Challenges of Constructing Cheyenne's First Dual-Lane, Five-Leg Roundabout

Kenneth H. Voigt, P.E.
Ayres Associates
17865 Elm Terrace
Brookfield, Wisconsin USA
Phone: (414) 870-2054
Fax: (262) 523-4477
kvoigt@sbcglobal.net

4th International Conference on Roundabouts
April 16-18, 2014
Seattle, Washington

Submitted: February 28, 2014
Word Count: 2,283
Number of Tables: 5
Number of Figures: 15

Challenges of Constructing Cheyenne's First Dual-Lane, Five-Leg Roundabout

Abstract

Numerous public and engineering challenges were overcome to approve and construct a dual lane roundabout at a high crash, over capacity, closely spaced set of intersections that formed a five-leg traffic signalized intersection. A total of eight different intersection improvement concepts were analyzed by two different engineering firms, with both firms concluding that construction of a roundabout was the only reasonable solution. This analysis was followed by a public education program to explain to the public how to drive and navigate the proposed roundabout. Traffic signing was a critical element in the final roundabout design. Construction was phased to maintain traffic flow through the intersection. Since the roundabout was in close proximity to a school, rectangular rapid flashing beacons were included in the final design.

Challenges of Constructing Cheyenne's First Dual Lane, Five-Leg Roundabout

Kenneth H. Voigt, P.E.
Ayres Associates

4th International Conference on Roundabouts
April 16-18, 2014
Seattle, Washington

Project Background

The city of Cheyenne Metropolitan Planning Organization (MPO) retained Ayres Associates to prepare a corridor improvement study for a one mile segment of Pershing Boulevard. Pershing Boulevard is a four-lane urban street with a 35 mph speed limit, carrying 17,000 vehicles on a typical weekday. Traffic levels on Pershing Boulevard are projected to increase to 30,000 vpd. As shown on Figure 1, the Pershing Boulevard intersection with Converse Street and 19th Street creates a five-leg triangular intersection configuration with the following problems:

- Visually confusing to motorists
- Close proximity of intersection spacing (90 feet) and approach angle of cross streets
- Inefficient traffic signal timings
- Safety and queuing from limited distance between left turns
- Northbound left turn storage capacity that can create peak hour gridlock
- Non-standard through and left turn lane transitions
- Pedestrian unfriendly
- Immediate proximity of numerous driveways to intersection

Figure 1: Existing Pershing Boulevard Intersection with Converse Avenue and 19th Street

