	68	0	77	47	93	0	AM
11:30 AM	193	836	118	0	94	681	80	0	172	160	150	0	193	138	154	0	AM
4:45 PM	155	750	163	0	151	804	89	0	219	220	164	0	183	215	156	0	PM
																	PM

APPENDIX B

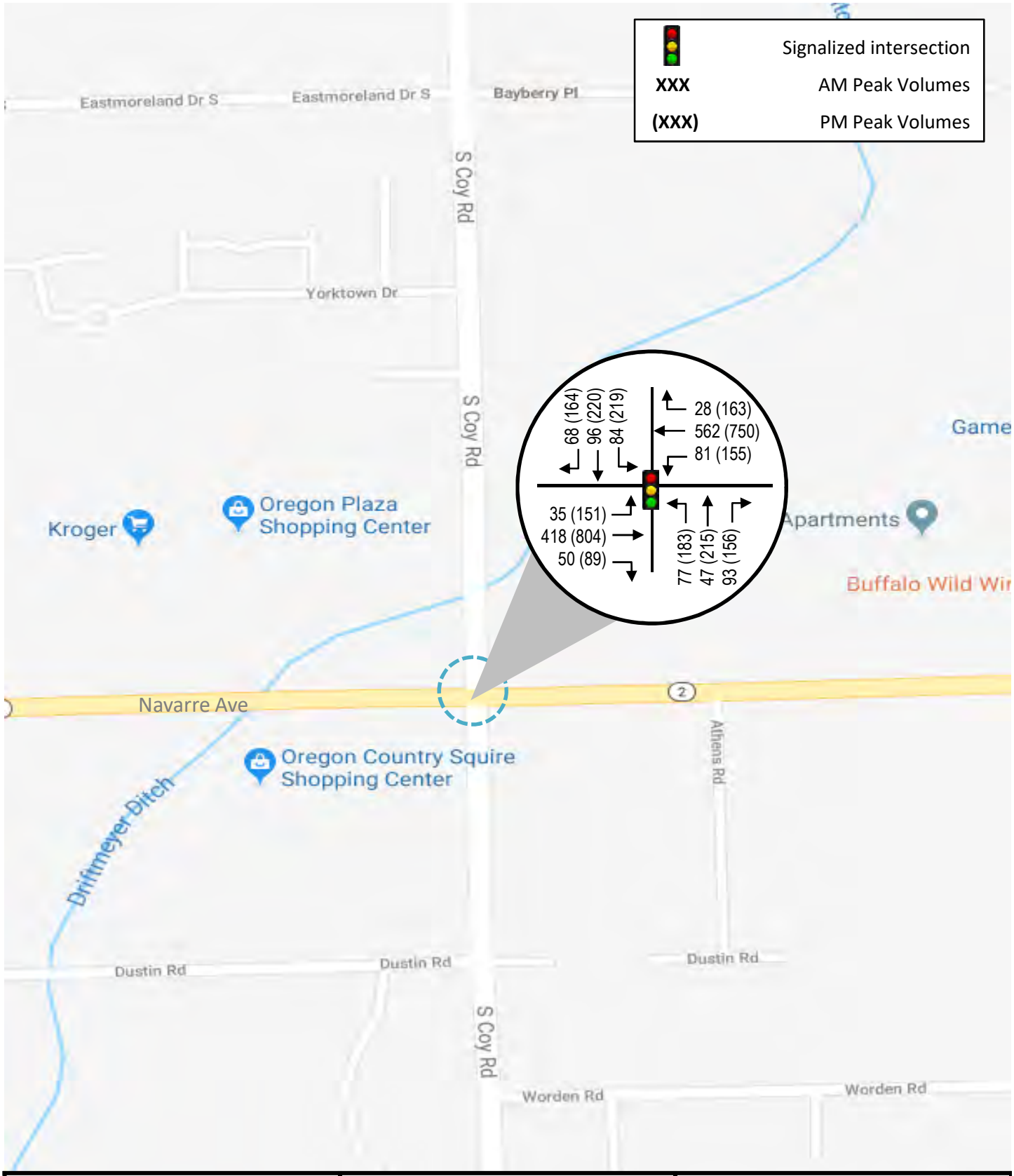
Traffic Figures



DGL CONSULTING ENGINEERS	**NAVARRE & COY SAFETY STUDY**	Location Map
	2018 EXISTING TRAFFIC DATA	



DGL CONSULTING ENGINEERS	**NAVARRE & COY SAFETY STUDY**	Location Map
	2021 PROPOSED TRAFFIC DATA	



DGL CONSULTING ENGINEERS	**NAVARRE & COY SAFETY STUDY**	Location Map
	2041 PROPOSED TRAFFIC DATA	

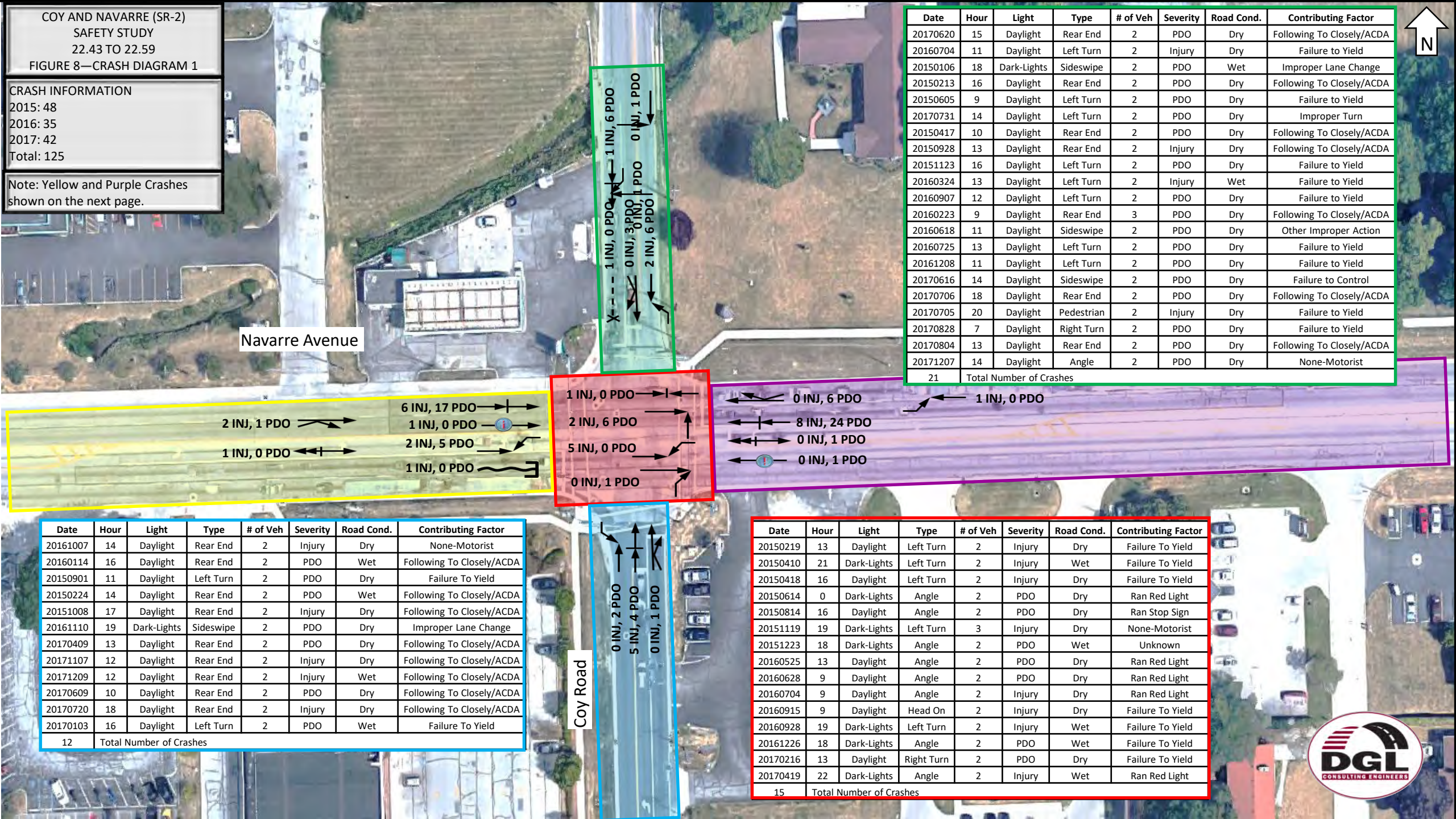
APPENDIX C

Crash Analysis

COY AND NAVARRE (SR-2)
SAFETY STUDY
22.43 TO 22.59
FIGURE 8—CRASH DIAGRAM 1

CRASH INFORMATION
2015: 48
2016: 35
2017: 42
Total: 125

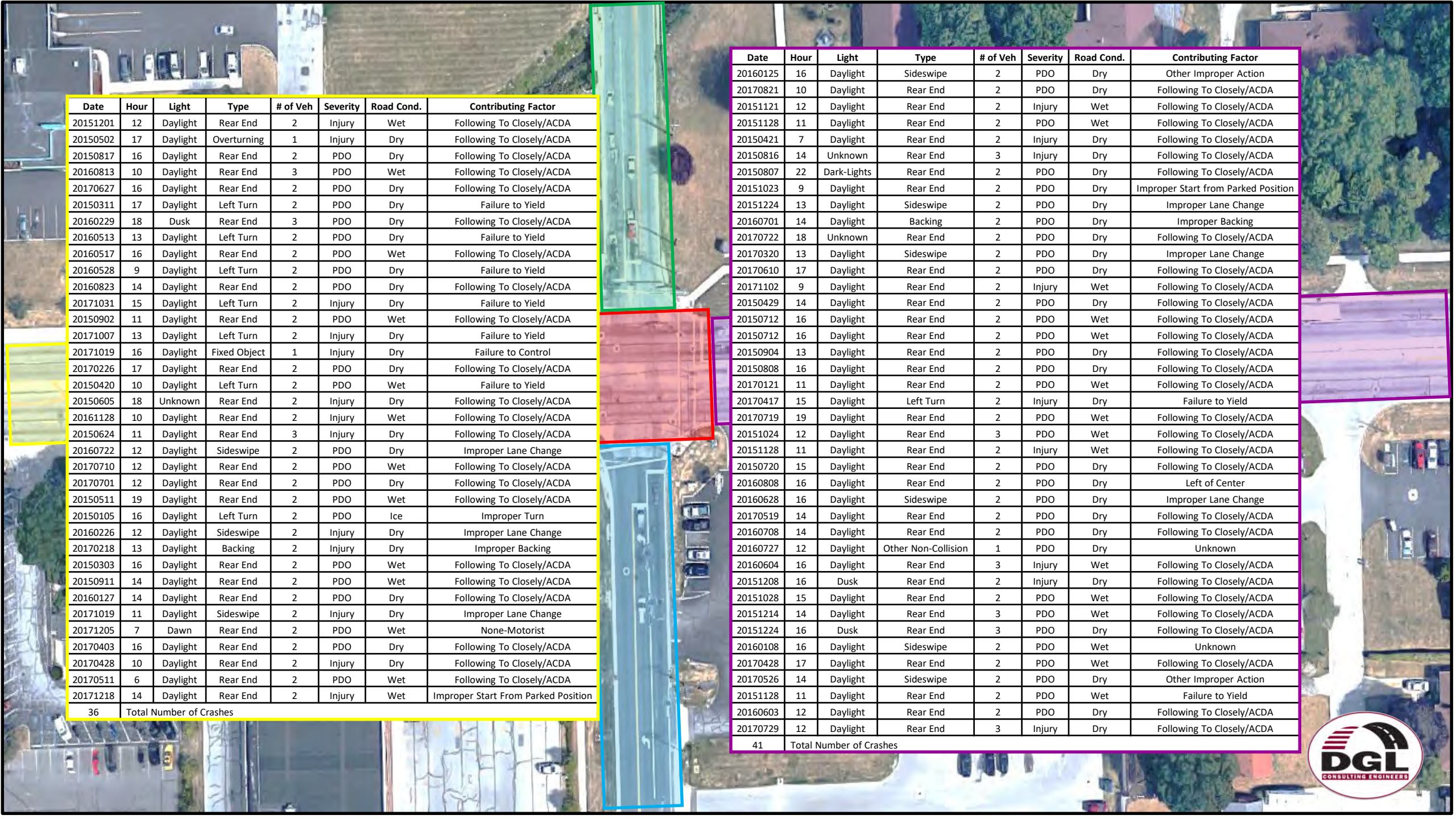
Note: Yellow and Purple Crashes shown on the next page.



Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20170620	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160704	11	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20150106	18	Dark-Lights	Sideswipe	2	PDO	Wet	Improper Lane Change
20150213	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150605	9	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20170731	14	Daylight	Left Turn	2	PDO	Dry	Improper Turn
20150417	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150928	13	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20151123	16	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160324	13	Daylight	Left Turn	2	Injury	Wet	Failure to Yield
20160907	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160223	9	Daylight	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160618	11	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20160725	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20161208	11	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20170616	14	Daylight	Sideswipe	2	PDO	Dry	Failure to Control
20170706	18	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170705	20	Daylight	Pedestrian	2	Injury	Dry	Failure to Yield
20170828	7	Daylight	Right Turn	2	PDO	Dry	Failure to Yield
20170804	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171207	14	Daylight	Angle	2	PDO	Dry	None-Motorist
21	Total Number of Crashes						

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20161007	14	Daylight	Rear End	2	Injury	Dry	None-Motorist
20160114	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150901	11	Daylight	Left Turn	2	PDO	Dry	Failure To Yield
20150224	14	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151008	17	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20161110	19	Dark-Lights	Sideswipe	2	PDO	Dry	Improper Lane Change
20170409	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171107	12	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20171209	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20170609	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170720	18	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170103	16	Daylight	Left Turn	2	PDO	Wet	Failure To Yield
12	Total Number of Crashes						

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20150219	13	Daylight	Left Turn	2	Injury	Dry	Failure To Yield
20150410	21	Dark-Lights	Left Turn	2	Injury	Wet	Failure To Yield
20150418	16	Daylight	Left Turn	2	Injury	Dry	Failure To Yield
20150614	0	Dark-Lights	Angle	2	PDO	Dry	Ran Red Light
20150814	16	Daylight	Angle	2	PDO	Dry	Ran Stop Sign
20151119	19	Dark-Lights	Left Turn	3	Injury	Dry	None-Motorist
20151223	18	Dark-Lights	Angle	2	PDO	Wet	Unknown
20160525	13	Daylight	Angle	2	PDO	Dry	Ran Red Light
20160628	9	Daylight	Angle	2	PDO	Dry	Ran Red Light
20160704	9	Daylight	Angle	2	Injury	Dry	Ran Red Light
20160915	9	Daylight	Head On	2	Injury	Dry	Failure To Yield
20160928	19	Dark-Lights	Left Turn	2	Injury	Wet	Failure To Yield
20161226	18	Dark-Lights	Angle	2	PDO	Wet	Failure To Yield
20170216	13	Daylight	Right Turn	2	PDO	Dry	Failure To Yield
20170419	22	Dark-Lights	Angle	2	Injury	Wet	Ran Red Light
15	Total Number of Crashes						



Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20151201	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150502	17	Daylight	Overturning	1	Injury	Dry	Following To Closely/ACDA
20150817	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160813	10	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20170627	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150311	17	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160229	18	Dusk	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160513	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160517	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20160528	9	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160823	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171031	15	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20150902	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20171007	13	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20171019	16	Daylight	Fixed Object	1	Injury	Dry	Failure to Control
20170226	17	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150420	10	Daylight	Left Turn	2	PDO	Wet	Failure to Yield
20150605	18	Unknown	Rear End	2	Injury	Dry	Following To Closely/ACDA
20161128	10	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150624	11	Daylight	Rear End	3	Injury	Dry	Following To Closely/ACDA
20160722	12	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170710	12	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170701	12	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150511	19	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150105	16	Daylight	Left Turn	2	PDO	Ice	Improper Turn
20160226	12	Daylight	Sideswipe	2	Injury	Dry	Improper Lane Change
20170218	13	Daylight	Backing	2	Injury	Dry	Improper Backing
20150303	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150911	14	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20160127	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171019	11	Daylight	Sideswipe	2	Injury	Dry	Improper Lane Change
20171205	7	Dawn	Rear End	2	PDO	Wet	None-Motorist
20170403	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170428	10	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170511	6	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20171218	14	Daylight	Rear End	2	Injury	Wet	Improper Start From Parked Position
36	Total Number of Crashes						

