

ROUNABOUT CRITICAL DESIGN PARAMETERS DOCUMENT

(for a working copy of this template: [FDM 11-26 A5.1 File 1](#))

Project ID
 Title
 Limits
 Route
 County

ROUNABOUT CRITICAL DESIGN PARAMETERS

DESIGN PARAMETERS	LEG 1	LEG 2	LEG 3	LEG 4	LEG 5	LEG 6
Approach Width, FT						
Entry Width, FT						
Entry Angle, PHI Φ , DEG						
Inscribed Circle Diameter, FT						
Exit Width, FT						
Circulating Roadway Width Upstream of Entry, FT						

FASTEST SPEED PATH

R_1 , Radius/Speed, FT/MPH						
R_2 , Radius/Speed, FT/MPH						
R_3 , Radius/Speed, FT/MPH						
R_4 , Radius/Speed, FT/MPH						
R_5 , Radius/Speed, FT/MPH						
Bypass R_5 , Radius/Speed, FT/MPH						

MINIMUM SIGHT PARAMETERS

Approach Design Speed, MPH						
Horizontal Stopping Sight Distance, FT						
Circulating Intersection Sight Distance, FT/MPH						
Entering Intersection Sight Distance, FT/MPH						

Design Vehicle:

Truck Apron Width:

OSOW Accommodations:
 (including vertical design checks)

Circulating Roadway Cross-Slope:

Access Control:

Parking Control:

Bicycle & Pedestrian Accommodations:

Designer:

Reviewer:

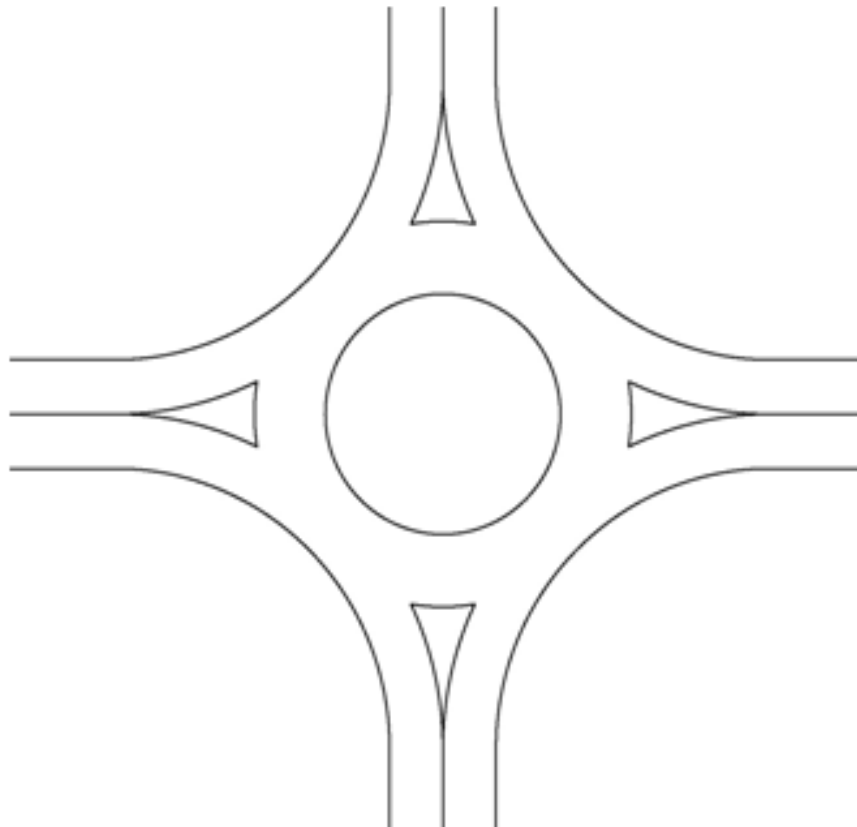
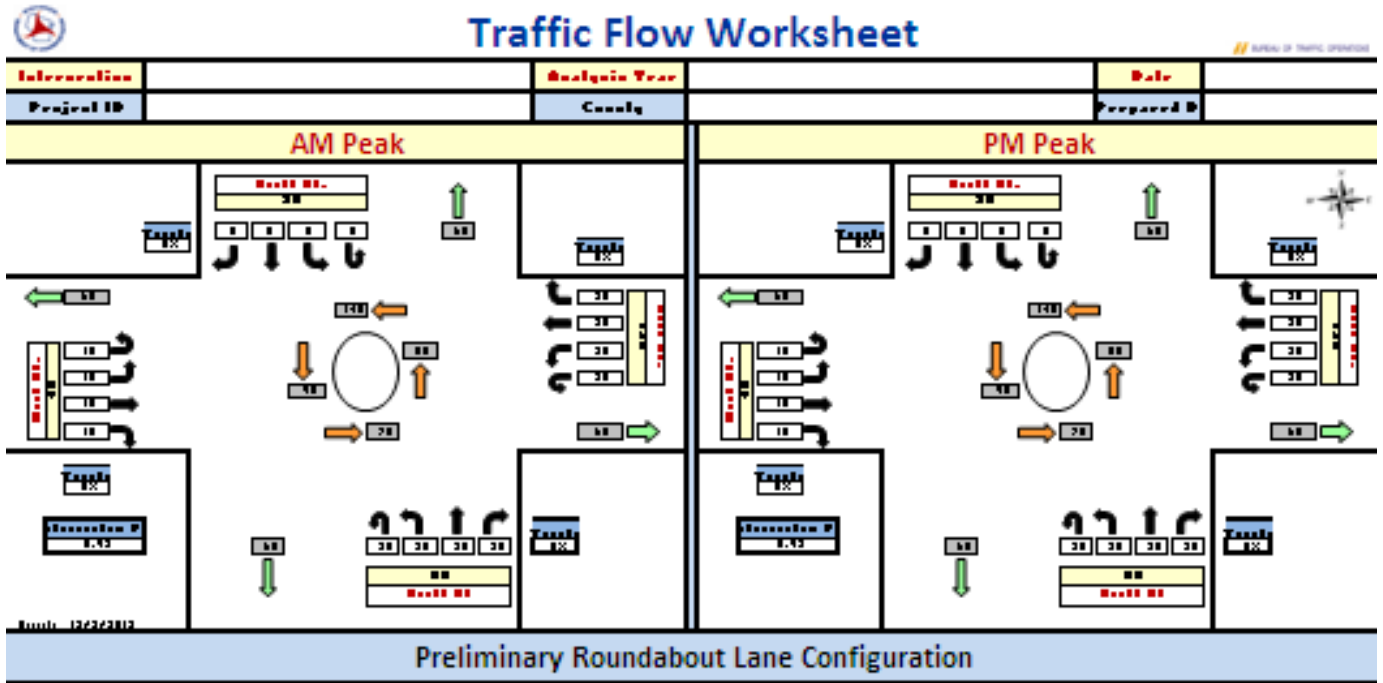
SIGNATURE: _____

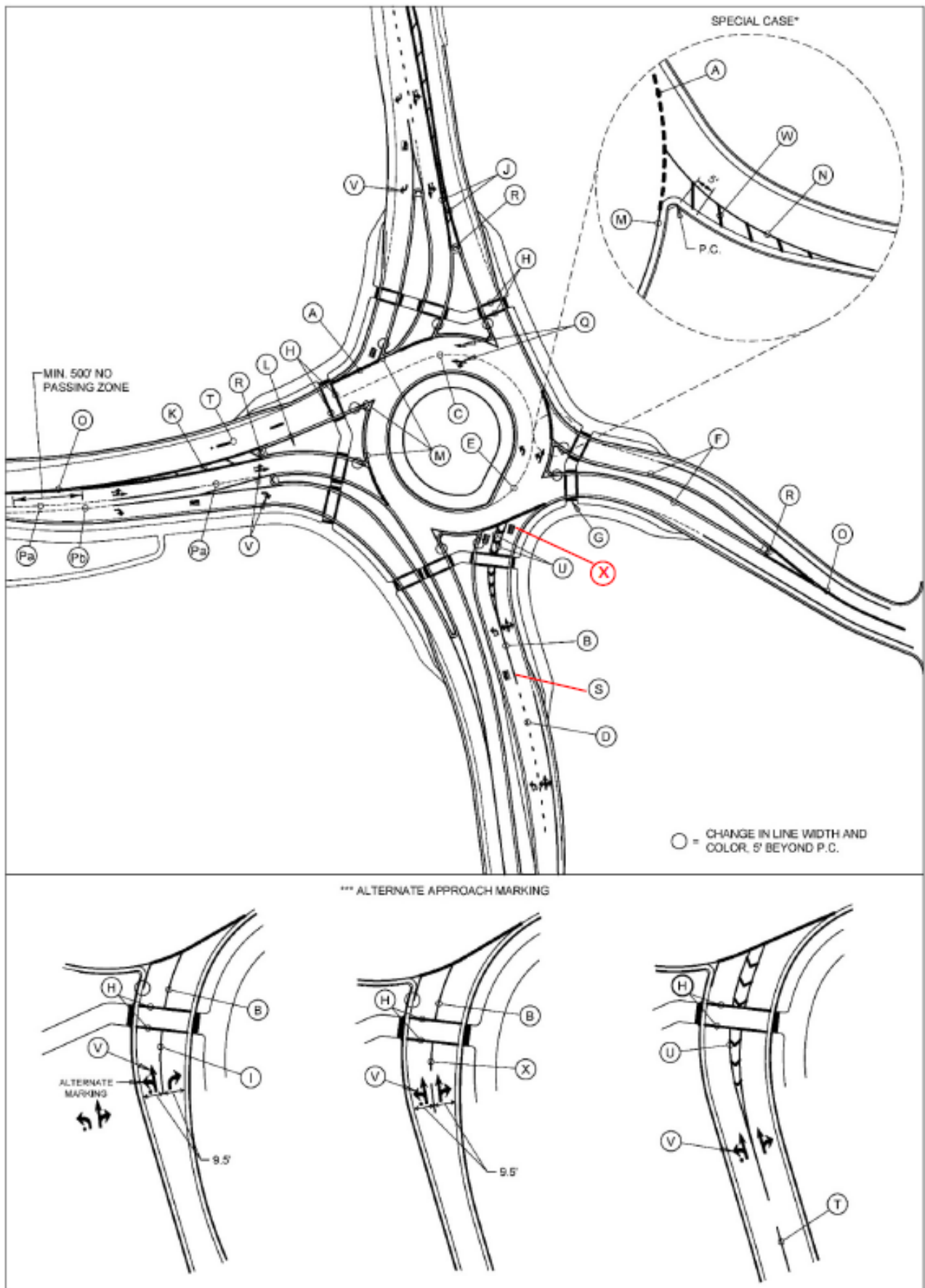
DATE:

NAME:

The reviewer's signature on this document indicates that the design has been reviewed and is in general compliance with good roundabout principals. The critical design elements have been addressed. The project design engineer in responsible charge of final plan development will stamp the plans when applicable.

