

Traffic Commission Meeting April 6<sup>th</sup>, 2016



# Northern Arizona University Capstone

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Additional Team Members: Jordan Weyrauch, Joseph Davis, Ralph Ubert & Amal Abdelaziz

# Project Overview

- Client: City of Flagstaff
- POC: Stephanie Sarty
- Location: N. Country Club Dr. and E. Old Walnut Canyon Rd.
- Project Budget: \$1,115,000 FY2018
- Purpose: Redesign the intersection for both a traffic signal and roundabout

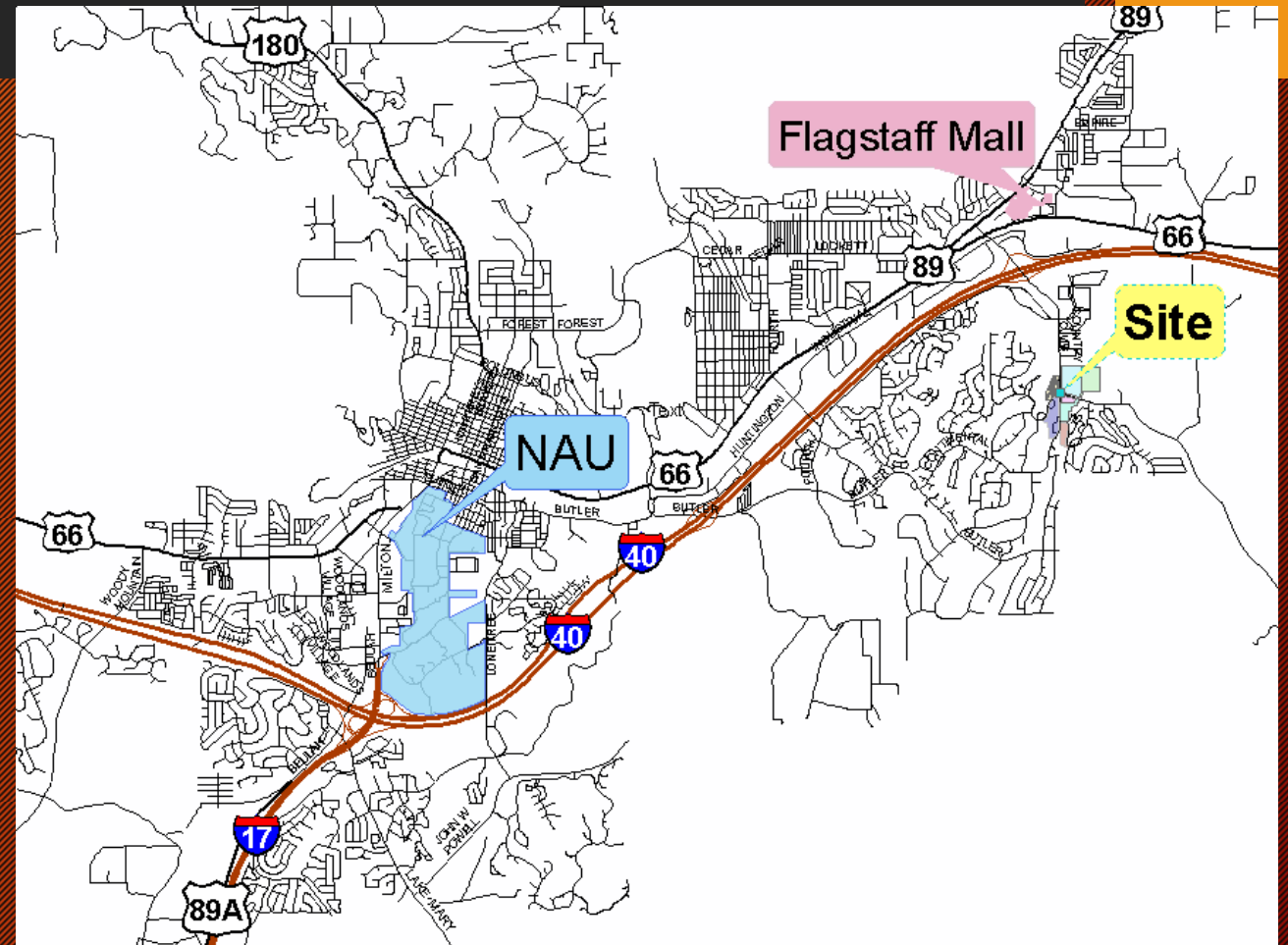


Figure 1: Intersection Location [1]

# Agenda

- Current Conditions
- Traffic Studies
  - Speed & Volume Data
  - Vehicle Classification
  - Current/Projected LOS
  - Right of Way
  - Sight Distance
- Signal Alternative
- Roundabout Alternative



Figure 2: Intersection Location [1]

