BRO-50-2.839 Feasibility Study, Brown County, Ohio

Ohio Department of Transportation District 9
April 21, 2025

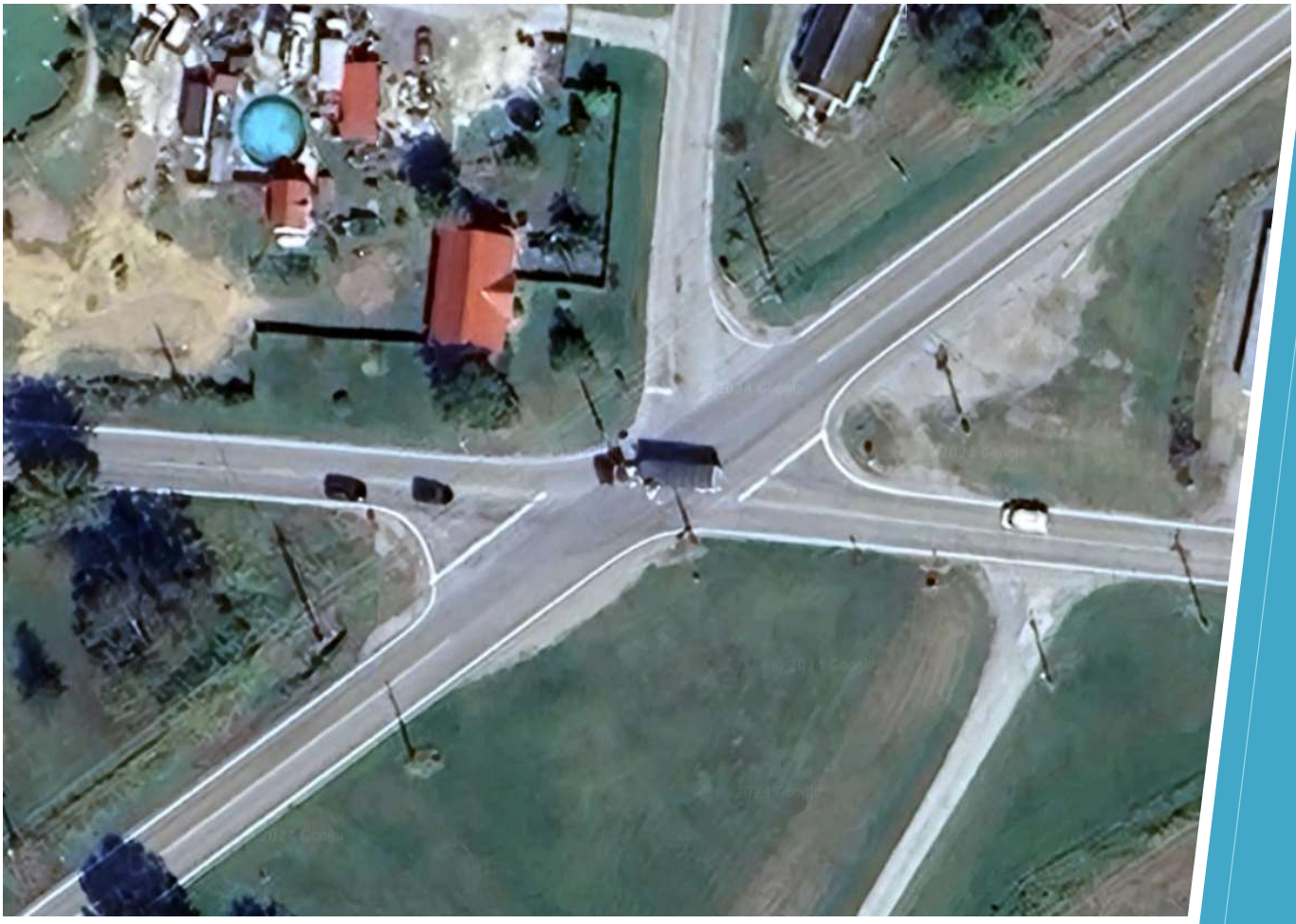

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Table of Contents

List of Tables

List of Figures

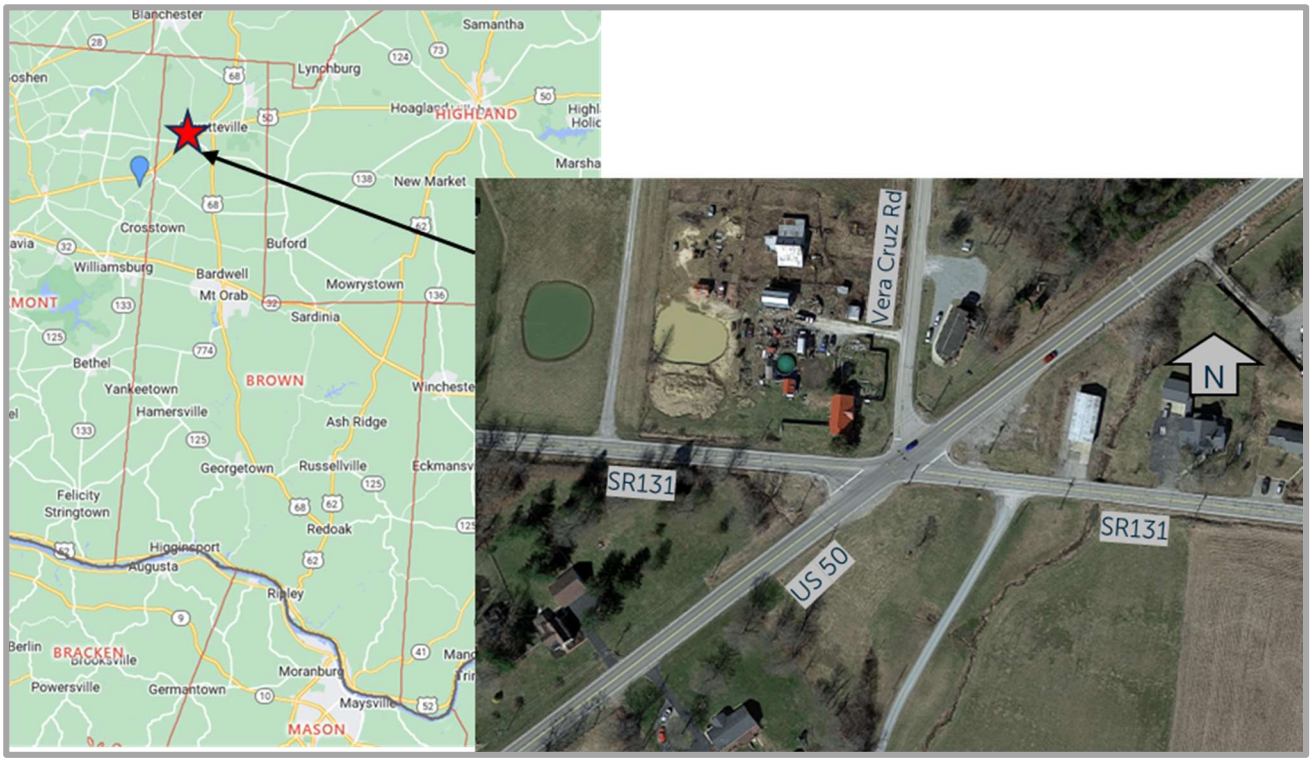
APPENDICES

Introduction

Background

This study evaluates the feasibility of various configurations at the intersection of US 50/SR 131 and Vera Cruz Rd. located in Brown County. The general location map is included in **Figure 1**. This intersection has been previously evaluated by ODOT District 9 for various low and medium cost alternatives to improve safety and operations, however, due to the skewed geometry and 5-leg configuration, a longer-term improvement is deemed to be more impactful. A traffic signal installation was discussed in the past, however, locals were not receptive to a signal installation at this high-speed intersection.

