



ENGINEERING, REIMAGINED

# 2018 ROAD SAFETY AUDIT

Oglala Sioux Tribe

*July 2018*

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## 1.0 EXECUTIVE SUMMARY

There were a reported 36 crashes on BIA 2 on the Oglala Sioux Indian Reservation from January 1, 2008 to December 31, 2017. Of these 36 crashes, 21 occurred from the east end of Kyle to the junction with state highway 44. Animal crashes, over-turning off road and fixed object crashes were the top three crash types. Off these crashes, it was determined over 40% occurred on vertical curves or where horizontal alignment changed. This route also has a high severity with 19 or the 36 reported crashes, or 53% resulting in an injury or a fatality.

To address these safety concerns the Oglala Sioux Tribe initiated a Road Safety Audit to include BIA route 2 from the community of Kyle to the junction with SD 44. Safety issues identified along the studied corridors were assigned specific countermeasure to address each issue location based on the available crash data. Recommended countermeasure includes the following:

### Urban Section:

- Install Separated Shared Use Pathway
- Install Sidewalks
- Install Signed, Marked Crosswalks
- Install Pedestrian Rapid Flashing Beacons
- Install Two-Way Left Turn Lane
- Install Four-Way Control at Intersection

### Rural Section:

- Install Guardrail
- Install Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Signs
- Install Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Horizontal Alignment
- Add Shoulders and latten Side Slopes
- Flatten Crest Vertical Curves
- Remove Fixed Objects from Clear Zone

Using the crash data, countermeasures, enforcement input and from observations during a field review, the RSA recommended improvements within Kyle as well as the rural section of the road. Detailed information can be found in **Section 6.0** of this report. These recommendations included:

- Shared Use Pathway in Kyle from Hospital Housing to the Grocery Store
- Attached Sidewalk from Oglala Lakota College to Little Wound School
- Signed Marked Crosswalks at three locations
- Installation of Pedestrian Activated Rapid Flashing Beacons at two Crosswalks
- Installation of a Two Way Left Turn Lane from the Health Clinic to the Junction with BIA 4
- Install four way stop controlled intersection at Junction with BIA 4
- Realign and Improve Intersection with Old Allen Road
- Reconstruction of Rural Section of Route

## 2.0 INTRODUCTION

The Pine Ridge Indian Reservation encompasses over 2 million acres (3,469 square miles) in the entirety of Oglala Lakota County, the southern half of Jackson County, and the northwest portion of Bennett County in southwest South Dakota and is home to the Oglala Sioux Tribe (OST). The northern and western boundary is along the Oglala Lakota county border. The northern border is also defined by the White River in Jackson County. The southern boundary is the South Dakota/Nebraska state border. While most of the eastern border is not defined by natural land features, a portion of it follows the Jackson/Mellette county boundary.

*Figure 2.1: Pine Ridge Indian Reservation Location*



Agriculture is the predominant industry on the reservation. Revenue from tourism and the Prairie Wind Casino generate funds for the Tribe. The major employers include the tribe itself, Oglala Lakota College, Indian Health Services, Bureau of Indian Affairs, and the Prairie Wind Casino.

The Oglala Sioux Tribe Department of Transportation is responsible for maintaining nearly 520 miles of BIA roadways and over 1,450 miles of Tribal roadways within the Pine Ridge Indian Reservation.

Past planning efforts undertaken by the Oglala Sioux Tribe have typically addressed transportation safety concerns on a case by case basis. In October 2016, a Tribal Transportation Safety Management Plan was implemented to address transportation safety with engineering, enforcement, education and emergency services strategies included. The plan was amended in June 2018. The safety plan identified existing programs on the reservation and identified additional strategies that needed to be implemented to address safety issues.

As a result, the Oglala Sioux Transportation Program determined an inventory of safety-related transportation conditions was merited. Further, a detailed description of corridor level safety concerns and potential opportunities to improve safety would enable the Oglala Sioux Tribe to use a systemic approach to better prioritize future safety improvement projects. As a result, this Road Safety Audit (RSA) was undertaken.

## Plan Purpose

According to the Federal Highway Administrations' website, a *Road Safety Audit (RSA)* is the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users.

The purpose of this RSA is to inventory and assess the safety attributes of roads and intersections within the Oglala Sioux Study Area. Specific, low cost policies and countermeasure improvements are to be recommended to address identified safety deficiencies.

A systemic approach was used for analysis of all of BIA route 2 on the Pine Ridge Indian Reservation, with . *A systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types. The approach helps agencies broaden their traffic safety efforts at little extra cost,* according to the Federal Highway Administration.

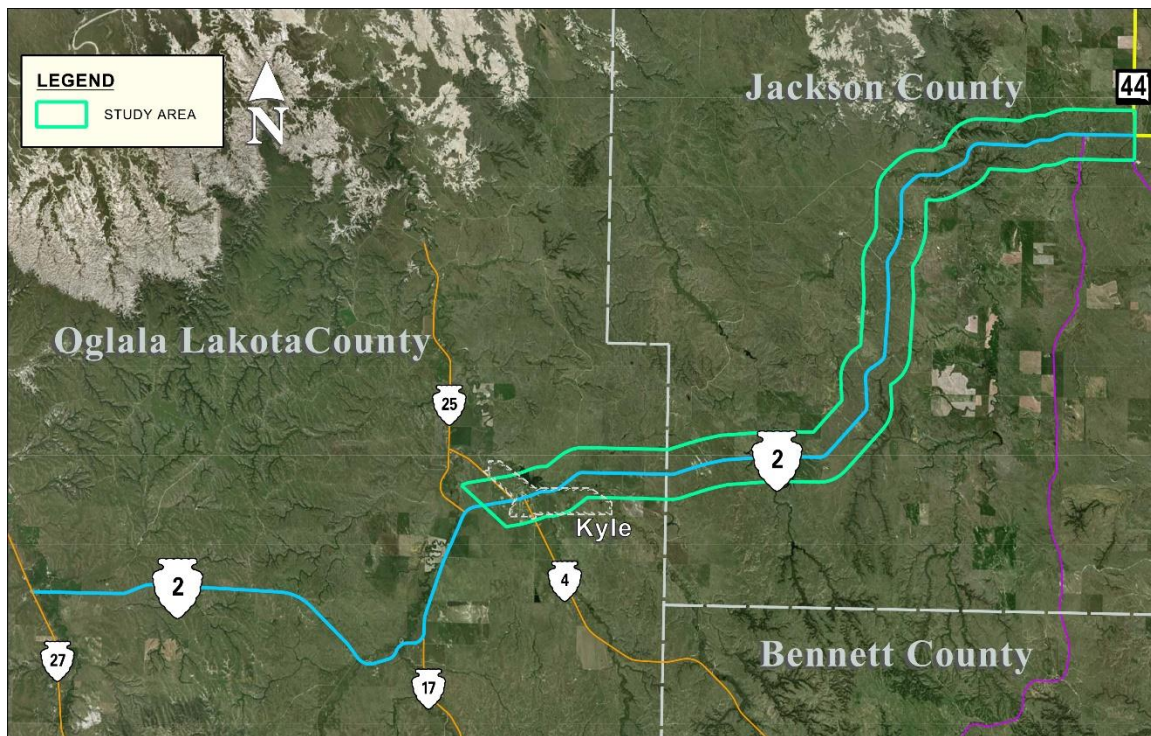
Further analysis and design detail will be required as projects proceed to fruition.

