Roundabouts Near At-Grade Railroad Crossings

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ABSTRACT
Roundabouts near at-grade railroad crossings present safety issues that are similar to other intersections. There are two major problems: vehicles queued at an approach to a roundabout may get caught on the railroad tracks; and vehicles queued at the railroad track may back up into the roundabout and interfere with the roundabout operations. Approaches to these problems will be explored through a case study of a roundabout network near a railroad with freight train operations. Roadway links in the transportation network could be blocked by trains for up to 4 minutes. Through analysis with simulation software, queues were analyzed and traffic control techniques evaluated to provide safe operations at nearby roundabouts. These techniques include providing additional capacity within the nearby roundabouts and approaches and signalizing nearby roundabout approaches. Conclusions from this case study can be applied to other similar at-grade railroad crossing/roundabout configurations.

INTRODUCTION

The Town of Eagle is located about 20 miles west of Vail along the I-70 corridor in western Colorado. As shown in Figure 1, US 6 parallels I-70 in the Eagle area and provides access to the Town of Eagle, a community of about 5,000 residents. The Union Pacific railroad is located between US 6 and I-70 and only one roadway, Eby Creek Road, connects I-70 with US 6. Eby Creek Road has a grade-separated crossing of the Union Pacific railroad.

The Town of Eagle's *Comprehensive Plan* calls for expansion of the existing commercial area to the east, in an area bounded by I-70 to the north and US 6 to the south. As part of this planning, the Town desired to establish another connection between I-70 and US 6. A new interchange is planned on I-70, to be located about 1.8 miles to the east of the I-70/Eby Creek Road interchange, along with a connector road linking the new interchange with US 6.

The Town and the Colorado Department of Transportation (CDOT) both indicated a desire to have a roundabout at the intersection of US 6 and the new connector road. Since US 6 and the Union Pacific railroad are less than 100 feet apart in this area, concern was expressed about the effect of the railroad on operations of the roundabout. In addition, the Union Pacific railroad expressed concern about the proximity of the roundabout to the railroad. Another concern was raised by CDOT about the possibility of queues developing at the railroad crossing backing up into the new I-70 interchange.

Roundabouts near railroad crossings are relatively rare in the United States. France, however, had just completed a study "*Sécurité aux passages á niveau, Cas de la proximaté d'un carrefour giratoire*"(1), which provided useful information and guidance. In addition, the publication *Preemption of Traffic Signals Near Railroad Crossings*(2) was consulted for the principles on traffic signals near railroad crossings for application to roundabouts near railroad crossings.

THE FRENCH EXPERIENCE

The French report "*Sécurité aux passages á niveau, Cas de la proximaté d'un carrefour giratoire*" identified two major cases regarding roundabouts near railroad crossings. The first, illustrated in Figure 2, involves a queue developing on a roundabout approach backing up onto the railroad crossing, presenting a danger that vehicles may be caught on the crossing. Counter measures identified for this situation include:

- Signing to warn drivers not to stop on the tracks;
- Providing an area for vehicles to move into if they get caught on the tracks;
- Signalization of the roundabout approaches to hold vehicles while the queued approach clears.

The second case, illustrated in Figure 3, involves queues forming at a railroad crossing backing up into a nearby roundabout. Counter measures identified include:

- Signing;
- Signalization of adjacent roundabout approaches to allow for operation of some of the roundabout movements.

These counter measures were evaluated in the Eagle, Colorado, case study.

THE EAGLE VISSIM MODEL

In order to predict vehicle queues emanating from the proposed connector road crossing of the railroad, a VISSIM model was developed, with vehicular traffic projections taken from the I-70/East Eagle interchange Study. In order to forecast train blockage times, information provided by Union Pacific indicated that the longest train would be 5,000 feet long and would travel at a minimum speed of 25 mph. This translated into a maximum blockage time of 4 minutes and VISSIM was programmed so that a train would travel across the crossing for 4 minutes. 2025 PM peak hour volumes were input into the VISSIM model and the reporting capabilities of the model used to output maximum queues on various roundabout approaches. An iterative approach was used to test various lane configurations at the roundabouts (i.e., single-lane or multi-lane circulatory or approach operation).