# Current Speed/Volume Data

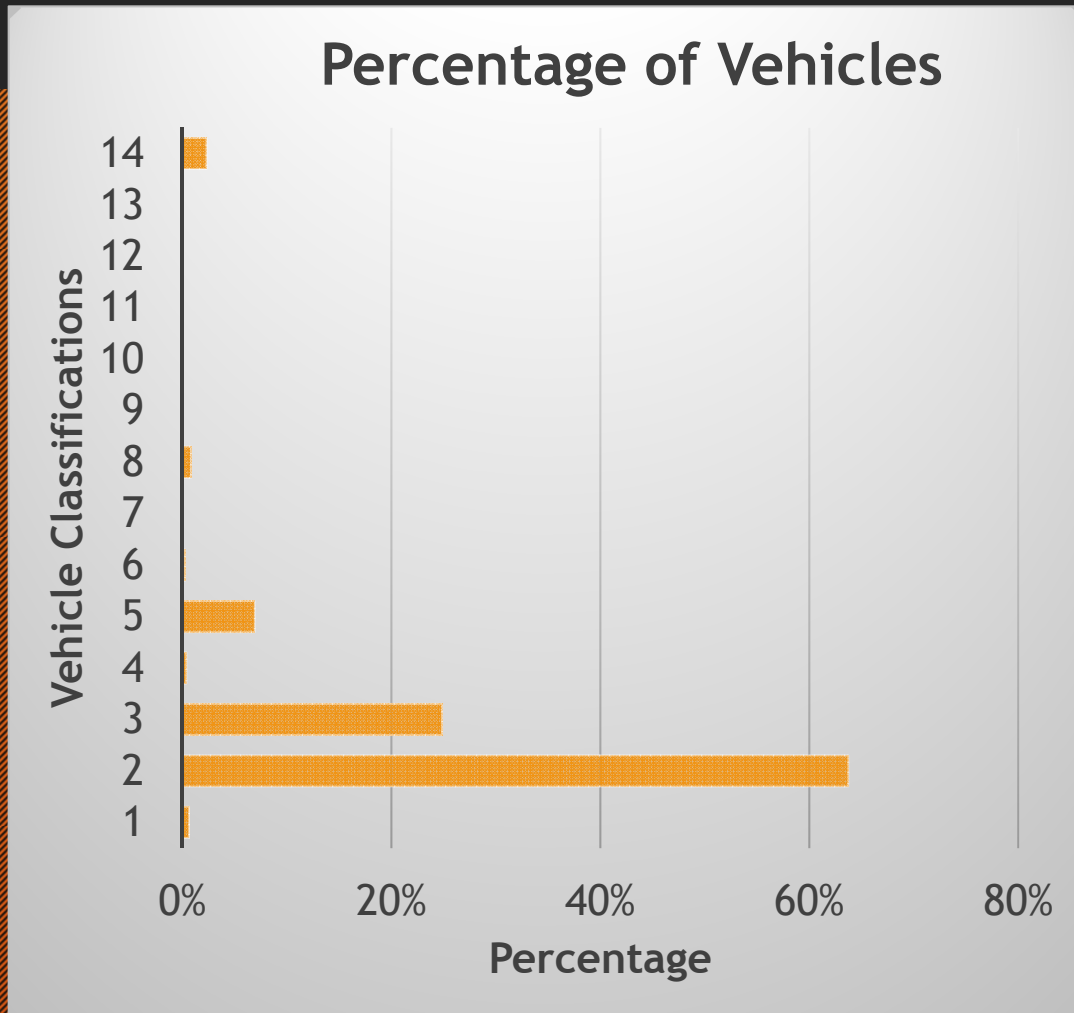


Table 1: AM/PM Peak Hours and Volume

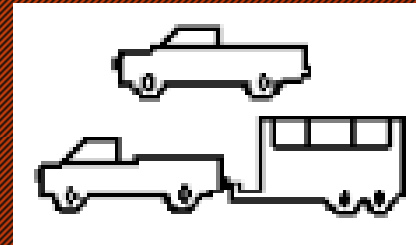
Leg of Intersection	Peak Hour Volume			
	AM Peak Hour	AM Volume	PM Peak Hour	PM Volume
NB Country Club	8:00-9:00	228	4:30-5:30	263
SB Country Club	7:15-8:15	540	5:00-6:00	687
EB Oakmont	11:00-12:00	142	3:00-4:00	174
WB Old Walnut Canyon	8:00-9:00	284	5:00-6:00	399

Figure 3: Speed and Volume Data

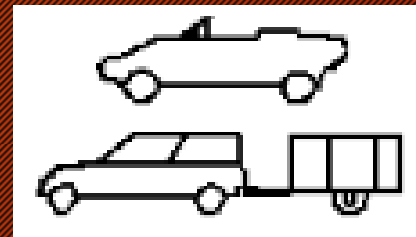
# Vehicle Classification



Class 14: Unclassified vehicles  
Class 5: Single Unit Trucks (2 Axle, 6 tire) including recreation vehicles



Class 3: Pickups & Vans (2 Axle, 4 tire) including those with light trailers



Class 2: Passenger vehicles including those pulling light trailers

Figure 4: Vehicle Classification Statistics

# Current LOS

Table 2: HCS Delay/Level of Service Output

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)		51	12														
Percent Heavy Vehicles		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			40		164		8						268	
Capacity			294			511		905		1319						1414	
v/c Ratio			0.29			0.08		0.18		0.01						0.19	
95% Queue Length			1.2			0.3		0.7		0.0						0.7	
Control Delay (s/veh)			22.2			12.6		9.9		7.7						8.1	
Level of Service (LOS)			C			B		A		A						A	
Approach Delay (s/veh)		22.2				11.1				0.4				4.3			
Approach LOS		C				B				A				A			

# Projected LOS with No Design Change

Table 3: HCS Delay/Level of Service Output

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	10	1	2	3	4	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)		65	14													
Percent Heavy Vehicles		2	2													
Proportion Time Blocked																
Right Turn Channelized		No			No			No			No			No		
Median Type		Left Only														
Median Storage		1														
Delay, Queue Length, and Level of Service																
Flow Rate (veh/h)			106		45		214		8					351		
Capacity			143		351		861		1240					1362		
v/c Ratio			0.74		0.13		0.25		0.01					0.26		
95% Queue Length			4.4		0.4		1.0		0.0					1.0		
Control Delay (s/veh)			81.0		16.8		10.6		7.9					8.6		
Level of Service (LOS)			F		C		B		A					A		
Approach Delay (s/veh)		81.0			12.6			0.3			4.5					
Approach LOS		F			B			A			A					