ROUNDBOUT TRAFFIC CONTROL WORKSHEET
 (for a working copy of this template: [FDM 11-26 A20.1 File 1](#))





Refer to following pages for Pavement Marking Key.

KEY:

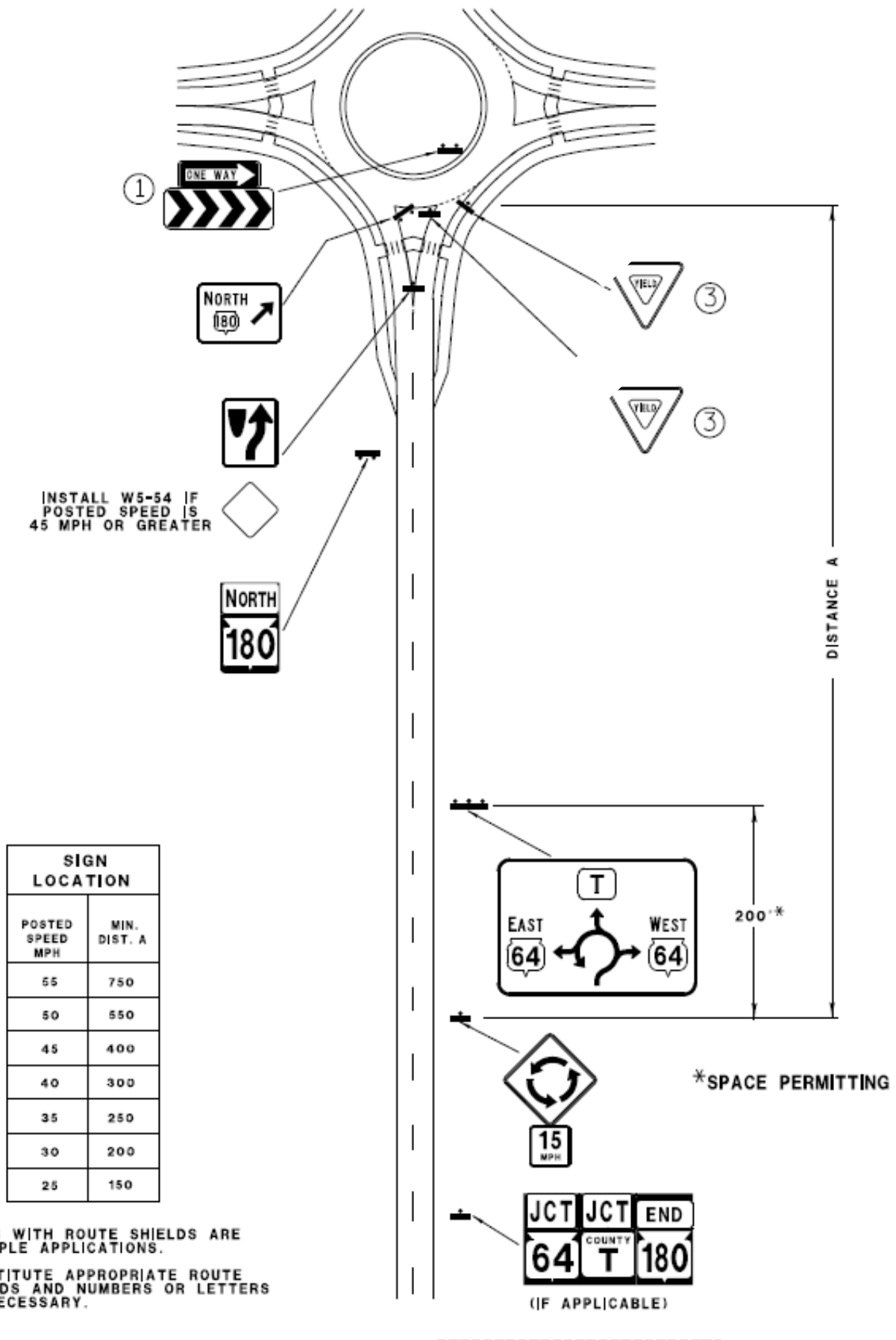
- A. Dotted Edge Line Extension, 18-Inch White, (2-ft segment, 2-ft gap)
- B. Approach Channelizing Line, 6-Inch White (standard); 10-Inch White may be selected to optimize operations. Contact the Region Traffic Engineer for final marking selection.
- C. Circulatory Lane Line, 6-Inch White (standard); 10-Inch White may be selected to optimize operations. Contact the Region Traffic Engineer for final marking selection, (6-ft segment, 3-ft gap).
- D. Approach Lane Line, 6-Inch White: 3-ft segment, 9-ft gap for advanced warning of an exclusive turn lane. Begin marking where flare widens to 12 feet for each lane or a minimum of 150 feet before the solid line if no flare is present.
- E. Dotted Lane Line, 6-Inch White (standard)**, (1-ft segment, 3-ft gap); 10-Inch White** (1-ft segment, 3-ft gap) may be selected to optimize operations. Contact the Region Traffic Engineer for final marking selection.
- F. Splitter Island Left Edge Line, 6-Inch Yellow.
- G. Truncated Domes, aligned to ramp direction, not crosswalk direction.
- H. Crosswalk, refer to crosswalk selection guidance under [TEOps 3-2-3](#) for selecting the appropriate crosswalk type.
 - I. Begin solid approach channelizing line where flare widens to 9.5-ft or 50-ft in advance of approach PC, whichever is shorter. This may be extended for certain exclusive lane configurations.
- J. Double Yellow 6-Inch
- K. Median Diagonal Marking, 12-Inch Yellow (apply within entire median gore area if distance at island nose is greater than 6-ft wide),
 - a. 25-ft C-C spacing, if median gore length greater than 50-Ft long.
 - b. 10-ft C-C spacing if median gore length less than 50-ft long.
- L. Splitter Island
- M. Gore Line, 10-Inch White to 5-ft beyond PC of nose
- N. * Left Edge Line, 6-Inch Yellow
- O. Center line Yellow Marking 4-Inch Double, or 4-Inch 500-ft segment and 12.5 segment, 37.5-Ft.
- P.
 - P_a. Bike Lane Marking, 6-Inch; 3-ft segment, 9-ft gap.
 - P_b. Bike Lane Marking, 10-Inch; 3-ft segment, 9-ft gap.
- Q. Circulatory Lane Use Arrows, White: No ovals shall be used on any arrows.
- R. Island Nose, Yellow
- S. Word, White
- T. Lane line, 4-Inch White, (12.5-ft segment, 37.5-ft gap)
- U. Truck Gore Separation, 10-Inch White. When the separation is greater than 6-ft, 12-inch white chevrons shall be placed every 25-ft if the gore length is longer than 50-ft and spaced every 10-ft if the gore length is 50-ft or less.
- V. Approach Lane: Use Arrows, White. Arrows with the oval shall only be used on the left-most turn lane.
- W. * Diagonals, 12-Inch Yellow, 10-Ft spacing. Place only if distance between curb flange and edgeline is greater than 3 feet.
- X. "Yield" only use if crashes occur because of motorist failing to yield.
- Y. Approach Lane Line, 6-Inch White; 12-ft segment, 12-ft gap, even segment gap ratio for symmetrical lane assignment. Begin marking where flare widens to 9.5 feet for each lane.

* SPECIAL CASE:

- This alternative pavement marking application should be used when additional space is needed to accommodate truck movements while still restricting the pavement width for smaller vehicles. It is expected that larger vehicles will have to drive over the markings to complete their maneuver. Use only with wide entry flares. Refer to [FDM 11-26-30.5.12](#) for further guidance.
- The point of the chevron should always 'point' upstream.

** Match width of marking extended.

Refer to the [TEOpS 3-2](#) Manual for further information on markings.



