MEMORANDUM

Date: June 12, 2015

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Single-lane Roundabout Implementation Justification**

Please see the attached technical memorandum from the Department of Transportation (DOT) regarding implementation of roundabout traffic intersections to improve capacity and safety.

The report has been prepared to justify the County's improving and constructing an additional number of roundabouts throughout the County. In the past, experimental roundabouts constructed by DOT have proved successful in reducing crash rates, congestion and vehicle delays, thereby improving environmental impacts associated with energy consumption and air pollution.

I have authorized DOT to construct additional roundabouts within the County as an alternative to constructing traditional signalized intersections. After review of their technical memorandum and other justifications, I believe this is the most appropriate response to traffic safety and congestion.

CHH/anc

Attachment

c: John Bernal, Deputy County Administrator for Public Works
Priscilla Cornelio, Director, Department of Transportation
Seth Chalmers, Division Manager, Department of Transportation
Hannah Olsen, Traffic Engineering Assistant, Department of Transportation

PIMA COUNTY
TRANSPORTATION

TECHNICAL MEMORANDUM

DATE: April 16, 2015

TO: John Bernal, PE
Deputy County Administrator

THRU: Priscilla Cornelio, PE
Department of Transportation Director

FROM: Seth Chalmers, PE
Traffic Engineering Division Manager

BY: Hannah Olsen, EIT
Traffic Engineering Assistant

SUBJECT: **Single-Lane Roundabout Implementation Justification**

In 2012 the Federal Highway Administration (FHWA) published a guidance memorandum that sought to promote the implementation of certain traffic safety countermeasures that had been proven effective but were not widely used in the United States. The second countermeasure listed in the memorandum was roundabouts.

The roundabout is a type of circular intersection defined by yield control of entering traffic, splitter islands on the approaches, and roadway curvature to reduce vehicle speeds. The design and operation of roundabouts, in particular single-lane roundabouts, gives them advantages over traditional stop-controlled, all-way stop-controlled (AWSC), or signalized intersections in the following areas: safety, traffic operations, cost, usability, and sustainability.

Safety Implications

According to the FHWA, studies have shown that converting a traditional intersection, of any kind, to a roundabout can reduce all crashes by 35%, injury crashes by 76%, and fatal crashes by 90%. These reductions are substantiated by the crash reduction factors (CRFs) listed in the FHWA Crash Modification Factors Clearinghouse. Some of the highest rated CRFs related to conversion of traditional intersections to roundabouts are shown below; they indicate that converting a traditional intersection to a roundabout results in significant reductions in injury crashes and, in most cases, reductions in all crashes:

1. Convert intersection with minor-road stop control to modern roundabout
    a. 44% decrease in all crashes
    b. 82% decrease in injury crashes
2. Convert AWSC intersection to roundabout
    a. 11% increase in all crashes
    b. 46% decrease in injury crashes
3. Convert signalized intersection to modern roundabout
    a. 48% decrease in all crashes
    b. 78% decrease in injury crashes

In addition to the national statistics, the safety benefits of roundabouts have been observed in Pima County. In 2009 the PCDOT installed a single lane roundabout in the Green Valley area at Camino Del Sol and Continental Road. In the five years before its installation a total of 12 crashes occurred at the intersection (see Attachment 1). They included four angle crashes (one classified as miscellaneous), three fixed-object crashes (one resulting in a serious injury), two rear-end crashes, two loss-of-control crashes, and one turning crash. Since the roundabout was installed, however, no crashes have been reported at the intersection.

Roundabouts effect this drastic crash reduction by significantly reducing the number of conflict points at an intersection as illustrated in Figure 1.

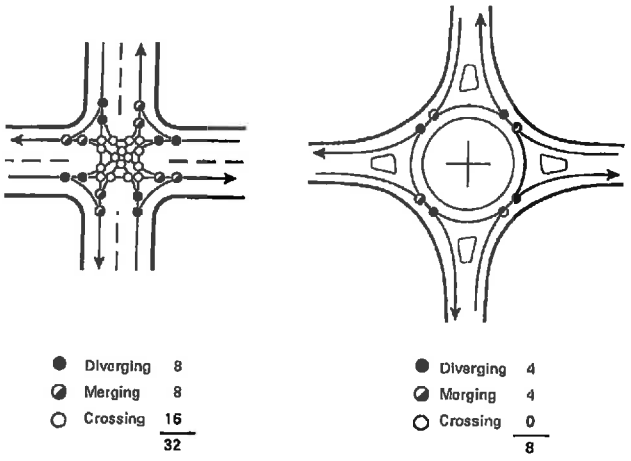

Figure 1—Intersection Conflicts at a Traditional Intersection vs. a Roundabout

Traditional intersections contain 32 conflict points. Sixteen of these are crossing conflicts where angle, turning, and head-on crashes occur. All three of the crash types can result in severe crashes, but angle crashes are the most severe type of crash as they often result in serious injuries or fatalities. They are a major recurring problem in the United States.

Due to their one-way operation, roundabouts have only eight conflict points, none of which are crossing conflicts. This practically eliminates the opportunity for the severe crashes discussed above, particularly the angle crashes. Furthermore, the channelization of the entries and curved geometry of the circulatory roadway force drivers to slow down as they approach and travel through the roundabout, which reduces the severity of crashes that do occur.

Additionally, roundabouts are self-regulating, meaning that there is no traffic signal or stop sign to run and drivers are not tempted to speed up to "beat the light." Therefore the consequences of driver error or aggressive driving are minimized in comparison to other forms of intersection control.

Traffic Operations Impacts

In addition to substantial safety benefits, the operational efficiency of roundabouts is much greater than AWSC or traffic signals. According to the FHWA publication *Roundabouts: An Informational Guide*[1], the typical daily service volume of a single-lane roundabout is 20,000 vehicles per day and the maximum daily service volume is about 25,000 vehicles per day. This is due, in large part, to the yield control, which only requires drivers to stop if a conflict is present, as well as the fact that roundabouts can safely allow more vehicles to pass through an intersection at one time. In 2014 the *Mythbusters* television show conducted a controlled experiment that showed that a single-lane roundabout is more efficient than AWSC (the video can be found at http://www.wimp.com/testroundabout/). The hosts concluded that the roundabout was nearly 20% more efficient than the AWSC intersection for the reasons mentioned above.

A drawback of the *Mythbusters* experiment was the assumption of equal volumes on all four legs of the intersection because this assumption does not accurately reflect real-world traffic. The performance of a real-world roundabout is highly dependent on the entering volumes and turning percentages of an intersection. Traffic

[1] Federal Highway Administration. (2000). *Roundabouts: an informational guide* (DOT Report No. FHWA-RD-00-067). Washington, DC: U.S. Government Printing Office.

simulation software or deterministic software that uses *Highway Capacity Manual* (HCM) methodologies can be used to assess an individual roundabout's performance. Traffic simulations have been conducted to compare roundabouts and traffic signals at two AWSC intersections in Pima County: Los Reales Road at Swan Road and Continental Road/Old Nogales Highway at Park Centre Avenue/Whitehouse Canyon Road (heretofore referred to as Continental Road at Whitehouse Canyon Road). The results of these simulations are summarized in Table 1 and Table 2.

Table 1—Los Reales Road and Swan Road Traffic Control Delay and LOS Comparison

AM Peak Hour Results

Intersection Control		Movement Delay (sec/veh) & Level of Service (LOS)												Int Delay/Veh (sec/veh)	Total Int Delay (hrs)	Total Delay (%) Compared to AWSC
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
AWSC	Delay	10.4	11.6	6.4	24.3	27.1	22.7	5.6	10.1	3.8	10.5	15.6	12.2	18.8	6.1	-
	LOS	B	B	A	C	D	C	A	B	A	B	C	B	C		
Signal	Delay	19.2	6.9	3.5	12.2	12.1	9.4	17.5	15.7	3.9	20.7	19.9	13.2	11.9	3.9	-36.1%
	LOS	B	A	A	B	B	A	B	B	A	C	B	B	B		
Roundabout	Delay	5.2	7.3	5.5	7	10.6	8.6	3	4.3	2.5	6.4	8.2	6.4	8.3	2.7	-55.7%
	LOS	A	A	A	A	B	A	A	A	A	A	A	A	A		

PM Peak Hour Results

Intersection Control		Movement Delay (sec/veh) & Level of Service (LOS)												Int Delay/Veh (sec/veh)	Total Int Delay (hrs)	Total Delay (%) Compared to AWSC
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
AWSC	Delay	20	21.5	15.9	11.3	10	4.1	5.5	8.6	2.8	10.9	6.9	10.4	15.5	5.2	-
	LOS	C	C	C	B	A	A	A	A	A	B	A	B	C		
Signal	Delay	14.2	11.9	9.4	15.8	6	2	18.7	13	5.2	19.4	7.7	10.2	10.8	3.7	-28.8%
	LOS	B	B	A	B	A	A	B	B	A	B	A	B	B		
Roundabout	Delay	10.2	12.5	9.3	3.4	5.9	4.7	3.3	5.2	3.6	4.7	2.1	4.8	8.4	2.8	-46.2%
	LOS	B	B	A	A	A	A	A	A	A	A	A	A	A		

