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KENWOOD ROAD ACCESS MANAGEMENT STUDY

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Prepared for:
Sycamore Township
8540 Kenwood Road
Sycamore Township, Ohio 45236

Prepared by:
TEC Engineering, Inc.
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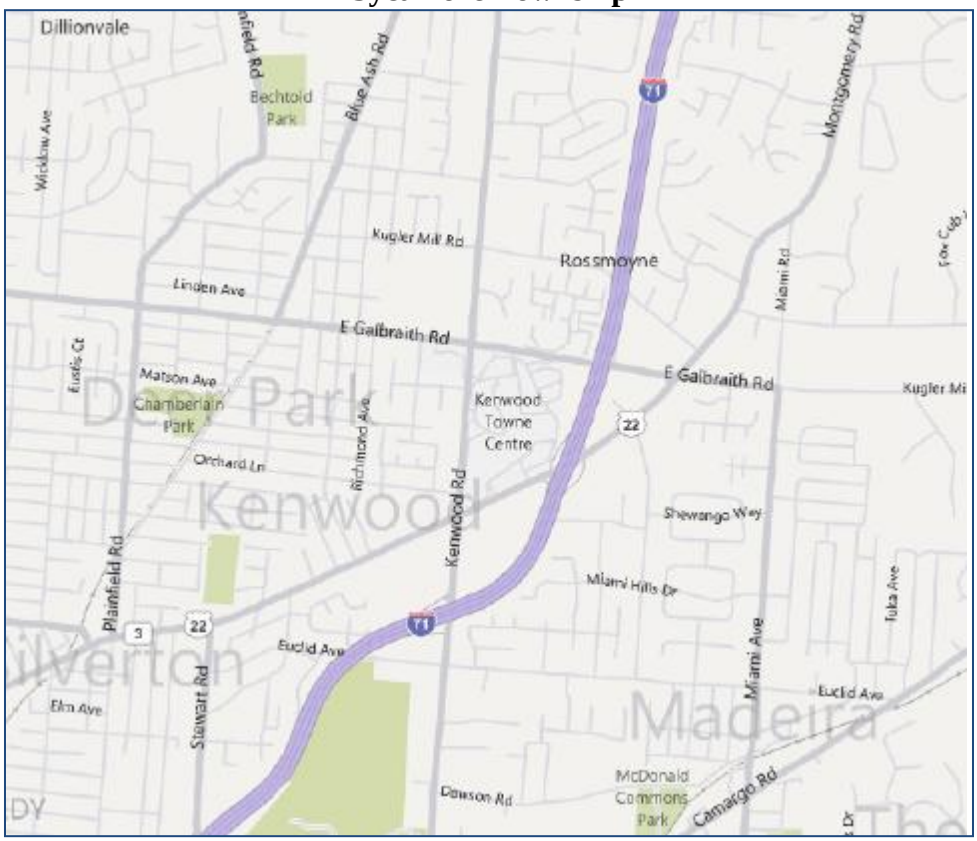
TEC PN – 11102-001
August 2011

CORRIDOR STUDY

Kenwood Road
Montgomery Road to Euclid Avenue
Hamilton County, Ohio

Prepared For:
Sycamore Township



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August 2011

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I. EXECUTIVE SUMMARY

A. Purpose

TEC Engineering, Inc. was retained to conduct a corridor study along the Kenwood Road corridor. The purpose of this study is to analyze the volumes, crashes, accesses and traffic flow along this segment and propose feasible countermeasures that will effectively reduce these crashes and congestion as well as recommend improvements to the overall feel of the corridor.

B. Background

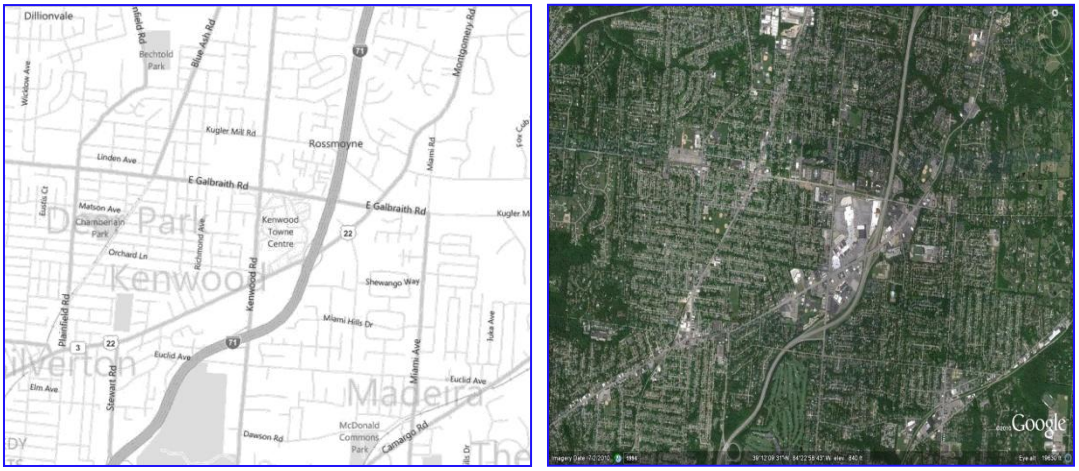
Kenwood Road is located in Sycamore Township on the northeast side of Hamilton County. The intersections located within the study area, from west to east, are listed below:

- Kenwood Road & I-71 NB Off Ramp
- Kenwood Road & I-71 SB On Ramp
- Kenwood Road & Sycamore Plaza

The I-71 NB Off Ramp and the Sycamore Plaza Entrance are signalized intersections. The I-71 SB On Ramp is an unsignalized intersection.

Figure 1 below shows a vicinity map and aerial photograph of the intersection.

Figure 1: Vicinity Map and Aerial Photograph



C. Crash Data and Analysis

The crash information provided was analyzed, and together with data gathered from traffic counts and field observations, used to determine potential safety issues at the intersection.

The raw crash data for Kenwood Road between Euclid Avenue and Montgomery Road for the years 2008 through 2010 were analyzed to identify patterns and possible safety deficiencies along the corridor. During this period a total of 87 crashes occurred along the roadway segment, with 14 of these crashes resulting in injuries. Six (7%) of the accidents occurred at night, and four (5%) occurred at dusk. The remainder of the accidents occurred during daylight hours.

Three main types of crashes occurred along the segment during the study years: rear end (44%), left turn (24%), and sideswipe passing (15%). Other accident types include angle, backing, and right turn.

These safety issues are listed below:

- Heavy Congestion
- Access Management
- Inadequate sidewalks
- Lack of right turn lanes

D. Recommended Countermeasures and Costs

Countermeasures were proposed to alleviate some of the safety issues listed above. These countermeasures are listed below:

- Review clearance intervals (Short Term)
- Install center median (Short Term)
- Access Management (Long Term)
- Streetscaping – Street furniture, plantings, etc. (Short & Long Term)

E. Rate of Return

Recommendation	Cost	ROR
Short Term Recommendations	$1,081,349	22.60%

II.

Recommendation	Cost	ROR
Long Term Recommendations	$2,892,967	5.32%

III. EXISTING CONDITIONS

Kenwood Road is an Urban Minor Arterial running north and south through Sycamore Township in the northeastern part of Hamilton County. The study area is a segment of Kenwood Road between Montgomery Road (US 22/3) and Euclid Avenue. This segment is approximately 0.5 miles long and includes the I-71 interchange with Kenwood Road. This segment has an average daily traffic (ADT) rate of 26,000 vehicles per day. The major intersections included in the study area from north to south are shown below in ***Table 1***.

Table 1: Study Area Intersections

Major Street	Minor Street	Major Street Classification	Minor Street Classification	Traffic Control
Kenwood Road	Montgomery Road	Urban Minor Arterial	Urban Principal Arterial	Traffic Signal
Kenwood Road	Sycamore Plaza	Urban Minor Arterial	Private Road	Traffic Signal
Kenwood Road	I-71 SB On Ramp	Urban Minor Arterial	Interstate Ramp	Uncontrolled
Kenwood Road	I-71 NB Off Ramp	Urban Minor Arterial	Interstate Ramp	Traffic Signal

The intersection of Kenwood Road and Montgomery Road is the northern boundary of the study area and carries the highest traffic volume among all study intersections. The study area will also include all driveways along Kenwood Road between Montgomery Road and Euclid Avenue. The AM, Midday and PM peak hour volumes for each intersection are shown in ***Table 2***. The turning movement volumes are shown in ***Figure 3*** and the raw traffic count data are shown in ***Appendix A***.

Table 2: Peak Hour Volumes

Intersection		Volume	
	AM	*Noon*	*PM*
Kenwood & I71 NB Off Ramp	1680	1753	1934
Kenwood & I71 SB On Ramp	2040	2059	2093
Kenwood & Sycamore Plaza/St. Vincent Ferrer	1728	1996	2384
Kenwood & Sycamore Plaza/Sycamore Crossing	1498	2157	2183

The pavement and pavement markings on Kenwood Road are in fair condition. The signage in the area is in good condition. The roadway is a four lane facility with 10-11 foot lane widths at the ramps and 12 foot lane widths from Sycamore plaza to the north. There is a two way left turn lane between Sycamore Plaza/St. Vincent Ferrer and Montgomery Road. The entire length of Kenwood Road has curb and gutter (in some areas, the gutter plate has been paved over). There are 4 foot sidewalks throughout the

study area. Bus stops exist at several locations in the study area. The terrain along Kenwood Road is generally flat.

The area is a mainly commercial with several fast food restaurants located immediately adjacent to the roadway. There are several driveways located within the half mile of roadway, with 17 driveways between Montgomery Road and Interstate 71. South of the interchange, Kenwood Road is mainly residential with several residential driveways and one business driveway (Kenwood Fellowship Church). The speed limit in the study area is 35 mph. There is a school zone along Kenwood Road for the St. Vincent Ferrier School. The school zone extends from the Burger King to the north to approximately the I-71 overpass; although school flashers are not present.

The pavement and pavement markings are in fair condition on all intersecting roadways as well. The pavement markings on some of the driveways are beginning to show deterioration. Sight Distance is not an issue along the corridor.

There are three Metro Bus routes along the Kenwood Road corridor. Route 2X (Madeira Express) travels south along Kenwood from Montgomery Road to Euclid Road. There is one stop on Montgomery Road at Kenwood. Route 3X (Montgomery Express) travels north on I-71 to Kenwood Road, then north along Kenwood to Kugler Mill Road. There is one stop on Montgomery Road at Kenwood Road. And Route 72 travels north on I-71 to Kenwood Road, then north along Kenwood Road to Montgomery Road. There is one stop on Kenwood Road at Montgomery Road.

Pictures of the corridor are shown in ***Appendix B*** and the existing conditions diagram is shown in ***Appendix C***.