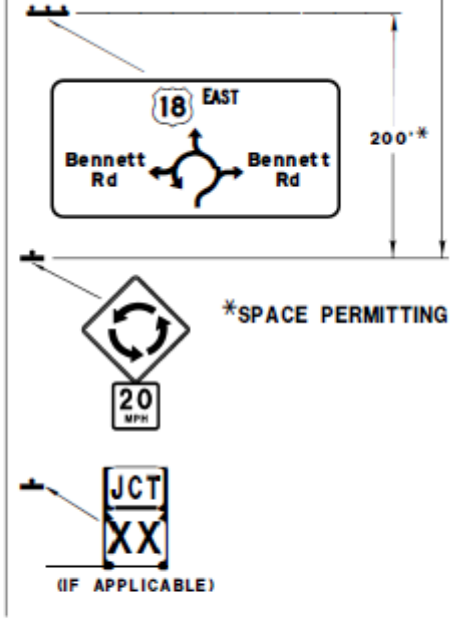
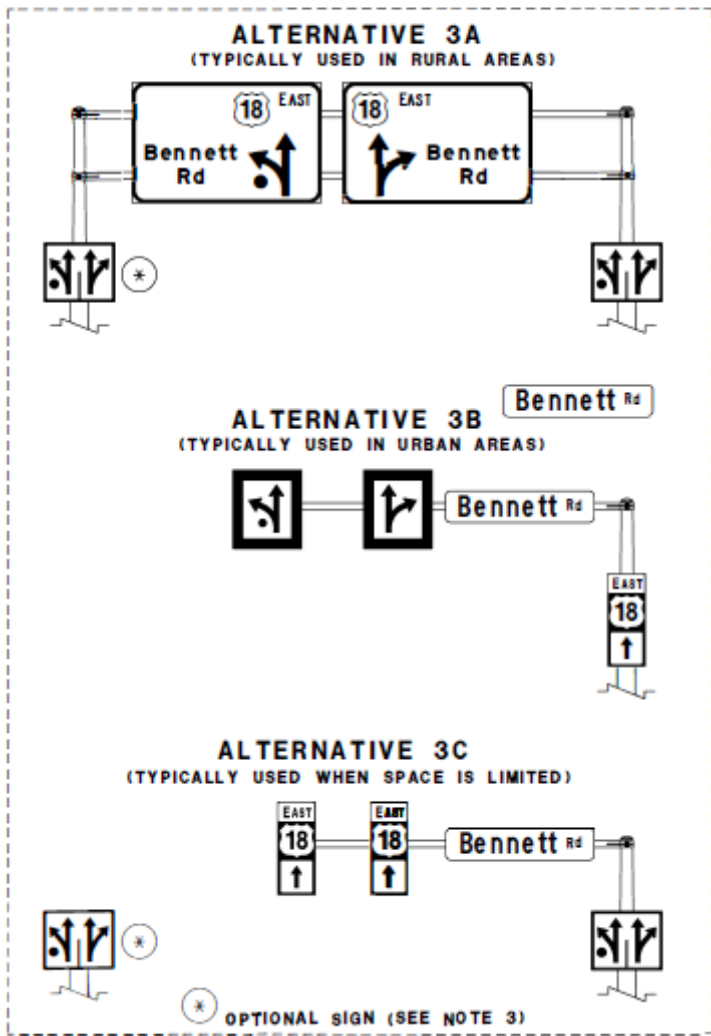
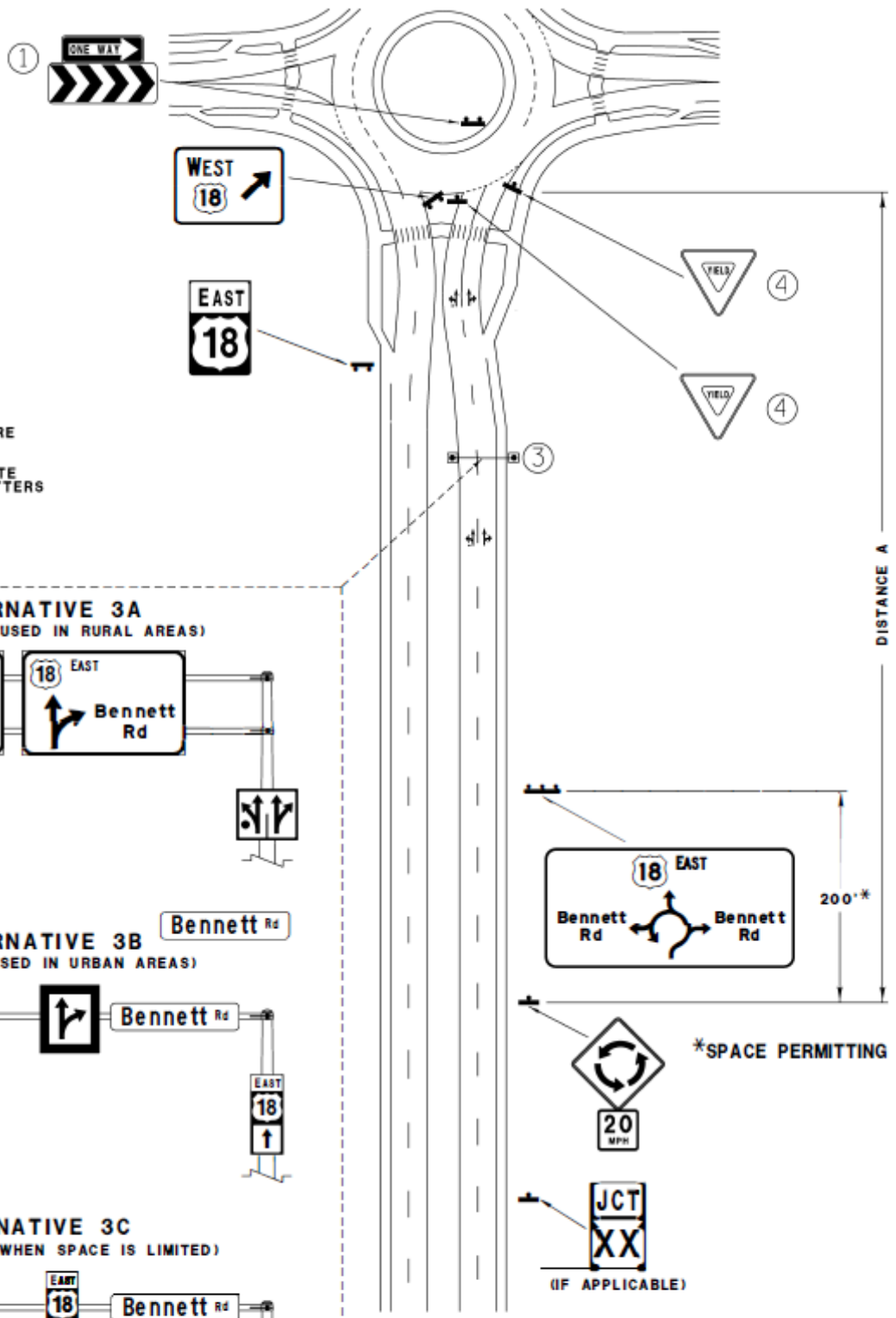
NOTES:

1. Place a ONE WAY (R6-1R) sign above the roundabout chevron bank (R6-4b) in the central island.
2. All YIELD signs shall be mounted at the same height (7' - 3"± to the bottom of the YIELD sign).
3. In general, the typical spacing between signs may be reduced to 100 feet in urban areas. Typical rural sign spacing is 200 feet.

SIGN LOCATION	
POSTED SPEED MPH	MIN. DIST. A
55	750
50	550
45	400
40	300
35	250
30	200
25	150

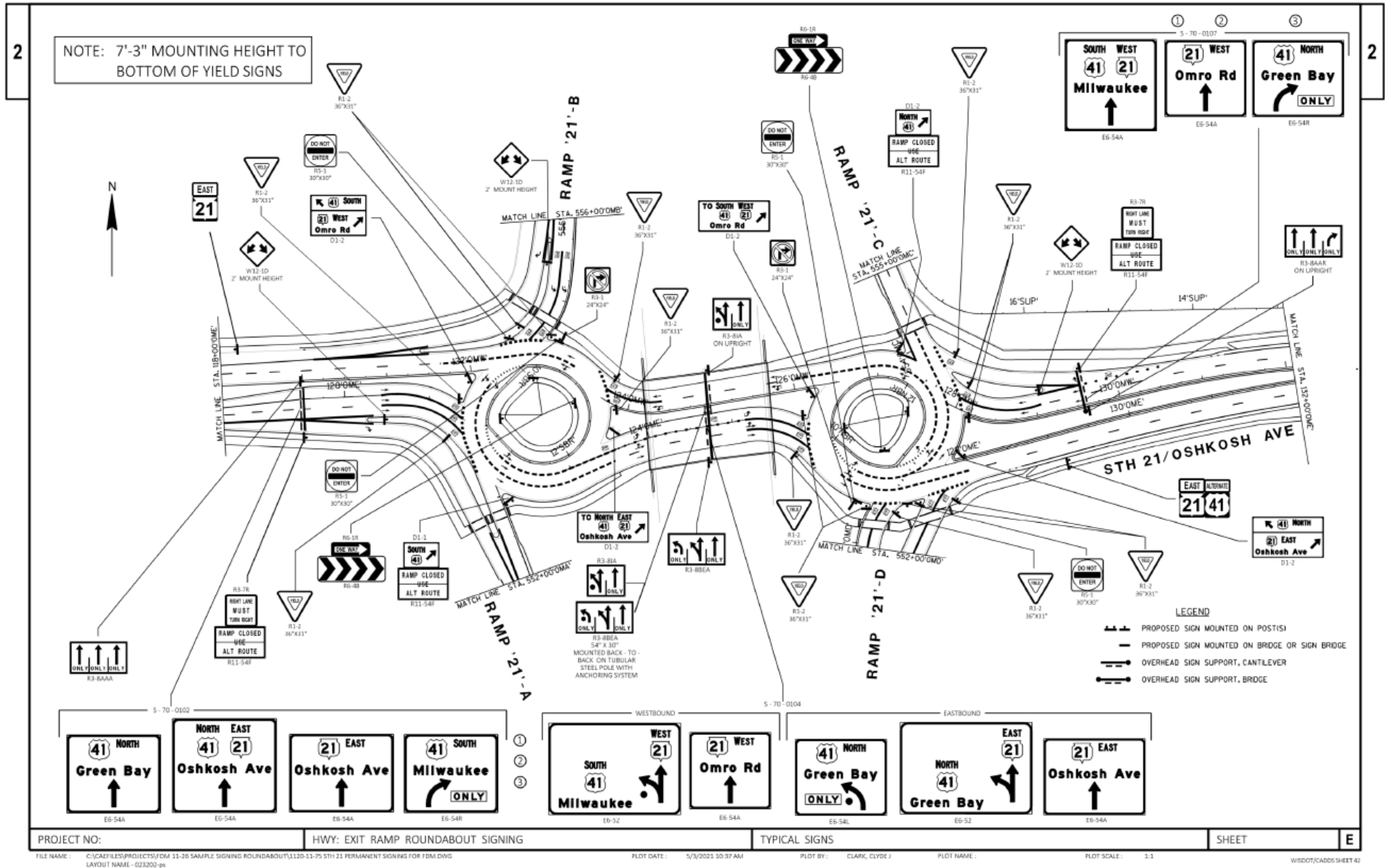
SIGNS WITH ROUTE SHIELDS ARE EXAMPLE APPLICATIONS.