Table 2—Continental Road at Whitehouse Canyon Road Traffic Control Delay and LOS Comparison

AM Peak Hour Results

Intersection Control		Movement Delay (sec/veh) & Level of Service (LOS)												Int Delay/Veh (sec/veh)	Total Int Delay (hrs)	Reduction in Total Delay (%)
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
AWSC	Delay	11.7	14.6	8.9	10.3	14.4	7.2	7.8	8.4	4.6	6.1	7.1	5	10.1	3.3	-
	LOS	B	B	A	B	B	A	A	A	A	A	A	A	B		
Signal	Delay	14.5	9.2	6.5	12.1	7.5	2.8	17	15.3	4.6	14.4	14.3	4.8	9.8	3.2	-3.0%
	LOS	B	A	A	B	A	A	B	B	A	B	B	A	A		
Roundabout	Delay	8.4	10.4	9	5.7	8.5	5.3	3.9	4.7	3.9	3.7	3.7	3.6	7	2.3	-30.3%
	LOS	A	B	A	A	A	A	A	A	A	A	A	A	A		

Midday Peak Hour Results

Intersection Control		Movement Delay (sec/veh) & Level of Service (LOS)												Int Delay/Veh (sec/veh)	Total Int Delay (hrs)	Reduction in Total Delay (%)
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
AWSC	Delay	15.8	17.9	9	11.9	16.8	7.9	11.7	9.4	5.6	5.7	9.2	6.8	12.5	4.5	-
	LOS	C	C	A	B	C	A	B	A	A	A	A	A	B		
Signal	Delay	17.2	11.6	6.5	14.6	9.5	3.3	18.3	13.7	4.9	10.8	13.2	5.3	11.3	4.1	-8.9%
	LOS	B	B	A	B	A	A	B	B	A	B	B	A	B		
Roundabout	Delay	8.6	10.1	8.6	5	8.2	4.6	5.4	6	5.1	3.7	5	4.3	7.2	2.6	-42.2%
	LOS	A	B	A	A	A	A	A	A	A	A	A	A	A		

PM Peak Hour Results

Intersection Control		Movement Delay (sec/veh) & Level of Service (LOS)												Int Delay/Veh (sec/veh)	Total Int Delay (hrs)	Reduction in Total Delay (%)
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
AWSC	Delay	18.5	21	9.1	12.5	16	7	12.7	9.7	6.2	7.2	9.2	8.1	14.1	5.2	-
	LOS	C	C	A	B	C	A	B	A	A	A	A	A	B		
Signal	Delay	17.2	12.5	6.6	16.2	9.7	3.8	19.5	12.7	5.9	12.1	11.3	5.8	11.7	4.3	-17.3%
	LOS	B	B	A	B	A	A	B	B	A	B	B	A	B		
Roundabout	Delay	8.1	10.2	8.3	4.1	7.4	4.2	6.3	7.1	6	4.7	5.1	4.7	7.4	2.7	-48.1%
	LOS	A	B	A	A	A	A	A	A	A	A	A	A	A		

In both instances, the simulations showed significantly better operations for the roundabouts than the traffic signals. At Los Reales Road and Swan Road intersection delay was reduced by 29–36% for the traffic signal and 46–56% for the roundabout when compared to AWSC. At Continental Road and Whitehouse Canyon Road intersection delay was reduced by 3–17% for the traffic signal and 30–48% for the roundabout when compared to AWSC.

The yield control of roundabouts greatly reduces entry delay for individual drivers. Figure 2 illustrates the average approach delay per vehicle, as perceived by the driver, for traffic signals and roundabouts at the MUTCD Peak-Hour Signal Warrant thresholds.

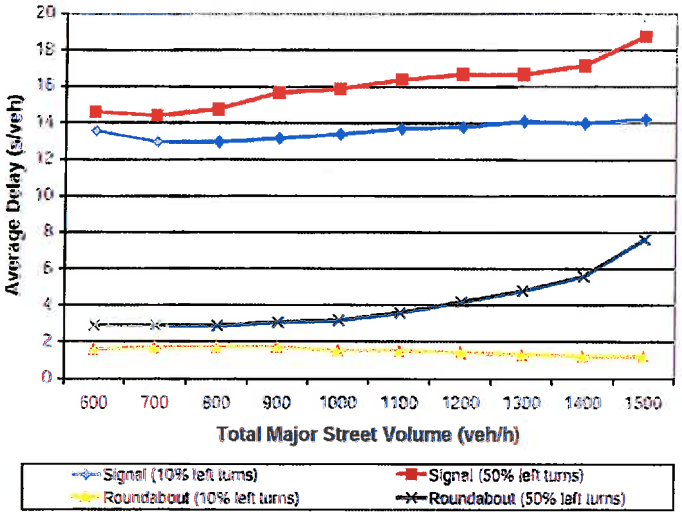

Figure 2—Average Delay per Vehicle at the MUTCD Peak-Hour Signal Warrant Thresholds

It is clear from this figure that drivers perceive substantially lower control delays for roundabouts than for traffic signals. Drivers appreciate yield control during peak hours. Moving queues that result from it are more tolerable than standing queues, so drivers are more likely to be patient. Drivers also appreciate yield control during off-peak hours because it does not require them to stop unnecessarily when no conflicts are present.

The yield control coupled with the large capacity of a single-lane roundabout makes it a long-lasting and adaptable intersection control method. Unlike traditional intersections which must progress through an upgrade chain from two-way stop control to AWSC to signal control, a roundabout can function well with a wide variety of entering volumes as a community grows around it. Additionally, roundabouts are able to function normally during power outages and special events, typically eliminating the need for law enforcement officers to direct traffic and emergency maintenance calls for a traffic technician to perform repairs.

Cost Considerations

The initial cost of installing a roundabout is comparable to a traffic signal, but it is generally a bit higher due to the more intensive design work. Roundabouts typically do not require more right-of-way acquisition than a traffic signal. Although roundabouts often need more space within the actual intersection, traffic signals can require significantly more space on the approaches to accommodate storage lanes for standing traffic queues during red phases. The extra storage lanes typically necessitate approach widening between 200 ft and 250 ft in advance of the intersection.

The Pima County Department of Transportation (PCDOT) recently completed construction of both a traffic signal and a roundabout. The traffic signal was built in 2011 at the intersection of Kolb Road and Mountain Shadows Place/Ventana Canyon Drive, heretofore referred to as Kolb Road and Ventana Canyon Drive, for a total cost of $432,293 (see Attachment 2), and the roundabout was built in 2009 at the intersection of Camino Del Sol and Continental Road for a total cost of $887,397 (see Attachment 3). The Camino Del Sol at Continental Road roundabout incorporated some atypical features in its design such as landscaping with mature vegetation and a bicycle bypass. In addition, the project included road widening, pavement preservation, and sidewalk installation along Continental Road that was not part of the roundabout. If the road work costs were not included, the total

installation cost would have been approximately $773,198. The proposed roundabout at Los Reales Road and Swan Road may serve as a better comparison. Using the unit prices from the Camino Del Sol at Continental Road roundabout an engineer's estimate of $577,369 was developed (see Attachment 4). All the actual and estimated installation costs are summarized in Table 3.

Table 3—Traffic Signal and Roundabout Cost Comparison

	Kolb Road at Ventana Canyon Drive (Traffic Signal)	**Camino Del Sol at Continental Road** (Roundabout)	**Los Reales Road at Swan Road** (Proposed Roundabout)
Design	*$59,533*	*$106,584*	*$150,000*
Construction	*$372,760*	*$780,813*	*$427,369*
Total	**$432,293**	**$887,397** ($773,198 w/o Road Work)	**$577,369**

As can be seen in the table above, the installation cost for a single-lane roundabout, as a stand-alone project, is comparable to that of a traffic signal. And even when the project scope is larger, the cost to install a roundabout is not unreasonable.

An additional factor that is not accounted for in the above estimates is that the FHWA favors the use of roundabouts as a safety improvement by funding eligible costs 100%. On the other hand, signalization projects require a 5.7% match, so eligible costs are only funded 94.3%. This amounts to a $25,000 reimbursement on a $450,000 project.

While installation costs for a traffic signal and a roundabout are similar, the service life of a roundabout is significantly longer than that of a traffic signal. According to the National Cooperative Highway Research Program (NCHRP) update to *Roundabouts: An Informational Guide*[2], the service life of a roundabout is approximately 25 years, while the service life of a traffic signal is approximately 10 years. Additionally, the operation and maintenance costs for roundabouts are far less than those of traffic signals since they do not require much of the hardware, maintenance, and electrical costs associated with traffic signals.

Recently the PCDOT Traffic Engineering Division (TED) completed lifecycle cost analyses for the traffic signal at Overton Road and Shannon Road and the roundabout at Camino Del Sol and Continental Road relative to signal and lighting costs (see Attachment 5 and Attachment 6). The traffic signal at Overton Road and Shannon Road was selected for this analysis because the intersection is representative of locations suitable for single-lane roundabout installation. Additionally, the life cycle cost analysis for the roundabout at Camino Del Sol and Continental Road was adjusted to represent a four-legged intersection, which would ensure a more accurate comparison. The lifecycle cost analyses showed that a traffic signal has an estimated yearly cost of $12,676, whereas a roundabout has an estimated yearly cost of $2,159. This results in an annual differential of approximately $10,500.