Figure 2: Metro Bus Routes

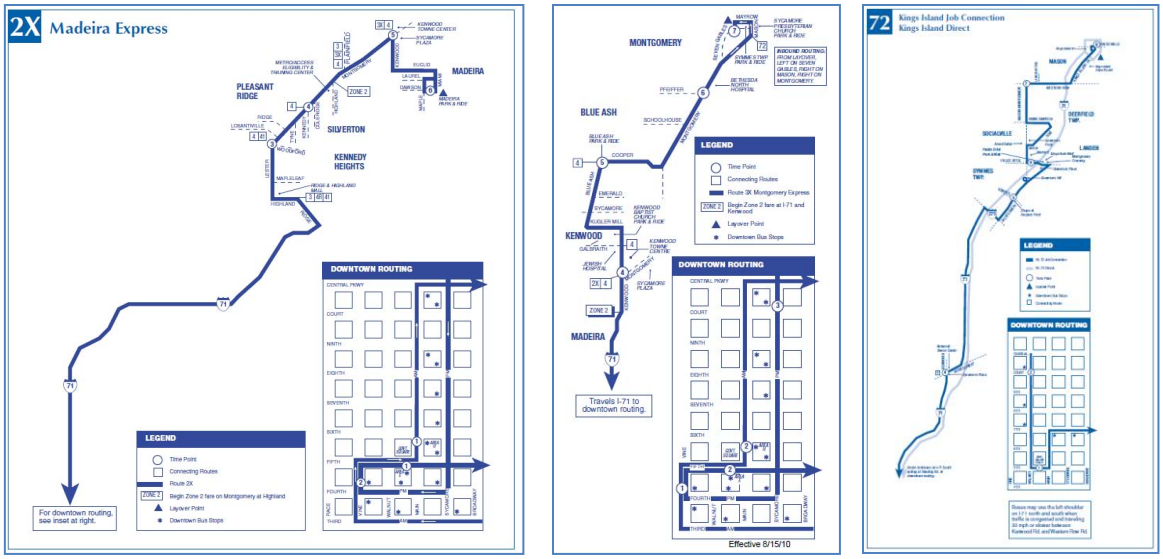
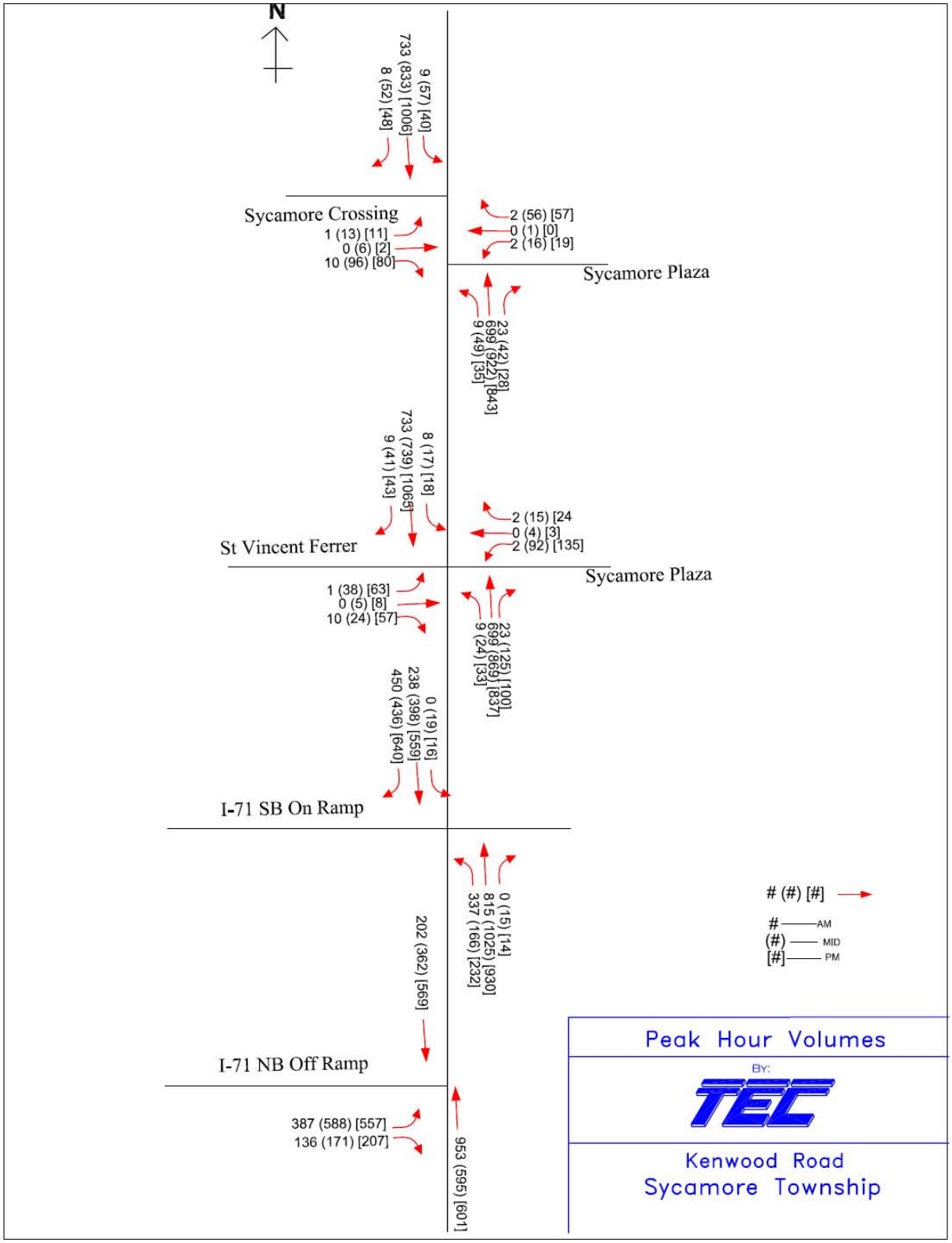


Figure 3: Existing Traffic Volumes



IV. CRASH DATA

A. Crash Report Summary

Crash data are the most important element of a safety study. The data can reveal crash patterns, which in turn can indicate safety problems. Without complete and accurate crash data, all analyses and recommendations are limited in value. Crash data for the intersection from 2008 through 2010 were obtained from the Ohio Department of Public Safety, as well as the Hamilton County Engineer's Office.

The crash reports were grouped using several different criteria, including crash type, severity and environmental conditions among others. Collision diagrams were created to provide a visual depiction of the accidents. The crash summary for the corridor is provided in ***Figures 4A-4D*** and the collision diagrams are shown in ***Figures 5A-5C***. More comprehensive crash data is presented in ***Appendix D***.

B. Crash Data

ODOT has established a Highway Safety Program (HSP) that emphasizes safety in all phases of highway development. The HSP establishes procedures for project evaluation and statewide prioritization. The criteria used for scoring projects and determining prioritization are based on a point system corresponding to assigned value ranges. These statistics are generated from data collected over the most recent consecutive three year period. Data for the roadway segment studied is listed below in ***Table 3a & 3b***.

Table 3a: Crash Statistics for Study Roadway Segment from 2008 – 2010

Roadway Segment	Crash Frequency	Crash Rate	RSI	EPDO Rate	Truck %
Kenwood Rd between Montgomery & Euclid	87	6.11	26903	10.37	2%

In addition to the most recent 3 year period, crash data was also tabulated for the corridor from 2007-2009. There was major construction in the area during 2010, which is thought to have some impact on the crash data from the 2008-2010 study period. As can be seen, the numbers are slightly lower, but still show similar trends.

Table 3b: Crash Statistics for Study Roadway Segment from 2007 – 2009

Roadway Segment	Crash Frequency	Crash Rate	RSI	EPDO Rate	Truck %
Kenwood Rd between Montgomery & Euclid	76	5.34	21314	8.74	2%

The *crash frequency* is simply the total number of crashes for a given intersection or roadway segment during the three year study period.

The *crash rate* takes into consideration traffic counts to recognize the exposure of each location. For an intersection, the crash rate is the number of crashes at that intersection per one million entering vehicles. The crash rate for a roadway segment is the number of crashes along that segment per one million vehicle miles traveled.

The *Relative Severity Index (RSI)* represents the relative cost to society of a specific crash type. The RSI is the sum of the relative costs per crash divided by the total number of crashes. The costs associated with specific crash types were determined by ODOT and can be seen in the rate of return worksheets (***Figures 8A-8B***).

The *Equivalent Property Damage Only (EPDO) Rate* weights crashes by property damage only, injury and fatality. The crashes are weighted as follows:

> *EPDO Rate = (# of PDO crashes * 1) + (# of injury crashes * 5.50) + (# of fatal crashes * 90.14)*

The EPDO Rate is then calculated by taking the EPDO value per one million entering vehicles for intersections or the EPDO value per one million vehicle miles for roadway segments.

Figure 4A: Crash Summary

LPA: Sycamore Township Proj#: 11102-001 Date: 1/25/2011

Crash Location: Kenwood Road between Montgomery & Euclid

Crash Data					
Three Year Total	87	PDO	72	Truck %	2%
Annual Average	29.00	Injury	14	Fatal	
ADT (vpd)	26000	RSI	26903	EPDO Rate	10.37
Crash Rate (acc/MEV)	6.11	Seg Length (mi)	0.5	ΔChange	0.48

	Freeway
√	Non-Freeway
√	Urban
	Rural
	Spot Location
√	Roadway Segment

Crash Type

Description	2008			2009			2010			Total			
	Total	Injury	Fatal	Total	Injury	Fatal	Total	Injury	Fatal	Total	%	Injury	Fatal
Not Stated													
Head On													
Rear End	9	3		8	1		20	6		37	43%	10	
Backing	2	1		1						3	3%	1	
Sideswipe Meeting / Left-Turn													
Sideswipe Passing	3			7			4			14	16%		
Angle	1	1		1			5	1		7	8%	2	
Parked Vehicle													
Pedestrian													
Animal													
Train													
Pedacycles													
Other Non Vehicle													
Fixed Object													
Other Object													
Right Turn	1			1			2			4	5%		
Overturning													
Left Turn	5			8	1		8			21	24%	1	
Grand Total	21	5		26	2		39	7		86	100%	14	

Red Text-Crash Types Not Shown in table "Crash Analysis" spreadsheet

Light Conditions

Description	2008			2009			2010			Total			
	Total	Injury	Fatal	Total	Injury	Fatal	Total	Injury	Fatal	Total	%	Injury	Fatal
1 Daylight	20	4		23	1		34	5		77	89%	10	
2 Dawn													
3 Dusk				1			3	1		4	5%	1	
4-6 Dark	1	1		2	1		3	1		6	7%	3	
7 Glare													
8 Other													
9 Unknown													
Grand Total	21	5		26	2		40	7		87	100%	14	

Road Conditions

Description	2008			2009			2010			Total			
	Total	Injury	Fatal	Total	Injury	Fatal	Total	Injury	Fatal	Total	%	Injury	Fatal
01 Dry	19	5		23	2		32	5		74	85%	12	
02 Wet	2			3			8	2		13	15%	2	
03 Snow													
04 Ice													
05 Sand, Mud, Etc.													
06 Water													
07 Slush													
08 Debris													
09 Rut, Holes, Etc.													
10 Other													
11 Unknown													
Grand Total	21	5		26	2		40	7		87	100%	14	

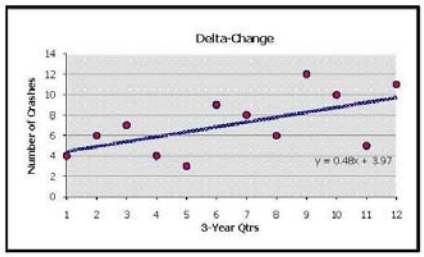
Weather

Description	2008			2009			2010			Total			
	Total	Injury	Fatal	Total	Injury	Fatal	Total	Injury	Fatal	Total	%	Injury	Fatal
01 Clear	12	3		11	2		20	2		43	49%	7	
02 Cloudy	7	2		12			14	3		33	38%	5	
03 Fog, Smog, Smoke													
04 Rain	2			3			5	2		10	11%	2	
05 Sleet, Hail													
06 Snow							1			1	1%		
07 Severe Crosswinds													
08 Blowing Soil, Sand, Dirt													
09 Other													
10 Unknown													
Grand Total	21	5		26	2		40	7		87	100%	14	

Figure 4B: Crash Summary

Direction (At Fault)													
Description	2008			2009			2010			Total			
	From	To	I/F (From)	From	To	I/F (From)	From	To	I/F (From)	From	To	% From	I/F (From)
1 North	3	14	1	13	9	2	12	12	3	28	35	37%	6
2 South	11	2	3	8	14		21	21	2	40	37	45%	5
3 East	4	2	1	3			5	5	2	12	7	11%	3
4 West	3	3		1	2		2	2		6	7	8%	
5 Northeast													
6 Northwest													
7 Southeast													
8 Southwest													
9 Unknown													
Grand Total	21	21	5	25	25	2	40	40	7	86	86	100%	14