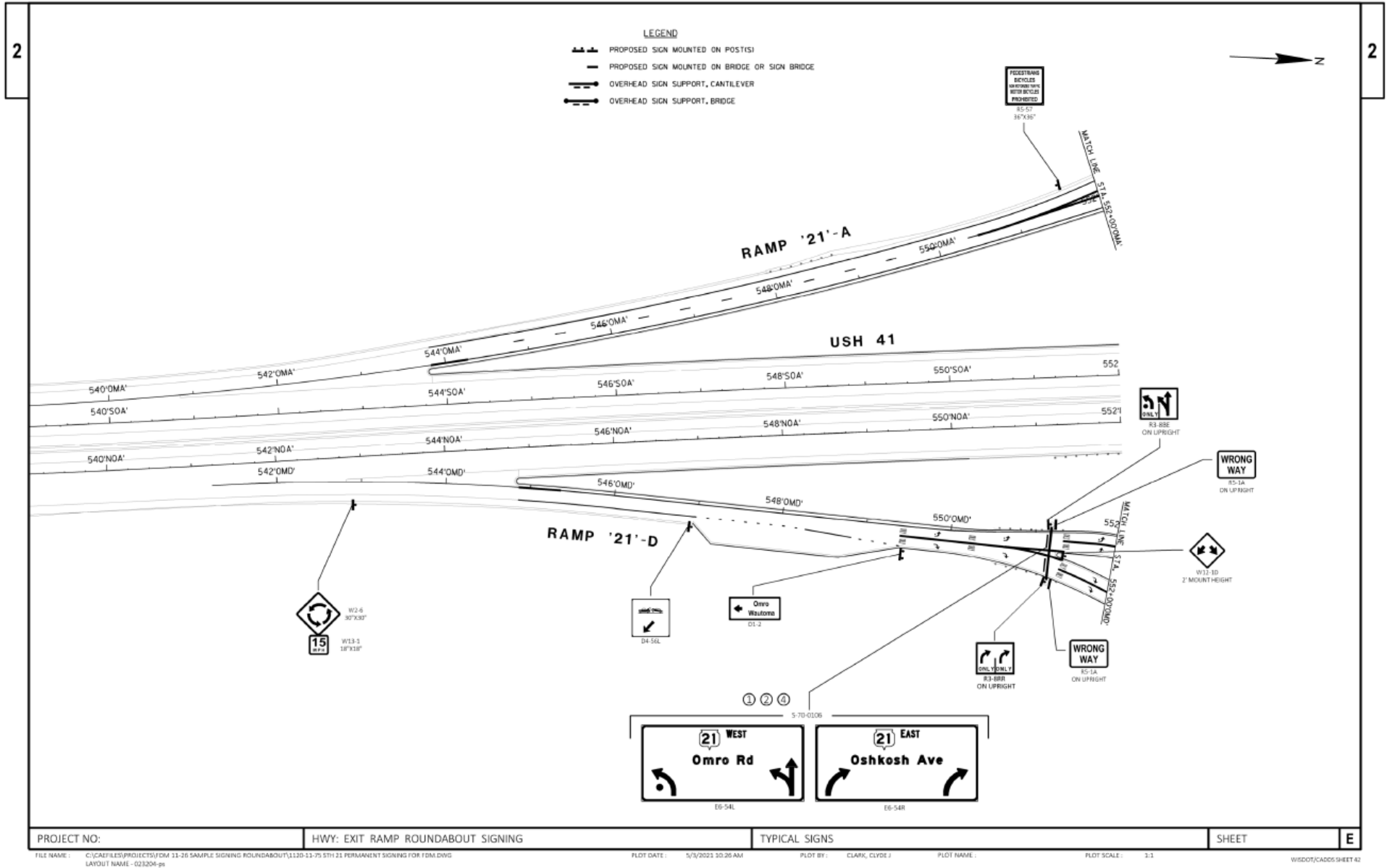
SUBSTITUTE APPROPRIATE ROUTE SHIELDS AND NUMBERS OR LETTERS AS NECESSARY.



NOTES:

1. Place a ONE WAY (R6-1R) sign above the roundabout chevron bank (R6-4b) in the central island.
2. All YIELD signs shall be mounted at the same height (7'-3"± to the bottom of the YIELD sign).
3. Lane use and destination guidance is required on multilane approaches. Approach speed and available lateral space will dictate which style of signing should be installed. Placement of the will depend on the approach speed, sight lines, and lane configuration. Consult the Regional Traffic Engineer for additional guidance.
 - a. When green and white (Type I) overhead guide signs are used, a ground mounted lane use sign (R3-8 series) shall be placed as well.
 - b. When Type I overhead guide signs are not feasible, overhead lane control signs (R3-5 or R3-6 series) should be used. Route directional sign assemblies (J-series) should be mounted to the structure upright or ground-mounted adjacent to the overhead structure. An advanced street name sign shall also be installed on the cross-arm for additional directional guidance. The route directional assemblies may be directionally split (left turns on the left side, right turns on the right) when multiple routes are concurrent. Use care when splitting these assemblies that the placement matches the adjacent lane designations. Consult the Regional Traffic Engineer for further guidance.
 - c. When Type I overhead guide signs are not feasible and lateral space will not allow ground-mounted route directional assemblies (J-series) to be placed, J-series assemblies may be mounted overhead. Ground-mounted lane use signs shall be placed as well. Consult the Regional Traffic Engineer before implementing this type of installation.
- * An additional lane use sign may be placed on the left side as well for additional emphasis. The additional sign should be placed when volumes are high, for approaches of three or more lanes, or any time when the sign may have a greater chance of being blocked by passing vehicles. Consult the Regional Traffic Engineer for additional guidance.
4. In general, the typical spacing between signs may be reduced to 100 feet in urban areas. Typical rural sign spacing is 200 feet.





NOTES:

1. The D15 series of overhead guide signs (Bureau of Traffic Operations A11-17 sign plate) may be used in lieu of the E6 series (BTO A11-13 sign plate) overhead guide signs. D15 series guide signs shall not be used on any approach that has an option lane. A mix of E6 and D15 series signs shall not be used on the same approach. Mixing of the signs may confuse unfamiliar drivers.

When roundabouts follow in close succession, as in the case of ramp terminals, all overhead signs in the same direction within the corridor shall match. Consult with the Regional Traffic Engineer regarding the final design of corridor overhead signing. Since D15 signs combine regulatory lane assignment and directional guidance, drivers may become distracted and confused if the location of information changes (on the sign or location of the sign).

2. When practical, combine overhead signs to reduce the amount of repetitious information the driver must process. Consult the Regional Traffic Engineer regarding the final design of overhead signing.
3. The ONLY plaque shall be used when a through lane becomes a dedicated turn lane. The ONLY plaque shall be placed on the inside of the curved arrow stem.
4. All lane arrows, pavement marking, regulatory sign, and overhead guide signs shall match for each lane of the approach. The return to the freeway through movement should be indicated by an arrow on the guide sign. Route shields and associated cardinals for the return movement are optional, however, may require significant space and contribute to message clutter when concurrent highways are involved. Consult with the Regional Traffic Engineer regarding the final design of off-ramp overhead signing.
5. Arrow stems should be centered over the center of the lane as space allows.

Creating Roundabout Fastest Paths (Spline Curves) in AutoCAD Civil 3D

Step 1: Copy Curb Offsets

Create the curb offsets as shown in [FDM 11-26-30](#), Figure 30.2 using the “offset” command.

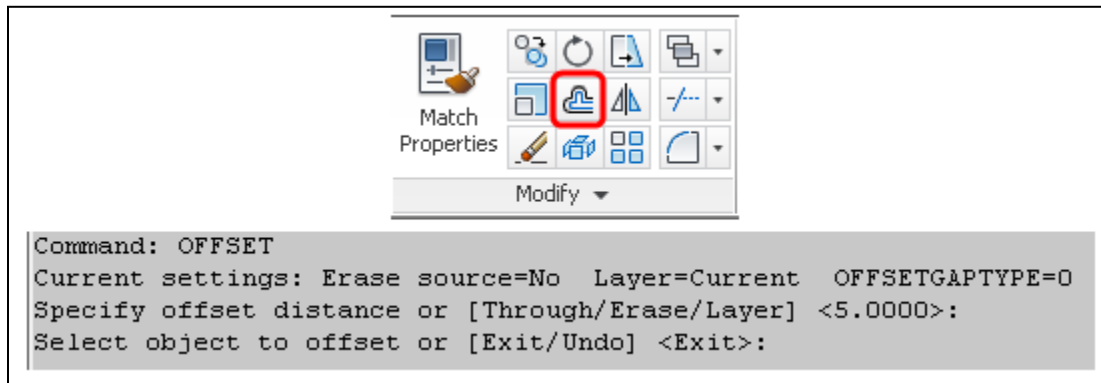


Figure 1 Offset

- A. 5' from left side face of curb or painted C/L (or 3' from painted edge line) on each approach.
- B. 5' from face of curb on driver's right side at each entry and exit.
- C. 5' from central island face of curb. Face of curb for the Type R and T is 6-inches from the back of curb.
- D. Not less than 165' from roundabout Inscribed Circle Diameter (ICD). Typically, this distance may be 165' but could be more depending on how a driver would approach the yield line at high speed. *“To determine the speed of a roundabout, the fastest path allowed by the geometry is drawn. This is the most realistic, smoothest path possible for a single vehicle, in the absence of other traffic and ignoring all lane markings, traversing through the entry, around the central island and out the exit” (R1).*

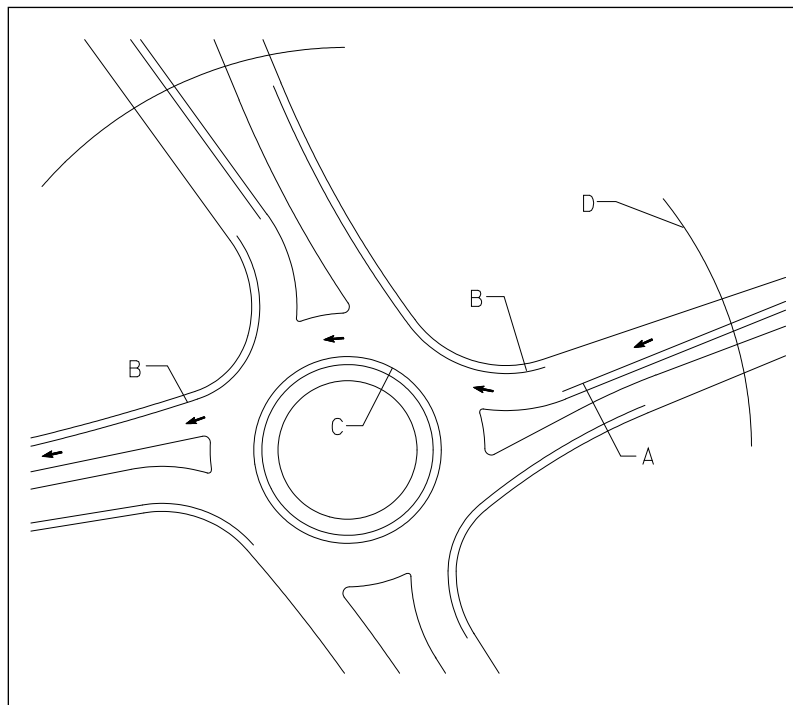
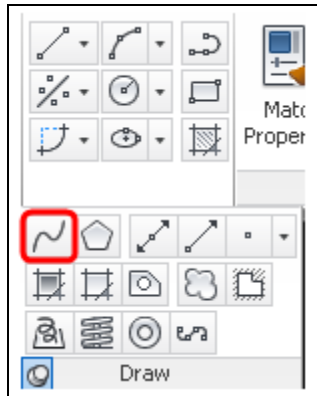