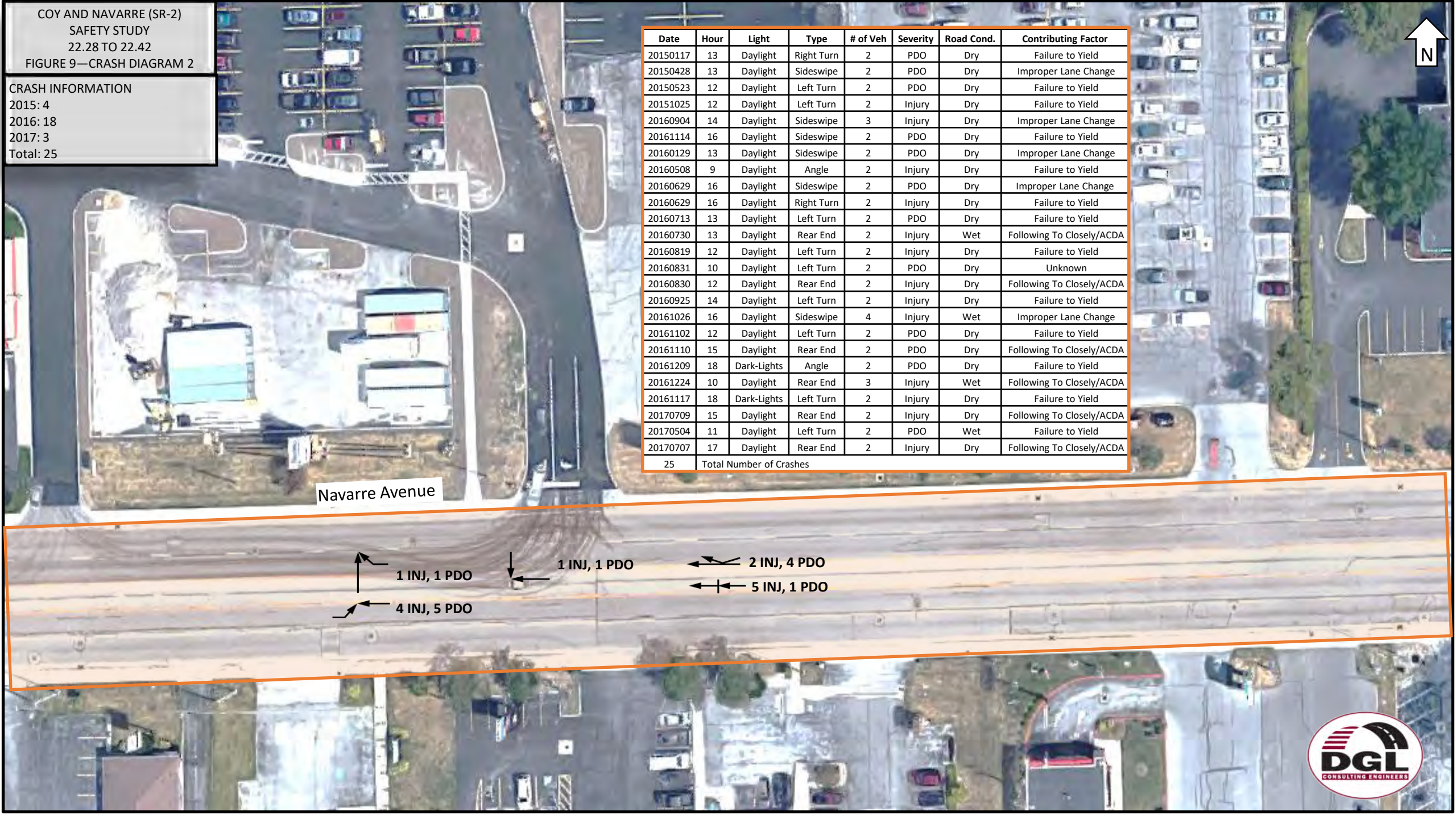
Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20160125	16	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20170821	10	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20151121	12	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20151128	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150421	7	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20150816	14	Unknown	Rear End	3	Injury	Dry	Following To Closely/ACDA
20150807	22	Dark-Lights	Rear End	2	PDO	Dry	Following To Closely/ACDA
20151023	9	Daylight	Rear End	2	PDO	Dry	Improper Start from Parked Position
20151224	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160701	14	Daylight	Backing	2	PDO	Dry	Improper Backing
20170722	18	Unknown	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170320	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170610	17	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20171102	9	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150429	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150712	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150712	16	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20150904	13	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20150808	16	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170121	11	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170417	15	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20170719	19	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151024	12	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20151128	11	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20150720	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160808	16	Daylight	Rear End	2	PDO	Dry	Left of Center
20160628	16	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20170519	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160708	14	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20160727	12	Daylight	Other Non-Collision	1	PDO	Dry	Unknown
20160604	16	Daylight	Rear End	3	Injury	Wet	Following To Closely/ACDA
20151208	16	Dusk	Rear End	2	Injury	Dry	Following To Closely/ACDA
20151028	15	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20151214	14	Daylight	Rear End	3	PDO	Wet	Following To Closely/ACDA
20151224	16	Dusk	Rear End	3	PDO	Dry	Following To Closely/ACDA
20160108	16	Daylight	Sideswipe	2	PDO	Wet	Unknown
20170428	17	Daylight	Rear End	2	PDO	Wet	Following To Closely/ACDA
20170526	14	Daylight	Sideswipe	2	PDO	Dry	Other Improper Action
20151128	11	Daylight	Rear End	2	PDO	Wet	Failure to Yield
20160603	12	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20170729	12	Daylight	Rear End	3	Injury	Dry	Following To Closely/ACDA
41	Total Number of Crashes						

DGL CONSULTING ENGINEERS

COY AND NAVARRE (SR-2)
SAFETY STUDY
22.28 TO 22.42
FIGURE 9—CRASH DIAGRAM 2

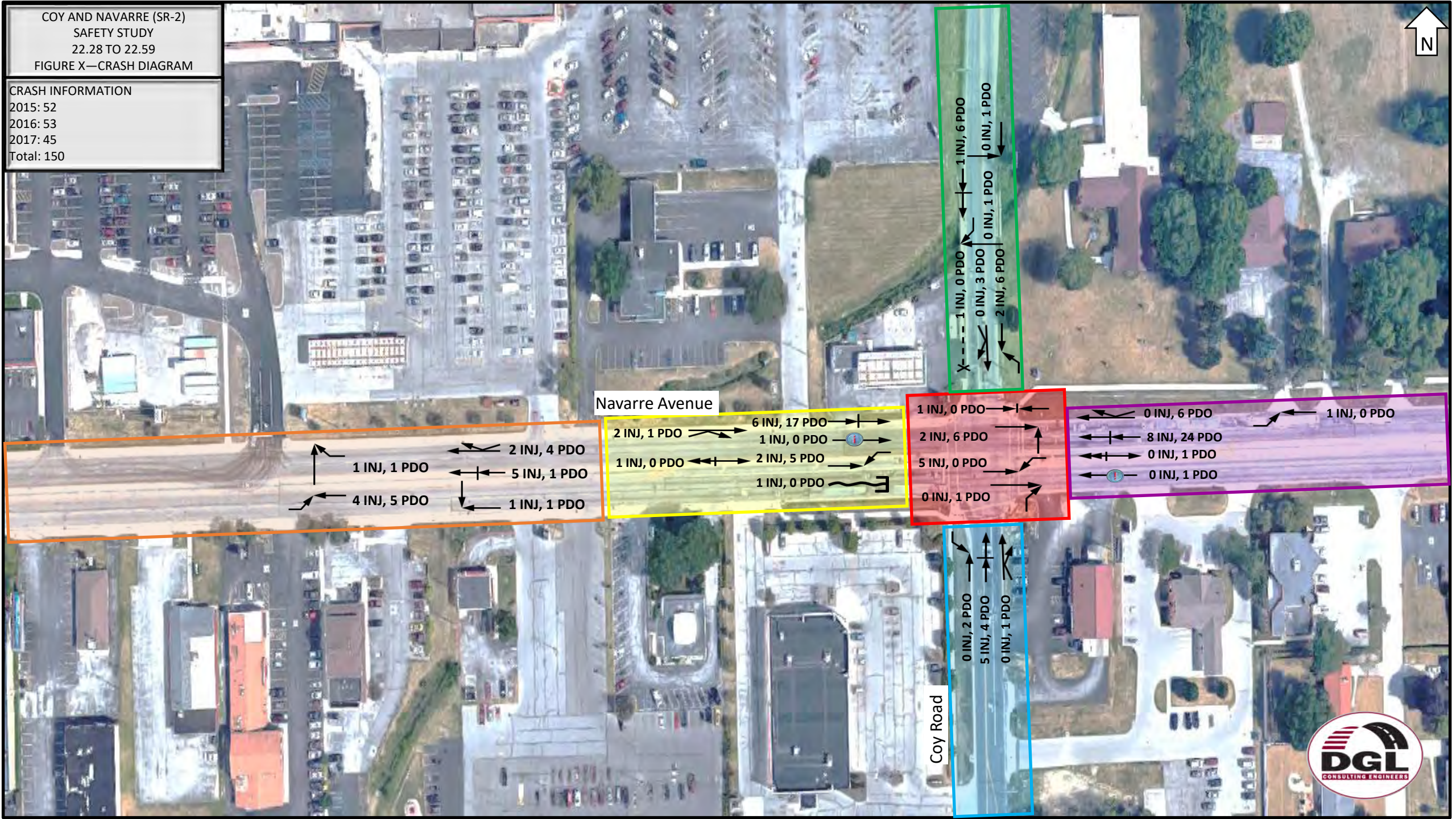
CRASH INFORMATION
2015: 4
2016: 18
2017: 3
Total: 25

Date	Hour	Light	Type	# of Veh	Severity	Road Cond.	Contributing Factor
20150117	13	Daylight	Right Turn	2	PDO	Dry	Failure to Yield
20150428	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20150523	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20151025	12	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20160904	14	Daylight	Sideswipe	3	Injury	Dry	Improper Lane Change
20161114	16	Daylight	Sideswipe	2	PDO	Dry	Failure to Yield
20160129	13	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160508	9	Daylight	Angle	2	Injury	Dry	Failure to Yield
20160629	16	Daylight	Sideswipe	2	PDO	Dry	Improper Lane Change
20160629	16	Daylight	Right Turn	2	Injury	Dry	Failure to Yield
20160713	13	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20160730	13	Daylight	Rear End	2	Injury	Wet	Following To Closely/ACDA
20160819	12	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20160831	10	Daylight	Left Turn	2	PDO	Dry	Unknown
20160830	12	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20160925	14	Daylight	Left Turn	2	Injury	Dry	Failure to Yield
20161026	16	Daylight	Sideswipe	4	Injury	Wet	Improper Lane Change
20161102	12	Daylight	Left Turn	2	PDO	Dry	Failure to Yield
20161110	15	Daylight	Rear End	2	PDO	Dry	Following To Closely/ACDA
20161209	18	Dark-Lights	Angle	2	PDO	Dry	Failure to Yield
20161224	10	Daylight	Rear End	3	Injury	Wet	Following To Closely/ACDA
20161117	18	Dark-Lights	Left Turn	2	Injury	Dry	Failure to Yield
20170709	15	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
20170504	11	Daylight	Left Turn	2	PDO	Wet	Failure to Yield
20170707	17	Daylight	Rear End	2	Injury	Dry	Following To Closely/ACDA
25	Total Number of Crashes						



COY AND NAVARRE (SR-2)
SAFETY STUDY
22.28 TO 22.59
FIGURE X—CRASH DIAGRAM

CRASH INFORMATION
2015: 52
2016: 53
2017: 45
Total: 150



APPENDIX D

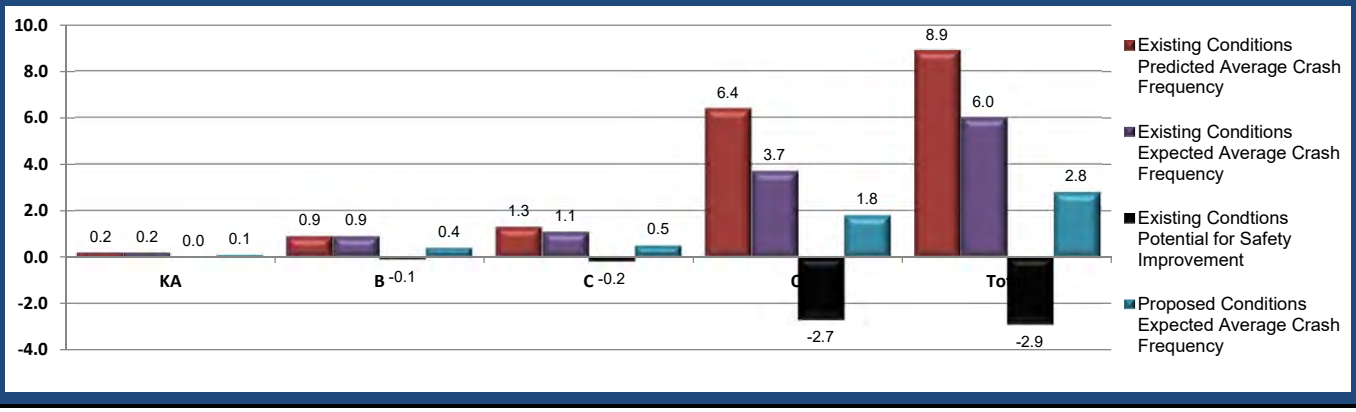
ECAT Reports

Project Safety Performance Report

General Information

Project Name	Navarre Avenue/SR 2 & Coy Road Safety	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.2030	0.9310	1.3080	6.4115	8.8535
$N_{expected}$ - Existing Conditions	0.1994	0.8632	1.1490	3.7465	5.9581
$N_{potential\ for\ improvement}$ - Existing Conditions	-0.0036	-0.0678	-0.1590	-2.6650	-2.8954
$N_{expected}$ - Proposed Conditions	0.0868	0.3889	0.5432	1.7928	2.8117

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
SR2; 22.51	Navarre Ave and Coy Road	0.203	0.931	1.308	6.4115	8.8535

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
SR2; 22.51	Navarre Ave and Coy Road	0.1994	0.8632	1.149	3.7465	5.9581

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
SR2; 22.51	Navarre Ave and Coy Road	-0.0036	-0.0678	-0.159	-2.665	-2.8954

Proposed Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
SR2; 22.51	Navarre Ave and Coy Road	0.0868	0.3889	0.5432	1.7928	2.8117

Project Safety Performance Report

General Information

Project Name	Navarre Avenue/SR 2 & Coy Road Safety	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Expected Crash Frequency
Unknown	0.0036	0.0037	**0.0001**	0.0016
Head On	0.0541	0.0537	-0.0004	0.0237
Rear End	4.2610	2.1974	-2.0636	1.1510
Backing	0.2197	0.2016	-0.0181	0.0878
Sideswipe - Meeting	0.1212	0.1180	-0.0032	0.0525
Sideswipe - Passing	1.0375	0.7704	-0.2671	0.3450
Angle	1.5543	1.1826	-0.3717	0.5601
Parked Vehicle	0.1296	0.1245	-0.0051	0.0540
Pedestrian	0.0141	0.0140	-0.0001	0.0048
Animal	0.0000	0.0000	0.0000	0.0000
Train	0.0002	0.0002	0.0000	0.0001
Pedalcycles	0.2932	0.2626	-0.0306	0.0785
Other Non-Vehicle	0.0000	0.0000	0.0000	0.0000
Fixed Object	0.2047	0.1954	-0.0093	0.0842
Other Object	0.0074	0.0074	0.0000	0.0032
Overturning	0.0107	0.0108	**0.0001**	0.0046
Other Non-Collision	0.0275	0.0273	-0.0002	0.0118
Left Turn	0.9145	0.7885	-0.1260	0.3488
Right Turn	0.0000	0.0000	0.0000	0.0000

Project Cost Estimate

Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Engineering Design %	11%
Contingency %	30%