## Study Area

The Oglala Sioux Tribe is located in southwestern South Dakota and includes the communities of Allen, Batesland, Kyle, Manderson-White Horse Cree, Oglala, Pine Ridge, Porcupine, Wakpamni Lake, Wanblee and Wounded Knee. The Study Area is located in Oglala Lakota and Jackson County.

This report focuses on BIA route 2, beginning near the town of Kyle traveling easterly approximately 20 miles, intersecting BIA 4 and 25 then terminating at the intersection of BIA 2 and State Highway 44. **Figure 2.1** shows the study area.

Figure 2.2: BIA 2 Study Area



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## 3.0 EXISTING CONDITIONS

The existing conditions inventory was initiated and completed in June 2018. It included a field inventory of sign and roadway elements on BIA 2. It also included a review and analysis of historical crash data over a 10-year period from January 1, 2008 to December 31, 2017.

### Sign and Roadside Elements Field Inventory

The sign and roadside elements were field inventory for analysis. The purpose of conducting this inventory was to develop a systematic review and correction of substandard conditions that could be used to by tribal representatives in the future.

#### **BIA 2**

BIA 2 is approximately a 34-mile paved east/west roadway that begins at the intersection of BIA 27 and BIA 2 traveling easterly intersecting BIA 4, 17 and 25 through the town of Kyle then terminates at the intersection of BIA 2 and State Highway 44. Along BIA 2 is the Oglala Sioux Tribe Veterans Cemetery which is approximately eight-miles east of Kyle. The study area features both urban and rural roadway features.

#### BIA 2 URBAN

The urban section of BIA 2 begins on the west end of Kyle and continues easterly for approximately 1-mile to the east end of Kyle. The town of Kyle is the third largest community within Oglala Lakota County and is centrally located within the Pine Ridge Indian Reservation. Tribal members travel to Kyle, in lieu of the City of Pine Ridge for goods and services due to its central location. BIA Route 2 divides the community of Kyle into north and south and BIA Route 4 divides Kyle into east and west.

The existing paved roadway is approximately 24-feet wide with two 12-foot travel lanes and no shoulders. There is very limited pedestrian facilities along this urban section and areas with current facilities are not ADA compliant. There are many private and public approaches along both sides of the road. The urban section of BIA 2 has a posted speed limit of 40 mph towards the outer edges of town then dropping to 25 mph and 15 mph for school zones closer to the center of the town.

*Figure 3.1: BIA 2 Urban Section within School Zone*



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## BIA 2 RURAL

The rural section of BIA 2 begins on the east end of Kyle and travels easterly for approximately 18.8-miles to the intersection of BIA 2 and State Highway 44. The existing paved roadway is approximately 24-feet wide with two 12-foot travel lanes and no shoulders. BIA 2 has steep side slopes, tight horizontal curves, excessive vertical curves, and many trees within the roadway clear zone. Additionally, due to the vertical curves and trees within the roadway clear zone, most of the roadway intersections have insufficient sight distance. BIA 2 rural section has a posted speed limit of 55 mph and many of the curves are too sharp for the current posted speed limit.

As a result, there have been numerous crashes and reports by residents, tribal agency personnel, and emergency management of avoiding the route, especially at night due to the potential for crashes. The roadway was last constructed approximately 40 years ago and does not meet the current safety standards for width, shoulders, recoverable side slopes and clear zone.

The roadway asphalt is nearing the end of its design life and will need to be milled and overlaid within the next 5-10 years. An asphalt overlay would build up from a thin asphalt layer and the edges would be tapered causing the road to be further narrowed. Many paved routes on the Pine Ridge Indian Reservation have shoulder rumble strips installed. Installing rumble strips to prevent run off road crashes is a high positive impact per dollar spent for the improvement. Unfortunately, BIA Route 2 at its current width is too narrow for rumble strips.

*Figure 3.2: BIA 2 Rural Section with Steep Side Slopes*



## 4.0 HISTORICAL CRASH DATA

Historical crash data for crashes occurring on BIA 2 was provided by the South Dakota Department of Public Safety (SDDPS) for a 10-year time interval covering January 1, 2008 through December 31, 2017. Crash data is submitted to the SDDPS by law enforcement using the Traffic and Criminal Software (TraCS), a data collection and reporting tool for the public safety community. Oglala Sioux Tribal police have only recently started using the system, resulting in some of the crashes that the Tribal Police respond to not having been reported to the SDDPS.

With crash data being limited to what was only reported to SDDPS, the data only shows a small portion of crashes that have occurred on BIA 2. The 36 reported crashes throughout the corridor could be higher if crash information was available through the Tribal Police. A systemic approach was used for analysis on BIA 2 for crashes that may not have been reported.

The 2016 Tribal Transportation Safety Plan provided an in-depth analysis of available crash data and trends from 2006 through 2013. The Safety Plan provides strategies and recommendations to improve education, enforcement/EMS, engineering and safety planning/other provisions to address safety needs within the reservation. Please refer to that document for additional recommendation to improve safety on the Pine Ridge Indian Reservation.

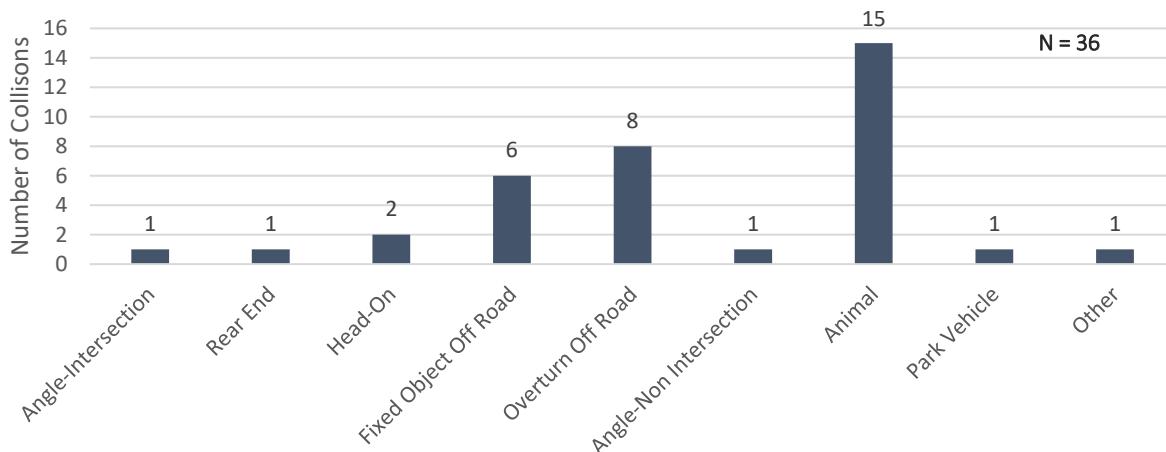
### Location of Crash

During the studied 10-year time interval, there were a reported 36 crashes or approximately 3.6 crashes per year on BIA 2. Of the 36 reported crashes, 33 crashes occurred at non-intersections, one occurred at a 4-way intersection, one was intersection related and one was driveway related.