Direction (Not At Fault)													
Description	2008			2009			2010			Total			
	From	To	I/F (From)	From	To	I/F (From)	From	To	I/F (From)	From	To	% From	I/F (From)
1 North	6	10	1	6	12	1	9	20	4	21	42	37%	6
2 South	9	6	3	9	8		17	11	1	35	25	35%	4
3 East	5	2	1	6	1		10	1	2	21	4	15%	3
4 West		2		4	4	1	3	5		7	11	10%	1
5 Northeast													
6 Northwest													
7 Southeast								1			1	1%	
8 Southwest								1			1	1%	
9 Unknown													
Grand Total	20	20	5	25	25	2	39	39	7	84	84	100%	14



Delta Change			
2008	2009	2010	Quarter
4	3	12	1
6	9	10	2
7	8	5	3
4	6	11	4
0.100	0.800	-0.800	ΔYear
0.479			ΔChange

Figure 4C: Crash Summary

Prepared By: TEC Engineering, Inc.
Three Year Totals: *2008* to *2010*

Contributing Factor (At-Fault)								
Description	2008		2009		2010		Total	
	#	%	#	%	#	%	#	%
01 None (Motorist)								
02 Failure to Yield	5	24%	8	31%	9	23%	22	25%
03 Ran Red Light, or Stop Sign			2	8%	2	5%	4	5%
04 Exceeded Speed Limit								
05 Unsafe Speed	1	5%					1	1%
06 Improper Turn	2	10%					2	2%
07 Left of Center					1	3%	1	1%
08 Followed Too Closely	7	33%	8	31%	19	48%	34	39%
09 Improper Lane Change/Passing/Off Road	1	5%	6	23%	3	8%	10	11%
10 Improper Backing	1	5%	1	4%	1	3%	3	3%
11 Improper Start from Parked Position	1	5%					1	1%
12 Stopped or Parked Illegally								
13 Erratic/Negligent Driving								
14 Swerving to Avoid								
15 Failure to Control			1	4%	2	5%	3	3%
16 Vision Obstruction								
17 Driver Inattentiveness					2	5%	2	2%
18 Fatigue/Asleep								
19 Operating Defective Equipment								
20 Load Shifting/Falling/Spilling								
21 Other Improper Action								
22 Unknown (M)	2	10%			1	3%	3	3%
23 None (N-M	1	5%					1	1%
24 Improper Crossing (N-M)								
25 Darting (N-M)								
26 Lying and/or Illegally in Roadway (N-M)								
27 Failure to Yield Right of Way (N-M)								
28 Not Visible (N-M)								
29 Inattentive (N-M)								
30 Failure to Obey Signs, Signals, Etc. (N-M)								
31 Wrong Side of the Road (N-M)								
32 Other (N-M)								
33 Unknown (N-M)								
Totals	21	24%	26	30%	40	46%	87	

Pre-Crash Actions (At-Fault)								
Description	2008		2009		2010		Total	
	#	%	#	%	#	%	#	%
01 Straight Ahead	10	48%	6	23%	16	40%	32	37%
02 Backing	2	10%	1	4%	1	3%	4	5%
03 Changing Lanes	1	5%	5	19%	2	5%	8	9%
04 Passing								
05 Turning Right			1	4%			1	1%
06 Turning Left	4	19%	2	8%	7	18%	13	15%
07 Making U-Turn								
08 Entering Lane			6	23%	4	10%	10	11%
09 Leaving Lane	1	5%	1	4%			2	2%
10 Parked								
11 Slowing/Stopped	3	14%	4	15%	10	25%	17	20%
12 Driverless								
13 Other								
14 Unknown								
15 Enter/Cross (N-M)								
16 Walking, Running (N-M)								
17 Working (N-M)								
18 Pushing Vehicle (N-M)								
19 App/Leave Veh (N-M)								
20 Play/Work On Veh (N-M)								
21 Standing (N-M)								
22 Other (N-M)								
23 Unknown (N-M)								
Totals	21	24%	26	30%	40	46%	87	

Vehicle Types								
Description	2008		2009		2010		Total	
	#	%	#	%	#	%	#	%
Trucks					2	2%	2	1%
Other	43	100%	55	100%	80	98%	178	99%
Totals	43	24%	55	31%	82	46%	180	

Figure 4D: Crash Summary

Alcohol/Drug Suspected								
Description	2008		2009		2010		Total	
	#	%	#	%	#	%	#	%
1 None	21	100%	25	96%	27	68%	73	84%
2-5 Yes					4	10%	4	5%
6 Unknown			1	4%	9	23%	10	11%
Totals	21	24%	26	30%	40	46%	87	

Driver Age								
Description	2008		2009		2010		Total	
	#	%	#	%	#	%	#	%
<20		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
20-24		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
25-65		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
>65		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
NA		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
Totals		#DIV/0!		#DIV/0!		#DIV/0!		

Relative Severity Index (RSI)					
Description	Total	RSI-Urban	Sum of Products	Freeway	Non-Freeway
Not Stated		28922.16901			
Head On		51696.43602			
Rear End	37	24949.70363	923139.0342		
Backing	3	24297.19978	72891.59935		
Sideswipe Meeting / Left-Turn		37430.16176			√
Sideswipe Passing	14	24272.3645	339813.1029	Urban	Rural
Angle	7	28552.75067	199869.2547		
Parked Vehicle		21194.58128			
Pedestrian		74466.37769			
Animal		18143.47956			
Train		200714.25			
Pedacycles		41648.65644		√	
Other Non Vehicle				Spot Location	Roadway Segment
Fixed Object		25433.61158			
Other Object		18485.26049			
Right Turn	4	28552.75067	114211.0027		
Overturning		42095.85164			
Left Turn	21	31608.11778	663770.4735		
Grand Total	86	26903	2313691.467		√