The lifecycle cost analyses discussed above considered only signal and lighting related costs. They did not take into account pavement preservation, signing and striping maintenance, or landscaping costs. The landscaping maintenance costs for roundabouts may be higher than those for signals, depending on the degree of landscaping provided on the central island, splitter islands, and perimeter. On the other hand, pavement marking maintenance costs may be higher for traffic signals if channelization for exclusive turn lanes, multiple approach lanes, and longer crosswalks and stop bars are present.

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[2] National Cooperative Highway Research Program. (2010). *Roundabouts: an informational guide* (2nd ed.) (NCHRP Report 672). Washington, DC: U.S. Government Printing Office.

In addition to monetary benefits, roundabouts provide environmental benefits. Roundabouts are an important part of low impact development (LID) and green infrastructure (GI). The central islands and splitter islands are ideal locations for water harvesting basins, and the landscaping, which can include trees on the central island, can help to reduce the heat island effect. Additionally, the yield control eliminates idling and reduces the need for stops followed by hard accelerations. This causes a significant reduction in vehicle emissions and noise pollution.

Usability Factors

The yield control, one-way operation, and slower speeds of single-lane roundabouts make them user-friendly and intuitive for all drivers, but especially for novice and elderly drivers. Decision making is simpler as it is only necessary to yield to traffic proceeding from the left, and the sight triangles needed for drivers to see one another are much smaller. The reduction in speed allows more time for drivers to safely select a gap to enter the roundabout. It also gives drivers more time to detect and correct their mistakes and the mistakes of others.

In general, single-lane roundabouts also have a high usability for pedestrians and bicyclists. Figure 3 illustrates how pedestrians and cyclists navigate a roundabout.

An Insurance Institute for Highway Safety (IIHS) study found that roundabouts reduce pedestrian collisions by 40%. This is probably due to two features of the roundabout. First, the crosswalk is positioned one car length in advance of the yield line. This means that drivers have the chance to check for and see pedestrians before they are focused on watching for gaps in traffic. Second, the use of raised splitter islands with pedestrian refuges creates a two-stage crossing, so pedestrians need only cross one direction of travel at a time. Roundabouts also minimize stopping and standing vehicles, when compared to traffic signals, which can create an extreme environment for pedestrians. Roundabouts are problematic, however, for pedestrians who are visually impaired as it is difficult for them to judge appropriate gaps in traffic due to the continuous flow and approach and exit curvature. These problems should be taken into account during site selection for roundabouts.

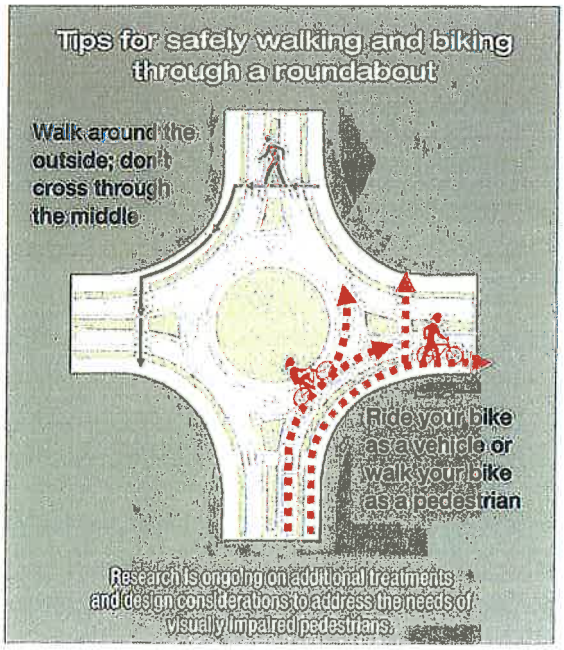


Figure 3—Travel Paths of Pedestrians and Bicyclists through a Roundabout

Based on their level of skill and confidence, bicyclists have two choices on how to navigate a roundabout. Confident cyclists can take the lane and travel through the roundabout in the same manner as a motorized vehicle, and less confident cyclists can access the sidewalk and walk through the roundabout in the same manner as a pedestrian.

When it was first installed, the roundabout at Camino Del Sol and Continental Road caused some confusion for golf cart drivers. Because they typically travel in the bike lanes, some of the drivers would get stuck after attempting to use the bicycle bypass which does not provide an outlet suitable for golf carts. The PCDOT/TED solved this problem by installing flexible delineators at the entrance to the bicycle bypass, so golf carts were not able to access it. Since then the roundabout has been very well accepted by the Green Valley community. According to a short survey by the PCDOT/TED, roadway users in Green Valley feel that the roundabout functions smoothly and has improved traffic operations immensely (see Attachment 7). Only one respondent reported atypical use of the roundabout, which was a bicyclist riding in the wrong direction.

The FHWA has created the Roundabout Education and Outreach Toolbox in order to assist transportation professionals in obtaining public and political support for roundabouts (the toolbox can be found at http://safety.fhwa.dot.gov/intersection/roundabouts/roundabouttoolbox/). It contains summaries of the education and outreach programs that have been successfully implemented by state and local transportation departments around the country. In addition, the FHWA has created an educational brochure entitled *Roundabouts—A Safer Choice* (see Attachment 8).

Conclusions and Recommendations

Single-lane roundabouts offer a multitude of advantages over traditional intersections, including traffic signals:

- Studies conducted by the FHWA and the IIHS show that roundabouts can reduce all crashes by 35%, injury crashes by 76%, fatal crashes by 90%, and pedestrian crashes by 40%.
- Single-lane roundabouts are more efficient than traditional intersections with daily service volumes up to 25,000 vehicles per day and simulated vehicle delay between two to four seconds lower per vehicle than signals.
- Roundabouts save approximately $10,500 in signal and lighting maintenance lifecycle costs annually and have comparable construction costs to signals.
- They are simple to use and have high driver acceptance rates as shown by the Green Valley survey.
- Roundabouts are a self-regulating and durable method intersection control that is safer and more cost effective than a signal or all-way stop control.

Based on these conclusions, PCDOT/TED recommends that single-lane roundabouts be implemented as a standard consideration for intersection control as applicable and feasible.

Attachments (8)

1. Camino Del Sol at Continental Road 5-Year Crash Summary Pre-Roundabout
2. Kolb Road at Mountain Shadow Place/Ventana Canyon Drive Traffic Signal Installation Cost
3. Camino Del Sol at Continental Road Roundabout Installation Cost
4. Los Reales Road at Swan Road Roundabout Engineer's Estimate
5. Overton Road at Shannon Road Traffic Signal Lifecycle Cost Analysis
6. Camino Del Sol at Continental Road Roundabout Lifecycle Cost Analysis
7. Green Valley Camino Del Sol and Continental Road Roundabout Survey
8. *Roundabouts—A Safer Choice*