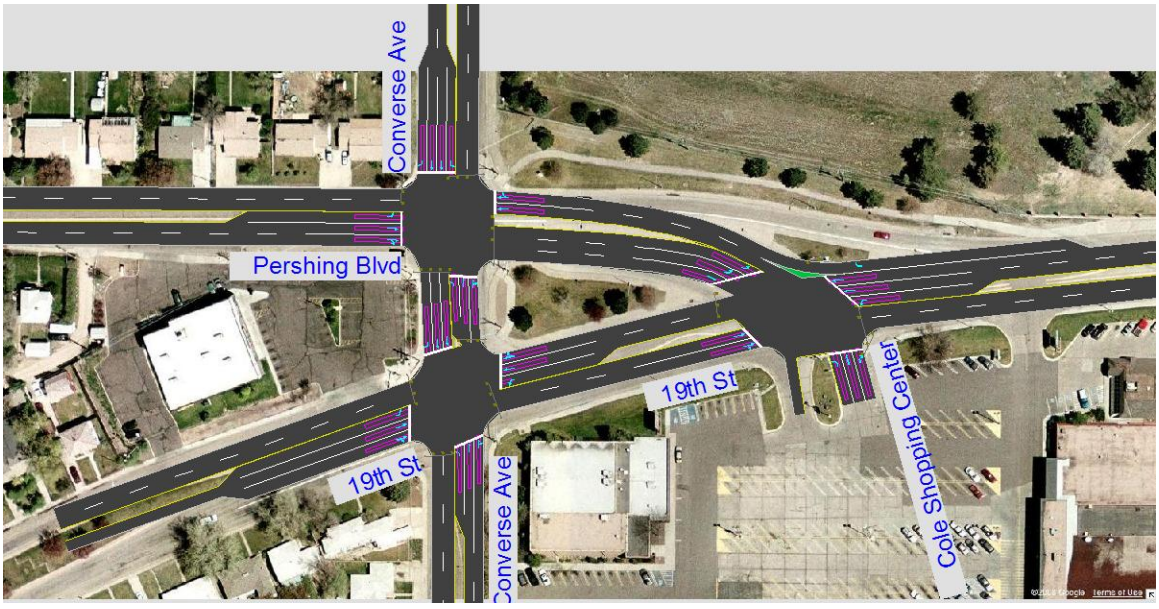
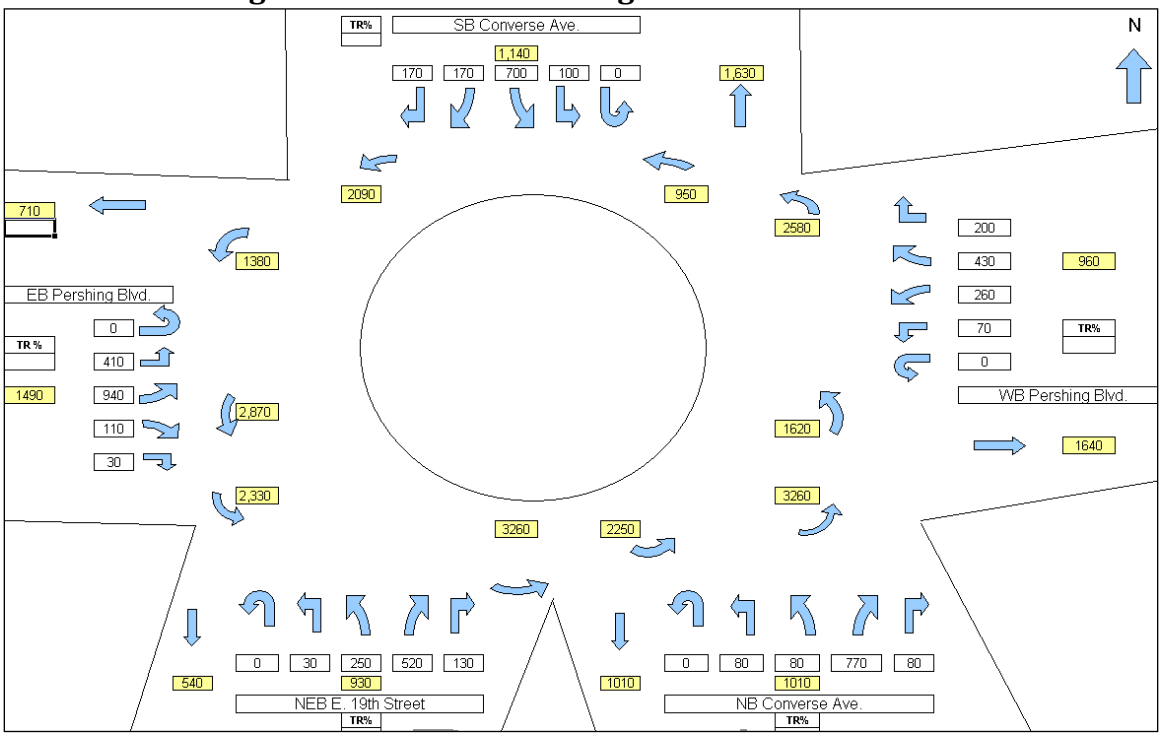


Figure 2 identifies year 2035 evening peak hour traffic volumes expected at the Pershing Boulevard/Converse Avenue/19th Street intersection triangle.

Figure 2: Year 2035 Evening Peak Hour Volumes



This paper discusses 1) improvement evaluation analysis; 2) public involvement/education; and 3) roundabout design challenges that were encountered and successfully overcome in the implementation of the first dual-lane, five-leg roundabout constructed in the city of Cheyenne, Wyoming.

Challenge 1: Improvement Evaluation Analysis

In 2006, the Cheyenne MPO had conducted an intersection safety/congestion improvement study that analyzed eight different alternatives for the Pershing Boulevard/Converse Avenue/19th Street intersection. That study recommended a roundabout as the best solution to solve existing and future traffic congestion and intersection safety problems. However, no decisions were made on implementing that recommendation in 2006. The following is a list of the improvement alternatives considered in the 2006 intersection study.