### Crash Types

Animal collisions were the most common reoccurring event on BIA 2, accounting for 15 of the 36 crashes reported. The other leading crash types were Overturn Off Road, 8 crashes and Fixed Object Off Road, 6 crashes totaling 14 of the 36 crashes reported in the 10-year time frame. These top three crash types are consistent when comparing them to the 2016 Safety Plan and overall crashes reported on the Pine Ridge Indian Reservation. **Figure 4.1** shows the different collision types that occurred on BIA 2.

Figure 4.1: Crash Types on BIA 2 (2008 – 2017)

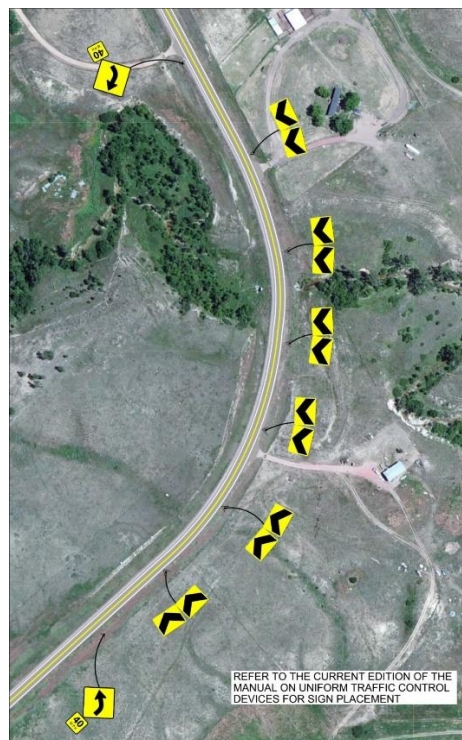


**Key Observation:** Given that the top three crash types are, Animal, Overturn Off Road, and Fixed Object Off Road crashes, it appears that the greatest impact on crash reduction could be from the following:

- Clear obstructions within the roadway clear zone.
- Add shoulders
- Improve inslope flattening inside the clear zone along roadway corridors.
- Where inslopes cannot be flattened, install guardrail in areas where the inslope exceeds the recommended 4:1 slope.
- Proper signing of horizontal curves may reduce overturn crashes by giving guidance to motorists of the change in the alignment of the roadway.
- Proper delineation along the roadway, used for motorist guidance at night and during adverse weather.
- Install Retro-Reflective Signs
- Center line and shoulder rumble strips, alert motorist as they cross the center or edge line of the roadway through creating noise and vibration inside the vehicle. This allows them to take corrective countermeasures to return to the travel lane safely.
- Improve horizontal alignment

Eleven of the 36 crashes reported occurred when the road curved. Horizontal Alignment Signs, Advisory Speed Plaque and Chevron Alignment Signs assist motorists on how to properly navigate through a change in roadway alignment. **Figure 4.2** shows an example of placement of these signs to assist motorists to navigate through a horizontal curve.

*Figure 4.2: Curve Warning Signs Example*

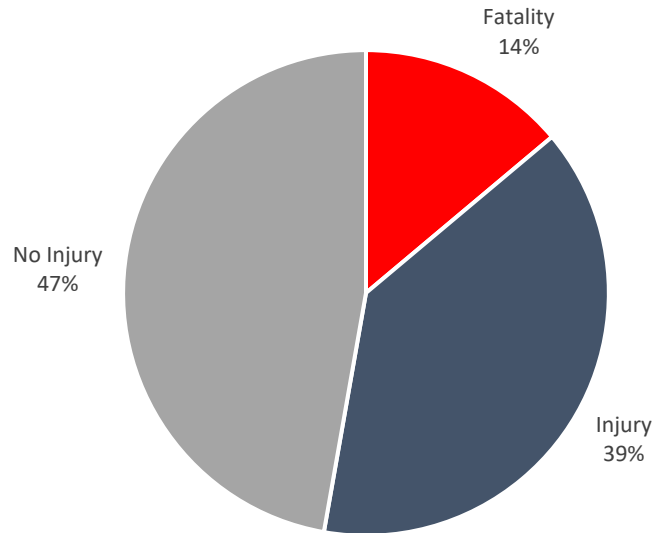


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### **Crash Severity**

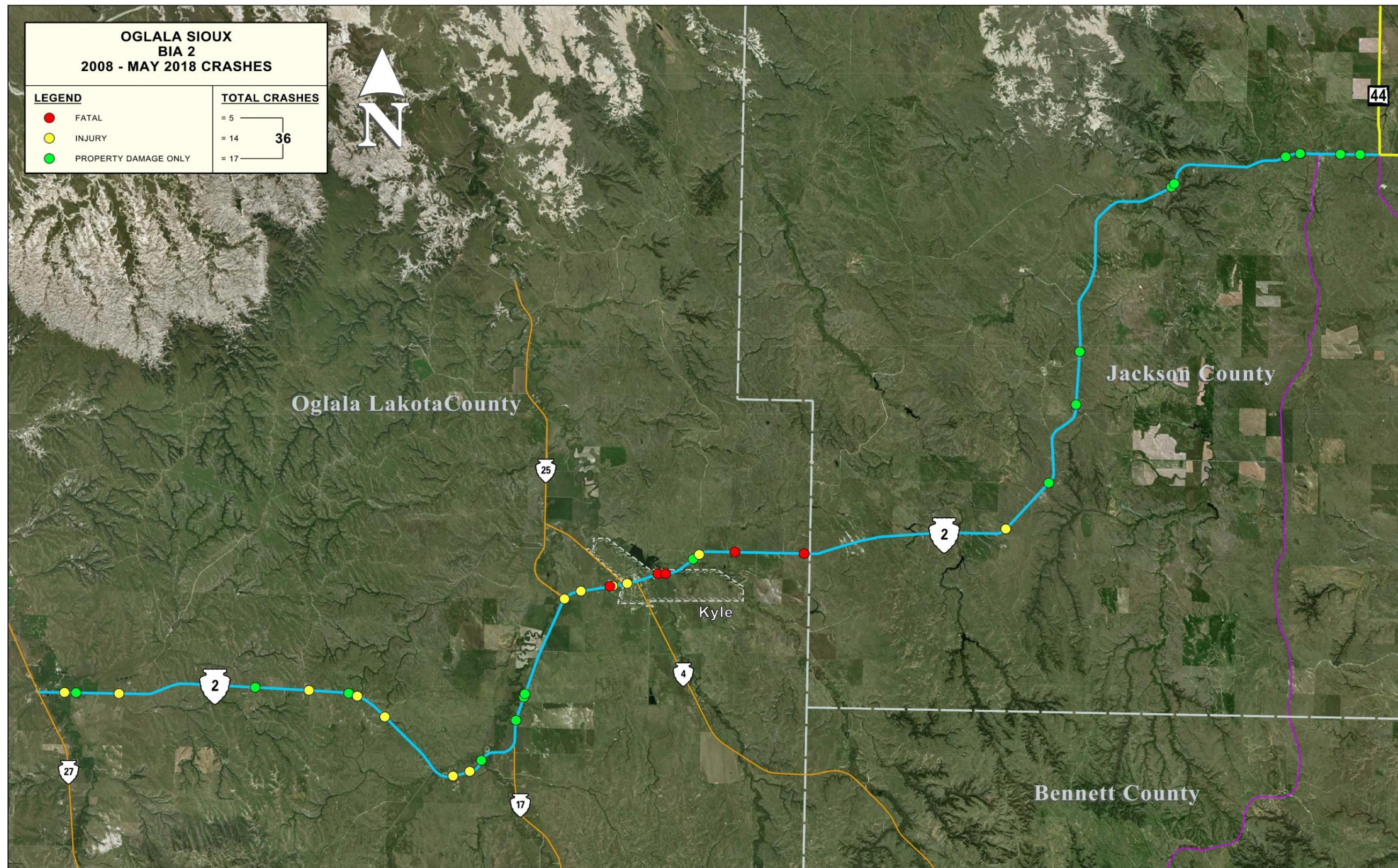
During the studied 10-year time interval, there were a reported five fatalities on BIA 2, three of which occurred in close proximity to the tribal community of Kyle. **Figure 4.3** summarizes the different injuries that occurred on BIA 2.

