50% Report

City of Flagstaff Roundabout Design

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Project:	Roundabout Design at Country Club and Old Walnut Canyon
Date:	Thursday, March 10, 2016
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Acknowledgements

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1. Project Purpose.

The goal of the project is to redesign the intersection of Old Walnut Canyon Road/Oakmont Drive and Country Club Drive. The purpose of redesigning the intersection is to improve the sight distance, and improve the intersection safety. The sight distance at the intersection is poor due to the presence of large grades on the southern leg. The intersection has to be redesigned, in order to make it safer and easier for vehicle drivers to merge smoothly with other traffic.

1.1. Project Background

1.1.1. Current State of the Site

This is a budgeted project by the City of Flagstaff Capital Improvement Program for the fiscal year of 2018-2019. Currently, the intersection of Old walnut Canyon Road/Oakmont Drive and Country Club Drive is a two-way stop controlled intersection in the east and west directions. The safety of the intersection is poor due to the ineffective sight distance due to the presence of large grades on the southern leg.

1.1.2. Location

The intersection of Old Walnut Canyon and Country Club Drive is located in the east side of Flagstaff, as shown in Figure 1.2. The intersection is surrounded by a residential area. The intersection serves homeowners, as well as other businesses such as, Wyndham Flagstaff resort, Flagstaff Athletics Club, and the golf courses in the area. Wyndham Flagstaff Resort and a golf course are located on North Country club Dr. next to the intersection, as shown in Figure 1.1. The intersection also serves vehicle drivers going to Flagstaff Athletics Club, which is located along North Country club drive, at the north side of the intersection.

1.1.3. Stakeholders

The stakeholders in the redevelopment of the intersection of Walnut Canyon Road/Oakmont Drive and Country Club Drive are the people who live in the surrounding neighborhoods and other users of the intersection, such as the people going to use Continental Golf Course. The people that will be most effective by the redesign will be the people who live in the houses surrounding the intersection. These people are stakeholders because they will be the ones that are using the new intersection on a day-to-day base. The local businesses and their customers

Figure 1.1: The intersection of Old Walnut Canyon Rd and Country Club Dr [1].

in the surrounding area, such as the Continental Golf Course, Oakmont Restaurant, the driving range, and the Kation RV and Boat Storage, will need to be managed during design. The City of Flagstaff will also be a stakeholder because they own the intersection and have to keep up with the maintenance.

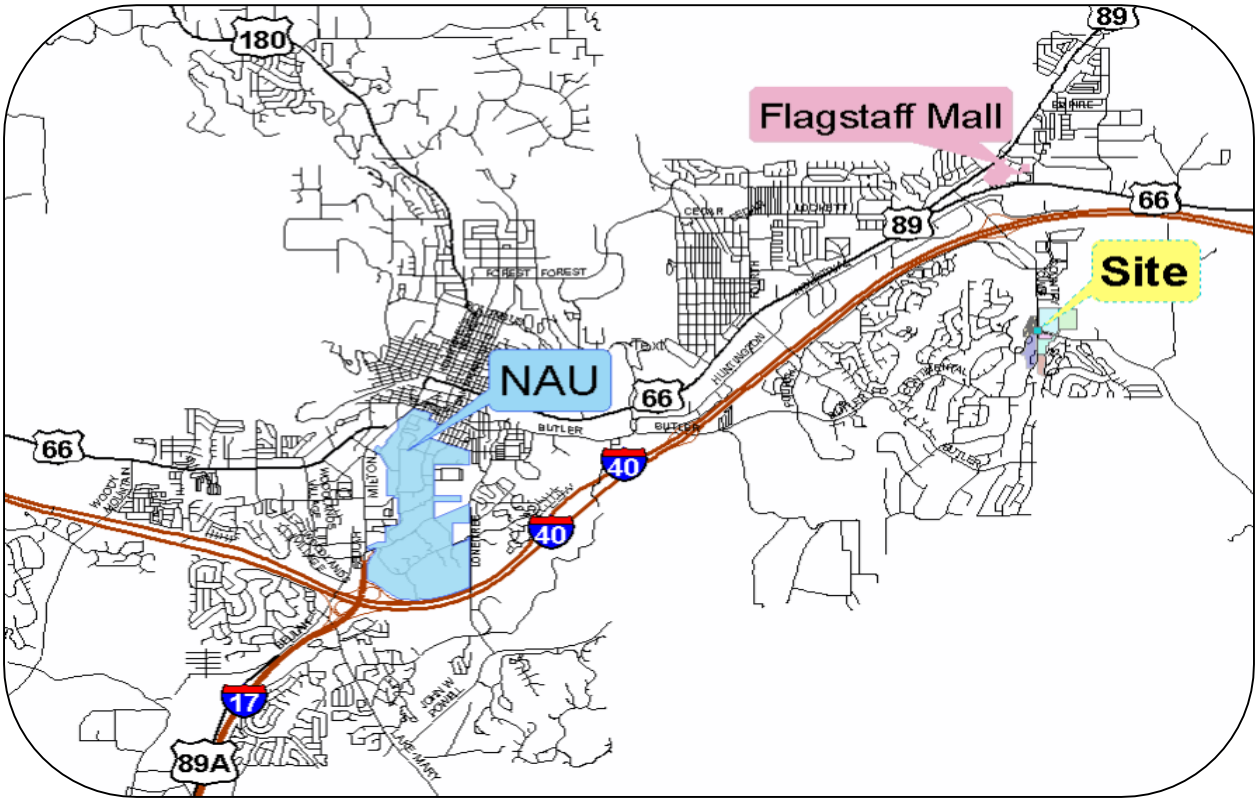


Figure 1.2: City of Flagstaff Overview

2. Analysis

A topographic survey was conducted in house to gather existing features including trees, bushes and utility valve boxes. Lidar data was given to us by the City of Flagstaff, this data consists of contours for the whole city of flagstaff. Together these surveys will be used to build the roundabout in Civil 3D, a computer aided drafting software.

