The National Academies of
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TRANSPORTATION RESEARCH BOARD

Roundabout Implementation Experience - Overcoming Challenges

Thursday, August 29, 2019
1:00-3:00 PM ET

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

Purpose

To provide guidance that overcomes challenges of roundabout implementation and leads to successful outcomes

Learning Objectives

At the end of this webinar, you will be able to:

- Describe how to design safer roundabouts through traffic analysis modeling
- Identify flexibility needed in roundabout implementations
- Describe how roundabouts may lower speeds to enhance pedestrian and bike integration outcomes
- Utilize other tools outside modeling to support the roundabout implementation experience

TRB 6th International Roundabout Conference

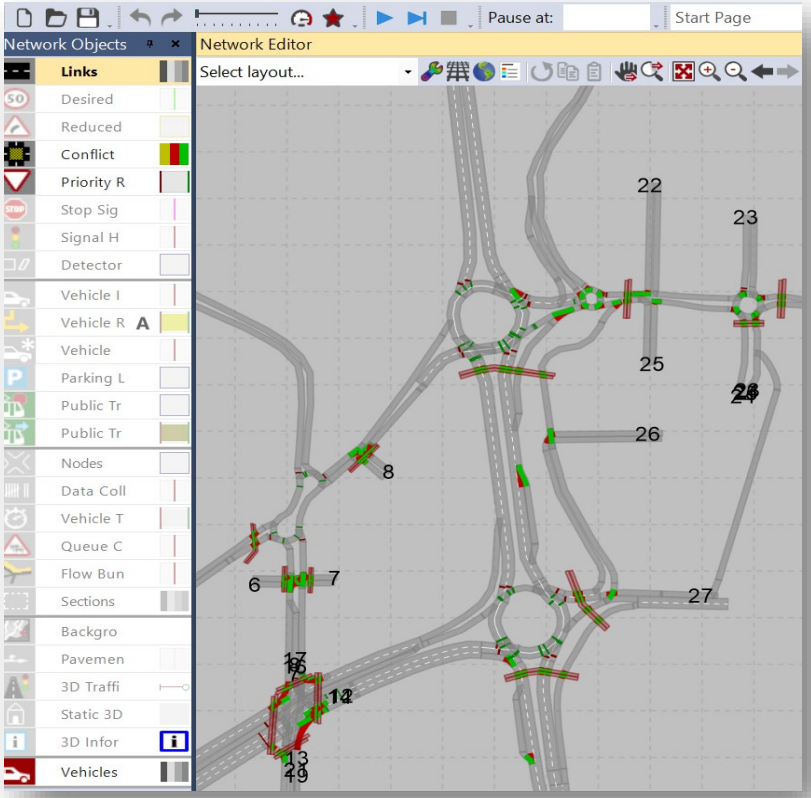
Monterey, California
May 18-20, 2020

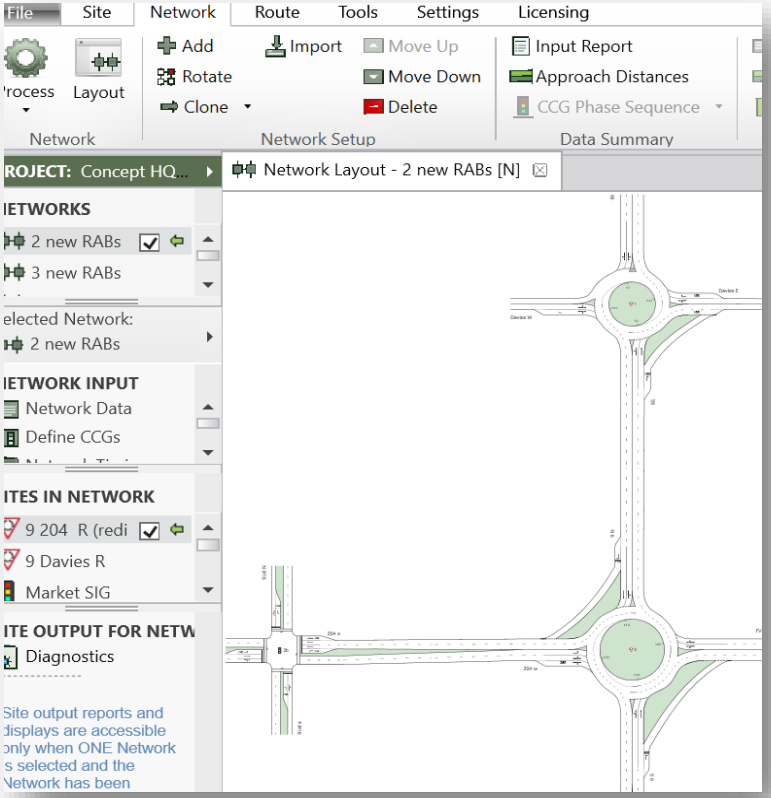
CALL FOR ABSTRACT

Submissions due August 30th, 2019

Roundabout Analysis

Operational and Planning / Scenario Analyses





Goal: Analysis done well enough to add value

Analysis is just one consideration

Models rarely decide - Decision makers consider many things

(Safety, operations, maintenance, funding, public input, context, modal, materials, regional and local land use, etc.)

The key to successful analysis

Define and stick to a process - It goes to credibility

The WSDOT Way:

1. If possible, use empirical insights from existing roundabouts
2. If needed, model (Deterministic or Microsimulation? Keep it simple)

Know the difference between a model, a modeler, and a modeling process

Every model has adjustments.
In the hands of a seasoned modeler operating the right models within well defined protocols and processes, model results from well developed models can help projects and their decision makers.

Anything less can quickly lead to expensive or less than desirable outcomes.

Know the difference between a model, a modeler, and a modeling process

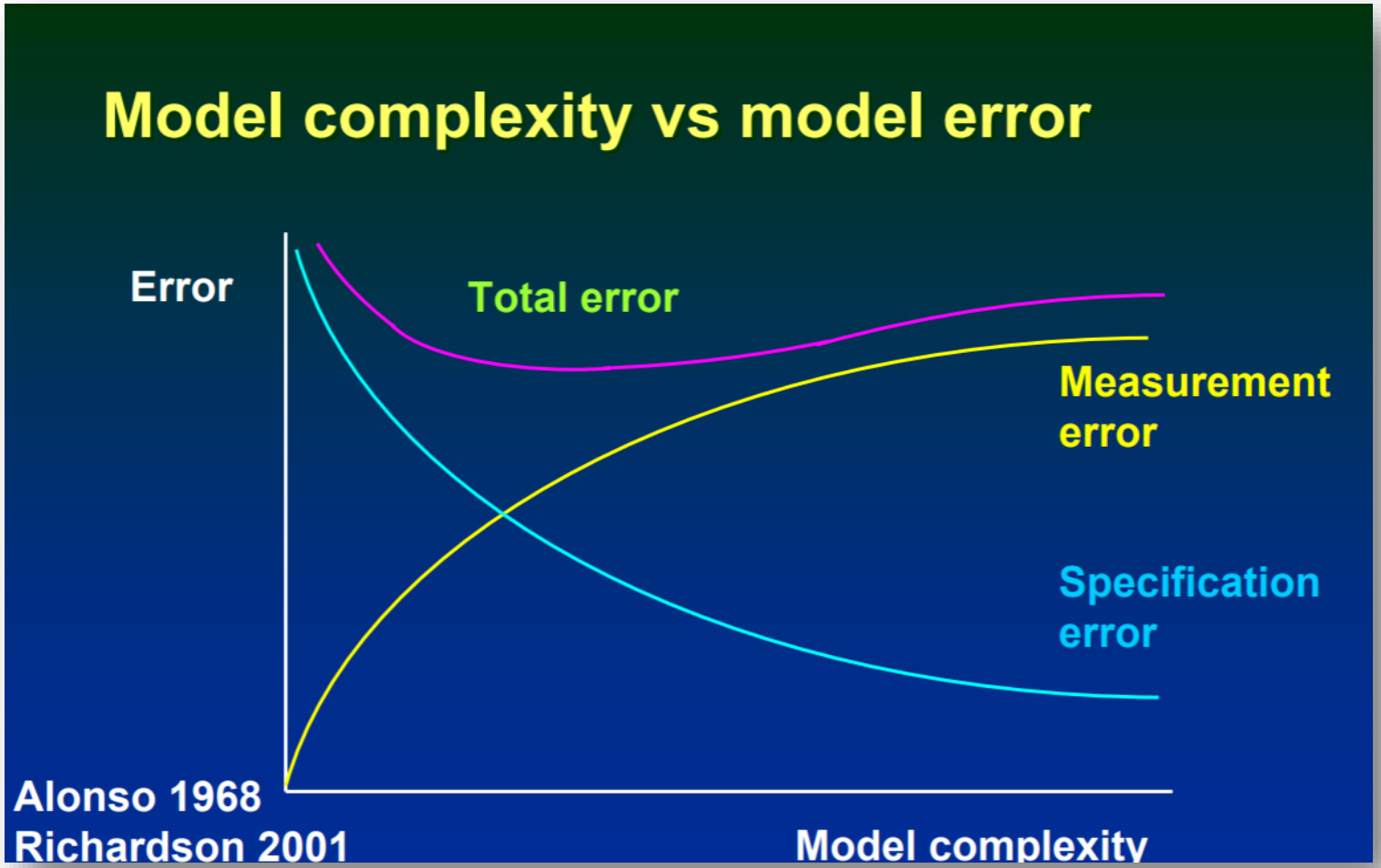
Caution

If you hear the following, start asking questions immediately: Sidra says…, Vissim says…, Synchro says…, Doug says…

What you want to hear is: The process resulted in the following findings…

Also be cautious of precision beyond reason and look for sensitivity analyses.

Finding the right model – a balance



SIDRA Guidance/Policy

WSDOT Sidra Policy Settings

This Brochure provides a reference guide for WSDOT policy settings needed to complete an analysis of roundabouts using **Sidra 8** regarding WSDOT projects or projects affecting state owned or state interest facilities. Any adjustments to either the settings or Sidra defaults (remaining parameters not discussed in this Brochure) should be documented in a Method and Assumptions document.

If you have questions about the content in this Brochure, please contact:

Doug McClanahan
WSDOT HQ Traffic
360-705-7984
mcclando@wsdot.wa.

The latest version of this Brochure is located on the WSDOT Traffic Analysis website : (http://www.wsdot.wa.gov/Design/Traffic/Analysis/).

June 2019

Lane Geometry Dialog

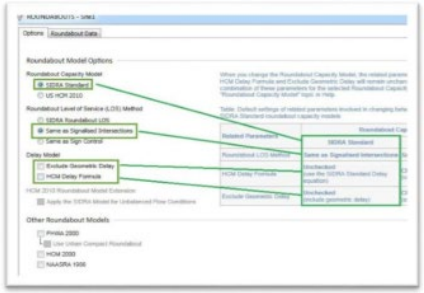
Lane Configuration Tab - Unless the roundabout being analyzed already exists or there is a detailed drawing available, use the following Lane Widths:

- Single lane approach: minimum 15 ft
- Mulit-lane approach: minimum 14 ft (each lane)

Roundabouts Dialog

Options Tab – Use the following settings for Roundabout Model Options parameters:

- Roundabout Capacity Model – Sidra Standard
- Roundabout LOS Method – Same as Signalized Intersections
- Delay Model – uncheck both Exclude Geometric Delay and HCM Delay Formula



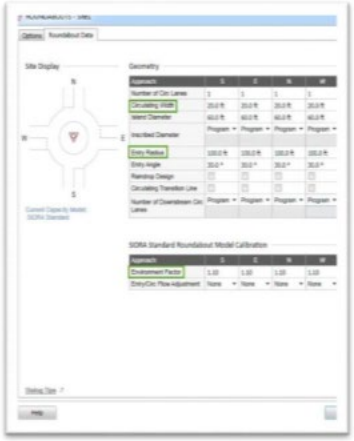
https://www.wsdot.wa.gov/NR/rdonlyres/0012E6B9-DC52-4B28-AE9C-5E4EACC98C0B/0/SidraPolicy.pdf

SIDRA Guidance/Policy (cont.)

Roundabouts Dialog

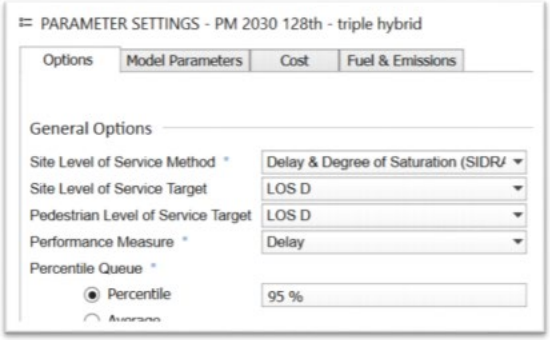
Roundabout Data Tab – Use the following settings:

- Circulating width: single lane RB minimum 18'-20', multi-lane 15' ea
- Entry Radius: 90' – 110' (unless a site specific design is available)
- Environment Factor: 1.1 for opening year and 1.0 for horizon year.



Parameter Settings Dialog

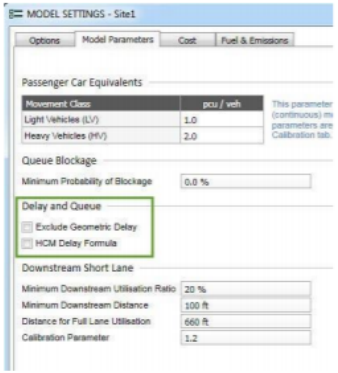
Options Tab – Use the following settings for Options Tab:



Model Settings Dialog

Model Parameters Tab – Use the following settings for the Delay and Queue parameters (if the recommended parameters for the Roundabouts dialog where followed, these parameters should already be unchecked):

- Exclude Geometry Delay: uncheck
- HCM Delay Formula: uncheck



Additional considerations

- **MOE**: Unlike other intersection control types, the primary MOE for roundabouts is not LOS. Instead, it is a mix of MOEs. For operational modeling, first attempt to balance each lane group to less than about 0.85 - 0.9 v/c with reasonable queues given local conditions (keeping in mind RAB queues are moving queues, which are not perceived to be as negative as static signal queues). MOE's in order of importance are v/c, stop rate, queue, and then LOS. Conduct sensitivity analyses by adjusting volumes and geometrics. If v/c => 0.9, examine volume projections & consider microsimulation. In addition queues for 20 year analyses need not be considered & Peak Flow Factor should be set to 1.0. Consider practical 10 to 15 year solutions.
- **Network Function**: The network function allows users to evaluate how multiple, closely spaced intersections will interact. The control types can be any combination of roundabout, signal, two way stop, and pedestrian midblock crossing. Sidra is a good tool for evaluating closely spaced intersections containing one or more roundabouts if it is determined that microsimulation is not warranted (based on the complexity of the project, scope, or budget). WSDOT does not recommend using Sidra to produce MOE's for intersection control types other than roundabouts.

Vissim Guidance/Policy

PROTOCOL FOR VISSIM SIMULATION

Washington State Department of Transportation

September 2014

ACKNOWLEDGMENTS

The following individuals were key contributors in the preparation of this document.

Washington State Department of Transportation
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The following individuals were key contributors in the June 2011 ODOT publication[1]; they have been listed under the agency/firm they were employed with at the time of publication.

Oregon Department of Transportation
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Jim Dale, P.E. Karen Giese, P.E. (Now with City of Austin, TX)
Jongsun Won

[1] Protocol for Vissim Simulation, C. Mai, C. McDaniel-Wilson, D. Noval, et al. (http://www.oregon.gov/ODOT/TD/TP/APM/AddC.pdf)

https://www.wsdot.wa.gov/NR/rdonlyres/378BEAC9-FE26-4EDA-AA1F-B3A55F9C532F/0/VissimProtocol.pdf

Even a good process cannot control everything

Precise/Accurate: Why bother with the details of simulation when something out of our control, like rain, economic change affecting trucks, ride sharing, and many other dynamics happen and can impart large and significant effects on traffic demand and infrastructure capacity?

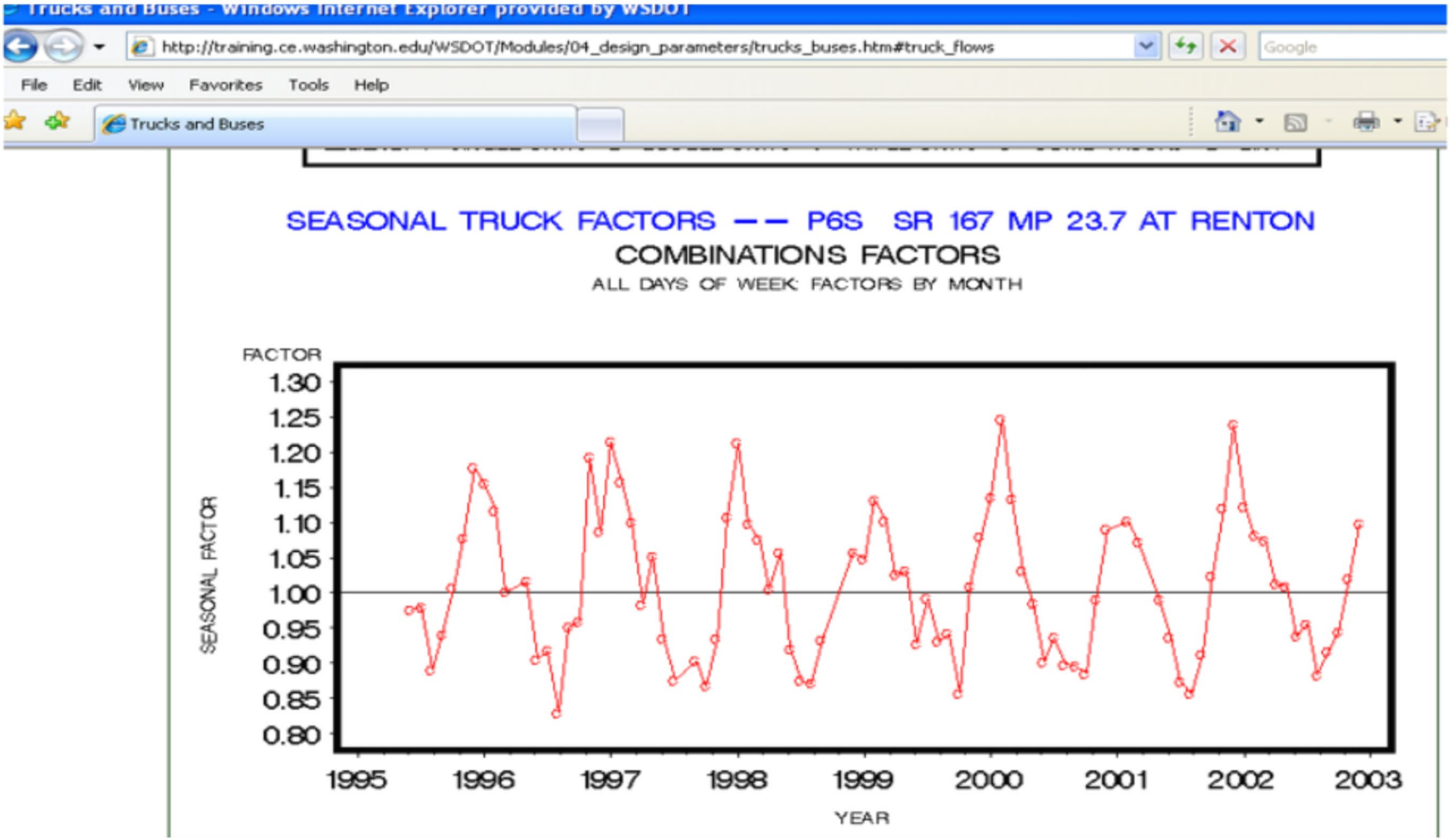
Prevailing analysis conditions to target:

Condition	Volume	Maximum Observed Flow	Capacity	Speed
Low Visibility	[no studies]	[no studies]	[no studies]	reduced 13%
Rain	[no studies]	reduced 0-20%	reduced 4-47%	[no studies]
Snow	reduced 7-47%	reduced 5-10%	reduced 30%	reduced 13-40%
Wind	[no studies]	[no studies]	[no studies]	reduced 10%

https://ops.fhwa.dot.gov/publications/weatherempirical/sect2.htm

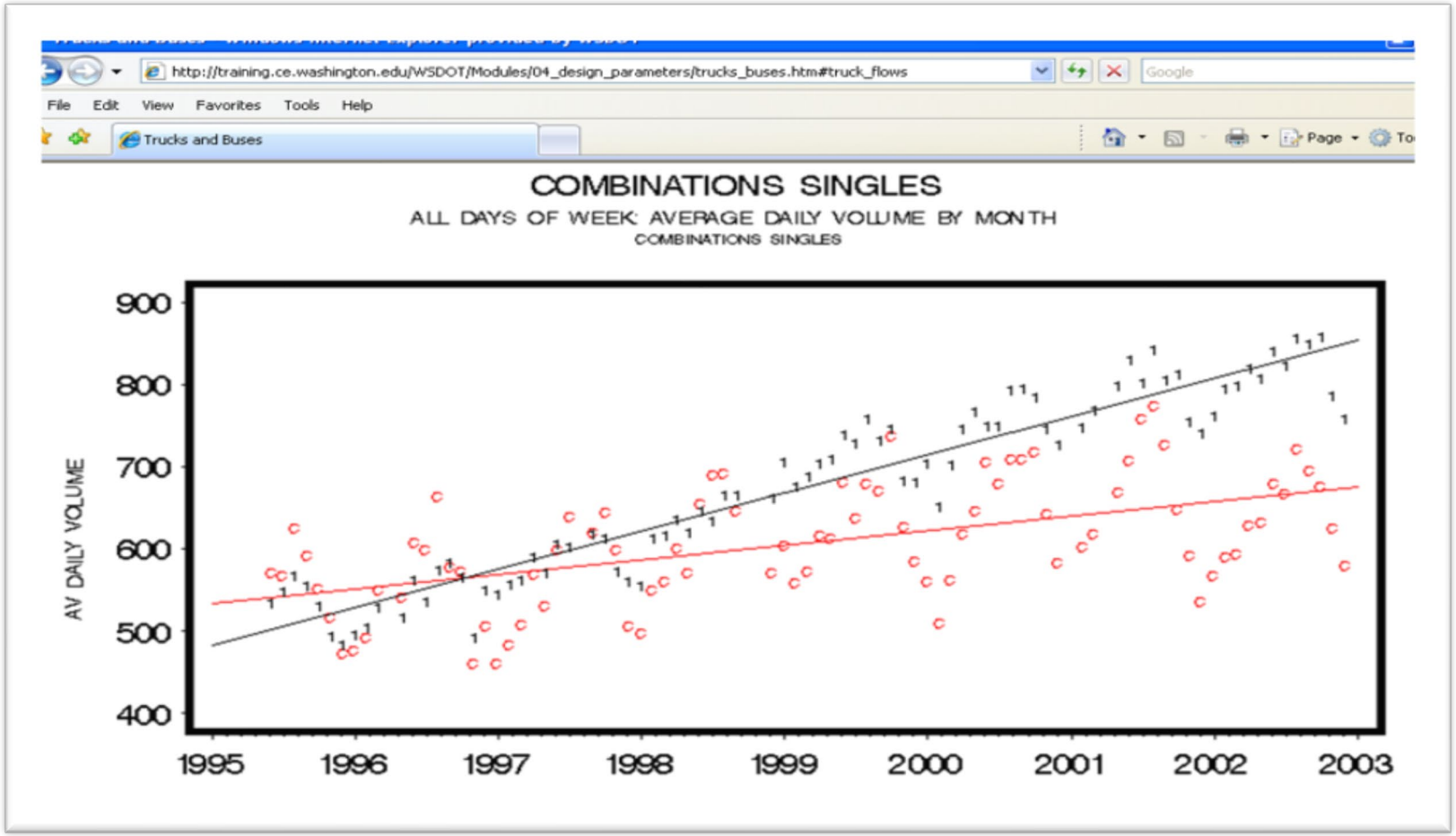
Many factors weigh on a roundabout's ability to function. Just as getting consensus on the design vehicle, prevailing conditions should be considered and design volumes/target capacity clearly communicated

Traffic composition is dynamic: season, month, day of the week, peak hour, peak period, economic cycle



Trend Data

Example: We can't control how truck types used will be changing during the 20 year horizon



Again, we can't control for everything but we can control model choice, focus, and expectations

- Use the least complicated model necessary to help choose between solution options
- Limit planning to scenario comparisons; useful findings will have scenario deltas greater than likely model error
- Operational models should better understand likely near term functionality

Agencies should provide guidance for process, model defaults and settings, techniques that help ensure consistent application, and state of the practice

Require electronic model files and documentation (methods and assumptions doc) for all projects

Guidance

https://www.wsdot.wa.gov/Design/Traffic/Analysis/

WSDOT Phone Book Field Services Applica roundabout - Google

Traffic Analysis

Traffic Analysis Resources

- WSDOT Traffic Analysis Guidebook (pdf 151 kb)
- WSDOT VISSIM Protocol
- Oregon's VISSIM Protocol (pdf 3 mb)
- WSDOT SIDRA Policy and Settings (pdf 841 kb)
- WSDOT Synchro and SimTraffic Protocol [ver. 10] (pdf 513 kb)
- Traffic Analysis Tools Primer
- Decision Support Methodology for Selecting Traffic Analysis Tools
- Guidelines for Applying Traffic Microsimulation Modeling Software
- NCHRP Report 765: Analytical Travel Forecasting Approaches
- Transportation Data & GIS
- WSDOT Design Manual Ch 320: Traffic Analysis (pdf 642 kb)

Assumption Documentation

Microsimulation Example

VISSIM Assumptions template or example.xls [Compatibility Mode] - Microsoft Excel

General VISSIM Assumptions

Project:
Date Created:
Created by:

Parameters not addressed in this document remained its default value/setting.

