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Technical Memorandum #2

TO: B. Finley Vinson, PE, PTOE

Director – Street & Engineering Dept., City of Conway, Arkansas

FR: Mark T. Johnson, PE (AR), MTJ Engineering, LLC

RE: Response to Review Comments for Highway 286/Dave Ward Dr. Roundabout Review

DT: March 24, 2015

As requested by the City of Conway, MTJ Engineering, LLC has reviewed the comments provided by the State, "Response to MTJ Review," dated Feb. 18, 2015. This document was in response to the previously provided MTJ Stage I Review memo, dated Feb. 11, 2015, for this project.

Overview:
MTJ was retained by the City to conduct a review on these roundabout designs. It is our understanding that the designs are being managed by AHTD. As part of this review MTJ had requested an opportunity to discuss our review comments with the State and/or Consulting Design Engineer. This would be a normal part of a Design Review. This request has not been granted, nor have we had any interactions with those in principal charge of the designs subsequent to our Stage 1 review comments. We have not reviewed any plans other than those provided to us in the Stage I review that were called 60% design plans.

Our original design Stage I review dated Feb. 11, 2015, was aimed at identifying potential areas of concern with the proposed design. It was anticipated that as part of a normal design review process there would be opportunities to interact with those in principal charge of the design to facilitate understanding of our Stage I review, and subsequently to move forward to our proposed Stage II review that would look to modify the proposed geometrics within available constraints to optimize the design and attempt to address the Stage I review findings. However, there has been no opportunity provided for any reasonable communications to facilitate this design review as originally contracted.

We have reviewed the single piece of communication provided to MTJ by AHTD called, *"Response to MTJ Review,"* dated Feb. 18, 2015, which contains responses by the design consulting firm and also brief responses by AHTD to the MTJ Stage I memo. Based on our review of this document, it is clear that the intent of the Stage I review has not been addressed. Rather, this document dismisses the Stage I review comments. The response document provide by AHTD contains incorrect assumptions and erroneous conclusions relative to the MTJ Stage I review.

Because MTJ has not been provided any reasonable opportunity to provide a proper review on these designs, any representations by any parties that indicate MTJ Engineering's review has led to any changes to address our Stage I review are unsubstantiated. MTJ Engineering, LLC takes no responsibility for these designs or any mitigations that may or may not have been incorporated into these designs based on our Stage I recommendations.

Below is our response to the received document, "*Response to MTJ Review"* dated Feb. 18, 2015, provided by AHTD. The "Response to MTJ Review" text is inserted below in the red boxes, followed by MTJ responses in **blue text.**

- **Wide Angles Between Legs**

6.3.3 – Wide Angles Between Legs

The primary control alignments for all approaches are based on no more than a 15 degree skew. A more perpendicular approach was initially developed for the southern approach on roundabout 1 but resulted in much more significant impacts to the development in that area. As mentioned in Section 6.3.3, perpendicular approaches are not a design requirement. Acceptable designs can be achieved with skewed angles between the approaches.

I agree. But, skewed intersections need to be the exception and not the rule.

While it is true that acceptable designs can be achieved with skews, this becomes more challenging with multi-lane designs. Based on our review, these designs are significantly less than optimal. And it is recommended that substantive geometric changes are necessary to ensure an optimized design for safety and operations.

- **Elongated Decision Making Zone**

6.5.6 – Elongated Decision Making Zone

With a 3 lane roundabout, there will be an increased area for making lane decisions. As recommended in Section 6.5.6, separation was minimized between entries and exits to eliminate paths merging.
As discussed, raised islands between all dual thru approach lanes will be added to reduce entry speed.

I have not reviewed the addition of raised islands between lanes 1-2. But this raises more concerns with safety, especially as it relates to motorcycle safety.