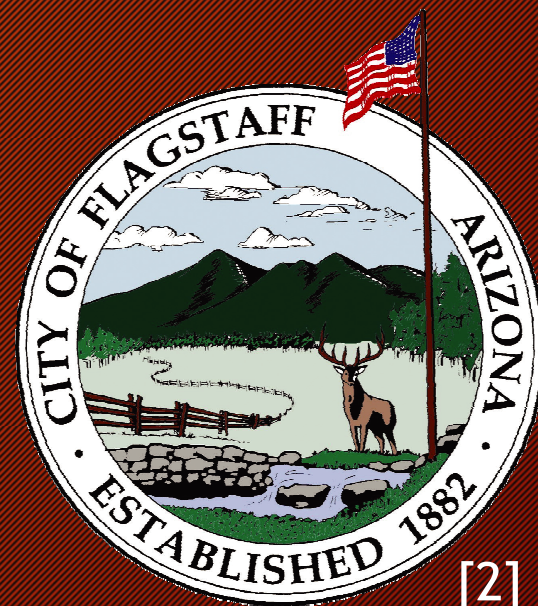
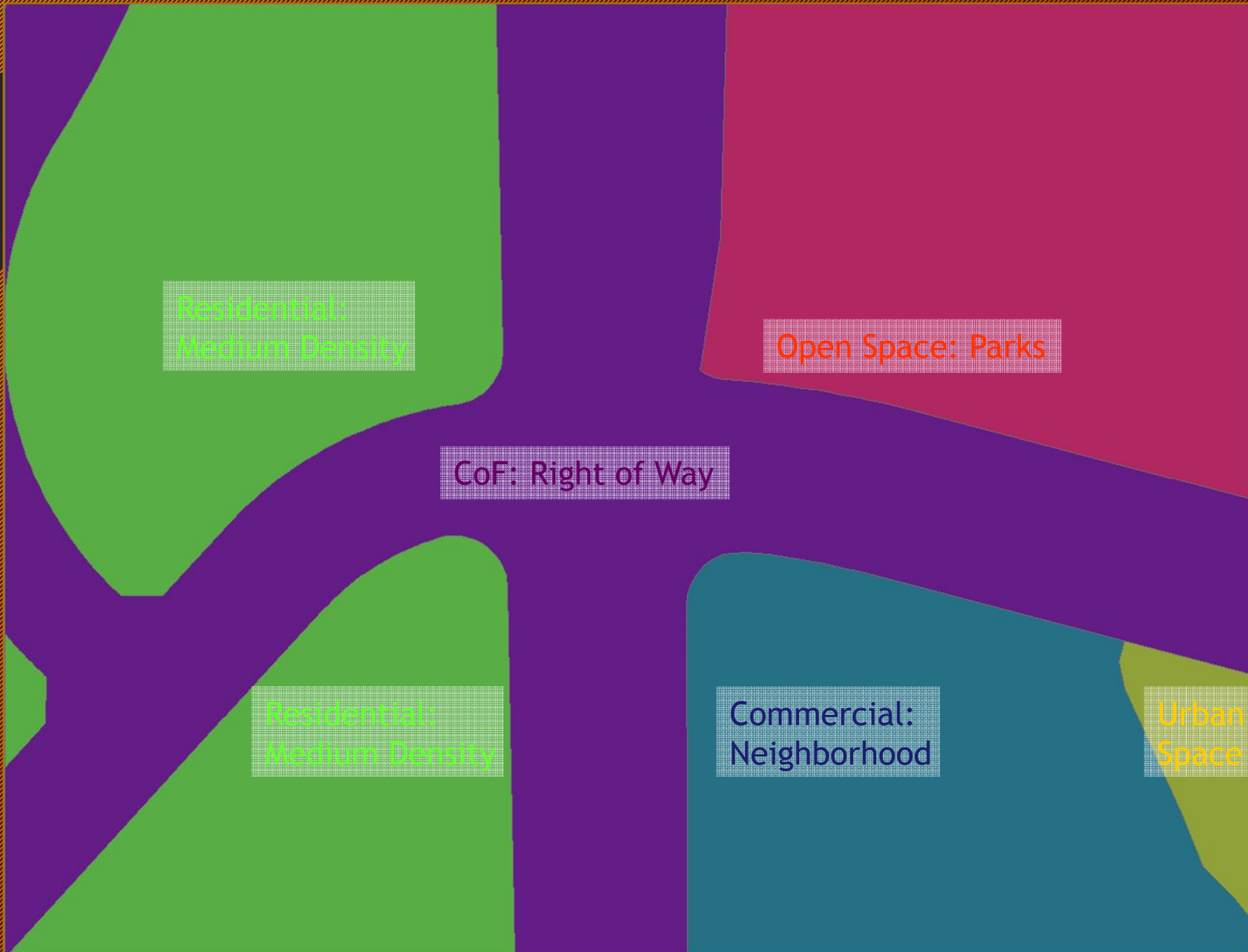


Figure 5: City of Flagstaff Zoning Boundaries



# Warranting

## Warrant 7- Crash Experience

- A traffic signal will be considered for an intersection if both of the following criteria are met.
  - Five collisions occur within a twelve month time span.
  - The volume of both the major and minor streets must also be high enough to where it meets the 80 percent columns of condition A and B from the eight-hour vehicle volume warrant.