*Figure 4.3: Crash Severity on BIA 2 (2008 – 2017)*



**Key Observation:** Fatal and injury crashes stand out due to their impact on lives. A total of 19 of the 36 reported crashes or 53% resulted in fatal or injury crashes. Countermeasures discussed later in this report can help to greatly reduce crash types and severity. **Figure 4.3** shows the locations of the crash severity's that occurred on BIA 2.

Figure 4.4: Crash Severity Location on BIA 2 (2008 – 2017)



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### **Road Surface Conditions**

BIA 2 is a paved route and an ideal driving surface; the conditions of the surface can influence the way motorists drive. The pavement on BIA 2 is showing signs of distress and is nearing the end of its design life for an asphalt roadway. BIA 2 is showing cracking, ruts, heaving and alligator cracking throughout the entire length of the corridor. Other contributing factors such as snow or ice on the roadway can contribute to crashes. Only four of the 36 crashes reported occurred when the road surface had ice/frost or snow/slush on it. One crash was reported as an unknown surface conditions and the remaining 31 crashes occurred on a dry surface.

**Key Observation:** Given that BIA 2 is nearing the design life for an asphalt roadway, a full reconstruct of the roadway should be considered. A milling and overlay typically seen to extend life of the road would build up from a thin asphalt lay and the edges would be tapered causing the road to be further narrowed.

*Figure 4.5: Alligator Cracking on BIA 2*



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## Road Alignment

BIA 2 has tight horizontal curves, excessive vertical curves, and many trees within the roadway clear zone. Additionally, due to the vertical curves and trees within the roadway clear zone, most of the roadway intersections have insufficient sight distance. Over 30% of the reported crashes occurred on curved roadway segments. **Table 4.1** shows the number of reported crashes in relation to the road alignment on BIA 2. It should be noted that 11 of the crashes reported for roadway alignment were designated as wild animal crashes and no roadway alignment information was provided.

Road Alignment	Number of Crashes
Straight-Level	7
Straight-Grade	5
Straight-Crest	2
Curve-Level	5
Curve-Grade	2
Curve-Crest	4
<b>Total</b>	<b>25</b>

*Table 4.1: Road Alignment Related Crashes (2008 – 2017)*

**Key Observation:** Given that over 40% of the crashes occurred on grade roadway segments or when horizontal alignment changed, countermeasures for these conditions should receive priority consideration.

## Light Conditions

There were 19 of 36 crashes that occurred in daylight. The number of crashes that occurred in the dark is significant from the standpoint that efforts to improve nighttime visibility could have a positive impact on reducing nighttime crashes. There were 17 of 36 crashes reported or 47.2% that occurred during non-daylight hours. This indicates that improvements to visibility along curves would be a beneficial crash reduction strategy.

**Key Observation:** An analysis of corridors where there were a higher number of crashes after dark was not conducted. It was assumed that a street lighting project was not applicable for rural corridors. However, recommendations for countermeasures to reduce the potential for after dark crashes or crash severity would be beneficial by the following:

- Proper signing of horizontal curves may reduce nighttime crashes by giving guidance to motorist of the change in the alignment of the roadway.
- Proper delineation along the roadway, used for motorist guidance at night and during adverse weather.
- Install Retro-Reflective Signs
- Center line and shoulder rumble strips alert motorist as they cross the center or edge line of the roadway through creating noise and vibration inside the vehicle. This allows them to take corrective countermeasures to return to the travel lane safely.
- Street lighting project for urban area could be beneficial.

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## 5.0 COUNTERMEASURES

Safety issues along the studied corridor were broken into two segments, urban and rural, due to the distinctive change in roadway features and issues, and were assigned specific countermeasure to address conditions based on the available crash data and field review. Recommended countermeasure includes the following:

Urban Section:

- Install Separated Shared Use Pathway
- Install Sidewalks
- Install Signed, Marked Crosswalks
- Install Pedestrian Rapid Flashing Beacons
- Install Two-Way Left Turn Lane
- Install Four-Way Control at Intersection

Rural Section:

- Install Guardrail
- Install Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Signs
- Install Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Horizontal Alignment
- Add Shoulders and Flatten Side Slopes
- Flatten Crest Vertical Curves
- Remove Fixed Objects from Clear Zone

Safety issues prevalent along the Oglala Sioux BIA 2 Route within the rural and urban roadway include poor road surface condition, poor road cross section, grade or curve issues, sign and pavement marking issues, lack of pedestrian features, poor intersection design and traffic congestion within the community of Kyle. Discretion was used in deciding whether a safety issue should be addressed with countermeasures. Although this Road Safety Audit is only limited to BIA 2 from Kyle to the Junction with SD 44 on the reservation, these countermeasures can be used on other routes where the tribe maybe experiencing similar issues.

Where applicable, Crash Reduction Factors (CRF) were listed for each countermeasure identified. These CRF's were taken from the FHWA's Crash Modification Factors Clearinghouse located at <https://safety.fhwa.dot.gov/tools/crf/resources/>. A CRF is an estimate of the percentage reduction in crashes due to a particular countermeasure. The CRF's give the Oglala Sioux Tribe Transportation staff additional information on the expected benefit of implementing a particular countermeasure. The intent is to support the process used in the RSA and to assist the Oglala Sioux Tribe to prioritize future projects. **Table 5.1** summarizes the CRF's for the recommended countermeasures.