Traffic data collection, including turning movements and vehicle classification count, was conducted by J3Z Engineering. The traffic data is used to find the level of service (LOS) of the intersection; this tells how well the intersection is working, A being the best and F being the worst. At the request of the client all traffic data was projected 20 years with a growth rate of 1.4%. The growth rate of 1.4% was taken from the 2013 edition of the City of Flagstaff Parks and Recreation Organizational Master Plan [1] which estimates an average growth of 1.4% between 2010 and 2030. The growth rate was applied to the turning movements using Equation 1 found in Table 1.

Figure 2.1: East Flagstaff map with the intersection of Old Walnut Canyon Rd and Country Club Dr [1].

For the LOS analysis only the peak hour is used for imputing data. From the peak hour the peak hour factor (PHF) is calculated using Equation 2. The PHF used for the LOS analysis is an average of the PHF each movement, thru, left, right, in each direction. The peak hour was found by summing all movements in an hour period and then comparing it to every other hour period, i.e. 7:15-8:15 compared to 7:30-8:30, etc. The peak hour was found to be 5:00pm to 6:00pm and the peak 15 minute was 5:30pm to 5:45pm. The full list of turning movement counts and PHF's can be found in Appendix A. The vehicle classification count is used to find the percentage of heavy vehicles using the road. For this analysis heavy vehicles are classes 4 and 6-13 as defined by Jamar Technologies as buses and vehicles with three or more axels [2] J3Z Engineering identified class 14 vehicles as mostly golf carts, thus they were not included in the heavy vehicle percentage. The full list of vehicle classifications can be found in Appendix A.

Table 2.1. : Equations

Equation: 1	$Future = Existing * (1 + i)^n$	Where i – Annual Growth Rate n – Design Life
Equation: 2	$PHF = \frac{V}{4 * V_{15}}$	Where V – Peak Hour Volume V_{15} – Peak 15 Minute Volume

The LOS for the existing two way stop sign controlled (TWSC) intersection was conducted using Highway Capacity Software (HCS) [3]. This software allows users to find the LOS of the approaches leading to the intersection. The user inputs the hourly volumes, the PHF and intersection geometry, and the software outputs the delay in seconds per vehicle and the LOS. Using HCS, the LOS was found for the existing TWSC with no growth rate and then it was analyzed again with the growth rate. These values are summarized in Table 2 below. The table shows that the eastbound, northbound, and southbound directions all have a LOS A currently and in the future. While the westbound direction has a LOS C, currently, and a LOS D for the future. This shows that the intersection currently sees a large amount of delay in the westbound direction and that the delay will only worsen over time. Analyzing the HCS reports illustrates that most of the delay comes from the left and thru lanes with 29.3 seconds per vehicle (s/veh) while the right turn lane has a delay of 9.3 s/veh.

Table 2.2. : Delay and LOS for Existing TWSC using HCS

Year		Eastbound	Westbound	Northbound	Southbound
2015	**Approach Delay (s/veh)**	8.9	17.1	1.8	1.3
	Approach LOS	A	C	A	A
2035	**Approach Delay (s/veh)**	9.3	29.3	1.9	1.3
	Approach LOS	A	D	A	A

The LOS for the proposed roundabout design will be conducted using roundabout specific software called Rodel Interactive [4]. This software requires more input values specific to the roundabout; so it cannot be completed until the roundabout vertical alignment is completed.

3. Design Alternatives

3.1. Landscaping Design Alternatives

Landscaping can be done on the central islands, splitter islands, and along the approaches. Landscaping has many benefits, which include public safety and enhancing the community. In order to determine the type and quantity of the landscaping to be done at a roundabout, three aspects need to be considered; maintenance, sight distance at the intersection, and available planting zones.

3.1.1. Design Alternative 1: Not having Landscaping:

One of the design alternatives is no landscaping. There are some advantages and disadvantages associated with that design option. The advantages of not having an intersection with landscape is that there will be no need for maintenance, and a reduction in the construction cost. The disadvantages of not designing a landscaped intersection is that there will be less visibility for drivers approaching the intersection compared to a landscaped intersection. There will also be a need to design for either rumble strips or dynamic warnings, to enhance the visibility of the drivers.

3.1.2. Design Alternative 2: Having Landscaped Intersection:

The second design alternative is to have a landscaped intersection. This design option has multiple advantages and disadvantages. The advantages of having a landscaped intersection is that

it enhances the safety of the intersection, by improving the visibility for drivers approaching the intersection, and it encourages the pedestrians to use the intersection properly by discouraging them to cross through the central island. Another advantage of having a landscaped intersection is that it would be aesthetically pleasing. The disadvantage of having a landscaped intersection is that it will increase the cost of construction, and will require maintenance.

3.1.3. Central Island Landscaping

The landscaping of the central island could be made of low-level shrubs, grass, or groundcover. According to the National Cooperation Highway Research Program for Roundabouts (NCHRP), it is preferred to use low level plants than using fixed objects, such as trees, or walls [5]. Due to the negative effect fixed objects could have on the sight distance at the intersection. The manual also suggests not to use plants which require water, because that can lead to a wet and slippery pavement.