FIGURE 1: PROJECT LOCATION MAP



Existing Conditions

US 50 is the major street at this intersection and runs northeast/southwest, SR 131 is an east-west roadway and Vera Cruz Road runs north/south. The existing roadway conditions are summarized in **Table 1**. The land uses are mostly residential and agricultural. The north approach has a heavily wooded property while the southeast quadrant is agricultural. US 50 approaches are free flow while SR 131 and Vera Cruz Road approaches are under stop control. Overhead flashers are provided at this intersection.

TABLE 1: EXISTING ROADWAY CONDITIONS

ROADWAY	POSTED SPEED LIMIT	LANE WIDTH	ROADWAY SECTION	2024 AADT	FUNCTIONAL CLASSIFICATION
US 50 (Northeast leg)	55 MPH	12' lanes	2-lane section, (2'-4' paved shoulders)	5,400 vpd	Minor Arterial
US 50 (Southwest leg)		12' lanes	2-lane section (2' shoulders)	3,400 vpd – (15% trucks)	Major Collector
SR 131	Statutory Speed Limit (55 MPH)	11' lanes (west leg), 10' lanes (east leg)	2-lane section (1' shoulder)	3,820 vpd – west leg (9% HVs) 1,600 vpd – east leg (9% HVs)	Minor Arterial (west leg) Major Collector (east leg)
Vera Cruz Rd	Not Posted, Statutory Speed Limit (55 MPH)	10' lanes	2-lane section, no paved shoulder	615 vpd	Minor collector

SR 131 and Vera Cruz Road intersect US 50 at an acute angle skew. Acute angles result in restricted sight distance, making it difficult for drivers to safely complete their turns. SR 131 approaches intersect US 50 at skew angles of 40 degrees and 44 degrees. Vera Cruz Road intersects US 50 at an angle of 52 degrees. ODOT's Location and Design Manual limits skews to 70 degrees.

FIGURE 2: EXISTING INTERSECTION SKEW

Purpose & Need

The purpose of this project is to improve the capacity and safety of the intersection. Under the existing conditions, during the PM Peak the eastbound approach of SR 131 experiences LOS D. By the design year 2047, the eastbound leg of SR 131 will experience LOS F with a delay of 102 seconds during the PM peak. This intersection experienced 16 crashes in a 5-year period between 2018 and 2022, and the number of conflict points at this skewed 5-leg intersection is 79 versus 32 conflict points at a standard 4-leg intersection.

Feasible Alternatives

The following alternatives are considered for this project to address the congestion and safety issues experienced at the study intersection

- No-Build (Existing geometry/traffic control)
- Build Alternative 1 – Single Lane Roundabout (five legs)
- Build Alternative 2 – Single Lane Roundabout (four legs) with relocated Vera Cruz Road
- Build Alternative 3 - Relocate Vera Cruz Road and convert main intersection to an All-way stop.

  Relocate Vera Cruz Road alignment to intersect with US 50 further east, and there by eliminate the fifth leg and reduce the number of conflict points at the main intersection. Convert the US 50 and SR 131 four-legged intersection to an all-way stop control.
- Other Alternatives Considered, but dismissed
  - RCUT Option: An RCUT option that restricts cross-streets (SR 131, Vera Cruz Road) to right-in/right-out movements and the direct left turn movements on US 50 are eliminated. Downstream U-turns will be provided to complete left/U-turn movements. However, US 50 is a 2-lane undivided high-speed roadway, the widening required for the addition of U-turn lanes and bulb-outs, and right turn lanes will have significant impacts to properties within the intersection vicinity. Also, the tapers along US 50 corridor based on high-speed design would be very long resulting in even larger footprint and significant property impacts including full takes.

Traffic & Safety Analysis

Data Collection

Turning movement counts were collected at the intersection of US 50 at SR 131/Vera Cruz Road on May 21, 2024, from 6 am – 7 pm. The AM peak hour is from 7 am – 8 am, and the PM peak hour is from 5 pm – 6 pm. Appendix A includes the turning movement count report.

Design Year Volume Estimates

The ODOT's TFMS program was utilized to identify the growth rate for US 50 corridor. Based on the results, the following annual growth rates are assumed for each leg.

- US 50 (southwest leg – 0.70%, northeast leg – 0.40%)
- SR 131, Vera Cruz Rd – 0.40%

Design year volumes were estimated for the study intersection using above growth rates. The ODOT TFMS program data and the design year estimates are also included in Appendix A.

Capacity Analysis

The capacity analysis was conducted for the intersection of US 50 with SR 131/Vera Cruz Road for the existing year 2024 and design year 2047 under the AM peak and PM peak conditions. Transmodeler software was utilized for the No-build and Build Alternative 1 scenarios, as HCS cannot model 5-leg intersections. Build Alternatives 2 and 3 were analysed with HCS software. The No-build analysis results are included in **Table 2**. As shown, during the PM peak, eastbound SR 131 experiences LOS D under the current conditions and is expected to experience LOS F by the design year 2047 with a delay of 102 seconds. The LOS reports are included in **Appendix B**.

TABLE 2: NO-BUILD LOS – US 50 & SR 131/VERA CRUZ RD INTERSECTION

INTERSECTION/ APPROACH LOS		2024 AM		2024 PM		2047 AM		2047 PM	
		LOS	Delay (secs)	LOS	Delay (secs)	LOS	Delay (secs)	LOS	Delay (secs)
No Build (Minor streets - stop control)	EB SR 131 (Stop)	B	14.1	D	26.9	C	15.0	F	101.5
	NEB US 50	A	0.2	A	0.5	A	0.3	A	0.6
	WB SR 131 (Stop)	B	14.4	C	18.2	C	15.6	C	21.3
	SWB US 50	A	0.0	A	0.1	A	0.0	A	0.1
	SB Vera Cruz (Stop)	B	12.0	B	14.7	B	13.4	C	18.0

The LOS results for the Build Alternative 1, 5-leg Single Lane Roundabout alternative are included in **Table 3**. Under the build conditions, all approaches will experience LOS A and the overall intersection LOS is also anticipated to be A.

TABLE 3: BUILD ALT 1 LOS – US 50 & SR 131/VERA CRUZ RD INTERSECTION (5-LEG ROUNDABOUT)

APPROACH	2047 AM		2047 PM	
	LOS	Delay (secs)	LOS	Delay (secs)
EB SR 131	A	5.6	A	5.5
NEB US 50	A	5.1	A	6.4
WB SR 131	A	5.5	A	7.6
SWB US 50	A	5.7	A	5.7
SB Vera Cruz	A	6.2	A	5.7
Overall Intersection	**A**	**5.6**	**A**	**6.0**

The LOS results for the Build Alternative 2 are included in **Table 4**. Alternative 2 includes realignment of Vera Cruz Road to intersection with US 50 further east as a T- intersection, where Vera Cruz Road will be under stop control. The intersection of US 50 with SR 131 will be a 4-leg intersection with a single lane roundabout configuration. Under the build conditions, all approaches will experience LOS A and the overall intersection LOS is also anticipated to be A.