Type	Location	Section	Assumption	Reason
Base Data	Distribution	Desired Speed	Linear Distribution	Default Distributions are Linear; No sufficient Speed
	Driving Behavior	Urban	5 max observed vehicles	Enhances interaction between vehicles
		Freeway	Safety Distance Reduction Factor = 0.3 for AM; 0.2 for PM	This factor was lowered due to drivers willing to ac highway during peak hour; HCS was used for Freeway Analysis
		Roundabout	Same as Urban Behavior except it observes vehicles on next lane(s)	Created so that when a truck's trailer extends into the appropriately
Traffic	Vehicle Compositions	Surface Street	97% Cars, 3% Trucks (25 mph - 40 mph)	Truck percentage on SRxxx based on data provided are based on posted speed limit
		Freeway	88% Cars (54.7-80.8mph), 12% Trucks (52.8-74.6mph)	Truck percentage on Interstate based on TDO's vehic posted speed limit
Signal Control	Controllers	Both Ramp Terminals	Fixed Time Signal Control Type	At peak hour actuated signals tend to operate similar to pretimed
Links & Connectors	SB Ramp Terminal	EB to SB	Lane Change = 2400 ft back	Accounts for lane utilization of the EB traffic using t
		WB to SB	Lane Change = 1000 ft back; Emergency Stop = 150 ft back	Accounts for lane utilization for movements to SB I-5
		SB to EB/WB	Lane Change = 1000 ft back; Emergency Stop = 200 ft back	Appropriately aligns traffic in the desired lane as they approach the intersection
		WB Approach	Left and Thru Vehicles on Different Links	Appropriately aligns traffic in the desired lane as they approach the intersection
	NB Ramp Terminal	EB to NB	Lane Change = 1000 ft back; Emergency Stop = 150 ft back	Accounts for lane utilization for movement to NB I-5 at
		EB Approach	Left and Thru Vehicles on Different Links	Appropriately aligns traffic in the desired lane as they

McClanahan:
The least we could do here is to ensure 85th percentile is set to the speed limit. This approach is debatable but I think it shows some good faith effort on our part.

McClanahan:
I'm not sure how FHWA will see the aggressivity of drivers being much different in the morning than in the afternoon. Do we have anything that could support our using different numbers for the two peak periods?

McClanahan:
Where on EB Pioneer would we sign (or would we sign) "SB I-5 use right lane"? I thought this signing was a standard distance and if so, why wouldn't we use that location as guidance for the distance input for this look input? Same question for all look distances.

McClanahan:
Isn't there some guidance from FHWA about seeding time as a ratio of expected congestion duration - or is it simply that we

Assumption Documentation

Find my error(s)

VISSIM Assumptions template or example.xls [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E
22		NB Ramp Terminal	EB to NB	Lane Change = 1000 ft back; Emergency Stop = 150 ft back	Accounts for lane utilization for movement to NB I-5 at
23			EB Approach	Left and Thru Vehicles on Different Links	Appropriately aligns traffic in the desired lane as they
24		Roundabouts	2 Lane Approaches	Lane Change = 1000 ft back; Emergency Stop = 50 ft back	Appropriately aligns traffic in the desired lane as they
25	Vehicle Inputs	All Inputs	Start Up Time	0-900: 75% of Peak Hour Volume	Seeding time for the network; Only 3/4 of the traffic w already in the network as the peak hour begins
26			Analysis Time	900-4500: Exact Volume	Used to appropriately compare data by assuring the same volume is compared between separate runs of the model
27	Routing Decisions	Static	All	Trucks and Cars have same routes	Due to the low truck percentage on
28	Desired Speed Decisions	Location	Ramps	Staggered Locations Used to Reduce/Increase Speed	Represents cars exiting/entering the
29			Roundabouts	Consistent Speed Thru Roundabout	The radius of the roundabout was u account for the slowest maneuver made thru the roundabout therefore representing a worst case
30				Set Speed Circul Cars 18-22 mph;	ionship dia
31	Reduced Speed Areas	Location	Roundabout Approaches	Used to slow ve roundabout	low vehicl elerating
32	Priority Rules	Location	Roundabouts	Entering Priority between Cars ar	to take ap
33				Circulating Vehic entering vehicles	gnize vehic
34			Ramp Terminal Left Turns	Inside Lane Yield Outside Lane	avoid off-t
35	Conflict Areas	Location	Roundabouts	Diverging Areas (Exiting/Circulating)	Allows vehicles on separate links to recognize each other
36				Approaches	gnize each other

McClanahan:
Isn't there some guidance from FHWA about seeding time as a ratio of expected congestion duration - or is it simply that we need to provide enough time for a vehicle to move entirely through the model? I think I remember FHWA making that comment on other projects so we should try to find that.

McClanahan:
FHWA may not agree with this approach. I believe they view VISSIM as a tool that recognizes random elements are a reality - like daily variations in traffic volume. I believe they want to see an average of multiple stochastic runs and averaged results used to compare scenarios. This may come down to philosophy of analysis so I'm sure they will hear you out. Just know that FHWA is up to speed on this issue and they have their preferences.

McClanahan:
This is a focus area for microsimulation. FHWA is going to want specifics as to why gap, distance, and speed inputs were adjusted rather than some simple comments as to why the rules were used. Did the gap differ from one approach to the next, from one vehicle type to the next, or from one roundabout to the next? If so, why and ...how was the input chosen actually determined? Same for speed, headway and placement decisions. I know that's a lot of documentation but better that than some project-delaying questions. This is our chance to save time by removing the issue from the table.

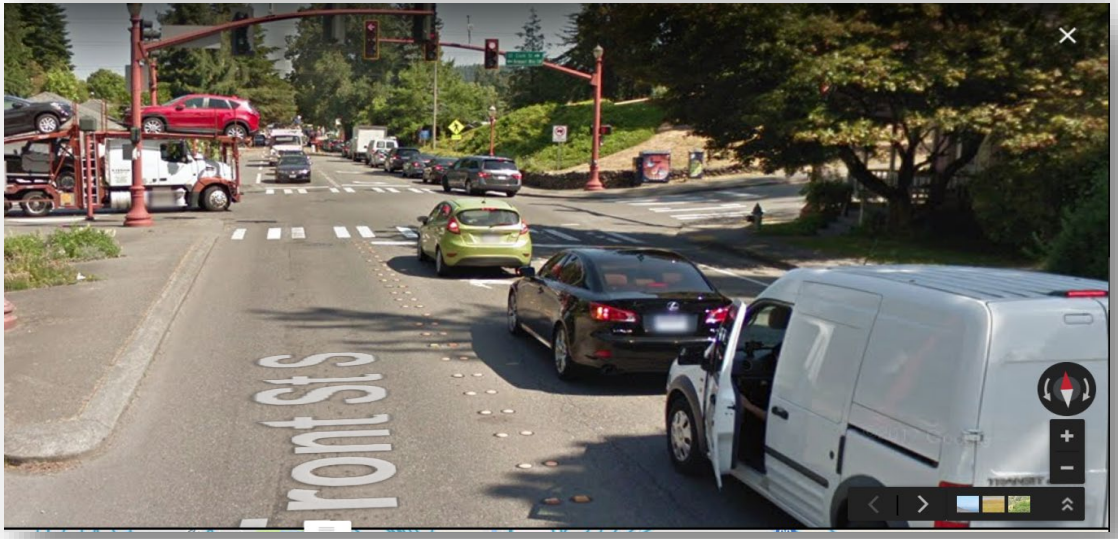
McClanahan:
Use of the Desired Speed Decision (according to the VISSIM help file) is used like a speed limit sign such that vehicles speed up or slow down according to their accel/decel function - after they run over the Decision line. This means it will take some time for a higher speed vehicle to slow for movement through a roundabout. I see you try to slow traffic down prior to running over the Desired Speed Decision using Reduced Speed Areas but they are far too short. The ones I measured were about 15 to 20 feet long and we just can't expect vehicles to slow from mainline speed to your Desired Speed Decision for the roundabouts in that distance. This is likely to catch the eye of FHWA.

McClanahan:
Just like Priority Rules, we need to clarify why they were used where they were used, what defaults were adjusted, and why they were adjusted. Front and rear gap, distances, safety factor adjustments and the whole lot for each place. I know I'm asking a lot but this is an opportunity to eliminate comments. You could also roll the dice and

McClanahan:
see comment above

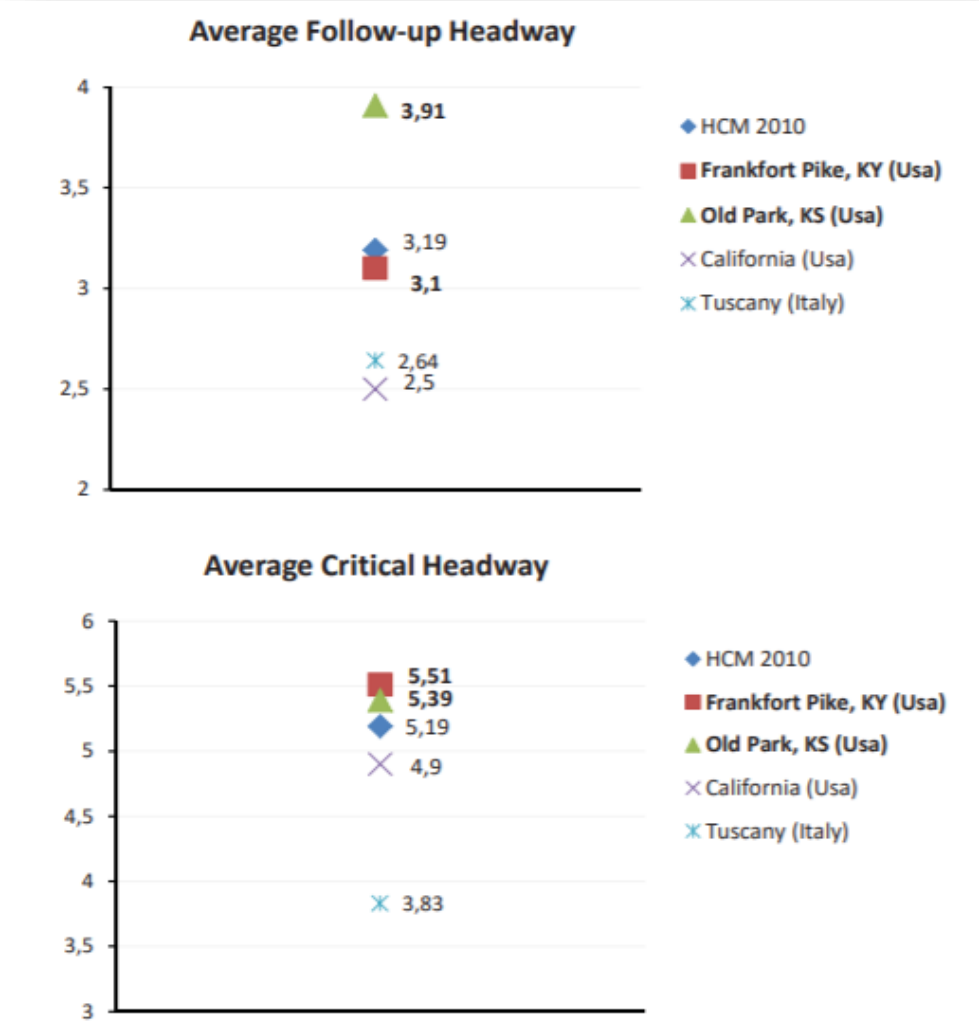
Cell A35 commented by McClanahan

Human Factors



Roundabouts can be more difficult to model than signals for individuals (given driver ability variance) but populations react predictably so their individual ability variance tends to average out in large populations thus, over time, roundabout model results reflect well enough what actually happens in the field so they are very appropriate for decision making.

Location Factors

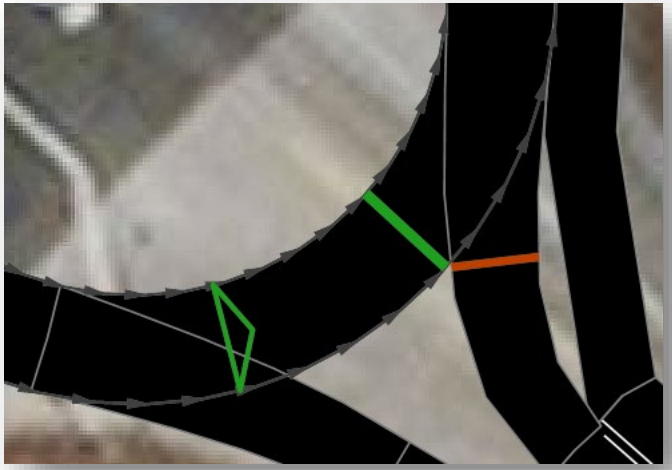


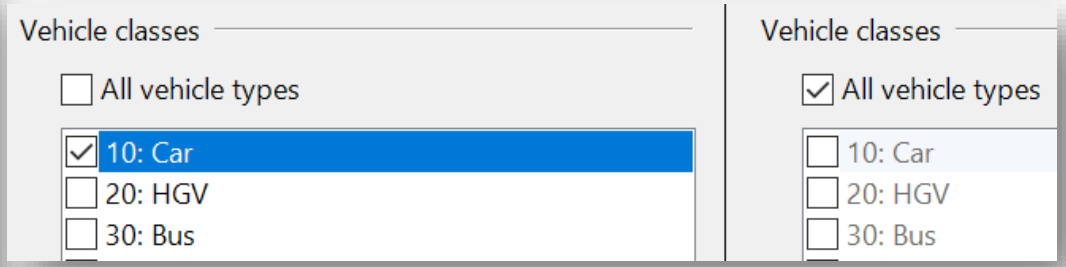
https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1000&context=ce_facpub

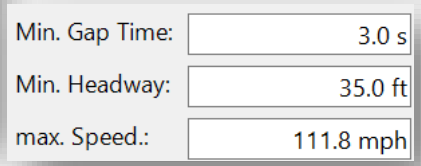
Planning Level Initial Settings (Vissim)

Too many settings to cover at one time but here are some:

- Use conflict areas for single lane, priority rules for multi
- CA: Use 1.5 rear gap, 0.5 front gap, and 0.8 SDF
- PR: Min Gap: 3 sec car, 4 sec bus, 5 sec HGV
- Min Headway: green goes to about the middle of egress

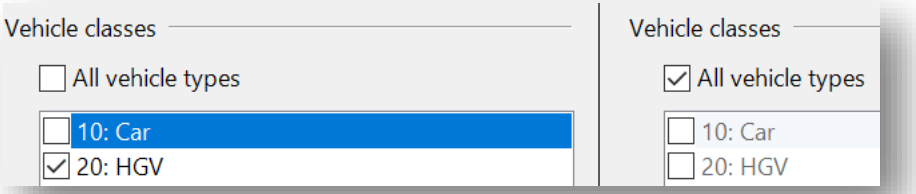


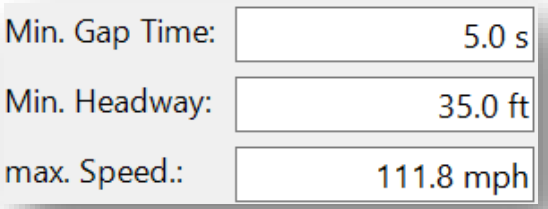


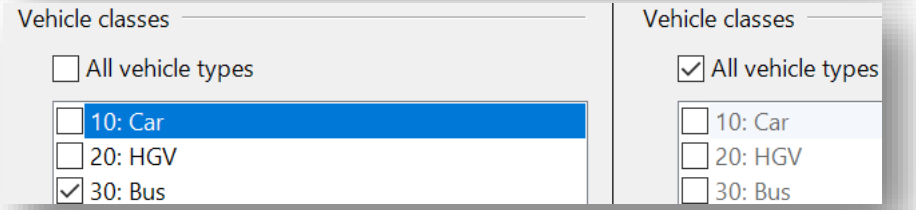


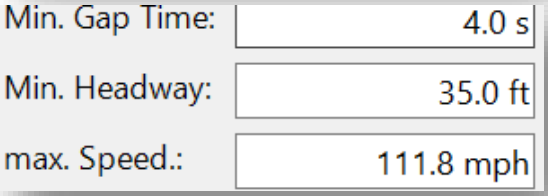
Planning Level Settings (Vissim)

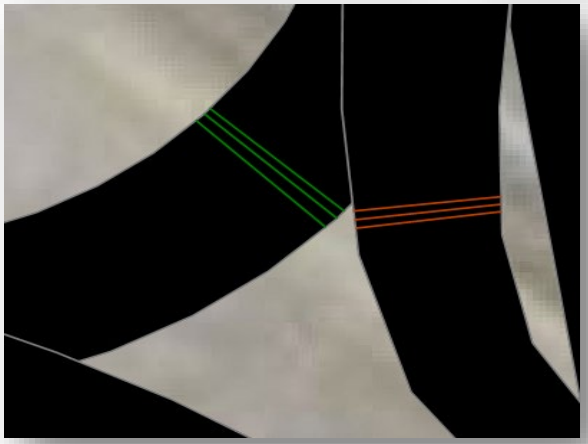
For PR: buses, and HGV











Planning Level Settings (Vissim)

For CA: The ability for circulating traffic to see approach traffic is still important as some circulators will wait for entering trucks in the real world but how far ahead will approaching cars normally be able to see circulating cars? You tell me – I can't find data on it yet. What about front and rear gaps and safety distance? I found data on calibrated models with what is shown below but will that work for your location?

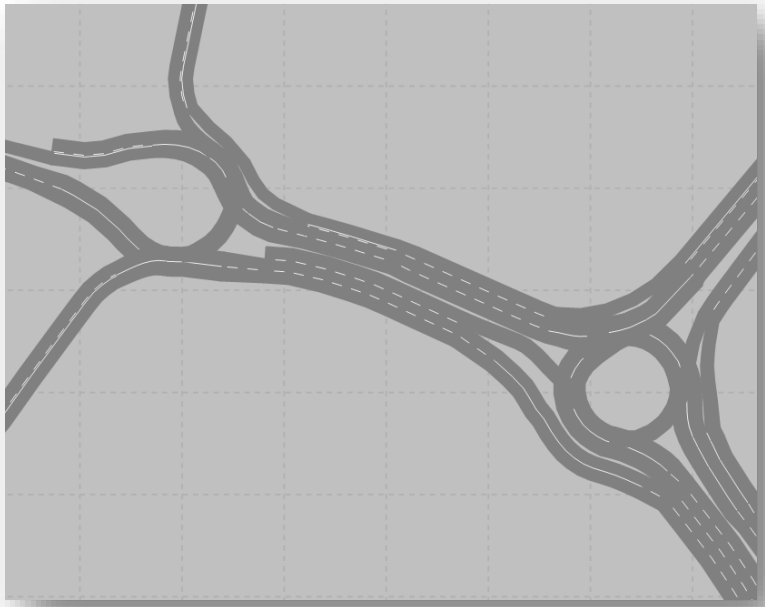
Start Page | Network Editor

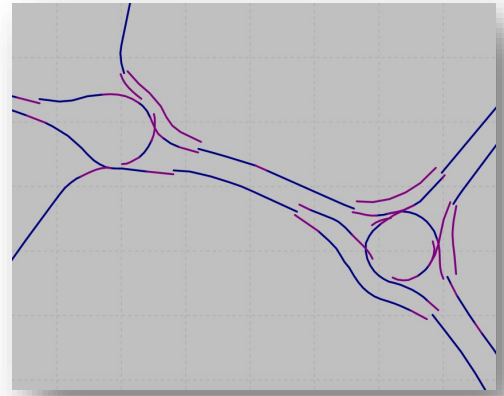
Conflict Areas

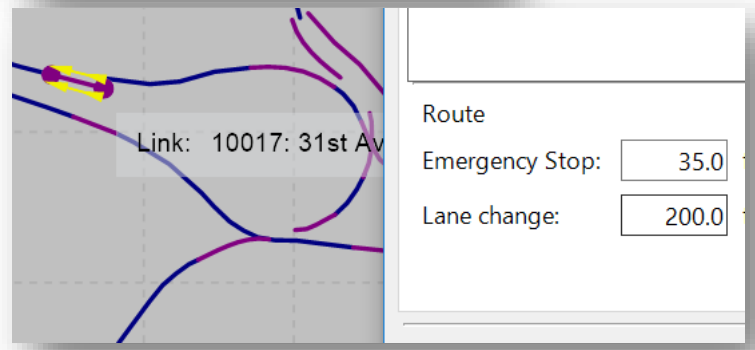
Select layout... | <Single List>

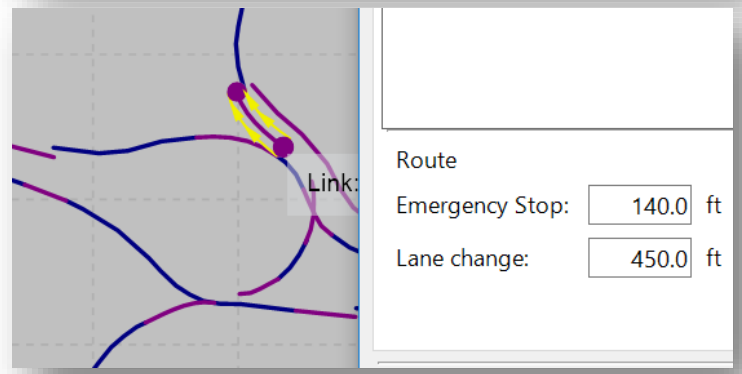
Count: 31	Link1	VisibLink1	Link2	VisibLink2	Status	FrontGapDef	RearGapDef	MinGapBlockDef	SafDistFactDef	AddStopDist	ObsAdjLns	AnticipRout	AvoidBlockMinor
8	3	50.0	10008	100.0	2 waits for 1	0.5	1.5	3.0	0.8	0.0		0.0 %	100.0 %

Into the Weeds Example 1 (Vissim settings)









Roundabouts require a bit of artistry to get traffic to flow like a modeler wants but make sure to model what's likely. Thoughts on WB lane utilization? Ask Sidra!