Figure 5A: Collision Diagram 2008

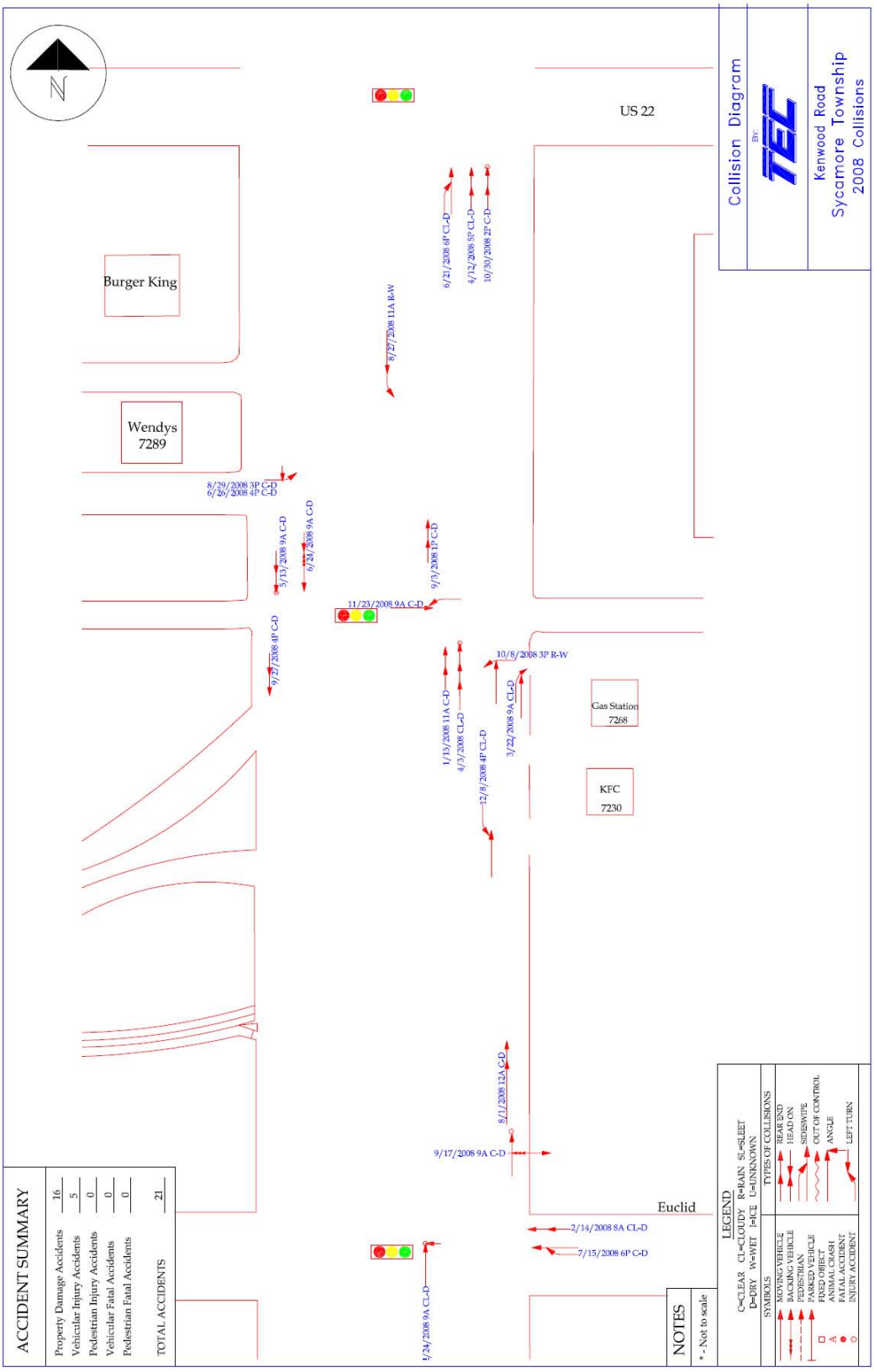


Figure 5B: Collision Diagram

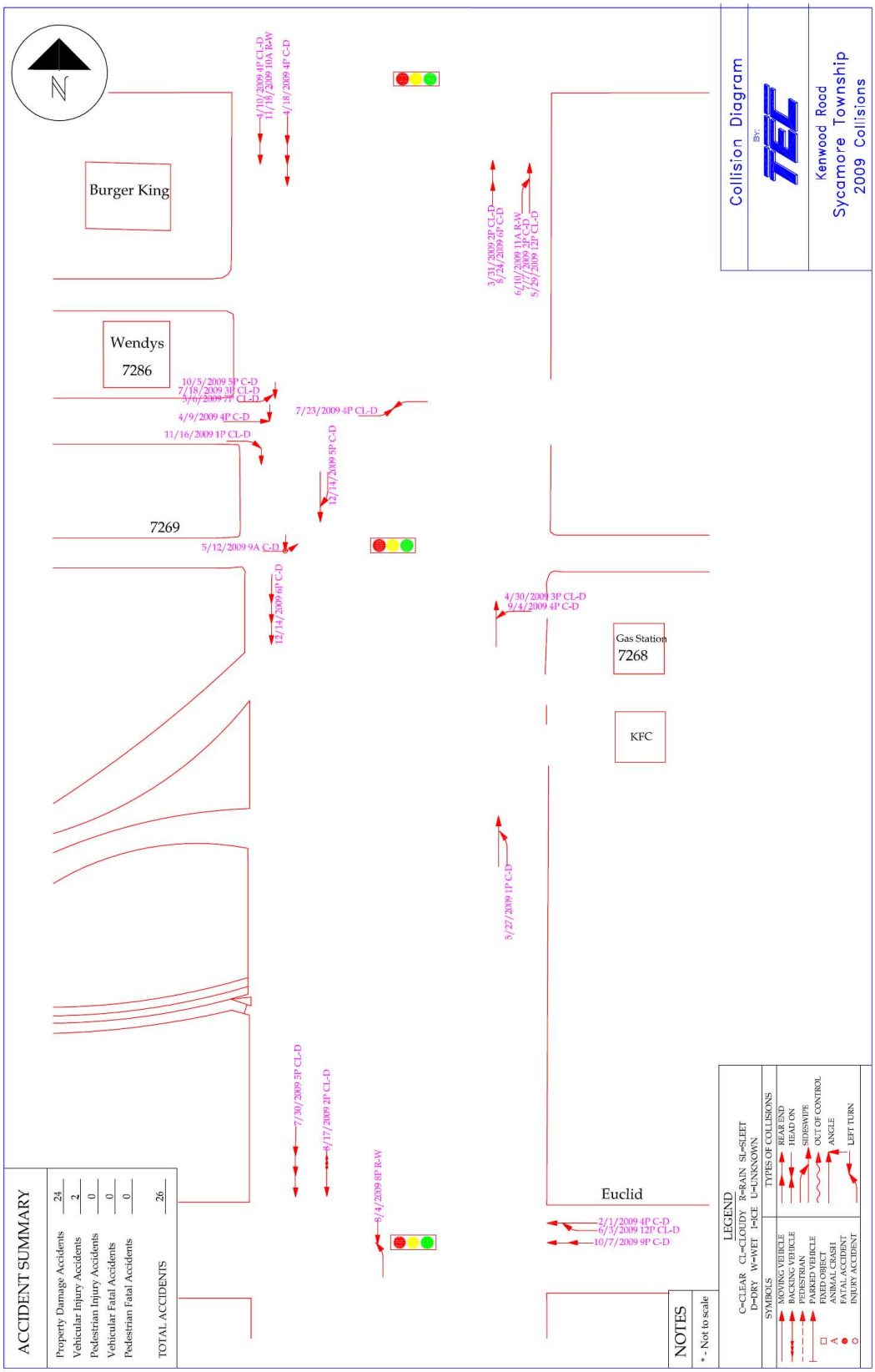
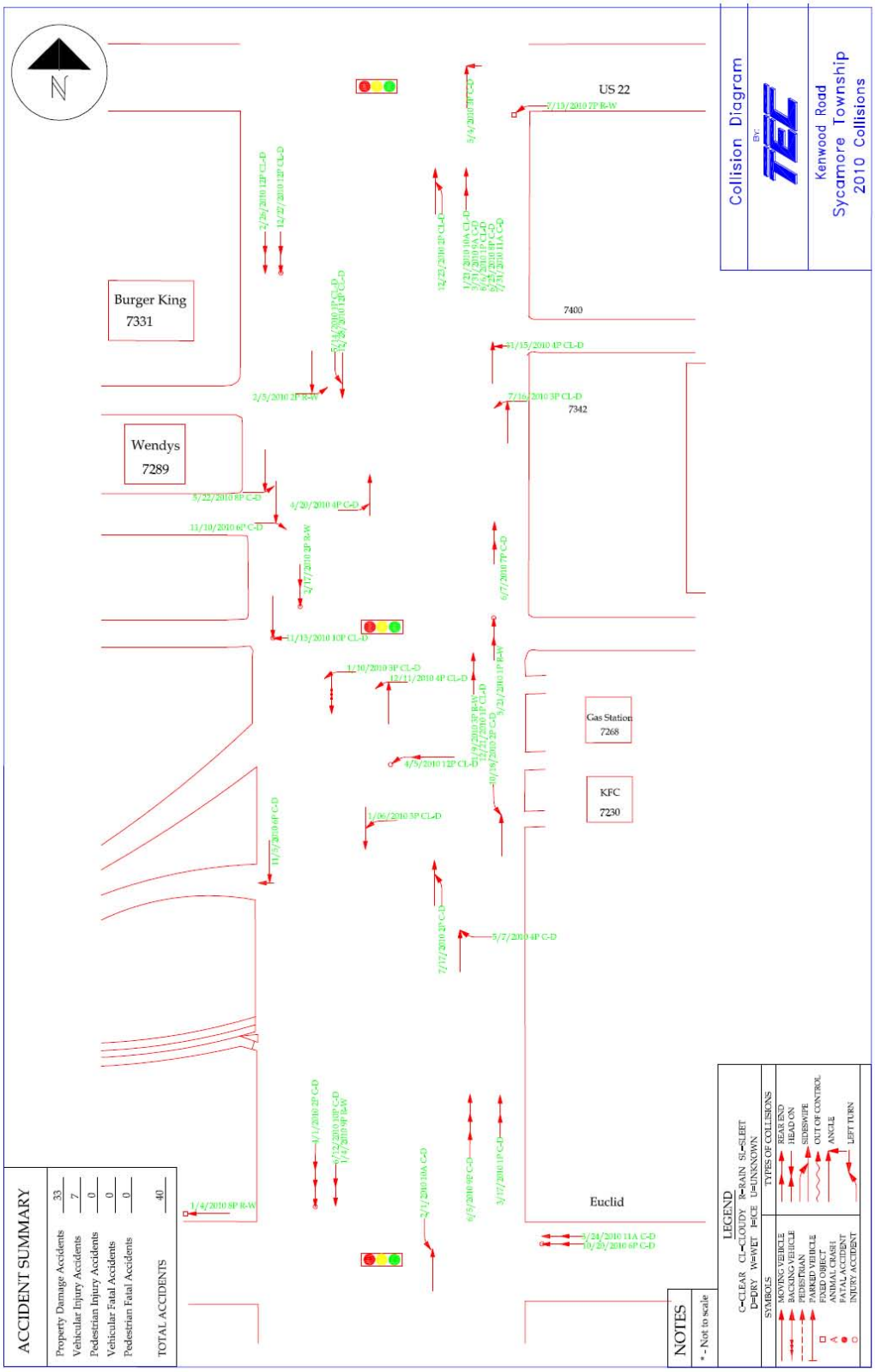


Figure 5C: Collision Diagram



V. CRASH ANALYSIS

A. Overview

The raw crash data for the years 2008 through 2010 were analyzed to identify patterns and possible safety deficiencies along the corridor. During this period a total of 87 crashes occurred along the roadway segment, with 14 of these crashes resulting in injuries. Six (7%) of the accidents occurred at night, and four (5%) occurred at dusk. The remainder of the accidents occurred during daylight hours.

Three main types of crashes occurred along the segment during the study years: rear end (44%), left turn (24%), and sideswipe passing (15%). Other accident types include angle, backing, and right turn.

Based on a review of the project corridor and the crash diagrams, the driveways along the project corridor have contributed greatly to the number of accidents within the three year period. The following table displays the number of accidents at each driveway between 2008 and 2010:

Burger King	5 accidents
Wendy's	10 accidents
Sycamore Plaza (Signal)	11 accidents
Gas Station	4 accidents
KFC	6 accidents

Due to construction in the area in 2010, the 3 year study period from 2007-2009 was also considered in this study. During this period a total of 76 crashes occurred along the roadway segment, with 11 of these crashes resulting in injuries. Three main types of crashes occurred along the segment during the study years: rear end (42%), left turn (17%), angle (14%) and sideswipe passing (14%). Other accident types include sideswipe meeting, backing, and right turn. Since the data shows similar trends, this study will evaluate the most up to date data, 2008-2010.

B. Possible Causes

Along the corridor, the most prevalent crash type was rear end; there were thirty-eight (38) rear end accidents. This is due to the heavy congestion that the corridor experiences most of the day, especially related to the high number of full access driveways, and the traffic signals at Montgomery Road, Sycamore Plaza and the I-71 NB Off Ramp.

The commercial driveways located along the corridor produce several turns into the driveways which leads to unexpected stops and rear end accidents. During the lunch peak hour, several of the businesses hire police officers to direct traffic. While necessary to allow vehicles to enter and exit the driveways (especially lefts in and out), this does lead to the confusion along the corridor. (The lunch peak hour contributed to approximately 28 accidents over the 3 year period analyzed).

The second most prevalent accident type was left turn accidents; there were twenty-one (21) left turn accidents within the three year period. These accidents are mainly related to the commercial driveways located along Kenwood Road. Not only do the commercial driveways increase the number and frequency of left turning movements along the corridor, but the heavy congestion along the corridor increases the number of left turning movements made through queued traffic. At the signalized intersection of Kenwood Road and Sycamore Plaza, there were several left turning accidents. These accidents could be related to the horizontal and vertical curves located on the westbound approach.

The third most prevalent accident type was angle accidents with seven (7) accidents over the three year period. Similar to the left turning accidents, these accidents are related to the heavy congestion, as well as the number of driveways. Several of the angle accidents occurred as vehicles exited driveways. Vehicles may have been crossing the two lanes of traffic to turn left onto Kenwood. Angle accidents could also be related to the clearance intervals at the signalized intersections.

C. Traffic Control Warrant Analysis

The Ohio Manual of Uniform Traffic Control Devices (OMUTCD) provides criteria and guidance for the installation of stop signs and traffic signals. One of the considerations of this report is to realign the intersection Kenwood Road and Sycamore Plaza to be adjacent to the Sycamore Crossing access. This manual was used to determine if the combined intersection warranted a traffic signal or a multi-way stop. Signal Warrants #3A and #3B were evaluated using volumes gathered from the peak hour counts performed by TEC Engineering. The intersection condition does satisfy Signal Warrant #3A. The remaining study intersections did not require signal warrants. The warrants are presented in ***Appendix F***.

D. Capacity Analysis

The software program *Synchro* was used to analyze capacity at the intersection. This software uses the methods prescribed in the *Highway Capacity Manual (HCM)* to determine the level of service (LOS). LOS is a measure of driver discomfort and intersection performance with respect to vehicular capacity and quality of service provided to road users. For intersections, LOS is defined in terms of delay. Delay refers to total average stopped delay experienced by motorists at the referenced intersection. For unsignalized intersections the LOS has six classifications ranging from A to F. These classifications are shown in ***Table 4***. For signalized intersections the LOS also has six classifications ranging from A to F. These classifications are shown in ***Table 5***.

Table 4: LOS at Unsignalized Intersections

Level of Service	Description	Delay (seconds per vehicle)
A	Very low delay	0-10
B	Good progression	10-15
C	Limit of acceptable delay	15-25
D	Start of traffic breakdown	25-35
E	High delay	35-50
F	Congested conditions, unacceptable delay	>50

Table 5: LOS at Signalized Intersections

Level of Service	Description	Delay (seconds per vehicle)
A	Very low delay	<10
B	Good progression	10-20
C	Limit of acceptable delay	20-35
D	Start of traffic breakdown	35-55
E	High delay	55-80
F	Congested conditions, unacceptable delay	>80

A capacity analysis was performed for the AM, Midday and PM peak hours to determine the existing LOS at each intersection and along the roadway segment. A capacity analysis to determine the LOS for the roadway with the proposed improvements was performed. Existing volumes were obtained from peak hour turning movement counts conducted by TEC Engineering. According to the Highway Capacity Manual, "At a two-way stopped-controlled and all-way stopped control intersections, control delay is the total elapsed time from a vehicle joining the queue until its departure from the stopped position at the head of the queue. The control delay also includes the time required to decelerate to stop and to accelerate to the free-flow speed." This is used for the stopped approach as well as for the slow or stopped movements of the free-flow approach. Control delay is not calculated for thru-only or thru-right movement in the free flow approaches.

A summary of the results of the capacity analysis for the intersections is shown in ***Table 6*** below. The complete *Synchro* results are presented in ***Appendix G***.

Table 6: Intersection LOS and Delay

	Scenario	Peak Hour	Approach Delay/LOS				Total
			NB	*SB*	*EB*	*WB*	*Delay/LOS*
Kenwood & Sycamore Plaza/Sycamore Crossing			*Kenwood Rd*		*Sycamore Plaza*		
	Existing	AM	0.0s	0.1s	-	18.3s/C	0.1s
		Mid	0.0s	0.7s	-	26.7s/D	1.3s
		PM	0.0s	0.4s	-	25.6s/D	1.2s
			Kenwood Rd		*Sycamore Crossing*		
	Existing	AM	0.1s	0.0s	12.5s/B	-	0.2s
		Mid	0.5s	0.0s	20.8s/C	-	1.4s
		PM	0.4s	0.0s	22.2s/C	-	1.2s
Kenwood & Sycamore Plaza/ St Vincent Ferrer			*Kenwood Rd*		*Sycamore Plaza / St. Vincent Ferrer*		
	Existing	AM	0.7s/A	0.7s/A	39.6s/E	59.1s/E	1.3s/A
		Mid	3.9s/A	3.4s/A	26.8s/C	30.3s/C	5.9s/A
		PM	4.8s/A	5.2s/A	38.4s/D	49.2s/D	9.8s/A
Kenwood and I71 SB On Ramp			*Kenwood Rd*		*I-71 SB On Ramp*		
	Existing	AM	4.0s	0.0s	-	-	2.6s
		Mid	1.2s	0.2s	-	-	0.8s
		PM	2.0s	0.1s	-	-	1.0s
Kenwood and I71 NB Off Ramp			*Kenwood Rd*		*I-71 NB Off Ramp*		
	Existing	AM	6.0s/A	4.2s/A	31.9s/C	-	13.9s/B
		Mid	7.6s/A	6.8s/A	32.2s /C	-	18.3s/B
		PM	7.2s/A	7.1s/A	31.8s/C	-	16.9s/B

***Unsignalized-LOS not available for free flow approaches or intersections that contain free flow approaches*

As seen in the table above, the capacity analysis reveals that all intersections are operating at an acceptable Level of Service.