Figure 2 Offsets for Fastest Path

Step 2: Draw Spline Curve

Create the spline curves as shown in [FDM 11-26-30](#), Figure 30.2 using the “spline” command and choosing either “Fit” method or “Control Vertices (CV)” method.



```
Command: SPLINE
Current settings: Method=Fit   Knots=Chord
Specify first point or [Method/Knots/Object]:
```

Or

```
Command: SPLINE
Current settings: Method=CV   Degree=3
Specify first point or [Method/Degree/Object]:
```

Figure 3 Place B-spline Curve

Draw the spline curve for the through movement as shown below, using the “near” object snaps for all points:

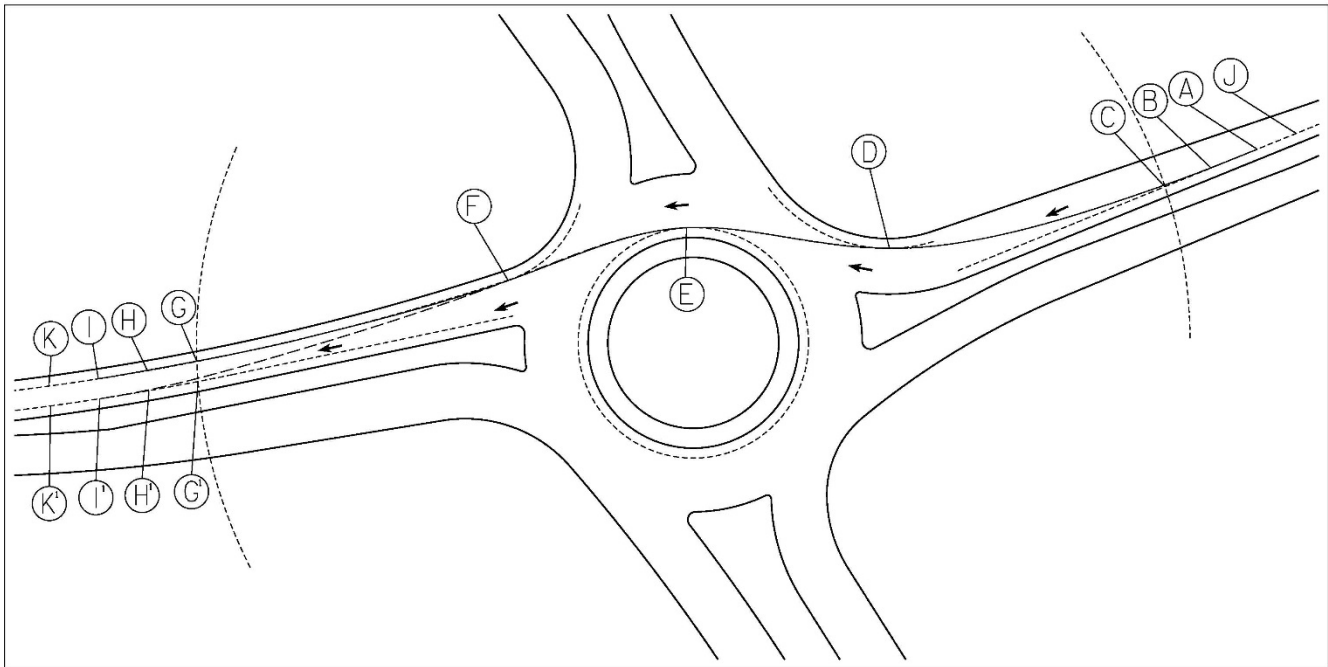


Figure 4 Spline Curve through movement

Clicking sequence:

1. Choose points A through C on the first 5' curb offset from splitter island. Choose 3 points that are approximately 25 feet apart that will approximate the path of an approaching vehicle. It is advisable to choose two points outside of the 165' line and one on the 165' line.
2. Choose a location so the spline is near point D on the 5' curb offset from entry curve.
3. Choose a location so the spline is near point E on the 5' curb offset from central island.
4. Choose a location so the spline is near point F on the 5' curb offset from exit curve.
5. Choose points G through I, or G¹ through I¹ on the 5' offset from the right side exit curb and the 165' arc. There may be times when it is appropriate to check the left side instead of the right side. The side is dependent on the anticipated driving path of the vehicle and the roadway alignment.
6. Press Enter to exit the command.

7. For the “Fit” method, select the spline and hover over the point A. Select Tangent Direction from the drop-down menu that appears. Choose point J on the 5’ curb offset just upstream from the end of the spline. This will force the spline to be tangent to the splitter island curb.
8. For the “Fit” method, select the spline and hover over the point I or I¹. Select Tangent Direction from the drop-down menu that appears. Choose point K on the 5’ curb offset just downstream from the end of the spline. This will force the spline to be tangent to the splitter island curb.

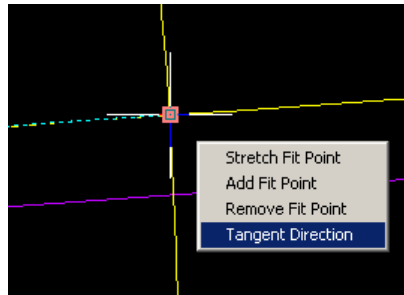


Figure 5 Tangent Direction

Step 3: Modify Spline Curve

Visually inspect the spline created in Step 2 above to see if it violates the 5’ curb offsets. Zoom into the areas of points B through D and visually inspect whether the spline curve violates the curb offsets.

In most cases, the spline may slightly violate the 5’ curb offset. Use engineering judgment to determine if the spline will need to be modified.

Modify the spline:

If the spline is between the curb offset and the curb or outside of the curb offset, it will need to be modified.

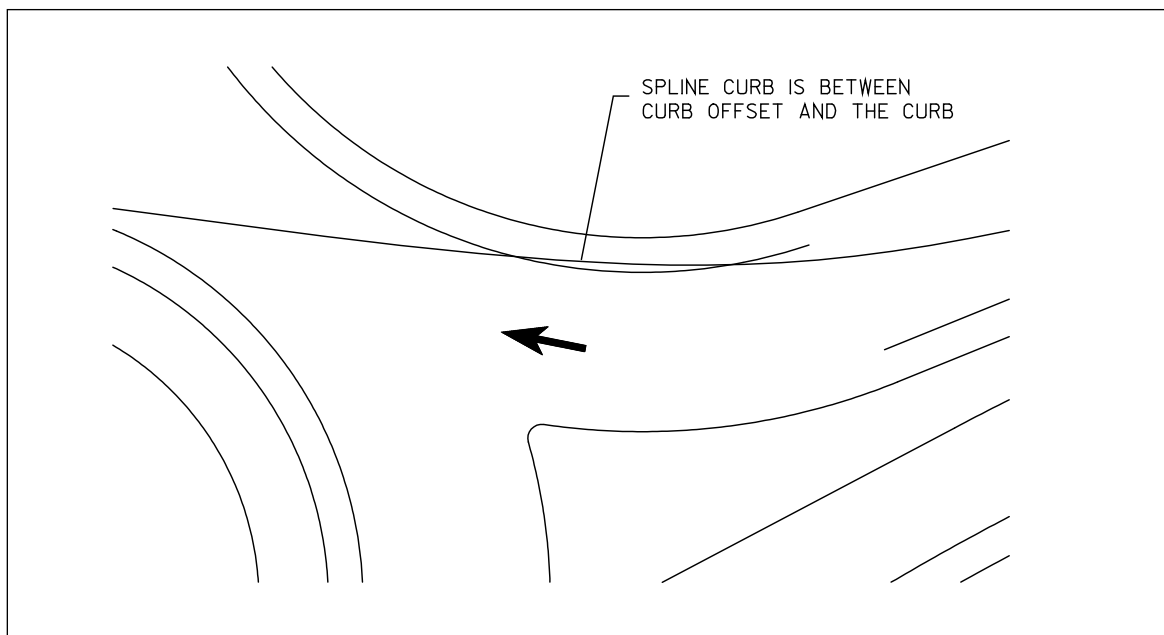


Figure 6 Spline curve between curb offset and the curb

Select the spline curve and click on the “Fit” point or “CV” point that needs adjustment. Pull it to a desired location so the spline is on top of the curb offset. This may need to be done a few times before the spline is on top of all the curb offsets. Evaluate the spline as a whole to see if it “looks” like it is the path that a vehicle would use. Oftentimes, the beginning or end of the spline may need to be pulled further away from the roundabout itself.

Step 4: Measure R-values

1. Once an acceptable spline is created, fit arcs to the spline to measure the R-values using the “arc”

command.

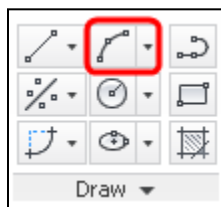


Figure 7 Place Arc

2. Using “Nearest” object snaps, fit an arc onto the spline at a point that appears to be the tightest portion of the spline. This should occur prior to the yield line and not more than 165’ from the yield line.
3. Check the length of the arc. Per [FDM 11-26, Figure 30.2](#) if the arc is not 65 to 80 feet long, recreate it to try to get an arc that is 65 to 80 feet long.
4. Measure the radius of the arc.
5. Repeat to find R-values for R-1, R-2, and R-3.
6. To find R-4, simply measure the radius of the 5’ curb offset from the central island.
7. To find R-5, create a spline that is tangential to the three curb offsets that define the R5 path (the 5’ splitter island offset on the entry, the 5’ offset on the inside of the right turn, and the 5’ splitter island offset on the exit). Check that the arc does not cross any curb offsets, especially when the geometry of the right turn movement is created with multiple arcs. Below is a diagram of a typical R5 spline.