PIMA COUNTY

TRANSPORTATION

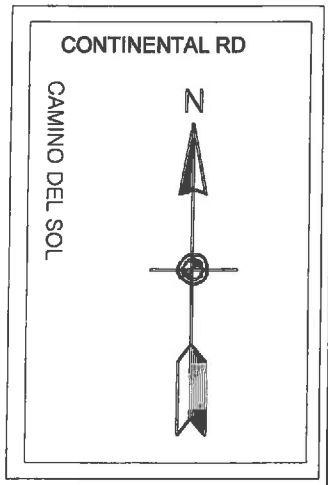
TRAFFIC ENGINEERING DIVISION

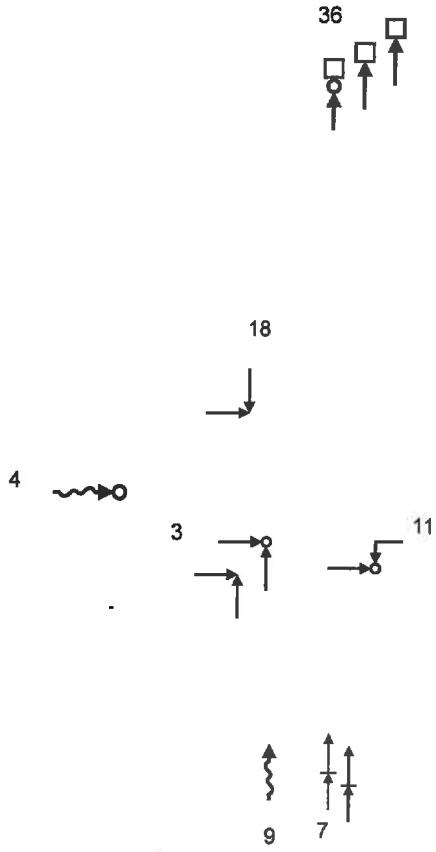
CAMINO DEL SOL@CONTINENTAL RD

1/1/2004 to 12/31/2008

LEGEND

- REAR END
- TURNING
- ANGLE
- OUT OF CONTROL
- MISC
- FIXED OBJ
- BACKING
- HEAD ON
- BODILY INJURY
- FATALITY





Print Date: 4/16/2015

CRASH AND INJURY SEVERITY SUMMARY

PROPERTY	8
INJURY	4
FATALITY	0
TOTAL	12

PIMA COUNTY
TRANSPORTATION
TRAFFIC ENGINEERING DIVISION

CAMINO DEL SOL @ CONTINENTAL RD

1/1/2004 to 12/31/2008

TYPE	DATE / CASE #	TIME / LIGHT	DAY	SEVERITY / BLOCK #	DISTRACTED DRIVING	VIOLATIONS CITED	NARRATIVE
7	11/6/2008 081106314	18:17 Dark	Thu	PROPERTY 21700 S		VEH 1: NONE NONE VEH 2: UNKNOWN NONE	NB REAR-END
36	9/27/2008 080927057	05:00 Dark	Sat	PROPERTY 21700 S		** VEH 1: RAN STOP SIGN OTHER UNSAFE PASSING	NB RAN THE STOP SIGN & HIT A TREE
7	7/28/2007 070728546	21:37 Dark	Sat	PROPERTY 21700 S		VEH 1: RAN STOP SIGN UNKNOWN	NB RAN THE STOP SIGN WENT THRU INTERSECTION INTO A DITCH
4	11/16/2006 061116336	18:45 Dark	Thu	INJURY - 2 21700 S		VEH 1: SPEED TOO FAST FOR CONDITIONS RAN STOP SIGN	NB RAN STOP SIGN LOST CTRL & WENT IN A WASH AT DEAD END INT
3	3/3/2006 060303205	14:13 Day	Fri	PROPERTY 1900 W		VEH 1: NONE NONE VEH 2: FAILURE TO YIELD NONE	EB HIT A NB RT THAT FTY FROM THE STOP SIGN
36	12/29/2005 051229327	21:44 Dark	Thu	INJURY - 4 1900 W		** VEH 1: EXCEEDED LAWFUL SPEED RAN STOP SIGN	NB SPEEDING RAN STOP SIGN LOST CTRL HIT SIGN, WIRE (ALCOHOL
3	8/15/2005 050815137	11:14 Day	Mon	INJURY - 3 1900 W		VEH 1: FAILURE TO YIELD NONE VEH 2: NONE NONE	EB MOTORCYCLE HIT NB FTY FROM STOP SIGN
11	12/22/2004 041222269	16:24 Day	Wed	INJURY - 2 1900 W	DR 2: UNKNOWN DISTRACTIONS	VEH 1: NONE UNKNOWN VEH 2: FAILURE TO YIELD	EB HIT WB LT THAT FTY FROM THE STOP SIGN
10	12/13/2004 041213113	10:24 Day	Mon	PROPERTY 21700 S	DR 2: UNKNOWN DISTRACTIONS	VEH 1: NONE NONE VEH 2: FAILURE TO YIELD	NB LT FTY HIT WB LT STOPPED FOR A SB VEHICLE

Date Printed 4/16/2015

** Denotes Driver Impairment

TYPE	DATE CASE #	TIME LIGHT	DAY	SEVERITY BLOCK #	DISTRACTED DRIVING	VIOLATIONS CITED	NARRATIVE
36	11/13/2004 041113369	20:37 Dark	Sat	PROPERTY 1900 W	DR 1: UNKNOWN DISTRACTIONS	VEH 1: RAN STOP SIGN	NB RAN THE STOP SIGN AND HIT A SIGN
18	3/23/2004 040323281	16:29 Day	Tue	PROPERTY 1900 W		VEH 1: NONE NONE VEH 2: FAILURE TO YIELD NONE	EB HIT A SB FTY FROM THE STOP SIGN
9	1/15/2004 040115056	06:50 Dawn	Thu	PROPERTY 21700 S	DR 1: UNKNOWN DISTRACTIONS	VEH 1: RAN STOP SIGN	NB RAN THE STOP SIGN RAN INTO WASH AREA

STAGE V ENGINEER'S ESTIMATE

JUNE 2011

Project Location: Mt. Shadows/Ventana Canyon/Kolb

Project Description: Intersection Signalization Improvements

Project Manager : Bob Roggenthen, PCDOT

Design Consultant : Kittelson & Associates

PC ITEM No.	ITEM DESCRIPTION	UNIT	Estimate		
			QUANT.	UNIT PRICE	AMOUNT
2010001	Clearing and Grubbing	L.S.	1.0	$ 2,000.00	$ 2,000
2020001	Removal of Structures & Obstructions	L.S.	1.0	$ 3,500.00	$ 3,500
2030300	Roadway Excavation	C.Y.	148.0	$ 14.00	$ 2,072
3030003	Aggregate Base	C.Y.	51.0	$ 31.00	$ 1,581
3040011	Emulsified Asphalt Slurry Seal (www.slurry.org/downloads/A105.pdf)	S.Y.	4,778.0	$ 3.00	$ 14,334
4040111	Tack Coat	TON	0.2	$ 1,000.00	$ 200
4060001	Asphaltic Concrete (No. 1)	TON	62.0	$ 71.00	$ 4,402
4060002	Asphaltic Concrete (No. 2)	TON	62.0	$ 90.00	$ 5,580
5050010	Manhole Adjustment (Storm Drain), PC/COT Std. Dtl. 303	EA	1.0	$ 1,000.00	$ 1,000
5150005	Utility Potholing, Depth Less Than Twelve Feet (12')	EA	4.0	$ 300.00	$ 1,200
5150007	Utility Potholing, Depth Twelve Feet And Greater (12')	EA	4.0	$ 450.00	$ 1,800
6070010	Sign Post (Perforated) (Single)	L.F.	140.0	$ 6.00	$ 840
6070110	Foundation for Sign Post (Perforated)	EACH	14.0	$ 150.00	$ 2,100
6080016	Sign Panel (Traffic Control) (Permanent) (Type IV)	S.F.	104.0	$ 16.00	$ 1,664
6080020	Sign Panel (Traffic Control) (Permanent) (Diamond Grade)	S.F.	-	$ 26.00	$ -
7010005	Traffic Control	L.S.	1.0	$ 8,000.00	$ 8,000
7010025	Flashing Arrow Panel	Each/Day	60.0	$ 14.00	$ 840
7010027	Changeable Message Board	Each/Day	60.0	$ 40.00	$ 2,400
7040010	Pavement Marking (White Hot-Sprayed Thermoplastic) (0.060")	L.F.	2,980.0	$ 0.25	$ 745
7040020	Pavement Marking (Yellow Hot-Sprayed Thermoplastic) (0.060")	L.F.	1,600.0	$ 0.25	$ 400
7040030	Pavement Marking (White Hot-Sprayed Thermoplastic) Sgl. Arrow (0.090")	EACH	11.0	$ 115.00	$ 1,265
7040051	Pavement Marking (White Hot-Sprayed Thermoplastic) Left-Thru Arrow (0.090")	EACH	1.0	$ 150.00	$ 150
7040060	Pavement Legend (White Hot-Sprayed Thermoplastic) (ONLY) (0.090")	EACH	4.0	$ 125.00	$ 500
7040110	Pavement Marking (White Hot Sprayed Thermoplastic)(Transverse) (0.090")	L.F.	1,530.0	$ 0.70	$ 1,071
7040120	Pavement Marking (Yellow Hot-Sprayed Thermoplastic)(Transverse) (0.090")	L.F.	1,530.0	$ 0.70	$ 1,071
7060025	Pavement Marker, Reflective, (Type D, Yellow, Two-Way)	EACH	38.0	$ 4.00	$ 152
7060030	Pavement Marker, Reflective, (Type G, Clear, One-Way)	EACH	15.0	$ 4.00	$ 60
7080001	Pavement Markering Painted	L.F.	7,637.0	$ 0.20	$ 1,527
7310045	Pole (Type Q)	EACH	4.0	$ 4,000.00	$ 16,000
7310085	Post (Type I) (Pedestrian Push Button)	EACH	2.0	$ 800.00	$ 1,600
7310230	Pole Foundation (Type Q)	EACH	4.0	$ 1,700.00	$ 6,800
7310255	Post Foundation (Type 1) (Pedestrian Push Button)	EACH	2.0	$ 500.00	$ 1,000
7310350	Control Cabinet Foundation	EACH	1.0	$ 1,000.00	$ 1,000
7310375	Service Pedestal Cabinet Foundation	EACH	1.0	$ 1,000.00	$ 1,000
7310410	Mast Arm (30 ft.) (Tapered)	EACH	1.0	$ 2,000.00	$ 2,000
7310415	Mast Arm (35 ft.) (Tapered)	EACH	1.0	$ 2,400.00	$ 2,400
7310420	Mast Arm (40 ft.) (Tapered)	EACH	2.0	$ 2,600.00	$ 5,200
7310535	Mast Arm (20 ft.) (Tapered) (Luminaire)	EACH	4.0	$ 700.00	$ 2,800
7320020	Electrical Conduit (2") (PVC)	L.F.	80.0	$ 9.00	$ 720
7320025	Electrical Conduit (2 1/2") (PVC)	L.F.	10.0	$ 9.50	$ 95
7320030	Electrical Conduit (3") (PVC)	L.F.	80.0	$ 10.00	$ 800
7320040	Electrical Conduit (4") (PVC)	L.F.	370.0	$ 15.00	$ 5,550
7320041	Electrical Conduit (4") (PVC) (Second in Trench)	L.F.	370.0	$ 7.50	$ 2,775
7320400	Pull Box (No. 3-1/2)	EACH	2.0	$ 300.00	$ 600
7320420	Pull Box (No. 7)	EACH	3.0	$ 500.00	$ 1,500
7320421	Pull Box (No. 7) (with Extension)	EACH	1.0	$ 625.00	$ 625
7320600	Conductors (Traffic Signals and Integral Street Lighting)	L.S.	1.0	$ 15,000.00	$ 15,000
7320690	Ground Rod (3/4" Dia. X 10')	EACH	2.0	$ 90.00	$ 180