- **Flat Entry (Phi) Angles**

6.7.4 – Flat Entry (Phi) Angles

A much more detailed discussion of Phi angles is presented in Wisconsin's Roundabout Guide. As mentioned in their guidelines, the typical range for the Phi angle is between 20 and 30 degrees, with designs being shown to operate correctly with a Phi angle as low as 16 degrees. The Phi angles for the approaches are based on the criteria shown in Figure 30.21 and 30.22 in the Wisconsin Guide. As mentioned in the guide, Phi angle is not a controlling criterion. Section 6.4.5 (and end of Section 6.5.4) in the NCHRP Report 672 also mentions that Phi angles are typically between 20 and 40 degrees. This is significantly different than the 40 degree minimum recommended by MTJ. For the viewing angles, Section 6.7.4 of NCHRP Report 672 bases the intersection angle on a triangle formed utilizing the intersection sight distance. The analysis shown by MTJ does not utilize the sight distance triangle and as a result it significantly misrepresents the viewing angle. The point of consideration should be based on the intersection sight distance, which would be based on a speed of 25mph to 30mph for a multilane roundabout. This correlates to a distance of 184' to 220' from the entry point. This results in significantly smaller angles of visibility than those reported by MTJ. Additionally, the guidelines only reference a preferred angle of 15 degrees instead of the 12 degrees mentioned by MTJ. As a point of reference, we even compared the recommended 3-lane roundabout entry geometry shown in Exhibit 6-32 of the NCHRP report (attached), and it would fail the criteria that MTJ has established. As mentioned in the NCHRP report, in complex roundabouts, corrections for one effect related to the sight angle can introduce other problems, and the engineer should balance the trade-offs when determining the best course of action. The yield bars for the outside lanes (worse case) have been set to provide the best viewing angle over the car to the left of the entering vehicle and are set at the edge of the circulating roadway. If desired, the yield bars could be set back further to lessen the angle.
I agree with explanation.

MTJ was a primary author of the Wisconsin DOT Roundabout Guidance. As well, MTJ was a co-author of the FHWA 2010 Roundabout Guide (Report 672), with primary emphasis in the multi-lane design sections. As such, we are very well versed in these issues.

The nomenclature for "Phi" angle as referenced in Report 672 is derived from UK design criteria. Phi angle is half the actual measured angle. The entry angle shown in our review memo shows 40 degrees and is 2x Phi. And therefore Phi = 20 degrees based upon the actual measured angle of 40. We have clarified this in our graphics. The design's actual angle is less than 15 degrees, which corresponds to a 7-8 degree Phi angle, and is substantially out of compliance.

With reference to the View angle, the graphics in the FHWA Guide are concept designs not specifically intended for final design reference. And, yes, MTJ uses a slightly different convention than what is shown in the FHWA Guide. Based on our experience, this convention is a better representation of the design attribute of view angle than what is shown in the FHWA guide.

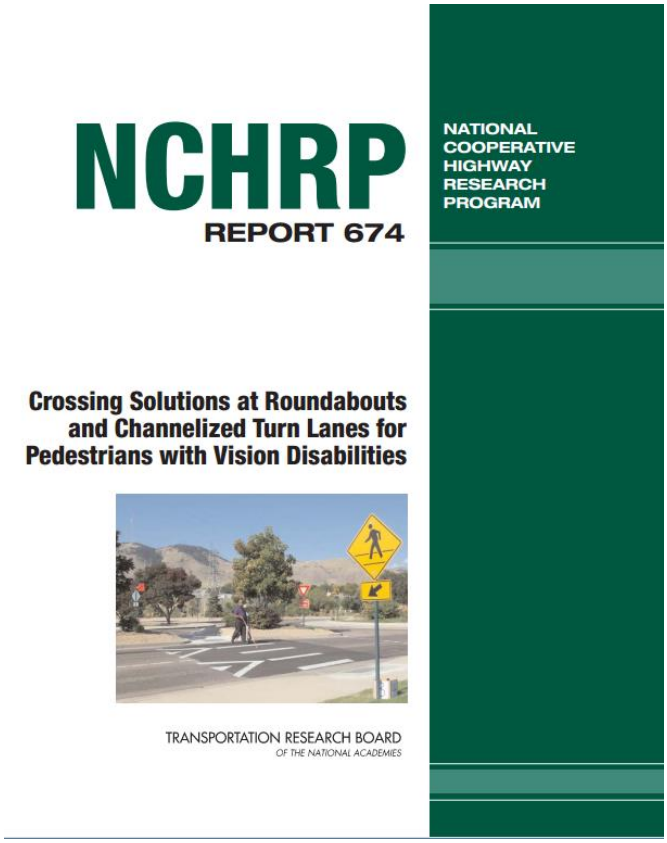
- **Pedestrian Refuge**

Pedestrian Refuge

The pedestrian refuge widths in the NCHRP report are specific to the splitter islands that separate opposing traffic movements. The outside low profile islands (also called vein islands) were never intended to be utilized for pedestrian refuge.