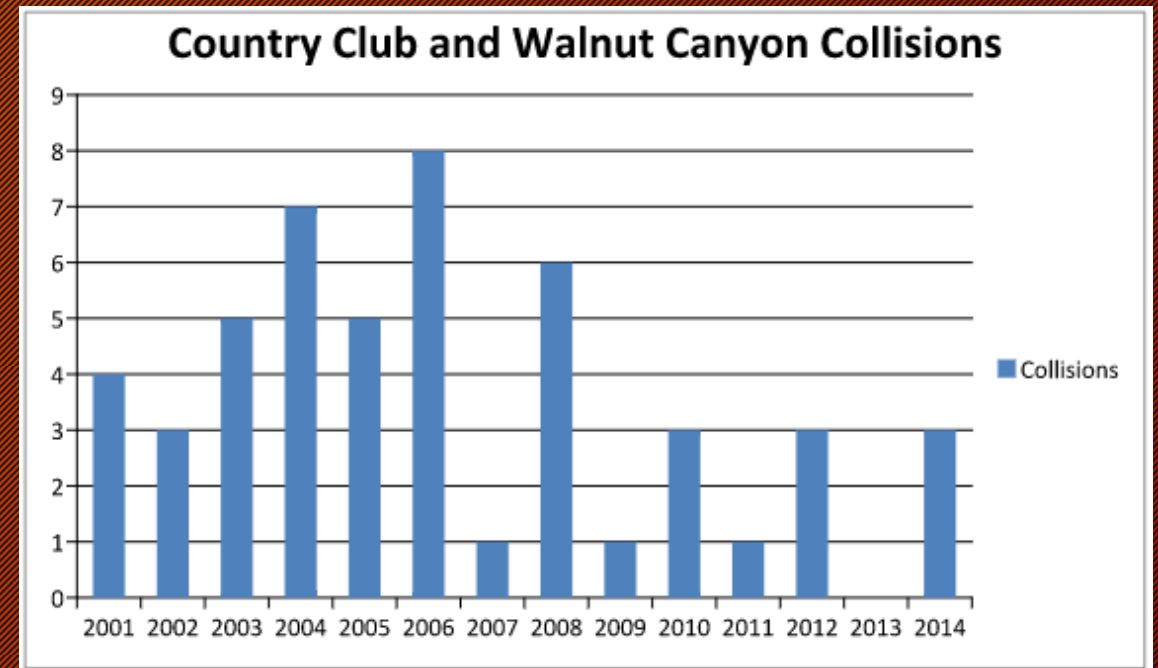
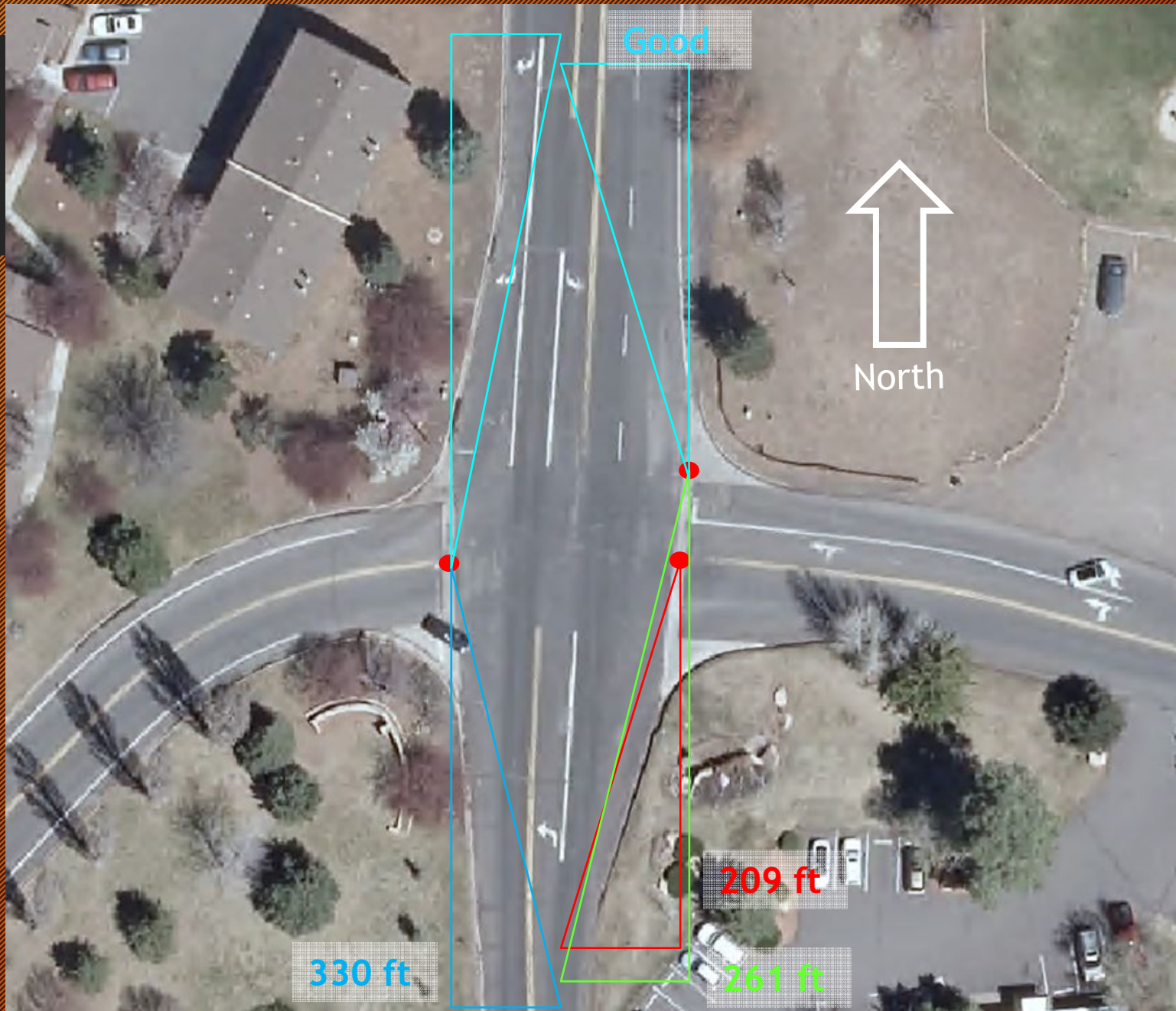