Another design alternative at the central island is to place statues, such as public art, or a fountain in the inner central island. Placing a large item in the inner central island will indicate to the drivers that they cannot pass straight through the intersection, and will improve the visibility at night. Designing a landscaped central island will require, a realistic maintenance program to be considered. According to the NCHRP, it is unrealistic that a typical highway agency would maintain a complex planting plan. As a result, agreements need to be made with local civic groups, and garden clubs to maintain the planting area of the roundabout.

3.1.4. Splitter Island Landscaping

Landscaping can be installed at the splitter islands. The landscaping at the splitter islands would encourage the pedestrians to cross the intersection properly using the crosswalks. The landscaping at the splitter island could be made of low shrubs, low gross plants, or grass. Large plants should not be used at the splitter island, because it will affect the visibility of the drivers.

3.2. Drainage

There are two design options for placing drainage at the roundabout. Drainage can be placed either on the outer curb line of the roundabout or along the central island for a roundabout.

According to the NCHRP, drainage inlets are usually placed on the outer curb line of the roundabout [6]. However, if the grade through the intersection is constant, the drainage inlets may be placed in the central island. Inlets also cannot be placed along the crosswalks.

4. Final Design

4.1. Geometric Design

The principle design objectives when designing a roundabout must follow and guide NCHRP. The overall design goal for our roundabout has taken in several design principles that accompanied by NCHRP [6] are

Figure 4.2:Old Walnut Canyon right-turn bypass lane highlighted in blue.

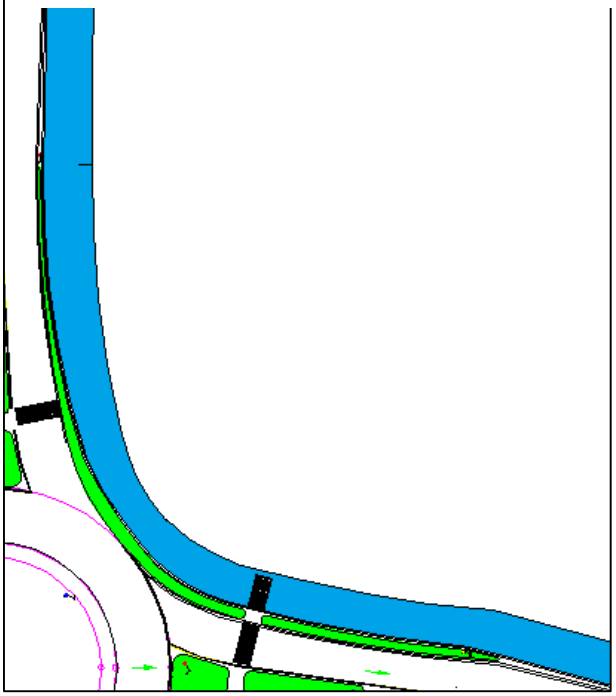
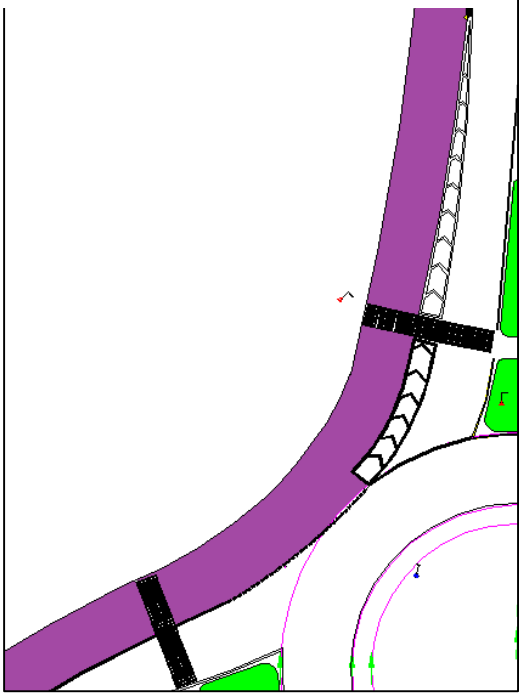


Figure 4.1: Country Club Drive right-turn only lane highlighted in purple.



- Speed Management: Provide slow entry speeds and consistent speeds through the roundabout using deflection.
- Lane arrangements: Provide the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume balance, and lane continuity.
- Path Alignment: Provide smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes.

- Design Vehicle: Provide adequate accommodation for the largest vehicle that will use the roundabout.
- Non-Motorized Design Users: Design to meet the needs of pedestrians and cyclists.
- Sight Distances and Visibility: Provide appropriate sight distance and visibility for driver recognition of the intersection and conflicting users.

Each of the above principles will directly affect the safety and efficiency of a roundabout.