It became apparent through these simulations that during a blockage of the railroad crossing the US 6/connector road roundabout would lock up unless additional traffic control measures were implemented. Under normal operations, a single-lane circulatory roadway with single-lane approaches provided sufficient capacity to accommodate projected peak-hour traffic. With a crossing blockage, however, the roundabout quickly locked up, since eastbound traffic desiring to turn left onto the connector road backed up into the roundabout, effectively blocking both eastbound and westbound through traffic on US 6. To address this problem, the roundabout was reconfigured for modified two-lane operation, with a two-lane eastbound approach. To simulate this operation, VISSIM was programmed with a traffic signal on the eastbound approach so that the inner lane was stopped during blockage events, with the outer through lane allowed to operate normally. With this configuration, VISSIM showed normal free flowing operations for through traffic on US 6. Moreover, the calculation of queues on the eastbound approach to the roundabout aided the design of the length of the two-lane approach for various blockage times. Figure 4 illustrates a VISSIM run with maximum queues.

Based on the VISSIM simulations, the design of the roundabout was modified for two-lane operation as shown in Figure 5. The design raised some issues for traffic control:

- Could the approach operate acceptably with normal “Yield” control? Would drivers see the train blockage and not venture into the roundabout and block through traffic?
- Would a traffic signal coordinated with the rail crossing signals and gates provide adequate control? What kind of operation should this signal have? A green/red indicator would be confusing. The green indicator would conflict with the “Yield” control on the approach. Would a dark/red indicator provide better indication?

- Should the approach have gates of its own? Would a raised island be needed between the 2 lanes?
- Would drivers encountering a long queue try to bypass the queue and then sneak in to make a left-turn at the roundabout?

These issues need further research and evaluation. The project team is leaning toward a signalized eastbound approach with dark/red control.

Figure 5 also shows three other modifications based on the French experience and the VISSIM simulations.

- The southbound approach was modified to provide enough stacking distance between the “Yield” line at the roundabout and the railroad tracks to store a WB-67 vehicle, the largest vehicle expected to use the roundabout.
- In addition, this approach was enlarged to provide an area wide enough to allow a passenger vehicle to move around a truck stopped at the “Yield” line.
- The westbound approach was widened to provide for stacking of westbound right-turning vehicles during a crossing blockage. This would allow westbound through vehicles to pass these waiting vehicles and use the roundabouts during a blockage event.

SIGNING AND STRIPING

Figure 6 illustrates the initial signing and striping plan. This plan follows the recommendations found in Chapter 8 of the 2003 *Manual of Uniform Traffic Control Devices* (MUTCD)[3] with the railroad/intersection warning sign modified with the roundabout symbol. Note that, as prescribed in the MUTCD, railroad pavement marking symbols are not used on the northbound approach to the rail crossing since the crossing is too close to the intersection. A “Do Not Stop on Crossing” sign is used to prevent vehicles queue at the roundabout from getting caught on the crossing when a train might be coming.

CONCLUSIONS

Roundabouts near railroad crossings present similar issues as conventional intersections near railroad crossings. Signing and striping need only slight modifications from standard practice found in Chapter 8 of the MUTCD. Like conventional ”T” inter-sections, roundabouts need to insure that adequate storage is available between the “Yield” line and the railroad crossing to store the design vehicle.

A subject for further research is the method of controlling traffic to minimize roundabout disruptions during a train blockage event. Controlling certain multi-lane approaches with traffic signals or gates synchronized with the railroad crossing signals and gates is an issue that needs further exploration.

References:

1. *Sécurité aux passages á niveau, Cas de la proximite d'un carrefour giratoire*, République Française ministére des Transports de l'Équipement du Tourisme et de la Mer, September 2006.
2. *Preemption of Traffic Signals Near Railroad Crossings, An ITE Recommended Practice*, Institute of Transportation Engineers, January 2006.
3. *Manual on Uniform Traffic Control Devices – 2003 Edition*, Federal Highway Administration.