Into the Weeds Example 2 (Vissim settings)

The bigger the network, the more we need to define how various links function. Doing so helps match a model to the field. Will such calibration hold true for future conditions as traffic patterns and vehicles change? AV/EV?

Driving Behaviors

Select layout...

Count: 2	No	Name
1	1	Urban (motorized)
2	2	Right-side rule (motorized)
3	3	Freeway (free lane selection
4	4	Footpath (no interaction)
5	5	Cycle-Track (free overtaking
6	6	Heavy Railway
7	7	Freeway merge/weave
8	8	CD merge/weave
9	9	Urban weave
10	10	Freeway higher headways
11	11	Freeway aggressive lane ch
12	12	41st
13	13	Freeway >lane change
14	14	MVD to 529
15	15	Freeway >LC, HH
16	16	Freeway >>> headways
17	17	529 to 528
18	18	US 2 to MVD
19	19	528 to 88th
20	20	MVD to 529 w/ adv merge

Necessary lane change (route)

	Own		Trailing vehicl
Maximum deceleration:	-13.12 ft/s2		-9.84 ft/s2
- 1 ft/s2 per distance:	100.00	ft	100.00
Accepted deceleration:	-3.28 ft/s2		-3.28 ft/s2

Waiting time before diffusion:	200.00 s
Min. headway (front/rear):	1.64 ft
To slower lane if collision time is above.	11.00 s
Safety distance reduction factor:	0.60
Maximum deceleration for cooperative braking:	-9.84 ft/s2

☐ Cooperative lane change

Maximum speed difference:	6.71 mph
Maximum collision time:	10.00 s

Necessary lane change (route)

	Own		Trailing vehicl
Maximum deceleration:	-14.00 ft/s2		-10.00 ft/s2
- 1 ft/s2 per distance:	200.00	ft	200.00
Accepted deceleration:	-6.50 ft/s2		-4.50 ft/s2

Waiting time before diffusion:	200.00 s
Min. headway (front/rear):	1.00 ft
To slower lane if collision time is above.	11.00 s
Safety distance reduction factor:	0.10
Maximum deceleration for cooperative braking:	-14.00 ft/s2

☑ Cooperative lane change

Maximum speed difference:	10.00 mph
Maximum collision time:	10.00 s

Into the Weeds Example 3 (Vissim settings)

Can Vissim emulate Sidra Dynamic Gap Acceptance? Not really but it can do more than you might think. Example?

Roundabouts have three stages of yield line behavior – How you could code them:

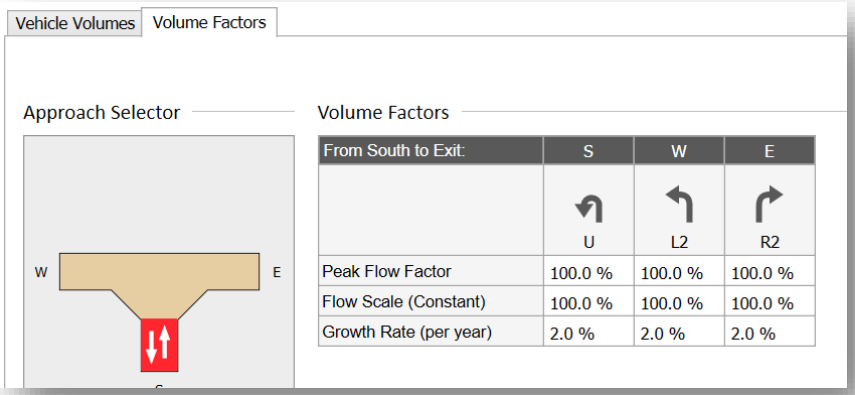
- approaching at speed (PR speed set to 100+ mph)
- follow up or when the circulating roadway is busy (PR set to about 10 mph max)
- Stopped at yield line (PR speed set to 3 mph max)

Each PR for each lane would need to be applied to each veh type and each would have their own min gap time (seconds). That's a lot of priority rules but the model will do it and by doing so, multi-lanes could better emulate what we know about capacity variance for left and right lanes and how roundabouts actually begin to queue and discharge which would affect the MOE: duration and extent of congestion. Ensure min observed is sufficient.

Into the Weeds Example 4 (Sidra settings)

Feel free to use PFF for operations analysis but for future year planning analyses which use projected volumes from a TDM effort, set PFF = 1.

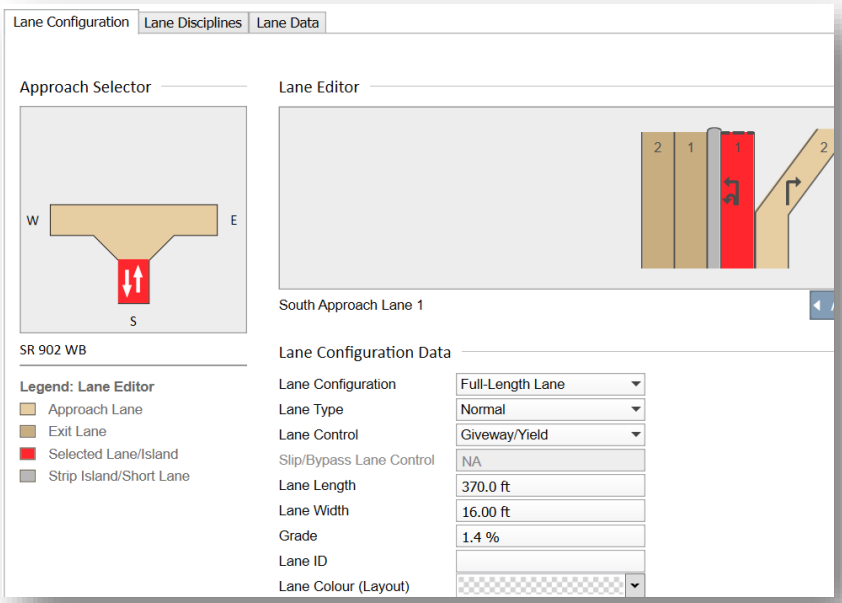
For example, if 92 (default) is used, Sidra will grow the already projected volumes by another 9% and you'll likely overdesign/overspend/overbuild and as a result, crash rates could be overrepresented which will negatively effect national roundabout statistics!



From South to Exit:	S	W	E
	U	L2	R2
Peak Flow Factor	100.0 %	100.0 %	100.0 %
Flow Scale (Constant)	100.0 %	100.0 %	100.0 %
Growth Rate (per year)	2.0 %	2.0 %	2.0 %

Into the Weeds Example 5 (Sidra settings)

Roundabout models are sometimes highly sensitive to certain inputs. In Rodel, modelers need to be careful with flare assumptions. In Sidra, designers and traffic analysis types need to be mindful of *lane width* and *short lane length* inputs. If the *short lane length* is less than the adjacent lane's queue, both lanes will be added to form a longer queue length.



Working with Safety Engineers

- These models exist but not my area of modeling
- Safety performance of signals, roundabouts, DDIs etc. are well documented – well understood - but we're still learning and evolving – check in with your safety engineer
- Recent research indicates that multi-lane roundabouts get better as the public gets used to them (safety performance and capacity)

Working with Designers

Working with Designers

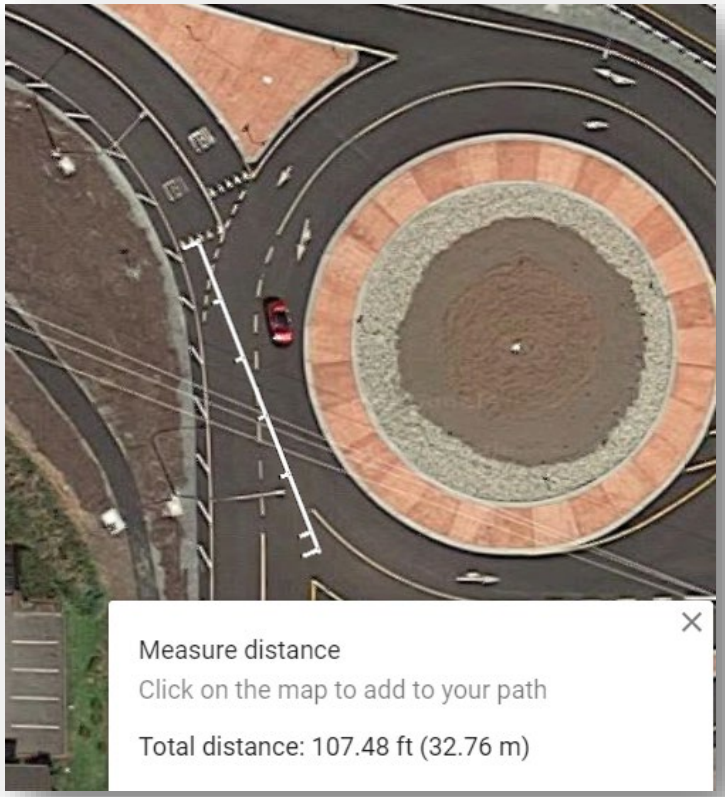
Models can look at many scenarios but modelers need to think about how traffic wants to travel. People like to spiral out so open up exits a bit more and reduce lanes where possible. Be mindful of exit speeds when pedestrians are on the exit. Also, keep an eye on your designers – we're all in this together. Sidra will model either but we should only build/operate one for this location.

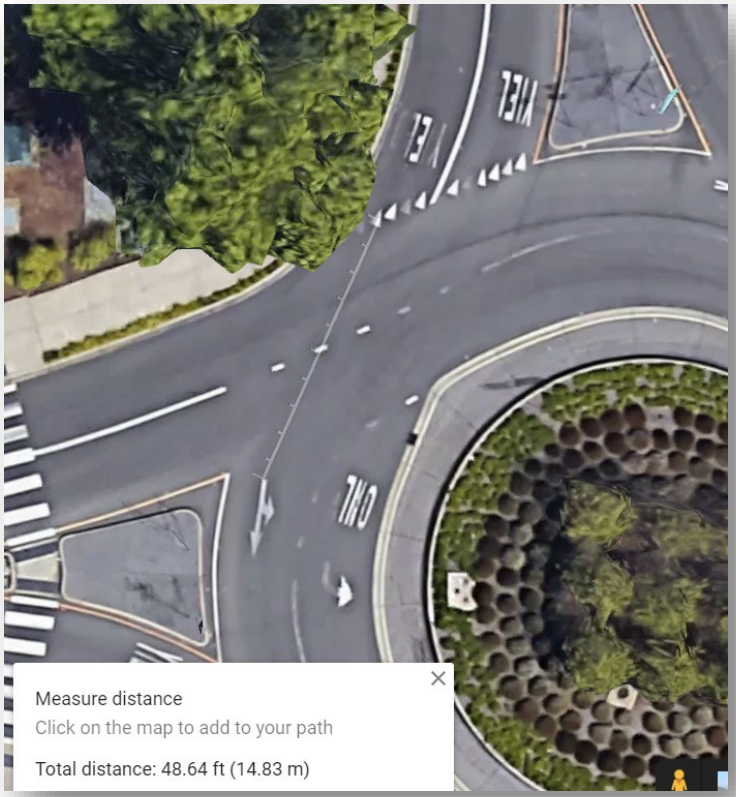
Working with Designers

Models can't do everything. For example, South leg's egress geometry. Why so constrained? If no peds on the south leg - open it up. Models would not have assumed such design constraints on capacity (slow departures and not enough splitter top width to help NB traffic optimize available gaps) but I assure you, this design has reduced NB and SB capacity in a way a model would not show.

Working with Designers

Will a static model understand crossing distances? Probably not but they are important for both capacity/flow efficiency and safety performance.





Working with Designers

Projects can and do have phases. If the 20 year numbers look much bigger than the 10 year, consider building for 20 but paving out the excess capacity until it is needed (S Leg).

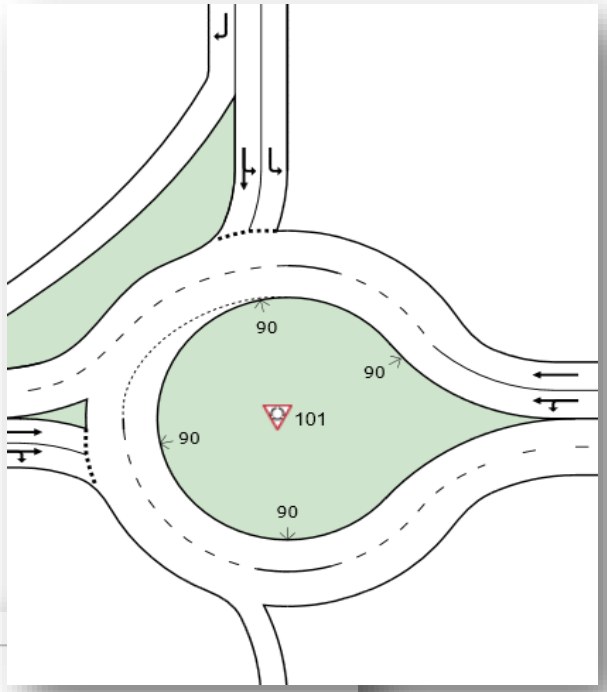
Working with Designers

Geometry

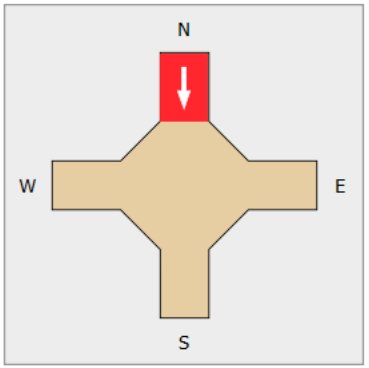
Approach:	S	E	N	W
Number of Circ Lanes	2	1	2	2
Circulating Width	30.0 ft	18.0 ft	30.0 ft	30.0 ft
Island Diameter	90.0 ft	90.0 ft	90.0 ft	90.0 ft
Inscribed Diameter	NA	Program	Program	Program
Entry Radius	NA	90.0 ft	65.0 ft	90.0 ft
Entry Angle	NA	30.0 °	30.0 °	30.0 °
Raindrop Design	NA	☑	NA	☐
Circulating Transition Line	☐	☐	☐	☑
Number of Downstream Circ Lanes	Program	Program	Program	Program

SIDRA Standard Roundabout Model Calibration

Approach:	S	E	N	W
Environment Factor	1.00	1.00	1.00	1.00
Entry/Circ Flow Adjustment	None	None	None	None



Approach Selector

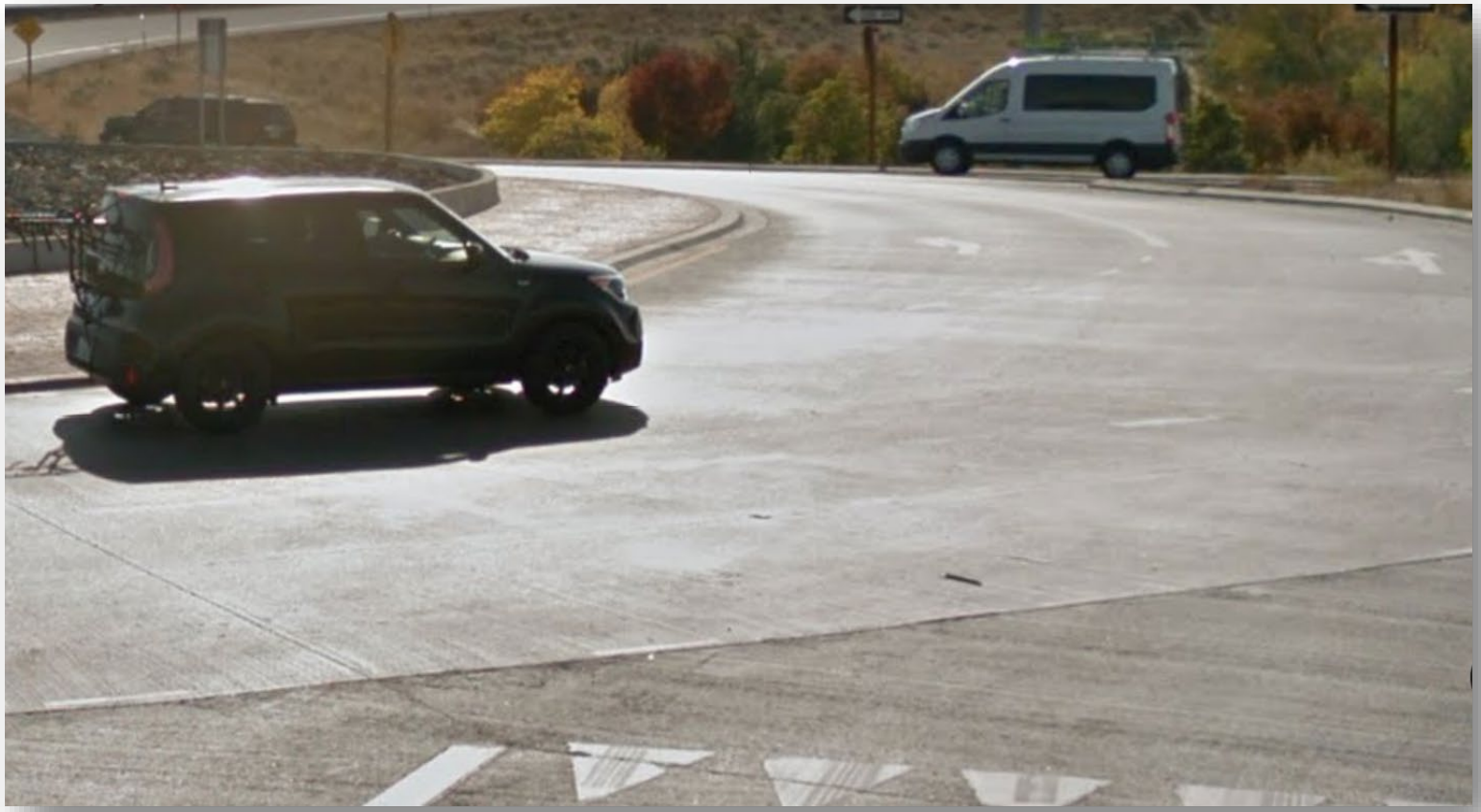


Volume Factors

From North to Exit:	E	S	W
	L2	T1	R2
Peak Flow Factor	95.0 %	95.0 %	95.0 %
Flow Scale (Constant)	100.0 %	100.0 %	100.0 %
Growth Rate (per year)	2.0 %	2.0 %	2.0 %

Working with Pavement Engineers

Models can’t differentiate between ACP and PCCP but drivers can (given the conspicuity of the delineation) and that affects capacity and safety performance.



Working with Delineation Engineers

Models can’t differentiate between clear striping and poor but drivers can.

Working with Elected Officials

Marketing 101: Through experience, we've learned that the word **Mini** isn't received well. **Compact** is more relatable to smaller roundabouts that are placed in context.

Our 80-95' ID **Compact**, 18' circulating, 15' approach, 90' entry radius roundabouts were compared to Sidra results and Sidra (with our policy settings) matched the field data.

Working with Elected Officials

Show them existing examples like this new ~90 foot ID compact

(www.troyohio.gov)(Mike Ullery | Miami Valley Today)

Working with Decision Makers

Visuals are an important part of how models can help the public, elected officials, and decision makers understand what the future can hold - so make a movie or produce some helpful graphics! Make sure to represent movies/clips from Vissim as animation rather than analysis.

Working with Decision Makers

Seeing is…

https://www.co.winona.mn.us/

Credit

For all slides and the information they contain, contact me directly:

Doug McClanahan

State Traffic Analysis Engineer

State Delineations and Markings Engineer

Washington State Department of Transportation

Headquarters Traffic Operations Div.