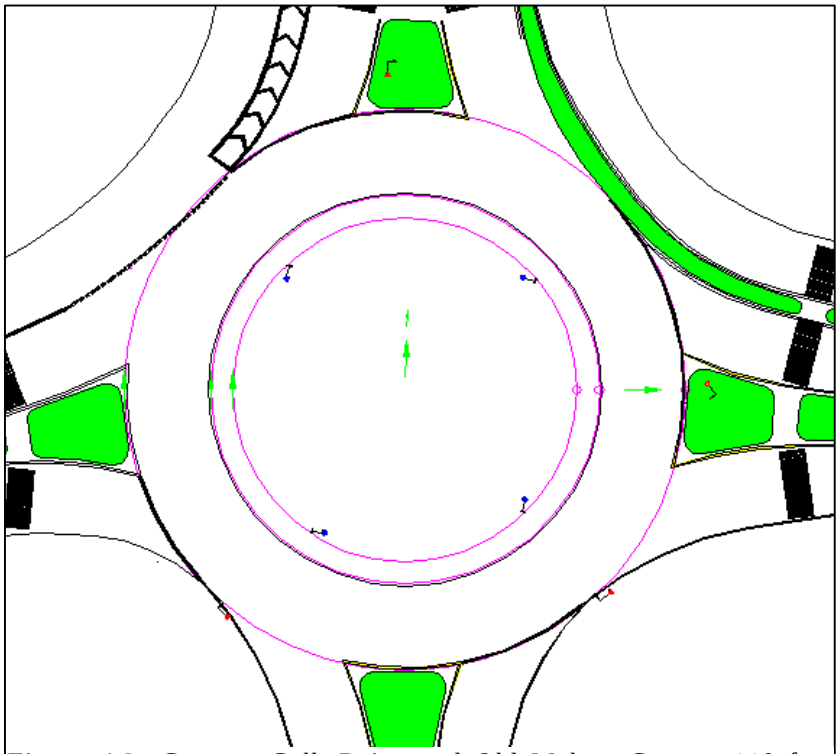


Figure 4.3: Country Culb Drive and Old Walnut Canyon 110 foot diameter roundabout.

Final design of a single-lane roundabout with two modifications has been decided for Country Club Drive and OWC. First, with a large amount of vehicle traffic in certain times of the day and season traveling west and taking a right hand turn north onto Country Club Drive. In Figure 4.2 the development of a right-turn bypass lane, highlighted in blue, for those vehicles which are separated by an island in green. These vehicles will no longer need to enter the roundabout and will have a safe and direct personal turn lane onto northbound Country Club Drive. Second, with two lanes approaching from the south on Country Club Drive our roundabout design will provide a right hand turn only lane, indicated by the purple highlight in Figure 4.1. The

intersection already provides a right turn lane in this direction and the amount of lanes is reduced to one on the south side of the intersection. Therefore, we decided that the right hand turn lane will provide the same type of movement currently and with little confusion or safety hazards.

In Figure 4.3, the roundabout design will use a 110- ft inscribed circle diameter. This will provide enough space for the roundabout design vehicle, large semi-trailer (WB-50), at the same time using the least amount of land to be purchased for any right-a-way easement. Also, designing a roundabout with a 110-ft diameter will allow vehicles to travel at 20-mph through the roundabout path. This path will provide safety to pedestrians and bicycles that use it. In addition to speed limit

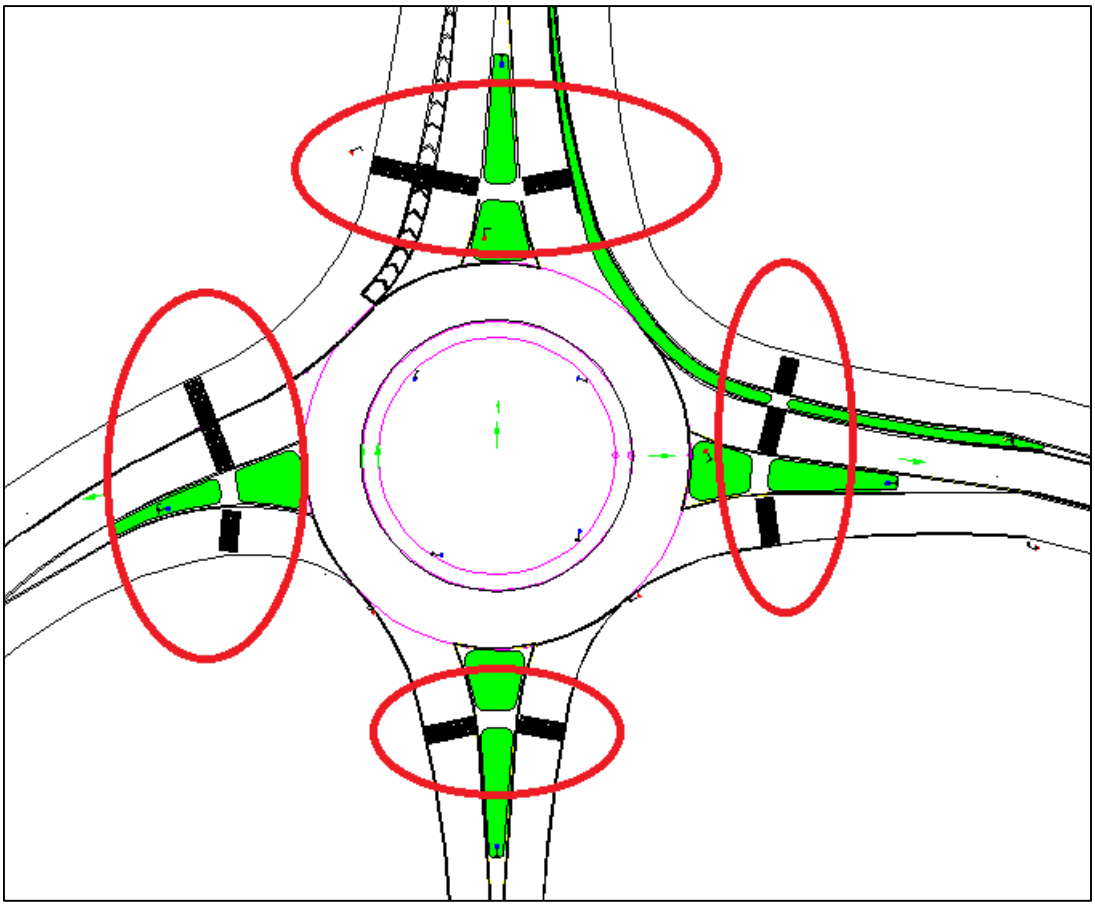


Figure 4.4: Pedestrian cross walk circled in red.

safety in Figure 4.4 the design of accessible pedestrian crossings, circled in red, has been provided in the splitter islands for all directions.