Figures

1 Eagle Vicinity Map
2 Roundabout Queue Backing Into Railroad Crossing
3 Railroad Crossing Queue Backing Into Roundabout
4 Queues from VISSIM
5 US 6/Connector Road Roundabout
6 US 6/Connector Road Signing and Striping Plan

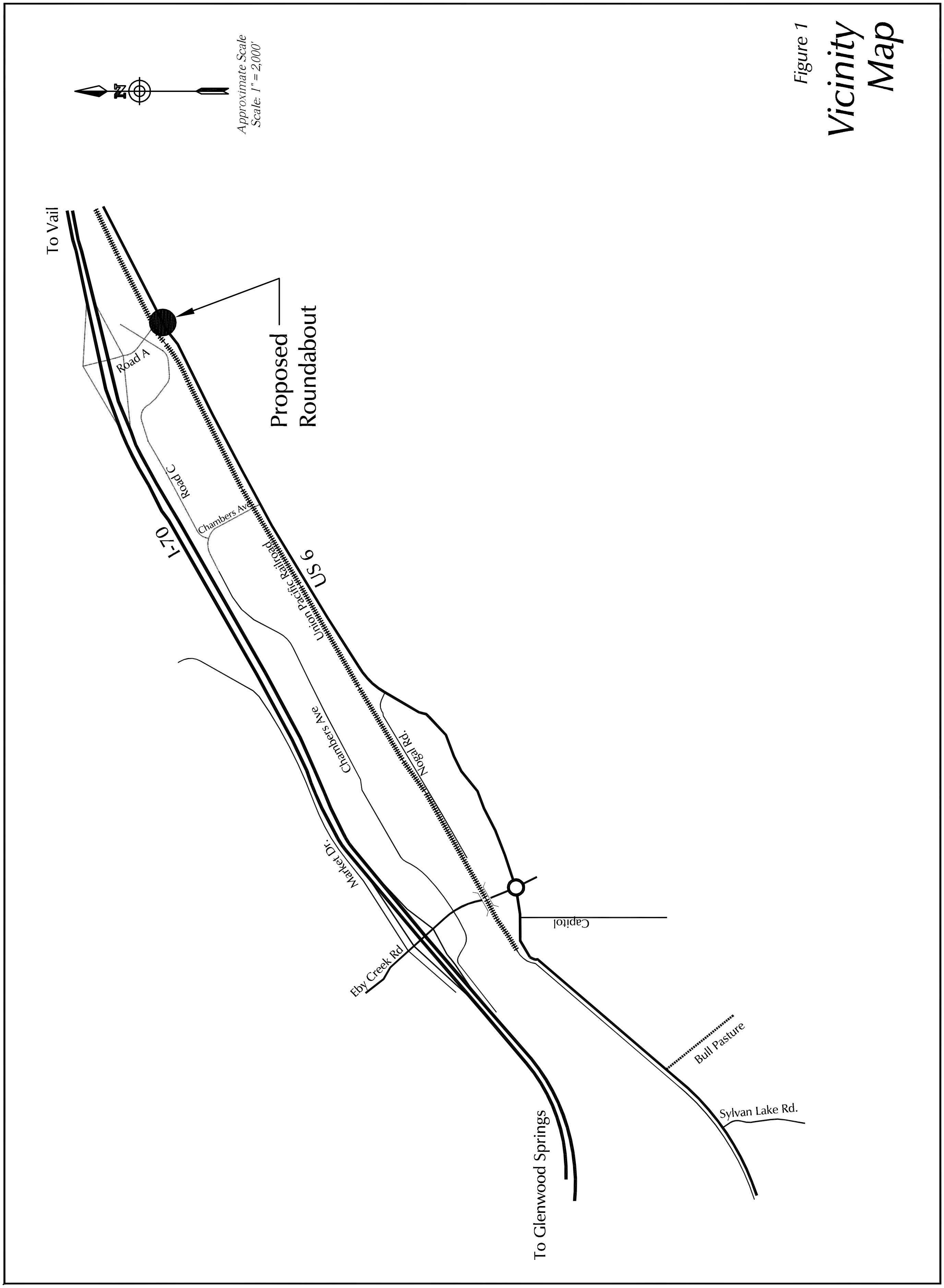

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Figure 2 – Roundabout Queue Backing Into Railroad Crossing