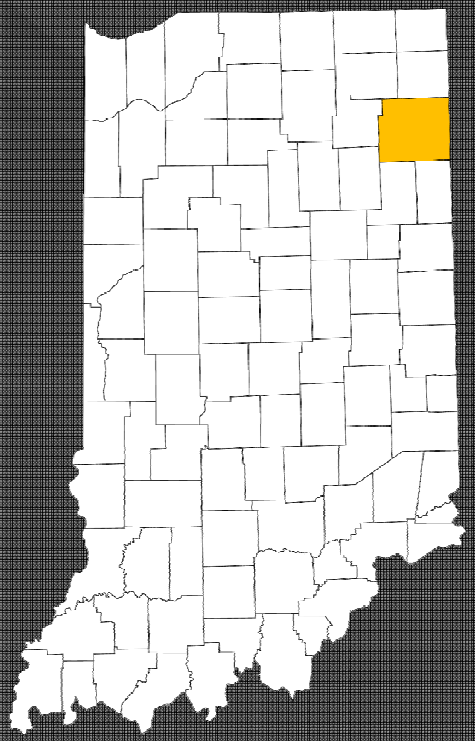
360-705-7984

mcclando@wsdot.wa.gov

BASS ROAD/ HADLEY ROAD ROUNDABOUT

OWNER: ALLEN COUNTY | **ENGINEER:** AMERICAN STRUCTUREPOINT

PROJECT LOCATION:
Allen County Indiana

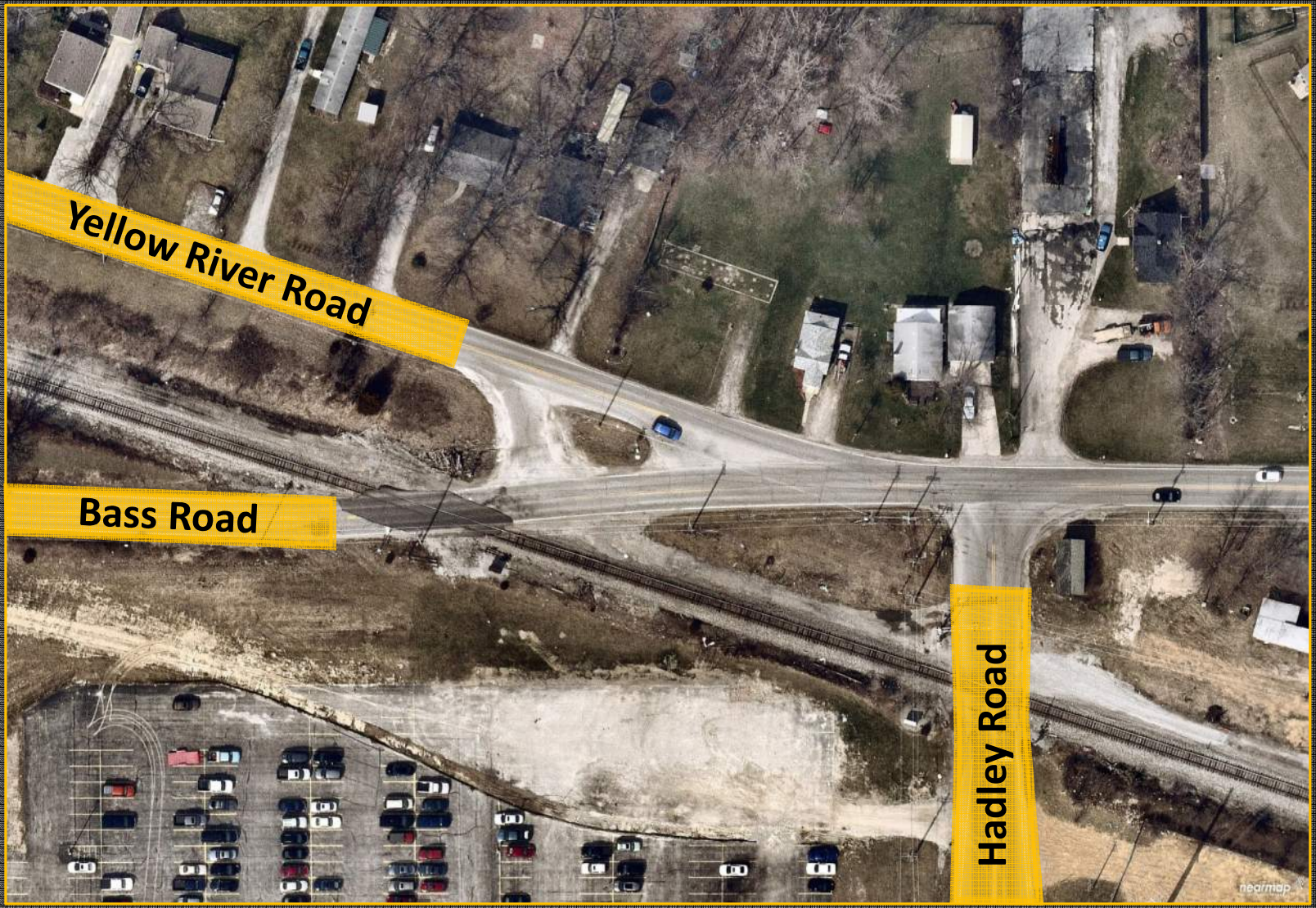


PROJECT HISTORY

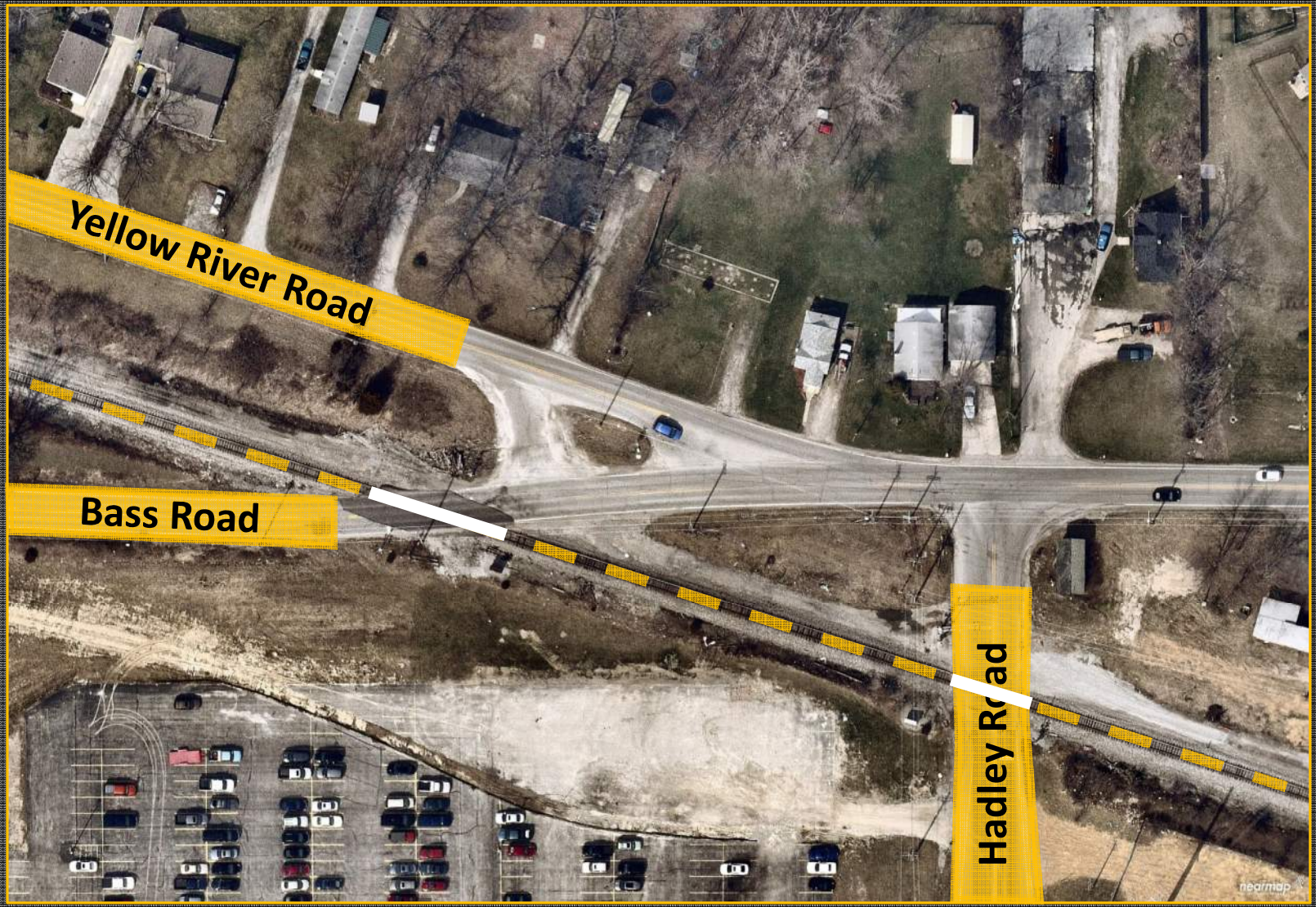
2009 – Existing Intersection: Bass/Hadley/Yellow River

- Two skewed railroad crossings
- Yellow River Road skewed approach
- Two-way, stop-controlled intersection
- Substandard curvature along Bass

EXISTING INTERSECTION

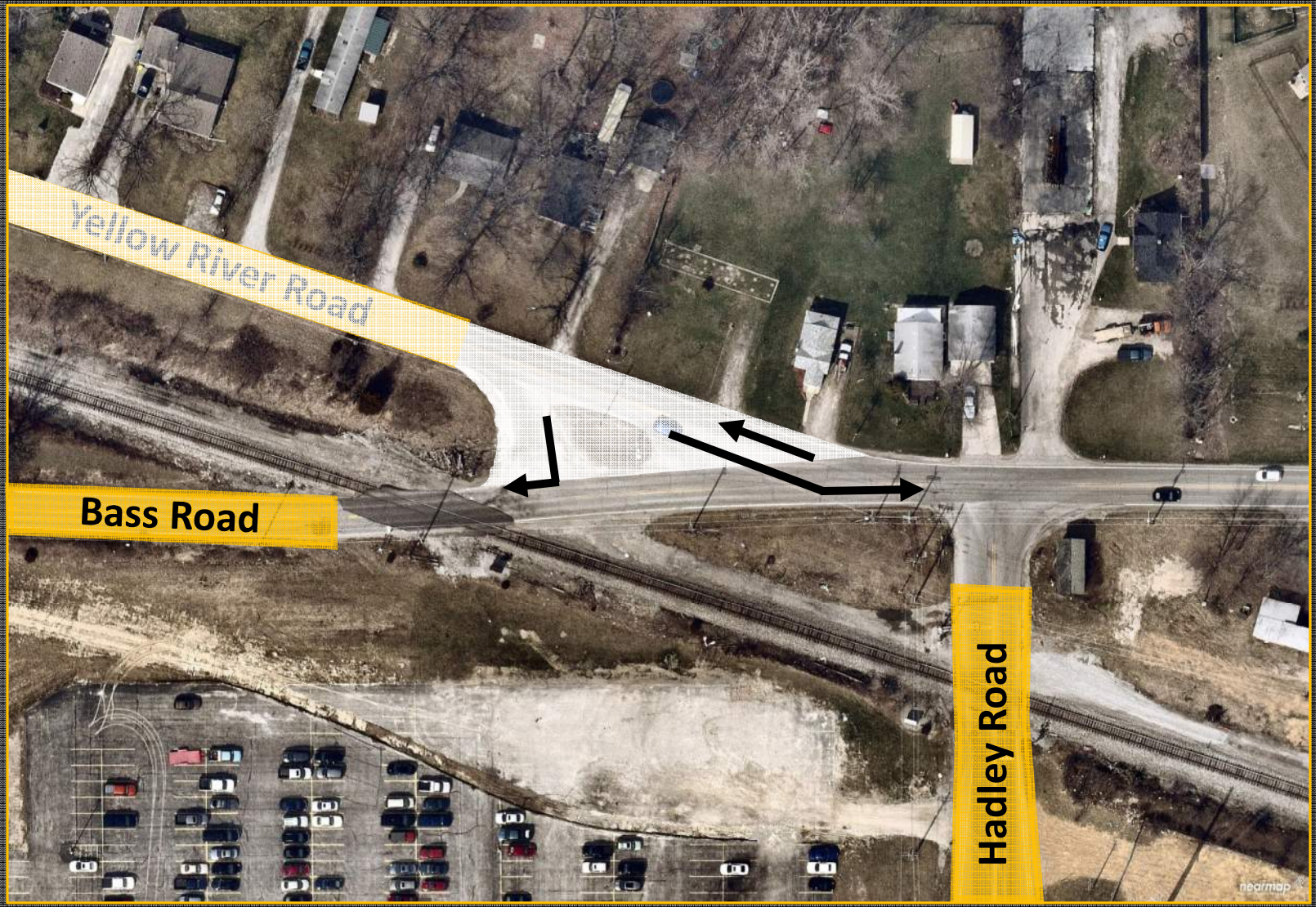


SKEWED RAILROAD CROSSINGS

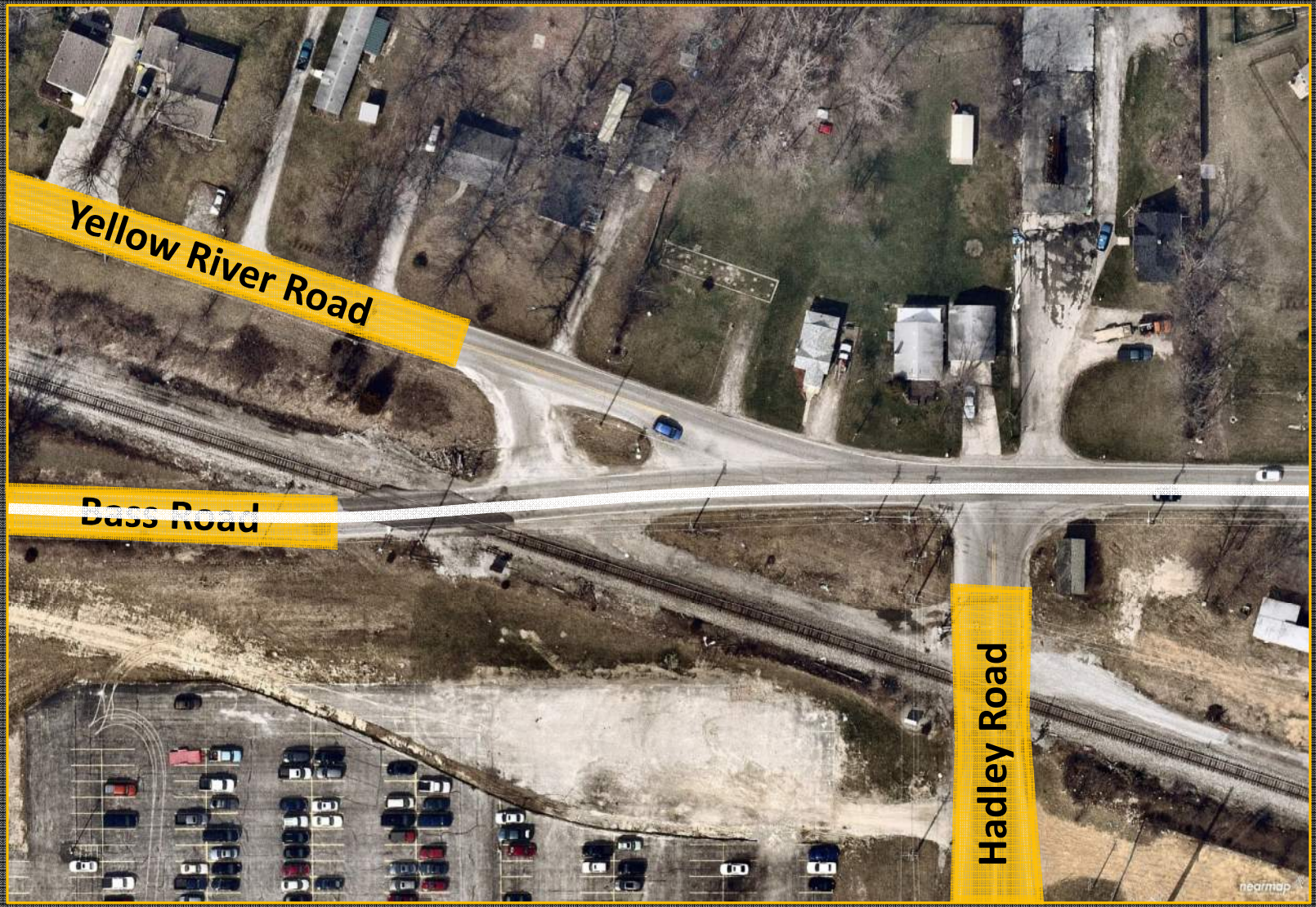


YELLOW RIVER

Skewed Intersection (25 degrees)



BASS ROAD CURVATURE



EXISTING INTERSECTION

Railroad Data

- Freight trains only (no passenger trains)
- 4 trains/day
- Trains operate at speeds < 40 mph
- Flashing lights at both crossings
- Gates at Hadley Road crossing
- No gates at Bass Road crossing

Traffic Data

- < 2% trucks
- Peak hour traffic, year 2030
  - 756 am (864 pm) at Bass crossing
  - 758 am (945 pm) at Hadley crossing

PROJECT SCOPE Bass Road

Approximately 4.5 miles of widening/reconstruction for two-way left turn lane along Bass Road

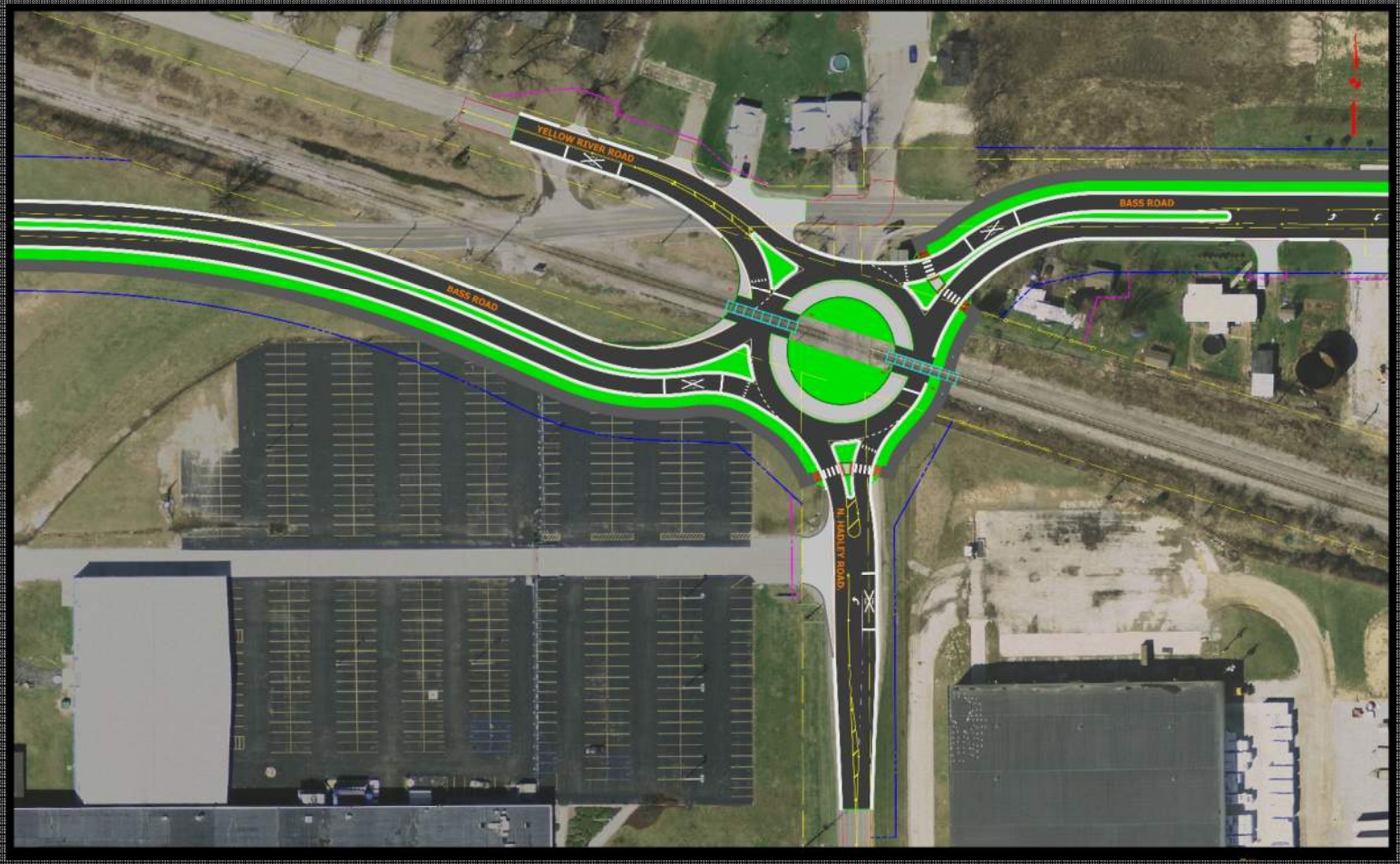
Intersection improvements

Phased design/construction

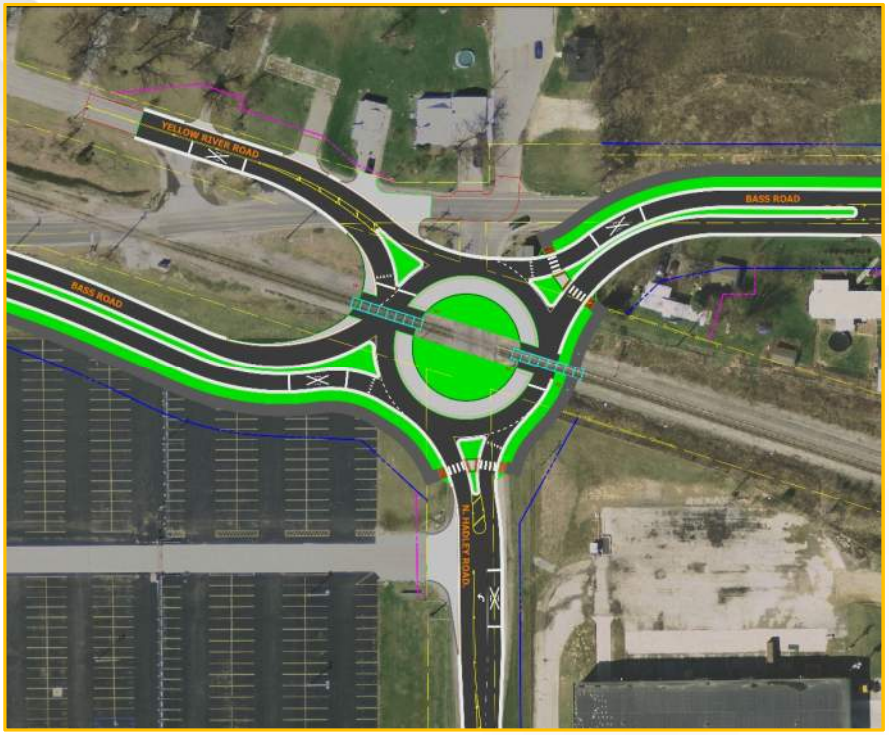
ORIGINAL DESIGN SOLUTION Bass/Hadley

DESIGN ALTERNATIVE

Circular Roundabout

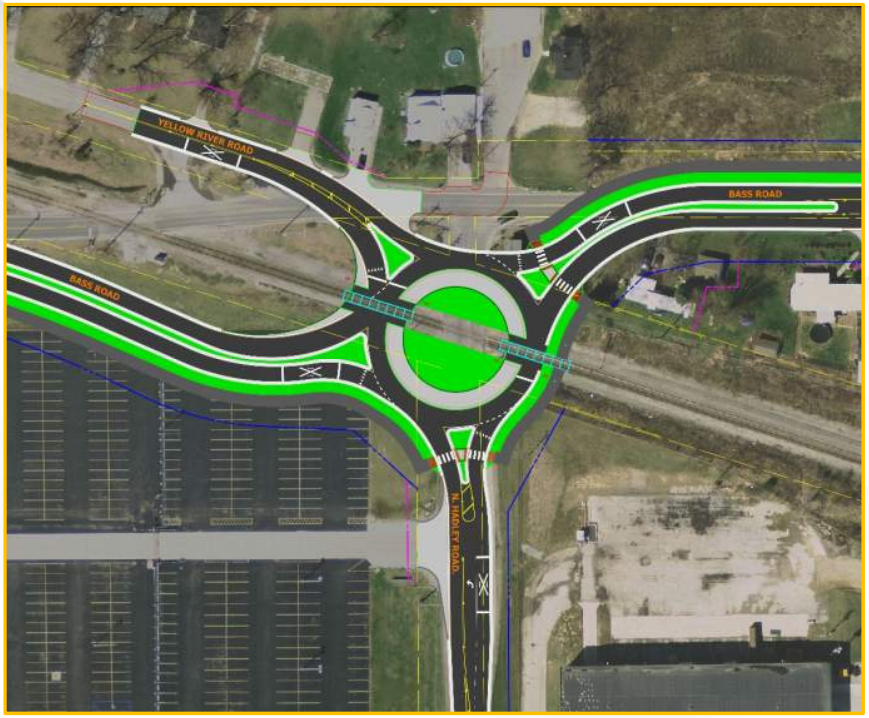


RAILROAD CONCERNS



- Increased traffic through crossings as a result of the roundabout
  - Yellow river road traffic crossing twice
- Driver attention to “weaving” instead of on the crossings
- Reduced sight distance to warning devices
- Traffic stacking on tracks when gates come down
- More warning devices than traditional crossing
- Future maintenance will require a shut down of the roundabout