4.2. Drainage

The design for drainage is not finished, it will be completed after the vertical alignment design for the roundabout is determined, and the grading is completed.

4.3. Grading

As for now the grading is not finished. More AutoCAD work will need to be done to finalize the cut and fill to determine the grading at the site.

4.4. Signage and Striping

The signage and striping for this roundabout will apply with the guidelines found in the NCHRP and MUTCD Manual. The roundabout that has been chosen seen in Figure 4.3 will be having both signage applied before and around it. When approaching the roundabout from the south and westbound legs a roundabout circulation plaque (R6-5P) will be placed to let the upcoming drivers know that a roundabout is coming (Figure 6.5). It is going to help people traveling northbound traveling over the increase grade south of the roundabout. Since the splitter islands are less than 75^2 it will have a double yellow line leading up to the splitter and will proceed to go into one yellow line as seen in Figure 4.5.

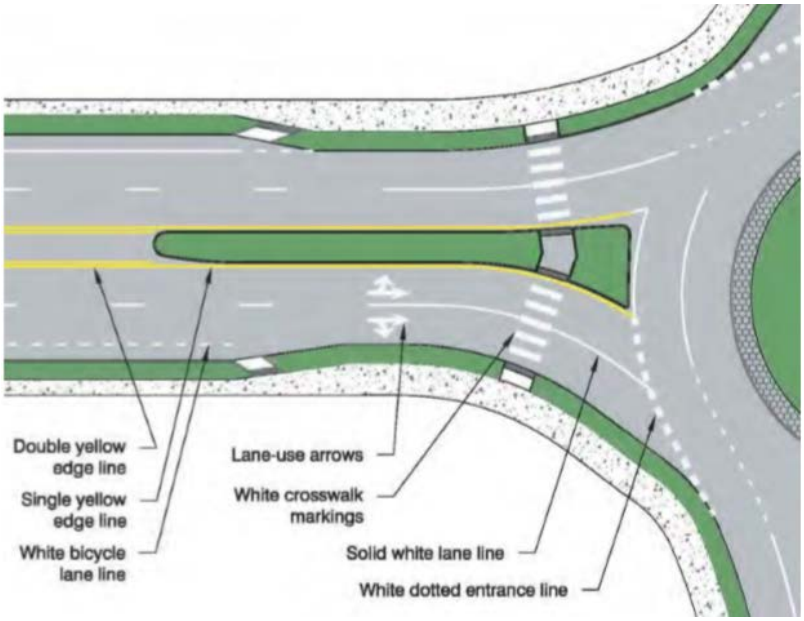


Figure 4.5: Example of stripping for lanes in a roundabout.

For the southbound and westbound splitter islands that separates the right only lane and the thru lane it will have a solid white lane starting at the beginning of the lanes splitting and will expand up to the splitter island. Also, in order to make sure people are in the correct lane arrows will be installed on the ground. Lane arrows are not required for a single lane roundabout; it will help with confusion. These arrows will be the normal arrows that are provided in the MUTCD manual see Figure 4.6 below.

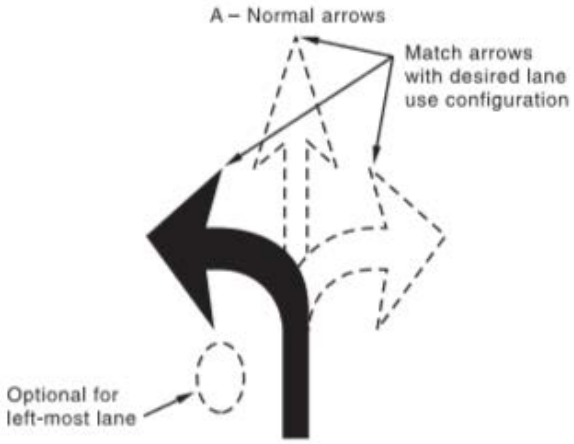


Figure 4.6: Arrow stripping

Since flagstaff gets snow and heavy amounts of rain there will also be keep right sign (Figure 6.6) installed in the splitter island between the thru and right turn only lane (Figure 6.7), and one way signs (Figure 6.8) will be placed in the middle of the roundabout instead of directional arrow [7]. Each approach leg will have a yield bar and yield sign (Figure 6.9) at the entrance of the roundabout. These are required by the NCHRP manual. A yield ahead sign (Figure 6.10) will be installed on the northbound approach on the other side of the hill so that people will be warned that they will know that a yield sign in coming. Dotted lines will be used on the entrances of the roundabout along with where the cars are willing to exit the roundabout. This can be seen in the Figure 4.7 below.