Countermeasures	Construction Costs	Right of Way Costs	Engineering Design Costs	Contingency Amount	Total Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value
Site Characteristic Improvements (i.e. Lane widening)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Lighting)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Signal Phasing)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Added Right Turn Lane)			$0.00	$0.00	**$0.00**		
CMF 1 - Modify change plus clearance interval to ITE 1985 Proposed Recommended Practice (4-leg signalized)	$2,000.00	$0.00	$275.60	$600.00	**$2,875.60**		
CMF 2 - Resurface pavement	$100,000.00	$0.00	$13,780.00	$30,000.00	**$143,780.00**		
CMF 3 - Installation of Median	$180,000.00	$100,000.00	$24,804.00	$54,000.00	**$358,804.00**		
CMF 4 - Install Right Turn Lane	$531,000.00	$600,000.00	$73,171.80	$159,300.00	**$1,363,471.80**		
CMF 5 - Improve Visibility of Signal Heads	$5,000.00	$0.00	$689.00	$1,500.00	**$7,189.00**		
CMF 6 - Remove Driveways near intersection	$20,000.00		$2,756.00	$6,000.00	**$28,756.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
Totals	**$838,000.00**	**$700,000.00**	**$115,476.40**	**$251,400.00**	**$1,904,876.40**	**$0.00**	**$0.00**

Inflation %	7%

Final Costruction Cost:	**$2,038,217.75**

*Final construction cost should match the Project Cost Estimate

Safety Benefit - Cost Analysis

General Information

Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Site Characteristic Improvements (i.e. Lane widening)		$0.00			$0.00	$0.00	-0.713	$421,001
Site Characteristic Improvements (i.e. Lighting)		$0.00			$0.00	$0.00		
Site Characteristic Improvements (i.e. Signal Phasing)		$0.00			$0.00	$0.00		
Site Characteristic Improvements (i.e. Added Right Turn Lane)		$0.00			$0.00	$0.00		
CMF 1 - Modify change plus clearance interval to ITE 1985 Proposed Recommended Practice (4-leg signalized)	5	$2,875.60			$17,253.60	$29,776.26	-0.029	$131,241
CMF 2 - Resurface pavement	30	$143,780.00			$143,780.00	$143,780.00	0.000	$0
CMF 3 - Installation of Median	30	$358,804.00			$358,804.00	$358,804.00	-1.200	$687,155
CMF 4 - Install Right Turn Lane	30	$1,363,471.80			$1,363,471.80	$1,363,471.80	-1.205	$690,354
CMF 5 - Improve Visibility of Signal Heads	30	$7,189.00			$7,189.00	$7,189.00	0.000	$0
CMF 6 - Remove Driveways near intersection	30	$28,756.00			$28,756.00	$28,756.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
Totals		**$1,904,876.40**	**$0.00**	**$0.00**	**$1,919,254.40**	**$1,931,777.06**	**-3.146**	**$1,929,751**

Safety Benefit - Cost Analysis

General Information

Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Benefit - Cost Calculator

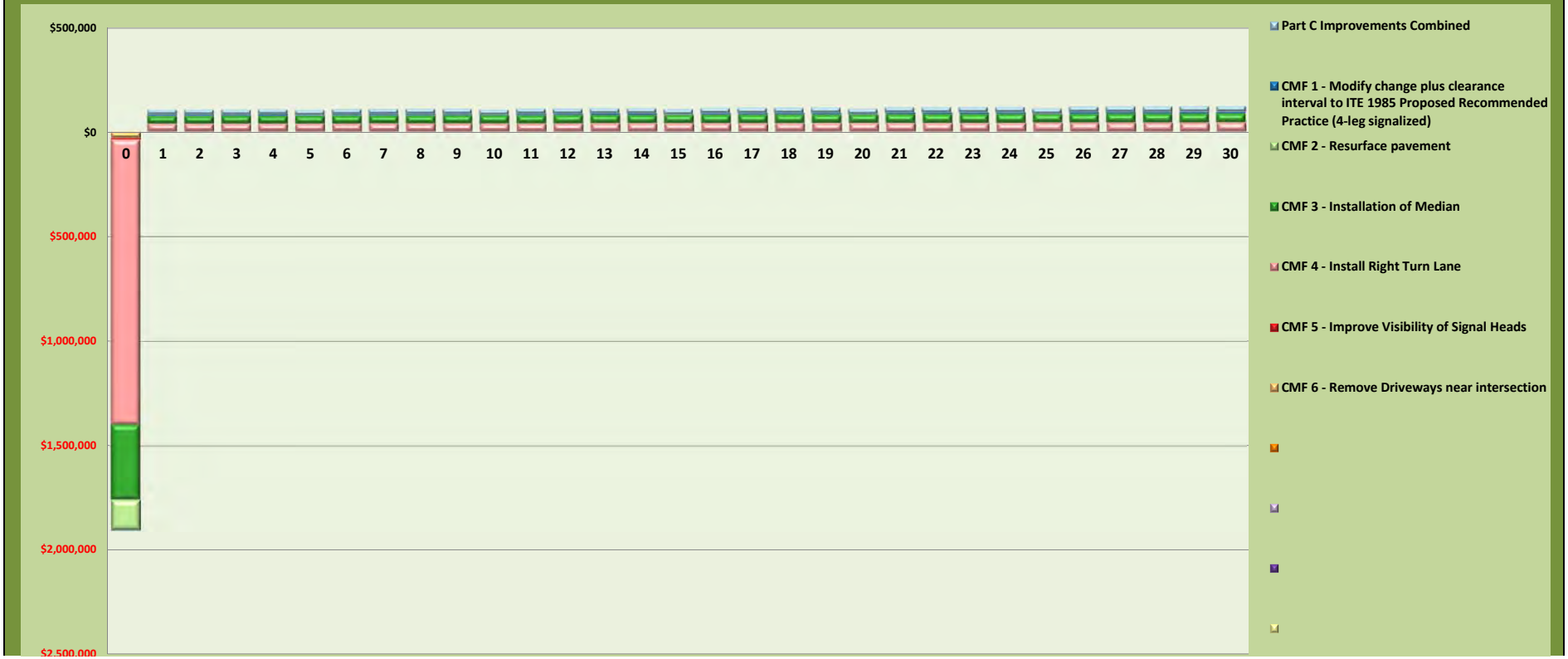
Net Present Value of Project	$1,919,254.40
Net Present Value of Safety Benefits	$1,929,750.96
Net Benefit	$10,496.56
Benefit / Cost Ratio	1.01

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.113
Number of Injury Crashes	-1.193
Number of Total Crashes	-3.146

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year



Safety Benefit - Cost Analysis

General Information

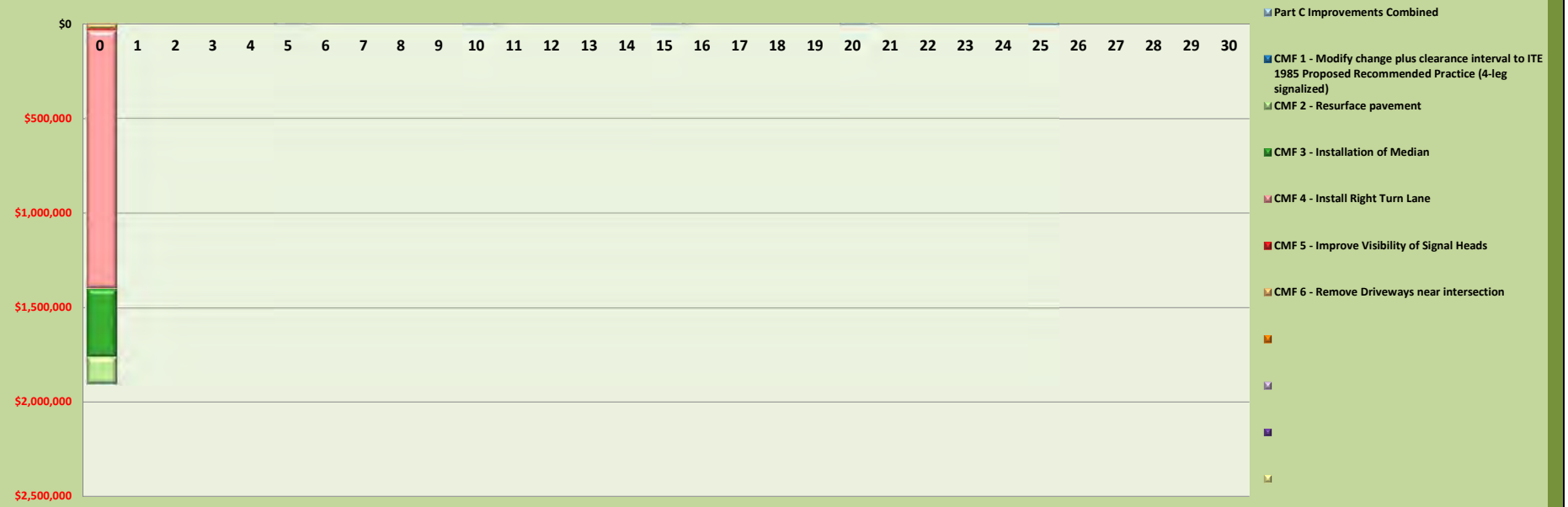
Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Safety Benefit - Cost Analysis

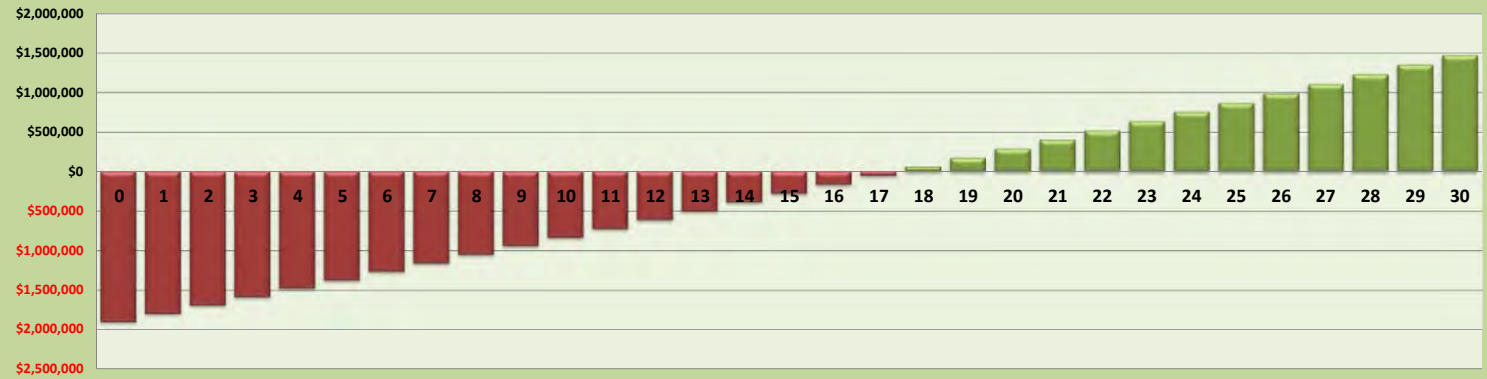
General Information

Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study	Contact Email	clochtefeld@dgl-ltd.com
Project Description	Navarre Ave & Coy Rd Intersection	Contact Phone	419-535-1015 ext 236
Reference Number	10862	Date Performed	9/7/2018
Analyst	CML	Analysis Year	2018
Agency/Company	DGL Consulting Engineers		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)



First year to observe a positive return on investment: 2036 (18 years)

Percentage of Service Life to observe a continuous Positive Return on Investment: 43.33%

Safety Funding Application

General Project Information	
Project Sponsoring Agency	City of Oregon
Project Name	Navarre Avenue/SR 2 & Coy Road Safety Study
PID	Navarre Ave & Coy Rd Intersection
Project Manager	Paul Roman
Contact Phone	(419) 698-7047
Contact Email	proman@oregonohio.org

Location Information			
ODOT District	2	**County**	LUC
Route Number	SR-2R	**Road Name**	Navarre Avenue
Begin Logpoint	22.510	**End Logpoint**	22.680
Begin Latitude		**Begin Longitude**	
End Latitude		**End Longitude**	

Project Description

Summary of Crash Patterns

At the Navarre Avenue/SR 2 and Coy Road intersection a large number of crashes have been observed. Currently the intersection is listed as #39 on the 2016 Urban Intersection Highway Safety Improvement Program list. Within the influence area of the intersection, there were 143 crashes between 2015-2017. With a majority of the crashes being Rear End and Left Turn crashes. Only injury and property damage crashes have occurred in the years studied.

Summary of Recommended Countermeasures

For the intersection the following countermeasures were recommended; install backplates on existing signal heads, modify the clearance intervals, add additional signal heads to the existing poles, increase pavement friction, install a median along Navarre Avenue/SR 2, install a Thru-Right lane for Southbound Coy and extend the lane to Dustin Road, install a right turn lane for Northbound Coy, and decrease the drive density around the intersection.

Project Priority Information

The project is listed as #39 on the 2016 Urban Intersection HSIP list

Crash Data

Crash Totals

	Fatal & Serious Injury (KA)	Visible Injury (B)	Non-Visible (C)	Property Damage Only (O)	Total
Existing Conditions: Predicted Crash Frequency	0.2030	0.9310	1.3080	6.4115	8.85
Existing Conditions: Expected Crash Frequency	0.1994	0.8632	1.1490	3.7465	5.96
Potential for Safety Improvement	-0.0036	-0.0678	-0.1590	-2.6650	-2.90
Proposed Conditions: Expected Crash Frequency	0.0868	0.3889	0.5432	1.7928	2.81
Observed Crashes	0.3333	6.0000	6.6667	28.3333	41.33

Observed People Injury Totals

	Fatal Injury (K)	Serious Injury (A)	Visible Injury (B)	Non-Visible (C)	Total
Observed People Injury Totals	0.0000	0.3333	8.0000	11.3333	19.67

Application Scoring

Category	Scoring Value	Points Awarded	Points Possible
Expected Crash Frequency	8.85	4	10
Ratio of Observed Fatal and Serious Injuries to Observed Total Crashes	0.01	1	5
% of the Potential for Safety Improvement to Total Expected Crashes	69.30%	20	20
Relative Severity Index	$2,908,988	10	10
Equivalent Property Damage Only Index	3.75	3	5
Volume to Capacity Ratio	0.77	6	10
Benefit Cost Ratio	1.01	3	30
Safety Funding Request Percentage	80.00%	4	10
Total		51	100

Strategic Highway Safety Plan

Functional Class	Other Principal Arterial Roadway
Major Route AADT	18,550
Ohio Emphasis Area	Emphasis Area V - Incident and Congestion Related Crashes
Ohio Emphasis Area Subcategory	Rear End Crashes
FHWA Emphasis Area	Other
FHWA Improvement Category	Intersection geometry
FHWA Improvement Subcategory	Auxiliary lanes - add right-turn lane

Work Locations

NLFID	Begin Logpoint	End Logpoint	Begin Latitude	Begin Longitude	Location Termini (i.e. from Street 1 to Street 2)
SLUCSR00002**C	22.510	0.000			

OHIO DEPARTMENT OF TRANSPORTATION

Safety Funding Application

Project Funding

Project Phase	Safety Study	Interchange Mod. Study	PE - Environmental	PE - Detailed Design	Right of Way /Utilities	Construction	Total
Fiscal Year	2018			2019	2020	2021	
Project Phase Completed	☑	☐	☐	☐	☐	N/A	
Previous Safety	$0.00						$0.00
New Safety				$115,476.00	$700,000.00	$921,800.00	$1,737,276.00
Sponsor Funding	$25,000.00		$25,000.00		$300,000.00	$167,600.00	$517,600.00
							$0.00
Total	$25,000.00	$0.00	$25,000.00	$115,476.00	$1,000,000.00	$1,089,400.00	$2,254,876.00

Additional Funding Detail

The City of Oregon is planning to pursue additional funding for culvert replacement along the north leg of Coy Road.