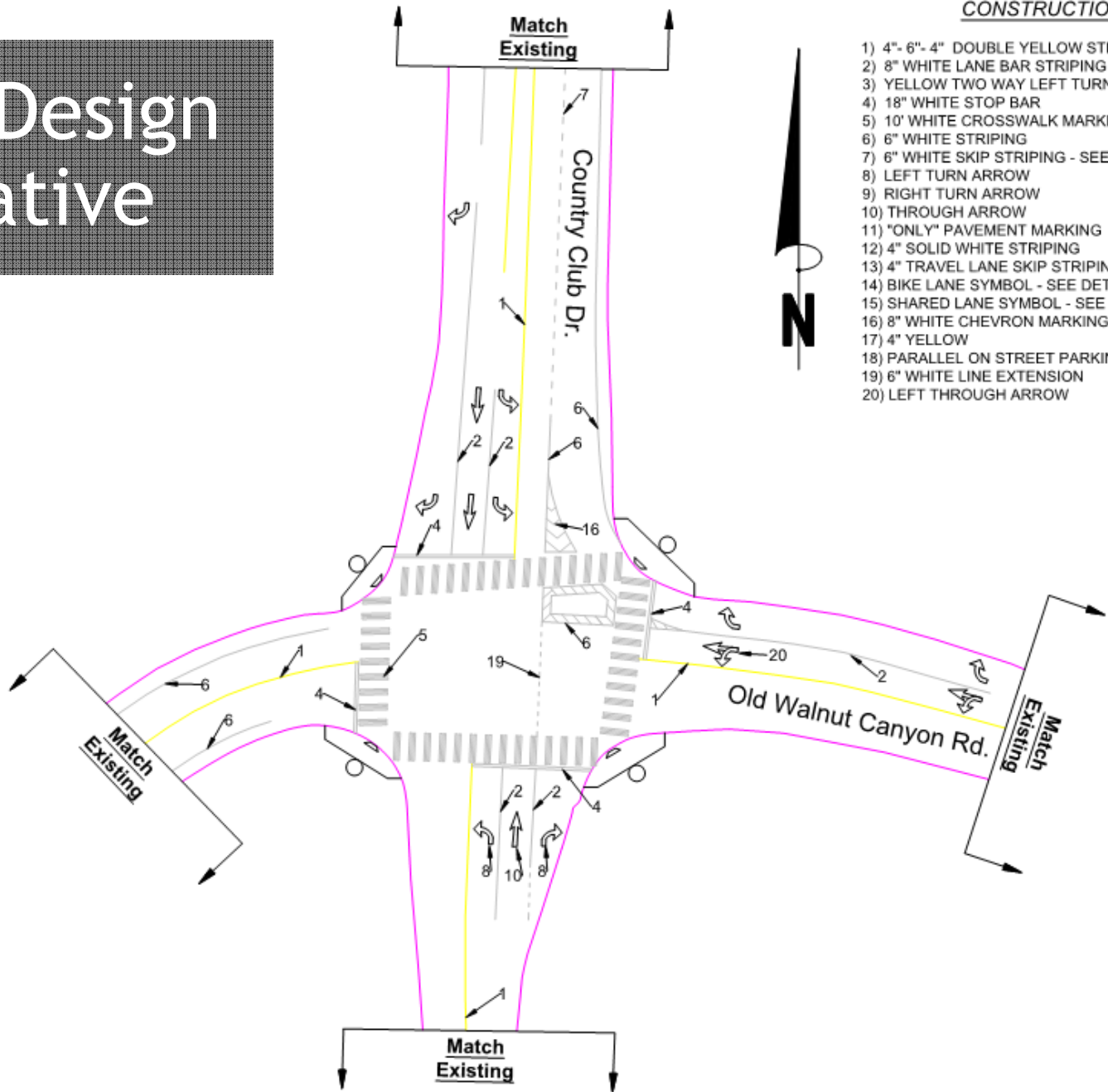
Figure 6: Crash Experience Statistics



- Per AASHTO Standards:
- 290 ft
  - 290 ft
  - 390 ft

Figure 7: Intersection Sight Distance

# Signal Design Alternative



## CONSTRUCTION NOTES

- 1) 4"-6"-4" DOUBLE YELLOW STRIPING
- 2) 8" WHITE LANE BAR STRIPING
- 3) YELLOW TWO WAY LEFT TURN LANE STRIPING
- 4) 18" WHITE STOP BAR
- 5) 10' WHITE CROSSWALK MARKINGS - SEE DETAIL SHEET
- 6) 6" WHITE STRIPING
- 7) 6" WHITE SKIP STRIPING - SEE DETAIL SHEET
- 8) LEFT TURN ARROW
- 9) RIGHT TURN ARROW
- 10) THROUGH ARROW
- 11) "ONLY" PAVEMENT MARKING
- 12) 4" SOLID WHITE STRIPING
- 13) 4" TRAVEL LANE SKIP STRIPING - SEE DETAIL SHEET
- 14) BIKE LANE SYMBOL - SEE DETAIL SHEET
- 15) SHARED LANE SYMBOL - SEE DETAIL SHEET
- 16) 8" WHITE CHEVRON MARKINGS
- 17) 4" YELLOW
- 18) PARALLEL ON STREET PARKING "T"
- 19) 6" WHITE LINE EXTENSION
- 20) LEFT THROUGH ARROW