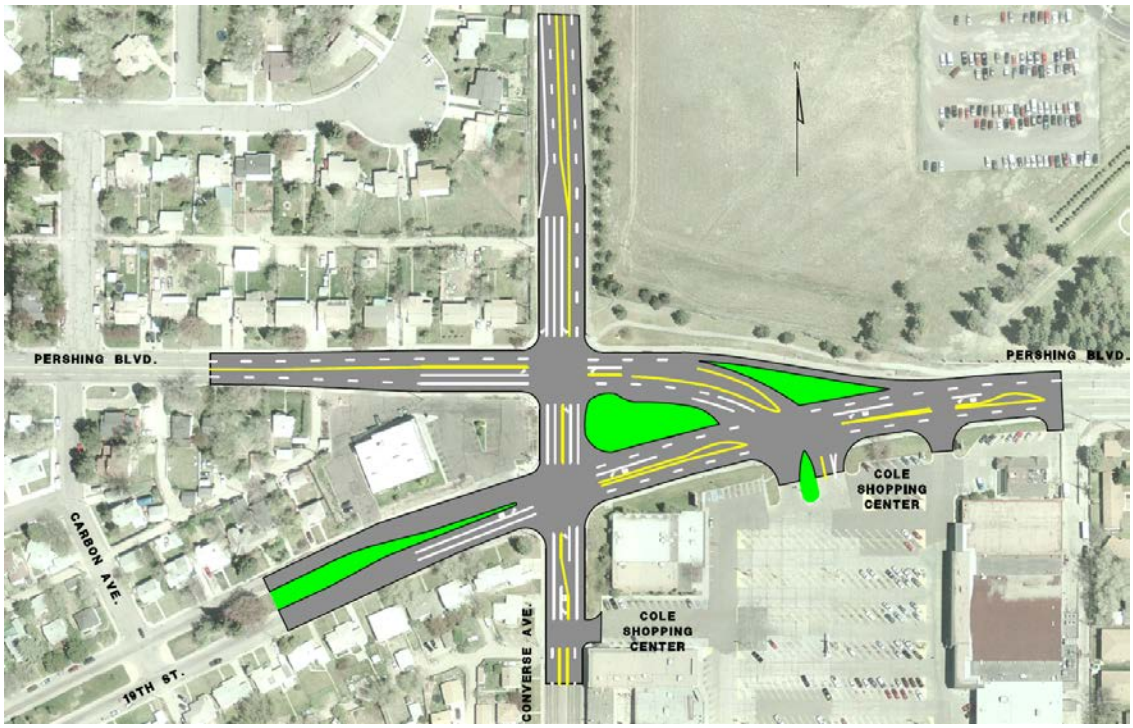
1. Existing Conditions
2. Pershing Westbound Direct
3. Pershing East and Westbound Direct
4. Eliminate 19th/Pershing Intersection
5. Eliminate 19th/Pershing and Relocate Pershing/Converse to the North

6. Converse Grade Separation
7. Modern Roundabout
8. 19th Realignment with Cole Shopping Center

As part of the Pershing Boulevard Corridor Improvement Study, Ayres Associates conducted a review of the initial eight intersection improvement alternatives, as well as its own analysis of additional improvement options. Due to the complexity of a potential roundabout design at this intersection, GHD was retained as a sub-consultant to assist in the design and operational analysis.

A detailed year 2035 traffic operation and safety evaluation of the intersection improvement alternatives indicated the following evening peak hour Level of Service (LOS) and safety impacts for the four options taken to the public for review and comment. The 'No Build' and four intersection improvement option operation and safety impacts are summarized below, along with an intersection geometric diagram.