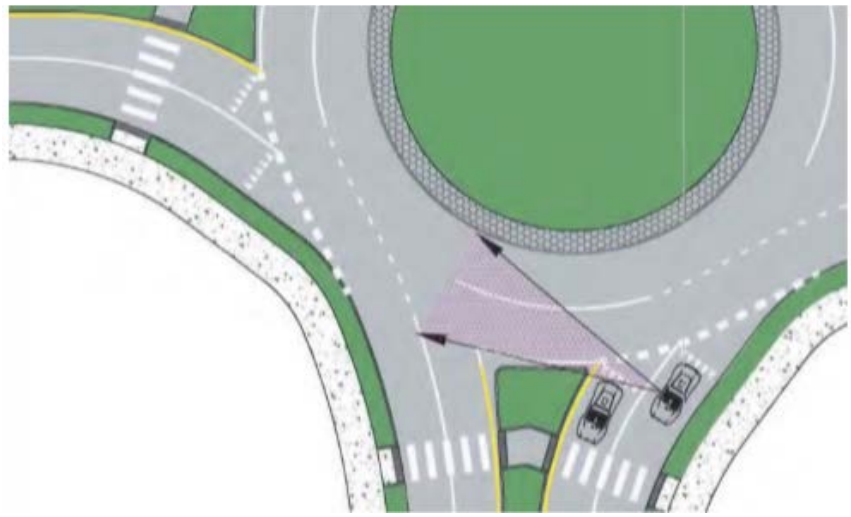


Figure 4.7: Sight distance

Yellow edge lines will be installed on the inner part of the roundabout, and along the splitter islands. NCHRP and the MUTCD require that the line be installed and they need to be 4-6 inches wide. With accordance of Section 3C.03 of the MUTCD manual these lines are also to be installed outer part of the roundabout and roadway. An overview outline of our roundabout design and all stripping and signage will be completed after the final design is completed.

4.5. Final Landscaping Design

After comparing the advantages and the disadvantages of having landscaping versus not having landscaping at the intersection, the decision was made to have a landscaped intersection for the following reasons. First, the sight distance at the intersection is deficient, and having a landscaped intersection would help in improving the visibility of the roundabout for the drivers. The landscape will decrease the headlight glare of the oncoming vehicles, and will help in reducing the speed of vehicles. Having landscape at the intersection will also help visually impaired pedestrians to locate the location of the sidewalk and the crosswalk.

The landscape on the central island was designed to be made of low grass. It was decided not to have large objects in the center of the roundabout, such as a fountain or a statue, because of the following reasons. First, a statue or a fountain could limit the visibility of the drivers at the intersection, especially because the sight distance in the intersection is low. Another reason a

fountain is not a good option to be installed in the central island, is that the weather in flagstaff is sometimes very windy, which could lead to a spray of the fountain water, and limit the visibility for the vehicle commuters.

4.6. Pedestrian and Bike Consideration

According the traffic analysis that was taken by J3Z Engineering there was a rather low amount of pedestrian traffic traveling through the intersection. But since there is some pedestrian traffic our roundabout design is going to accommodate them. There will be a section in the splitter islands where a sidewalk will be put through. The crosswalk markings that will be installed are the “Zebra” or “Continental” crosswalk markings [7]. These markings where chosen due to the high degree of visibility, they will won’t be confused with entrance lines, and less maintenance. These markings will be a 6- 10 feet long, 12 to 24 inches wide, and will be spaced 12- 60 inches. An example of this can be seen in the figure below.

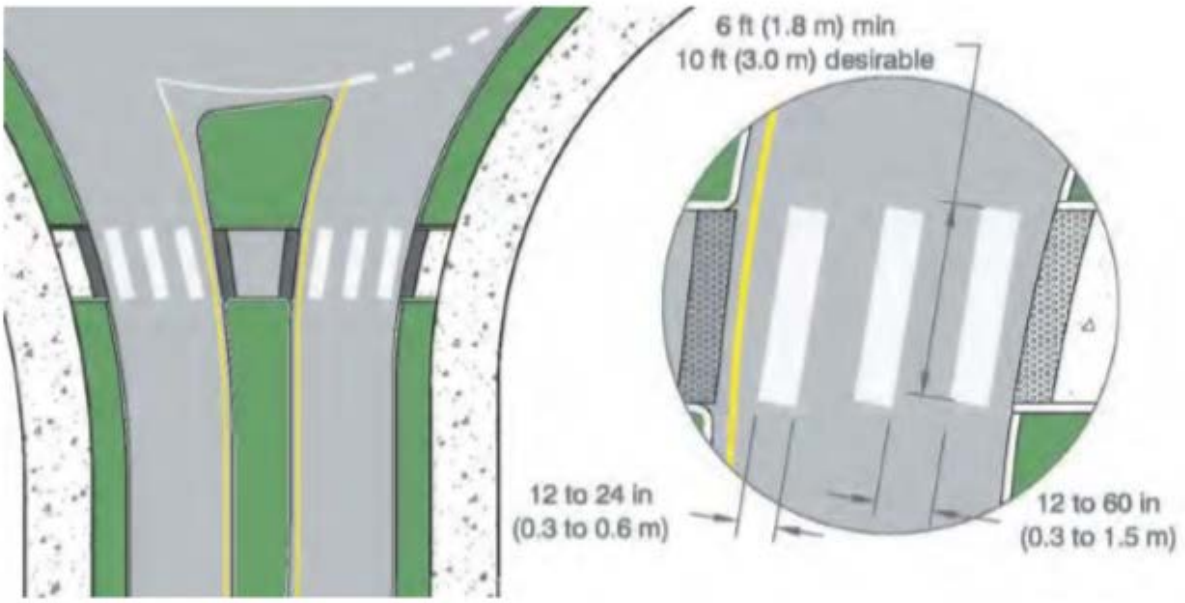


Figure 4.8: Stripping for pedestrian cross-walks.

These crosswalks will be installed at ever leg of the roundabout. To insure the safety of the pedestrians and that these markings will be hard to see in the winter a pedestrian crossing sign (W11-2) will be installed in front of the crosswalk. With accordance to the MUTCD manual

Section 6.8, prohibits the use of marked bicycle lanes within the roundabout. If there is bike traffic they will have to merge onto the sidewalk and cross a pedestrian or enter the roundabout at their own risk.