Project Development

Project Phase	Completed by	Completion Date
Safety Study	Corrinne Lochtefeld	9/20/2018

Applicant Information

Name	Title	Phone Number
Paul Roman	Director of Public Service	(419) 698-7047
Signature		**Date**
		September 28, 2018

Version: 20150917

The following information should be included in submission of the safety project application:

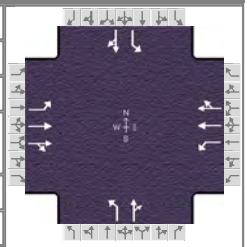
1. An electronic copy of the Safety Engineering Study
2. All Excel Analysis Files
   May include Crash Analysis Module (CAM) Tool, Economic Crash Analysis Tool (ECAT), HSIP Application and Scoring Tool.
3. Benefit-Cost Results (Economic Analysis)
4. DSRT approval signatures

APPENDIX E

HCS 7 & Synchro 9 Reports

HCS7 Signalized Intersection Results Summary

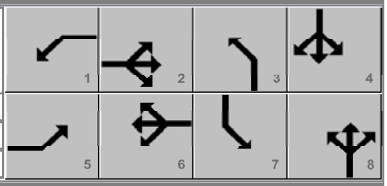
General Information				Intersection Information	
Agency	DGL Consulting Engineers			Duration, h	0.25
Analyst	CMS	Analysis Date	7/20/2018	Area Type	Other
Jurisdiction	City of Oregon	Time Period	2018 Existing AM Peak	PHF	0.93
Urban Street	Navarre Ave	Analysis Year	2018	Analysis Period	1> 7:00
Intersection	Navarre and Coy	File Name	2018 Existing AM.xus		
Project Description	Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	31	376	44	71	494	25	68	41	82	74	85	60

Signal Information			
Cycle, s	85.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	9.5	23.5	9.3	20.3	0.0	0.0
Yellow	3.9	3.9	3.6	3.6	0.0	0.0
Red	1.6	1.6	2.1	2.1	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	4.0	1.1	4.0	1.1	4.0	1.1	4.0
Phase Duration, s	15.0	29.0	15.0	29.0	15.0	26.0	15.0	26.0
Change Period, ($Y+R_c$), s	5.5	5.5	5.5	5.5	5.7	5.7	5.7	5.7
Max Allow Headway (*MAH*), s	3.1	3.0	3.1	3.0	3.1	3.2	3.1	3.2
Queue Clearance Time (g_s), s	3.0	10.5	4.3	12.7	4.3	7.5	4.5	8.3
Green Extension Time (g_e), s	0.0	1.6	0.0	1.6	0.0	0.5	0.0	0.5
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.00	0.03	0.04	0.06	0.06	0.00	0.10	0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	229	223	76	281	277	73	132		80	156	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900	1830	1810	1900	1867	1810	1696		1810	1768	
Queue Service Time (g_s), s	1.0	8.4	8.5	2.3	10.7	10.7	2.3	5.5		2.5	6.3	
Cycle Queue Clearance Time (g_c), s	1.0	8.4	8.5	2.3	10.7	10.7	2.3	5.5		2.5	6.3	
Green Ratio (*g/C*)	0.39	0.28	0.28	0.39	0.28	0.28	0.35	0.24		0.35	0.24	
Capacity (*c*), veh/h	397	525	506	433	525	516	460	405		476	422	
Volume-to-Capacity Ratio (*X*)	0.084	0.436	0.440	0.176	0.535	0.537	0.159	0.326		0.167	0.369	
Back of Queue (*Q*), ft/ln (95 th percentile)	17.1	161.9	158.2	40.1	203.3	201.2	42.3	96.9		46.2	115.5	
Back of Queue (*Q*), veh/ln (95 th percentile)	0.7	6.5	6.3	1.6	8.1	8.0	1.7	3.9		1.8	4.6	
Queue Storage Ratio (*RQ*) (95 th percentile)	0.06	0.07	0.07	0.21	0.10	0.09	0.23	0.19		0.34	0.05	
Uniform Delay (d_1), s/veh	17.2	25.3	25.3	17.3	26.1	26.1	19.2	26.7		19.2	27.0	
Incremental Delay (d_2), s/veh	0.0	0.2	0.2	0.1	0.6	0.6	0.1	0.2		0.1	0.2	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (*d*), s/veh	17.2	25.5	25.6	17.4	26.7	26.7	19.3	26.9		19.3	27.2	
Level of Service (LOS)	B	C	C	B	C	C	B	C		B	C	
Approach Delay, s/veh / LOS	25.0	C		25.6	C		24.2	C		24.5	C	
Intersection Delay, s/veh / LOS	25.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	2.29	B	2.29	B
Bicycle LOS Score / LOS	0.89	A	1.01	A	0.83	A	0.88	A

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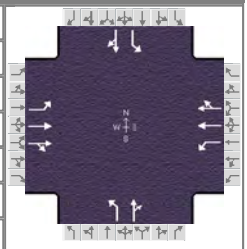
HCS7 Signalized Intersection Results Summary

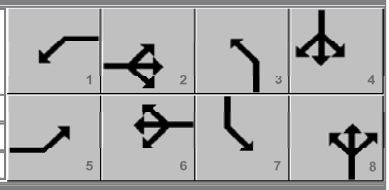
General Information				Intersection Information	
Agency	DGL Consulting Engineers			Duration, h	0.25
Analyst	CMS	Analysis Date	7/20/2018	Area Type	Other
Jurisdiction	City of Oregon	Time Period	2018 Existing	PHF	0.93
Urban Street	Navarre Ave	Analysis Year	2018	Analysis Period	1> 7:00
Intersection	Navarre and Coy	File Name	Existing Intersection.xus		
Project Description	Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	133	706	78	136	659	143	161	189	137	192	193	144

Signal Information			
Cycle, s	105.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	10.0	38.0	10.0	27.0	0.0	0.0	
Yellow	4.0	4.0	4.0	4.0	0.0	0.0	
Red	1.0	1.0	1.0	1.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	4.0	1.1	4.0	1.1	4.0	1.1	4.0
Phase Duration, s	15.0	43.0	15.0	43.0	15.0	32.0	15.0	32.0
Change Period, (*Y+R c*), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.1	3.0	3.1	3.0	3.1	3.2	3.1	3.2
Queue Clearance Time (*g s*), s	6.9	21.6	7.0	22.5	9.2	21.3	10.8	22.2
Green Extension Time (*g e*), s	0.1	3.3	0.1	3.2	0.0	0.9	0.0	0.8
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.95	0.08	1.00	0.09	1.00	0.32	1.00	0.47

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	143	429	414	146	445	418	173	351		206	362	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900	1833	1810	1900	1782	1810	1766		1810	1764	
Queue Service Time (*g s*), s	4.9	19.5	19.6	5.0	20.5	20.5	7.2	19.3		8.8	20.2	
Cycle Queue Clearance Time (*g c*), s	4.9	19.5	19.6	5.0	20.5	20.5	7.2	19.3		8.8	20.2	
Green Ratio (*g/C*)	0.46	0.36	0.36	0.46	0.36	0.36	0.35	0.26		0.35	0.26	
Capacity (*c*), veh/h	337	688	663	345	688	645	289	454		298	454	
Volume-to-Capacity Ratio (*X*)	0.424	0.624	0.624	0.424	0.647	0.647	0.600	0.772		0.694	0.799	
Back of Queue (*Q*), ft/ln (95 th percentile)	88.2	338.8	329.1	90.3	354	336.3	144.2	348.9		186.5	366.8	
Back of Queue (*Q*), veh/ln (95 th percentile)	3.5	13.6	13.2	3.6	14.2	13.5	5.8	14.0		7.5	14.7	
Queue Storage Ratio (*RQ*) (95 th percentile)	0.30	0.14	0.14	0.46	0.17	0.16	0.80	0.67		1.38	0.15	
Uniform Delay (*d 1*), s/veh	19.9	27.6	27.6	19.7	27.9	27.9	27.2	36.1		27.5	36.5	
Incremental Delay (*d 2*), s/veh	0.3	1.3	1.4	0.3	1.7	1.8	2.4	7.3		5.7	9.0	
Initial Queue Delay (*d 3*), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (*d*), s/veh	20.2	28.9	29.0	20.0	29.6	29.7	29.6	43.4		33.3	45.5	
Level of Service (LOS)	C	C	C	B	C	C	C	D		C	D	
Approach Delay, s/veh / LOS	27.7	C		28.2	C		38.8	D		41.1	D	
Intersection Delay, s/veh / LOS	32.2						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	2.29	B	2.29	B
Bicycle LOS Score / LOS	1.30	A	1.32	A	1.35	A	1.43	A

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MOVEMENT SUMMARY

Site: 101 [Coy & Navarre Safety Study (1-Lane)]

2021 PM Peak
Site Category: 1-Lane
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Coy Rd												
3	L2	177	3.0	1.058	84.7	LOS F	25.9	664.0	1.00	2.31	5.33	15.6
8	T1	209	3.0	1.058	84.7	LOS F	25.9	664.0	1.00	2.31	5.33	15.6
18	R2	151	3.0	1.058	84.7	LOS F	25.9	664.0	1.00	2.31	5.33	15.4
Approach		537	3.0	1.058	84.7	LOS F	25.9	664.0	1.00	2.31	5.33	15.5
East: Navarre Ave												
1	L2	150	3.0	1.269	148.4	LOS F	93.6	2395.0	1.00	3.95	8.80	10.9
6	T1	727	3.0	1.269	148.4	LOS F	93.6	2395.0	1.00	3.95	8.80	10.9
16	R2	158	3.0	1.269	148.4	LOS F	93.6	2395.0	1.00	3.95	8.80	10.8
Approach		1035	3.0	1.269	148.4	LOS F	93.6	2395.0	1.00	3.95	8.80	10.9
North: Coy Rd												
7	L2	212	3.0	1.083	90.5	LOS F	31.0	792.5	1.00	2.49	5.83	15.0
4	T1	213	3.0	1.083	90.5	LOS F	31.0	792.5	1.00	2.49	5.83	15.0
14	R2	159	3.0	1.083	90.5	LOS F	31.0	792.5	1.00	2.49	5.83	14.8
Approach		584	3.0	1.083	90.5	LOS F	31.0	792.5	1.00	2.49	5.83	14.9
West: Navarre Ave												
5	L2	147	3.0	1.284	155.5	LOS F	93.3	2389.6	1.00	4.04	9.21	10.6
2	T1	779	3.0	1.284	155.5	LOS F	93.3	2389.6	1.00	4.04	9.21	10.5
12	R2	86	3.0	1.284	155.5	LOS F	93.3	2389.6	1.00	4.04	9.21	10.5
Approach		1012	3.0	1.284	155.5	LOS F	93.3	2389.6	1.00	4.04	9.21	10.5
All Vehicles		3167	3.0	1.284	129.2	LOS F	93.6	2395.0	1.00	3.43	7.80	12.0

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

Site: [Coy & Navarre Safety Study (2-Lane)]

2021 PM Peak
Site Category: 2-Lane
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Coy Rd												
3	L2	177	3.0	0.562	20.8	LOS C	2.9	74.7	0.81	0.97	1.37	27.2
8	T1	209	3.0	0.562	19.4	LOS C	3.0	76.5	0.80	0.96	1.36	28.3
18	R2	151	3.0	0.562	18.6	LOS C	3.0	76.5	0.79	0.95	1.35	28.3
Approach		537	3.0	0.562	19.6	LOS C	3.0	76.5	0.80	0.96	1.36	27.9
East: Navarre Ave												
1	L2	150	3.0	0.625	14.9	LOS B	5.6	142.4	0.75	0.96	1.32	30.0
6	T1	727	3.0	0.625	14.4	LOS B	5.7	145.2	0.74	0.95	1.30	30.5
16	R2	158	3.0	0.625	14.0	LOS B	5.7	145.2	0.74	0.94	1.29	30.1
Approach		1035	3.0	0.625	14.4	LOS B	5.7	145.2	0.74	0.95	1.30	30.3
North: Coy Rd												
7	L2	212	3.0	0.567	19.6	LOS C	3.1	79.0	0.79	0.95	1.36	27.5
4	T1	213	3.0	0.567	18.2	LOS C	3.2	80.9	0.78	0.94	1.34	28.8
14	R2	159	3.0	0.567	17.6	LOS C	3.2	80.9	0.77	0.93	1.33	28.6
Approach		584	3.0	0.567	18.6	LOS C	3.2	80.9	0.78	0.94	1.34	28.3
West: Navarre Rd												
5	L2	147	3.0	0.635	15.8	LOS C	5.6	142.6	0.77	0.98	1.38	29.7
2	T1	779	3.0	0.635	15.2	LOS C	5.7	145.9	0.76	0.97	1.36	30.2
12	R2	86	3.0	0.635	14.7	LOS B	5.7	145.9	0.75	0.97	1.35	29.8
Approach		1012	3.0	0.635	15.2	LOS C	5.7	145.9	0.76	0.97	1.36	30.1
All Vehicles		3167	3.0	0.635	16.3	LOS C	5.7	145.9	0.77	0.96	1.34	29.4

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Sign Control.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: US HCM 6.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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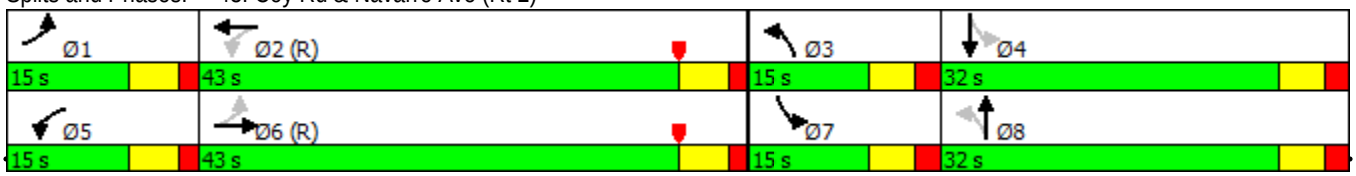
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	133	706	78	136	659	143	161	189	137	192	193	144
Future Volume (vph)	133	706	78	136	659	143	161	189	137	192	193	144
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	1752	0	1787	1763	0
Flt Permitted	0.169			0.164			0.157			0.157		
Satd. Flow (perm)	318	3432	0	312	3261	0	295	1752	0	295	1763	0
Satd. Flow (RTOR)		13			34			38			39	
Lane Group Flow (vph)	156	913	0	148	897	0	187	400	0	216	399	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2			8			4		
Total Split (s)	15.0	43.0		15.0	43.0		15.0	32.0		15.0	32.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5		4.7	3.7		4.7	3.7	
Act Effct Green (s)	50.9	41.8		50.8	41.8		35.7	26.4		35.7	26.4	
Actuated g/C Ratio	0.48	0.40		0.48	0.40		0.34	0.25		0.34	0.25	
v/c Ratio	0.53	0.66		0.51	0.68		0.76	0.85		0.88	0.85	
Control Delay	20.6	28.9		19.9	28.8		42.7	48.2		58.4	50.6	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	20.6	28.9		19.9	28.8		42.7	48.2		58.4	50.6	
LOS	C	C		B	C		D	D		E	D	
Approach Delay		27.7			27.6			46.4			53.4	
Approach LOS		C			C			D			D	
Queue Length 50th (ft)	54	266		51	257		92	237		97	227	
Queue Length 95th (ft)	85	317		87	333		#149	#184		#217	#356	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			199			250			250		
Base Capacity (vph)	302	1375		301	1318		246	499		246	503	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.52	0.66		0.49	0.68		0.76	0.80		0.88	0.79	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 35.7 Intersection LOS: D
Intersection Capacity Utilization 75.9% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

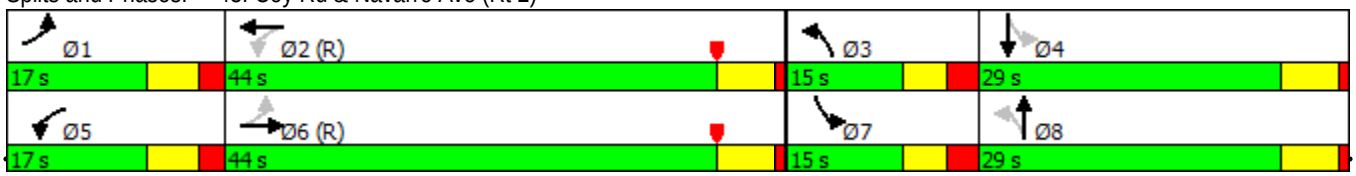


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	1752	0	1787	1765	0
Flt Permitted	0.166			0.161			0.167			0.167		
Satd. Flow (perm)	312	3432	0	306	3261	0	314	1752	0	314	1765	0
Satd. Flow (RTOR)		13			35			37			37	
Lane Group Flow (vph)	159	927	0	150	911	0	190	406	0	219	403	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2			8			4		
Total Split (s)	17.0	44.0		17.0	44.0		15.0	29.0		15.0	29.0	
Total Lost Time (s)	5.0	3.5		5.0	3.5		5.0	3.5		5.0	3.5	
Act Effct Green (s)	51.6	42.3		51.4	42.2		33.5	25.0		33.5	25.0	
Actuated g/C Ratio	0.49	0.40		0.49	0.40		0.32	0.24		0.32	0.24	
v/c Ratio	0.52	0.67		0.50	0.68		0.79	0.91		0.91	0.90	
Control Delay	19.3	28.5		18.7	28.5		46.9	60.8		67.5	59.9	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	19.3	28.5		18.7	28.5		46.9	60.8		67.5	59.9	
LOS	B	C		B	C		D	E		E	E	
Approach Delay		27.1			27.1			56.4			62.5	
Approach LOS		C			C			E			E	
Queue Length 50th (ft)	52	262		49	255		97	250		104	240	
Queue Length 95th (ft)	82	318		83	334		#164	#389		#232	#396	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			200			250			250		
Base Capacity (vph)	325	1390		324	1330		240	453		240	456	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.49	0.67		0.46	0.68		0.79	0.90		0.91	0.88	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 38.8 Intersection LOS: D
Intersection Capacity Utilization 77.5% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)