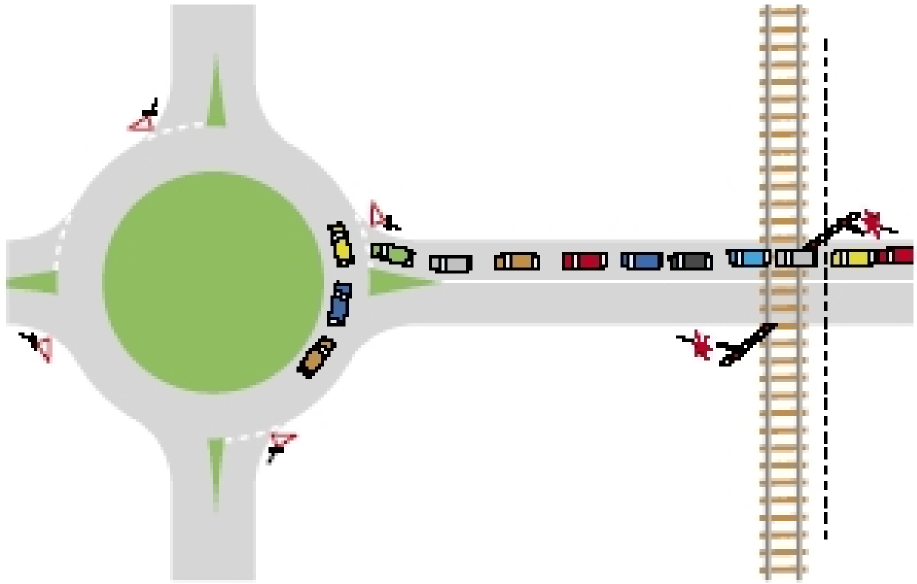
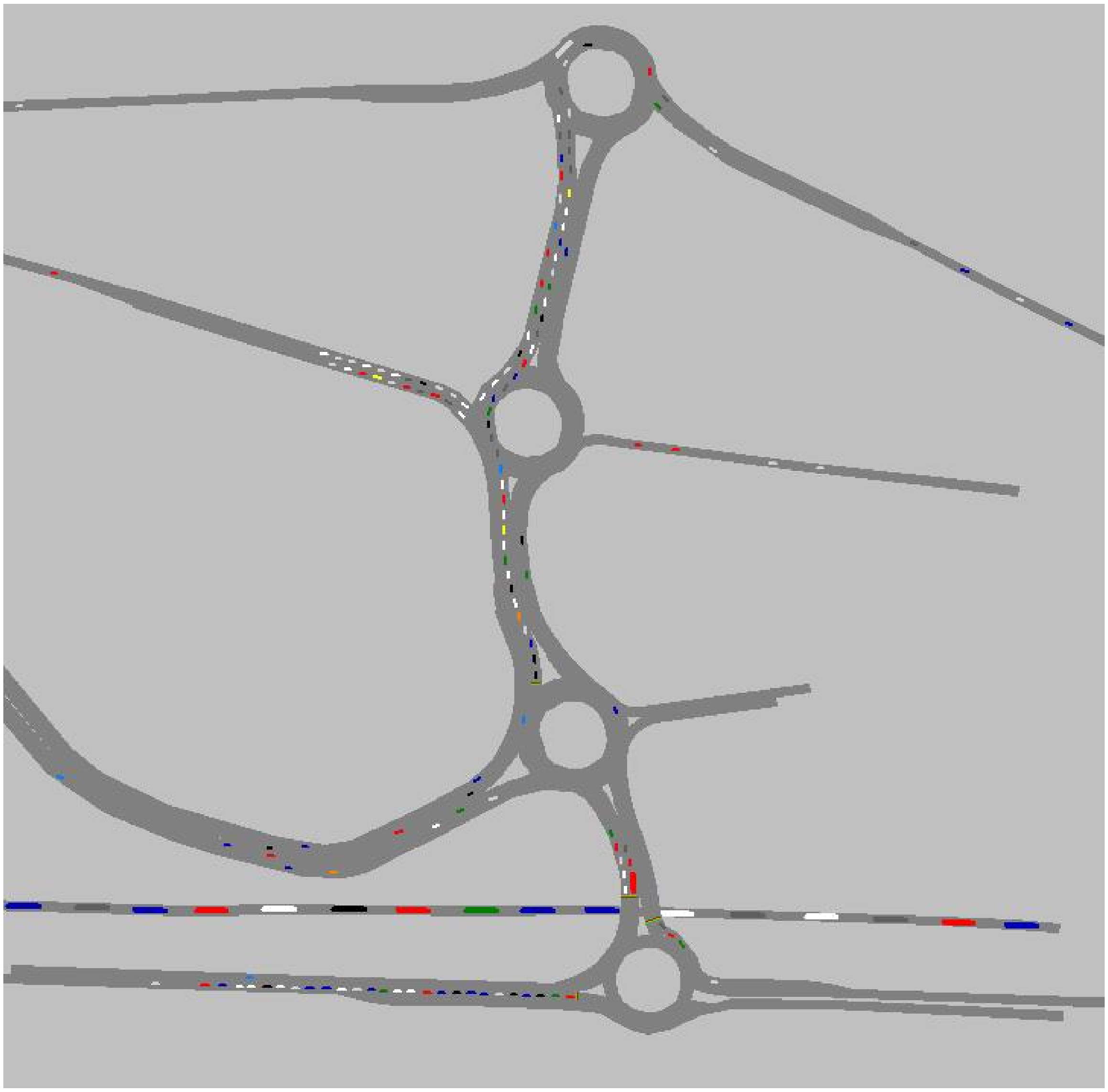