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
XX	ARIZ	0001	XX	XX	
J.S.Z. ENGINEERING AN ENGINEERING FIRM					
CONSTRUCTION NOTES					
NO.	DESCRIPTION	UNIT	QTY		

NOTE:

FLAGSTAFF, ARIZONA		
Striping Plan		
DATE: 04/18	DATE: ???	DWG. NO. 001
SCALE: 1"=40' HORIZONTAL	SCALE: 1"=40' VERTICAL	XX OF XX

# Roundabout Design Alternative

## Single Lane Roundabout

Diameter - 110 ft

Speeds - 20 mph

Splitter Island

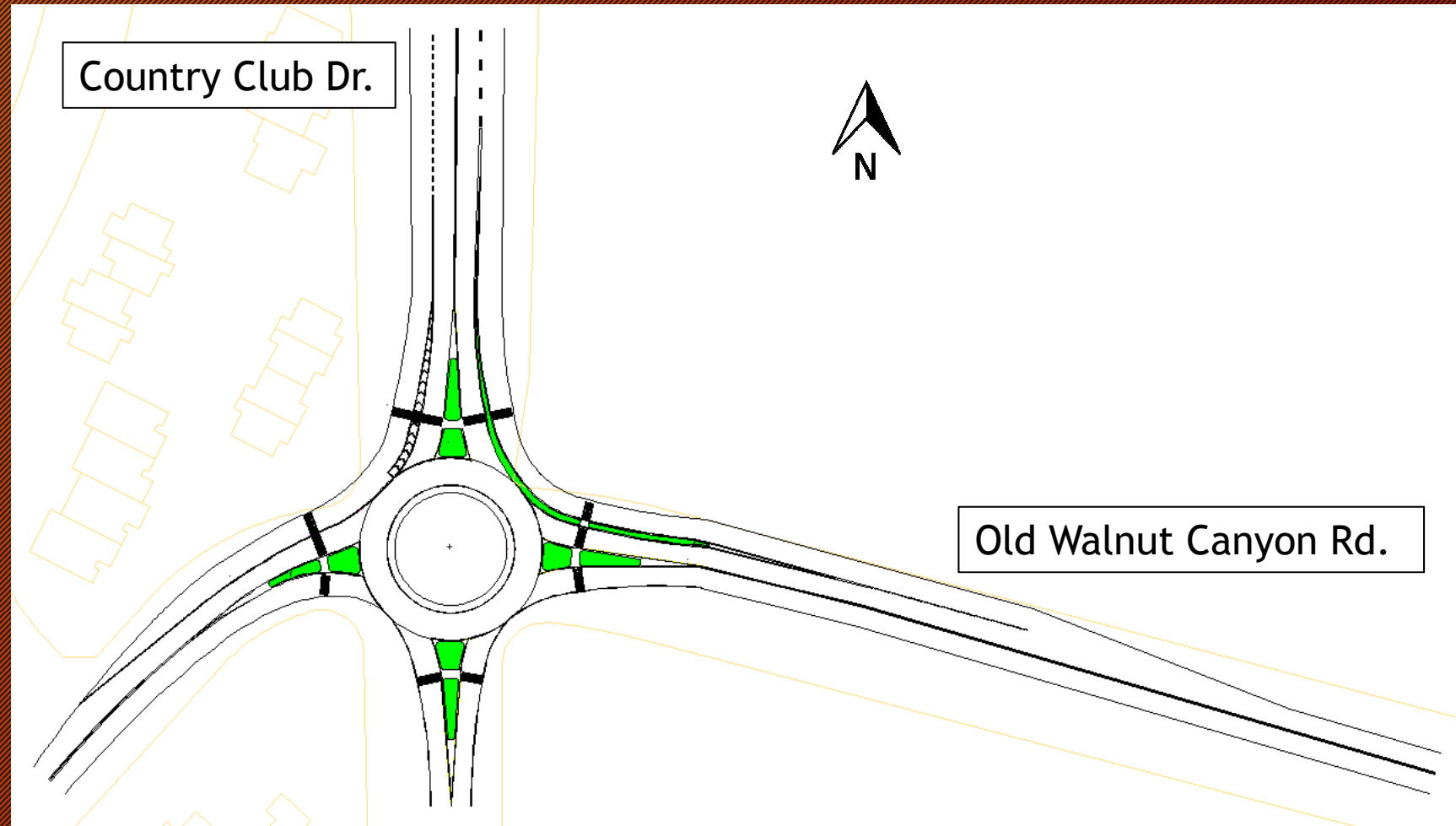
Pedestrian cross walks

Entry Width and Circulatory  
Roadway Width of 16 ft

Design Vehicle - large semi-trailer  
(WB-50)