I agree with explanation.

As proposed, the designs do not appear to address pedestrian recommendations of NCHRP 674, "Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities."

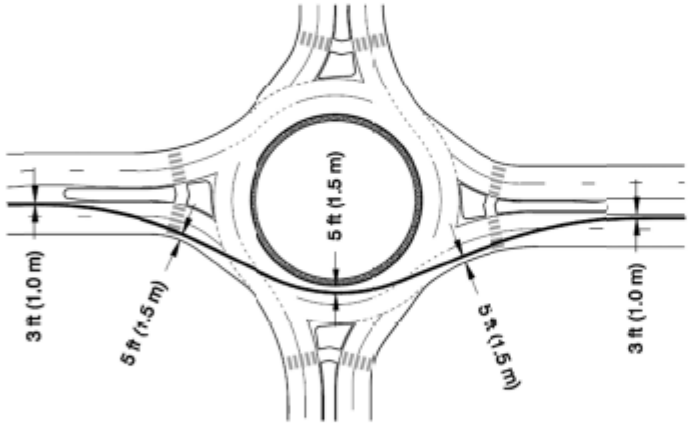


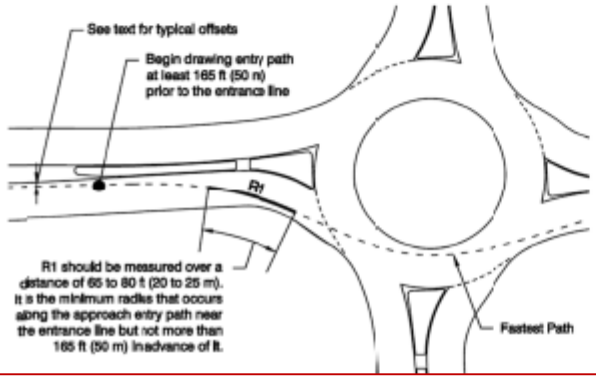
- **Fastest Path Checks**

6.7.1 – Fastest Path Checks

There are several noticeably incorrect fastest paths shown in the diagram provided by MTJ. The entry from the southern approach of roundabout 1 (ramp 3) crosses over an island, and the western approach into roundabout 1 does not adhere to the correct offset to the entry island. The proposed entry speeds listed on the southern approach of roundabout 2 (South Amity Road) are also substantially off since they are all controlled by the 25mph curve entering the roundabout (within the 165' zone). It would be impossible for a vehicle to instantaneously reach 57mph coming through a 25mph curve. All of the fastest path checks created by Garver were created based on the recommended path criteria shown in Section 6.7.1.1. As noted in that section, the vehicle paths should be drawn 5' from a concrete curb, 5' from a roadway centerline, and 3' from a painted edge line (diagram below). As also mentioned in the guidelines, a tangent section should be included between the curves to account for the time it takes for a driver to turn the steering wheel. Several of the paths shown by MTJ do not appear to adhere to these criteria. Most of the paths shown lack a tangent section between the curves, and several of the offsets do not match the recommended offsets. The path alignments developed by Garver utilize the criteria presented in the NCHRP report and were developed utilizing the recommended "B-spline" curve method presented in the Wisconsin Guidelines. The roundabout entry widths were developed to accommodate WB-67 vehicles in all approach lanes without creating over-tracking issues into adjacent lanes. Utilizing smaller radii or smaller lane widths will result inadequate space for WB-67 vehicles. As noted in Section 6.7.1.4, for multilane roundabouts, it is difficult to produce a balanced design to meet all of the criteria. If the goal is to further reduce entry speeds, an easy modification of the existing design would be to simply add the low profile lane separation (vein islands) to the inside lanes (just like the outside lanes) to cut off any possible fast path movements.