Lanes, Volumes, Timings
43: Coy Rd & Navarre Ave (Rt 2)

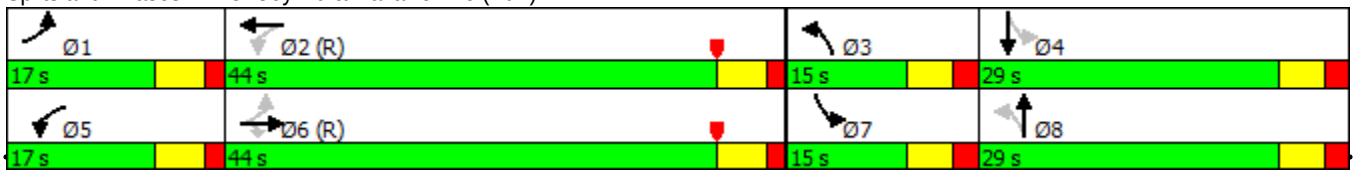
09/04/2018

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Satd. Flow (prot)	1787	3471	1615	1805	3261	0	1787	1751	0	1787	1765	0
Flt Permitted	0.167			0.204			0.167			0.167		
Satd. Flow (perm)	314	3471	1615	388	3261	0	314	1751	0	314	1765	0
Satd. Flow (RTOR)			144		35			37			36	
Lane Group Flow (vph)	159	834	93	150	911	0	190	406	0	219	403	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6		6	2			8			4		
Total Split (s)	17.0	44.0	44.0	17.0	44.0		15.0	29.0		15.0	29.0	
Total Lost Time (s)	4.5	3.5	5.5	4.5	3.5		4.7	3.7		4.7	3.7	
Act Effct Green (s)	52.6	42.6	40.6	52.2	42.4		34.2	24.9		34.2	24.9	
Actuated g/C Ratio	0.50	0.41	0.39	0.50	0.40		0.33	0.24		0.33	0.24	
v/c Ratio	0.51	0.59	0.13	0.44	0.68		0.77	0.92		0.89	0.91	
Control Delay	18.6	26.9	1.3	16.7	28.2		44.8	58.9		62.3	61.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	18.6	26.9	1.3	16.7	28.2		44.8	58.9		62.3	61.0	
LOS	B	C	A	B	C		D	E		E	E	
Approach Delay		23.5			26.6			54.4			61.4	
Approach LOS		C			C			D			E	
Queue Length 50th (ft)	52	227	0	48	253		95	251		104	241	
Queue Length 95th (ft)	81	282	6	82	334		#159	#281		#227	#400	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300		215	199			250			250		
Base Capacity (vph)	337	1409	713	367	1338		246	449		246	452	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.47	0.59	0.13	0.41	0.68		0.77	0.90		0.89	0.89	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 37.0 Intersection LOS: D
Intersection Capacity Utilization 76.5% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

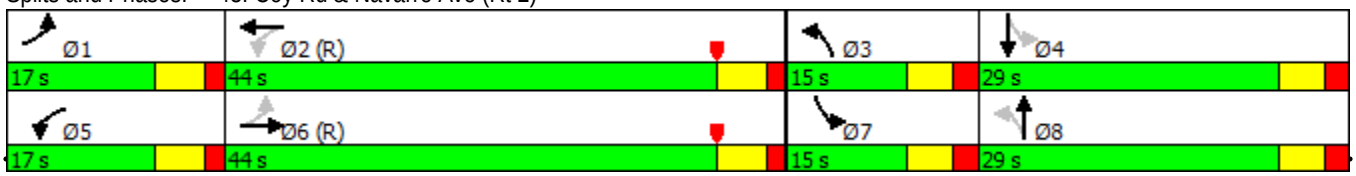


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	3328	0	1787	1765	0
Flt Permitted	0.167			0.164			0.168			0.360		
Satd. Flow (perm)	314	3432	0	312	3261	0	316	3328	0	677	1765	0
Satd. Flow (RTOR)		13			35			183			36	
Lane Group Flow (vph)	159	927	0	150	911	0	190	406	0	219	403	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2			8			4		
Total Split (s)	17.0	44.0		17.0	44.0		15.0	29.0		15.0	29.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5		4.7	3.7		4.7	3.7	
Act Effct Green (s)	52.7	42.7		52.3	42.5		34.1	24.8		34.1	24.8	
Actuated g/C Ratio	0.50	0.41		0.50	0.40		0.32	0.24		0.32	0.24	
v/c Ratio	0.51	0.66		0.49	0.68		0.77	0.44		0.67	0.91	
Control Delay	18.5	28.1		18.0	28.1		44.6	16.9		35.7	61.5	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	18.5	28.1		18.0	28.1		44.6	16.9		35.7	61.5	
LOS	B	C		B	C		D	B		D	E	
Approach Delay		26.7			26.7			25.7			52.4	
Approach LOS		C			C			C			D	
Queue Length 50th (ft)	52	260		48	253		95	71		104	241	
Queue Length 95th (ft)	81	318		82	334		#158	72		163	#400	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			200			250			250		
Base Capacity (vph)	337	1403		338	1341		246	940		328	452	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.47	0.66		0.44	0.68		0.77	0.43		0.67	0.89	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 31.3 Intersection LOS: C
Intersection Capacity Utilization 75.1% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

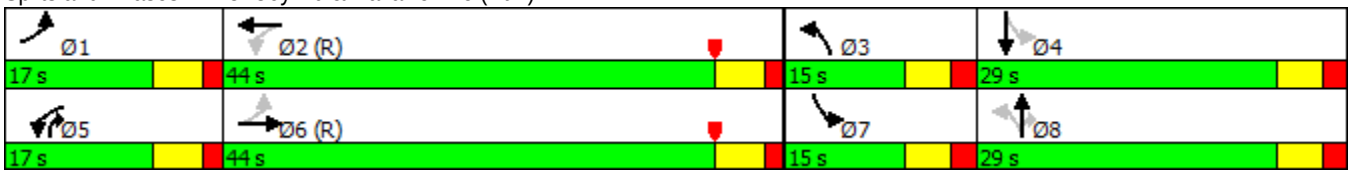


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	1900	1599	1787	3353	0
Flt Permitted	0.198			0.194			0.300			0.338		
Satd. Flow (perm)	372	3432	0	369	3261	0	564	1900	1577	636	3353	0
Satd. Flow (RTOR)		13			35				92		180	
Lane Group Flow (vph)	159	927	0	150	911	0	190	223	183	219	403	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	pm+ov	pm+pt	NA	
Protected Phases	1	6		5	2		3	8	5	7	4	
Permitted Phases	6			2			8		8	4		
Total Split (s)	17.0	44.0		17.0	44.0		15.0	29.0	17.0	15.0	29.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5		4.7	3.7	5.5	4.7	3.7	
Act Effct Green (s)	58.0	48.3		57.7	48.1		28.8	19.5	27.2	28.8	19.5	
Actuated g/C Ratio	0.55	0.46		0.55	0.46		0.27	0.19	0.26	0.27	0.19	
v/c Ratio	0.46	0.58		0.43	0.60		0.69	0.63	0.38	0.76	0.53	
Control Delay	15.0	23.6		14.7	23.6		35.7	42.7	13.0	46.1	22.7	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	15.0	23.6		14.7	23.6		35.7	42.7	13.0	46.1	22.7	
LOS	B	C		B	C		D	D	B	D	C	
Approach Delay		22.3			22.3			31.3			30.9	
Approach LOS		C			C			C			C	
Queue Length 50th (ft)	44	231		42	224		98	143	52	114	69	
Queue Length 95th (ft)	81	318		82	334		102	172	32	163	105	
Internal Link Dist (ft)		2556			2037			562			298	
Turn Bay Length (ft)	300			200			250		250	250		
Base Capacity (vph)	380	1586		380	1513		274	457	506	287	944	
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	
Reduced v/c Ratio	0.42	0.58		0.39	0.60		0.69	0.49	0.36	0.76	0.43	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 25.5 Intersection LOS: C
Intersection Capacity Utilization 67.3% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

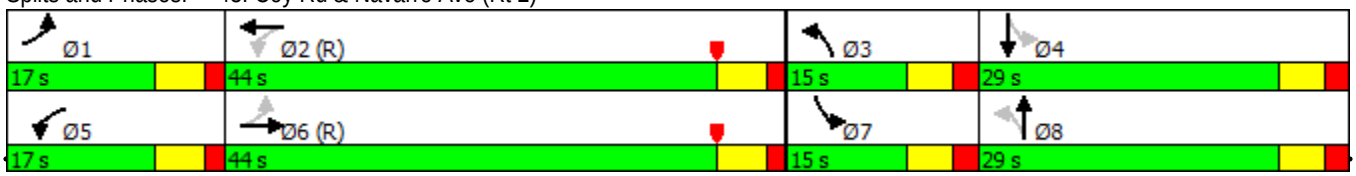


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	146
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	146
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	1751	0	1787	3349	0
Flt Permitted	0.167			0.163			0.364			0.167		
Satd. Flow (perm)	314	3432	0	310	3261	0	685	1751	0	314	3349	0
Satd. Flow (RTOR)		13			35			37			183	
Lane Group Flow (vph)	159	927	0	150	911	0	190	406	0	219	406	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2			8			4		
Total Split (s)	17.0	44.0		17.0	44.0		15.0	29.0		15.0	29.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5		4.7	3.7		4.7	3.7	
Act Effct Green (s)	52.6	42.6		52.2	42.4		34.1	24.9		34.2	24.9	
Actuated g/C Ratio	0.50	0.41		0.50	0.40		0.32	0.24		0.33	0.24	
v/c Ratio	0.51	0.66		0.49	0.68		0.58	0.92		0.89	0.43	
Control Delay	18.6	28.1		18.1	28.2		27.3	58.9		62.1	19.7	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	18.6	28.1		18.1	28.2		27.3	58.9		62.1	19.7	
LOS	B	C		B	C		C	E		E	B	
Approach Delay		26.7			26.8			48.8			34.6	
Approach LOS		C			C			D			C	
Queue Length 50th (ft)	52	260		48	253		95	251		104	64	
Queue Length 95th (ft)	81	318		82	334		102	#281		#227	105	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			200			250			250		
Base Capacity (vph)	337	1400		337	1338		330	449		246	945	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.47	0.66		0.45	0.68		0.58	0.90		0.89	0.43	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 32.1 Intersection LOS: C
Intersection Capacity Utilization 75.9% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

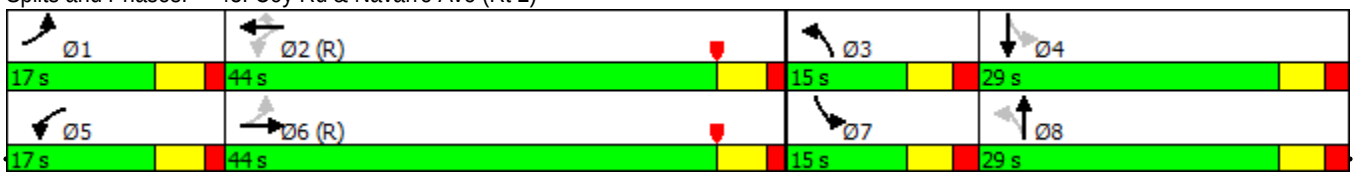


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	144
Satd. Flow (prot)	1787	3432	0	1805	3312	1599	1787	1751	0	1787	1765	0
Flt Permitted	0.253			0.163			0.167			0.167		
Satd. Flow (perm)	476	3432	0	310	3312	1599	314	1751	0	314	1765	0
Satd. Flow (RTOR)		13				184		37			36	
Lane Group Flow (vph)	159	927	0	150	727	184	190	406	0	219	403	0
Turn Type	pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2		2	8			4		
Total Split (s)	17.0	44.0		17.0	44.0	44.0	15.0	29.0		15.0	29.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5	5.5	4.7	3.7		4.7	3.7	
Act Effct Green (s)	52.6	42.6		52.2	42.4	40.4	34.2	24.9		34.2	24.9	
Actuated g/C Ratio	0.50	0.41		0.50	0.40	0.38	0.33	0.24		0.33	0.24	
v/c Ratio	0.42	0.66		0.49	0.54	0.25	0.77	0.92		0.89	0.91	
Control Delay	16.0	28.1		18.1	26.2	4.3	44.8	58.8		62.3	61.0	
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay	16.0	28.1		18.1	26.2	4.3	44.8	58.8		62.3	61.0	
LOS	B	C		B	C	A	D	E		E	E	
Approach Delay		26.4			21.2			54.4			61.4	
Approach LOS		C			C			D			E	
Queue Length 50th (ft)	52	260		48	194	0	93	251		104	241	
Queue Length 95th (ft)	81	318		82	259	29	#159	#281		#227	#400	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			200		209	250			250		
Base Capacity (vph)	401	1400		337	1338	728	246	449		246	452	
Starvation Cap Reductn	0	0		0	0	0	0	0		0	0	
Spillback Cap Reductn	0	0		0	0	0	0	0		0	0	
Storage Cap Reductn	0	0		0	0	0	0	0		0	0	
Reduced v/c Ratio	0.40	0.66		0.45	0.54	0.25	0.77	0.90		0.89	0.89	

Intersection Summary

Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 36.2 Intersection LOS: D
Intersection Capacity Utilization 76.5% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)

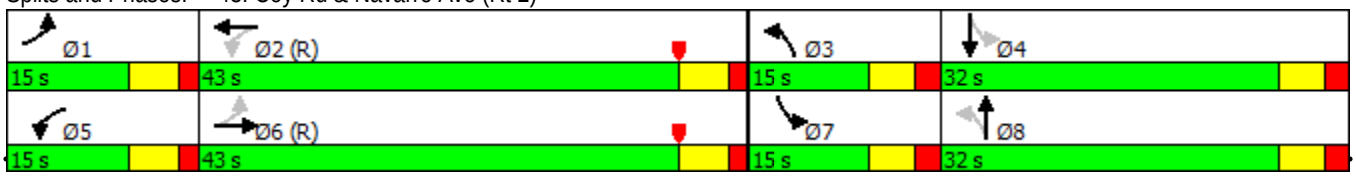


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	146
Future Volume (vph)	135	717	79	138	669	145	163	192	139	195	196	146
Satd. Flow (prot)	1787	3432	0	1805	3261	0	1787	1752	0	1787	1763	0
Flt Permitted	0.162			0.157			0.156			0.156		
Satd. Flow (perm)	305	3432	0	298	3261	0	293	1752	0	293	1763	0
Satd. Flow (RTOR)		13			34			39			39	
Lane Group Flow (vph)	159	927	0	150	911	0	190	406	0	219	406	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases	6			2			8			4		
Total Split (s)	15.0	43.0		15.0	43.0		15.0	32.0		15.0	32.0	
Total Lost Time (s)	4.5	3.5		4.5	3.5		4.7	3.7		4.7	3.7	
Act Effct Green (s)	50.8	41.7		50.7	41.6		35.9	26.6		35.9	26.6	
Actuated g/C Ratio	0.48	0.40		0.48	0.40		0.34	0.25		0.34	0.25	
v/c Ratio	0.55	0.68		0.52	0.69		0.77	0.86		0.89	0.86	
Control Delay	21.3	29.3		20.5	29.3		43.9	48.9		60.5	51.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	21.3	29.3		20.5	29.3		43.9	48.9		60.5	51.8	
LOS	C	C		C	C		D	D		E	D	
Approach Delay		28.1			28.0			47.3			54.8	
Approach LOS		C			C			D			D	
Queue Length 50th (ft)	55	272		52	263		93	241		98	232	
Queue Length 95th (ft)	87	324		88	340		#154	#195		#222	#368	
Internal Link Dist (ft)		2556			2037			562			2575	
Turn Bay Length (ft)	300			199			250			250		
Base Capacity (vph)	296	1370		295	1313		246	500		246	503	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.54	0.68		0.51	0.69		0.77	0.81		0.89	0.81	