Figure 3 – Railroad Crossing Queue Backing Into Roundabout

Source: *Sécurité aux passages á niveau*

Figure 4 – Queues From VISSIM



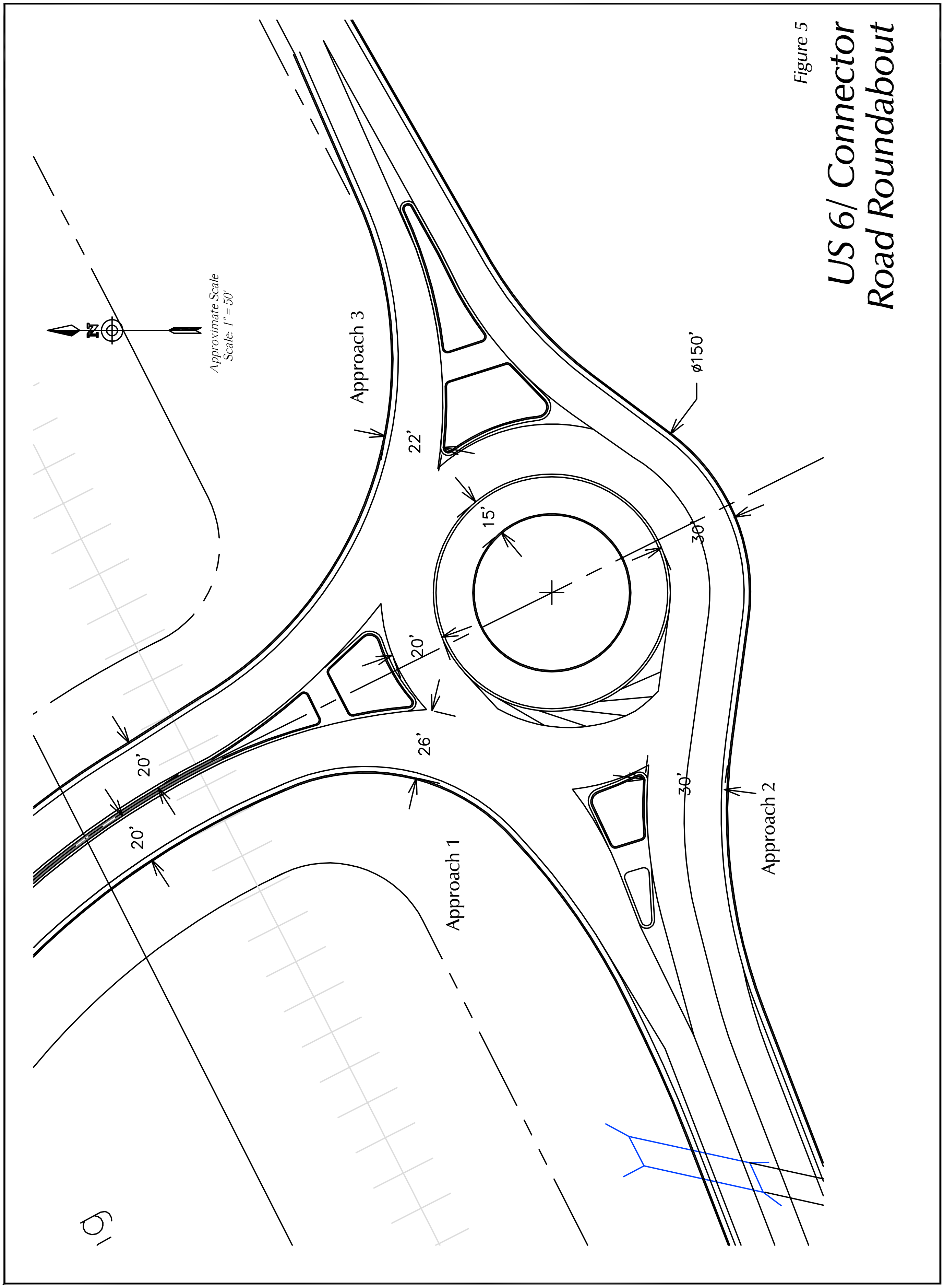


Figure 5

US 6/ Connector Road Roundabout