I agree with above explanation and recommendation to provide raised vain islands. Also, I recommend locating stagger of yield Lines to provide the most appropriate viewing angle for approaching traffic.





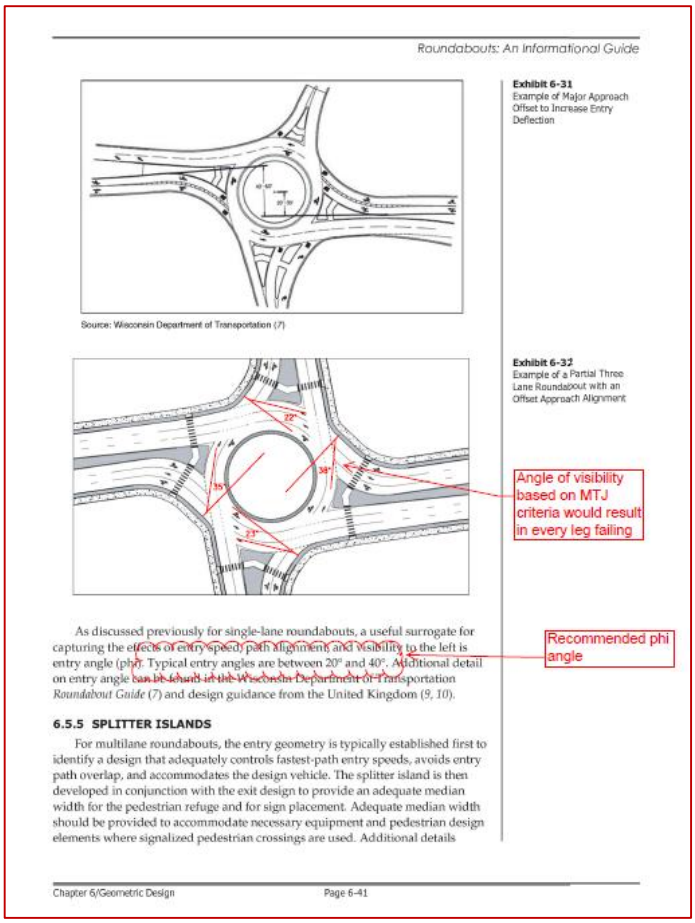
The numeric values shown in our graphic representation of the fast paths were based upon actual fast path constructs from our CAD-level fast path checks (attached).

The graphical representation we provided was intended to visually represent the issue, and to show in relative terms how out of specifications the original fast path constructs were developed. These graphically produced fast path constructs were not intended to reflect the actual fast path construction. Therefore, any reference to them being out of compliance is not applicable. Please see attached actual CAD fast path constructs.

- **Natural Path**

Natural Path

Due to the presence of 3 circulatory lanes with a single exit on Enterprise Avenue, there will be a transition required to the outside lane to allow for the left hand movement. As discussed in 6.7.2, there is a tangent transition between the curves that allows for the movement, giving the driver adequate time to make the movement (no sudden changes in curvature). A larger radius and shorter tangent section could be striped if desired.



See previous MTJ comments related to the above comments pertaining to angle of visibility and Phi angle.

Conclusion

Multi-lane high-flow roundabouts require correct composition for optimal safety and operations. Poor composition has been shown to directly equate to poor performance, lower safety performance, and public acceptance concerns. Design details are inexpensive and easy to correct, but it can be very expensive and difficult to correct poor composition once constructed.

Poor roundabout performance is less about the individual components (e.g., too big or too small) and more accurately attributed to the arrangement and relationship of all the geometric design elements; i.e., its composition. The composition of geometric design elements takes skill and experience to apply correctly in high-flow, multi-lane roundabout applications.

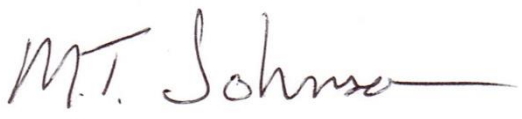
These designs exhibit many undesirable design elements related to its overall composition, and it is recommended that the designs be substantially modified to address these compositional issues prior to construction for optimal safety and operations.