Recommended Urban Countermeasure	CRF (%)
Install Sidewalks	N/A
Install Separated Shared Use Pathway	N/A
Install Marked Crosswalks	15
Install Pedestrian Rapid Flashing Beacons	28
Install Two Way Left Turn Lane	27
Install 4-Way Intersection Control	28
Recommended Rural Countermeasure	CRF (%)
Install Guardrail	26
Install Shoulder Rumble Strips	24
Install Delineators	15
Install Retro-Reflective Signs	18
Install Horizontal Alignment Signs	18
Install Chevrons	18
Improve Horizontal Alignment	50
Add Shoulders and Flatten Side Slopes	43
Flatten Crest Vertical Curves	50
Remove Fixed Objects from the Clear Zone	40

*Table 5.1: Crash Reduction Factors for Recommended Countermeasures*

Guidance for application of these countermeasures is contained in the Manual on Uniform Traffic Control Devices (MUTCD) and American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets. It is strongly recommended that these manuals be consulted and adhered to prior to application of these countermeasures.

## Attached Sidewalks

An attached sidewalk in urban areas is intended to remove pedestrians from the travelled way and reduce or eliminate interaction with vehicles. There may be additional separation provided if on street parking is allowed. Generally, these are used behind a curb and gutter section and may include a buffer area for trees or grass.

## Separated Shared Use Pathway

Shared use paths are facilities that are separated from a roadway and occupy an exclusive right-of-way. Intended users are non-motorized and may include: bicyclists, in-line skaters, roller skaters, wheelchair users (both non-motorized and motorized) and pedestrians, including walkers, runners, people with baby strollers, people walking dogs, etc. These facilities are most commonly designed for two-way travel. An example is shown in **Figure 5.1**.

*Figure 5.1 Separated Pathway*



## Marked Crosswalks

Providing marked crosswalks traditionally has been one measure used in an attempt to facilitate pedestrian crossings. Such crosswalks commonly are used at uncontrolled locations (i.e., sites not controlled by a traffic signal or stop sign) and sometimes at midblock locations. The use of these marked crosswalks such as shown in **Figure 5.2** have been shown to be an effective countermeasure in the reduction of pedestrian injuries and fatalities.

*Figure 5.2 Marked Crosswalk*



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## Pedestrian Rapid Flashing Beacon

Rectangular rapid-flash beacons are devices that are placed on both sides of a crosswalk below the pedestrian crossing sign and above the arrow indication pointing at the crossing, see **Figure 5.3**. These devices should not be used if the crossing is controlled by a YIELD sign, STOP sign or traffic signal. If there is a pedestrian refuge or other type of median, a beacon can be installed in the median rather than the far-side of the roadway. The pedestrian activation can be with pushbuttons or automated through pedestrian detection, and should be unlit when not activated.

*Figure 5.3 Pedestrian Rapid Flashing Beacon*



## Two Way Left Turn Lanes

TWLTs have been used to reduce rear-end, head-on, and turning-related crashes occurring on two-lane roads. An example of a TWLTL is shown in **Figure 5.4**. This strategy may reduce turning-related crashes because vehicles are removed from the primary travel lane while drivers wait for an acceptable gap to turn. TWLTs may also reduce head-on collisions by providing a buffer between opposing directions of travel, as discussed in the National Cooperative Highway Research Program's *NCHRP Report 500 Volume 4: A Guide for Addressing Head-On Collisions*.<sup>(4)</sup> The NCHRP guide concludes that this strategy cannot be considered a proven strategy because there were no valid estimates of the effectiveness of such conversions based on pertinent before-after studies for two-lane roads.

*Figure 5.4 Two Way Left Turn Lane*



## Four Way Stop

Four way stop controlled intersections are those that require all entering traffic to come to a stop and take turns entering the intersection. While these are not ideal and can lead to some increased congestion, they have been shown reduce more serious injury and fatal crashes from right angle crashes. The intersection of BIA 2/BIA 4/School approach is currently a two way stop.

## Guardrail

Guardrail is a safety barrier that is intended to prevent vehicles leaving the roadway in areas that have objects inside of the clear zone that cannot be removed, steep embankments or side slopes. Given the high cost of guardrail, significant discretion was used in selecting the locations where the greatest need appeared to exist. Decisions regarding the extent and type of guardrail to serve the needs of given location will need to be addressed as projects are programmed for implementation. **Figure 5.5** shows an example of guardrail used on the roadway that has steep side slopes.

*Figure 5.5: Guardrail Installed for Steep Side Slopes*



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## Shoulder Rumble Strips

Shoulder rumble strips are placed on shoulders near the lane edge to warn drivers that they are entering a part of the roadway not intended for routine traffic use. They are an effective countermeasure for reducing roadway departure crashes. Rumble strips are used on highspeed rural roads with adequate shoulder width. **Figure 5.6** shows an example of shoulder rumble strips.

*Figure 5.6: Shoulder Rumble Strips*



## Delineators

Proper delineation along the roadway is used for motorist guidance at night and during adverse weather. Delineators are also beneficial at locations where roadway alignment changes and are considered as guidance devices rather than warning devices. They come in various sizes and designs to address varying applications. Delineators are typically used on rural roadways with no street lighting and marking approaches. **Figure 5.7** shows various examples of delineators.

*Figure 5.7: Roadside Delineators Example*



## Retroreflective Signs

Traffic signs provide valuable information to motorists. For these signs to be effective, traffic sign visibility must be maintained during daytime and nighttime conditions. The reflective sheeting used on traffic signs allows better visibility for motorists at nighttime. Many of the signs on the routes are deteriorated and have little to no reflectivity. It is recommended that signs be replaced every five to ten years to maintain proper reflective sheeting. Current practices use Type IV reflective sheeting or XI high intensity reflective sheeting for signs. Fluorescent yellow type XI high intensity reflective sheeting should be used for horizontal alignment warning signs. Fluorescent yellow green type XI high intensity reflective sheeting should be used for traffic signs used for school areas. **Figure 5.8** shows examples of the different types of reflective sheeting for traffic signs.

*Figure 5.5: Different Types of Reflective Sheeting for Traffic Signs*



Type IV Reflective Sheeting



Type XI Fluorescent Yellow Reflective Sheeting



Type XI Fluorescent Yellow Green Reflective Sheeting

## Horizontal Alignment Signs

Advance horizontal alignment signs provide a warning to motorists of the presence of a curve ahead and of the need to possibly slow down to safely navigate a curve. If the difference of the speed to safely navigate a curve differs by 10 miles per hour or greater from the posted speed limit on the roadway, a supplemental advisory speed plaque is required to alert motorists to slow down. The advisory speed is determined by an engineering study that follows established engineering practices. Traditionally a ball-bank indicator is used to establish an advisory speed and should be determined based on free-flowing traffic conditions. In some locations on BIA 2, the horizontal alignment signs and advisory speed plaques were missing or deteriorated. **Figure 5.9** shows an example of the use of a horizontal alignment sign with a supplemental advisory speed plaque.