The following table summarizes the corridor measures of effectiveness. This table compares the existing condition along Kenwood Road to the Short Term Improvements, which includes access management improvements.

Table 7: Corridor Measures of Effectiveness

AM Existing				AM Short Term			% Change		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	9	8	9	9	8	8	0%	0%	-11%
Queue Delay / Veh (s/v)	0	0	0	0	0	0	-	-	-

Total Delay (hr)	13	8	21	13	8	21	0%	0%	0%
Stops (#)	2124	636	2760	2107	619	2726	-1%	-3%	-1%
Average Speed (mph)	18	16	17	18	16	17	0%	0%	0%
Total Travel Time (hr)	28	15	42	28	15	42	0%	0%	0%
Fuel Consumed (gal)	45	19	64	45	19	64	0%	0%	0%
Fuel Economy (mpg)	11.2	11.9	11.4	11.2	12	11.4	0%	1%	0%
Unserved Vehicles (#)	0	0	0	0	0	0	-	-	-
Vehicles in dilemma zone (#)	87	40	127	87	40	127	0%	0%	0%
Performance Index	19.3	9.8	29.1	19.2	9.7	28.9	-1%	-1%	-1%

MID Existing				**MID Short Term**			**% Change**		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	12	9	10	11	9	10	-8%	0%	0%
Queue Delay / Veh (s/v)	0	0	0	0	0	0	-	-	-
Total Delay (hr)	18	12	30	18	11	30	0%	-8%	0%
Stops (#)	1771	1203	2974	1668	1034	2702	-6%	-14%	-9%
Average Speed (mph)	15	15	15	15	15	15	0%	0%	0%
Total Travel Time (hr)	32	20	52	32	20	52	0%	0%	0%
Fuel Consumed (gal)	45	28	74	45	27	72	0%	-4%	-3%
Fuel Economy (mpg)	10.7	10.1	10.5	11	10.6	10.9	3%	5%	4%
Unserved Vehicles (#)	0	0	0	0	0	0	-	-	-
Vehicles in dilemma zone (#)	131	98	229	131	98	229	0%	0%	0%
Performance Index	23.2	14.9	38.2	22.8	14.2	37	-2%	-5%	-3%

PM Existing				**PM Short Term**			**% Change**		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	11	11	11	11	11	11	0%	0%	0%
Queue Delay / Veh (s/v)	0	0	0	0	0	0	-	-	-
Total Delay (hr)	17	18	36	17	18	35	0%	0%	-3%
Stops (#)	1903	1600	3503	1824	1483	3307	-4%	-7%	-6%
Average Speed (mph)	15	13	14	15	13	14	0%	0%	0%

Total Travel Time (hr)	31	29	59	31	29	59	0%	0%	0%
Fuel Consumed (gal)	45	39	84	44	38	83	-2%	-3%	-1%
Fuel Economy (mpg)	10.4	9.4	9.9	10.6	9.6	10.1	2%	2%	2%
Unserved Vehicles (#)	0	0	0	0	0	0	-	-	-
Vehicles in dilemma zone (#)	107	115	222	107	115	222	0%	0%	0%
Performance Index	22.7	22.6	45.3	22.4	22.1	44.5	-1%	-2%	-2%

As can be seen from Table 7, the short term recommendations improve the corridor, especially in during the midday conditions. Table 8 compares the 2030 existing conditions to the short term improvements. Similar to the present day, the 2030 analysis shows a large improvement during the Midday peak.

Table 8: 2030 Corridor Measures of Effectiveness

AM 2030 Ex Cond				AM 2030 Short Term Imp			% Change		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	10	8	9	10	8	9	0%	0%	0%
Queue Delay / Veh (s/v)	0	0	0	0	0	0	-	-	-
Total Delay (hr)	17	10	27	17	10	27	0%	0%	0%
Stops (#)	2846	773	3619	2824	751	3575	-1%	-3%	-1%
Average Speed (mph)	18	16	17	18	16	17	0%	0%	0%
Total Travel Time (hr)	34	18	52	34	18	52	0%	0%	0%
Fuel Consumed (gal)	57	23	80	57	23	80	0%	0%	0%
Fuel Economy (mpg)	10.6	11.9	11	10.6	12	11	0%	1%	0%
Unserved Vehicles (#)	0	0	0	0	0	0	-	-	-
Vehicles in dilemma zone (#)	101	47	148	101	47	148	0%	0%	0%
Performance Index	25	11.8	36.7	24.9	11.7	36.5	0%	-1%	-1%

MID 2030 Ex Cond				MID 2030 Short Term Imp			% Change		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	20	11	16	20	10	16	0%	-9%	0%
Queue Delay / Veh	0	0	0	0	0	0	-	-	-

(s/v)									
Total Delay (hr)	39	16	55	39	16	55	0%	0%	0%
Stops (#)	2246	1580	3826	2105	1344	3449	-6%	-15%	-10%
Average Speed (mph)	10	13	11	11	13	11	10%	0%	0%
Total Travel Time (hr)	56	26	82	56	26	82	0%	0%	0%
Fuel Consumed (gal)	68	37	105	67	35	102	-1%	-5%	-3%
Fuel Economy (mpg)	8.6	9.3	8.8	8.8	9.9	9.2	2%	6%	5%
Unserved Vehicles (#)	118	0	118	118	0	118	-	-	-
Vehicles in dilemma zone (#)	150	114	264	150	114	264	0%	0%	0%
Performance Index	45.2	20.8	66.1	44.6	19.9	64.5	-1%	-4%	-2%

PM 2030 Ex Cond				PM 2030 Short Term Imp			% Change		
Direction	NB	SB	All	NB	SB	All	NB	SB	All
Control Delay / Veh (s/v)	16	16	16	16	16	16	0%	0%	0%
Queue Delay / Veh (s/v)	0	0	0	0	0	0	-	-	-
Total Delay (hr)	30	32	62	30	32	61	0%	0%	-2%
Stops (#)	2492	2058	4550	2378	1901	4279	-5%	-8%	-6%
Average Speed (mph)	12	10	11	12	10	11	0%	0%	0%
Total Travel Time (hr)	46	45	90	46	44	90	0%	-2%	0%
Fuel Consumed (gal)	62	56	118	61	55	116	-2%	-2%	-2%
Fuel Economy (mpg)	9	7.9	8.5	9.2	8.2	8.7	2%	4%	2%
Unserved Vehicles (#)	13	39	53	13	39	53	-	-	-
Vehicles in dilemma zone (#)	123	131	254	123	131	254	0%	0%	0%
Performance Index	36.6	37.7	74.3	36.2	37	73.2	-1%	-2%	-1%

VI. ACCESS MANAGEMENT

The Kenwood Road Corridor was reviewed to identify opportunities for access management to improve the traffic flow. From the *Access Management Manual*, access management can be defined as follows:

"Access Management is the systematic control of the location, spacing, design and operation of driveways, median openings, interchanges and street connections to a roadway. It also involves roadway design applications, such as median treatments and auxiliary lanes, and the appropriate spacing of traffic signals."

The Kenwood Road Corridor contains many businesses most with at least one driveway located on Kenwood Road. This lack of access management not only causes safety problems, but also increases the congestion along Kenwood Road due to slowing traffic and turning movements. The most conflict-prone and dangerous movement from any commercial driveway is the left out maneuver followed by the left in movement. Eliminating these movements where possible can improve safety.

TEC reviewed the corridor in conjunction with the Access Management Regulations established by the Hamilton County Engineer's Office. Based on the Hamilton County Thoroughfare Plan, Kenwood Road is classified as a Major Arterial. Form the Access Management Regulations, the minimum full-access driveway spacing should be 405' and left turn, right turn and acceleration lanes are required at all driveways. The existing spacing of the driveway starting on the south at the traffic signal at the Sycamore Plaza Entrance is as follows:

West Side Driveways	Distance (ft)
Wendy's South	75
Wendy's North	150
Burger King South	215
Burger King North	315
Graeter's	415
Tire Discounters South	480
Tire Discounters North	550
Trader Joe's	615
PNC Bank	800
Kenwood Corner Bldg	870

East Side Driveways	Distance (ft)
MicroWines	50
Kenwood Plaza South	115
Kenwood Plaza North	430
Sycamore Plaza	500
Cord Camera	575

Given that the corridor as a whole is only approximately 0.5 miles long, and the section from the Sycamore Plaza Signal to Montgomery Road is approximately 1000 feet long, the accesses along this roadway do not meet the current standards. In addition, along most of Kenwood Road, most of the corridor has a two-way left turn lane (TWLTL), however, none of the driveways have a right turn lane, or acceleration lane.

This study defines a short term solution to eliminate left in and out movements, as well as a long term solution to establish access to the businesses without impacting Kenwood Road. Additional solutions have been evaluated and are included in Appendix G. Some concepts listed here are entirely on private property and would require cooperation of private property owners to provide cross/shared access to adjacent property owners. These types of concepts are made where elevations between properties are the same or

similar and where cross connection could provide the opportunity to not only limit dangerous and difficult left out movements, but also provide the public access to signalized intersections through adjacent properties.

Some concepts may not be practical under existing conditions at certain properties but should be considered as properties redevelop. Particular attention should be paid to corner properties where there are existing access driveways onto both Kenwood Road and the adjacent side street. There are many locations where buildings have minimum setbacks with parking very close to Kenwood Road.

There are also locations where there are no defined driveways and instead the sites have access openings which span the entire width of the property. At selected locations, curbs could be constructed around the intersection radius and in front of the site to provide for and delineate a dedicated access location. This would not only define the access locations, but prevent vehicles from direct entry into the middle of an intersection.

Efforts to incorporate access management would be facilitated and expedited by a long range plan for the appearance and functional standard of Kenwood Road. A framework is needed to provide a common goal and vision of how Kenwood Road will appear and function in the future. Access management is a long term process that requires a substantial and consistent effort as the corridor gradually redevelops.

VII. RECOMMENDED COUNTERMEASURES AND COSTS

Traffic Signal Upgrades

The clearance intervals should be updated. Inadequate clearance intervals are often the cause of red light running accidents, which include angle and left turn accidents. These updated values are shown below. The cost for this would be approximately $500 per intersection.

Table 9: Clearance Intervals

			Existing		Proposed	
	Approach	Speed	Yellow	All Red	Yellow	All Red
Kenwood Road & Sycamore Plaza	EB	25	3.0	1.0	3.0	2.5
	WB	25	3.0	1.0	3.0	2.5
	NB	35	3.0	1.0	3.6	1.9
	SB	35	3.0	1.0	3.6	1.9
Kenwood Road & I-71 NB Off Ramp	EB	45	4.0	2.0	4.3	1.6
	NB	35	4.0	2.0	3.6	2.7
	SB	35	4.0	2.0	3.6	2.7

In addition to clearance interval improvements, changes should be made to the intersection of Montgomery Road & Kenwood Road to change this intersection to fully actuated. This would allow the intersection to operate free during most times of the day.