STAGE V ENGINEER'S ESTIMATE

JUNE 2011

Project Location: Mt. Shadows/Ventana Canyon/Kolb

Project Description: Intersection Signalization Improvements

Project Manager : Bob Roggenthen, PCDOT

Design Consultant : Kittelson & Associates

PC ITEM No.	ITEM DESCRIPTION	UNIT	Estimate		
			QUANT.	UNIT PRICE	AMOUNT
7320800	Service Pedestal Cabinet	EACH	1.0	$ 1,800.00	$ 1,800
7320820	Battery Back Up Power System	EACH	1.0	$ 6,000.00	$ 6,000
7320890	Electrical Service Installation	L.S.	1.0	$ 5,000.00	$ 5,000
7330045	Traffic Signal Face (Type F)	EACH	14.0	$ 500.00	$ 7,000
7330200	Traffic Signal Face (Pedestrian) (Man/Hand)	EACH	8.0	$ 450.00	$ 3,600
7330320	Traffic Signal Mounting Assembly (Type V)	EACH	4.0	$ 400.00	$ 1,600
7330350	Traffic Signal Mounting Assembly (Type XI)	EACH	8.0	$ 175.00	$ 1,400
7330490	Tenon Clamp (Pelco Astro-Brac)	EACH	10.0	$ 250.00	$ 2,500
7330500	Pre-Empt Beacon	EACH	4.0	$ 450.00	$ 1,800
7330510	Pre-Empt Sensor	EACH	4.0	$ 500.00	$ 2,000
7340040	Traffic Signal Controller Assembly (Type IV)	EACH	1.0	$ 23,000.00	$ 23,000
7350000	Video Detection System	EACH	1.0	$ 31,000.00	$ 31,000
7350100	Loop Detector (6' x 6')	EACH	2.0	$ 500.00	$ 1,000
7350400	Pedestrian Push Button (2" ADA Button) (With Sign)	EACH	8.0	$ 380.00	$ 3,040
7360040	Luminaire (Horizontal Mount) (HPS 400 Watt)	EACH	4.0	$ 370.00	$ 1,480
7360190	Photo Electric Control	EACH	1.0	$ 80.00	$ 80
8030020	Decomposed Granite	S.Y.	354.0	$ 4.00	$ 1,416
8100001	AZPDES/NPDES (Original)	L.S.	1.0	$ 5,000.00	$ 5,000
8100011	AZPDES/NPDES (Modified)	F.A.	1,000.0	$ 1.00	$ 1,000
9080001	Concrete Curb (PC/COT Std. Dtl. 209) (Type 1)	L.F.	486.0	$ 13.00	$ 6,318
9080201	Concrete Sidewalk (4")	S.F.	214.0	$ 4.00	$ 856
9080203	Concrete Sidewalk (6")	S.F.	361.0	$ 6.00	$ 2,166
9080288	Curb Access Ramp	EACH	6.0	$ 1,250.00	$ 7,500
9080402	Concrete Header	L.F.	23.0	$ 10.00	$ 230
9090002	Survey Monument	EACH	1.0	$ -	$ -
9140100	Masonry Retaining Wall (ADOT B-18.50)	S.F.	154.0	$ 60.00	$ 9,240
9250001	Construction Survey and Layout	L.S.	1.0	$ -	$ -
9300001	Incidental Items	F.A.	3,000.0	$ 1.00	$ 3,000
9330001	Barricade Railing (PC/COT Std. Dtl. 105)	L.F.	43.0	$ 50.00	$ 2,150
			ESTIMATE CONSTRUCTION TOTAL		$ 259,275

ESTIMATE Design	$	60,000.00
ESTIMATE PROJECT COST	$	319,275.40
ACTUAL PROGRAM DESIGN COST	$	59,553.00
ACTUAL PROGRAM CONSTRUCTION COST	$	372,760.00
ACTUAL PROGRAM COST SIGNAL	$	432,293.00

Roundabout Camino del Sol and Continental

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1070001	AZPDES (ORIGINAL)	L.SUM	1	$10,000.00	$10,000.00
1070011	AZPDES (MODIFICATIONS)	F.A.	5,000	$1.00	$5,000.00
2010001	CLEARING AND GRUBBING	L.SUM	1	$10,000.00	$10,000.00
2020020	REMOVAL OF CURB	L.FT.	550	$2.00	$1,100.00
2020029	REMOVAL OF BITUMINOUS PAVEMENT	SQ.YD.	8,543	$3.00	$25,629.00
2020201	SAWCUTTING	L.FT.	4,242	$2.00	$8,484.00
2050001	GRADING ROADWAY FOR PAVEMENT	SQ.YD.	16,340	$2.00	$32,680.00
3030003	AGGREGATE BASE	CU.YD.	1,893	$30.00	$56,790.00
4010001	PORTLAND CEMENT CONCRETE PAVEMENT	SQ.YD.	252	$40.00	$10,080.00
4040111	TACK COAT	TON	3	$600.00	$1,800.00
4060001	ASPHALTIC CONCRETE (NO. 1)	TON	1,299	$45.00	$58,455.00
4060002	ASPHALTIC CONCRETE (NO. 2)	TON	1,482	$45.00	$66,690.00
5011032	PIPE, REINFORCED CONCRETE, CLASS II, 30"	L.FT.	259	$140.00	$36,260.00
5030030	CATCH BASIN, PC/COT STD. DTL. 308 (TYPE 4, SINGLE)	EACH	1	$10,000.00	$10,000.00
6010002	STRUCTURAL CONCRETE (CLASS S) (FC = 3,000)	CU.YD.	4	$400.00	$1,400.00
6050001	REINFORCING STEEL	LB.	125	$0.90	$112.50
6070010	SIGN POST (PERFORATED) (SINGLE)	L.F.	350	$9.00	$3,150.00
6070110	FOUNDATION FOR SIGN POST (PERFORATED)	EACH	35	$180.00	$6,300.00
6080015	SIGN PANEL (TRAFFIC CONTROL) (PERMANENT) (TYPE III)	SQ.FT.	267	$20.00	$5,340.00
7010001	MAINTENANCE AND PROTECTION OF TRAFFIC	L.SUM	1	$30,000.00	$30,000.00
7040010	PAVEMENT MARKING (WHITE HOT-SPRAYED THERMOPLASTIC) (0.060")	L.FT.	21,698	$0.30	$6,509.40
7040020	PAVEMENT MARKING (YELLOW HOT-SPRAYED THERMOPLASTIC) (0.060")	L.FT.	8,737	$0.30	$2,621.10
7040050	PAVEMENT MARKING(WHITE HOT-SPRAYED THERMOPLASTIC)MERGE ARROW(0.090")	EACH	3	$200.00	$600.00
7040080	PAVEMENT MARKING (HOT-SPRAYED THERMOPLASTIC) (SYMBOL) (0.090")	EACH	20	$200.00	$4,000.00
7040110	PAVEMENT MARKING (WHITE HOT-SPRAYED THERMOPLASTIC)(TRANSVERSE) (0.090")	L.FT.	2,214	$0.50	$1,107.00
7040120	PAVEMENT MARKING(YELLOW HOT-SPRAYED THERMOPLASTIC)(TRANSVERSE)(0.090")	L.FT.	603	$0.50	$301.50
7050090	PAVEMENT MARKING PREFORMED, SYMBOL (SHARKSTOOTH)	EACH	18	$100.00	$1,800.00
7060020	PAVEMENT MARKER, REFLECTIVE, (TYPE C, CLEAR, RED)	EACH	17	$5.50	$93.50
7060025	PAVEMENT MARKER, REFLECTIVE, (TYPE D, YELLOW, TWO-WAY)	EACH	190	$5.50	$1,045.00
7060030	PAVEMENT MARKER, REFLECTIVE, (TYPE G, CLEAR, ONE-WAY)	EACH	26	$5.50	$143.00
7080001	PAVEMENT MARKING PAINTED	L FT.	65,382	$0.10	$6,538.20
8060040	TRANSPLANT TREES	EACH	30	$500.00	$15,000.00
8060046	TRANSPLANT CACTUS	EACH	30	$500.00	$15,000.00
8061005	TREE (15 GALLON)	EACH	30	$100.00	$3,000.00