Please see Attachments:

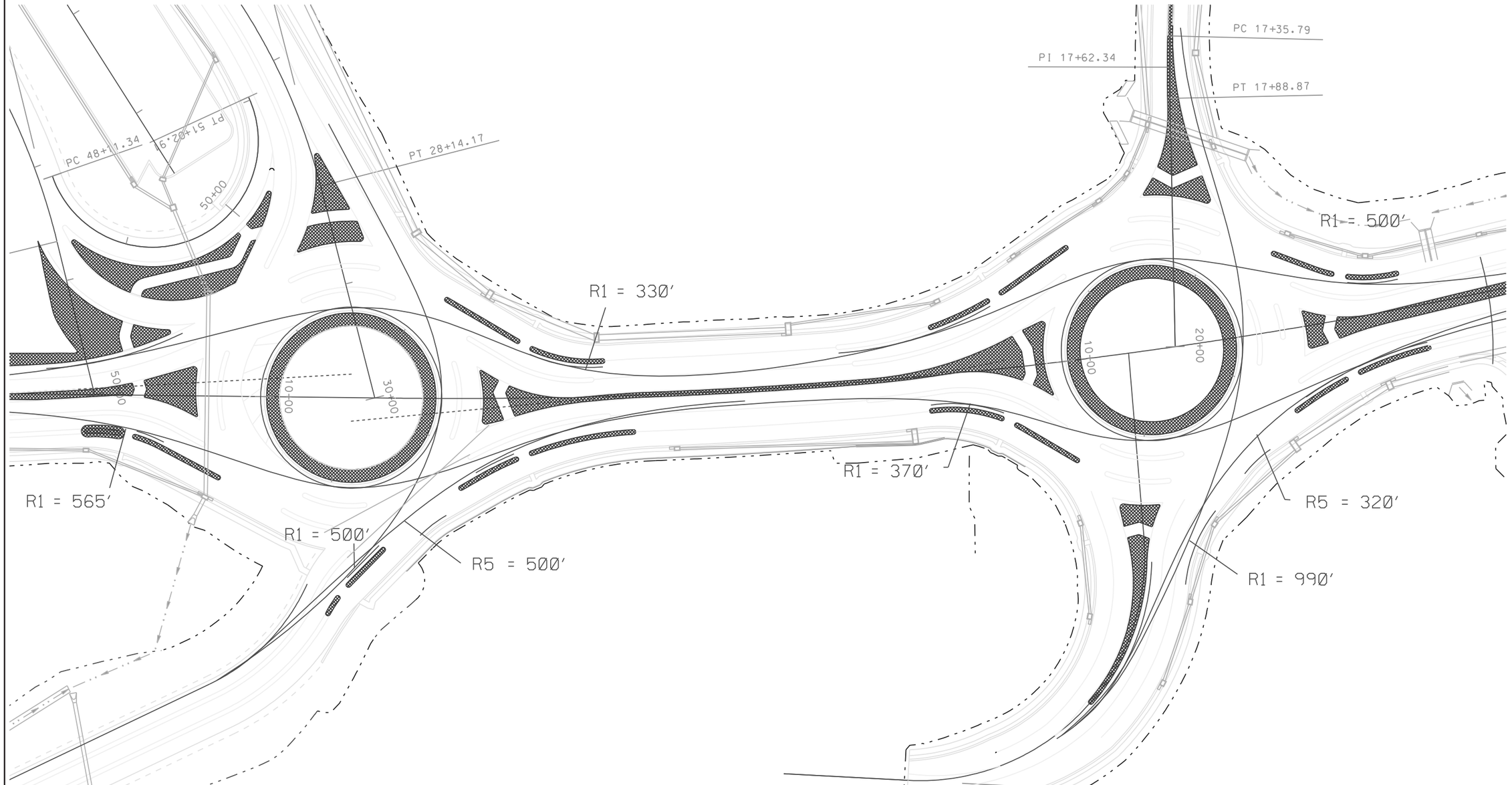
- Fast Path Construct from CAD
- Revised Phi Angle Graphic

If you have any questions or would like to discuss further, please feel free to contact me.