*Figure 5.9: Horizontal Alignment Sign with Supplemental Advisory Speed Plaque*



## Chevrons

A chevron is a type of horizontal alignment warning sign used instead of or in addition to standard delineators to highlight the presence of a change in the roadway alignment. In some locations on BIA 2 chevrons were not installed, missing or the spacing between the signs were not consistent. The MUTCD provides guidance for the placement of chevrons and spacing requirements depending on the radius of the curve.

## Improve Horizontal Alignment

Reconstructing and flattening of sharp curves like the one shown in **Figure 5.10**, can help to reduce the number of vehicles that errantly leave the road often leading to severe crashes. Guidance for curve radius and super elevation can be found in the American Association of State highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets.

*Figure 5.10: Sharp Horizontal Curve*



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## Add Shoulders and Flatten Side Slopes

Many older two lane roadways were constructed with little to no shoulder width and slopes that were extremely steep causing vehicles to roll over if they leave the roadway. As design standards have advanced, they now require wider paved surfaces and flattened slopes for safety reasons. Guidance on minimum widths and slopes can be found in the American Association of State highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets and the AASHTO Roadside Design Guide.

## Flatten Crest Vertical Curves

Reconstructing and flattening sharp crest vertical curves that do not allow for adequate stopping sight distance have been shown to have significant positive impact on crashes. For rural two lane roadways like the location shown in **Figure 5.11**, injuries and fatalities have shown to be reduced by 50%.

*Figure 5.11 Sharp Crest Vertical Curve*



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## Remove Fixed Objects from the Clear Zone

Fixed objects such as tree, utility poles, mailboxes and rocks, such as shown in **Figure 5.12**, that are within the designated clear zone near the roadway have been found to be a significant cause of crashes, particularly injuries and fatalities in rural areas. Removal of these hazards can significantly reduce crashes and severity. Information on clear zone limits and calculation can be found in the AASHTO Roadside Design Guide.

*Figure 5.12 Example Fixed Object*



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## 6.0 RECOMMENDED IMPROVEMENTS

BIA 2 is a major east west route for the Oglala Sioux Tribe that connects BIA Routes 27, 25 and 17 to South Dakota Highway 44. These connections are vital for the community of Kyle to gain access to health services, jobs and access to I-90, Rapid City and Pine Ridge. The Road Safety Audit looked at improvements within the Kyle community and on BIA 2 as it travels east to connect to SD 44. This was due to recent improvements to other segments of the roadway and the higher crash severity in these locations.

### Urban Improvements within Kyle:

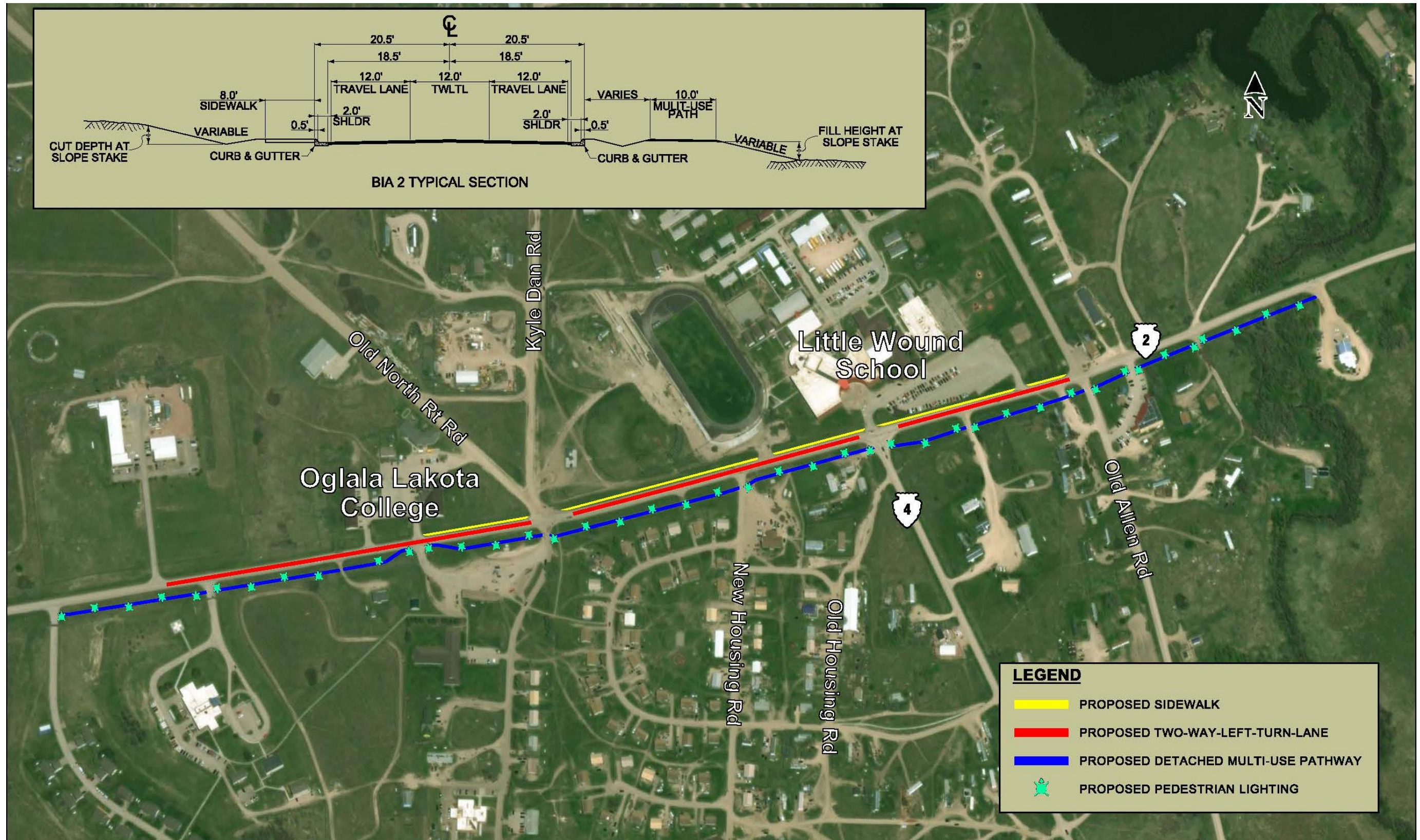
Three of the 5 fatal crashes occurred within the community of Kyle, as well as, two of the injury crashes. While pedestrian crashes were not identified in the data that was available from the South Dakota Department of Public Safety, anecdotal information and discussions with Tribal Police indicated that there is a concern with movement of pedestrians and vehicles within Kyle. Due to the crash history, observations on site and input from local law enforcement, the recommended improvements for this section of BIA 2 route include the following:

- Install Separated Shared Use Pathway
- Install Sidewalks
- Install Signed, Marked Crosswalks
- Install Pedestrian Rapid Flashing Beacons
- Install Two-Way Left Turn Lane
- Install Four-Way Control at Intersection

With the high vehicle traffic in the area and the presence of two schools, grocery store, gas station, convenience store, health clinic, tribal housing and other traffic generators there is significant conflict between through vehicles, turning vehicles, vehicles accessing BIA 2 and pedestrians. The first recommendation was to alleviate the interaction between turning vehicles. It was determined that the best approach to doing this was to change the cross section of the roadway from a rural 2 lane road to an urban section with a two-way left turn lane, curb and gutter and sidewalks. This section is recommended from the health clinic on the west end of town up to the intersection with Old Allen Road as seen in **Figure 6.1**.