TABLE 4: BUILD ALT 2 LOS – US 50 & SR 131 (4-LEG ROUNDABOUT) AND US 50 & VERA CRUZ RD INTERSECTION

APPROACH	2047 AM PEAK				2047 PM PEAK			
	US 50 & SR 131		US 50 & Vera Cruz		US 50 & SR 131		US 50 & Vera Cruz	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Intersection Control	Roundabout		Minor Street Stop		Roundabout		Minor Street Stop	
EB SR 131	A	4.9			A	5.9		
NEB US 50	A	4.2	A	1.0	A	8.0	A	0.90
WB SR 131	A	4.4			A	5.6		
SWB US 50	A	5.5	A	0.01	A	4.5	A	0.01
SB Vera Cruz			B	10.2			A	9.8
Overall Intersection	**A**	**4.9**			**A**	**6.3**		

The LOS results for the Build Alternative 3 are included in **Table 5**. Alternative 3 includes realignment of Vera Cruz Road to intersection with US 50 further east as a T- intersection, where Vera Cruz Road will be under stop control. The intersection of US 50 with SR 131 will be a 4-leg intersection with all-way stop control. Under the build conditions, all approaches will experience LOS C or better, and the overall intersection LOS is anticipated to be B during both peaks.

TABLE 5: BUILD ALT 3 LOS – US 50 & SR 131 (4-LEG, ALL-WAY STOP) AND US 50 & VERA CRUZ RD INTERSECTION

APPROACH	2047 AM PEAK				2047 PM PEAK			
	US 50 & SR 131		US 50 & Vera Cruz		US 50 & SR 131		US 50 & Vera Cruz	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Intersection Control	All-way Stop		Minor Street Stop		All-way Stop		Minor Street Stop	
EB SR 131	B	10.3			C	15.6		
NEB US 50	A	9.4	A	1.0	B	14.8	A	0.90
WB SR 131	A	9.4			B	10.1		
SWB US 50	B	11.2	A	0.01	B	11.6	A	0.01
SB Vera Cruz			B	10.2			A	9.8
Overall Intersection	**B**	**10.4**			**B**	**14.0**		

Crash Analysis

Crash data for the study intersection was obtained from ODOT's GCAT crash database for a five-year period between 2018 and 2022. The OH-1 crash report for each documented crash was reviewed to confirm accuracy and to locate crashes properly within the study limits. A crash diagram and a CAM tool summary are included in **Appendix C**. A total of 16 crashes were reported at the intersection of US 50, SR 131 and Vera Cruz Road, of which 19% resulted in injuries. No fatal crashes were recorded at the intersection during the study period. The following trends were observed:

- Angle (88%) crashes are the primary crash type as shown on **Table 6**.
- Based on Time-of-day patterns, the extended weekday PM peak from 12 PM to 6 PM experienced most crashes (63%).

TABLE 6: CRASH FREQUENCY BY CRASH TYPE (2018-2022)

CRASH TYPE	INJURY	PDO/NO INJURY	TOTAL
Angle	2	12	**14**
Rear End	0	1	1
Fixed Object	1	0	1

Crash reports indicated that drivers on the cross streets had stopped for the stop sign, however, 'failure to yield properly' was the primary contributing factor for all angle crashes.

To support the HSIP application, crash analysis has been updated for the most recent 5-years: 2020 through 2024. A total of 23 crashes were reported during this five-year period, of which 35% resulted in injuries. Two (2) crashes resulted in serious injuries, and six (6) crashes resulted in minor injuries. Angle crashes accounted for 74% of all crashes. 'Failure to Yield properly' has remained the primary contributing factor.

Safety/ECAT Analysis

The Highway Safety Manual (HSM) methodology based ODOT's Economic Crash Analysis Tool (ECAT) safety analysis was conducted for the intersection of US 50, SR 131 and Vera Cruz Road. The analysis estimated three factors: Predicted crash frequency, expected crash frequency and the

Potential for Safety Improvement (PSI), and are included in **Table 7**. The ECAT output reports are included in **Appendix D.**

TABLE 7: EXISTING CONDITIONS ECAT SUMMARY

EXPECTED CRASH FREQUENCY-EXISTING CONDITIONS ($N_{EXPECTED}$)	PREDICTED CRASH FREQUENCY ($N_{PREDICTED}$)	EXPECTED EXCESS CRASHES/POTENTIAL FOR SAFETY IMPROVEMENT
5.12	6.55	-1.43

The ECAT analysis results indicate that the crash rate at this intersection is less than the predicted crash rate when compared to similar sites in Ohio. The ECAT tool only analyzes 3-leg or 4-leg intersections, so the No-build analysis ignores the 5th leg at this intersection.

The ECAT analysis was also conducted for the three proposed Build alternatives, and the resulting expected crash frequency is summarized in **Table 8**. Similar to the No-build ECAT analysis, for Alternative 1, the ECAT tool doesn't take the fifth leg into consideration of safety performance.

TABLE 8: PROPOSED CONDITIONS ECAT SUMMARY

ALTERNATIVE	ALT 1 – FIVE-LEG ROUNDABOUT	ALT 2 – FOUR-LEG ROUNDABOUT, RELOCATED VERA CRUZ RD	ALT 3 – FOUR-LEG ALL-WAY STOP, RELOCATED VERA CRUZ RD
Expected Crash Frequency-proposed conditions ($N_{expected}$)	1.0	2.4	2.77

Roadway

The proposed concepts follow a design speed of 55 mph on the three roadways, and a design speed of 30 mph on the roundabout approaches. The following sections describe the design details of the proposed improvements. This section is primarily for roundabout alternatives (Alt 1 & Alt 2).

Typical Sections

The proposed pavement buildup for the full depth pavement was determined using the Pavement Design Manual, Section 400. The buildup contains the following layers:

- Item 442 – 1.5" Asphalt Concrete Surface Course, 9.5mm, Type A (446), As Per Plan
- Item 407 – Tack Coat (0.055 Gal/SY)
- Item 442 – 1.75" Asphalt Concrete Intermediate Course, 12.5mm, Type A (446), As Per Plan
- Item 301 – 6" Asphalt Concrete Base
- Item 304 – 6" Aggregate Base

Without geotechnical data, the following subgrade buildup was assumed for all full depth pavement:

- Item 204 – Geotextile Fabric
- Item 204 – Granular Material, Type B (12")

The proposed approaches were designed with a 4' graded shoulder per the ODOT Location & Design Manual (L&D Manual), Volume 1, Figure 301-3. Pavement design follows a 1.6% typical cross slope, and a pavement buildup per the Pavement Design Manual – Section 400. Per the L&D Manual, Volume 1, Section 305.2, there are 3 types of curbs called for:

- Type 2 curb is used along the outer edge of pavement,
- Type 9 mountable curb along the truck aprons,
- and Type 6 along splitter islands and the central island.

Appendix E includes the proposed typical sections for US 50, SR 131 and Vera Cruz Road.