Thank you,



Mark T. Johnson, PE



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MTJ REVIEW - GEOMETRIC FAST PATHS REVIEW
3.24.2015

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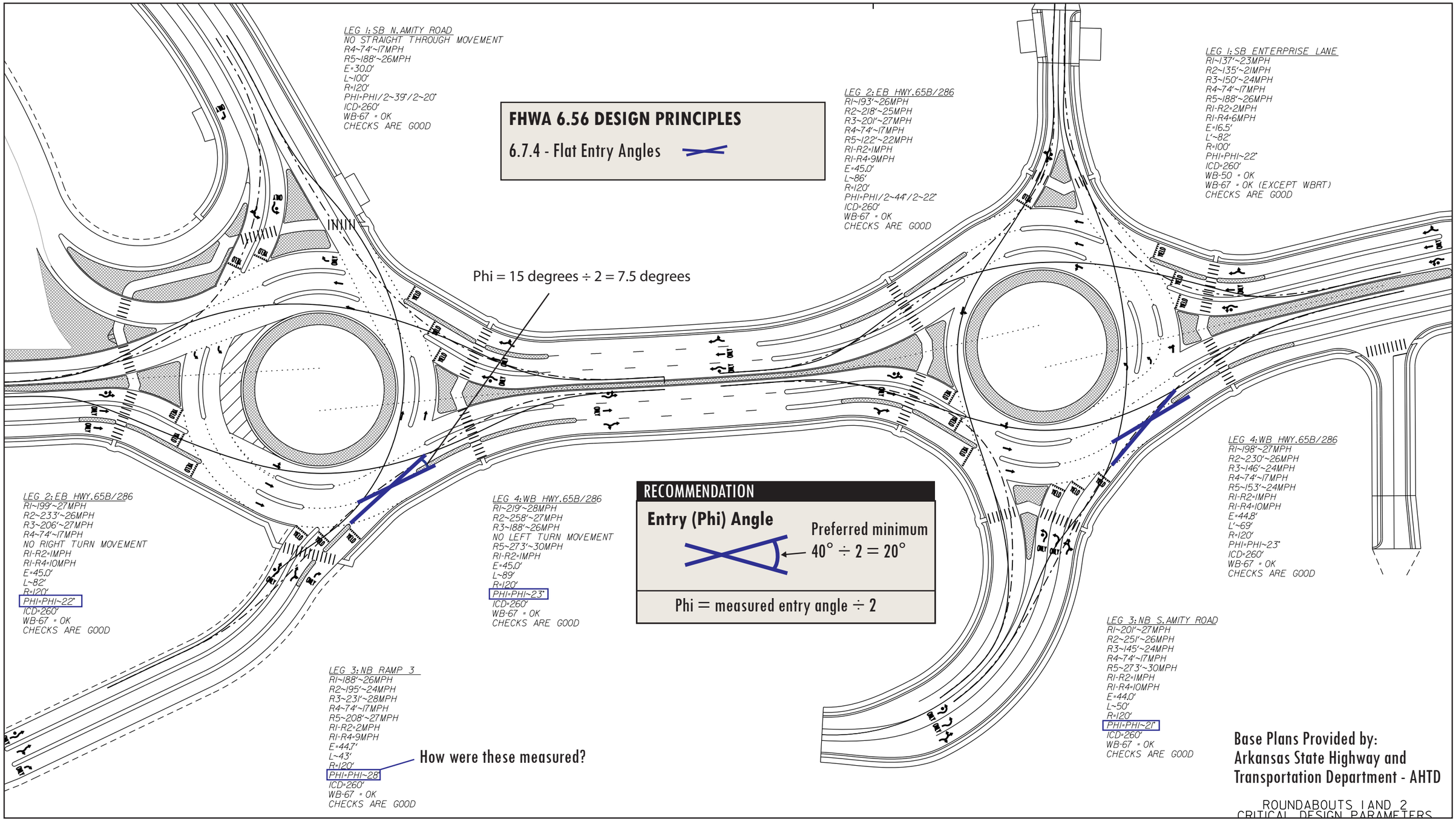
EXHIBIT #4