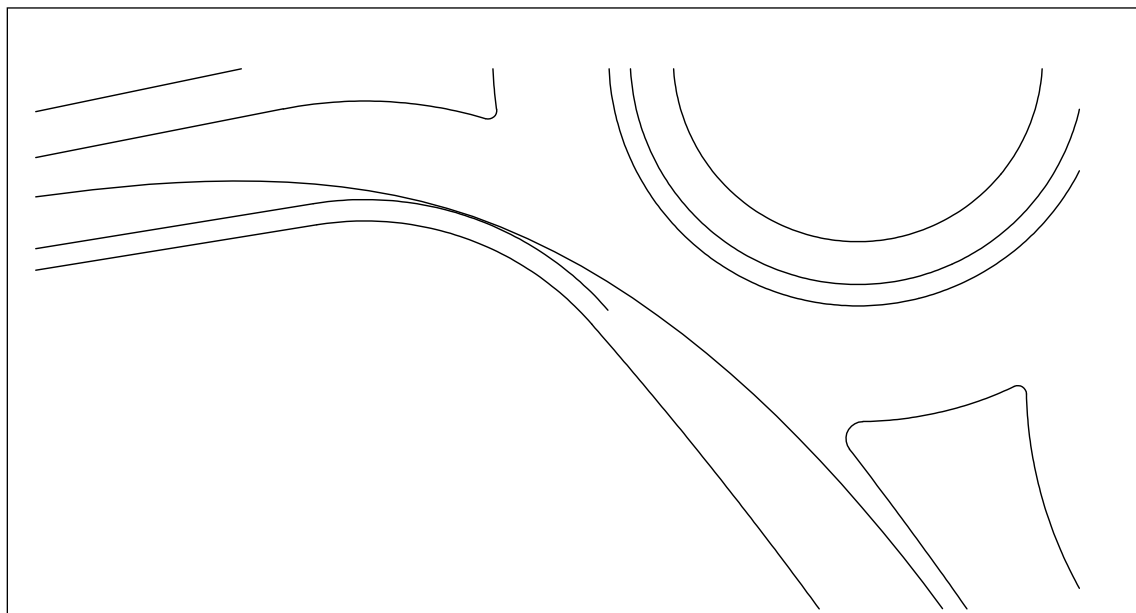


Figure 8 Example R5 Spline

Creating Roundabout Fastest Paths (Spline Curves) in Microstation Version 8i

Step 1: Copy Curb Offsets

Create the curb offsets as shown in [FDM 11-26-30](#), Figure 1 using the move/copy parallel function.

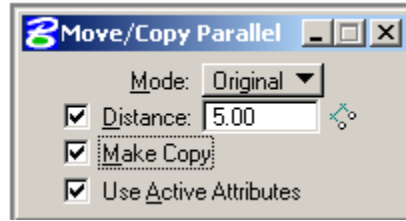


Figure 1 Move/Copy Parallel

- A. 5' from left side face of curb or painted C/L (or 3' from painted edge line) on each approach.
- B. 5' from face of curb on driver's right side at each entry and exit.
- C. 5' from central island face of curb. Face of curb for the Type R and T is 6-inches from the back of curb.
- D. Not less than 165' from roundabout Inscribed Circle Diameter (ICD). Typically, this distance may be 165' but could be more depending on how a driver would approach the yield line at high speed. *"To determine the speed of a roundabout, the fastest path allowed by the geometry is drawn. This is the most realistic, smoothest path possible for a single vehicle, in the absence of other traffic and ignoring all lane markings, traversing through the entry, around the central island and out the exit" (R1).*

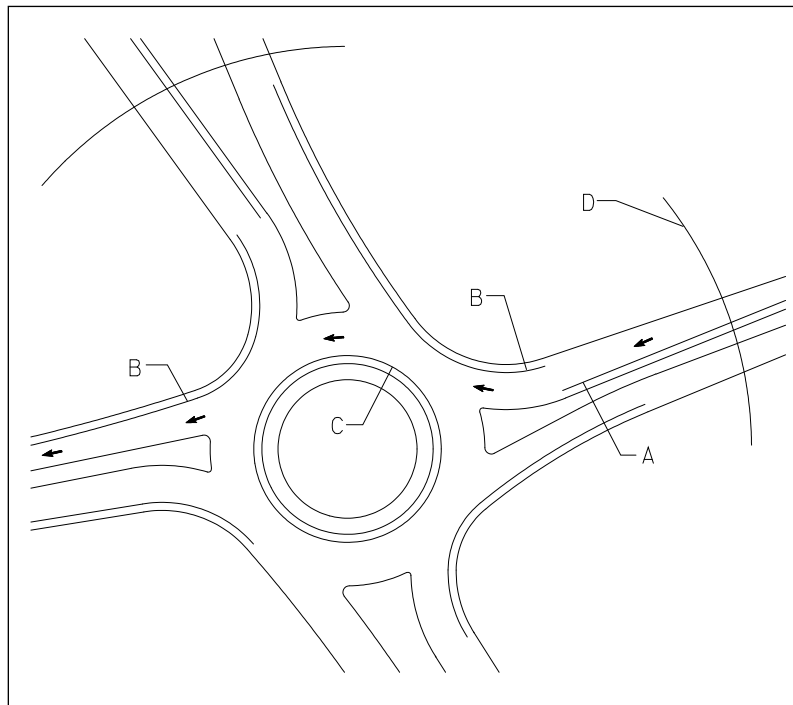


Figure 2 Offsets for Fastest Path

Step 2: Draw Spline Curve

Choose the "Define Control Pts" method as shown below:

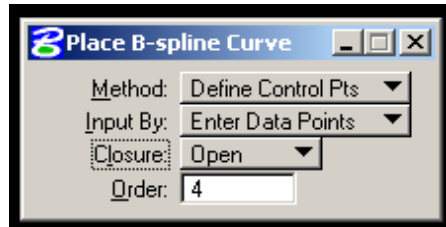


Figure 3 Place B-spline Curve

Draw the spline curve for the through movement as shown below, using “near” snaps for all points picked:

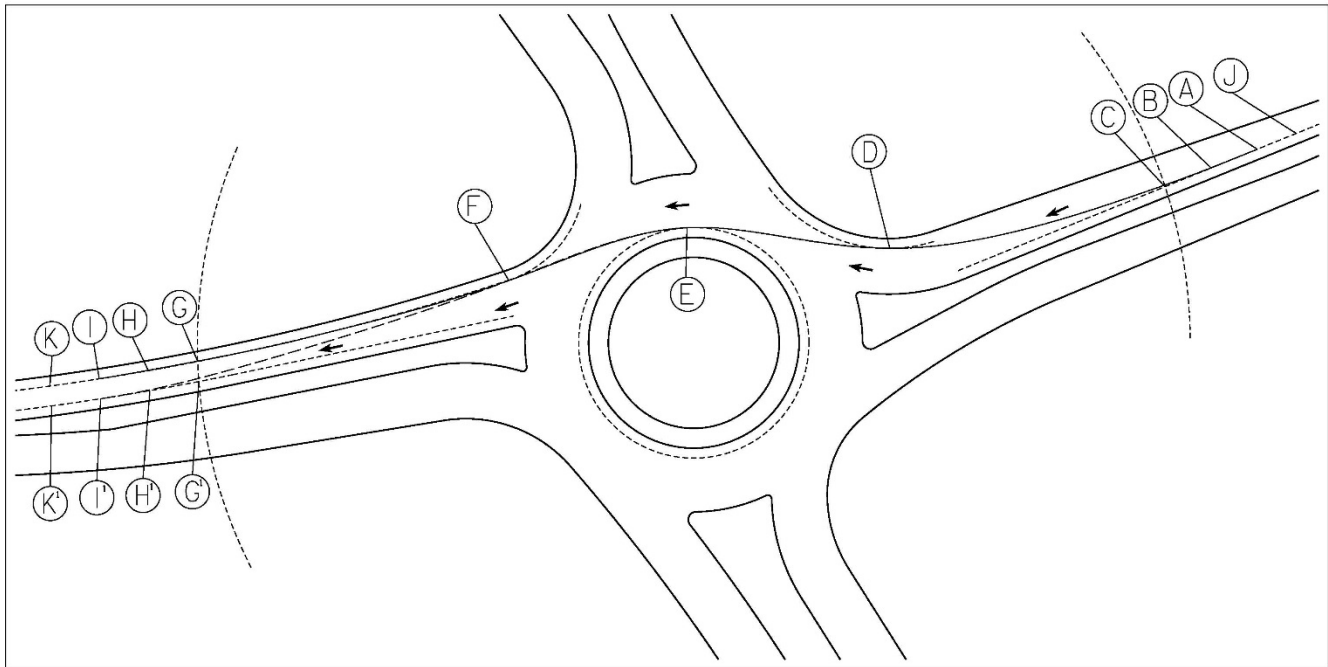


Figure 4 Spline Curve through movement

Clicking sequence:

1. Choose points A through C on the first 5' curb offset from splitter island (tentative snap, then left click to accept). Choose 3 points that are approximately 25 feet apart that will approximate the path of an approaching vehicle. It is advisable to choose two points outside of the 165' line and one on the 165' line.
2. Choose point D on the 5' curb offset from entry curve (tentative snap, then left click to accept).
3. Choose point E on the 5' curb offset from central island (tentative snap, then left click to accept).
4. Choose point F on the 5' curb offset from exit curve (tentative snap, then left click to accept).
5. Choose points G through I, or G¹ through I¹, on the 5' offset from the right side exit curb (tentative snap, then left click to accept). There may be times when it is appropriate to check the left side instead of the right side. The side is dependent on the anticipated driving path of the vehicle and the roadway alignment. Choose 3 points that are approximately 5 feet apart that will approximate the path of an exiting vehicle. Two points should be outside the 165' line and one point inside of the 165' line.
6. Right click to end the spline curve. MicroStation will then “jump” back to the start of the curve.
7. Snap to a point just upstream from the start of the spline at point J (tentative snap, then left click to accept). This forces the beginning of the spline to be tangent to the splitter island curb.
8. Microstation will then “jump” to the end of the curve.
9. Snap to a point just downstream from the end of the spline at point K (tentative snap, then left click to accept). This forces the end of the spline to be tangent to the splitter island curb.

Step 3: Modify Spline Curve

Check the spline created in Step 2 above to see if it violates the 5' curb offsets. This can be done two different ways. One with the "Measure Distance" tool using the "Minimum Between" function. Measure the distance between the face of curb and the spline curve at points A through I shown above.