Roundabout Alignment

The proposed roundabout designs have an inscribed circle diameter of 150 feet. Within the roundabout, a lane width of 18 feet is used. A 10-foot truck apron surrounds the center island. A WB-67 was used as the controlling design vehicle for the roundabout design. Two alternatives were evaluated for the approach work of the BRO-50 roundabout.

Build Alternate 1 (five-leg roundabout)

The first alternative would replace the existing intersection with a five-leg roundabout as shown on **Figure 3**. The five roundabout approaches will include entrances from both directions of SR 131, both directions of US 50, and an entrance from Vera Cruz Road. Each approach will follow the typical section layout of 12 foot lanes, with a 10 foot median. Concrete islands are proposed for the right turn movements on the eastbound and westbound SR 131 and the southwestbound US 50 approaches, these movements have acute angles and the channelized right turn islands improve turning angle/path.

Additional improvements include reconstructed concrete driveway aprons for all properties within the construction limits. The farm driveway on the east leg will be relocated east of its existing location (parcel 230518120000) to accommodate all movements from this drive, without

relocation this drive would be the sixth leg of the roundabout. The proposed relocated drive was designed using a WB-62 design vehicle.

Build Alternate 2 (4-leg roundabout and relocated Vera Cruz Drive)

This alternative would replace the existing intersection with a four-leg roundabout with US 50 and SR 131 approaches. Vera Cruz Road will be relocated approximately 450' northeast from the intersection. The roundabout approaches are similar to Alternative 1, except instead of the channelized right turn islands for the eastbound and westbound right turns, truck aprons will be placed along the outside edge of pavement. These truck aprons provide additional space for larger trucks to perform right turns from these approaches.

Two scenarios for the four-leg roundabout were evaluated: A) intersection shifted southeast of the current location similar to Alternative 1 B) centered at current location

Figure 4 graphically shows the Alternative 2A. Figure 5 shows the centered roundabout alternative (Alternative 2B), which involves fully acquiring the northwest parcel and demolishing the building. This option has a smaller footprint as it avoids realignment of the west leg of SR 131 and the two US 50 approaches when compared to Alternative 2A. This centered roundabout option will be referenced as Alternative 2 for the reminder of this Feasibility Study.

The current Vera Cruz Road. leg will be replaced with a cul-de-sac to maintain access to properties along the street. The new, relocated, Vera Cruz Road intersection with US 50 is expected to be under stop-control, where Vera Cruz Road will be under stop control, and US 50 approaches will remain free-flow.

Additional improvements included reconstructed concrete driveway aprons for all properties within construction limits. The farm driveway on the west leg (south side) will be relocated east of its existing location, similar to Alternative 1.

Stop Control and relocated Vera Cruz Rd Alignment

Build Alternative 3

This alternative would convert the existing intersection where minor street approaches are under control to an all-way stop intersection. Also, Vera Cruz Road will be relocated away from the intersection further north and will be under stop control where it intersects with US 50. Figure 6 graphically shows this alternative.

At the main intersection, minor widening will be necessary to accommodate truck turning, given the heavy skew of the SR 131 legs of the intersection.

Grading

A 2 foot graded shoulder is placed behind all proposed Type 2 curb. Following this graded shoulder is cut or fill grading at a 3:1 slope. In the tapers, ditches are proposed for drainage purposes. These ditches are designed with a 3:1 foreslope, a 2 foot wide ditch, and a 3:1 backslope. Water collected within the proposed ditches will then drain to the proposed culverts.

Construction Limits

Construction limits are based on the roundabout limits, proposed driveways, and proposed grading. These limits are primarily shown for the Roundabout alternatives.