In addition, the intersection could be coordinated with Montgomery Road and/or Kenwood Road based on the time of the day and the prevalent traffic flow. This change would be relatively simple because of the presence of video detection at the intersection. This improvement would require having a contractor draw loops along Montgomery Road and reprogramming the controller to accept Phases 4 and 8 as coordinated phases during certain times of the day. This signal could then be coordinated with:

- Kenwood Road & Euclid Road
- Kenwood Road & I-71 NB Off Ramp
- Kenwood Road & Sycamore Plaza
- Kenwood Road & Orchard Lane
- Kenwood Road & Galbraith Road

Cost

The cost to change Montgomery Road & Kenwood Road to fully actuated would be approximately $1500.

Access Management

Minor Access Management improvement should be reviewed with movement towards the major access management changes. Sycamore Township should begin to work with businesses as soon as possible to promote the access management solutions presented in this report. It is extremely important to begin discussions and promote buy-in for the consolidation and elimination of access points along Kenwood Road, as soon as possible. This will allow these solutions to be included in the final design for the long term solutions along Kenwood Road. Of particular importance are the potential benefits of consolidating and eliminating access points. These benefits include:

- Safety Improvements – each driveway or access points creates approximately 36 conflict points within its intersection on Kenwood Road. Reducing the number of access points along the project corridor reduces the number of conflict points and therefore the accident potential for the roadway.

- Traffic Flow – each driveway or access point along a roadway has a detrimental effect on the traffic flow along the corridor. In many instances, drivers will experience heavy congestion in areas with poor access management; as vehicles enter the traffic stream from multiple driveway access points, flowing traffic must slow down to accommodate them. The higher the concentration of access points, the more delay is likely.

- At several locations along the corridor, business owners have hired off-duty law enforcement officers to stop traffic along Kenwood Road to allow drivers to enter and exit the businesses. This is especially prevalent with the fast food restaurants.

It is recommended that the Township begin working with the local business owners to promote buy-in for the corridor plan, including access consolidation. Within this report, the TEC team has presented several access management options for the businesses within

the corridor. These options should be presented to the business owners to promote buy-in before the roadway design is finalized. This will allow the curb lines to be set, driveways to be defined and on-street parking to be maximized. These recommendations can be seen in ***Appendix G.***

In the short term, it is recommended that a median is constructed through the corridor. This median would prevent left turns at all unsignalized accesses. Left turn lanes are necessary at the intersection of Sycamore Plaza/St. Vincent Ferrer and Kenwood. In order to accommodate future traffic, the northbound left turn lane should be 150' and the south bound left turn lane should be 200'. The storage length includes a 50' taper. The existing left turn lane at Kenwood and Montgomery was also reviewed for length. This turn lane should be 425'. A small median should be built along the turn lane to prevent crossing traffic. This concept is shown in ***Figure 6***.

Impact of Median
With the addition of a center median, left turns will be prohibited at all driveways except for the signalized intersections. This will change the way that vehicular traffic enters and exits the commercial driveways. The majority of the traffic using the commercial driveways enter from the North on Kenwood Road. This means that patrons of the businesses on the westside of the roadway will have their exiting patterns changed, and patrons on the eastside of the roadway will have their entering patterns changed.

Northern Traffic: It is anticipated that vehicular traffic from the North will not be redirected into the commercial driveways on the westside of the roadway, as these are right turn movements. These vehicles will be impacted as they exit. It is anticipated that these vehicles may use the Sycamore Plaza site to turn around; either driving to the access on Montgomery Road, or exiting to the north on Kenwood Road. This is especially true of vehicles from the North, specifically Blue Ash, or the Kenwood Towne Center. A second possibility is that these vehicles will proceed down to Euclid, and either right or left. Vehicles proceeding to Deer Park and Silverton will most likely travel west on Euclid to Ken Arbre or Stewart Road. Vehicles proceeding to Madeira or to the east will most likely travel east on Euclid to Miami Road.

For the eastside commercial driveways, their entrance maneuver will require drivers to enter Kenwood Road from the south. It is possible that vehicles may use Sycamore Plaza from Montgomery Road to enter the corridor from the South. Drivers from Deer Park and Silverton will most likely use Stewart or Ken Arbre Road to Euclid; drivers from Madeira and locations to the east may use Galbraith Road, Miami Road and Euclid Road.

Southern Traffic: This traffic will be minor in nature; however its impact should be evaluated. Patrons of the eastside driveways may use Sycamore Plaza to turn around and exit at the existing signal. Drivers may also use Montgomery Road (to Ken Arbre & Euclid, or Galbraith & Miami) to access locations to the east or west.

For westside driveways, drivers will need to redirect their route to enter the commercial drives. This could be through the Sycamore Plaza to Montgomery Road, Euclid Avenue to Ken Arbre Road, or Euclid Avenue to Miami and Galbraith Road.

It is recommended that the Township pursue a wayfinding signage program to direct drivers to the preferred path. This should direct drivers along public roadways such as Euclid and Ken Arbre and away from private developments such as Sycamore Plaza.

Cost – Short Term Improvements

The cost for the short term improvements was calculated and is presented in the following table. This cost includes replacing the existing sidewalk as well as some enhancement and landscaping improvements such as paver bricks, and low level planting areas.

Table 10: Short Term Cost Estimate

Item No.	Description	Unit	Unit Cost	Two Foot Widening One Side	
				Quantity	Total
REMOVALS					
202	Pavement Removed, Asphalt	Sq. Yd.	$7.50	2250	$16,875
202	Curb Removed	Foot	$3.00	3535	$10,605
202	Sidewalk Removed	Sq. Ft.	$3.50	1800	$6,300
203	Excavation	Cu. Yd.	$25.00	50	$1,250
203	Embankment	Cu. Yd.	$25.00	400	$10,000
252	Full Depth Pavement Sawing	Foot	$2.00	5150	$10,300
254	Pavement Planing	Sq. Yd.	$4.50	7670	$34,515
	subtotal removals				**$89,845**
PAVEMENT					
448	Asphalt Surface Course	Cu. Yd.	$200.00	750	$150,000
448	Asphalt Intermediate Course	Cu. Yd.	$200.00	24	$4,800
301	Asphalt Concrete Base	Cu. Yd.	$150.00	150	$22,500
304	Aggregate Base	Cu. Yd.	$65.00	150	$9,750
407	Tack Coat Intermediate Course (0.04 gal/sy)	Gallon	$3.25	35	$114
407	Tack Coat (0.075 gal/sy)	Gallon	$3.00	65	$195

609	Curb, Type 6	Foot	$12.50	2755	$34,438
609	Combination Curb & Gutter	Foot	$12.50	2700	$33,750
608	Walk	Sq. Ft.	$4.00	16650	$66,600
609	Concrete Island	Sq. Ft.	$45.00	125	$5,625
	Curb Ramps	Each	$500.00	8	$4,000
	Commercial Drives	Each	$2,500.00	27	$67,500
	subtotal pavement				**$399,271**
DRAINAGE					
604	Catch Basin, No. 3	Each	$2,250.00	8	$18,000
604	Manhole, No. 3	Each	$2,000.00	6	$12,000
603	12" Conduit	Foot	$40.00	500	$20,000
603	18" Conduit	Foot	$50.00	500	$25,000
603	24" Conduit	Foot	$60.00	200	$12,000
	subtotal drainage				**$87,000**
WATERMAIN					
638	6" Fire Hydrant	Each	$2,600.00	5	$13,000
	subtotal water main				**$13,000**
TRAFFIC CONTROL					
644	Edge Line (Yellow)	Mile	$3,130.00	0.5	$1,565
644	Edge Line (White)	Mile	$3,130.00	0.5	$1,565
644	Lane Line	Foot	$1,950.00	0.5	$975
644	Channelizing Line	Foot	$3.00	550	$1,650
644	Stop Line	Foot	$6.00	144	$864
644	Lane Arrows	Each	$100.00	6	$600
	subtotal traffic control				**$7,219**
MISCELLANEOUS					
	Retaining Wall	Foot	$250.00	140	$35,000
	Maintenance of Traffic	Lump			$35,000
	Mobilization	Lump			$30,000
	Construction Layout Stakes	Lump			$15,000

	Utility Relocation / Adjust to Grade	Lump			$25,000
659	Seeding & Mulching	Sq. Ft.	$2.00	900	$1,800
	subtotal miscellaneous				**$141,800**
MISCELLANEOUS					
	Mulch	Lump	$1,500.00	1	$1,500
	Plants	Lump	$5,500.00	1	$5,500
	Hardscape	Lump	$5,000.00	1	$5,000
	Stamped Concrete	Sq Ft	$15.00	4800	$72,000
	Sprinkler System	Lump	$20,000.00	1	$20,000
	subtotal landscaping				**$104,000**
		Subtotal			$842,135
		Contingency (10%)			$84,214
		GRAND TOTAL			**$926,349**

Figure 6: Short Term Recommendation

Long Term Improvements

Signal System

It is recommended that the Township pursue a project to upgrade the existing twisted pair interconnect to a fiber optic interconnect. Fiber optic offers a much higher bandwidth and allows for the transfer of information at a high rate. This would allow the Township to install traffic surveillance cameras within the Kenwood & Montgomery Road signal system, and eventually allow the system to be remotely controlled, especially during the heavy traffic conditions surrounding the holiday shopping season. Pan-tilt-zoom cameras can be installed at critical points throughout the project area to allow for remote viewing of the traffic conditions.

In addition, an upgraded communication system would allow for the eventual installation of a central based signal system. This will allow the system to be more fluid in responding to the constantly changing traffic demands. With the ongoing underground utility project, extra conduits were installed for traffic communication use; these could be used to begin this project, and run the fiber optic line along Kenwood Road between US 22 and Euclid Avenue.

Signage

In addition to the signal pole and mast arm improvements, the Township could consider amenities such as decorative sign borders, and LED street name and regulatory signs. The decorative sign borders simply add an aesthetically pleasing element to road side signs. The LED sign are internally illuminated which will aid in the identification of cross streets and regulatory signs (such as lane use signs) at each intersection, especially at night.

Streetscaping

The Kenwood Road corridor is a very urbanized corridor with little streetscaping or hardscaping. It is recommended that the Township implement a streetscaping plan along the corridor to beautify the street and make it more attractive to visitors and residents. TEC has included some designated areas for plantings, including some in front of businesses, as well as locations within the right-of-way. Street furniture could be added along the project corridor to improve the functionality of the corridor. This could include garbage cans, benches, etc. These could be especially useful near the bus stops along the corridor.

Access Management Recommendations

For the short term improvements, a median was built along the length of Kenwood Road

to improve safety for the corridor. It is recommended that the Township pursue a longer term solution to construct an access road to the businesses along Kenwood Road. This would allow rear access to all business and better access to all. There is property available behind the Wendy's and Burger King that could be used to build a rearage road. To protect the existing structures within the St. Vincent's Property, proper landscape screening should be provided. In addition property's on the east side of the roadway should be evaluated to improve access. Figure 7 shows the recommended rearage road, and driveway improvements.

Cost – Long Term Recommendations

The cost for the long term access management improvements was calculated and is presented in the following table. This cost includes the rearage road near St. Vincent, as well as the driveway improvements along the rearage road, Kenwood Road, and the Trader Joe's driveway. The current configuration of this intersection is somewhat confusing and may lead to an increase in accidents with the increase in traffic. The long term costs only include improvements beyond the short term recommendations (i.e. the cost of the median is not included in this cost).