9010001	MOBILIZATION	L.SUM	1	$55,000.00	$55,000.00
9050001	GUARD RAIL, W-BEAM, SINGLE FACE	L.FT.	175	$25.00	$4,375.00
9050036	GUARD RAIL, ANCHOR ASSEMBLY	EACH	2	$750.00	$1,500.00
9080001	CONCRETE CURB (PC/COT STD. DTL. 209) (TYPE 1)	L.FT.	1,748	$15.00	$26,220.00
9080006	CONCRETE CURB WEDGE (PC/COT STD. DTL. 209)	L.FT.	271	$25.00	$6,775.00
9080090	CONCRETE CURB TERMINAL SECTION (PC/COT STD. DTL. 212)	EACH	8	$150.00	$1,200.00
9080150	CONCRETE MEDIAN PAVEMENT	SQ.FT.	1,036	$3.00	$3,108.00
9080201	CONCRETE SIDEWALK	SQ.FT.	4,625	$6.00	$27,750.00
9080282	CONCRETE SIDEWALK RAMP (TYPE III)	EACH	4	$1,250.00	$5,000.00
9080288	CURB ACCESS RAMP	EACH	11	$1,250.00	$13,750.00
9130001	RIP RAP (DUMPED)	CU.YD.	14	$125.00	$1,750.00
9250101	THREE-PERSON SURVEY PARTY	L.SUM	1	$25,000.00	$25,000.00
9300101	INCIDENTAL ITEMS (FORCE ACCOUNT)	F.A.	50,000	$1.00	$50,000.00

$658,457.20

Contingency 65845.72

Program Estimate Total	**$724,302.92**

ACTUAL PROGRAM DESIGN COST	**$**	**106,584.00**
ACTUAL PROGRAM CONSTRUCTION COST	**$**	**780,366.00**
ACTUAL PROGRAM COST ART	**$**	**447.00**
ACTUAL PROGRAM COST ROUNDABOUT TOTAL	**$**	**887,397.00**

Roundabout and Los Reales and Swan

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1070001	AZPDES (ORIGINAL)	L.SUM	1	$10,000.00	$10,000.00
1070011	AZPDES (MODIFICATIONS)	F.A.	5,000	$1.00	$5,000.00
2010001	CLEARING AND GRUBBING	L.SUM	1	$10,000.00	$10,000.00
2020029	REMOVAL OF BITUMINOUS PAVEMENT	SQ.YD.	8,543	$3.00	$25,629.00
2020201	SAWCUTTING	L.FT.	4,242	$2.00	$8,484.00
2050001	GRADING ROADWAY FOR PAVEMENT	SQ.YD.	16,340	$2.00	$32,680.00
3030003	AGGREGATE BASE	CU.YD.	1,893	$30.00	$56,790.00
4010001	PORTLAND CEMENT CONCRETE PAVEMENT	SQ.YD.	252	$40.00	$10,080.00
4040111	TACK COAT	TON	3	$600.00	$1,800.00
4060001	ASPHALTIC CONCRETE (NO. 1)	TON	619	$45.00	$27,855.00
4060002	ASPHALTIC CONCRETE (NO. 2)	TON	413	$45.00	$18,585.00
6010002	STRUCTURAL CONCRETE (CLASS S) (FC = 3,000)	CU.YD.	4	$400.00	$1,400.00
6050001	REINFORCING STEEL	LB.	125	$0.90	$112.50
6070010	SIGN POST (PERFORATED) (SINGLE)	L.F.	350	$9.00	$3,150.00
6070110	FOUNDATION FOR SIGN POST (PERFORATED)	EACH	35	$180.00	$6,300.00
6080015	SIGN PANEL (TRAFFIC CONTROL) (PERMANENT) (TYPE III)	SQ.FT.	267	$20.00	$5,340.00
7010001	MAINTENANCE AND PROTECTION OF TRAFFIC	L.SUM	1	$30,000.00	$30,000.00
7040010	PAVEMENT MARKING (WHITE HOT-SPRAYED THERMOPLASTIC) (0.060")	L.FT.	21,698	$0.30	$6,509.40
7040020	PAVEMENT MARKING (YELLOW HOT-SPRAYED THERMOPLASTIC) (0.060")	L.FT.	8,737	$0.30	$2,621.10
7040050	PAVEMENT MARKING(WHITE HOT-SPRAYED THERMOPLASTIC)MERGE ARROW(0.090")	EACH	3	$200.00	$600.00
7040080	PAVEMENT MARKING (HOT-SPRAYED THERMOPLASTIC) (SYMBOL) (0.090")	EACH	20	$200.00	$4,000.00
7040110	PAVEMENT MARKING (WHITE HOT-SPRAYED THERMOPLASTIC)(TRANSVERSE) (0.090")	L.FT.	2,214	$0.50	$1,107.00
7040120	PAVEMENT MARKING(YELLOW HOT-SPRAYED THERMOPLASTIC)(TRANSVERSE)(0.090")	L.FT.	603	$0.50	$301.50
7050090	PAVEMENT MARKING PREFORMED, SYMBOL (SHARKSTOOTH)	EACH	18	$100.00	$1,800.00
7060020	PAVEMENT MARKER, REFLECTIVE, (TYPE C, CLEAR, RED)	EACH	17	$5.50	$93.50
7060025	PAVEMENT MARKER, REFLECTIVE, (TYPE D, YELLOW, TWO-WAY)	EACH	190	$5.50	$1,045.00
7060030	PAVEMENT MARKER, REFLECTIVE, (TYPE G, CLEAR, ONE-WAY)	EACH	26	$5.50	$143.00
7080001	PAVEMENT MARKING PAINTED	L.FT.	65,382	$0.10	$6,538.20
9060001	CONCRETE CURB (PC/COT STD. DTL. 209) (TYPE 1)	L.FT.	1,748	$15.00	$26,220.00
9060005	CONCRETE CURB WEDGE (PC/COT STD. DTL. 209)	L.FT.	271	$25.00	$6,775.00
9060090	CONCRETE CURB TERMINAL SECTION (PC/COT STD. DTL. 212)	EACH	8	$150.00	$1,200.00
9060150	CONCRETE MEDIAN PAVEMENT	SQ.FT.	1,036	$3.00	$3,108.00
9060201	CONCRETE SIDEWALK	SQ.FT.	4,625	$6.00	$27,750.00
9060282	CONCRETE SIDEWALK RAMP (TYPE III)	EACH	4	$1,250.00	$5,000.00
9060288	CURB ACCESS RAMP	EACH	11	$1,250.00	$13,750.00
9130001	RIP RAP (DUMPED)	CU.YD.	14	$125.00	$1,750.00
9250101	THREE-PERSON SURVEY PARTY	L.SUM	1	$25,000.00	$25,000.00

Construction Est	$388,517.20
Contingency 10%	38851.72
	$427,368.92
Design & Admin	$ 150,000.00
Total Project Estimate	**$577,368.92**

Cost Estimate: Shannon/Overton SIGNAL Maintenance & Operation

Item	Unit Cost	Unit	Quantity	Interval (Yrs)	Use B,D,E Yearly Cost	Expense Category
PTZ Camera Maintenance	$220.00	year	1	1	**$220.00**	Contract Service
Wireless Com Maintenance	$360.00	year	1	1	**$360.00**	Contract Service
Electrical Service Cost*	$859.40	year	1	1	**$859.40**	Electricity
Trouble/Demand/TAR call out	$20.08	hr	3	1	**$60.24**	Man Hour
Observation Man Hours	$32.00	hr	2	0.5	**$128.00**	Man Hour
PM Visits	$17.93	hr	3	0.5	**$107.58**	Man Hour
Q pole***	$3,774.00	ea.	4	30	**$503.20**	Supplies
Ped Push Button Post	$209.27	ea.	8	10	**$167.42**	Supplies
20' Luminaire Mast Arm***	$725.00	ea.	4	30	**$96.67**	Supplies
35' Signal Mast Arm***	$1,900.00	ea.	4	30	**$253.33**	Supplies
Pull box lid #7	$137.28	ea.	4	6	**$91.52**	Supplies
Pull box lid #3.5	$20.35	ea.	4	3	**$27.13**	Supplies
Intersection Wiring***	$11,500.00	ea.	1	30	**$383.33**	Supplies
Meter Pedestal	$900.00	ea.	1	25	**$36.00**	Supplies
Battery Backup System	$3,301.00	ea.	1	25	**$132.04**	Supplies
Batteries for BBS	$280.00	ea.	4	3	**$373.33**	Supplies
F head Signal Housing	$103.70	ea.	12	20	**$62.22**	Supplies
Green Arrow	$38.88	ea.	0	6	**$0.00**	Supplies
Green Ball	$37.50	ea.	12	3	**$150.00**	Supplies
Yellow Arrow	$38.88	ea.	0	6	**$0.00**	Supplies
Yellow Ball	$37.50	ea.	12	6	**$75.00**	Supplies
Red Ball	$37.50	ea.	12	3	**$150.00**	Supplies
Pedestrian Signal Housing	$163.93	ea.	12	20	**$98.36**	Supplies
Pedestrian Countdown Module	$190.00	ea.	8	6	**$253.33**	Supplies
Traffic Signal Mounting Pelco	$205.00	ea.	12	30	**$82.00**	Supplies
Traffic Signal Mounting Type XI	$50.43	ea.	8	30	**$13.45**	Supplies
EVP Strobes	$186.76	ea.	4	6	**$124.51**	Supplies
Opticom detector (711)	$421.85	ea.	4	6	**$281.23**	Supplies
Traffic Signal Cabinet	$16,977.00	ea.	1	15	**$1,131.80**	Supplies
New MMU	$873.00	ea.	1	6	**$145.50**	Supplies
New Controller	$2,016.54	ea.	1	6	**$336.09**	Supplies
New Bus Interface Unit	$150.00	ea.	3	3	**$150.00**	Supplies
BBS filter changed at PM	$4.32	ea.	1	0.5	**$8.64**	Supplies
Control cabinet filter changed at PM	$4.32	ea.	1	0.5	**$8.64**	Supplies
EVP phase selector	$2,338.35	ea.	1	6	**$389.73**	Supplies
Encore camera for vehicle detection	$3,990.00	ea.	4	6	**$2,660.00**	Supplies
Terra Interface Panel (TIP)	$812.00	ea.	1	6	**$135.33**	Supplies
Terra Access Panel (TAP)	$2,815.00	ea.	1	6	**$469.17**	Supplies
Detector Amplifier	$308.09	ea.	2	6	**$102.70**	Supplies
Loop Detector (6' x 6')***	$435.00	ea.	4	10	**$174.00**	Supplies
Pedestrian Push Button	$150.00	ea.	8	6	**$200.00**	Supplies
Luminaire Housing	$330.00	ea.	8	30	**$88.00**	Supplies
400 watt lamp	$10.65	ea.	4	3	**$14.20**	Supplies
Ballast	$98.00	ea.	4	9	**$43.56**	Supplies
Photo Cell	$26.65	ea.	1	6	**$4.44**	Supplies
PTZ and Wireless equipment	$12,000.00	ea.	1	10	**$1,200.00**	Supplies
Call out/Trouble Shooting (miles)	$1.00	miles	150	1	**$150.00**	Vehicle
Milage for Scheuled PM	$1.00	mile	40	0.5	**$80.00**	Vehicle
PM Bucket Truck Use	$1.14	mile	40	3	**$15.20**	Vehicle
Observation Milage	$1.00	mile	40	0.5	**$80.00**	Vehicle
			Yearly Total Cost		**$12,676.28**	