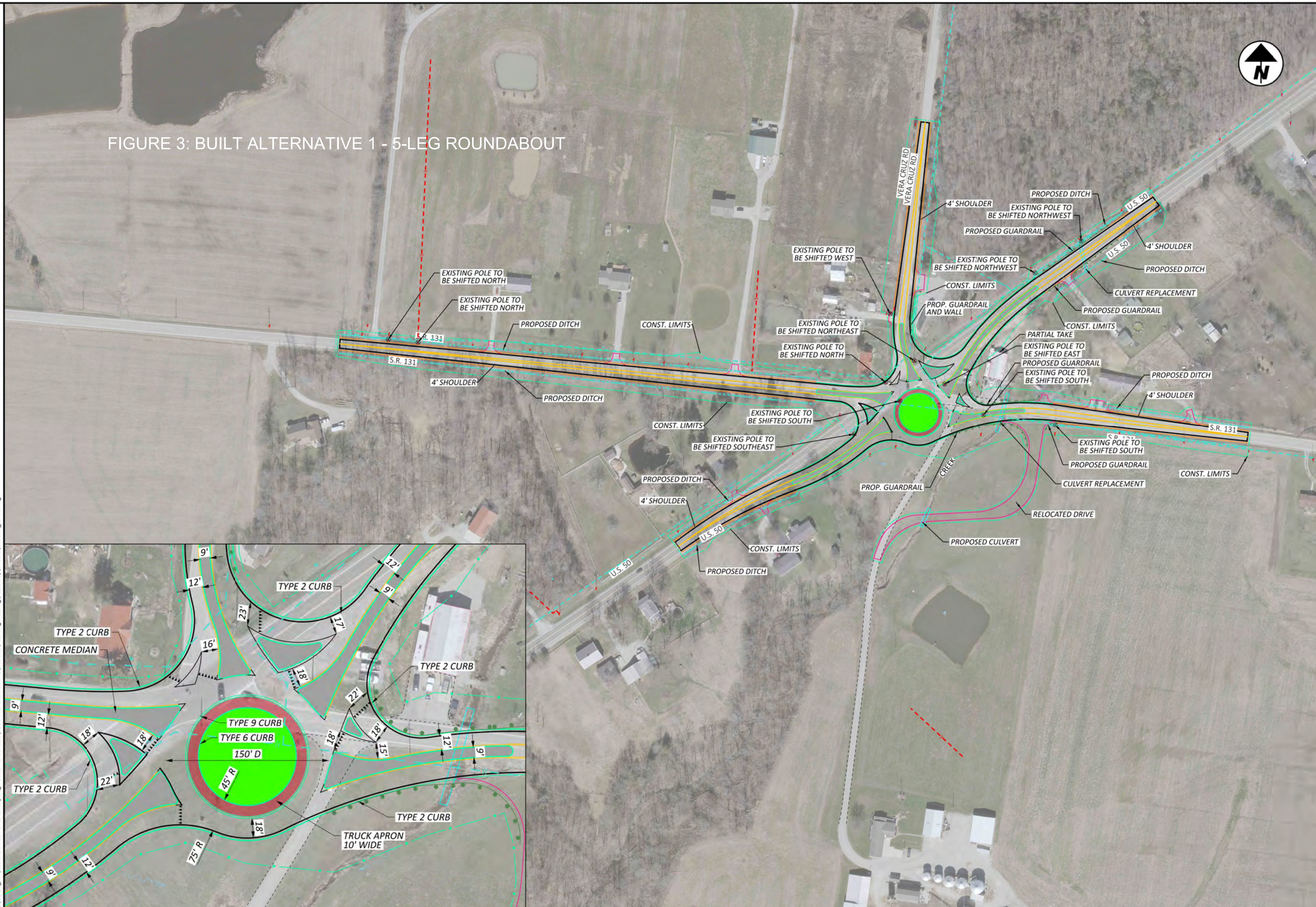


FIGURE 3: BUILT ALTERNATIVE 1 - 5-LEG ROUNDABOUT

BRO-50-2.839 CONCEPT PLAN - ALTERNATE 1

DESIGN AGENCY

DESIGNER ARW

REVIEWER JRE 07/18/24

PROJECT ID 119622

SHEET 1 TOTAL 1

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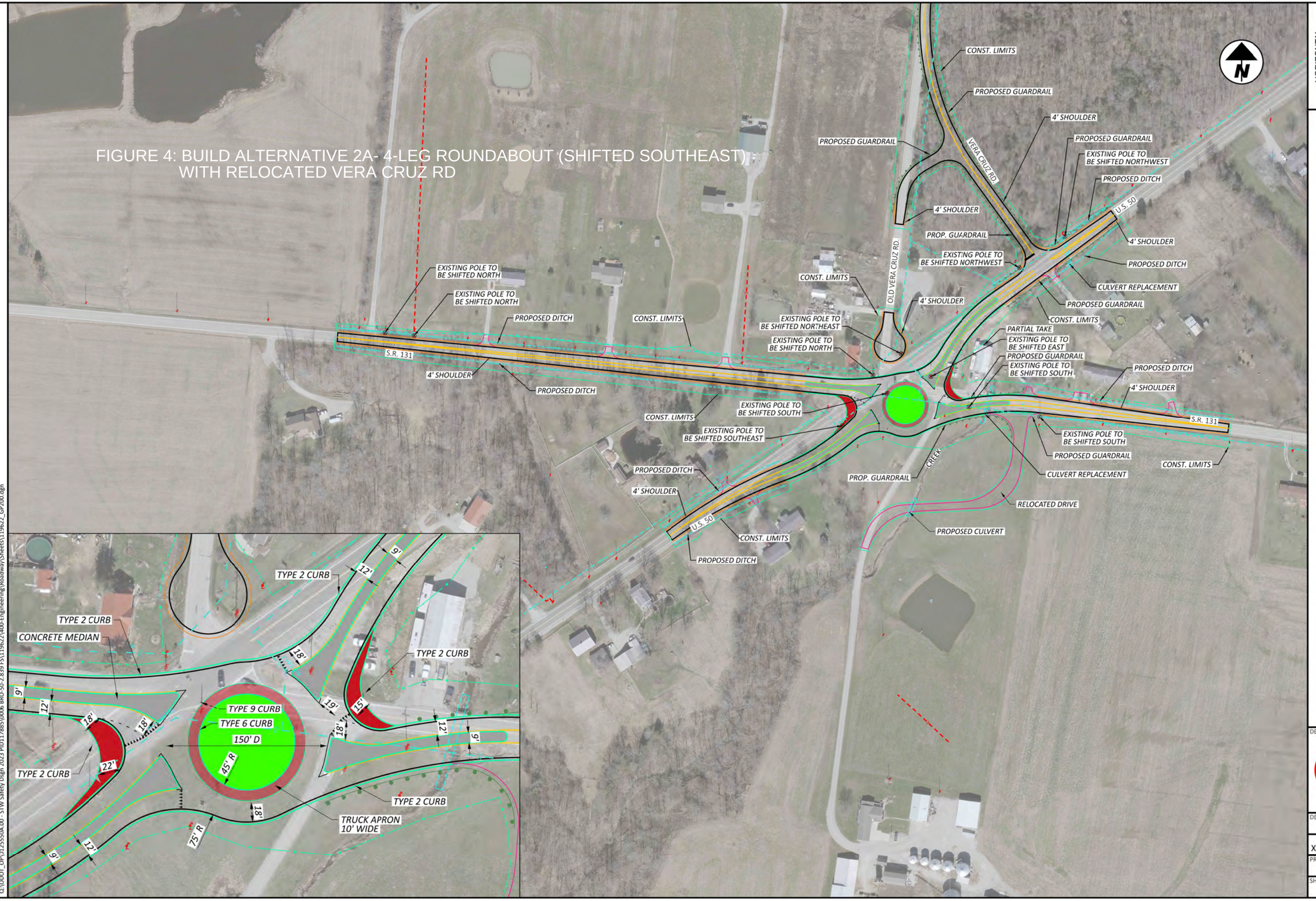
FIGURE 4: BUILD ALTERNATIVE 2A- 4-LEG ROUNDABOUT (SHIFTED SOUTHEAST) WITH RELOCATED VERA CRUZ RD