Intersection Summary

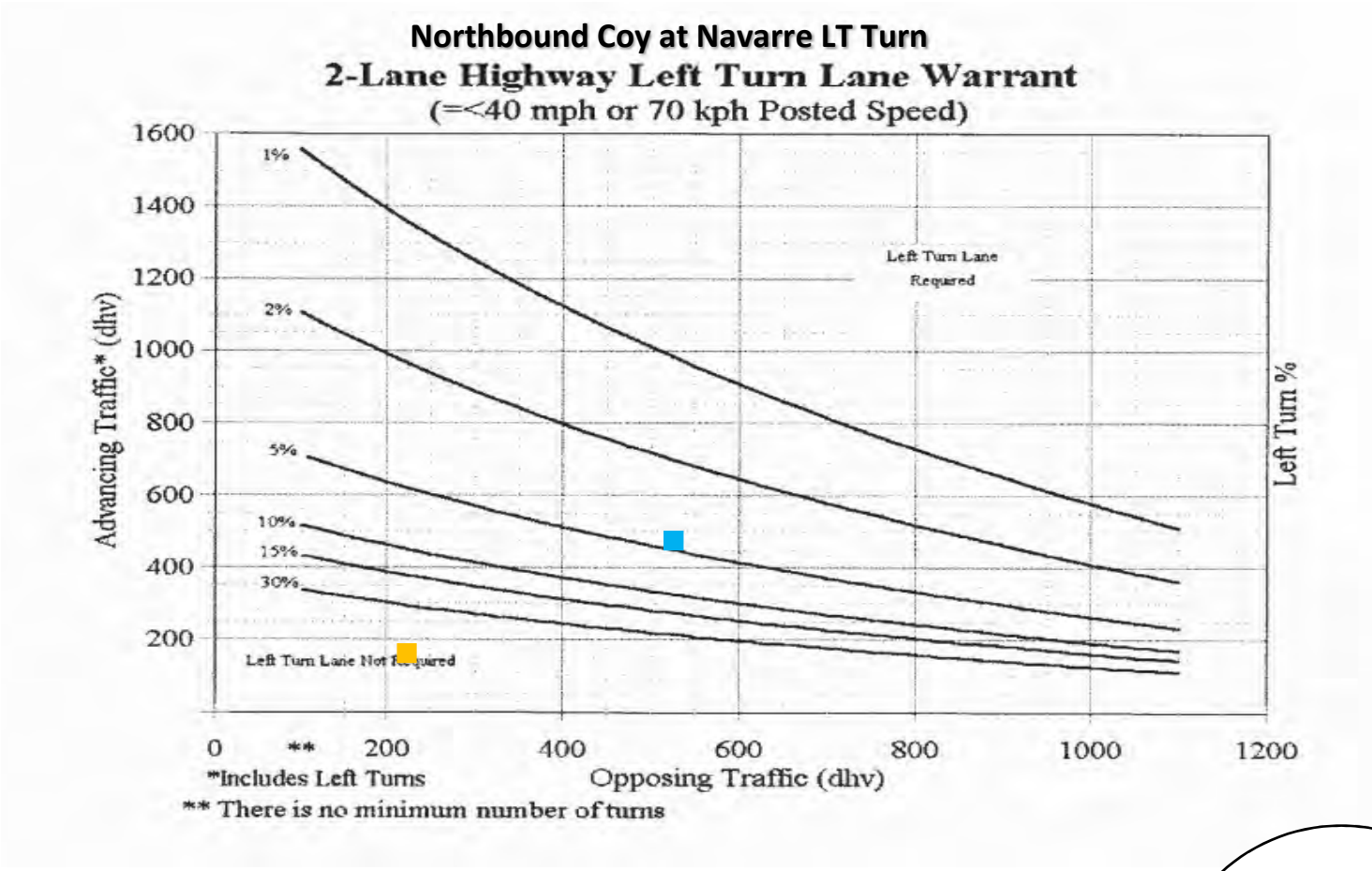
Cycle Length: 105
Actuated Cycle Length: 105
Offset: 85 (81%), Referenced to phase 2:WBTL and 6:EBTL, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.89
Intersection Signal Delay: 36.5 Intersection LOS: D
Intersection Capacity Utilization 76.5% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

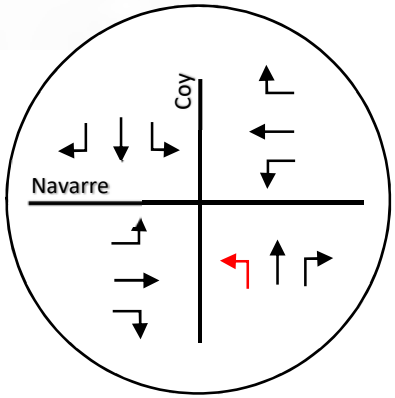
Splits and Phases: 43: Coy Rd & Navarre Ave (Rt 2)



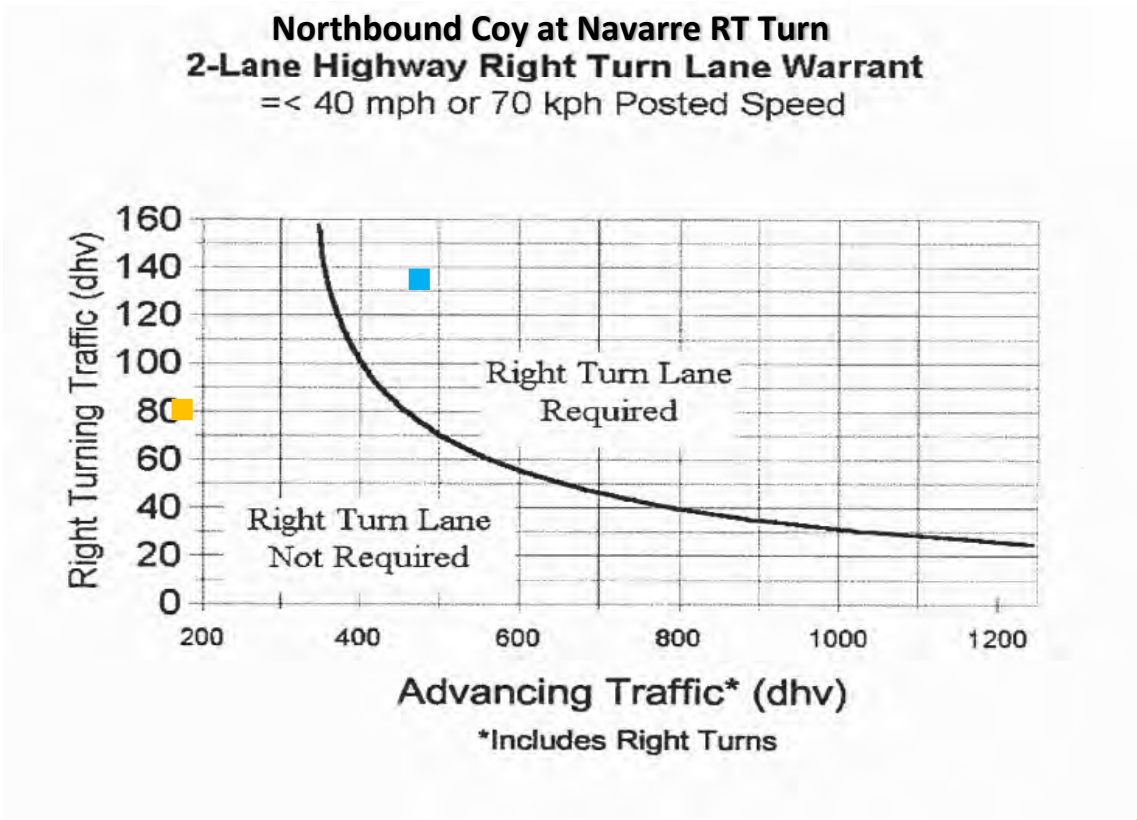
APPENDIX F

Calculations

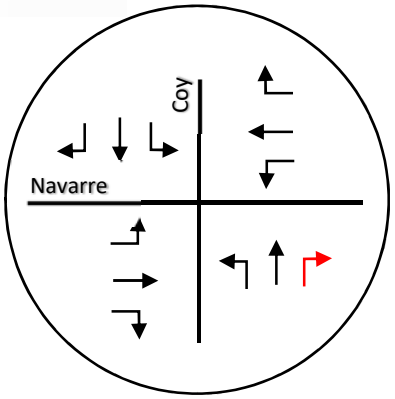




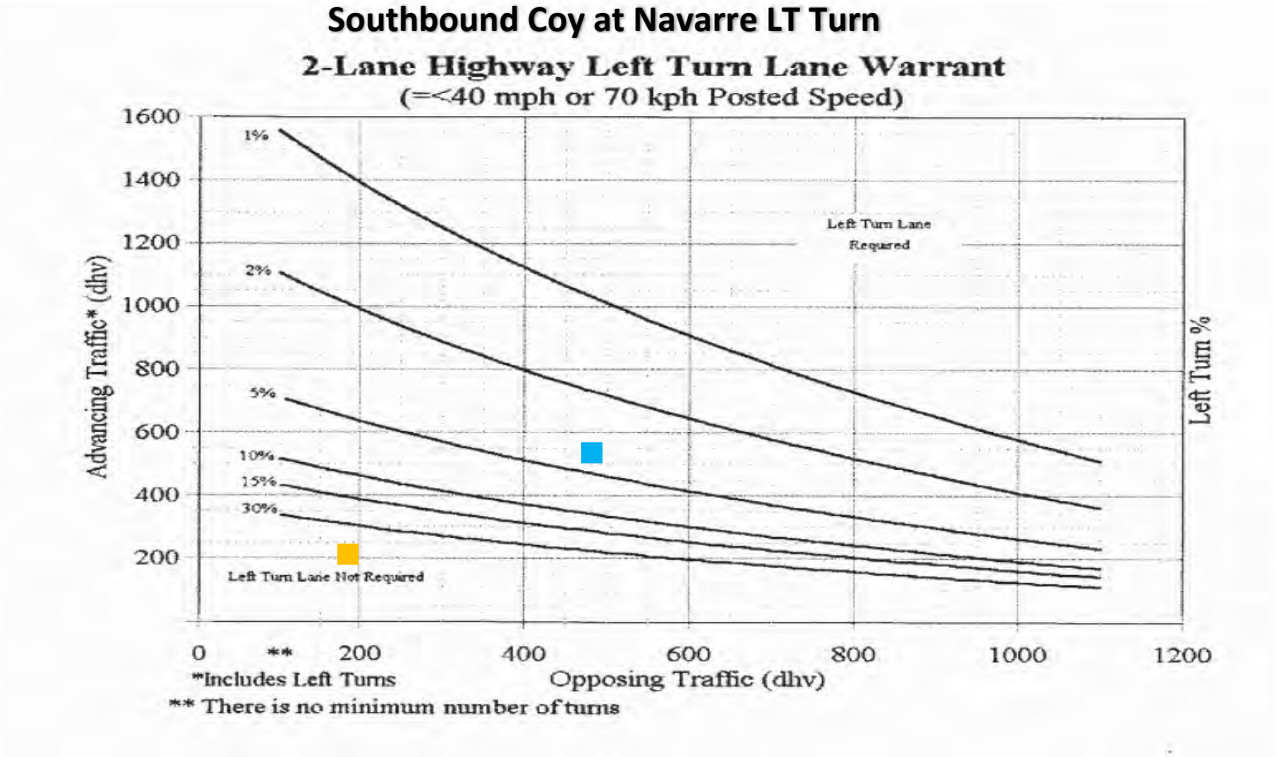
		Opposing Traffic	Advancing Traffic	LT Turn Traffic	% LT	Warranted?
	2018 AM Peak	219	191	68	36%	No
	2018 PM Peak	529	487	161	33%	Yes



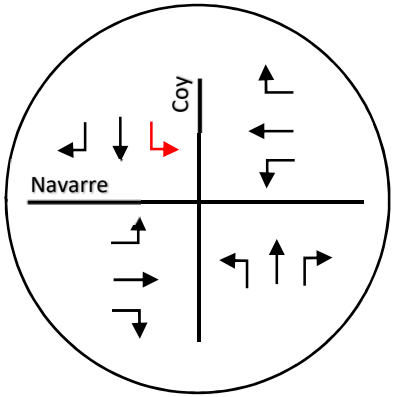
		Advancing Traffic	RT Turn Traffic	Warranted?
	2018 AM Peak	191	82	No
	2018 PM Peak	487	137	Yes