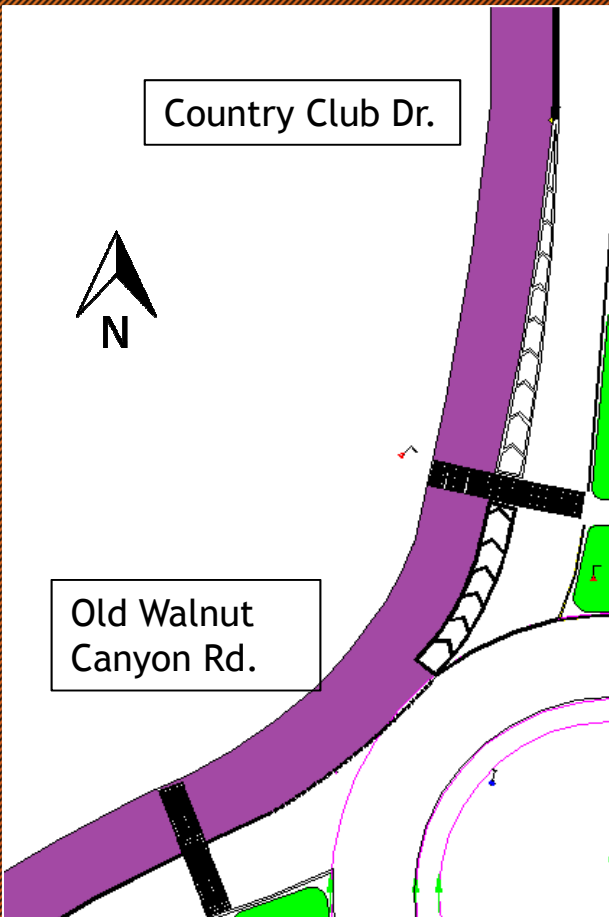
Center offset of 1.5 ft N / 13.5 ft E

Total right-away need from  
surrounding parcels - 700 sqft



# Roundabout Design Alternative Cont.

Right-Turn Only



## Further Resolves

Safety

Congestion

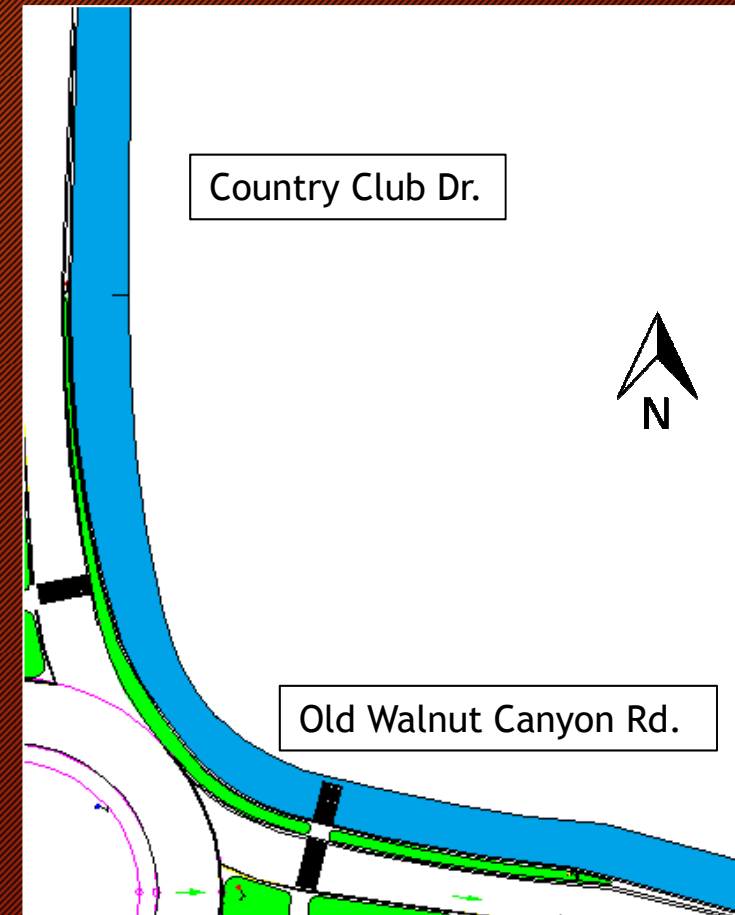
Conflict Points

Queuing Conflicts

*Diverging conflicts*

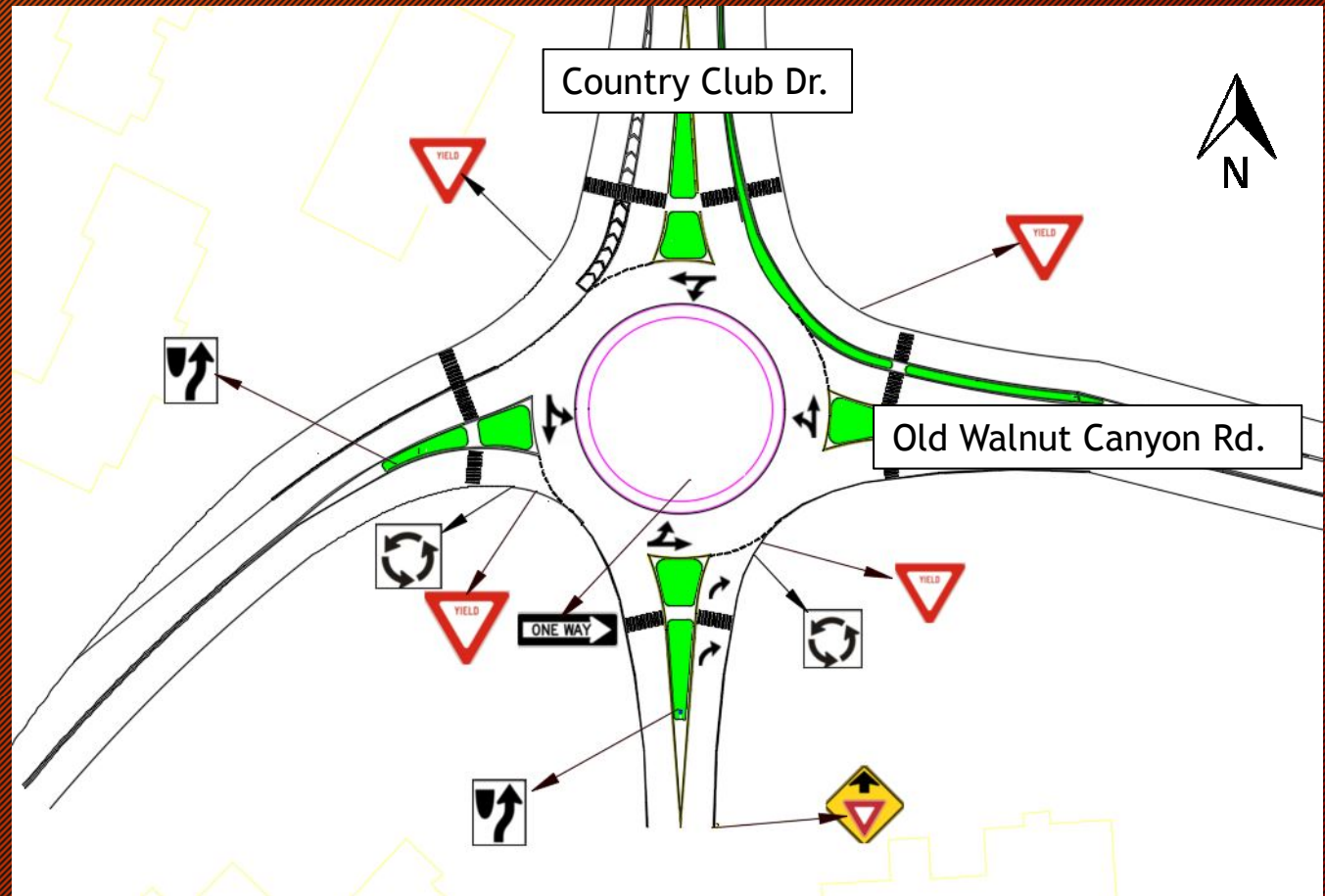
*Merging conflicts*

Right-Turn Bypass



# Roundabout Design Alternative Cont.

- Circulation plaque: South and west bounds.
- Keep right plaque: installed at the splitter island.
- One way sign: middle of the roundabout.
- Yield plaque: installed at each approach leg.