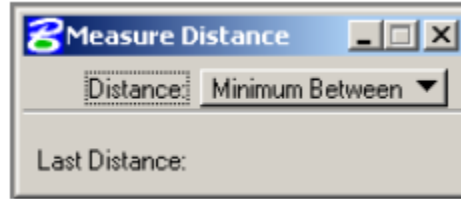


Figure 5 Measure Distance

The second is to zoom into the areas of points A through I and visually inspect whether the spline curve violates the curb offsets.

In most cases, the spline may slightly violate the 5' curb offset. Use engineering judgment to determine if the spline will need to be modified. As shown, the spline should be modified.

Modify the spline:

If the spline is between the curb offset and the curb or outside of the curb offset, it will need to be modified.

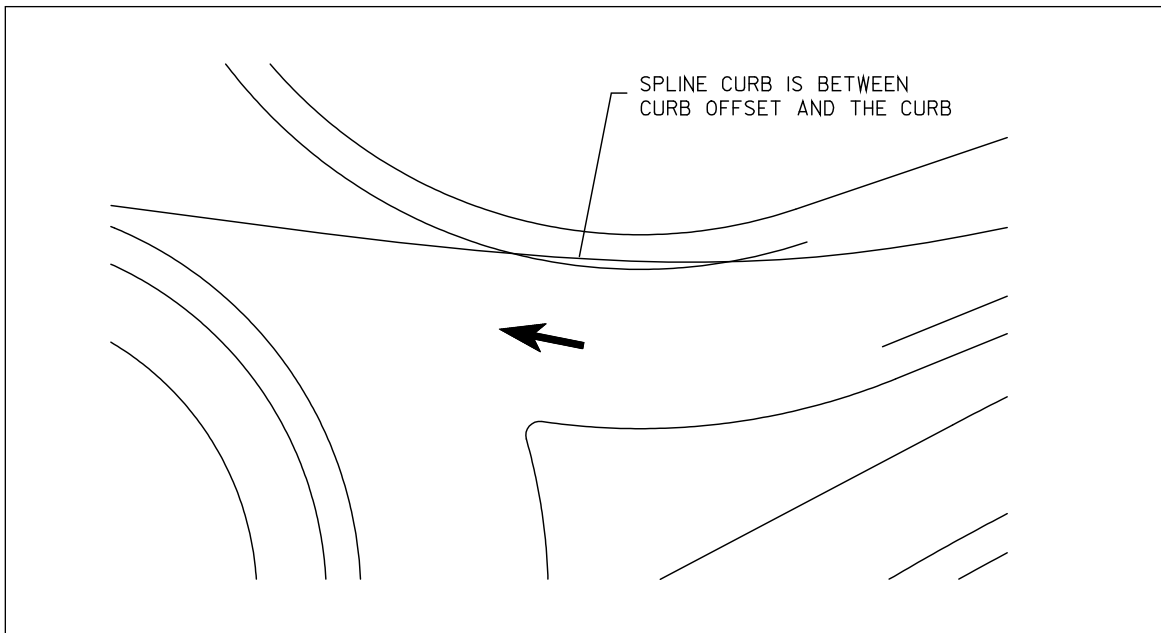


Figure 6 Spline curve between curb offset and the curb

Using the tool 'Modify Element' shown below grab the spline curve and pull it to a desired location on top of the curb offset. This may need to be done a few times before the spline is on top of all the curb offsets.



Figure 7 Modify Element

Evaluate the spline as a whole to see if it "looks" like it is the path that a vehicle would use. Oftentimes, the beginning or end of the spline may need to be pulled further away from the roundabout itself.

Step 4: Measure R-values

1. Once an acceptable spline is created, fit arcs to the spline to measure the R-values using the “Place Arc” tool with the “Edge” method.

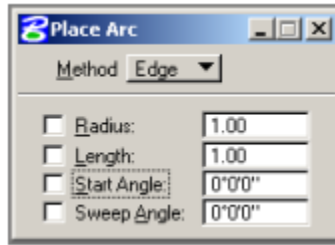


Figure 8 Place Arc

2. Using “Near” snaps, fit an arc onto the spline at a point that appears to be the tightest portion of the spline. This should occur prior to the yield line and not more than 165’ from the yield line.
3. Check the length of the arc. Per [FDM 11-26, Figure 30.2](#) if the arc is not 65 to 80 feet long, recreate it to try to get an arc that is 65 to 80 feet long.
4. Measure the radius of the arc.
5. Repeat to find R-values for R-1, R-2, and R-3.
6. To find R-4, simply measure the radius of the 5’ curb offset from the central island.
7. To find R-5, create a spline that is tangential to the three curb offsets that define the R5 path (the 5’ splitter island offset on the entry, the 5’ offset on the inside of the right turn, and the 5’ splitter island offset on the exit). Check that the arc does not cross any curb offsets, especially when the geometry of the right turn movement is created with multiple arcs. Below is a diagram of a typical R5 spline.



Figure 9 Example R5 Spline

Guide for Using AutoTURN¹

Below is a step-by-step demonstration of driving a truck through a roundabout

- Once AutoTURN has been loaded, the ribbon below should appear on the screen in AutoCAD Civil 3D as shown in Figure 1a. In Microstion, a tool bar should appear as shown in Figure 1b. A few operational devices have been labeled in the graphic below.

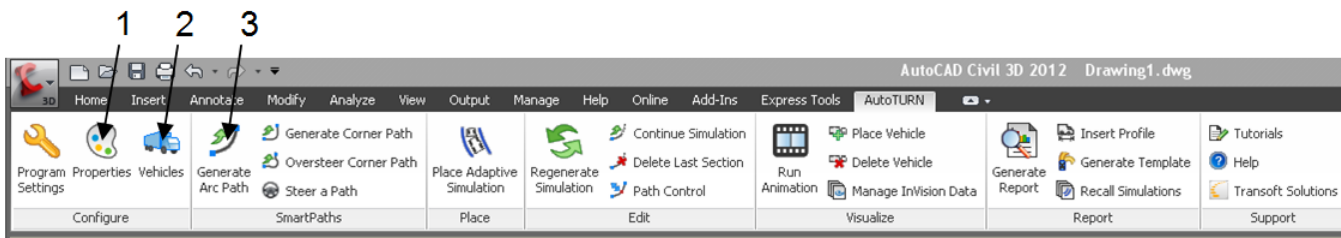


Figure 1a AutoTURN ribbon in AutoCAD Civil 3D



Figure 1b AutoTURN toolbar in Microstation

- Select device labeled 1, the AutoTURN: Simulation Properties box should show up. Select Envelopes from the select category box and the screen should be similar to the one below.

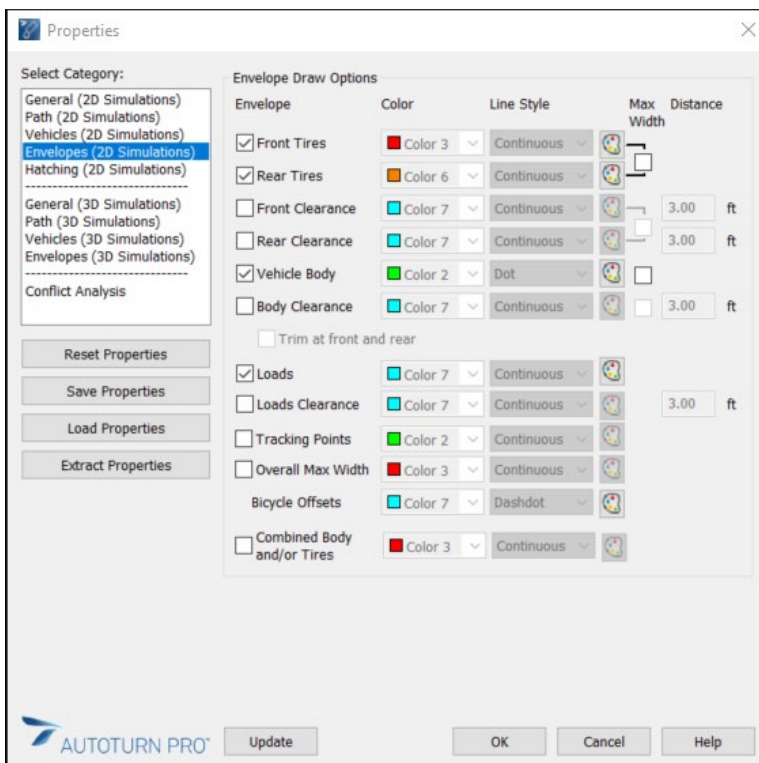


Figure 2 AutoTURN Simulation Properties

- Once in this screen, toggle on the boxes for front tires and rear tires. This will give an accurate envelope for the outside paths of the tires. Other envelopes can be toggled on/off as needed.
- Select device labeled 2
 - Use this device to choose the correct group and correct design vehicle

- Below is an example of the WB-65 design vehicle. Note the difference in size from the WisDOT WB-65 design vehicle. AASHTO requires 43.50 ft from king pin to rear axle, WisDOT only requires 43.00 ft. Leave as 43.50 ft to be slightly conservative.

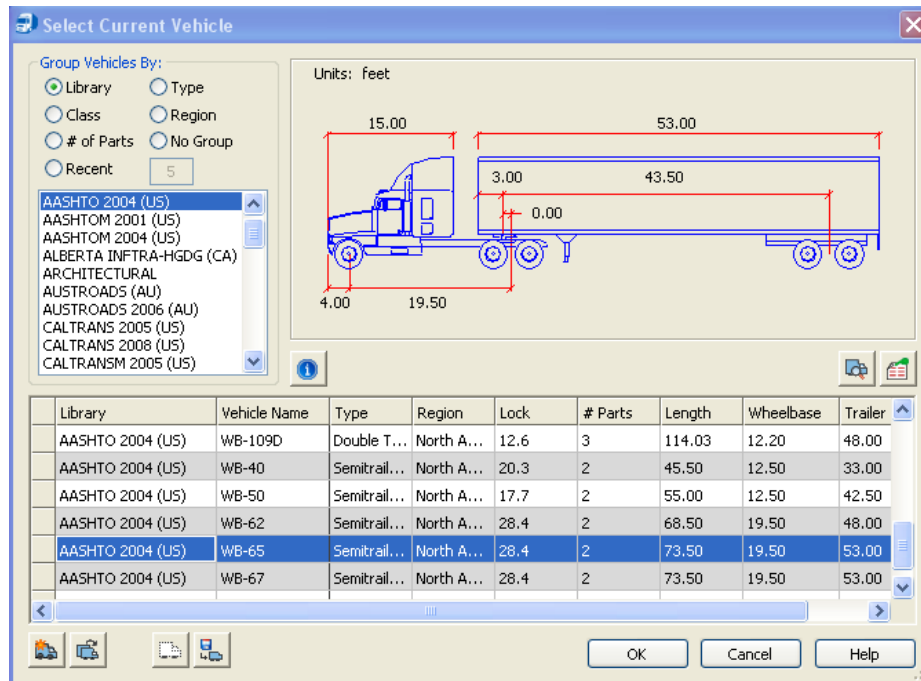


Figure 3 AutoTURN Select Current Vehicle

- Once the correct vehicle is highlighted, select device labeled 3.
- A top-view of the design vehicle should show up on the display. That view should look similar to the graphic below.