*Electrical Service Cost from Dec 2013-2014 at Shannon & Overton

** Estimate is a lifecycle cost analysis. It does not include foundation replacement, conduit replacement, or pull box replacement (only lids)

*** Contractor installed cost

Cost Estimate: Roundabout Maintenance & Operation

Item	Unit Cost	Unit	Quantity	Interval (Yrs)	Use B,D,E Yearly Cost	Expense Category
Electrical Service Cost*	$1,000.00	year	1	1	$1,000.00	Electricity
Maintenance	$20.08	hr	5	3	$33.47	Man Hour
Trouble/Demand/TAR call out	$20.08	hr	2	1	$40.16	Man Hour
G pole***	$1,625.00	ea.	8	30	$433.33	Supplies
20' Luminaire Mast Arm***	$725.00	ea.	4	30	$96.67	Supplies
Pull box lid #7	$137.28	ea.	1	6	$22.88	Supplies
Pull box lid #3.5	$20.35	ea.	8	3	$54.27	Supplies
Electrical Wiring	$710.00	ea.	1	30	$23.67	Supplies
Meter Pedestal	$900.00	ea.	1	25	$36.00	Supplies
Luminaire Housing	$330.00	ea.	8	30	$88.00	Supplies
150 watt lamp	$10.65	ea.	8	3	$28.40	Supplies
Ballast	$98.00	ea.	8	9	$87.11	Supplies
Photo Cell	$26.65	ea.	1	6	$4.44	Supplies
Call out/Trouble Shooting (miles)	$150.00	year	1	1	$150.00	Vehicle
Milage for Scheuled Maintenance	$1.14	milage	40	3	$15.20	Vehicle
PM Truck Use	$1.14	mile	40	1	$45.60	Vehicle
			Yearly Total Cost		$2,159.19	

*Electrical Service Cost from Jan 2014 to Jan 2015 at Continental/Camino Del Sol Intersection (Adjusted for a 4 leg intersection)

** Estimate is a lifecycle cost analysis. It does not include foundation replacement, conduit replacement, or pull box replacement (only lids)

*** Contractor installed cost

Camino Del Sol and Continental Road Survey Responses

1. **What was your previous experience and feelings toward roundabouts prior to the Camino Del Sol Roundabout project?**
   1.1. *Only driving roundabouts in New England and Britian. I didn't think they would be any problem in GV.*
   1.2. *I don't think I was on the committee when this first came up. I was skeptical when it was first announced. However, since it has been installed, I have had no significant issues with it. There are still drivers that totally stop before entering the roundabout. I go through this introspection* [intersection] *multiple times a day. I am familiar with them from time in Europe and in Maine.*
   1.3. *Growing up in NJ, I experienced roundabouts daily, mostly on major highways. While they tested some drivers abilities, I believe they relieved a lot of congestion on these roads, US Rt1, US Rt9, for example. There were not many circles on local roads. However, in traveling and driving all over western Europe, roundabouts where the norm. They were encountered almost everywhere except, perhaps in some city centers. But they did exist in some major cities, like Paris and London, without major issues experienced by me.*

   My feelings are that they kept the traffic moving and potentially saved on traffic issues relating to stop signs and traffic lights. While this a trade off with the potential of accidents in a roundabout, I believe the roundabouts to be a better solution.

   1.4. *I don't fit your requirements as I was never opposed to the roundabout. I was always in favor of it and am very pleased how well it is working.*
   1.5. *Limited to vacations overseas.*
   1.6. *My previous experience with roundabouts was in Washington DC where traffic is very heavy. I thought they were frightening. I was hesitant about them for Green Valley because of the age of the population. I have seen little problem since they were installed. They make for a much smoother movement of traffic.*
   1.7. *I've seen a few roundabouts previously (Colorado) and had a pretty positive feeling that they work. The only reservations might have been that some drivers might not have been familiar with the concept and drivers in Green Valley in particular might be confused.*
2. **What helped convince you that a roundabout might actually work or changed your feelings to give them a chance? (cost?, capacity?, delay?, provisions for pedestrians or cyclists?)**
   2.1. *I thought this was a perfect solution to fix this intersection.*
   2.2. [blank]
   2.3. *I didn't need to be convinced. The particular problems inherent on Continental and Camino del Sol were such that the roundabout made the most sense. I'm not privy to any cost differences, but the resulting movement of traffic, minimizing delays, along with the difficulty in maneuvering the turns, was enough to convince me of having one at this location was justified.*
   2.4. [blank]
   2.5. *Capacity, delay, and smoother transition for cyclists.*
   2.6. [blank]
   2.7. *I was convinced that a roundabout would work much, much better than the existing intersection design where backups frequently occurred. What gave me great confidence that Matt Zoll, PCDOT, and Jim Jordan were much involved in the design and review process.*

3. **What would you say to someone that says they don't want roundabouts installed because they don't like them?**
   3.1. *I would point out the advantages of them. PCDOT could also show an antmated* [animated] *video of traffic thru the roundabout. The only problem I've experienced is a roundabout in Tucson that had so much continuous thru traffic that the side traffic didn't have any openings to enter.*
   3.2. [blank]
   3.3. *It's hard to understand a reason for not liking them. Maybe specific reasons would help me answer this. Yielding to traffic/merging, is a normal occurrence, ie, entering a highway from an off ramp. There is more gas used in stopping and starting at a stop sign or traffic light. Wear on the brakes is also more prevalent in stopping completely as opposed to slowing down.*
   3.4. [blank]
   3.5. *Give the roundabout a chance and you will grow to love it. If you are inexperienced find a roundabout and practice several trips through it. Then try it again during a busy time and see how well the traffic flows.*
   3.6. [blank]
   3.7. *That they are living in the past where roundabouts – perhaps they were called rotaries – were poorly designed free-for-alls. Modern roundabouts such as the subject one are pretty much no brainers – you yield to traffic when entering. Also, these intersections are safer that* [than] *standard cross roads. Collisions, if they occur, are not 90 degree encounters but at lesser angles which, with the slower speeds required at a roundabout, are not as likely to result in serious injury.*
4. **What do you say to people that complain about the roundabout at this particular location?**
   4.1. *I haven't heard any complaints. I have driven and biked thru it from all directions with no problems.*
   4.2. [blank]
   4.3. *It's hard to imagine anyone not being pleased with the outcome. If they had previously tried to turn left onto Continental from Camino del Sol, they were met with challenges of traffic turning onto Camino del Sol from Continental going west. What's to complain about? I'd need to know the reason for the complaint.*
   4.4. [blank]
   4.5. *The traffic flow is so much smoother than before, no more bottle neck with cars waiting to turn left off of Continental onto Del Sol.*
   4.6. [blank]
   4.7. *I would guess they were not familiar with what it replaced. Traffic backed up, sometimes as the result of someone being extra polite and waving people on, even though they had the right of way. Courtesy is great but it can result in confusion and poor decision making. If cyclist have complained they have to understand the choices they have – either get out in vehicle traffic lane a la golf cart, stick to the bike lane which works quite well in most circumstances, or act like a pedestrian and use the appropriate pathways.*

   Hope this helps. The only problem my wife and I have had in this intersection has been from cyclist riding the wrong way! Not a good thing, especially in a corner.