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MTJ REVIEW - GEOMETRIC DESIGN PRINCIPLES
3.24.2015

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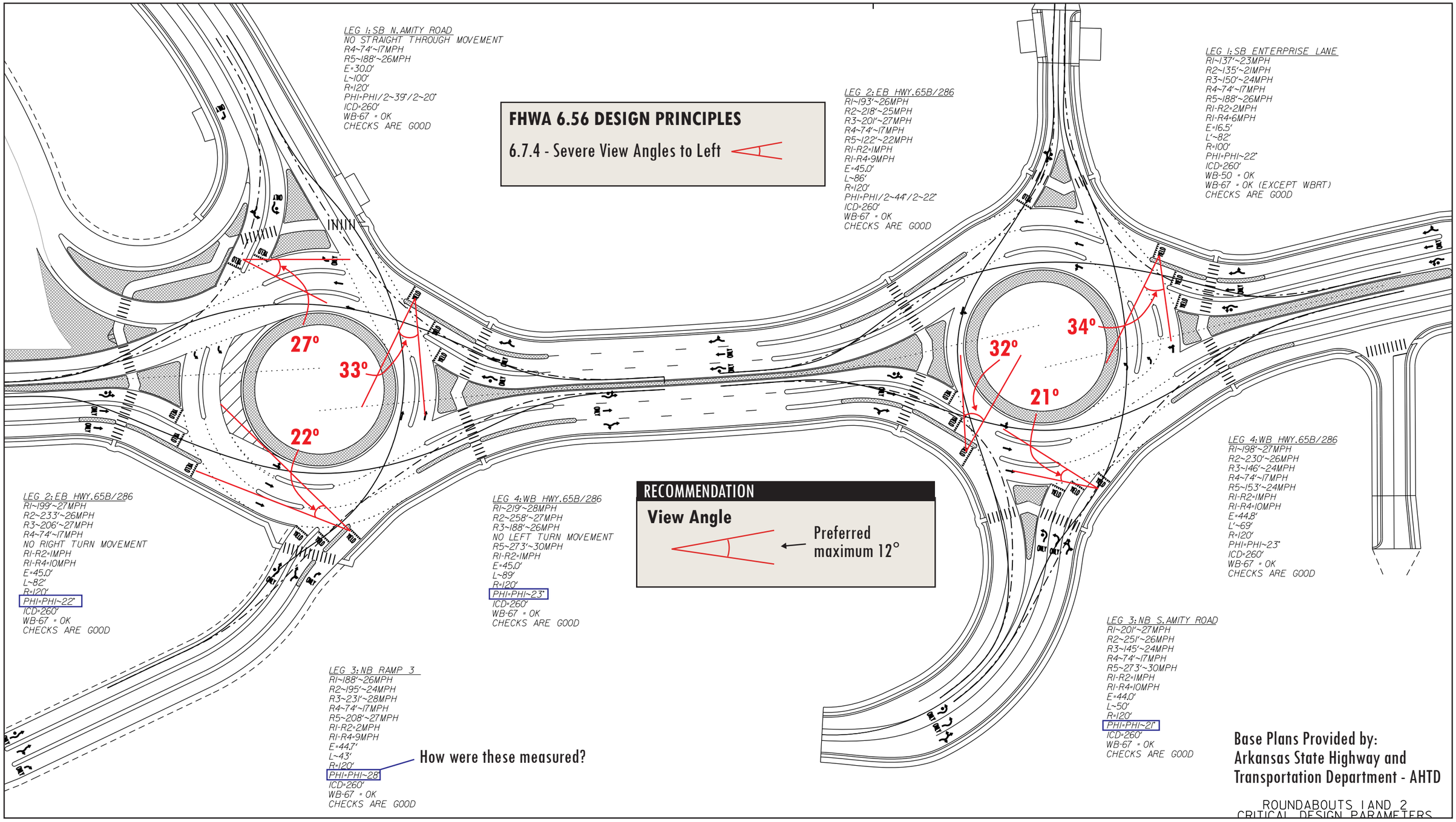
EXHIBIT #3



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