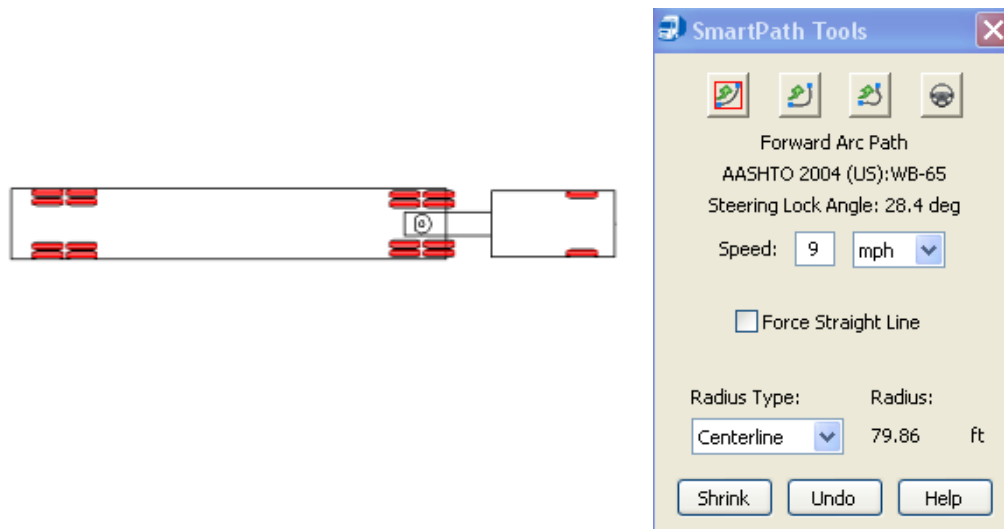


Figure 4 Selected Design Vehicle

- With the design vehicle loaded, select the correct placement for the start of the arc path. The starting point should be prior to the roundabout entrance at a proper angle a truck would be driving if it were approaching a roundabout.
- The box to the right will pop up, use this box to input a reasonable speed (6mph minimum and 9mph desirable) for a driving truck. There may be rare situations where the speed will be below the minimum. AutoTURN sets the steering lock angle.
- Begin to the steer the vehicle through the entrance making sure the truck tires do not go onto the

gutter pan at any point.

- Continue to steer the vehicle through the circular roadway of the roundabout avoiding the gutter pans. The truck apron should only be used by the rear trailer tires for through and left turn movements. The vehicles front tires should not use the truck apron for any movement.
- Continue steering the vehicle until it exits the circular roadway at the correct exit.
- A completed right turn movement is shown in the two graphics below.

Multilane roundabouts can be designed in two different ways to accommodate large trucks. One way to design a multilane roundabout is to assume a truck will use two lanes to enter, circulate and exit the roundabout, as shown be below.

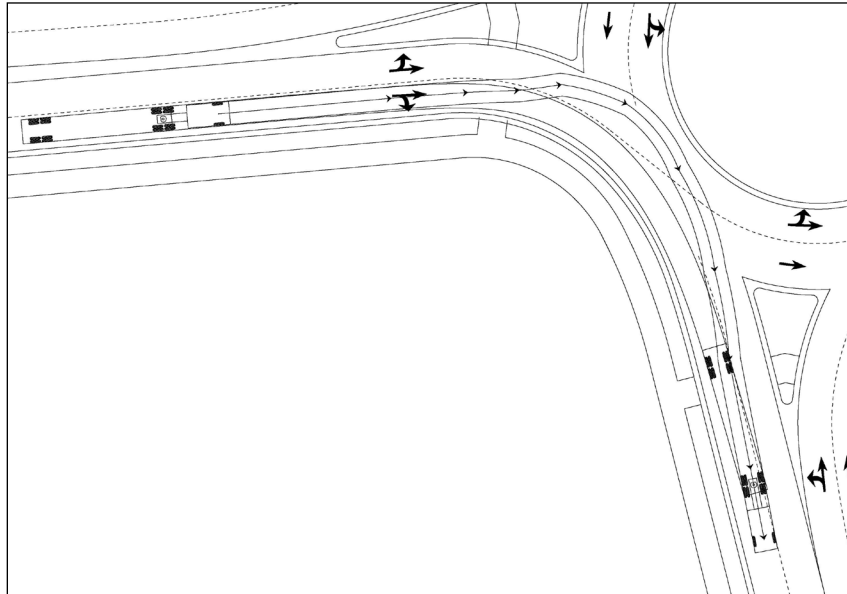


Figure 5 AutoTURN Right turn Movement

Alternatively, a roundabout can be designed so that trucks can remain in one lane as they traverse the intersection. This approach is less commonly used since overall geometry must be larger, possibly resulting in increased ROW needs, higher cost, and a potential for increases in certain types of crashes. An example of this design is shown below. This example utilizes a truck hatching area to allow the truck to make the right turn without encroaching on the adjacent left lane.

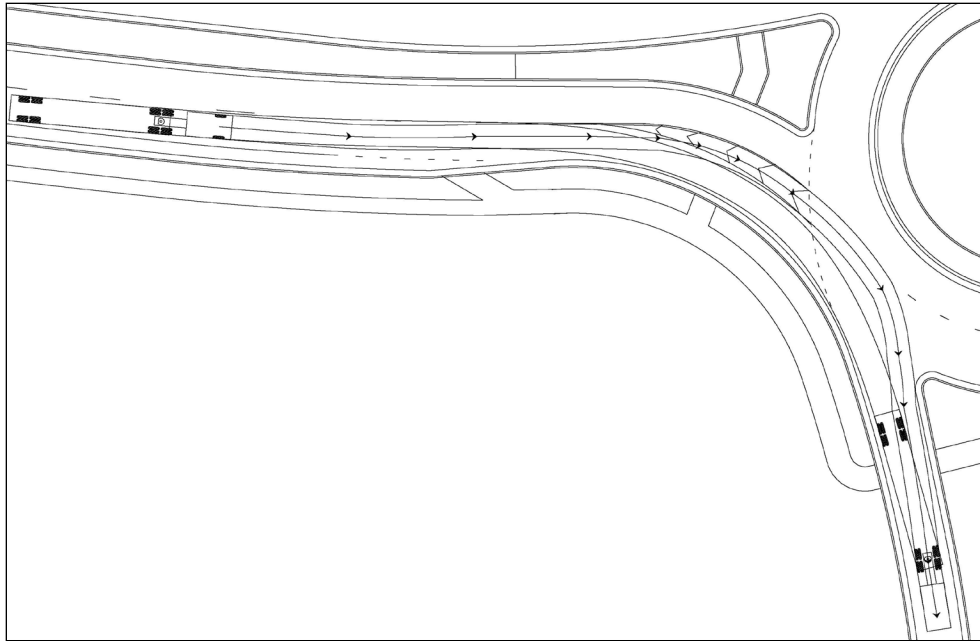


Figure 6 AutoTURN Right turn Movement w/truck hatching

AutoTURN is also a tool utilized for evaluating the size of a truck apron needed at roundabouts. As shown below, when a left turn movement is utilized in AutoTURN the rear wheel path of the truck movement provides guidance for determining the central island truck apron width.

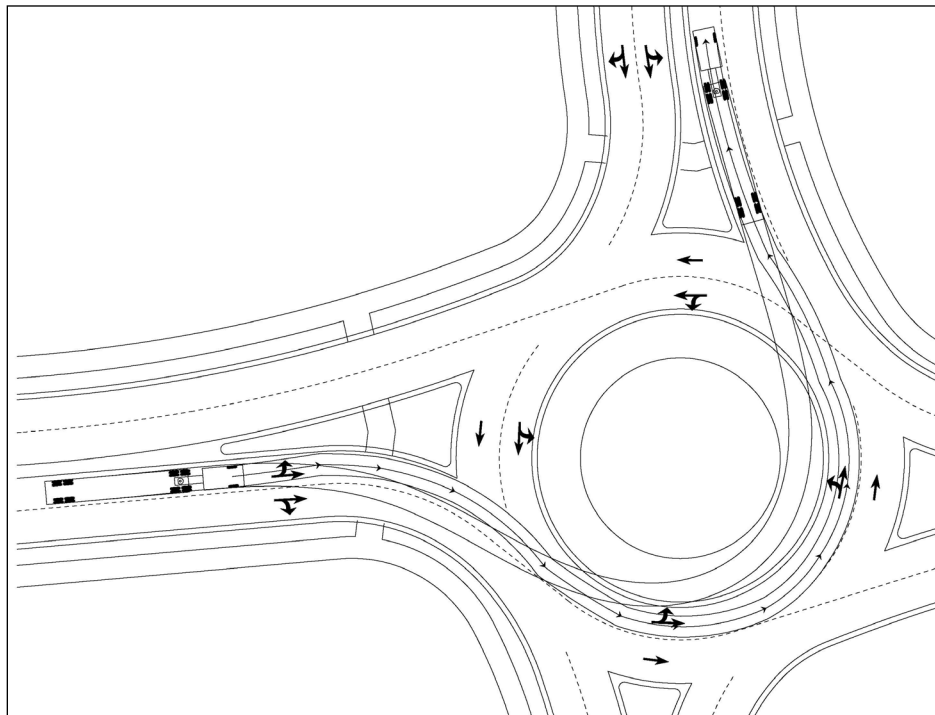


Figure 7 AutoTURN Left turn Movement

1 AutoTURN Version 8.0 shown. Other versions of AutoTURN and AutoTURN Pro 3D are similar.