- Yield ahead: Placed on the northbound.
- Dotted lines: Installed at entrances of roundabout.
- Ground lane arrows: Normal arrows based on MUTCD.



# Undergraduate Research and Design Symposium

- Friday April 29<sup>th</sup>, 2016
- NAU DuBois Center-Agassiz Room
- Traffic Signal Design 1:40PM
- Roundabout Design 2:05PM

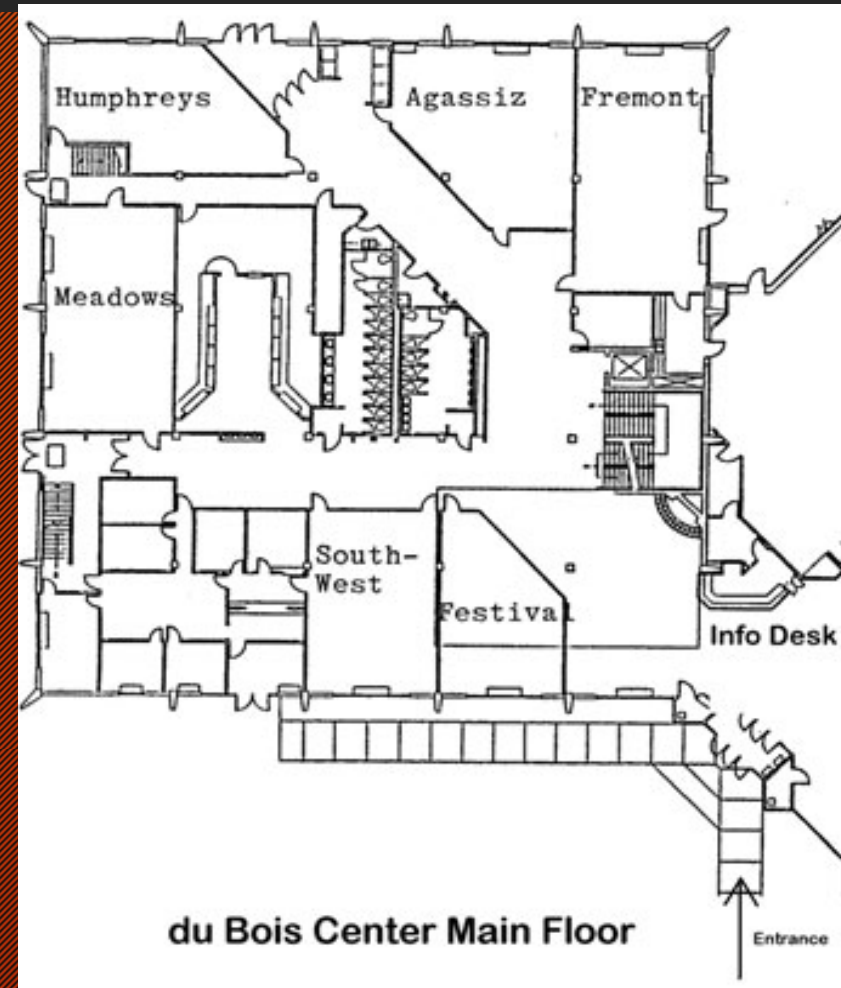


Figure 8: NAU DuBois Center

# References

- [1] “Google Maps.” *Google Maps*. Web. Oct. 2016.
- [2] “City of Flagstaff” *City of Flagstaff*. Web. 2016
- [3] “Nonneseter-Simulation in VISSIM” *Ramboll*. Web. 2013
- [4] *Golberg Osborne*. Web. Jan. 2016.