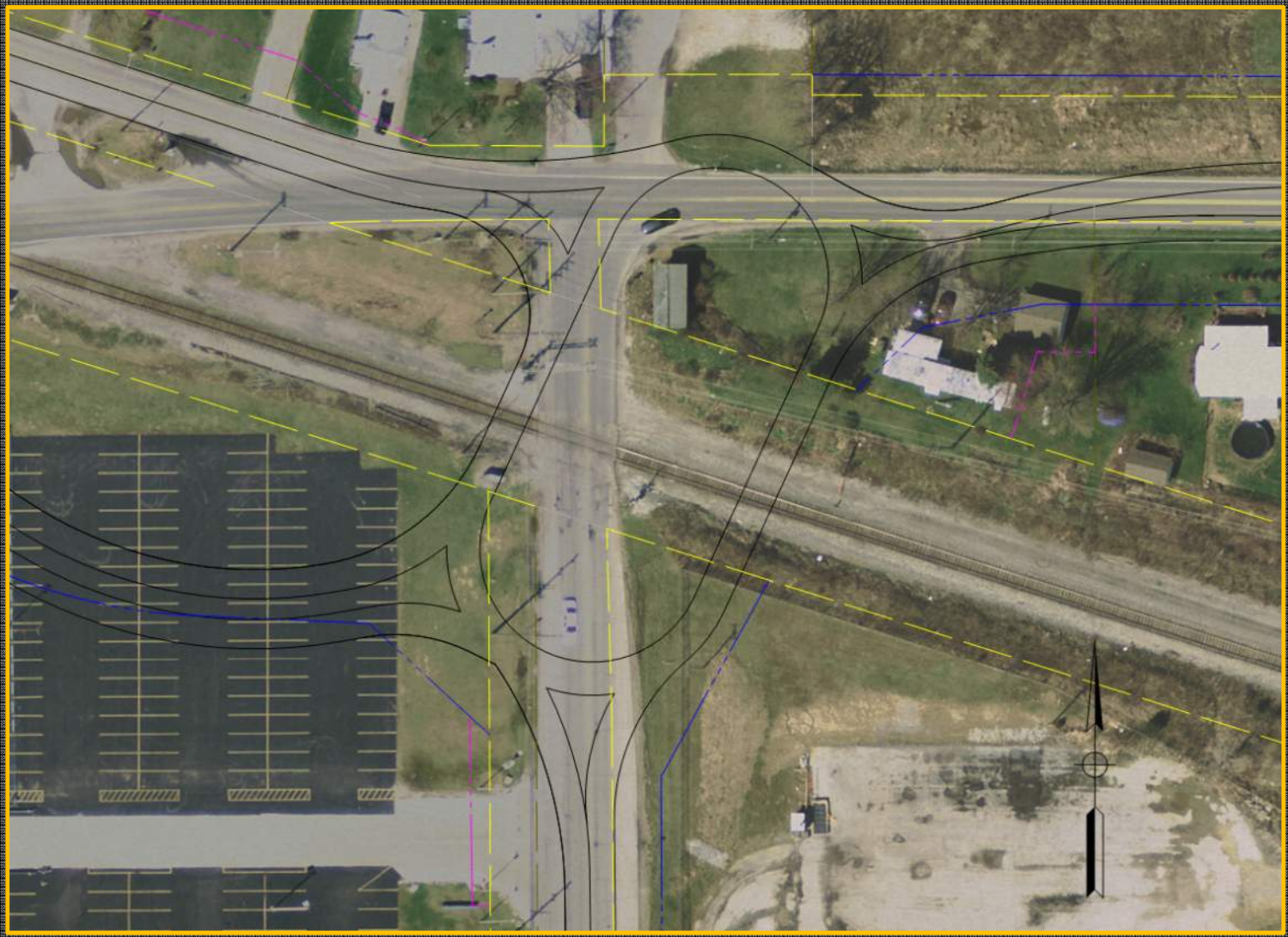
ADDITIONAL RAILROAD CONCERNS



- Sight Distance to gates
- Complicated Driving
  - Entering/Exiting
  - Observing and reacting to other entering vehicles
  - Observing activated crossing signals
- Risk of trapping vehicles on tracks
- Future railroad expansion
- Crossing railroad on curve

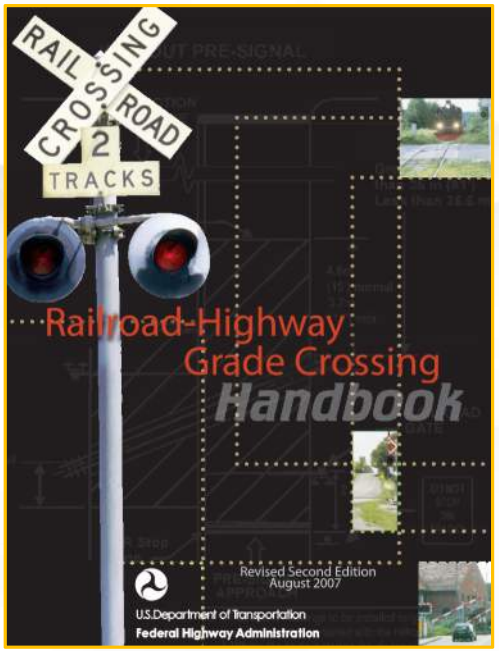
DESIGN ALTERNATIVE

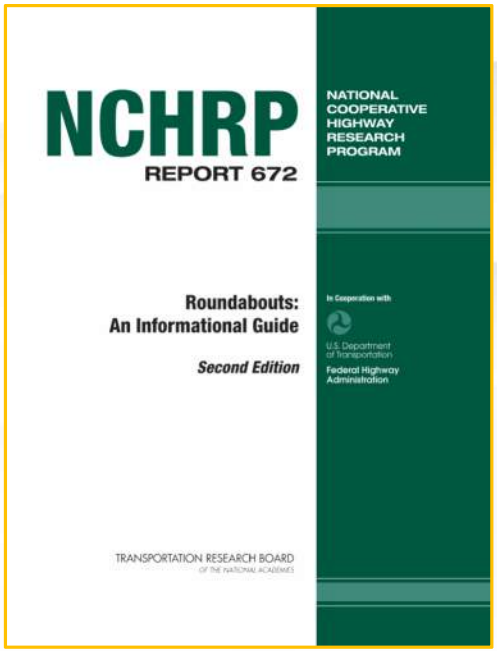
Oval Roundabout



DESIGN GUIDANCE

Railroad Highway Grade Crossing Handbook





NCHRP Report 672 – Roundabouts: An Informational Guide

DESIGN GUIDANCE

Railroad Highway Grade Crossing Handbook

K. Roundabouts

In the event that a grade crossing is included in a roundabout, design considerations include the provision of traffic control (such as crossing gates and flashing lights) at the grade crossing consistent with treatments at other highway-rail grade crossings. In addition, where queuing could occur (such as gridlocking within the roundabout), additional measures may be necessary up to and including the installation of supplementary devices such as traffic signals to preclude blockages of the track that cannot be cleared in advance of the arrival of a train.

At the June 2006 meeting of NCUTCD, the council approved provisions that would require an engineering study of the potential for traffic to back up across a grade crossing due to a roundabout and the identification of appropriate countermeasures, including possible use of traffic signals.

Roundabouts: An Informational Guide

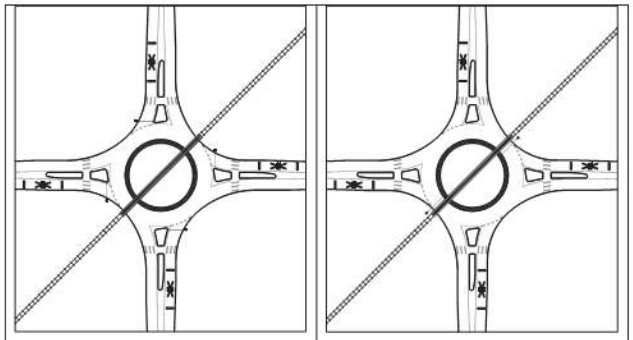


Exhibit 7-35
Rail Crossing through Center of Roundabout

(a) Gates at all Entries	(b) Gates on the Circulatory Roadway
• Maximizes safety by stopping all entering vehicles to prevent interaction with the rail. • Introduces minor increases in delay, particularly where there are heavy right turns. • Preferred at small-diameter roundabouts where queue storage on the circulatory roadway is limited.	• Minor benefits from a delay standpoint where there are heavy right turns that can be accommodated while the train is present. • Most practical at larger diameter roundabouts where queue storage is available for through and left-turn vehicles.

ENGINEERING STUDY

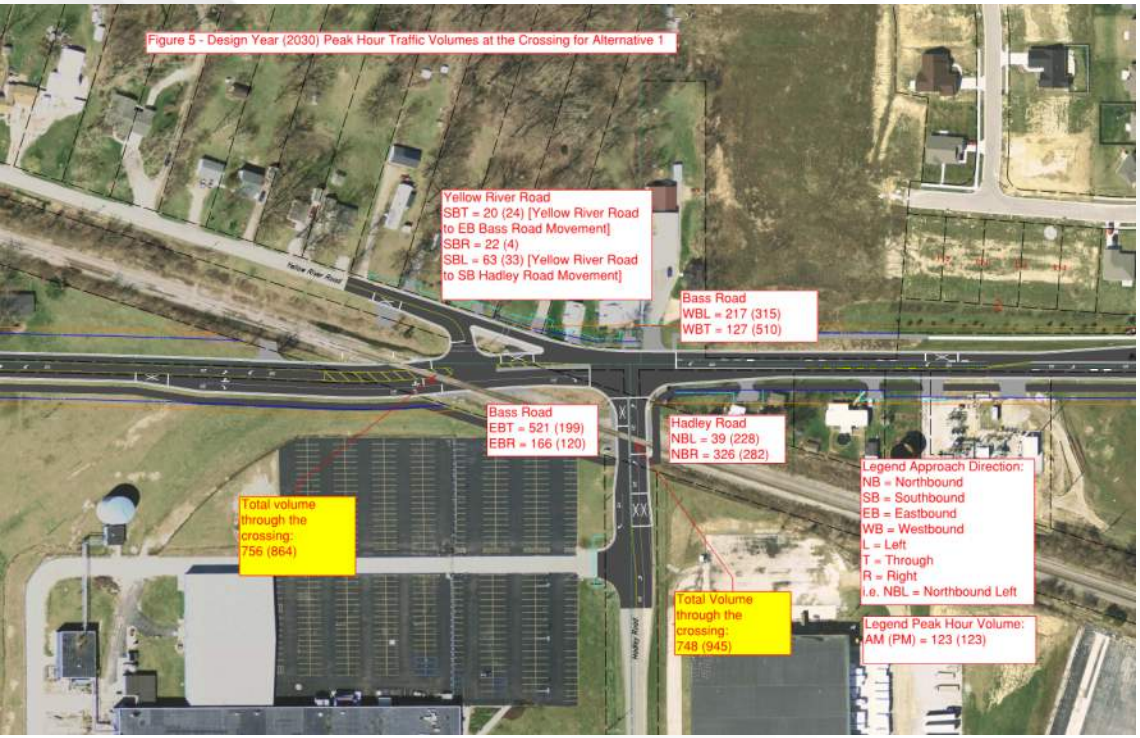
Compare alternatives for "measures of effectiveness" (MOEs)

- Capacity analysis
- Queue analysis
- Safety
  - Traffic control devices
  - Sight distance
  - Vehicle escape routes
  - Driver decision points
  - Effects of track expansion
- Track maintenance
- Right-of-way impacts and construction cost

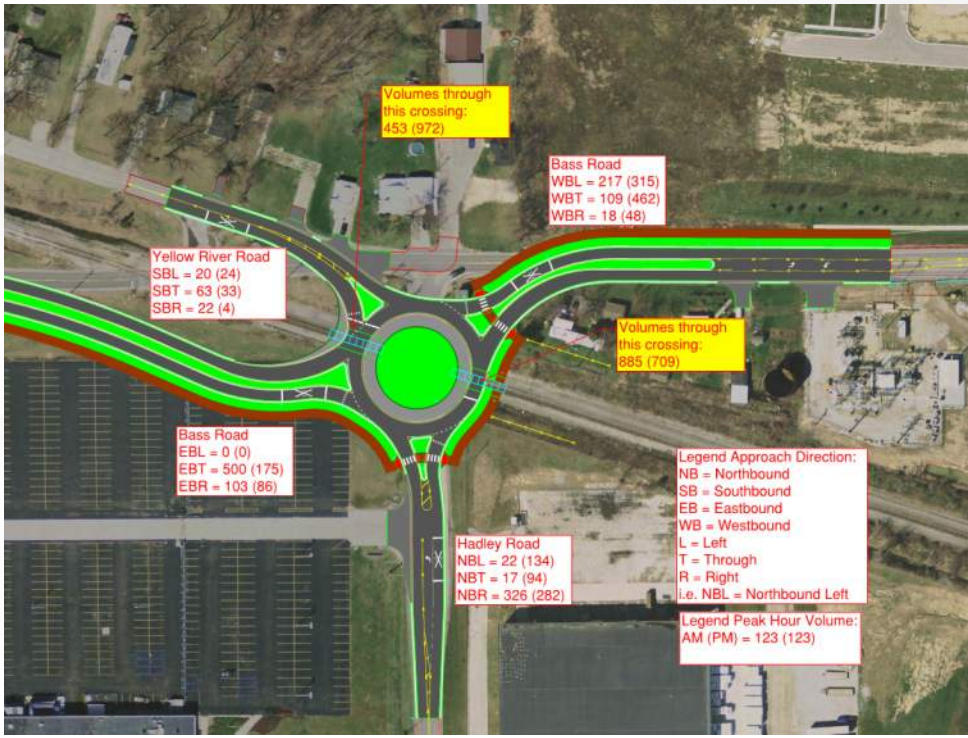
(Oval roundabout performed similar to the circular roundabout)

COMPARISON Peak Hour Volume (2030)

Signal - 10% More Traffic Crossing

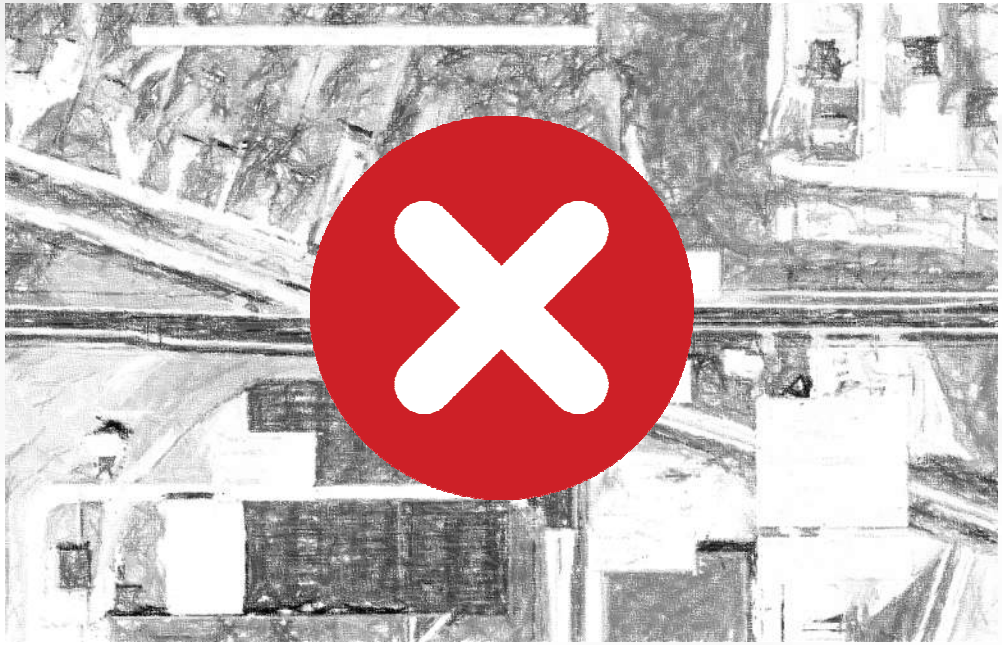


Roundabout – 10% Less Traffic Crossing



COMPARISON Peak Hour Volume (2030)

Signal - 10% More Traffic Crossing



SIGNAL 0

Roundabout – 10% Less Traffic Crossing

ROUNDABOUT 1

COMPARISON Capacity Analysis

		2030 AM Peak Hour			2030 PM Peak Hour		
Alternative	**Approach**	**LOS**	**Delay (sec)**	**95th Percentile Queue Length (ft)**	**LOS**	**Delay (sec)**	**95th Percentile Queue Length (ft)**
Traffic Signal	NB	B	10.2	36	B	10.9	138
	EB	B	13.4	208	B	14.1	119
	WB	A	4.1	18	B	10.4	182
	Overall[1]	**B**	**10.3**	**208**	**B**	**11.3**	**182**
Circular Roundabout	NB	A	7.9	44	A	8.0	58
	SB	A	4.2	8	A	5.5	6
	EB	A	8.6	76	A	5.1	20
	WB	A	5.6	24	C	16.6	222
	Overall[1]	**A**	**7.4**	**76**	**B**	**11.7**	**222**
Oval Roundabout	NB	A	7.5	42	A	7.5	54
	SB	A	4.3	8	A	4.9	6
	EB	A	9.6	88	A	5.5	22
	WB	A	5.5	24	C	16.3	264
	Overall[1]	**A**	**7.7**	**88**	**B**	**11.5**	**264**

[1] *Queue value documented from the approach with maximum queue, Delay is average intersection delay*

COMPARISON Capacity Analysis

Alternative	Approach	2030 AM Peak Hour			2030 PM Peak Hour		
		LOS	Delay (sec)	95th Percentile Queue Length (ft)	LOS	Delay (sec)	95th Percentile Queue Length (ft)
	NB	B	10.2	96	B	10.9	138
	EB	B	13.4	208	B	14.1	119
	WB	A	4.1	18	B	10.4	182
	Overall[1]	**B**	**10.3**	**208**	**B**	**11.3**	**182**
Cir[illegible]out	NB	A	7.9	44	A	8.0	58
	SB	A	4.2	8	A	5.5	6
	EB	A	8.6	76	A	5.1	20
	WB	A	5.6	24	C	16.6	222
	Overall[1]	**A**	**7.4**	**76**	**B**	**11.7**	**222**
O[illegible]t	NB	A	7.5	42	A	7.5	54
	SB	A	4.3	8	A	4.9	6
	EB	A	9.6	88	A	5.5	22
	WB	A	5.5	24	C	16.3	264
	Overall[1]	**A**	**7.7**	**88**	**B**	**11.5**	**264**

[1] *Queue value documented from the approach with maximum queue. Delay is average intersection delay*

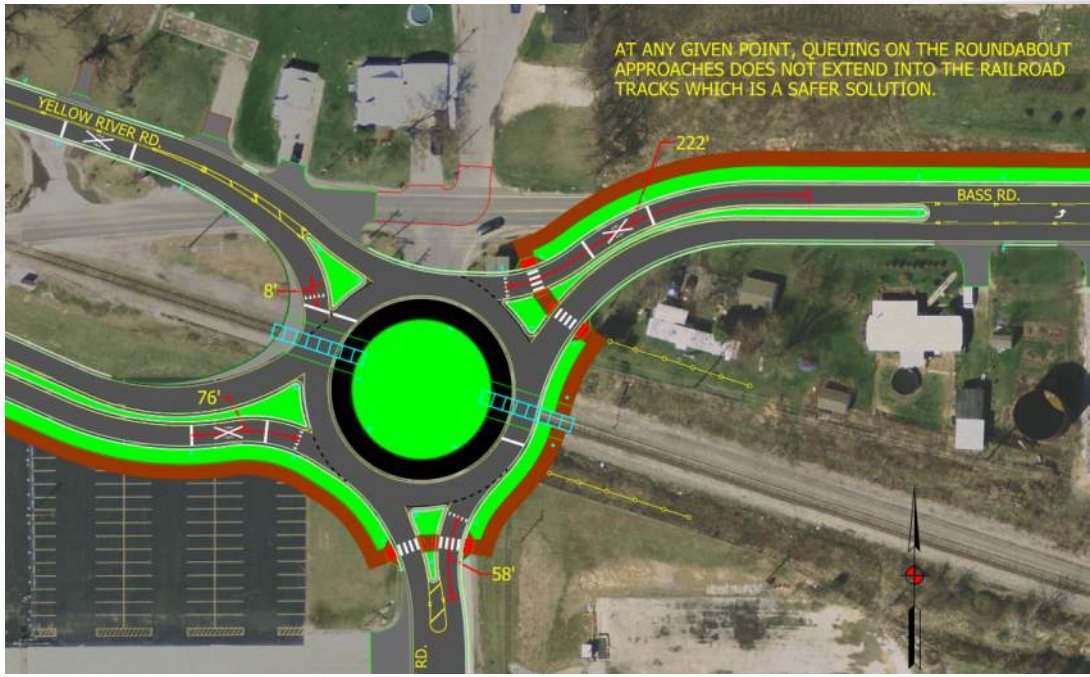
SIGNAL 1

ROUNDABOUT 2

COMPARISON Queue Analysis

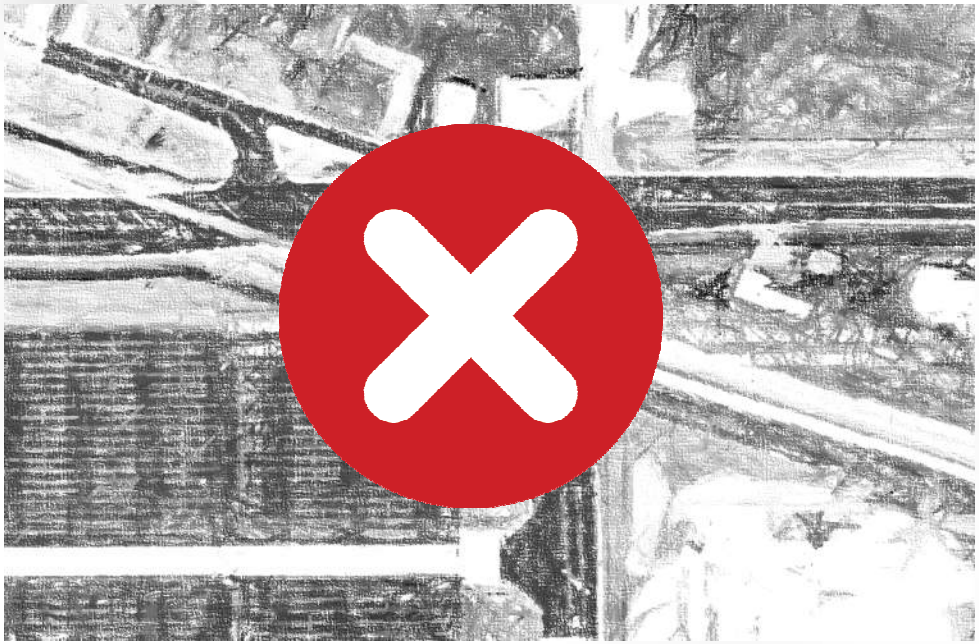
Signal – Potential to Queue on tracks

Roundabout – No Queues on tracks



COMPARISON Queue Analysis

Signal – Potential to Queue on tracks



Roundabout – No Queues on tracks

SIGNAL 0

ROUNDABOUT 3

COMPARISON Railroad Warning Devices

Alternative	Pre-Signal	Preemption	Railroad Cantilever Signals	Gates w/RR Flashers
Signal	Yes (Due to extremely short distance between the NB Stopbar on Hadley Road and the railway tracks)*	Yes [Complex preemption sequence necessary for track clearance for both NB and EB traffic approaches during train event]	Yes	Yes
Circular Roundabout	No	No**	No	Yes
Oval Roundabout	No	No**	No	Yes