Figure 3: Existing Condition



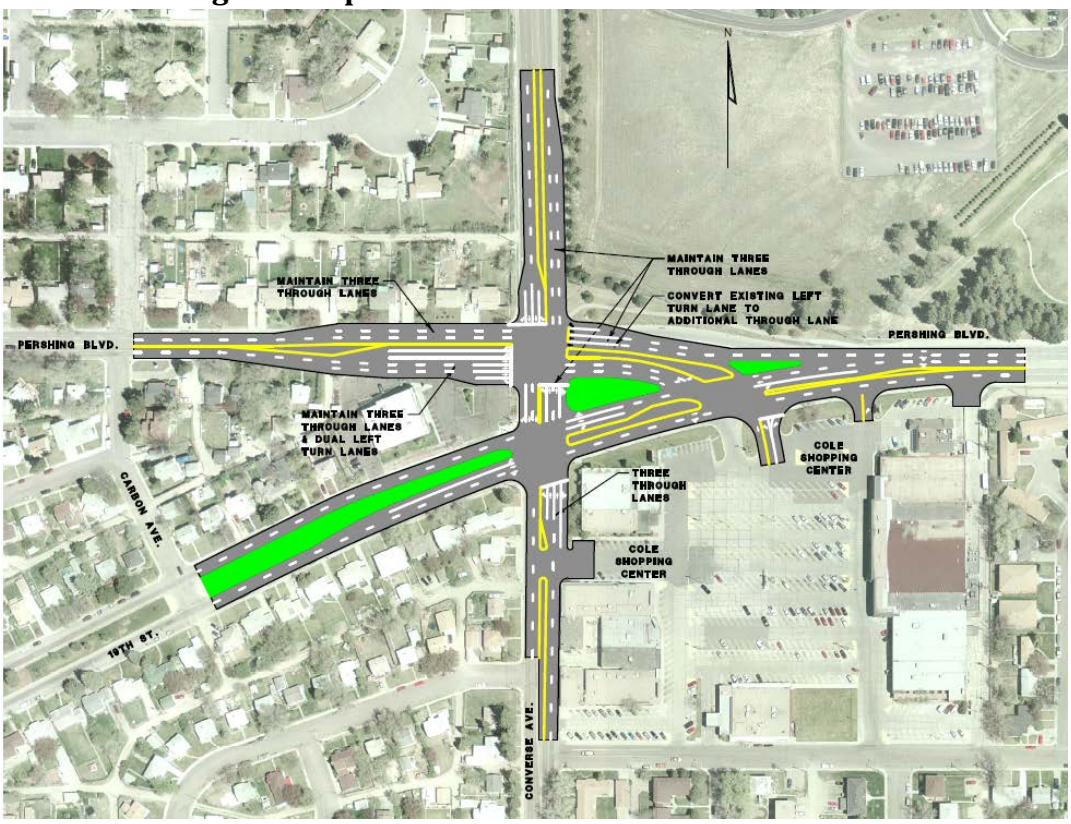
Safety

- Total 3 year crashes = 50

Table 1: Existing Condition Intersection Operation

Level of Service and Vehicle Backups - 2035 PM Peak Hour													
Intersection	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Overall LOS/Delay
Pershing Blvd at Converse Ave	C 30'	F 500'	C 500'	C 60'	F 440'	C 80'	F 450'	D 235'	D 235'	N/A N/A	C 115'	C 115'	F / 126
19th St	C 30'	C 30'	C 0'	D 160'	C 30'	N/A N/A	N/A N/A	C 250'	C 250'	F 10'	B 105'	B 0'	F / 81
19th St at Converse Ave	B 50'	C 300'	C 300'	N/A N/A	B 200'	B 15'	F 250'	B 175'	B 175'	D 100'	C 130'	N/A N/A	C / 28

Figure 4: Option 1: Geometric Enhancements



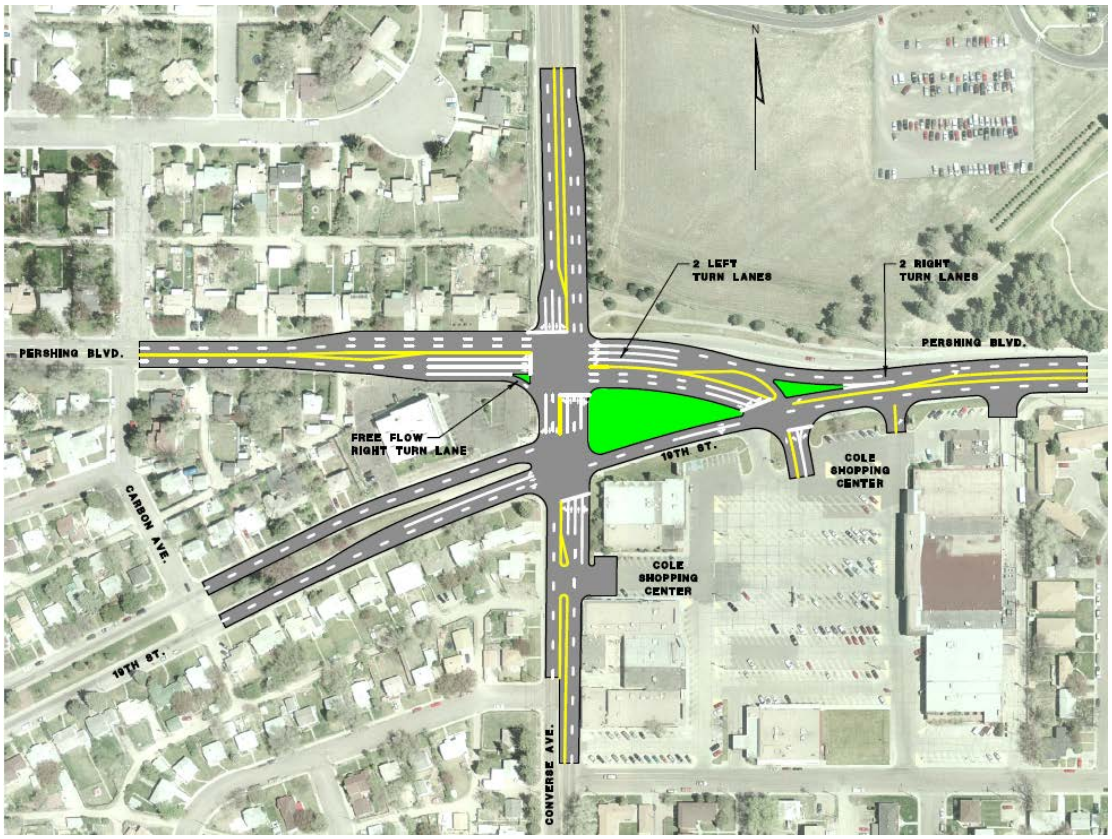
Safety

- Total 3 year expected crashes = 45 (10% reduction)

Table 2: Option 1 – Geometric Enhancements Intersection Operation

Level of Service and Vehicle Backups - 2035 PM Peak Hour													
Intersection	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Overall LOS/Delay
Pershing Blvd at Converse Ave	D 85'	B 165'	N/A N/A	B 60'	C 330'	B 60'	E 215'	C 210'	B 60'	N/A N/A	D 130'	D 55'	C / 29
19th St	D 40'	D 30'	D 0'	A 25'	A 5'	N/A N/A	N/A N/A	C 270'	C 0'	C 15'	C 110'	A 0'	B / 15
19th St at Converse Ave	C 55'	B 185'	B 185'	N/A N/A	B 140'	A 0'	D 210'	C 240'	C 240'	D 110'	D 160'	N/A N/A	C / 25