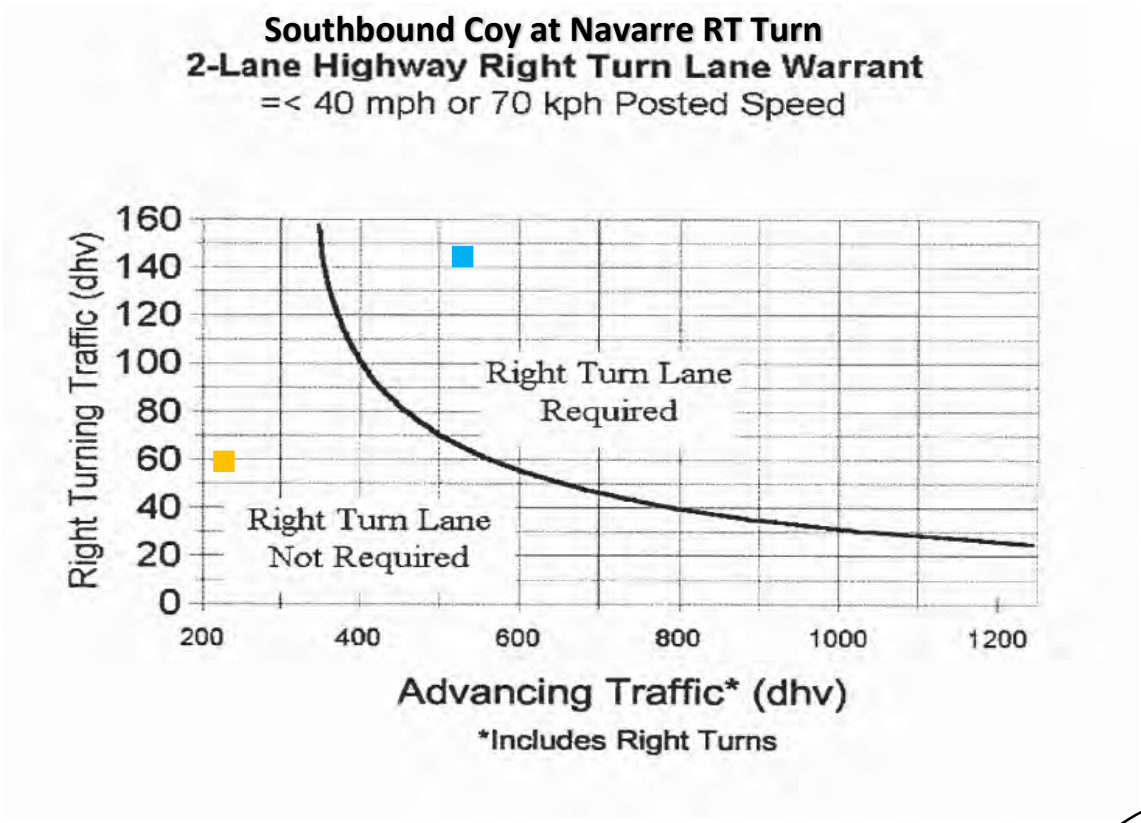


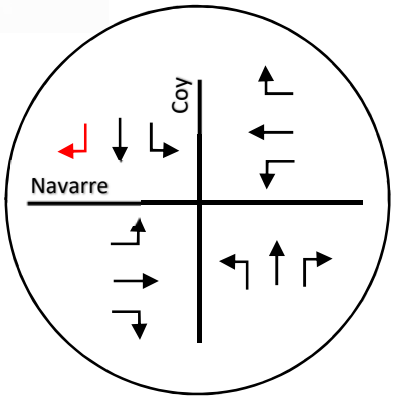
Southbound Coy at Navarre LT Turn



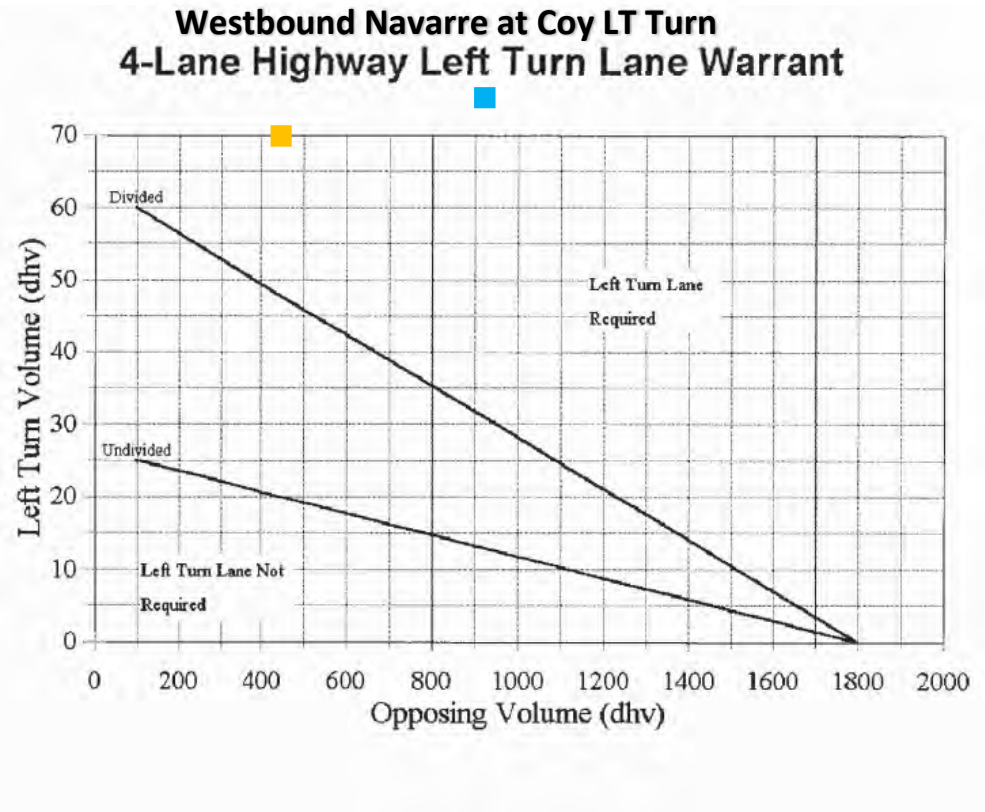
		Opposing Traffic	Advancing Traffic	LT Turn Traffic	% LT	Warranted?
	2018 AM Peak	191	219	74	34%	Yes
	2018 PM Peak	487	529	192	36%	Yes



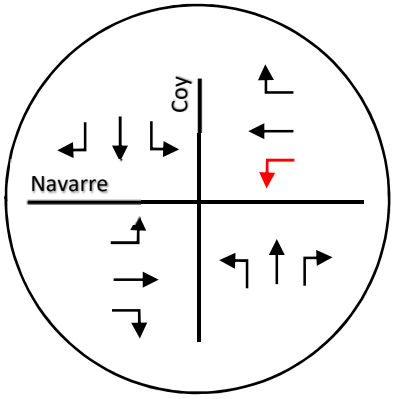


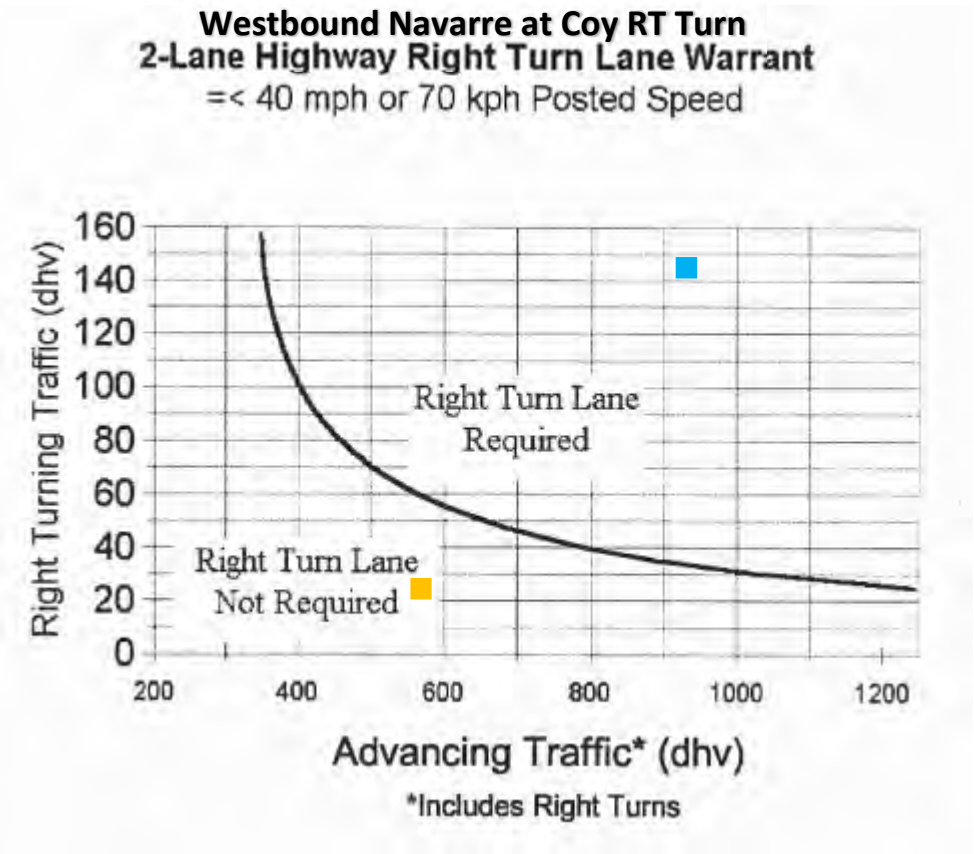


		Advancing Traffic	RT Turn Traffic	Warranted?
	2018 AM Peak	219	60	No
	2018 PM Peak	529	144	Yes

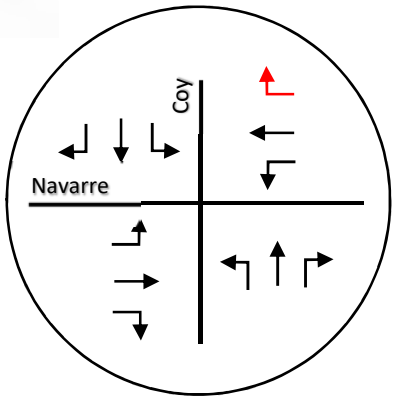


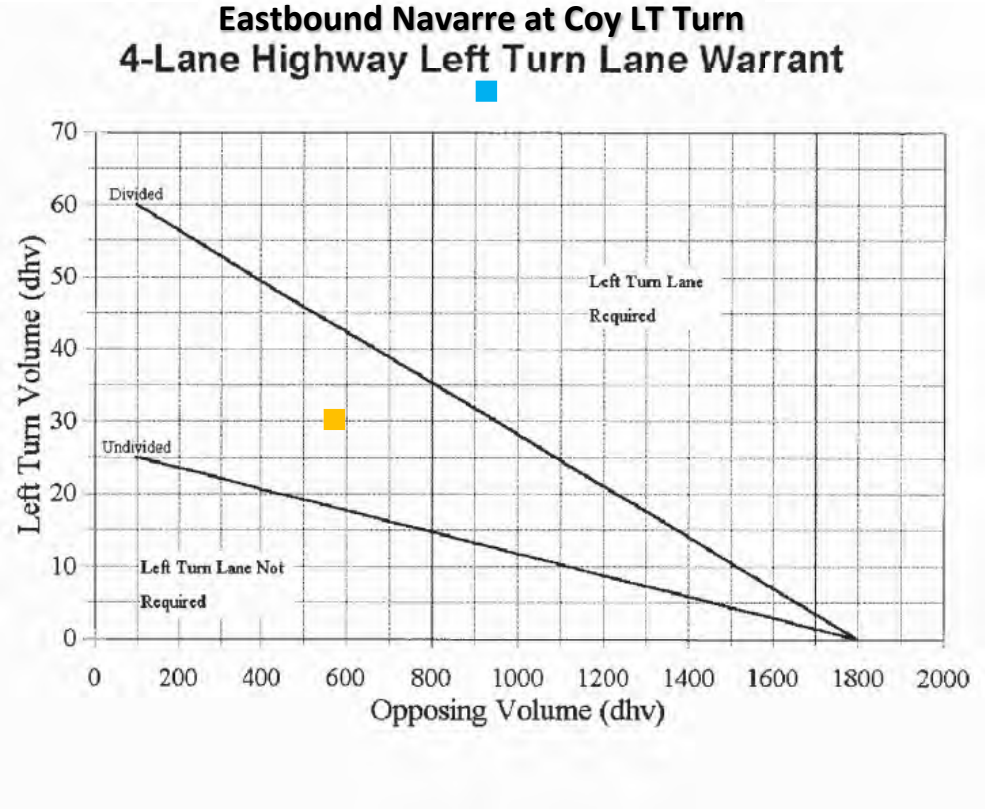
		Opposing Traffic	LT Turn Traffic	Warranted?
■	2018 AM Peak	442	71	Yes
■	2018 PM Peak	917	136	Yes

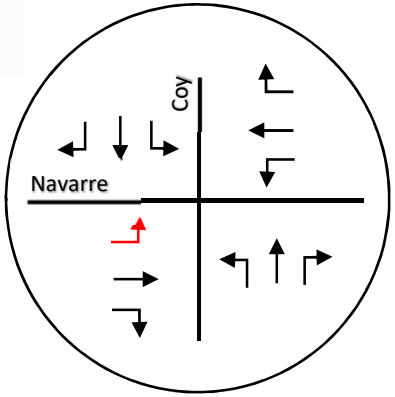




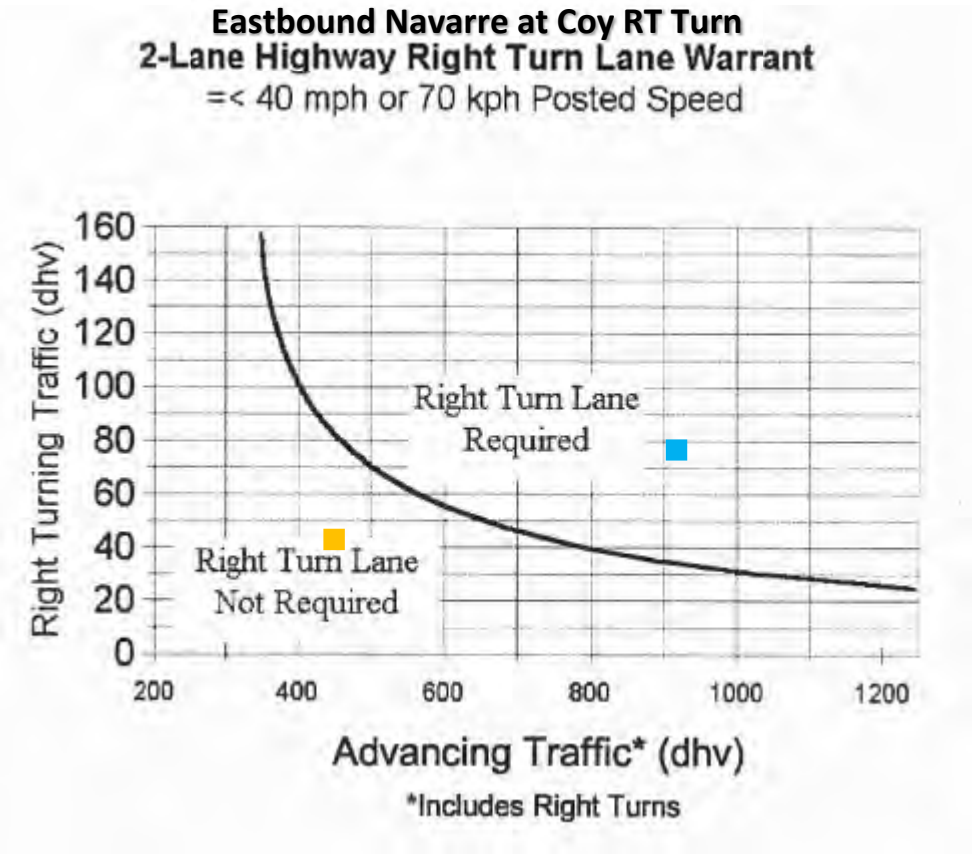
		Advancing Traffic	RT Turn Traffic	Warranted?
	2018 AM Peak	590	25	No
	2018 PM Peak	938	143	Yes

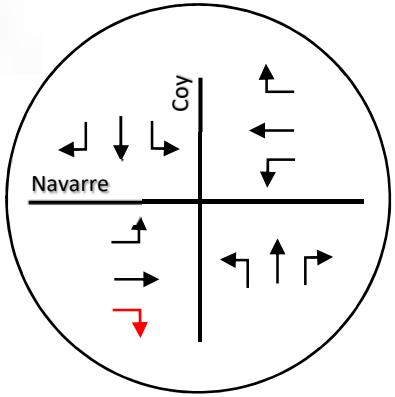






		Opposing Traffic	LT Turn Traffic	Warranted?
	2018 AM Peak	590	31	Yes
	2018 PM Peak	938	133	Yes





		Advancing Traffic	RT Turn Traffic	Warranted?
	2018 AM Peak	442	44	No
	2018 PM Peak	917	78	Yes

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Calculated by: CMS **Checked by:**

Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**

Road Name: **NB Coy to Navarre LT**

Left Turn Movement:	**183**	33.03% Left Turns		
Thru Movement:	**215**			
Right Turn Movement:	**156**	28.16% Right Turns	Signalized	**x**
Approach Volume:	**554**		Cycle Length (if known)	
Speed Limit:	**35**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	**x**
			Right Turn	

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	**A**	A	** B or C	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 6

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **300**

Condition B: High Speed Deceleration Only

Design Speed 35 MPH

Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed MPH

Length Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	215
Average Vehicles Per Cycle	6
Num. of Lanes	1
Thru Block	**250** Feet

Proposed Turn Lane Length: 300 Feet

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Project: **Coy & Navarre Safety Study**

Road Name: **NB Coy to Navarre RT**

Left Turn Movement:	**183**	33.03% Left Turns		
Thru Movement:	**215**			
Right Turn Movement:	**156**	28.16% Right Turns	Signalized	**x**
Approach Volume:	**554**		Cycle Length (if known)	
Speed Limit:	**35**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	
			Right Turn	**x**

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	**A**	A	** B or C	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 5

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **250**

Condition B: High Speed Deceleration Only

Design Speed 35 MPH

Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed MPH

Length Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	215
Average Vehicles Per Cycle	5
Num. of Lanes	1
Thru Block	**200** Feet

Proposed Turn Lane Length: 250 Feet

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Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**
Road Name: **SB Coy to Navarre LT**

Left Turn Movement:	**219**	36.32% Left Turns		
Thru Movement:	**220**			
Right Turn Movement:	**164**	27.20% Right Turns	Signalized	**x**
Approach Volume:	**603**		Cycle Length (if known)	
Speed Limit:	**35**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	**x**
			Right Turn	

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	**A**	A	** B or C	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume
** Whichever is greater

Average Vehicles per Cycle: 7

Condition A: Storage Only
Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)
Turn Lane Length: **325**

Condition B: High Speed Deceleration Only
Design Speed 35 MPH
Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage
Design Speed MPH
Length Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	220
Average Vehicles Per Cycle	7
Num. of Lanes	1
Thru Block	**275** Feet

Proposed Turn Lane Length: 325 Feet

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Calculated by: CMS **Checked by:**

Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**

Road Name: **SB Coy to Navarre RT**

Left Turn Movement:	**219**	36.32% Left Turns		
Thru Movement:	**220**			
Right Turn Movement:	**164**	27.20% Right Turns	Signalized	**x**
Approach Volume:	**603**		Cycle Length (if known)	
Speed Limit:	**35**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	
			Right Turn	**x**

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	**A**	A	** B or C	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 5

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **250**

Condition B: High Speed Deceleration Only

Design Speed 35 MPH

Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed MPH

Length Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	220
Average Vehicles Per Cycle	5
Num. of Lanes	1
Thru Block	**200** Feet