* Preemption of Traffic Signals Near Railroad Crossings: An ITE Recommended Practice, Railroad-Highway Grade Crossing Handbook Second Edition (USDOT, FHWA)

** Preemption is not needed for the circular or oval roundabout alternate because of following reasons:

a) No downstream driveway or intersection that could potentially back into the roundabout and across the tracks

b) Intersection control itself does not cause any backups

c) Roundabout is not anticipated to be operating under fully saturated conditions in design year that can cause backups on the tracks

COMPARISON Railroad Warning Devices

Alternative	Pre-Signal	Preemption	Railroad Cantilever Signals	Gates w/RR Flashers
	Yes (Due to extremely short distance between the NB Stopbar on Hadley Road and the railway tracks)*	Yes [Complex preemption sequence necessary for track clearance for both NB and EB traffic approaches during train event]	Yes	Yes
Circular Roundabout	No	No**	No	Yes
Oval Roundabout	No	No**	No	Yes

* Preemption of Traffic Signals Near Railroad Crossings- An ITE Recommended Practice, Railroad-Highway Grade Crossing Handbook Second Edition (USDOT, FHWA)

** Preemption is not needed for the circular or oval roundabout alternate because of following reasons:

a) No downstream driveway or intersection that could potentially back into the roundabout and across the tracks

b) Intersection control itself does not cause any backups

c) Roundabout is not anticipated to be operating under fully saturated conditions in design year that can cause backups on the tracks

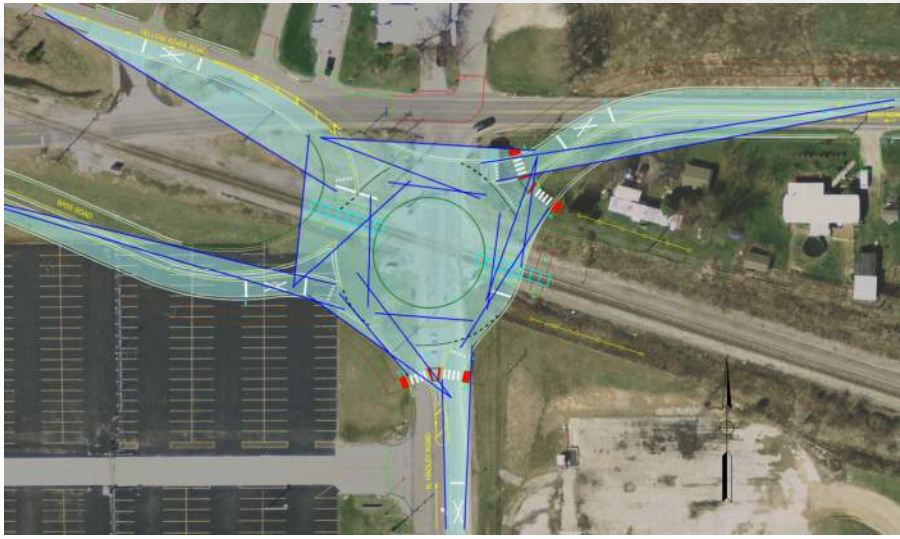
SIGNAL 0

ROUNDABOUT 4

COMPARISON Sight Distance

Signal – OK

Roundabout – OK



COMPARISON Sight Distance

Signal – OK

Roundabout – OK

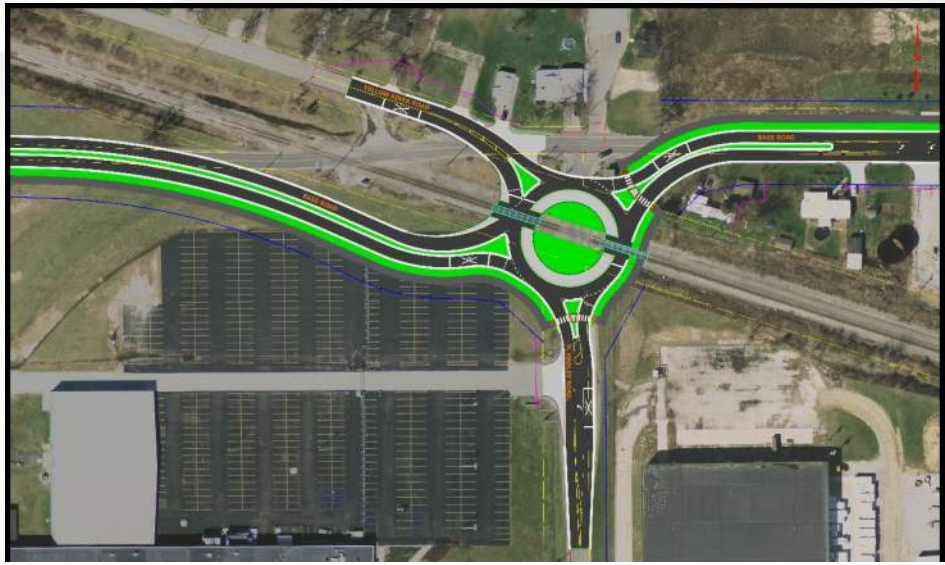
SIGNAL 1

ROUNDABOUT 5

COMPARISON Fastest Path

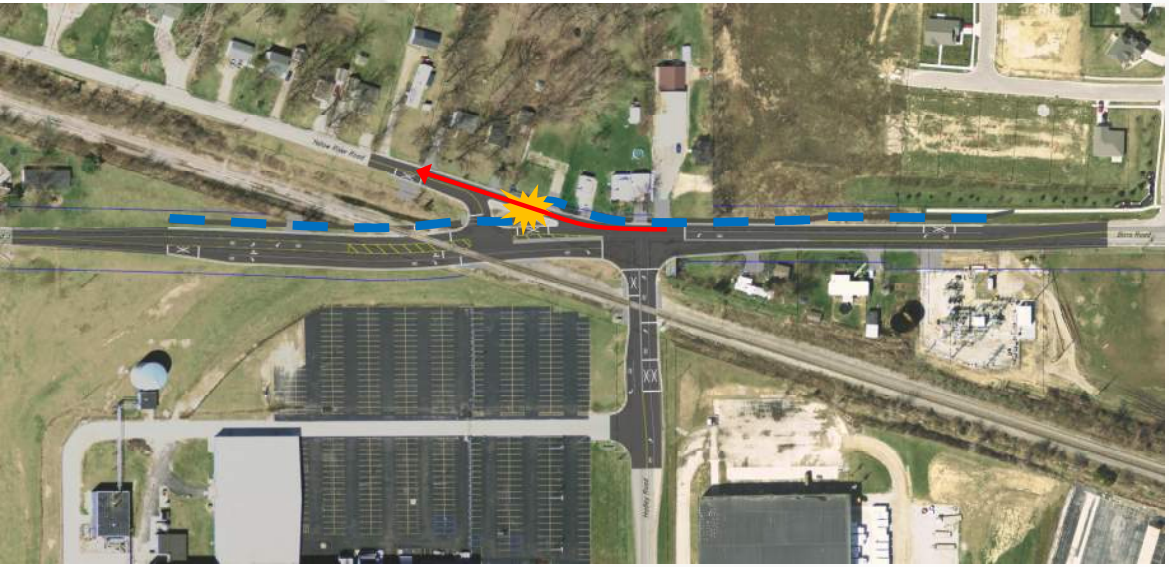
Signal – FAST!

Roundabout – SLOW
(meets FHWA criteria)

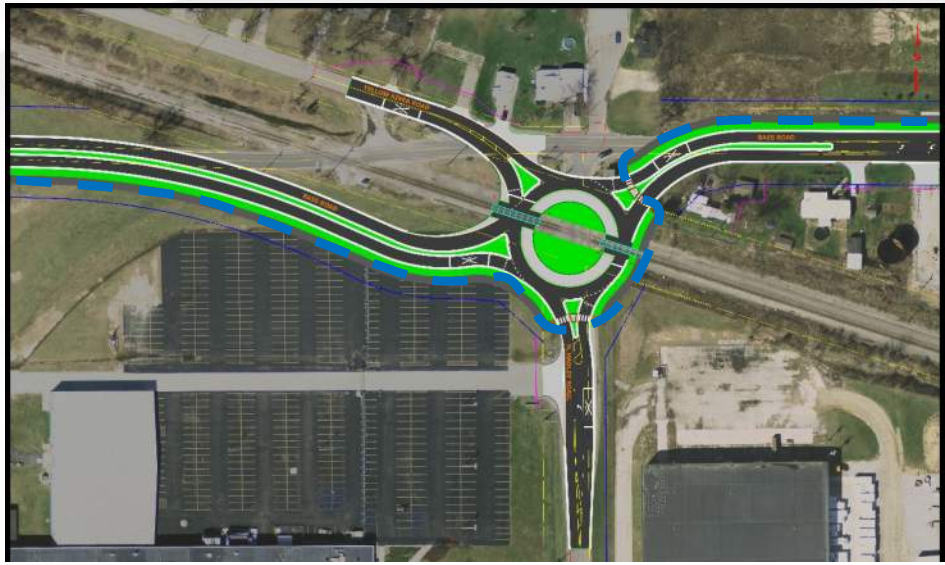


COMPARISON Fastest Path

Signal – Pedestrian Crossings



Roundabout – Pedestrian Crossings



COMPARISON Fastest Path

Signal – FAST!

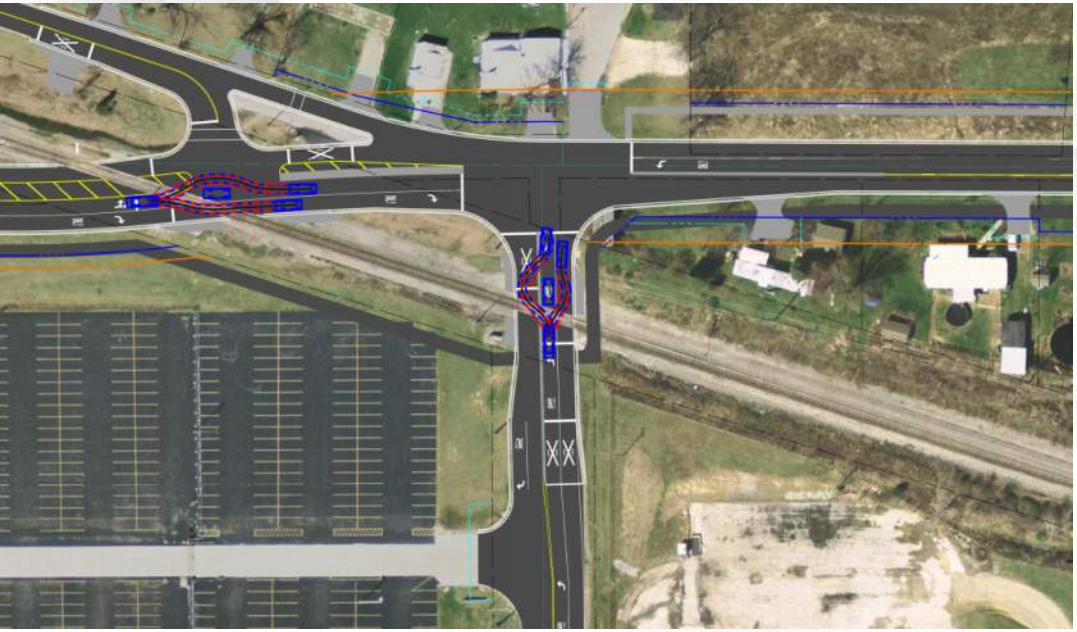
SIGNAL 1

Roundabout – SLOW
(meets FHWA criteria)