Figure 5: Option 2: One-way 19th Street



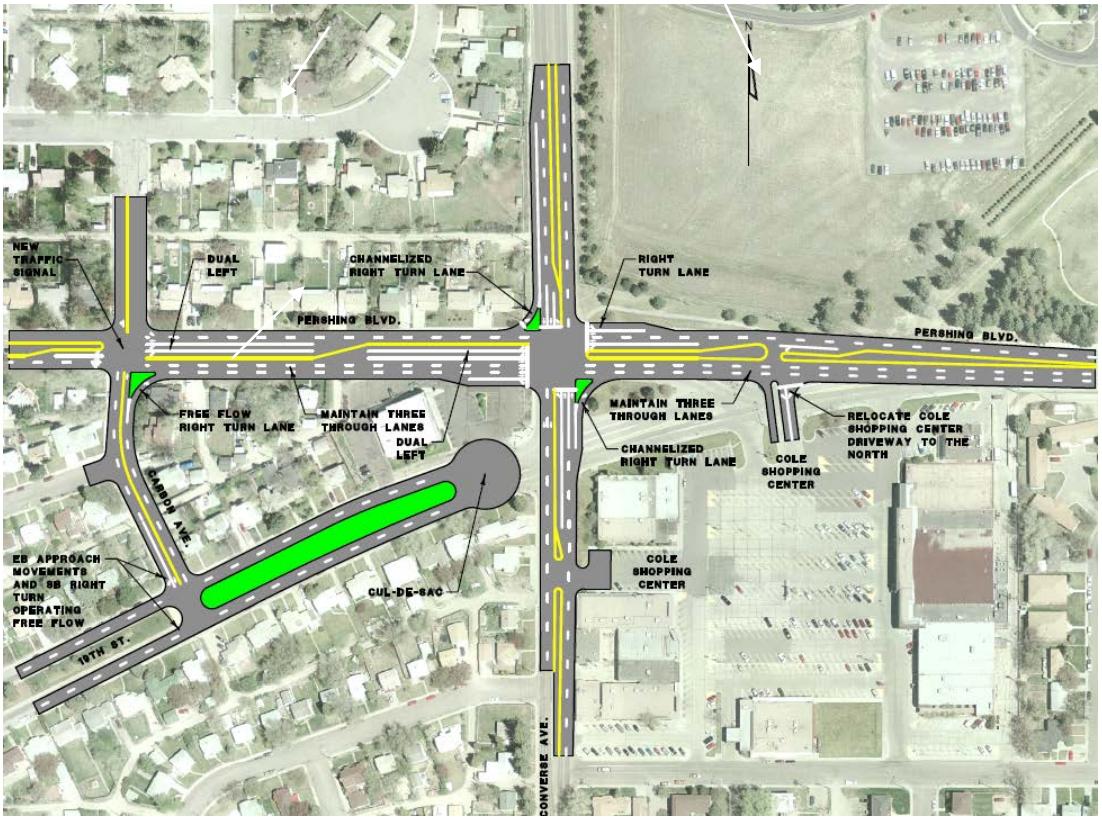
Safety

- Total 3 year expected crashes = 45 (10% reduction)

Table 3: Option 2 – One-Way 19th Street Intersection Operation

Level of Service and Vehicle Backups - 2035 PM Peak Hour													
	Northbound			Southbound			Eastbound			Westbound			Overall
Intersection	L	T	R	L	T	R	L	T	R	L	T	R	LOS/Delay
Pershing Blvd at Converse Ave	F	F	N/A	F	F	D	F	F	D	F	C	C	F / 27
	245'	750'	N/A	220'	635'	140'	715'	630'	125'	150'	300'	300'	
19th St	N/A	B	B	C	A	N/A	N/A	D	D	E	N/A	A	C / 27
	N/A	35'	0'	25'	5'	N/A	N/A	365'	365'	25'	N/A	0'	
19th St at Converse Ave	E	C	C	N/A	B	D	C	C	C	N/A	N/A	N/A	C / 31
	120'	355'	355'	N/A	95'	10'	255'	300'	300'	N/A	N/A	N/A	