5. Works Cited

[1] City of Flagstaff Parks and Recreation Organizational Master Plan, Flagstaff: Web, 2013.

[2] Support Article." Support Article. Jamar Technologies, n.d. Web. 07 Mar. 2016.

[3] HCS 2010. Computer software. HCS 2010 Overview. Vers. 6.80. McTrans Center, n.d. Web.

[4] Rodel Interactive. Computer software. Roundabout Analysis Software. Vers. V1. Rodel Interactive, n.d. Web

[5] N. C. H. R. Program, Ed., Landscaping, US. Department of Transportation.

[6] N. C. H. R. Program, Ed., Geometric Design, US. Department of Transportation.

[7] N. C. H. R. Program, Ed., Application of Traffic Control Devices, US. Department of Transportation.

6. Appendix A

Figure 6.1: Grown Turning Movements and PHF

	SB				WB				NB				EB			
Start Time	LT	Thr	RT	Ped	LT	Thr	RT	Ped	LT	Thr	RT	Ped	LT	Thr	RT	Ped
07:15 AM	3	5	13	0	36	4	2	0	2	25	1	0	1	4	12	0
07:30 AM	6	20	11	0	41	8	0	0	2	23	1	0	1	1	13	0
07:45 AM	8	9	14	0	56	1	1	0	3	33	0	0	0	4	15	0
08:00 AM	14	12	24	0	55	6	4	0	0	31	2	0	0	1	17	0
8:15 AM	6	17	16	0	44	3	4	0	6	30	1	0	0	6	10	0
08:30 AM	10	15	16	0	28	3	3	0	3	34	3	0	0	4	11	0
08:45 AM	21	18	21	0	41	5	3	0	6	21	3	0	1	2	7	0
09:00 AM	19	20	17	0	35	1	6	0	4	31	1	0	0	4	11	0
09:15 AM	7	16	19	0	24	3	3	0	4	24	2	0	0	5	9	0
09:30 AM	10	12	22	0	23	5	6	0	3	23	1	0	0	4	15	0
09:45 AM	8	20	15	0	35	5	3	0	3	29	3	0	0	3	11	0
10:00 AM	15	14	19	0	26	3	2	0	1	22	1	0	1	1	13	0
10:15 AM	12	12	21	0	34	1	1	0	3	22	2	0	0	3	8	0
10:30 AM	10	20	26	0	22	1	0	0	3	17	0	0	1	0	15	0
10:45 AM	15	13	19	0	29	3	2	0	3	26	2	0	0	0	12	0
11:00 AM	9	16	12	0	31	6	4	0	2	15	2	0	0	3	13	0
11:15 AM	8	17	21	0	23	2	1	0	2	13	1	0	1	3	16	0
11:30 AM	16	15	24	0	26	5	2	0	2	35	5	0	0	0	13	0
11:45 AM	20	11	20	0	17	2	5	0	2	21	2	0	0	2	13	0
12:00 PM	15	17	20	0	19	1	1	0	2	16	0	0	0	2	8	0
12:15 PM	14	13	17	0	33	3	1	0	6	28	2	0	3	4	12	0
12:30 PM	15	20	23	0	21	1	2	0	3	19	1	0	2	3	11	0
12:45 PM	10	18	22	0	25	1	2	0	6	17	1	0	3	3	16	1
01:00 PM	14	22	27	1	20	4	4	0	5	18	0	0	1	4	17	0
01:15 PM	19	28	25	0	33	7	4	1	5	13	0	0	0	7	18	0
01:30 PM	15	15	36	0	43	1	0	0	7	27	3	0	2	3	13	0
01:45 PM	12	15	25	0	21	2	2	0	4	35	0	0	0	3	11	0
02:00 PM	13	18	17	0	22	4	1	0	4	24	2	0	1	1	16	0
02:15 PM	11	20	32	1	17	5	1	1	5	16	2	0	0	1	19	0
02:30 PM	13	18	27	0	24	1	3	0	6	19	4	0	0	0	15	0
02:45 PM	12	17	27	0	29	1	5	0	0	19	0	0	1	0	7	0
03:00 PM	17	15	24	0	40	0	2	0	3	15	2	0	4	4	11	0
03:15 PM	18	22	34	0	16	3	3	0	3	14	3	0	0	3	26	0
03:30 PM	15	19	38	0	21	1	1	0	6	16	0	0	0	5	12	0
03:45 PM	19	26	33	0	29	6	2	0	5	28	0	0	4	4	25	0
04:00 PM	19	21	39	0	25	6	3	2	5	19	1	0	0	4	15	0
04:15 PM	17	24	46	0	23	3	4	0	5	21	0	0	0	2	18	0
04:30 PM	18	25	37	0	25	5	4	1	5	24	2	0	0	4	9	0
04:45 PM	20	18	43	0	33	2	5	0	7	19	0	1	2	2	7	0
05:00 PM	27	23	59	2	25	2	6	0	8	20	1	0	1	2	12	0
05:15 PM	10	33	47	0	31	3	5	0	5	34	1	0	2	4	8	0
05:30 PM	17	35	60	0	33	8	3	0	8	17	2	0	0	2	17	0
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06:15 PM	19	18	45	0	26	1	3	0	4	20	3	0	0	4	6	0
06:30 PM	22	26	59	0	42	2	2	1	4	23	3	0	2	6	11	0
06:45 PM	11	24	35	0	25	3	2	0	4	19	2	0	1	4	14	0
07:00 PM	18	14	24	0	20	2	2	0	1	12	4	0	3	2	19	0
	SB				WB				NB				EB			
	LT	THR	RT	PED	LT	THR	RT	PED	LT	THR	RT	PED	LT	THR	RT	PED
	683	897	1355	4	1412	147	130	6	193	1067	76	1	39	143	633	1
Hourly Volume	67	120	209	2	128	14	17	0	29	94	6	0	4	12	51	0
Peak 15	17	35	60	0	39	8	6	0	8	34	2	0	1	4	17	0
PHF	0.985	0.857	0.871		0.821	0.438	0.708		0.906	0.691	0.750		1.000	0.750	0.750	
	0.904				0.655				0.782				0.833			