With the two schools, housing, commercial and health facilities that all generate considerable pedestrian traffic the need for improved pedestrian facilities clearly exist. As part of the overall improvements in Kyle it is recommended that a 10' wide separated shared use pathway be installed on the south side of the route from the Hospital Housing on the west end of town to the Grocery Store on the east end. With little to no roadway lighting in the area and to improve safety and security of those using the pathway, pedestrian lighting should also be installed along the pathway. The pathway is recommended on the south side of the road due to the relatively large amount of space that exists there and as not to impact college or school land and facilities. With both the College and the Little Wound School being located on the north side of BIA 2, within the urban section it is recommended that an 8' sidewalk be included to connect these facilities. These recommendations can also be seen in **Figure 6.1**.

Figure 6.1 Overall Improvements in Kyle



To provide a safe crossing from the Oglala Lakota College across BIA 2 to access the separated pathway and commercial facilities a signed and marked crosswalk is recommended as shown in **Figure 6.2**. Since this crossing would occur at the approaches to the College and the Gas Station that does not require BIA 2 traffic to stop, the addition of pedestrian activated rapid flashing beacons should also be installed. This would also enhance the safety by allowing drivers in the through lanes who may have visibility of the full crosswalk blocked by vehicles in the two-way left turn lane to be given a visible warning that pedestrians are using the crosswalk.