FHWA-SA-08-006

"Personally, I love them, and I'll tell you why. You only have to stop one lane of traffic, then go to the middle and wait. The cars can't go much faster than 20 mph through the roundabout so the crossing aspect is great."

Denise Haltom
School Crossing Guard, Suamico, Wisconsin
Green Bay Press-Gazette
February 6, 2001

"We have had a lot of people not very happy about the idea of roundabouts, but after they are constructed, those fears mostly go away."

Brian Walsh
Washington State Department of Transportation
Seattle Times
June 5, 2002

"We all know people speed up to get through a yellow light. But at the roundabout, all the vehicles have to slow down ... we have almost 50 roundabouts now, we have a lot [fewer] personal injuries. We have fewer fatalities."

James Brainard
Mayor, City of Carmel, Indiana
www.nbc17.com
November 8, 2007

Safe Roads for a Safer Future
Investment in roadway safety saves lives

Education is key.

Education is vital to the acceptance and success of a roundabout. Navigating a roundabout is easy. But because people can be apprehensive about new things, it's important to educate the public about roundabout use.

There are just a few simple guidelines to remember when driving through a roundabout:

1. Slow down.
2. If there's more than one lane, use the left lane to turn left, the right lane to turn right, and all lanes to go through, unless directed otherwise by signs and pavement markings.
3. Yield to pedestrians and bicyclists.
4. Yield at the entry to circulating traffic.
5. Stay in your lane within the roundabout and use your right-turn signal to indicate your intention to exit.
6. Always assume trucks need all available space — don't pass them!
7. Clear the roundabout to allow emergency vehicles to pass.

Visit safety.fhwa.dot.gov to learn more about roundabouts

U.S. Department of Transportation
Federal Highway Administration

Design standards for roundabouts continue to evolve, and not all features of existing roundabouts meet current recommended practice. Please refer to FHWA's web site for recommendations on current design practice.

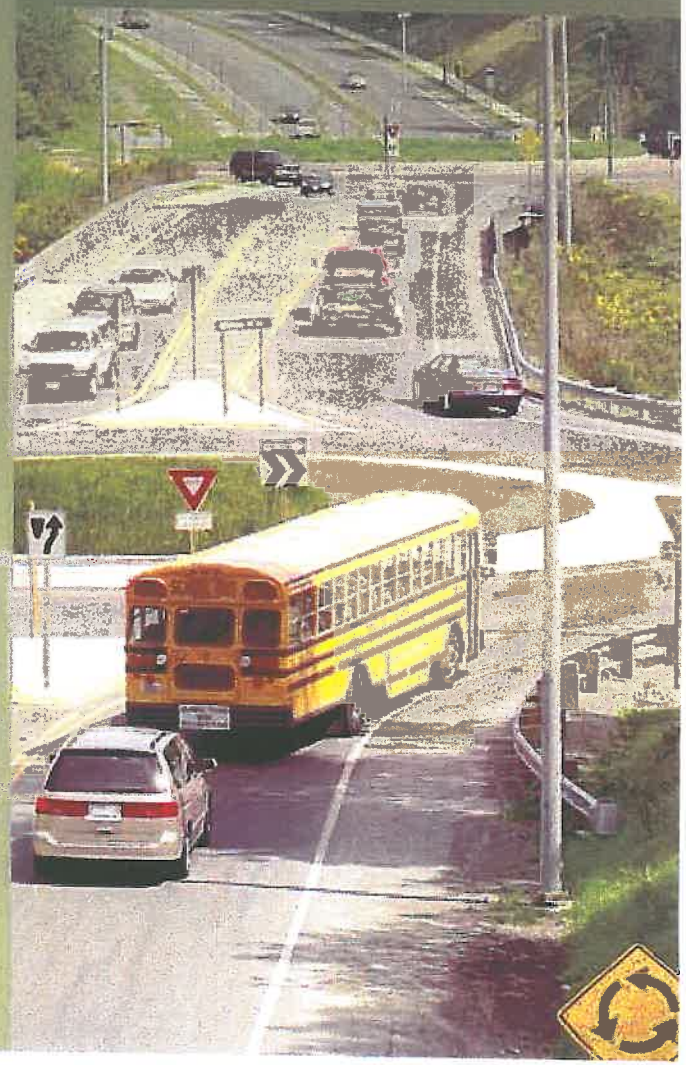
Original source photo by Lee Rodegerdts. Photo has been altered to illustrate roundabout and updated signage.

09-0276

U.S. Department of Transportation
Federal Highway Administration

Roundabouts

A Safer Choice

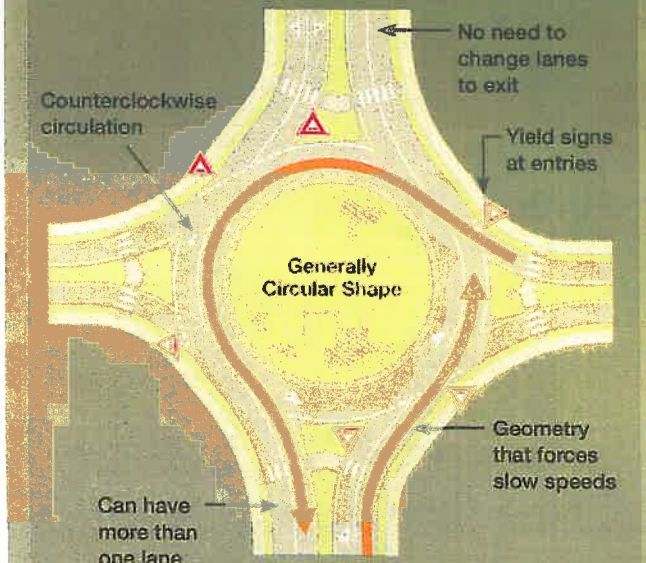


What is a roundabout?

A roundabout is a type of circular intersection with yield control of entering traffic, islands on the approaches, and appropriate roadway curvature to reduce vehicle speeds.

Modern roundabouts are different from rotaries and other traffic circles. For example, roundabouts are typically smaller than the large, high-speed rotaries still in use in some parts of the country. In addition, roundabouts are typically larger than neighborhood traffic circles used to calm traffic.

A roundabout has these characteristics:



Source: *Roundabouts: An Informational Guide*, Federal Highway Administration, Washington, D.C., latest version, except as noted.

Why consider a roundabout?

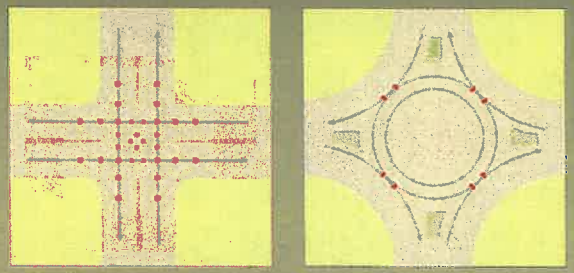
Compared to other types of intersections, roundabouts have demonstrated safety and other benefits.

Roundabouts:

> Improve safety

- More than 90% reduction in fatalities*
- 76% reduction in injuries**
- 35% reduction in all crashes**
- Slower speeds are generally safer for pedestrians

With roundabouts, head-on and high-speed right angle collisions are virtually eliminated.



[Traditional intersection] [Roundabout]

● Potential vehicle conflict point

> Reduce congestion

- Efficient during both peak hours and other times
- Typically less delay

> Reduce pollution and fuel use

- Fewer stops and hard accelerations, less time idling

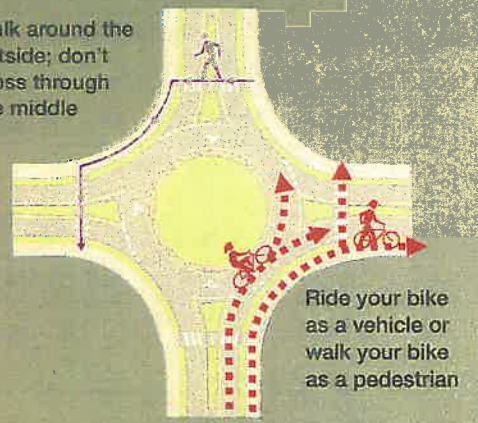
> Save money

- Often no signal equipment to install, power, and maintain
- Smaller roundabouts may require less right-of-way than traditional intersections
- Often less pavement needed

> Complement other common community values

- Quieter operation
- Functional and aesthetically pleasing

Tips for safely walking and biking through a roundabout



Research is ongoing on additional treatments and design considerations to address the needs of visually impaired pedestrians.

* "Safety Effect of Roundabout Conversions in the United States: Empirical Bayes Observational Before-After Study," Transportation Research Record 1751, Transportation Research Board (TRB), National Academy of Sciences (NAS), Washington, D.C., 2001.

** NCHRP Report 572, Roundabouts in the United States, National Cooperative Highway Research Program, TRB, NAS, Washington, D.C., 2007.