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BRO-50-2.839 CONCEPT PLAN

DESIGN AGENCY

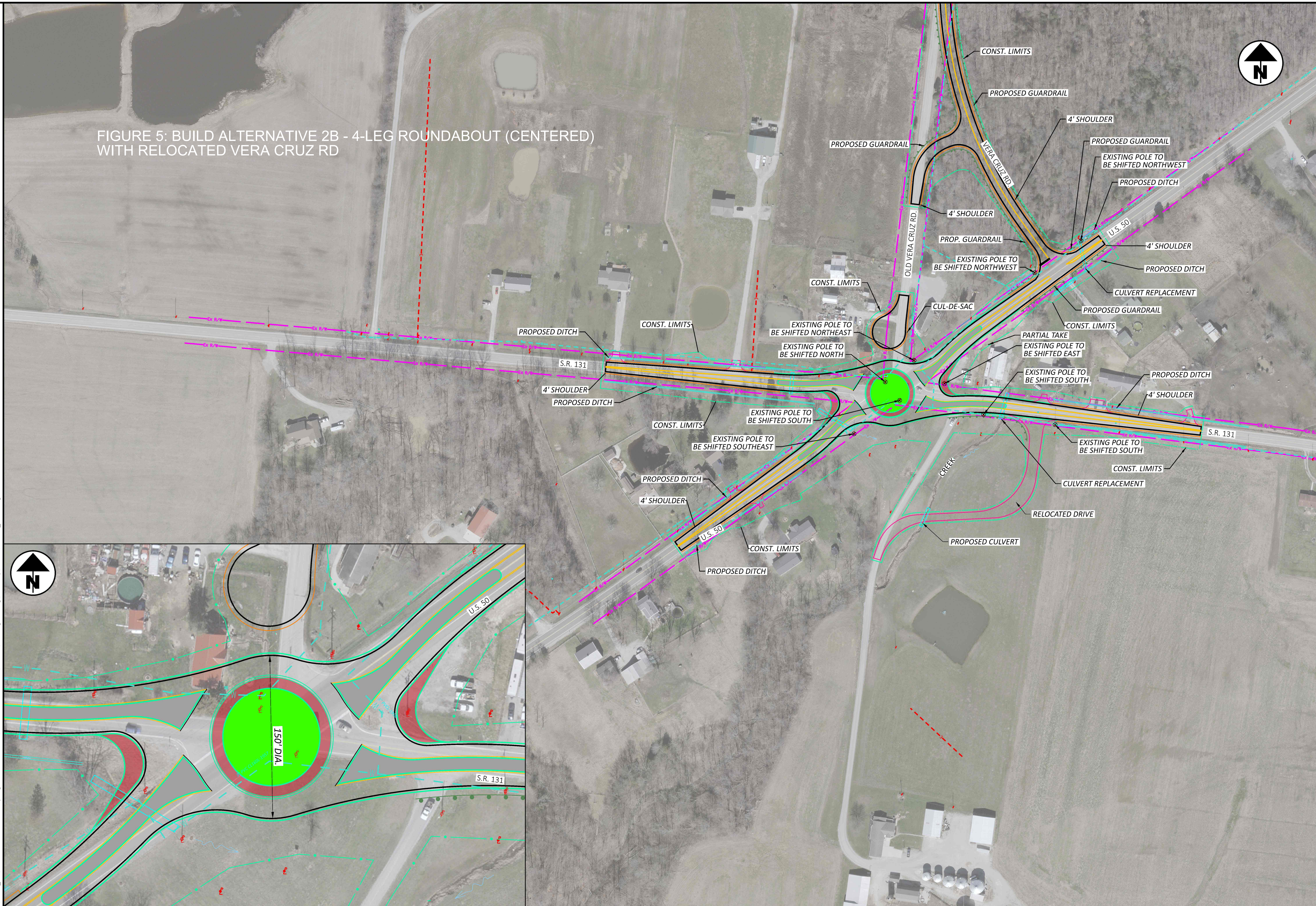
DESIGNER XXX

REVIEWER XXX XX/XX/XX

PROJECT ID 119622

SHEET 1 TOTAL 1

FIGURE 5: BUILD ALTERNATIVE 2B - 4-LEG ROUNDABOUT (CENTERED) WITH RELOCATED VERA CRUZ RD



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BRO-50-2.839 CONCEPT PLAN

DESIGN AGENCY

DESIGNER
XXX

REVIEWER
XXX XX/XX/XX

PROJECT ID
119622

SHEET	TOTAL
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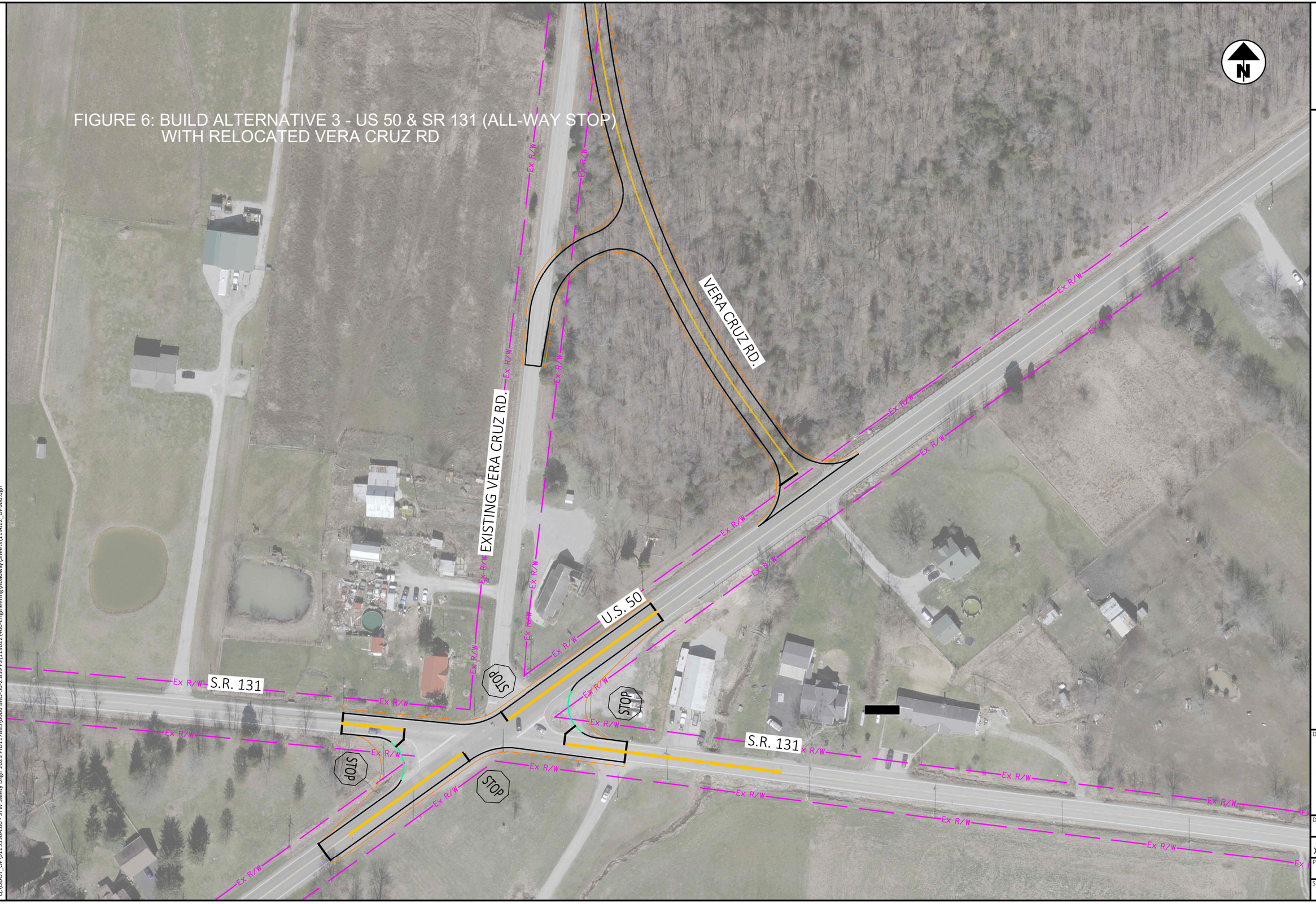
FIGURE 6: BUILD ALTERNATIVE 3 - US 50 & SR 131 (ALL-WAY STOP)
WITH RELOCATED VERA CRUZ RD



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BRO-50-2.839 CONCEPT PLAN - ALL-WAY STOP

DESIGN AGENCY

DESIGNER XXX

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PROJECT ID 119622

SHEET 1 TOTAL 1

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Maintenance of Traffic (Roundabout Alternatives)

Maintenance of Traffic strategies are vital for a roundabout alternative where closure with detours is preferred over maintaining traffic throughout the construction. This section is intended for the roundabout alternatives, and two primary strategies for maintaining traffic with the roundabout configuration include part-width and closure with detours. Since the intersection has five-legs, three roadways are involved. The primary concept is to build the proposed with the least amount of negative impact to the traveling public. The negative impacts include the delay and cost of detouring, right of way for temporary conditions, crashes and injuries and the cost of temporary facilities. This means:

- building as much as possible without impacting any traffic movements,
- closing the lowest volume roads the longest and the highest volume roads the shortest,
- keeping the temporary conditions as simple as possible by keeping Vera Cruz Road (CR 7) closed throughout the project.

The following Sequence of Construction was developed with the above goals in mind.

Sequence of Construction—Closure and Detour

1. Close and detour Vera Cruz Road (CR 7) south of Fayetteville Blanchester Road (CR 12) and at the US 50/SR 131 intersection. Detour Vera Cruz Road (CR 7) via Fayetteville Blanchester Road (CR 12) and US 50. The closure and detour of Vera Cruz Road (CR 7) will have minor impacts according to the District's Detour Justification worksheet.

   Maintain traffic on existing US 50 and existing SR 131. Construct the Vera Cruz Road (CR 7) approach, some of the roundabout central island and the south and east approaches' drainage, culverts, earthwork, curb and pavement while not affecting existing US 50 or existing SR 131.