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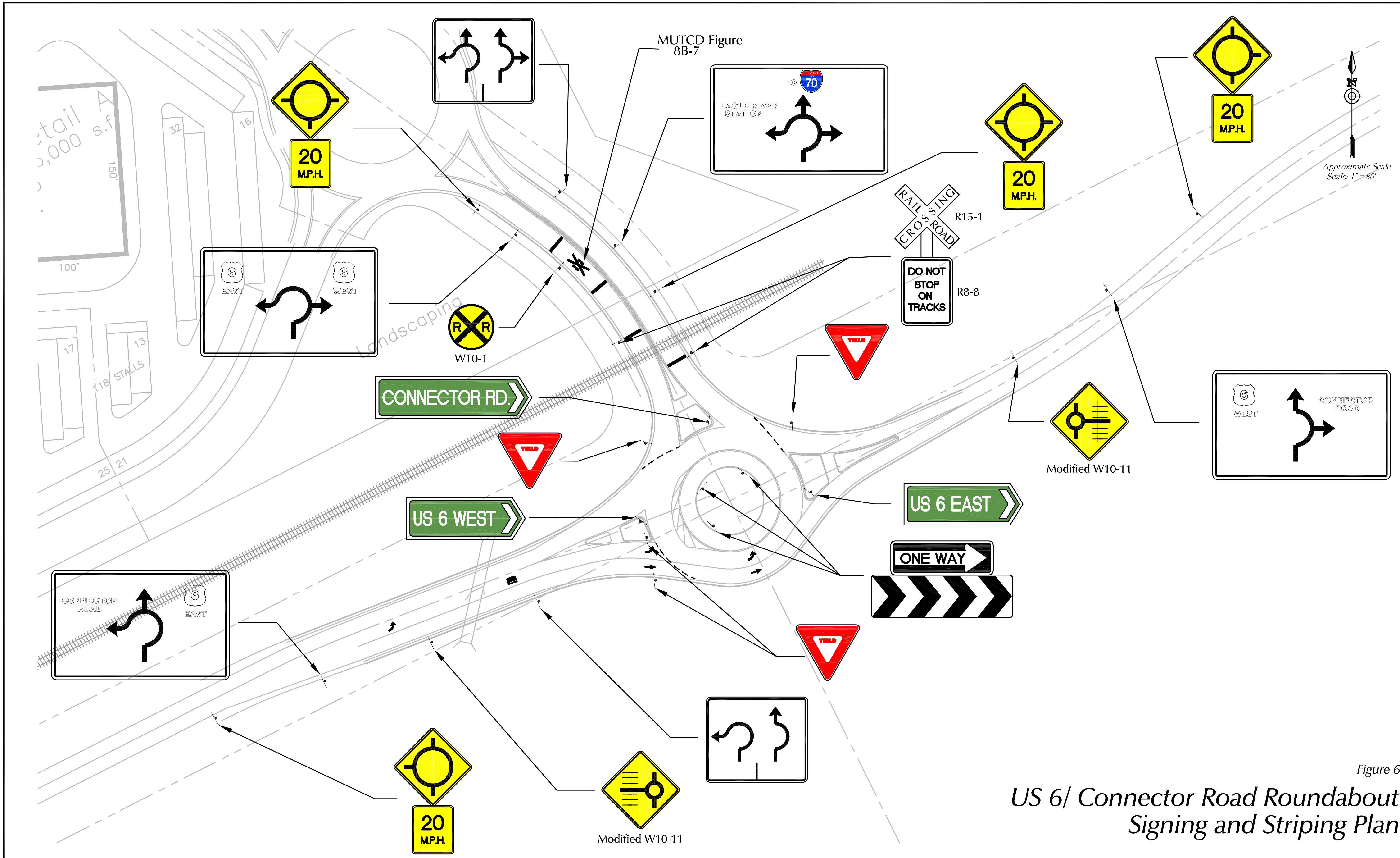

Figure 6

US 6/ Connector Road Roundabout
Signing and Striping Plan

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