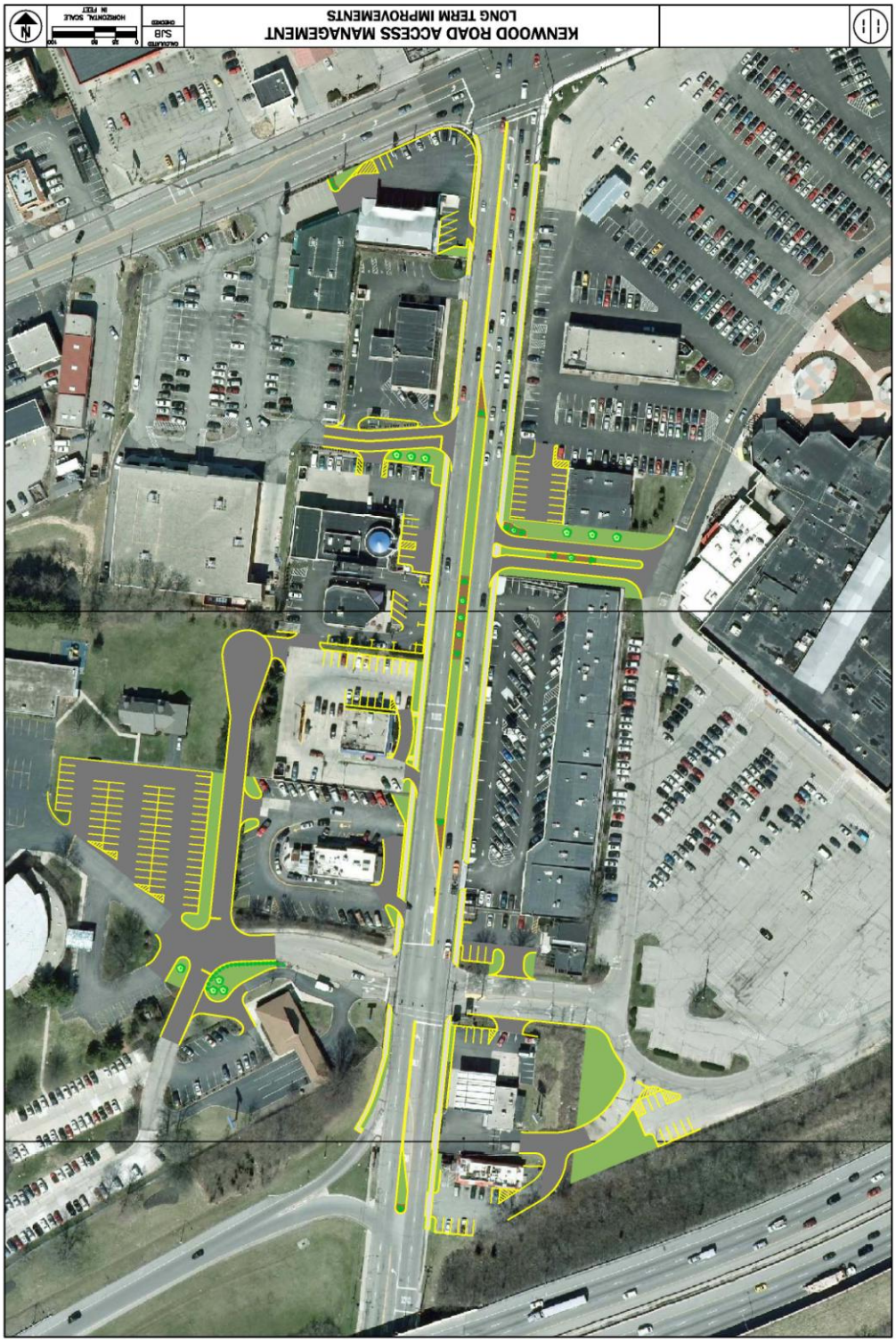
Table 11: Long Term Cost Estimate – Access Improvements

Item No.	Description	Unit	Unit Cost	Qty	Total
Montgomery & Kenwood Corner Lot					
	Restriping	Each	$500.00	1	$500
	Reducing Access Drive	Each	$5,000.00	1	$5,000
	Connecting Parkinglots	Each	$10,000.00	1	$10,000
	Embankment/Topsoil	Cu. Yd.	$35.00	5	$175
	Right of Way	Lump	$20,000.00	1	$20,000
	Montgomery & Kenwood Corner Lot Total				**$35,675**
Trader Joe's Entrance					
	Remove Ex. Drive	Sq. Yd.	$25.00	450	$11,250
	Relocate Sign	Each	$20,000.00	1	$20,000
	New Access Drive	Sq. Ft.	$7.50	4050	$30,375
	TD Access to new drive	Each	$2,000.00	1	$2,000
	Close TD Ex Drive	Each	$3,000.00	1	$3,000
	TD Parking Lot Reconfig	Each	$500.00	1	$500
	Embankment/Topsoil	Sq. Yd.	$35.00	10	$350
	Landscaping	Lump	$5,000.00	1	$5,000
	Right of Way	Lump	$25,000.00	1	$25,000
	Trader Joe's Entrance Total				**$97,475**
Sycamore Plaza Entrance					
	Pavement Removal	Sq. Yd.	$7.50	2500	$18,750
	Curb Removal	Foot	$10.00	120	$1,200
	New Access Drive Pavement	Sq. Ft.	$5.00	1000	$5,000
	Parking Lot Pavement	Sq. Ft.	$2.00	1000	$2,000
	Curb	Foot	$18.00	850	$15,300
	Walk	Sq. Ft.	$4.00	730	$2,920
	Striping Prop. Lot	Foot	$5.00	375	$1,875
	Center Line	Mile	$3,500.00	0	$0
	Edge Line (yellow)	Mile	$3,013.00	0	$0
	Channelizing Line	Foot	$3.00	0	$0
	Excavation	Cu. Yd.	$25.00	20	$500
	Embankment/Topsoil	Cu. Yd.	$35.00	350	$12,250
	Landscaping	Lump	$5,000.00	1	$5,000
	Right of Way	Lump	$20,000.00	0	$0

	Utility Relocation	Lump	$50,000.00	0	$0
	Sycamore Plaza Entrance Total				**$64,795**
KFC, Gas Station & Wine Store					
	Reduce KFC Drive Width	Lump	$1,500.00	1	$1,500
	Remove Gas Station Drive	Lump	$1,500.00	1	$1,500
	New Gas Station Access Drive	Lump	$3,000.00	1	$3,000
	Gas Station & KFC Shared Drive	Lump	$30,000.00	1	$30,000
	Pavement Removal	Sq. Yd.	$7.50	880	$6,600
	Wine Store Access Drive	Lump	$3,500.00	1	$3,500
	Remove Wine Store Access Drive	Lump	$1,500.00	1	$1,500
	Parking Lot Restriping	Lump	$1,500.00	1	$1,500
	Embankment/Topsoil	Cu. Yd.	$35.00	160	$5,600
	Landscaping	Lump	$2,000.00	1	$2,000
	Right of Way	Lump	$50,000.00	1	$50,000
	Trader Joe's Entrance Total				**$106,700**
Stop Controlled Stub Road					
	Excavation	Cu. Yd.	$25.00	2700	$67,500
	Embankment	Cu. Yd.	$25.00	50	$1,250
448	Asphalt Surface Course	Cu. Yd.	$200.00	100	$20,000
448	Asphalt Intermediate Course	Cu. Yd.	$200.00	100	$20,000
301	Asphalt Concrete Base	Cu. Yd.	$150.00	310	$46,500
304	Aggregate Base	Cu. Yd.	$65.00	310	$20,150
407	Tack Coat Intermediate Course (0.04 gal/sy)	Gallon	$3.25	75	$244
407	Tack Coat (0.075 gal/sy)	Gallon	$3.00	140	$420
609	Curb, Type 6	Foot	$18.00	1650	$29,700
	Church Parking Lot Pavement	Sq. Ft.	$2.00	23500	$47,000
	Wendy's Access Drive	Lump	$3,500.00	1	$3,500
	Wendy's Parking Lot Reconfigure	Lump	$10,000.00	1	$10,000
	BK & Greater's Shared Drive	Lump	$5,000.00	1	$5,000
	BK Parking Lot Reconfigure	Lump	$7,500.00	1	$7,500
	Greater's Parking Lot Reconfigure	Lump	$1,500.00	1	$1,500
	Bank Drive	Lump	$7,500.00	1	$7,500
	Drive Closing	Each	$2,000.00	4	$8,000
	Access Drive Reconfigure	Each	$2,000.00	1	$2,000
	Church Restriping	Foot	$2.00	1750	$3,500
	Restaurant Restriping	Lump	$750.00	1	$750
	Retaining Wall	Sq. Ft.	$35.00	1500	$52,500

	Right-of-Way	Lump	$450,000	1	$450,000
	Maintanence of Traffic	Lump	$7,500.00	1	$7,500
	Stop Controlled Stub Road Total				**$812,014**
		Subtotal			$1,116,659
	Contingency	Lump	30%		$334,998
	Mobilization	Lump	$50,000.00	1	$50,000
		GRAND TOTAL			**$1,501,657**

Figure 7: Long Term Recommendations



Public Involvement

A public open house was held on June 21, 2011 and a public meeting and presentation was held on August 9, 2011. The sign in sheet and the public surveys are included in Appendix H. Overall, the public was very receptive of the short and long term recommendations.

VIII. RATE OF RETURN

The rate of return is a value used to quantify the benefits expected due to the implementation of improvements. Essentially, this value measures the expected yield or effective return of safety countermeasures. The effective return is an estimated interest rate that will make the net present value of the countermeasure minus the net present value of the countermeasure cost equal to zero. In this case, the net present value of the countermeasure is the expected dollar value of safety benefits in terms of crashes prevented. ODOT calculates the cost of crashes based on severity and location, and these costs were used in the rate of return calculation. The "Countermeasure Reduction Factors" used in the worksheets were provided by ODOT and are shown in ***Appendix H***.

The rate of return was calculated for the short term improvements including the median installation along the entire length of the corridor, and the resurfacing of Kenwood Road. The rate of return was calculated for the long term improvement cost, including the cost of the short term improvements. The rate of return worksheets can be seen in ***Figures 8A-8D.***

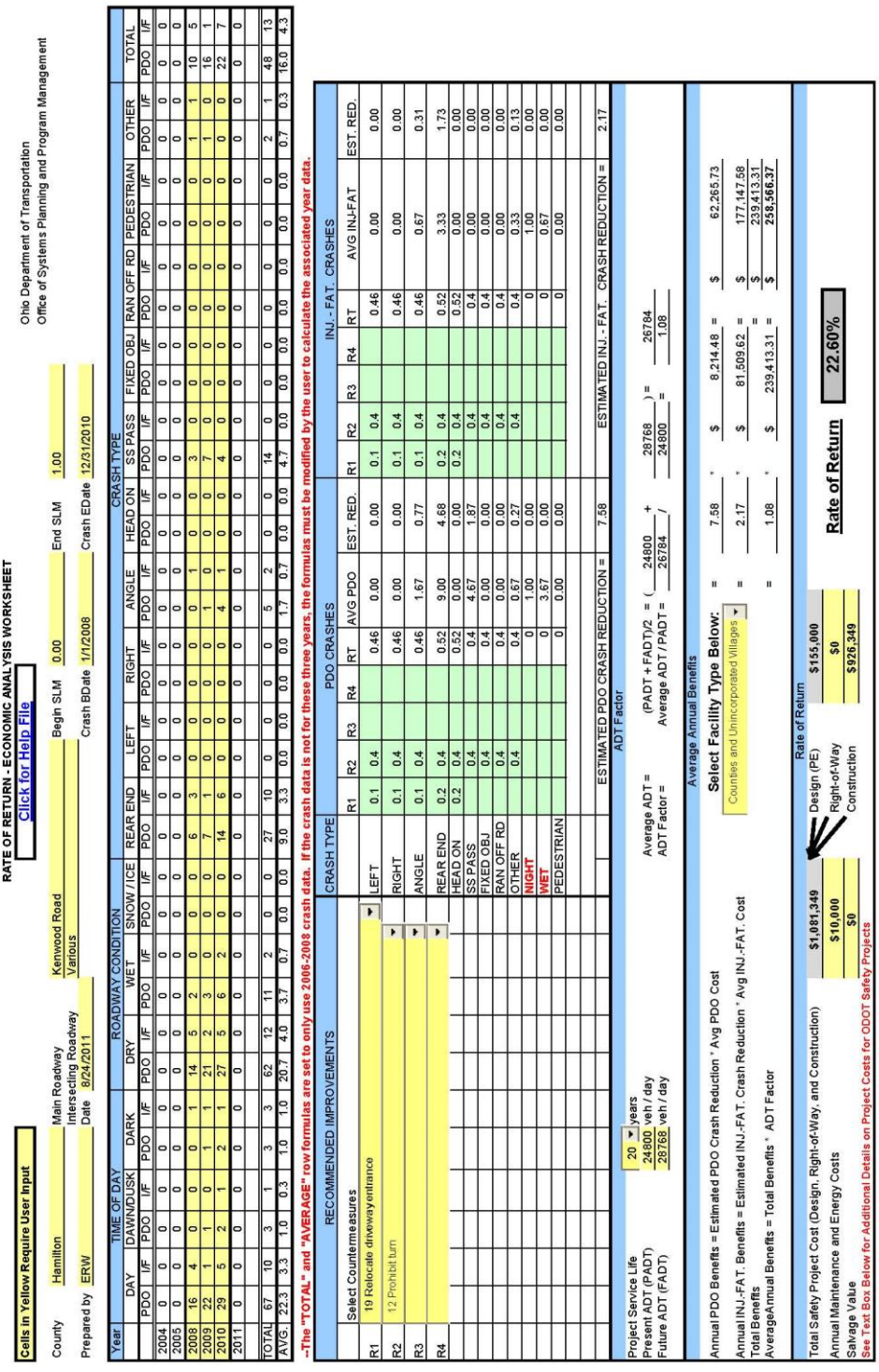
Table 12: Rate of Return – Short Term Countermeasures