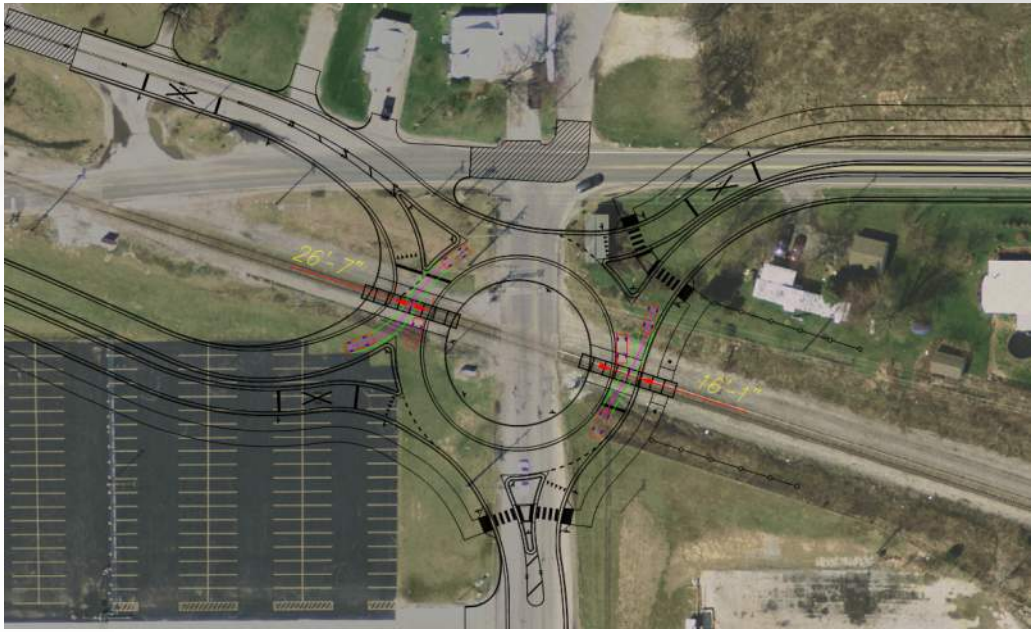
ROUNDABOUT 8

COMPARISON Escape Routes

Signal – OK



Roundabout – OK



COMPARISON Escape Routes

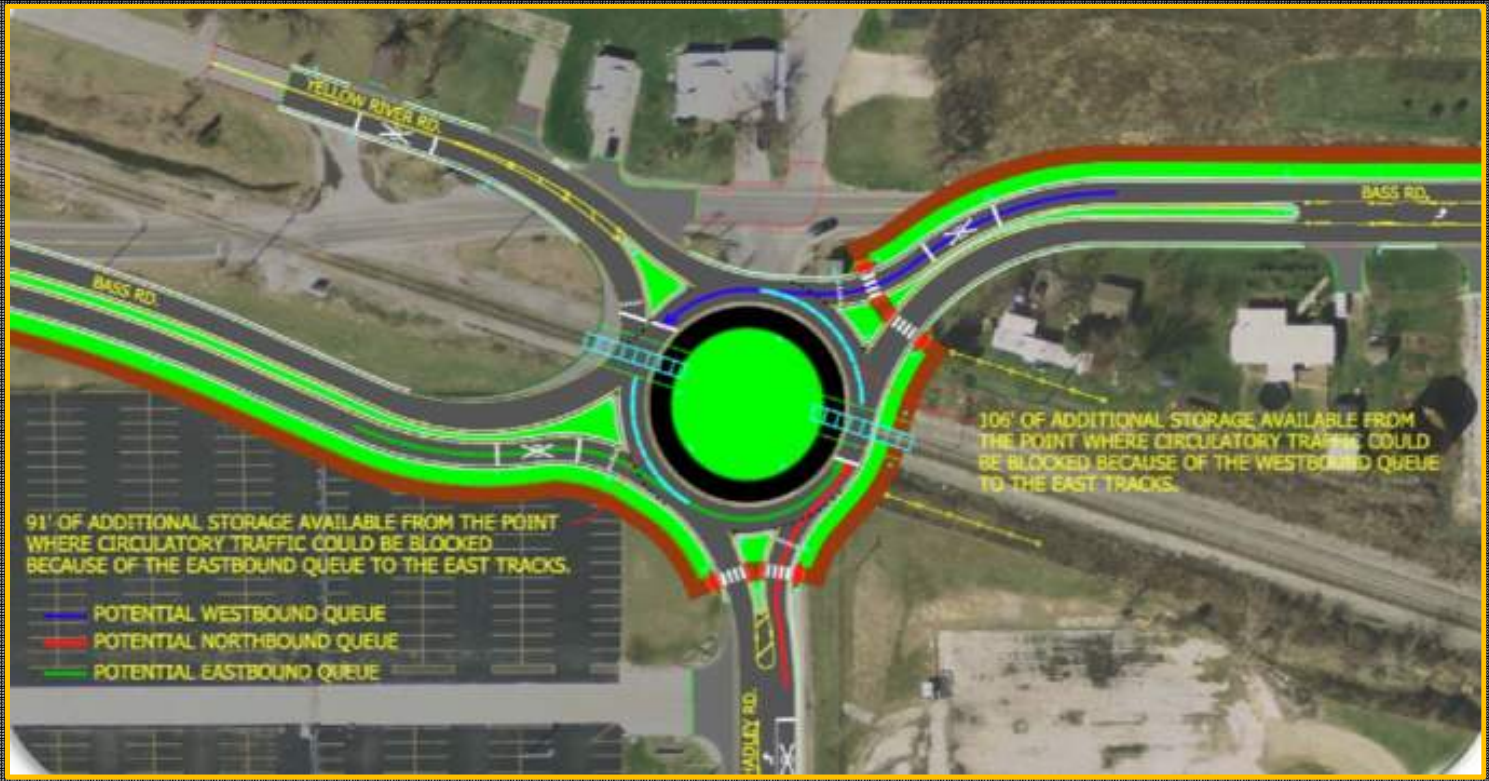
Signal – OK

Roundabout – OK

SIGNAL 2

ROUNDABOUT 1

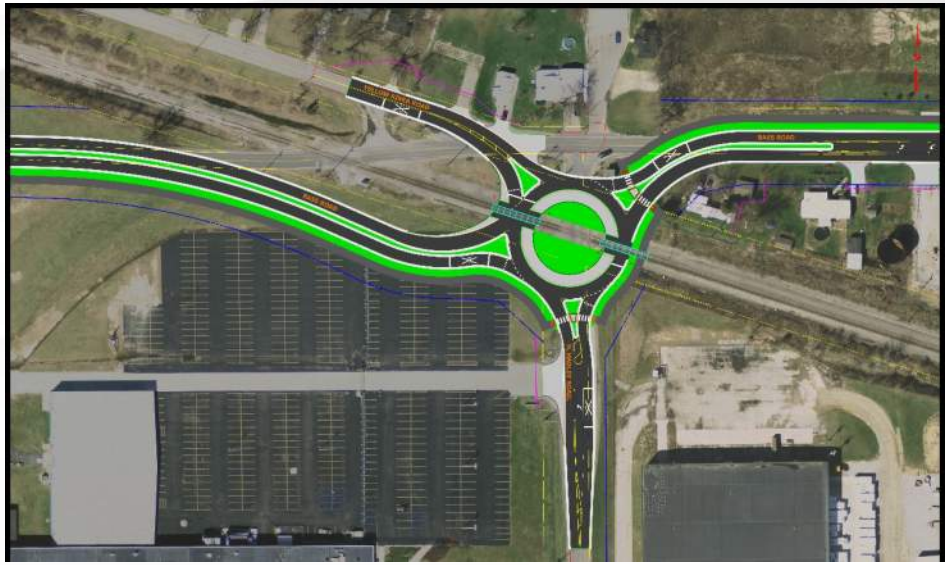
ROUNDABOUT
Queue Storage



COMPARISON Driver Decision Points

Signal – Many due to turn lanes and signal phases

Roundabout – Few due to simplicity of single-lane roundabout



COMPARISON Driver Decision Points

Signal – Many due to turn lanes and signal phases

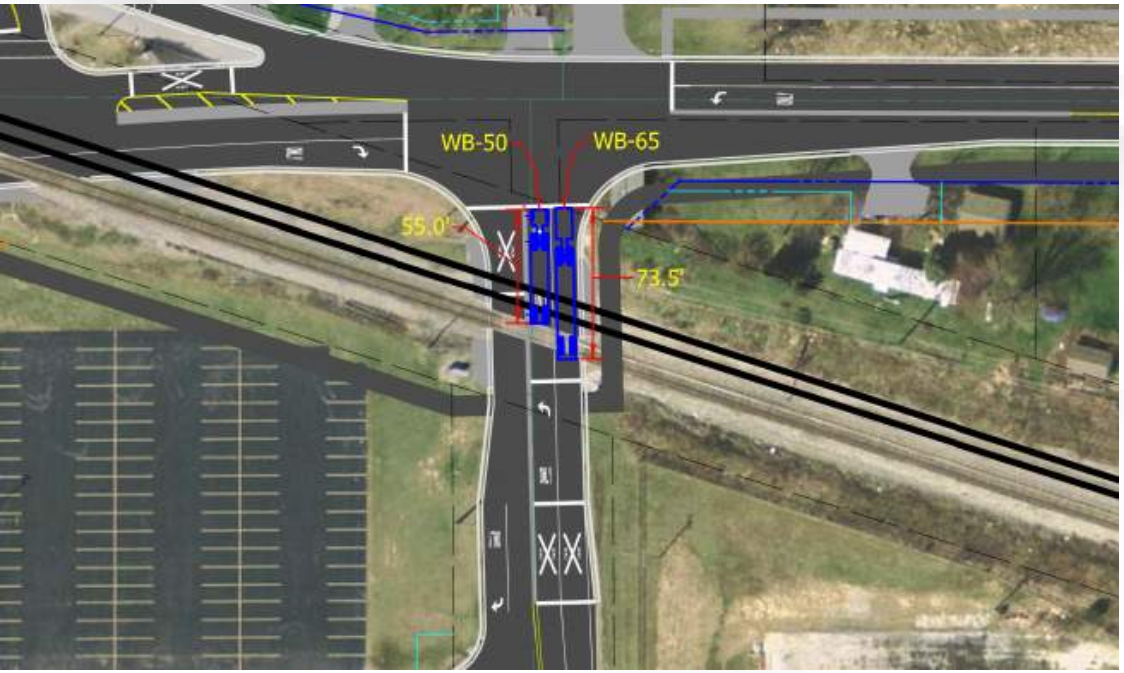
SIGNAL 2

Roundabout – Few due to simplicity of single-lane roundabout

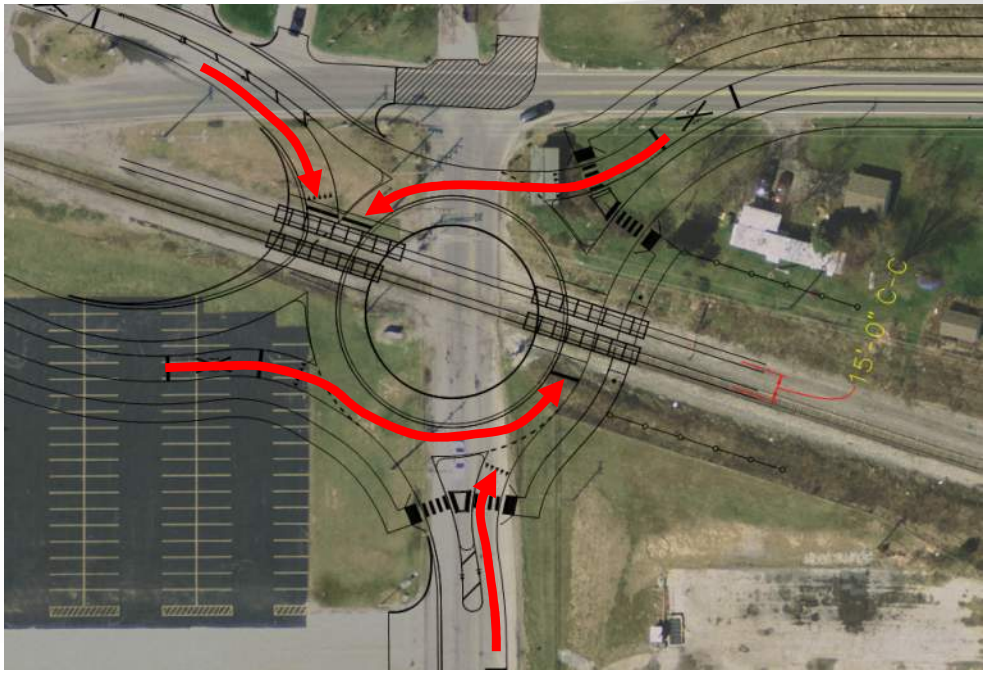
ROUNDABOUT 8

COMPARISON Track Expansion

Signal – Potential for Trucks to Queue on Tracks



Roundabout – No Issues



COMPARISON Track Expansion

Signal – Potential for Trucks to Queue on Tracks

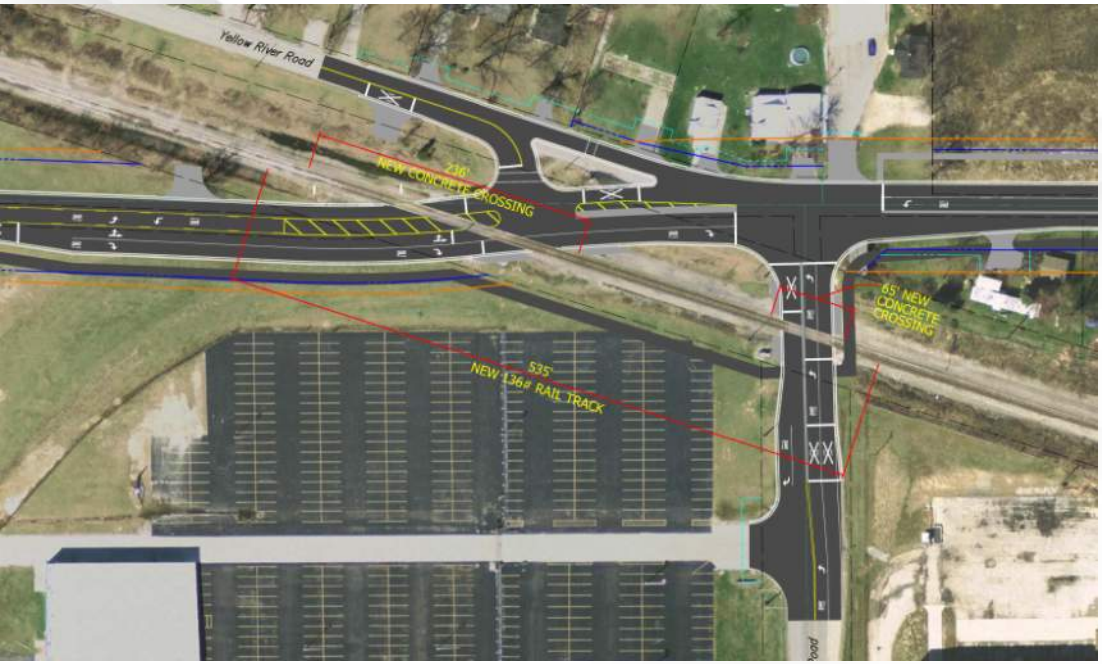
SIGNAL 2

Roundabout – No Issues

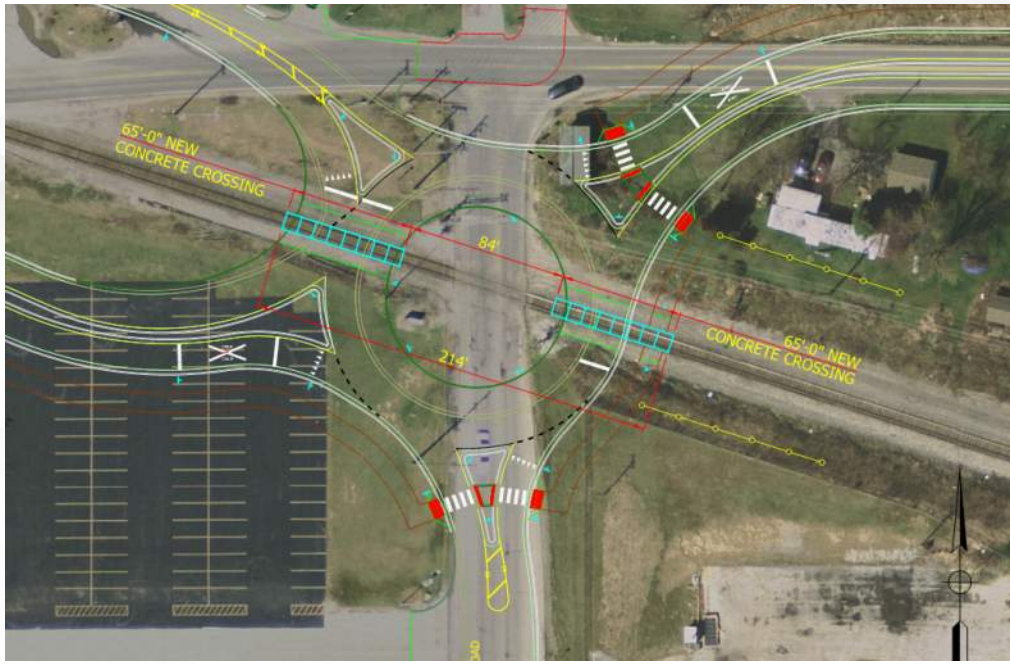
ROUNDABOUT 9

COMPARISON Maintenance

Signal – 535’ Total Crossing

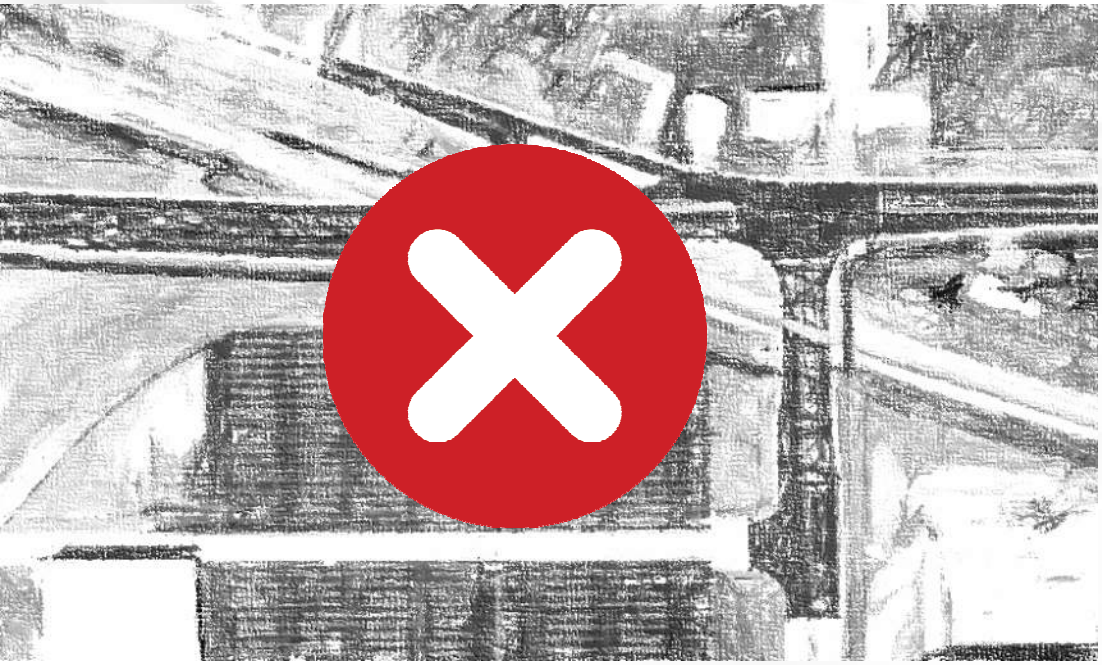


Roundabout – 214’ Total Crossing



COMPARISON Maintenance

Signal – 535’ Total Crossing



SIGNAL 2

Roundabout – 214’ Total Crossing

ROUNDABOUT 10

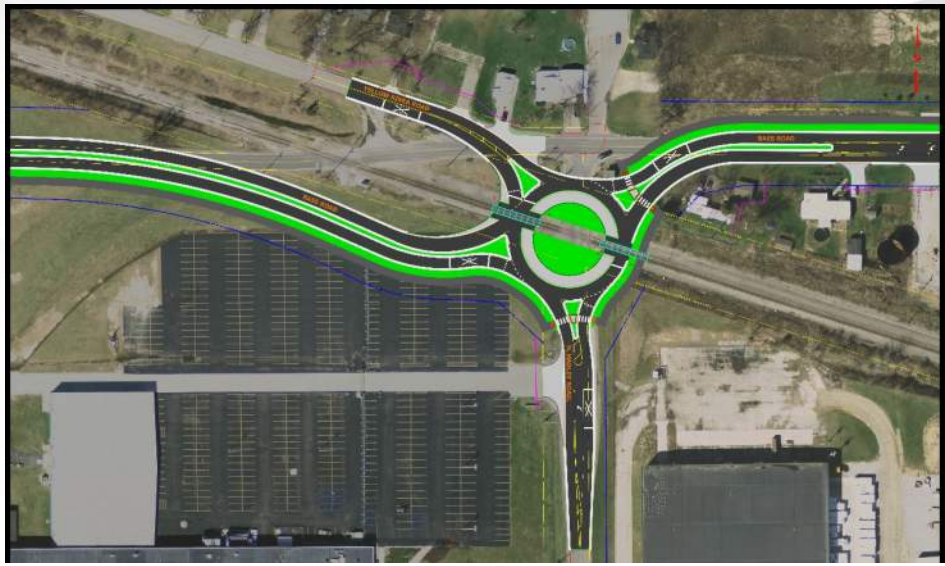
COMPARISON Construction and Right-of-Way

Signal

- $2.9 Million
- 4.1 Acres

Roundabout

- $3.2 Million
- 4.4 Acres



COMPARISON Construction and Right-of-Way

Signal

- $2.9 Million
- 4.1 Acres

Roundabout

- $3.2 Million
- 4.4 Acres

SIGNAL 3

ROUNDABOUT 10

RANKING MATRIX

Neutral = 0

Best = 1 or 2

Worst = -1 to -2

	Alternatives		
Measure of Effectiveness	**Signal**	**Circular Roundabout**	**Oval Roundabout**
Level of Service/Delay (AM and PM)	-1	0	0
95th Percentile Queue Length/Potential for Queue Backup on Tracks (AM and PM)	-2	2	0
Motorist Safety Features (Anticipated Cost + General Motorist Safety)	-2	0	0
Pedestrian & Bicyclist Safety	-2	2	0
Sight Distance	0	0	0
Vehicle Speeds (Fastest Path)	-2	2	0
Track Expansion	-1	0	0
Escape Route	-2	0	0
Maintenance	-1	0	1
Driver Decision Points	-2	0	0
Right-of-Way	1	0	-1
Construction Cost	1	-1	0
Total	-13	5	0
Rank	**3**	**1**	**2**

RANKING MATRIX

Neutral = 0

Best = 1 or 2

Worst = -1 to -2

	Alternatives		
Measure of Effectiveness	**Signal**	**Circular Roundabout**	**Oval Roundabout**
Level of Service/Delay (AM and PM)	-1	0	0
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Track Expansion	-1	0	0
Escape Route	-2	0	0
Maintenance	-1	0	1
Driver Decision Points	-2	0	0
Right-of-Way	1	0	-1
Construction Cost	1	-1	0
Total	-13	5	0
Rank	**3**	**1**	**2**

PROJECT TIMELINE

Corridor
Environmental Document
COMPLETE 2012

INDOT Rail Order
To Construct Roundabout
2014

Railroad Crossings
Open/Road Open To Public
3/1/2019

2010

2014

2018

Design Start
2009

Modified Intersection To
Roundabout
2013

Begin Hadley Roundabout Construction
7/15/2018

Hadley Roundabout Road Construction
COMPLETE 11/30/2018

Roundabouts and Regional Pathways

Hillary Isebrands, PE, PhD

FHWA Office of Technical Services, Resource Center,
Safety and Design Team

720-545-4367

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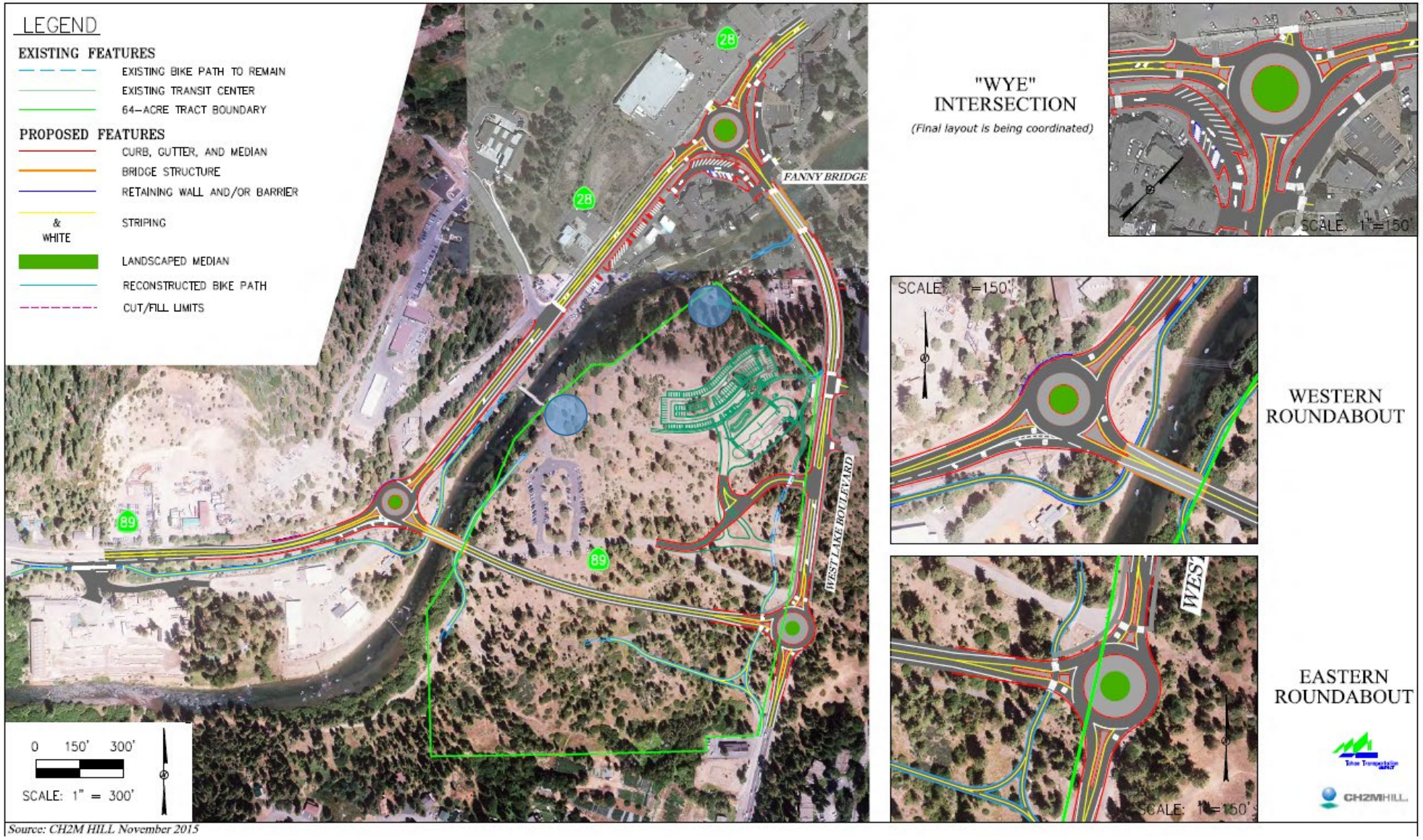
Photo credits: Hillary Isebrands

Locations of Discussion for Today

- Tahoe City, CA (west shore of Lake Tahoe)
- Grand Teton National Park, WY
- Eagle County, CO
- Austin, TX

Photo source: Hillary Isebrands

Tahoe City, CA (Placer County)