2. In addition to Vera Cruz Road (CR 7), close and detour SR 131 east of SR 133 and west of US 68 in Chasetown. Detour SR 131 via SR 133, US 50, SR 286 and US 68. The closure and detour of SR 131 will have minor impacts according to the District's Detour Justification worksheet.

   Maintain traffic on existing US 50. Build temporary driveway access pavements. Construct and complete SR 131 approaches.

3. In addition to Vera Cruz Road (CR 7) and SR 131, close and detour US 50 north of SR 286 in Marathon and south of US 68 in Fayetteville with limitations on the duration. Detour US 50 via SR 286 and US 68. The closure of US 50 will have minor impacts according to the District's Detour Justification worksheet.

   Construct US 50 approaches and remaining islands and pavement. Construct and complete all remaining pavement and drainage items.

Duration of Work

The anticipated duration of the phases of the Sequence of Construction would be Phase 1 = 60 days, Phase 2 = 30 days and Phase 3 = 21 days as summarized in **Table 9**. For Build Alternative 1, this would result in the total duration of closure for Vera Cruz Road (CR 7), SR 131 and US 50 would be 111 days, 51 days and 21 days respectively.

For Build Alternative 2, this would result in the total duration of closure for Vera Cruz Road (CR 7), SR 131 and US 50 would be 60 days, 51 days and 21 days respectively.

TABLE 9: CONSTRUCTION PHASE & DURATION OF CLOSURE SUMMARY

PHASE	VERA CRUZ RD	SR 131	US 50
ALTERNATIVE 1 (FIVE-LEG ROUNDABOUT)			
1	60	-	-
2	30	30	-
3	21	21	21
Total Duration	**111**	**51**	**21**
ALTERNATIVE 2 (FOUR-LEG ROUNDABOUT WITH RELOCATED VERA CRUZ RD)			
1	60	-	-
2	-	30	-
3	-	21	21
Total Duration	**60**	**51**	**21**

Structures (Culverts)

There are two culverts in this project: one on US 50 (Culvert #1) and another on SR 131 (Culvert #2). Both culverts were analysed for their hydraulic capacity using ODOT's CDSS program. Per the site visit and the TIMS website, Culvert #1 is 61 foot long and consists of three segments: a 13 foot long, 4.5' diameter corrugated pipe; a 34-foot-long box culvert with a 5' span by 3' rise; and a 14 foot long, 4.5' diameter corrugated pipe. Similarly, Culvert #2 is a 28-foot-long four-sided box culvert with a 6.2' span by 3.5' rise. Refer to **Figure 7** for an aerial view of the culvert locations. Culvert#1 and Culvert#2 will be impacted under the roundabout alternatives (Alt #1 and Alt #2).

FIGURE 7: CULVERT LOCATION MAP

Design Criteria and Design Data

The US 50 ADT is higher than 3000 vehicles per day. Per the ODOT's L&D Manual Vol. 2, Section 1004.2, for a roadway with an ADT over 3000, the culvert should be designed to clear a 4% AEP Storm. This design storm must not exceed 1 foot below the near, low edge of the pavement for drainage areas less than 1000 acres. This should also not exceed 2 feet above the inlet crown of the culvert or above a tailwater elevation.

Additionally, a 1% AEP Storm should be used as a check condition to limit the maximum headwater depth to twice the diameter or rise of the culvert. The replacement structure should also be sized to ensure that upstream flooding is not increased during a 1% AEP storm when compared to the

existing structure.

The culvert location is not within a regulatory floodplain or an area of significant flood hazard. According to FEMA, the location is classified as an "Area of Minimal Flood Hazard" or Zone X. Therefore, data was collected from StreamStats (USGS) and compiled in a report using the project location coordinates. The StreamStats report is available in Appendix C of this document. Flow data used in the analyses are presented in **Table 10**.

TABLE 10: PROJECT FLOW DATA FROM STREAMSTATS

STRUCTURE	PROJECT FLOW DATA (STREAMSTATS)		
	Flow Profile	Discharge (cfs)	Recurrence Interval
Culvert 1	Q25	169	25-year recurrence
	Q100	242	100-year recurrence
Culvert 2	Q25	192	25-year recurrence
	Q100	275	100-year recurrence

Hydraulic Analysis

The ODOT's CDSS software (Version 1.0.0.3) was used for the hydraulic design of the proposed culverts. Flow data from StreamStats was input into the program's analysis module to evaluate the proposed conditions. A Manning's N value of 0.02, representing predominantly bare, natural ground, was used in the analysis.

Using these parameters, various box culvert sizes were considered, and the resulting headwater conditions were compared. According to L&D Vol. 2, Section 1006.2.2, a 1% AEP check storm was utilized to compare headwater depths. The maximum headwater depth should be limited to twice the diameter or rise of the culvert, and the headwater elevation should not exceed the existing flood elevation at the inlet.

- **Culvert #1 (US 50, northeast leg):** The existing culvert was not analyzed in detail due to its variable sections and materials along its length. Instead, it has been simplified as a single uniform corrugated pipe throughout for analysis, mimicking the conditions at the inlet and outlet. The stream runs parallel to the road at both the inlet and outlet, meeting the culvert at a skewed angle.

  For the proposed condition, wingwalls will be installed at different angles (0 degrees and 60 degrees) to direct the flow and assist with grading on both the inlet and outlet sides. Tailwater elevations of 1 foot and 4 feet were applied for the 25-year and 100-year discharges, respectively. The proposed inlet invert elevation will be 923.50. Headwater depths must remain below 929.48 for the 4% AEP design storm, and for the 1% AEP storm check, headwater depths should be below 931.50. **Table 11** presents a comparison of results for different box culvert sizes and the resulting headwater conditions.

  TABLE 11: CULVERT 1 ANALYSIS RESULTS COMPARISON

CULVERT SIZE	4% AEP HEADWATER (INLET)	1% AEP HEADWATER (INLET)
4 x 4	930.80	934.86
5 x 4	929.40	932.00
6 x 3	929.13	932.34
6 x 4	928.23	930.45

- **Culvert #2 (SR 131, east leg):** The existing culvert was analysed as a uniform four-sided box culvert with full headwalls and 45-degree wingwalls. Tailwater elevations of 1 foot and 3 feet were assumed for the 25-year and 100-year discharges, respectively. The proposed inlet

invert elevation will be 919.23. Headwater depths must remain below 924.73 for the 4% AEP design storm, and for the 1% AEP storm check, headwater depths should be below 926.23. Table 12 presents a comparison of results for different box culvert sizes and the resulting headwater conditions.

TABLE 12: CULVERT 2 ANALYSIS RESULTS COMPARISON

CULVERT SIZE	4% AEP HEADWATER (INLET)	1% AEP HEADWATER (INLET)
5 x 4	926.20	929.93
6 x 4	925.11	927.70
7 x 4	924.14	926.35

Multiple sizes of four-sided, precast box culverts were analysed for this stream. The goal was to determine the optimal culvert size for the stream crossing and compared it to the existing culvert. Based on the above analysis, the culvert sizes of 6' span by 4' rise for Culvert 1 and 7' span by 4' rise for Culvert 2 are the first to meet the 1% AEP storm check requirement, as stipulated in the ODOT L&D Manual, Volume 2. The CDSS hydraulic analysis output summaries are included in Appendix F.