Proposed Turn Lane Length: 250 Feet

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Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**

Road Name: **WB Navarre to Coy LT**

Left Turn Movement:	**155**	14.51% Left Turns		
Thru Movement:	**750**			
Right Turn Movement:	**163**	15.26% Right Turns	Signalized	**x**
Approach Volume:	**1068**		Cycle Length (if known)	
Speed Limit:	**40**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	**x**
			Right Turn	

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	A	A	** **B or C**	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 5

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **250**

Condition B: High Speed Deceleration Only

Design Speed 40 MPH

Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed 40 MPH

Length **315** Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	750
Average Vehicles Per Cycle	5
Num. of Lanes	1
Thru Block	**200** Feet

Proposed Turn Lane Length: 315 Feet

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Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**
Road Name: **WB Navarre to Coy RT**

Left Turn Movement:	**155**	14.51% Left Turns		
Thru Movement:	**750**			
Right Turn Movement:	**163**	15.26% Right Turns	Signalized	**x**
Approach Volume:	**1068**		Cycle Length (if known)	
Speed Limit:	**40**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	
			Right Turn	**x**

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	A	A	** **B or C**	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume
** Whichever is greater

Average Vehicles per Cycle: 5

Condition A: Storage Only
Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)
Turn Lane Length: **250**

Condition B: High Speed Deceleration Only
Design Speed 40 MPH
Length 0 Feet

Turn Lane Length: **0** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage
Design Speed 40 MPH
Length **315** Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	750
Average Vehicles Per Cycle	5
Num. of Lanes	1
Thru Block	**200** Feet

Proposed Turn Lane Length: 315 Feet

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Calculated by: CMS **Checked by:**

Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**

Road Name: **EB Navarre to Coy LT**

Left Turn Movement:	**151**	14.46% Left Turns		
Thru Movement:	**804**			
Right Turn Movement:	**89**	8.52% Right Turns	Signalized	**x**
Approach Volume:	**1044**		Cycle Length (if known)	
Speed Limit:	**40**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	**x**
			Right Turn	

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	A	A	** **B or C**	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 5

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **250**

Condition B: High Speed Deceleration Only

Design Speed 40 MPH

Length 125 Feet

Turn Lane Length: **125** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed 40 MPH

Length **315** Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	804
Average Vehicles Per Cycle	5
Num. of Lanes	1
Thru Block	**200** Feet

Proposed Turn Lane Length: 315 Feet

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Calculated by: CMS **Checked by:**

Date: 9/5/2018 **Date:**

Project: **Coy & Navarre Safety Study**

Road Name: **EB Navarre to Coy RT**

Left Turn Movement:	**151**	14.46% Left Turns		
Thru Movement:	**804**			
Right Turn Movement:	**89**	8.52% Right Turns	Signalized	**x**
Approach Volume:	**1044**		Cycle Length (if known)	
Speed Limit:	**40**		Unsignalized Stopped Crossroad	
			Unsignalized Through Road	
			Left Turn	
			Right Turn	**x**

Unsignalized or 2 Phase: 3 Phase: 4 Phase: **x**

Type of Traffic Control	Design Speed (MPH)					
	30-35		40-45		50-60	
	Turn Demand Volume					
	High	Low*	High	Low*	High	Low*
Signalized	A	A	** **B or C**	** B or C	** B or C	** B or C
Unsignalized Stopped Crossroad	A	A	A	A	A	A
Unsignalized Through Road	A	A	C	B	** B or C	B

* Low is considered 10% or Less of Approach Traffic Volume

** Whichever is greater

Average Vehicles per Cycle: 3

Condition A: Storage Only

Length = 50' (diverging taper) + Storage Length (L&D Figure 401-10)

Turn Lane Length: **200**

Condition B: High Speed Deceleration Only

Design Speed 40 MPH

Length 125 Feet

Turn Lane Length: **125** Feet- Including 50' Diverging Taper

Condition C: Moderate Speed Deceleration and Storage

Design Speed 40 MPH

Length **265** Feet (including 50' Diverging Taper)

Thru Block: (Left Turn Only)

Thru Movement	804
Average Vehicles Per Cycle	3
Num. of Lanes	1
Thru Block	**150** Feet

Proposed Turn Lane Length: 265 Feet

Northbound

Thru Vehicles per Lane	Assumed Cycles	Veh per Cycle	Length	*Length fro
veh/hr/ln	sec/cycle	veh/cycle/ln	ft/ln	
215	120	7.17	275	

Southbound

Thru Vehicles per Lane	Assumed Cycles	Veh per Cycle	Length
veh/hr/ln	sec/cycle	veh/cycle/ln	ft/ln
220	120	7.33	275

Eastbound

Thru Vehicles per Lane	Assumed Cycles	Veh per Cycle	Length
veh/hr/ln	sec/cycle	veh/cycle/ln	ft/ln
402	120	13.40	475

Westbound

Thru Vehicles per Lane	Assumed Cycles	Veh per Cycle	Length
veh/hr/ln	sec/cycle	veh/cycle/ln	ft/ln
375	120	12.50	475

ASSOCIATED PHASE	DIRECTION	MOVEMENT	TRAFFIC SIGNAL														
			FACTORS								CALCULATED (TEM 403-2)			FINAL CLEARANCE		
			POSTED SPEED LIMIT	PERCEPTION/REACTION TIME (1s TYP)	YELLOW CHANGE APPROACH SPEED	ALL RED APPROACH SPEED	DECELERATION RATE (10 sq. fps TYP)	WIDTH OF INTERSECTION	LENGTH OF VEHICLE (20 ft TYP)	APPROACH GRADE	YELLOW	ALL RED	Y + AR	YELLOW	ALL RED	Y + AR
				t	V_Y	V_R	a	W	L	g	Y	AR	TOTAL	Y (3-6s TYP)	AR (1-6s TYP)	TOTAL
			MPH	SEC	MPH	MPH	SQ. FPS	FT	FT	%	SEC	SEC	SEC	SEC	SEC	SEC
1	EB LT	LEFT TURN	40	1	35	25	10	101	20	0	3.6	2.3	5.9	4	2	6.0
2	WB	THROUGH/RT	40	1	47	47	10	70	20	0	4.5	0.3	4.8	4.5	1	5.5
3	NB LT	LEFT TURN	35	1	30	25	10	103	20	0.25	3.2	2.3	5.5	3.5	2.5	6.0
4	SB	THROUGH/RT	35	1	42	42	10	86	20	0.25	4.1	0.7	4.8	4.5	1	5.5
5	WB LT	LEFT TURN	40	1	35	25	10	84	20	0	3.6	1.8	5.4	4	2	6.0
6	EB	THROUGH/RT	40	1	47	47	10	72	20	0	4.5	0.3	4.8	4.5	1	5.5
7	SB LT	LEFT TURN	35	1	30	25	10	86	20	0.25	3.2	1.9	5.1	3.5	2.5	6.0
8	NB	THROUGH/RT	35	1	42	42	10	89	20	0.25	4.1	0.8	4.9	4.5	1	5.5

CMF / CRF Details

CMF ID: 2514

Replace TWLTL with raised median

Description:

Prior Condition: Two way left turn lane (TWLTL)

Category: Access management

Study: *Modeling and Evaluating the Safety Impacts of Access Management (AM) Features in the Las Vegas Valley*, Mauga and Kaseko, 2010

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.77
Adjusted Standard Error:	
Unadjusted Standard Error:	0.0616

Crash Reduction Factor (CRF)	
Value:	23 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	6.16

Applicability

Crash Type:	Angle,Fixed object,Head on,Rear end,Run off road,Sideswipe,Single vehicle
Crash Severity:	All
Roadway Types:	All
Number of Lanes:	
Road Division Type:	All
Speed Limit:	30-45
Area Type:	Urban
Traffic Volume:	4883 to 96080
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	2002 to 2006
Municipality:	
State:	NV

Country:	
Type of Methodology Used:	Regression cross-section
Sample Size Used:	Crashes

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Aug-11-2010
Comments:	

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CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 2971

Provide a right-turn lane on one major-road approach

Description:

Prior Condition: Neither major approach to a 4-leg unsignalized intersection has a right-turn lane

Category: Intersection geometry

Study: *Using a Reliability Process to Reduce Uncertainty in Predicting Crashes at Unsignalized Intersections*, Haleem et al., 2010

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.75
Adjusted Standard Error:	
Unadjusted Standard Error:	0.19

Crash Reduction Factor (CRF)	
Value:	25 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	18.8

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Not specified
Traffic Volume:	
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Stop-controlled
Major Road Traffic Volume:	8955 to 66171 Annual Average Daily Traffic (AADT)
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	2003 to 2006
Municipality:	Orange County
State:	FL

Country:	U.S.A.
Type of Methodology Used:	Regression cross-section
Sample Size Used:	176 Crashes

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Mar-21-2011
Comments:	Countermeasure name has been slightly modified for consistency across Clearinghouse

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CMF / CRF Details

CMF ID: 5650

Install right-turn lane

Description:

Prior Condition: Unsignalized intersections or driveways without right turn lane

Category: Intersection geometry

Study: *Safety Impacts of Right-Turn Lanes at Unsignalized Intersections and Driveways on Two-Lane Roadways: Crash Analysis*, Ale et al., 2014

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.7
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	30 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	

Applicability

Crash Type:	Rear end
Crash Severity:	All
Roadway Types:	Principal Arterial Other Freeways and Expressways
Number of Lanes:	2
Road Division Type:	Undivided
Speed Limit:	
Area Type:	All
Traffic Volume:	
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	
Traffic Control:	Uncontrolled
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	2000 to 2005
Municipality:	
State:	MN

Country:	
Type of Methodology Used:	Regression cross-section
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Jan-21-2015
Comments:	This CMF is for rear-end crashes caused by right turn vehicles in right turn lanes.

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CMF / CRF Details

CMF ID: 225

Convert signalized intersection to modern roundabout

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection geometry

Study: ***NCHRP Report 572: Applying Roundabouts in the United States,*** **Rodegerdts et al., 2007**

Star Quality Rating:	★★★★☆

Crash Modification Factor (CMF)	
Value:	0.52
Adjusted Standard Error:	0.06
Unadjusted Standard Error:	0.05

Crash Reduction Factor (CRF)	
Value:	48 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	6

Unadjusted Standard Error:	5

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not Specified
Number of Lanes:	1 or 2
Road Division Type:	
Speed Limit:	
Area Type:	All
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	Not Specified
Traffic Control:	Signalized
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	

Country:	
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	Yes. HSM lists this CMF in **bold** font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.
Date Added to Clearinghouse:	Dec-01-2009
Comments:	Countermeasure name changed to match HSM

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CMF / CRF Details

CMF ID: 1417

Add signal (additional primary head)

Description:

Prior Condition: Intersection has one primary signal head per approach

Category: Intersection traffic control

Study: *Safety Benefits of Additional Primary Signal Heads*, Felipe et al., 1998

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.72
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	28 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	Rear end
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	Urban
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	Richmond, British Columbia
State:	
Country:	Canada

Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	Sites
Before Sample Size Used:	8 Sites
After Sample Size Used:	8 Sites

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Dec-01-2009
Comments:	The authors state that "three year of data were used for this analysis" (p. 7). This statement does not indicate if the before period was 3 years, the after period was 3 years, both were 3 years, or the total time period was 3 years (i.e. 1.5 years for before period and 1.5 years for after period).

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CMF / CRF Details

CMF ID: 1430

Improve visibility of signal heads

Description:

Prior Condition: Improvements included one or more of the following: signal lens size upgrade, installing new backboards, adding reflective tape to existing backboards, and installing additional signal heads.

Category: Intersection traffic control

Study: *Evaluating the Safety Impacts of Improving Signal Visibility at Urban Signalized Intersections*, Sayed et al., 2007

Star Quality Rating:	★★★★☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.93
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	*7 (This value indicates a **decrease** in crashes)*

Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	50 km/h (30 mph)
Area Type:	Urban
Traffic Volume:	
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	Roadway/roadway (not interchange related)
Intersection Geometry:	4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	1999 to 2004
Municipality:	City of Burnaby, City of Coquitlam, City of Kelowna, City of New Westminster, City of North Vancouver, City of Surrey

State:	
Country:	
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size Used:	Sites
Before Sample Size Used:	171 Sites
After Sample Size Used:	171 Sites

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

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CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 1686

Provide overhead lane-use signs

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection traffic control

Study: ***Signalized Intersections: Informational Guide*****, Rodegerdts et al., 2004**

Star Quality Rating:	Cannot Be Rated

Crash Modification Factor (CMF)	
Value:	0.9
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	10 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	Rear end
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	
Country:	

Type of Methodology Used:	
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

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CMF / CRF Details

CMF ID: 1687

Provide overhead lane-use signs

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Intersection traffic control

Study: ***Signalized Intersections: Informational Guide*, Rodegerdts et al., 2004**

Star Quality Rating:	Cannot Be Rated

Crash Modification Factor (CMF)	
Value:	0.8
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	20 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	Sideswipe
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	
Road Division Type:	
Speed Limit:	
Area Type:	
Traffic Volume:	
Time of Day:	

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	
Municipality:	
State:	
Country:	

Type of Methodology Used:	
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Dec-01-2009
Comments:	

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CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF / CRF Details

CMF ID: 2459

Change in driveway density from X to Y driveways per mile

Description: Curves and tangents.

Prior Condition: Greater or fewer number of driveways per mile

Category: Access management

Study: *Modeling and Evaluating the Safety Impacts of Access Management (AM) Features in the Las Vegas Valley*, Mauga and Kaseko, 2010

Star Quality Rating:	★★★☆☆ [View score details]

Crash Modification Factor (CMF)	
Value:	$e^{0.0096(Y-X)}$
Adjusted Standard Error:	
Unadjusted Standard Error:	

Crash Reduction Factor (CRF)	
Value:	$-100*\left(e^{0.0096(Y-X)}-1\right)$

Adjusted Standard Error:	
Unadjusted Standard Error:	

Applicability

Crash Type:	Angle,Fixed object,Head on,Rear end,Run off road,Sideswipe,Single vehicle
Crash Severity:	All
Roadway Types:	All
Number of Lanes:	
Road Division Type:	Divided by Median
Speed Limit:	30-45
Area Type:	Urban
Traffic Volume:	29320 to 96080
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	2002 to 2006
Municipality:	

State:	NV
Country:	
Type of Methodology Used:	Regression cross-section
Sample Size Used:	Crashes

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Aug-11-2010
Comments:	

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CMF / CRF Details

CMF ID: 9299

Resurface pavement

Description:

Prior Condition: ***No Prior Condition(s)***

Category: Roadway

Study: ***Time series trends of the safety effects of pavement resurfacing*****, Park et al., 2017**

Star Quality Rating:	★★★★☆ [View score details]

Crash Modification Factor (CMF)	
Value:	0.766
Adjusted Standard Error:	
Unadjusted Standard Error:	0.069

Crash Reduction Factor (CRF)	
Value:	23.4 *(This value indicates a **decrease** in crashes)*
Adjusted Standard Error:	

Unadjusted Standard Error:	6.9

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Principal Arterial Other
Number of Lanes:	1-4
Road Division Type:	
Speed Limit:	25mph to 65mph
Area Type:	Urban
Traffic Volume:	2100 to 40500 *Annual Average Daily Traffic (AADT)*
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	
Minor Road Traffic Volume:	

Development Details

Date Range of Data Used:	2004 to 2013
Municipality:	
State:	FL

Country:	USA
Type of Methodology Used:	Before/after using comparison group
Sample Size Used:	

Other Details

Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Jun-17-2018
Comments:	First year after treatment implementation

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APPENDIX G

Cost Estimate

LUC-2-22.42 Safety Study Proposed Conditions Estimated Costs		
Roadway Improvements	$	74,000.00
Erosion Control	$	2,000.00
Drainage	$	71,000.00
Pavement	$	324,000.00
Structure Addition	$	32,000.00
Traffic Control	$	60,000.00
Traffic Signal	$	150,000.00
Maintainance of Traffic	$	50,000.00
Incidentals	$	80,000.00
Total Project Cost:	**$**	**843,000.00**
Contingency (30%):	$	252,900.00
Inflation (7%)	$	133,342.00
Total:	**$**	**1,229,242.00**
Engineering (10%):	$	115,477.00
Right of Way	$	700,000.00
Grand Total:	**$**	**2,044,719.00**