Figure 6: Option 3: 19th Street Vacation



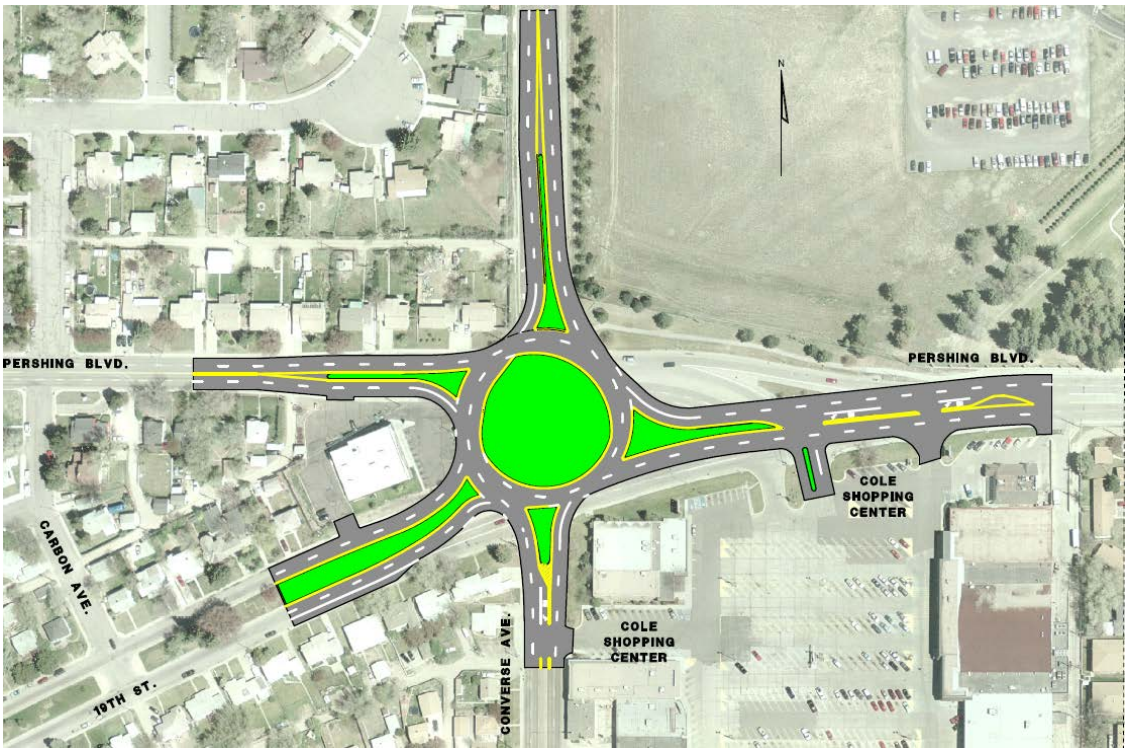
Safety

- Total 3 year expected crashes = 40 (20% reduction)

Table 4: Option 3 – 19th Street Vacation Intersection Operation

Level of Service and Vehicle Backups - 2035 PM Peak Hour													
	Northbound			Southbound			Eastbound			Westbound			Overall
Intersection	L	T	R	L	T	R	L	T	R	L	T	R	LOS/Delay
Pershing Blvd at Converse Ave	F	D	F	D	E	E	F	F	C	F	C	C	F / 278
	260'	270'	95'	100'	340'	355'	680'	300'	90'	190'	270'	90'	
Carbon Ave	E	E	A	E	E	E	A	D	D	D	A	A	C / 27
	100'	100'	0'	90'	90'	90'	30'	880'	0'	320'	15'	0'	
Cole Shopping Center	E	N/A	D	N/A	N/A	N/A	N/A	A	A	A	A	N/A	A / 3
	80'	N/A	20'	N/A	N/A	N/A	N/A	20'	0'	5'	120'	N/A	

Figure 7: Option 4: Modern Roundabout



Safety

- Total 3 year expected crashes = 25 (50% reduction)

Table 5: Option 4 – Modern Roundabout Intersection Operation

Level of Service and Vehicle Backups - 2035 PM Peak Hour															
Converse Ave Northbound			*Converse Ave* Southbound			*Pershing Blvd* Eastbound			*Pershing Blvd* Westbound			*19th St* Northeast			Overall
L	T	R	L	T	R	L	T	R	L	T	R	L	T	R	LOS/Delay
D	D	D	A	A	A	C	C	C	A	A	A	D	D	D	C / 18.5
460'	460'	460'	50'	50'	50'	375'	375'	375'	50'	50'	50'	375'	375'	375'	

All movements would operate at LOS 'D' or better through the year 2030, at a 50% confidence limit, according to the RODEL computer analysis program. To continue to operate at acceptable levels through the year 2035 and beyond, the roundabout would require a three-lane entry on the west approach of Pershing Boulevard, the 19th Street approach and the south approach of Converse Avenue, providing year 2035 LOS 'B' or better operation for all movements at the roundabout. As shown on the four improvement option summaries above, the modern roundabout also provides the biggest reduction in projected vehicle crashes.

An interesting part of the roundabout approval challenge involved reaching agreement on the roundabout operational Level of Service models. Initially, FHWA supported use of the Highway Capacity Analysis methodology, whereas Ayres

Associates utilized the RODEL and ARCADY computer traffic operation analysis software, due to the complexity of this roundabout as a dual-lane, five-leg roundabout. After consultation between FHWA, Ayres Associates, and GHD, RODEL was accepted as the methodology providing the most reasonable analysis results.

Based on the evaluation of intersection improvement alternatives, it was recommended to construct a dual-lane, five-leg roundabout at the intersection.