For both culverts, MGS guardrail is recommended around the proposed culverts per the ODOT L & D Manual, Volume 1, Section 603.1.2.1.

Utility & Right-of-Way Impacts

Right-of-Way Impacts

The current Right-of-Way is 30 feet from the roadway centerline on each side of the 5 intersection legs. Build Alternative 1 would require an additional 4.12 acres of right-of-way (30 parcels), while Alternative 2 would require an additional 5.49 acres of right-of-way (25 parcels) for the proposed designs, including a full take of the parcel on the northwest quadrant. Alternative 3 would require an additional 0.968 acres of right-of-way (4 parcels) for the proposed designs. These proposed right-of-way acquisitions include both permanent and temporary takes.

Utility Coordination/Impacts

The following utility companies were identified within the project limits:

- Charter
- Duke Energy
- TDS Telecom
- Fayetteville-Perry Township Regional Sewer
- Western Water Company
- ODOT

Plans were requested from the utility companies, and data has been traced into the plans. Note that the location of these utilities is for planning purposes only, the precise location/offsets will need to be confirmed during the detailed design phases.

Utilities identified within the proposed construction limits include underground electric, electric poles, and underground water lines. The fire hydrant, water meter, and water valve located on the east side of Vera Cruz Road will need to be relocated. On the west leg of SR 131, there are two poles that will need relocation. Three poles will be relocated on Vera Cruz Road for Alternative 1, with two being relocated for Alternative 2. Additional pole relocations include one pole on the

south leg of US 50, two poles on the east leg of SR 131, three poles on the north leg of US 50, and one pole within the center island. For Alternative 3, one pole each are potentially impacted in the southwest quadrant and northeast quadrant.

The summary of utility impacts is included in **Appendix G.**

Environmental Considerations

Cultural Resources

There are no sites, bridges, or districts listed in the National Register of Historic Places (NRHP) in the project area. There are no sites that would require Section 4(f) or Section 6(f) coordination, such as publicly-owned parks, playgrounds, or wildlife reserves.

Waterway Permits

For the roundabout alternatives, to accommodate the approach widening and splitter islands, up to two existing culverts over waterways will require reconstructed or extended, one for SR 131 and another for US 50. The culverts cross a tributary stream to the East Fork Little Miami River. In addition, one new culvert will be constructed over the same stream to maintain access to the property to the south with the roundabout alternatives. Each of these culverts will require USACE permits. The work is likely to be eligible for 404 Nationwide Permits. OEPA 401 permits will also be required as this project area is in an Ineligible Area.

TABLE 13: CULVERT IMPACTS BY ALTERNATIVE

CULVERT LOCATION	ALT 1 – FIVE-LEG ROUNDABOUT	ALT 2 – FOUR-LEG ROUNDABOUT, RELOCATED VERA CRUZ RD	ALT 3 – FOUR-LEG ALL-WAY STOP, RELOCATED VERA CRUZ RD
SR 131, east leg	Yes	Yes	No
US 50, Northeast leg	Yes	Yes	No
On Private Property (New Culvert)	Yes	Yes	No

Ecological Coordination

Due to new right-of-way acquisition and parts of the roundabout being constructed on a new alignment, a Level 1 Ecological Survey will likely be required. The National Wetlands Inventory does not show any wetlands in the project area. However, some wetlands may exist near the waterways.

Regulated Materials Review

Due to deep excavation (6' of greater) and new ROW, a Regulated Materials Review (RMR) Screening will be required. A desktop review shows the following sites that may require additional coordination or investigation:

- The garage between the northeast US 50 and east SR 131 approaches, which will require likely require a total take for Alternative 1, appears to have served as an automotive facility in the past.
- The property at 2659 SR 131 had underground storage tanks for gasoline (BUSTR record 08000042). Permanent ROW will be required from this property for Alternatives 1 and 2.

Farmland Coordination

The entire project area is outside the census urbanized area. Therefore, the Farmland MOU does not require any additional coordination for farmland.

Air Quality

The entire project area is outside non-attainment areas for air quality.

Noise Analysis

Construction of a roundabout will not add any through lanes to the intersecting roadways. While the realignment of US 50 approaching the roundabout will move the roadway closer to one residence, it is not 50% closer. Therefore, no additional noise coordination is anticipated.

Underserved Populations

The key demographic indicators of minority, low income, linguistically isolated, and older adult populations are all below the 50th-percentile in the two block groups (390159512013 and 390159512011) in the project area. No adverse and disproportionate impacts are anticipated to underserved populations.

Floodplains

While there are waterways in the project area, none of them are considered part of the 100-year floodplain or regulatory floodway. No additional floodplain coordination is anticipated.

Cost Estimate

Table 14 summarizes total construction costs for the various alternatives. These estimates include a contingency of 34.60%, and was calculated using a design risk of 15% and an inflation of 16.7% for 2027 construction. Detailed cost estimates and inflation calculator are included in Appendix H. These costs do not include design, right-of-way acquisition, utility relocation or construction inspection costs.

TABLE 14: COST SUMMARY

ALTERNATIVE	ALT 1 – FIVE-LEG ROUNDABOUT	ALT 2 – FOUR-LEG ROUNDABOUT, RELOCATED VERA CRUZ RD	ALT 3 – FOUR-LEG ALL-WAY STOP, RELOCATED VERA CRUZ RD
Construction Cost	$6.17 Million	$5.43 Million	$1.57 Million

Comparison of Alternatives

The three alternatives have been evaluated based on the potential to improve conditions and impacts and summarized in the table below.

TABLE 15: ALTERNATIVE EVALUATION SUMMARY

EVALUATION CRITERIA	NO-BUILD	BUILD ALTERNATIVE 1	BUILD ALTERNATIVE 2	BUILD ALTERNATIVE 3
Traffic Operations	LOS F by design year	LOS A by design year	LOS A by design year	LOS B by design year
Complexity/ Intersection Conflict Points	High (5-leg minor street stop controlled) 79 Conflict points (M=15, D=15, C=49)	Moderate (5-leg roundabout with channelized right turns on 4 approaches) 18 conflict points (M=9, D=9, C=0)	Low (4-leg roundabout & 3-leg stop intersection) 17 conflict points (M=7, D=7, C=3)	Moderate (4-leg & 3-leg stop controlled intersections) 41 Conflict points (M=11, D=11, C=19)
Safety Performance (Expected crashes per year)	5.12 crashes	1.0 crash	2.4 crashes	2.77 crashes
Culvert/Structures	No impact	2 structures to be replaced (US 50, SR 131)	2 structures to be replaced (US 50, SR 131)	None
ROW Impacts	No impact	30 parcels	26 parcels	4 parcels
Utility Impacts	No impact	US 50, SR 131 (High)	US 50, SR 131 (High)	US 50 (Low)
Project Cost (Construction)	$0.0	$6.17 Million	$5.43 Million	$1.57 Million
Safety Benefit Value	$0.0	$5.14 Million	$4.24 Million	$3.71 million

Note - Conflict Points: M – Merging, D – Diverging, C – Crossing movements

Conclusion & Next Steps

Based on the comparison of the build alternatives, complexity of the build configurations, expected safety performance, benefit-to-cost ratio and property impacts, Build Alternative 3 is recommended as the preferred alternative.

The next steps for this project include acquiring funds for detailed design and construction, public engagement, detailed design, ROW acquisition and utility relocation and construction.