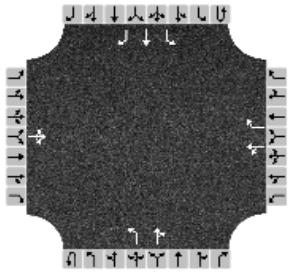
Figure 6.2: Vehicle Classifications

	South Leg Country Club		North Leg Country Club		East Leg Old Walnut		West Leg Oakmont	
Class	# of Vehicles	% of Vehicles	# of Vehicles	% of Vehicles	# of Vehicles	% of Vehicles	# of Vehicles	% of Vehicles
1	51	0.62%	109	0.50%	115	0.98%	28	0.48%
2	3916	47.77%	14855	67.91%	8066	68.62%	3537	60.76%
3	3103	37.85%	4957	22.66%	2497	21.24%	1284	22.06%
4	33	0.40%	82	0.37%	19	0.16%	49	0.84%
5	839	10.23%	1315	6.01%	532	4.53%	613	10.53%
6	19	0.23%	57	0.26%	35	0.30%	11	0.19%
7	1	0.01%	4	0.02%	1	0.01%	0	0.00%
8	98	1.20%	199	0.91%	77	0.66%	17	0.29%
9	2	0.02%	11	0.05%	7	0.06%	0	0.00%
10	0	0.00%	1	0.00%	0	0.00%	0	0.00%
11	0	0.00%	4	0.02%	1	0.01%	0	0.00%
12	2	0.02%	2	0.01%	0	0.00%	0	0.00%
13	0	0.00%	1	0.00%	0	0.00%	0	0.00%
14	134	1.63%	279	1.28%	404	3.44%	282	4.84%
Total	8198		21876		11754		5821	
	Percent Heavy Vehicles							
Heavy	155		361		140		77	
Percent	1.89%		1.65%		1.19%		1.32%	

Figure 6.3: HCS Report for TWSC – No Growth

General Information		Site Information	
Analyst	Kevin Farrell	Intersection	Country CLub Dr
Agency/Co.		Jurisdiction	City of Flagstaff
Date Performed	3/1/2016	East/West Street	Country Club Dr
Analysis Year	2016	North/South Street	Old Walnut Canyon
Time Analyzed		Peak Hour Factor	0.78
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	No Growth		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	1	0	1	1	0	0	1	1	1
Configuration			LTR			LT		R		L		TR		L	T	R
Volume (veh/h)		4	12	51		128	14	17		29	94	6		67	120	209
Percent Heavy Vehicles		2	2	2		2	2	2		2				2		
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

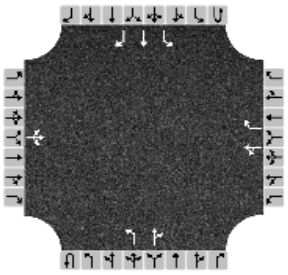
Delay, Queue Length, and Level of Service

Flow Rate (veh/h)			85			182		22		37				86		
Capacity			1015			484		922		1131				1449		
v/c Ratio			0.08			0.38		0.02		0.03				0.06		
95% Queue Length			0.3			1.7		0.1		0.1				0.2		
Control Delay (s/veh)			8.9			16.9		9.0		8.3				7.6		
Level of Service (LOS)			A			C		A		A				A		
Approach Delay (s/veh)	8.9				17.1				1.8				1.3			
Approach LOS	A				C				A				A			

Figure 6.4: HCS Report for TWSC – 2035 Growth

General Information		Site Information	
Analyst	Kevin Farrell	Intersection	Country CLub Dr
Agency/Co.		Jurisdiction	City of Flagstaff
Date Performed	3/1/2016	East/West Street	Country Club Dr
Analysis Year	2016	North/South Street	Old Walnut Canyon
Time Analyzed		Peak Hour Factor	0.78
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	2035 Growth		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	1	0	1	1	0	0	1	1	1
Configuration			LTR			LT		R		L		TR		L	T	R
Volume (veh/h)		4	14	65		167	16	19		36	122	6		87	157	274
Percent Heavy Vehicles		2	2	2		2	2	2		2				2		
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)			106			235		24		46				112		
Capacity			945			376		882		1012				1407		
v/c Ratio			0.11			0.63		0.03		0.05				0.08		
95% Queue Length			0.4			4.1		0.1		0.1				0.3		
Control Delay (s/veh)			9.3			29.3		9.2		8.7				7.8		
Level of Service (LOS)			A			D		A		A				A		
Approach Delay (s/veh)	9.3				29.3				1.9				1.3			
Approach LOS	A				D				A				A			

Figure 6.5: Roundabout Circulation Plaque (R6-5P)

Figure 6.6: Keep Right Plaque (R4-7)

Figure 6.7: Right Turn Only Plaque (R3-5R)

Figure 6.8: One Way Plaque (R6-1R)

Figure 6.9: Yield Plaque (R1-2)

Figure 6.10: Yield Ahead (W3-2)