Challenge 2: Public Involvement/Education

It was considered that the Pershing/Converse/19th Street intersection design question would take attention away from development of the corridor design process. Therefore, the Ayres corridor study approach was to focus public meeting discussions on design issues for the corridor cross-section, excluding the Pershing Boulevard/Converse Avenue/19th Street intersection. The final corridor design recommendation involved a minimal widening of Pershing Boulevard with sidewalk enhancements, driveway adjustments and intersection modifications. Once consensus was reached on the corridor cross-section, emphasis was directed to solving the Pershing Boulevard/Converse Avenue/19th Street intersection improvement design issue.

The eight improvement options were reduced to four options for presentation to the public. Those options that reduced intersection access from 19th Street were dismissed due to their impact on area street network connectivity or impact on adjacent developments and neighborhoods.

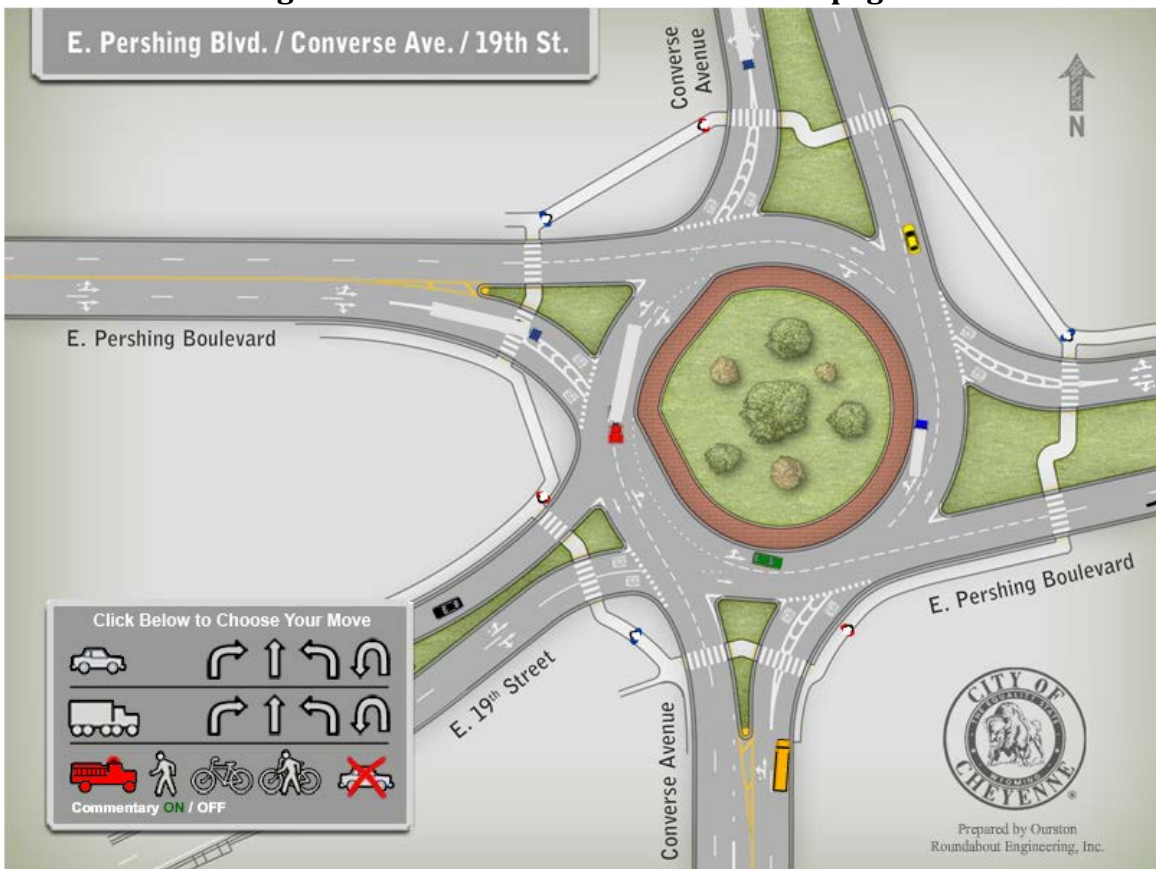
A 'No Build' and the four selected intersection improvement alternatives were presented at a public information meeting, which included the following special roundabout education program:

- A roundabout fact sheet
- FHWA Roundabout video presentation
- A ¼ inch scale drawing of the roundabout that the public could drive scale model cars and trucks around (Figure 8)
- A set of roundabout advance signing options for public comment (Figure 9)
- Development of a special interactive website program on how to drive a roundabout (Figure 10)
- Public question/answer period

Figure 8: Scale Model Roundabout Public Education

Figure 9: Signing Alternatives

Figure 10: Interactive Roundabout Webpage



As roundabout construction was nearing completion, several days of 'How to Drive a Roundabout' presentations were made at area service group, school and senior living centers. AARP partnered with the MPO and Ayres Associates to organize these presentations. The first set of presentations was made at the city library, which attracted a continuous crowd of interested citizens. This was in addition to a presentation on the evening television news. Overall, public acceptance and understanding of the roundabout was nearly unanimous.