https://www.tahoetransportation.org/fanny-new-1

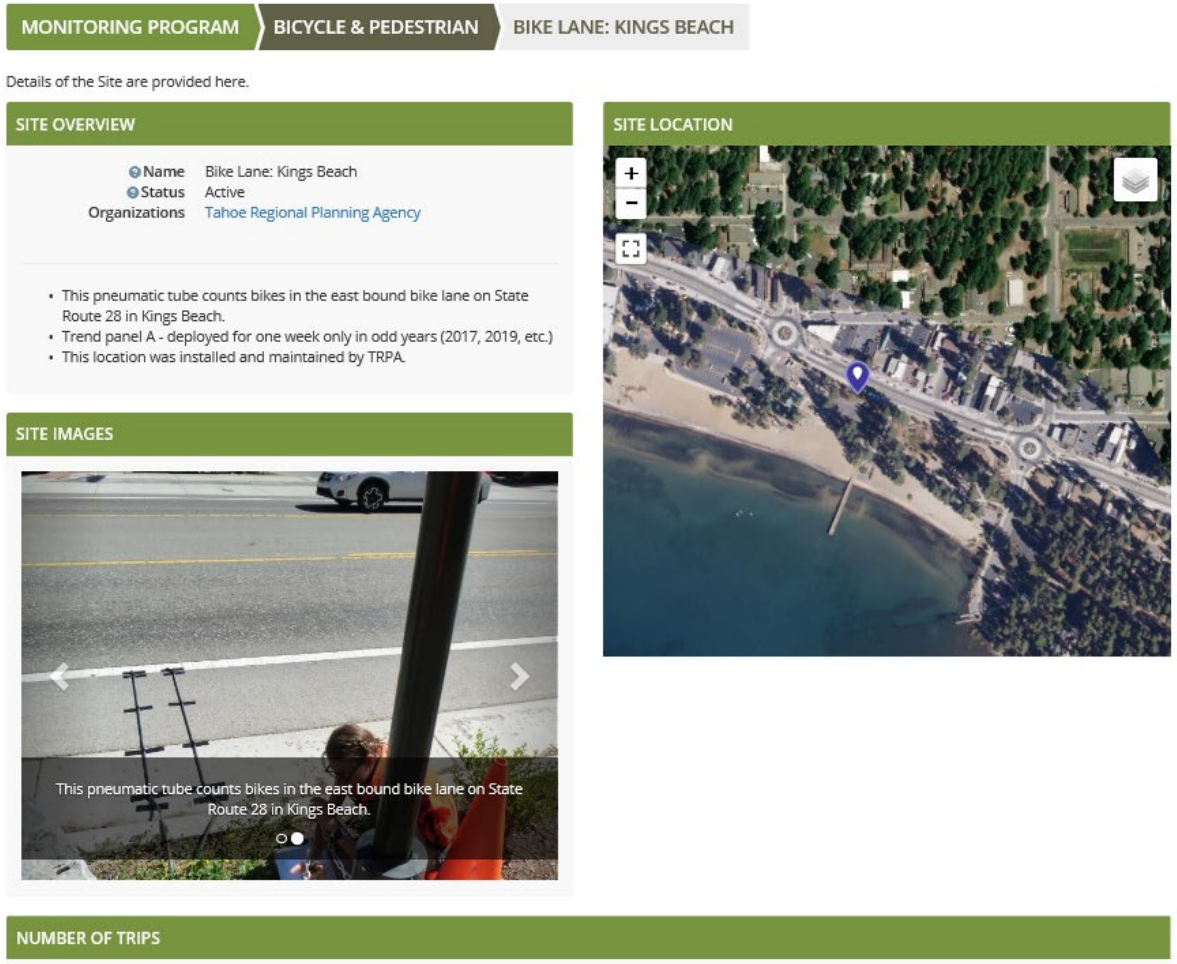
Tahoe City, CA West Roundabout

Tahoe City, “Wye” Roundabout

Rendering credits: TTD & Design Workshop

Lake Tahoe Roundabouts & Bicycle Facilities

Photo source: Hillary Isebrands



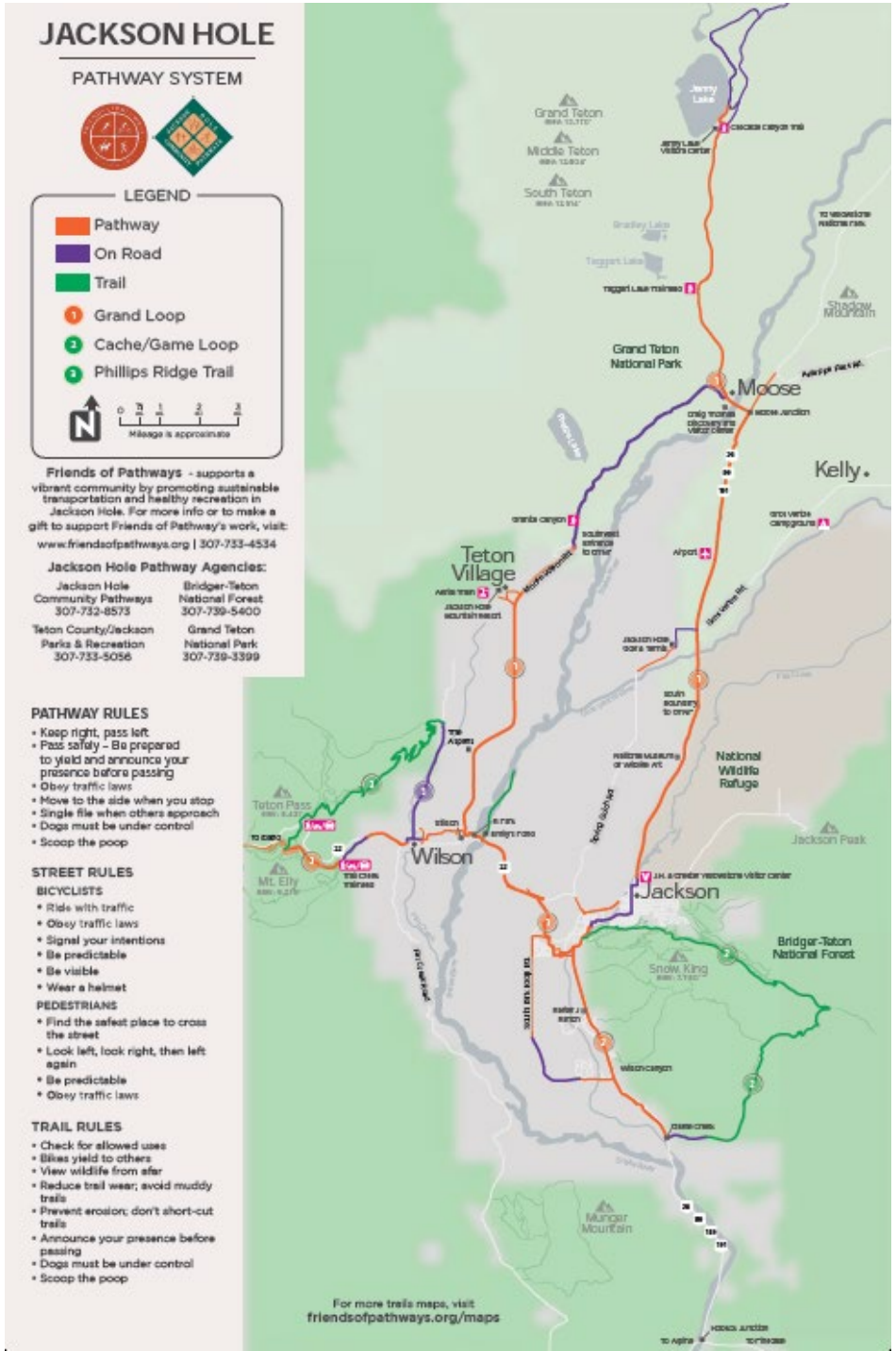
https://monitoring.laketahoeinfo.org/MonitoringSite/Detail/49

Dogs, Bus Riders, Bikers, Walkers….All at Roundabouts!

Video source: Hillary Isebrands

Grand Teton National Park Pathways Project

Photo source: Hillary Isebrands



Grand Teton National Park Pathways Project

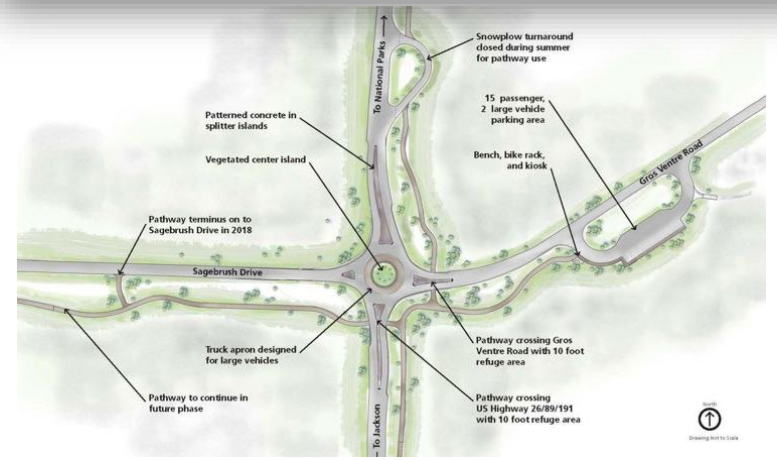


Image Source: Grand Teton National Park

Letters to the editor

Jul 3, 2019 1

Marvelous pathways

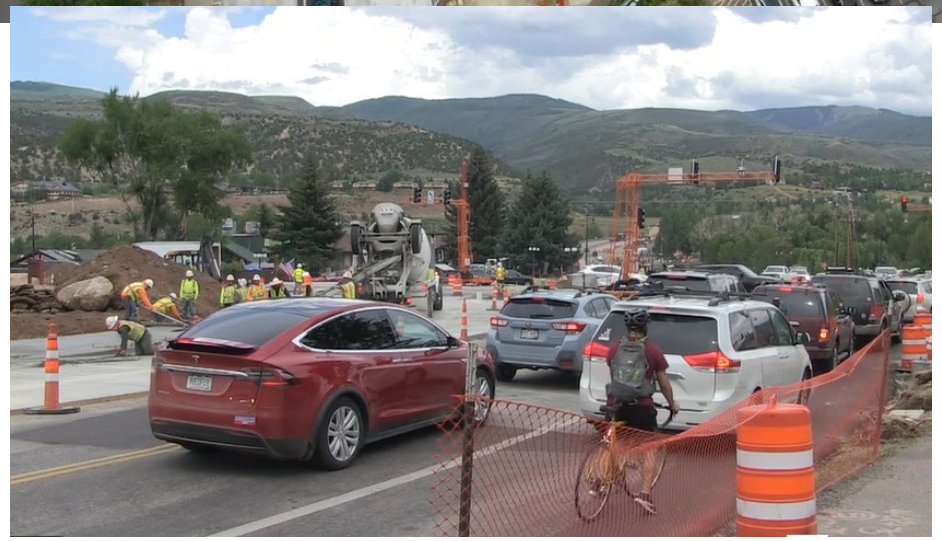
If you don't live in the middle of a city where riding a road bike can be dangerous and cumbersome, you can't appreciate the absolute thrill of being able to ride out of your garage and connect safely (because of the new roundabout) with dozens of miles of paved pathways.

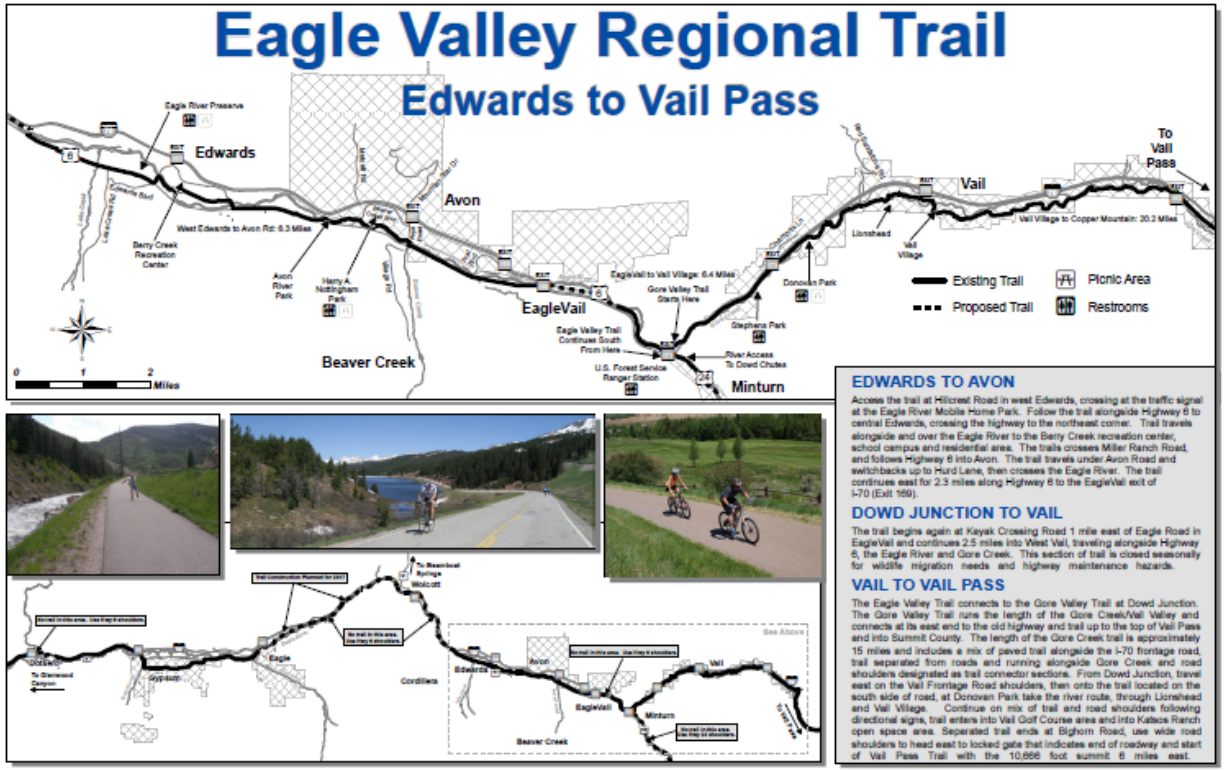
Everyone, not just riders, should express their appreciation to the voters of Teton County, who approved SPET funds for the pathways, the National Park Service and its representatives at Grand Teton National Park, and the tireless volunteer advocates at Friends of Pathways for what we have in the valley.

Where else in this country can one cycle for miles through such marvelous surroundings? The pathway system is truly a wonderful community asset.

https://www.jhnewsandguide.com/opinion/letters/letters-to-the-editor/article_3e51f4eb-f668-50f6-a67a-a5260272a7bf.html

Eagle County, Colorado





https://vimeo.com/351489847

https://www.eaglecounty.us/Trails/Documents/Edwards_to_Vail_021017_BW/

Austin, Texas Parks & Recreation Trails

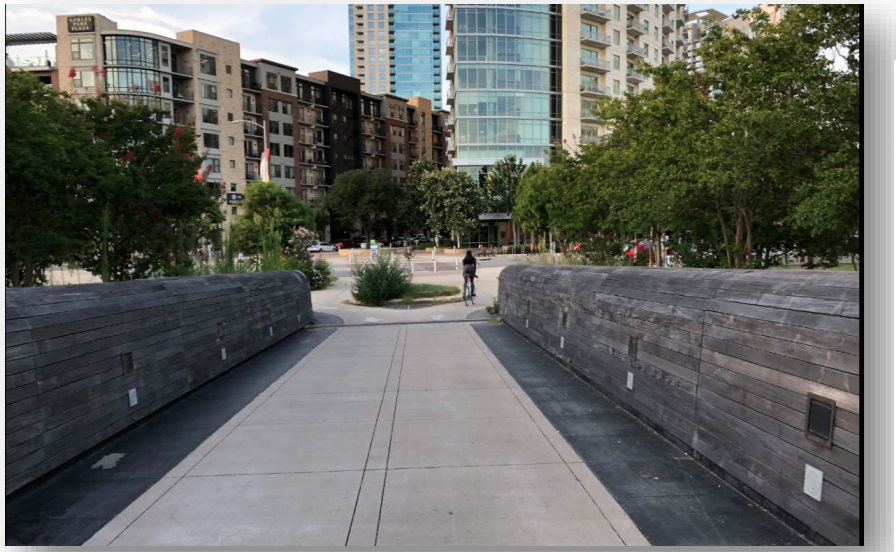
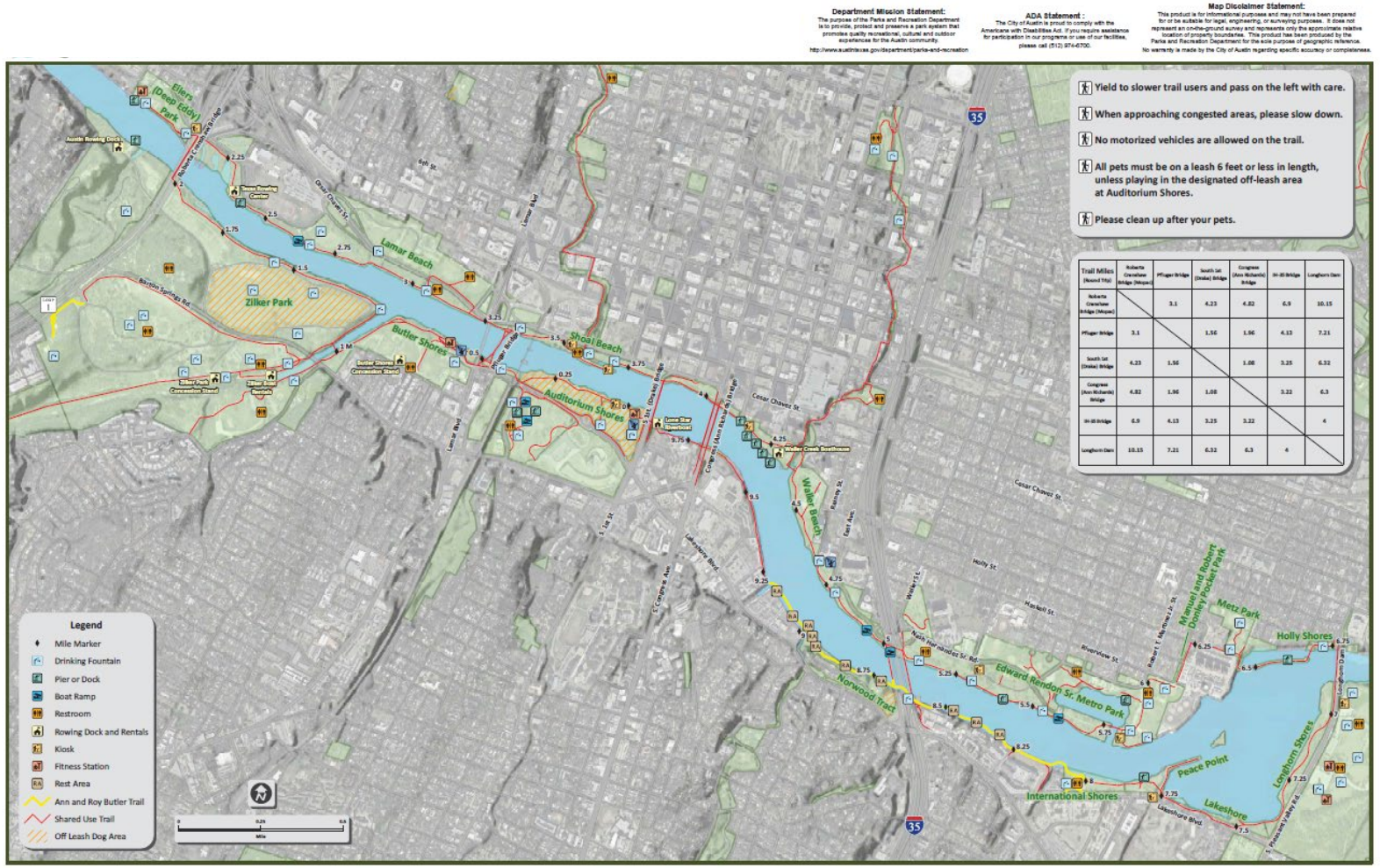


Photo source: Hillary Isebrands



http://www.austintexas.gov/sites/default/files/files/Parks/GIS/AnnRoyButlerTrailUpdate.pdf

Roundabouts and Pathways

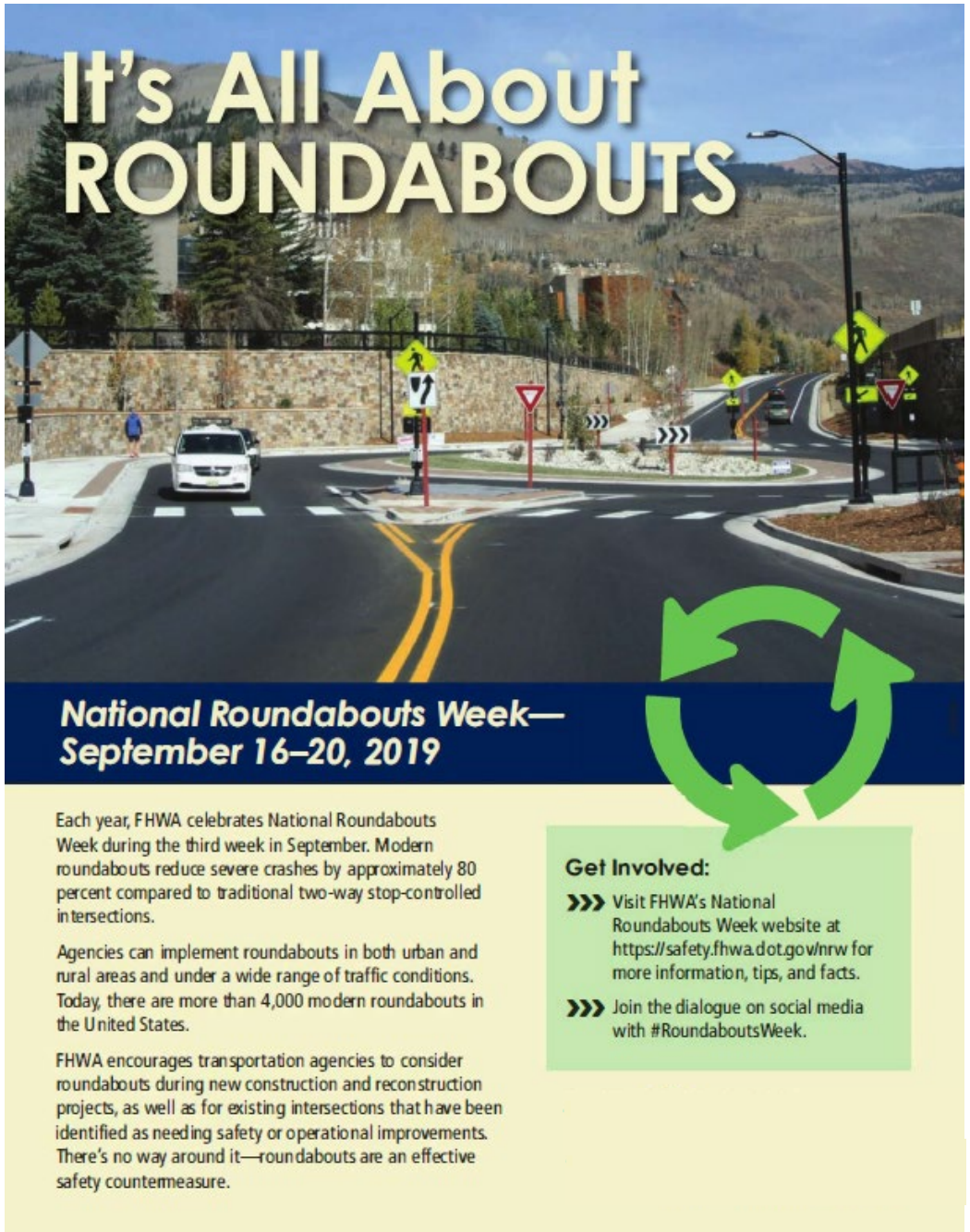
- Roundabouts and Bicycles live in harmony across the world
- Hundreds of examples exist where pathways cross roundabout approaches
- You can find bicycle roundabouts along pathways in dozens on communities
- Roundabouts save lives!

Photo source: Hillary Isebrands

National Roundabouts Week

September 16-20, 2019

#RoundaboutsWeek



It's All About ROUNDABOUTS

National Roundabouts Week—September 16–20, 2019

Each year, FHWA celebrates National Roundabouts Week during the third week in September. Modern roundabouts reduce severe crashes by approximately 80 percent compared to traditional two-way stop-controlled intersections.

Agencies can implement roundabouts in both urban and rural areas and under a wide range of traffic conditions. Today, there are more than 4,000 modern roundabouts in the United States.

FHWA encourages transportation agencies to consider roundabouts during new construction and reconstruction projects, as well as for existing intersections that have been identified as needing safety or operational improvements. There's no way around it—roundabouts are an effective safety countermeasure.

Get Involved:

- Visit FHWA's National Roundabouts Week website at https://safety.fhwa.dot.gov/nrw for more information, tips, and facts.
- Join the dialogue on social media with #RoundaboutsWeek.

https://www.fhwa.dot.gov/publications/publicroads/19summer/index.cfm

Thank you!

Hillary Isebrands, PE, PhD

FHWA Office of Technical Services, Resource Center, Safety and Design Team

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Photo credits: Hillary Isebrands

Today's Participants

- Doug McClanahan, *Washington Department of Transportation*, mcclando@wsdot.wa.gov
- Mike McBride, *America StructurePoint Inc.*, mmcbride@structurepoint.com
- Mike Maurovich, *American StructurePoint Inc.*, MMaurovich@structurepoint.com
- Hillary Isebrnads, *Federal Highway Safety Administration*, hillary.isebrands@dot.gov
- Daniel Spann, *Barge Design Solutions*, Daniel.Spann@bargedesign.com

U.S.Department of Transportation
Federal Highway Administration

Panelists Presentations

http://onlinepubs.trb.org/onlinepubs/webinars/190829.pdf

After the webinar, you will receive a follow-up email containing a link to the recording

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- Become a Friend of a Committee (http://bit.ly/TRBcommittees)
  - Networking opportunities
  - May provide a path to become a Standing Committee member
- ***Sponsoring Committee: ANB75***
- For more information: www.mytrb.org
  - Create your account
  - Update your profile

TRB turns 100 on November 11, 2020

100 YEARS 2020

TRB

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MOVING IDEAS: ADVANCING SOCIETY—100 YEARS OF TRANSPORTATION RESEARCH