Recommendation	Cost	ROR
Short Term Recommendations	$1,081,349	22.60%

Table 13: Rate of Return – Long Term Countermeasures (includes short term)

Recommendation	Cost	ROR
Long Term Recommendations	$2,892,967	5.32%

Figure 8A: Rate of Return – Short Term All Countermeasure



RATE OF RETURN - ECONOMIC ANALYSIS WORKSHEET

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Ohio Department of Transportation
Office of Systems Planning and Program Management

Cells in Yellow Require User Input

County: Hamilton | Main Roadway: Kenwood Road | Begin SLM: 0.00 | End SLM: 1.00
Prepared by: ERW | Intersecting Roadway: Various | Crash BDate: 1/1/2006 | Crash EDate: 12/31/2010
Date: 8/24/2011

Year	TIME OF DAY						ROADWAY CONDITION																																	
	DAY			DAWN/DUSK			DARK			DRY			WET			SNOW / ICE			CRASH TYPE: REAR END			LEFT			RIGHT			ANGLE			HEAD ON			SS PASS			FIXED OBJ			RAN OFF RD			PEDESTRIAN			OTHER			TOTAL		
	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	16	4	0	0	0	1	14	5	2	0	0	0	6	3	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	1	1	10	5														
2009	22	1	1	0	1	1	21	2	3	0	0	0	7	1	0	0	0	0	1	0	0	0	0	7	0	0	0	0	0	0	1	0	16	1														
2010	29	5	2	1	2	1	27	5	6	2	0	0	14	6	0	0	0	0	4	1	0	0	0	4	0	0	0	0	0	0	0	0	22	7														
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
TOTAL	67	10	3	1	3	3	62	12	11	2	0	0	27	10	0	0	0	0	5	2	0	0	0	14	0	0	0	0	0	0	2	1	48	13														
AVG	22.3	3.3	1.0	0.3	1.0	1.0	20.7	4.0	3.7	0.7	0.0	0.0	9.0	3.3	0.0	0.0	0.0	0.0	1.7	0.7	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	16.0	4.3														

--The "TOTAL" and "AVERAGE" row formulas are set to only use 2006-2008 crash data. If the crash data is not for these three years, the formulas must be modified by the user to calculate the associated year data.

	RECOMMENDED IMPROVEMENTS	CRASH TYPE	PDO CRASHES R1	PDO CRASHES R2	PDO CRASHES R3	PDO CRASHES R4	PDO CRASHES RT	PDO CRASHES AVG PDO	PDO CRASHES EST. RED.	INJ. - FAT. CRASHES R1	INJ. - FAT. CRASHES R2	INJ. - FAT. CRASHES R3	INJ. - FAT. CRASHES R4	INJ. - FAT. CRASHES RT	INJ. - FAT. CRASHES AVG INJ-FAT	INJ. - FAT. CRASHES EST. RED.
	Select Countermeasures															
R1	19 Relocate driveway entrance	LEFT	0.1	0.4			0.46	0.00	0.00	0.1	0.4			0.46	0.00	0.00
R2	12 Prohibit turn	RIGHT	0.1	0.4			0.46	0.00	0.00	0.1	0.4			0.46	0.00	0.00
R3		ANGLE	0.1	0.4			0.46	1.67	0.77	0.1	0.4			0.46	0.67	0.31
R4		REAR END	0.2	0.4			0.52	9.00	4.68	0.2	0.4			0.52	3.33	1.73
		HEAD ON	0.2	0.4			0.52	0.00	0.00	0.2	0.4			0.52	0.00	0.00
		SS PASS		0.4			0.4	4.67	1.87		0.4			0.4	0.00	0.00
		FIXED OBJ		0.4			0.4	0.00	0.00		0.4			0.4	0.00	0.00
		RAN OFF RD		0.4			0.4	0.00	0.00		0.4			0.4	0.00	0.00
		OTHER		0.4			0.4	0.67	0.27		0.4			0.4	0.33	0.13
		NIGHT					0	1.00	0.00					0	1.00	0.00
		WET					0	3.67	0.00					0	0.67	0.00
		PEDESTRIAN					0	0.00	0.00					0	0.00	0.00
								ESTIMATED PDO CRASH REDUCTION =	7.58					ESTIMATED INJ. - FAT. CRASH REDUCTION =		2.17

ADT Factor

Project Service Life: 20 years
Present ADT (PADT): 24800 veh / day
Future ADT (FADT): 28768 veh / day

Average ADT = (PADT + FADT)/2 = (24800 + 28768) = 26784
ADT Factor = Average ADT / PADT = 26784 / 24800 = 1.08

Average Annual Benefits

Annual PDO Benefits = Estimated PDO Crash Reduction * Avg PDO Cost = 7.58 * $ 8,214.48 = $ 62,265.73

Select Facility Type Below: Counties and Unincorporated Villages

Annual INJ.-FAT. Benefits = Estimated INJ.-FAT. Crash Reduction * Avg INJ.-FAT. Cost = 2.17 * $ 81,509.62 = $ 177,147.58

Total Benefits = $ 239,413.31 = $ 239,413.31

AverageAnnual Benefits = Total Benefits * ADT Factor = 1.08 * $ 239,413.31 = $ 258,566.37

Rate of Return

Total Safety Project Cost (Design, Right-of-Way, and Construction)	$1,081,349	Design (PE)	$155,000
Annual Maintenance and Energy Costs	$10,000	Right-of-Way	$0
Salvage Value	$0	Construction	$926,349

Rate of Return: 22.60%

See Text Box Below for Additional Details on Project Costs for ODOT Safety Projects

Figure 8B: Rate of Return – Long Term Countermeasures (includes short term)

Cells in Yellow Require User Input

RATE OF RETURN - ECONOMIC ANALYSIS WORKSHEET

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Ohio Department of Transportation
Office of Systems Planning and Program Management

County	Hamilton	Main Roadway	Kenwood Road	Begin SLM	0.00	End SLM	1.00
		Intersecting Roadway	Various				
Prepared by	ERW	Date	8/24/2011	Crash BDate	1/1/2008	Crash EDate	12/31/2010

Year	TIME OF DAY						ROADWAY CONDITION						CRASH TYPE																				TOTAL	
	DAY		DAWN/DUSK		DARK		DRY		WET		SNOW / ICE		REAR END		LEFT		RIGHT		ANGLE		HEAD ON		SS PASS		FIXED OBJ		RAN OFF RD		PEDESTRIAN		OTHER			
	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F	PDO	I/F
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	16	4	0	0	0	1	14	5	2	0	0	0	6	3	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	1	1	10	5
2009	22	1	1	0	1	1	21	2	3	0	0	0	7	1	0	0	0	0	1	0	0	0	7	0	0	0	0	0	0	0	1	0	16	1
2010	29	5	2	1	2	1	27	5	6	2	0	0	14	6	0	0	0	0	4	1	0	0	4	0	0	0	0	0	0	0	0	0	22	7
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	67	10	3	1	3	3	62	12	11	2	0	0	27	10	0	0	0	0	5	2	0	0	14	0	0	0	0	0	0	0	2	1	48	13
AVG.	22.3	3.3	1.0	0.3	1.0	1.0	20.7	4.0	3.7	0.7	0.0	0.0	9.0	3.3	0.0	0.0	0.0	0.0	1.7	0.7	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	16.0	4.3

--The "TOTAL" and "AVERAGE" row formulas are set to only use 2006-2008 crash data. If the crash data is not for these three years, the formulas must be modified by the user to calculate the associated year data.

RECOMMENDED IMPROVEMENTS

	Select Countermeasures
R1	19 Relocate drivewayentrance
R2	12 Prohibit turn
R3	
R4	

CRASH TYPE	PDO CRASHES							INJ. - FAT. CRASHES						
	R1	R2	R3	R4	RT	AVG PDO	EST. RED.	R1	R2	R3	R4	RT	AVG INJ-FAT	EST. RED.
LEFT	0.1	0.4			0.46	0.00	0.00	0.1	0.4			0.46	0.00	0.00
RIGHT	0.1	0.4			0.46	0.00	0.00	0.1	0.4			0.46	0.00	0.00
ANGLE	0.1	0.4			0.46	1.67	0.77	0.1	0.4			0.46	0.67	0.31
REAR END	0.2	0.4			0.52	9.00	4.68	0.2	0.4			0.52	3.33	1.73
HEAD ON	0.2	0.4			0.52	0.00	0.00	0.2	0.4			0.52	0.00	0.00
SS PASS		0.4			0.4	4.67	1.87		0.4			0.4	0.00	0.00
FIXED OBJ		0.4			0.4	0.00	0.00		0.4			0.4	0.00	0.00
RAN OFF RD		0.4			0.4	0.00	0.00		0.4			0.4	0.00	0.00
OTHER		0.4			0.4	0.67	0.27		0.4			0.4	0.33	0.13
NIGHT					0	1.00	0.00					0	1.00	0.00
WET					0	3.67	0.00					0	0.67	0.00
PEDESTRIAN					0	0.00	0.00					0	0.00	0.00
	ESTIMATED PDO CRASH REDUCTION =						7.58	ESTIMATED INJ. - FAT. CRASH REDUCTION =						2.17

ADT Factor

Project Service Life 20 years
Present ADT (PADT) 24800 veh / day
Future ADT (FADT) 28768 veh / day

Average ADT = (PADT + FADT)/2 = (24800 + 28768) = 26784
ADT Factor = Average ADT / PADT = 26784 / 24800 = 1.08

Average Annual Benefits

Select Facility Type Below: Counties and Unincorporated Villages

Annual PDO Benefits = Estimated PDO Crash Reduction * Avg PDO Cost	=	7.58	* $ 8,214.48	=	$ 62,265.73
Annual INJ.-FAT. Benefits = Estimated INJ.-FAT. Crash Reduction * Avg INJ.-FAT. Cost	=	2.17	* $ 81,509.62	=	$ 177,147.58
Total Benefits				=	$ 239,413.31
AverageAnnual Benefits = Total Benefits * ADT Factor	=	1.08	* $ 239,413.31	=	**$ 258,566.37**

Rate of Return

Total Safety Project Cost (Design, Right-of-Way, and Construction)	**$2,892,967**	Design (PE)	**$309,961**
Annual Maintenance and Energy Costs	**$20,000**	Right-of-Way	**$545,000**
Salvage Value	**$0**	Construction	**$2,038,006**

Rate of Return **5.32%**

See Text Box Below for Additional Details on Project Costs for ODOT Safety Projects