An additional public education element was proposed to involve a 'Roundabout Rodeo'. This education element involved using a large commercial parking lot on the Pershing Boulevard corridor to lay out a scaled roundabout and allow the public to navigate golf carts through the roundabout. First, drivers would be educated on how to drive a golf cart and how a roundabout works before they could test drive the downsized roundabout. Each driver would be escorted by a project team member for safety purposes. This education element, which was considered to draw extensive publicity for the new roundabout, was dismissed when the City Attorney advised on the potential liability risk involved.

As the roundabout design was developed, meetings were held with city street maintenance, fire, and police representatives to explain how they would drive and

snow plow at the roundabout. This included use of a video on snow plowing techniques for a roundabout, as well as contact information for their peers in cities with established roundabouts. These meetings resolved city staff concerns with the roundabout.

An additional part of public acceptance was the city requirement that the intersection remain open to traffic during construction. As the roundabout construction was nearing completion, the public could drive through the intersection, which was coned off to provide a basic single lane roundabout driving experience. This provided drivers with a simplified decision making process and was done at low speeds through the work zone.

The public education program proved to be very successful in gaining public support and knowledge on how to drive the new roundabout.

Challenge 3: Roundabout Design Considerations

The first design challenge involved minimizing property impacts to an adjacent shopping center in the southeast quadrant of the intersection, a movie video store located in the southwest corner of the intersection, a Veteran's Administration property and storm water retention area in the northeast quadrant of the intersection and single family residential development in the northwest quadrant of the intersection. These property constraints controlled the roundabout design flexibility. The city of Cheyenne owned the residential property on the northwest quadrant, which solved some of the alignment configuration concerns to minimize impacts on the other quadrant developments.

The second design challenge involved the uncertainty on ADA pedestrian crossing requirements. After much discussion with the city of Cheyenne engineering staff and the MPO, it was decided to install conduit and bases for potential future traffic signals or RRFBs. This was an especially important consideration due to concerns that the western leg of the roundabout was also a marked school crossing. As the roundabout design was nearing completion, it was decided to install push button RRFBs at each pedestrian crosswalk. When construction was completed in December, 2013, RRFBs were operational at all the roundabout crosswalks.

The third design challenge involved development of landscaping design enhancements of the roundabout center circle. The Pershing Boulevard/Converse Avenue/19th Street intersection serves as a northeastern gateway to the city of Cheyenne. It was desired to create a gateway feature inside the roundabout that would reflect the western heritage of the city of Cheyenne. This desire was countered by cost and annual maintenance impacts that included installation of an irrigation system for a gateway feature. The initial gateway discussion centered on a public art sculpture treatment versus native landscaping. Ultimately, it was agreed to install a native rock design with landscaping and irrigation, as shown on Figure 11.

Figure 11: Roundabout Landscaping Plan

The final challenge involved an attorney representing the video store property located at the southwest quadrant of the intersection. The issue involved driveway access closures on the western Pershing Boulevard and 19th Street approaches to the roundabout. The original roundabout design consolidated the two driveways on each street into a single drive on each street at the western edge of the video store property, farthest away from the roundabout center circle, as shown on Figure 12. In addition to an attorney, the video store retained an engineering consultant to develop alternative roundabout design configurations. Based on traffic operation, pedestrian concerns, and adjacent property impacts, especially to the adjacent shopping center, the city of Cheyenne recommended completion of the original roundabout design. The video store property owner decided to take the City to court based on potential damages to the value of his land. In the end, immediately prior to a court hearing, the City reached a compromise with the property owner that allowed ingress to remain at the two eastern driveways but not allow parking lot traffic to exit from those driveways, which are in very close proximity to the pedestrian crosswalks previously shown on Figure 12.

Figure 12: Hollywood Video Driveway Issue

Conclusions

The process to recommend construction of Cheyenne, Wyoming's first dual-lane roundabout at a complicated triangular intersection faced many obstacles for success. First, it was necessary to conduct an analytical analysis of alternative improvement options that could operate safely and at acceptable levels of service in the year 2035, without limiting street system connectivity, while minimizing impacts to the adjacent built environment. Secondly, it was necessary to develop a detailed education program to create public and agency staff acceptance and understanding of how to drive and maintain the roundabout. Finally, it was necessary to overcome uncertainty associated with pedestrian crosswalk safety requirements for a dual-lane roundabout, to create a gateway landscaping plan, and to overcome a court suit related to access driveway changes to an adjacent property.

The concerted planning and involvement efforts of the Cheyenne MPO and the city of Cheyenne engineering staff were a key element in making Cheyenne's first dual-lane, five-leg roundabout a successful reality.

Special thanks are given the Mr. Thomas Mason, Cheyenne MPO Director; Mr. Nathan Beauheim, City of Cheyenne Traffic Engineer; Mr. Kevin Kuhlow, GHD Engineering; and Mr. Andrew Dana, Ayres Associates Project Engineer for their assistance in making this a successful project. Roundabout construction has been completed and opened to traffic in December, 2013.