*Figure 6.2 Crosswalk at Oglala Lakota College*

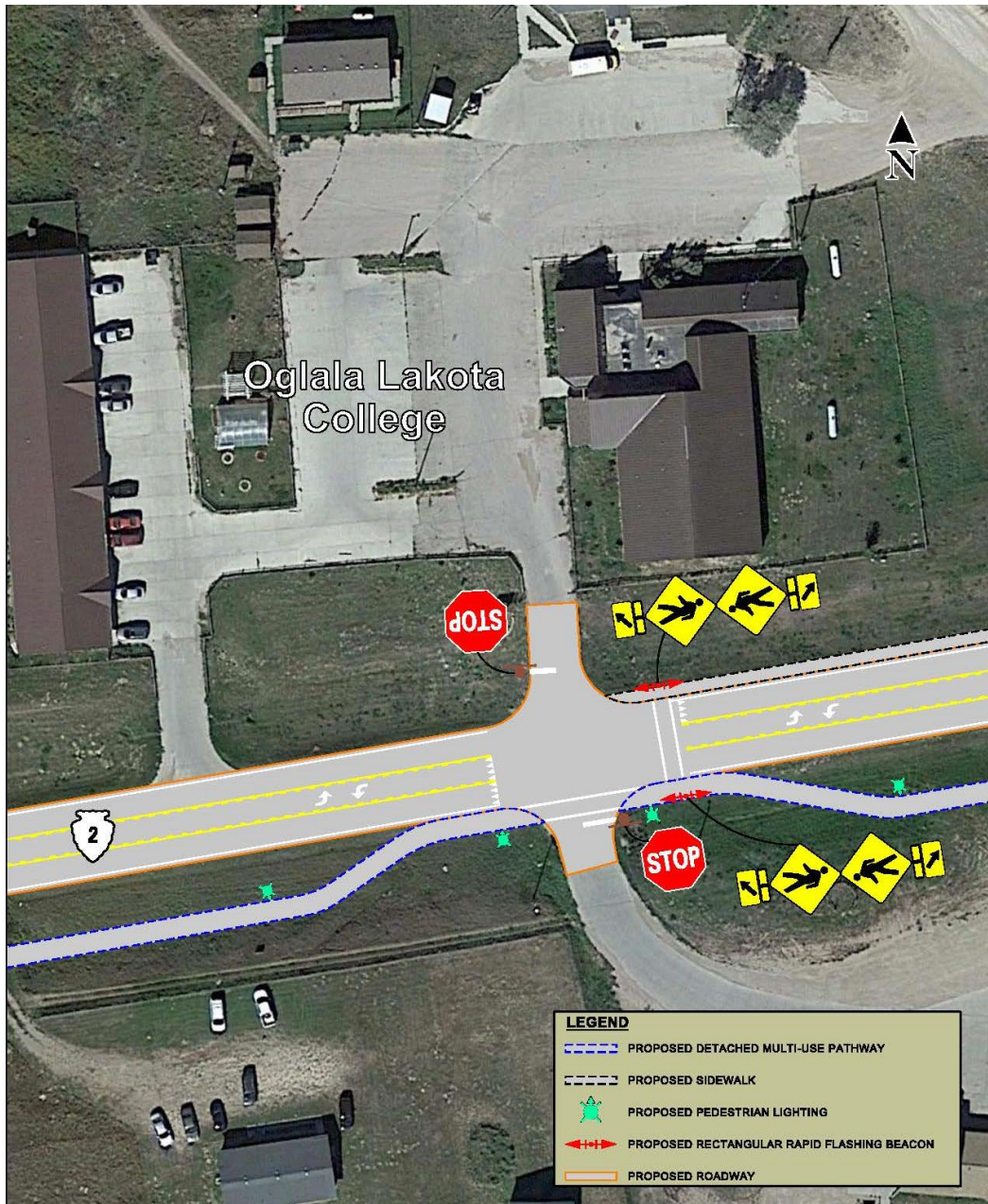
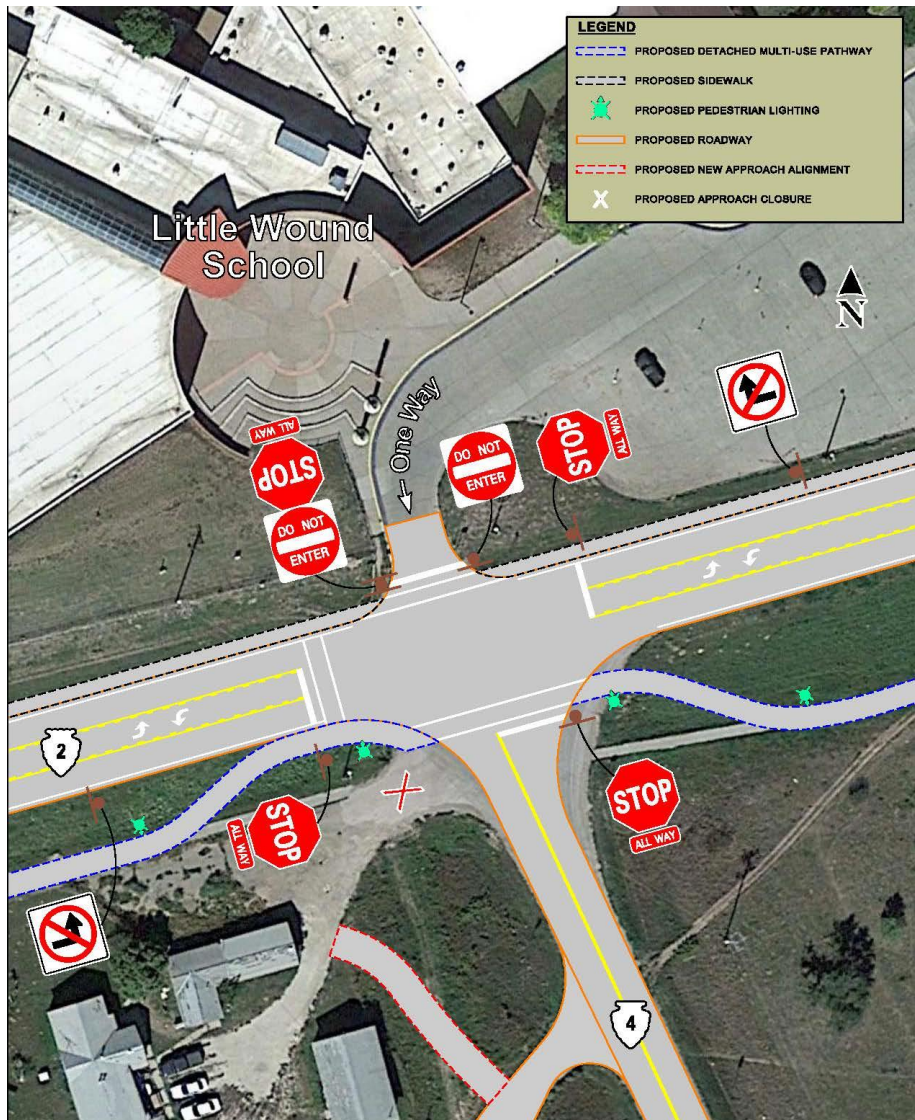
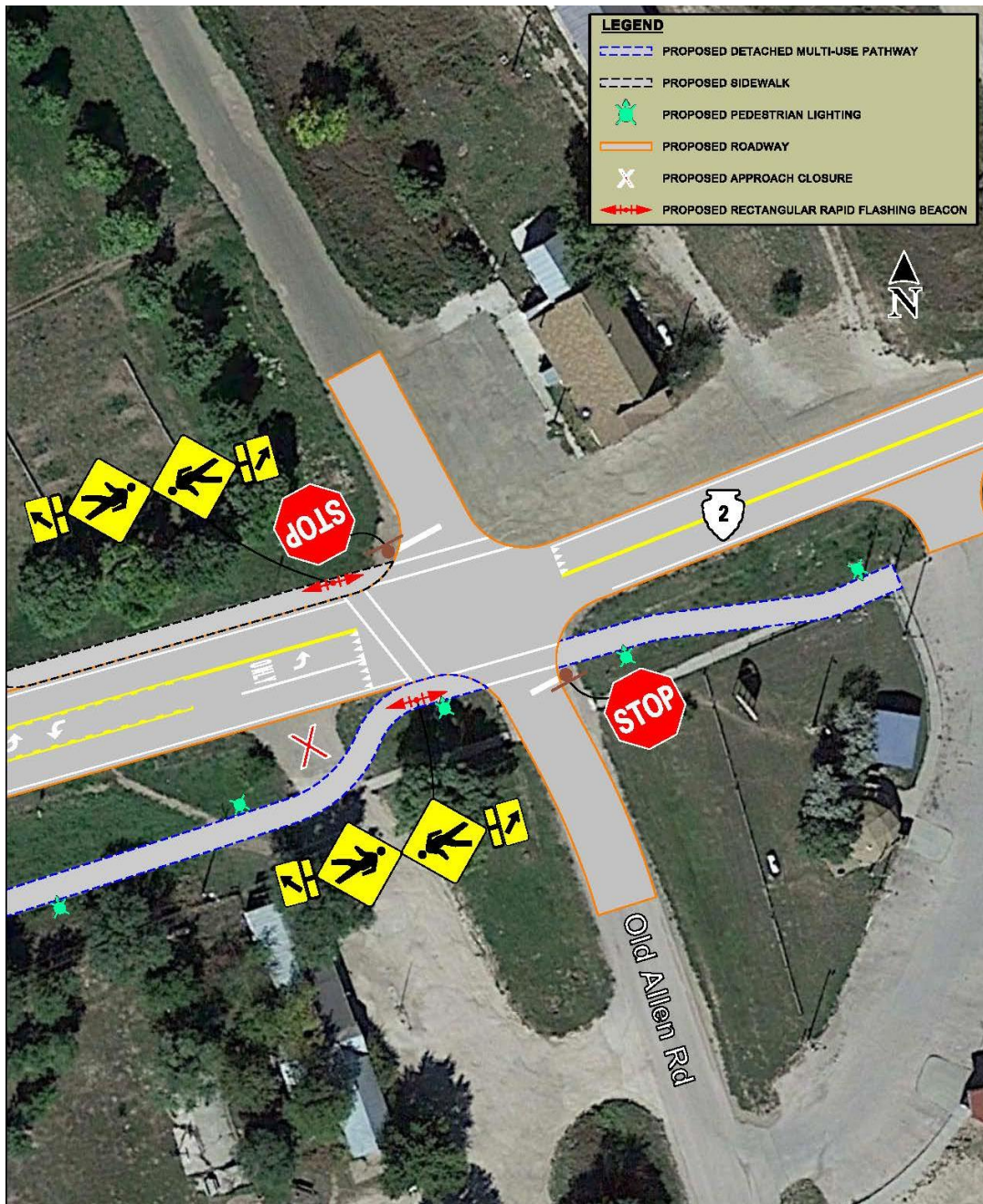


Figure 6.3 BIA 2 Intersection with Little Wound School and BIA 4



The existing intersection of BIA 2 with BIA 4 and the Little Wound School is a two way stop controlled intersection. With the amount of traffic from the school at release times and to improve pedestrian safety in the area, it is recommended that the intersection be changed to a four way stop and marked crosswalks added to the intersection as shown in **Figure 6.3**. There is also an existing private approach onto BIA 4 that is in the immediate proximity of the intersection. This approach should be closed and re-routed further up the leg of BIA 4. This will be especially important with the installation of a shared use pathway in the area.

Figure 6.4 BIA 2 Intersection with Old Allen Road



The existing intersection of BIA 2 with Old Allen Road was also identified as deficient. It is recommended that the approaches be reconstructed to better line up the intersection. Currently there is an off-set from the two approaches to the road. With the BIA 2 Traffic not being required to stop at the intersection it is recommended that marked pedestrian crossings with rapid flashing beacons be installed at this location as well. There is an approach on to BIA 2 just west of the intersection that should also be closed and access provided off of Old Allen Road. These recommendations can be seen in **Figure 6.4**.

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## Rural Recommendations:

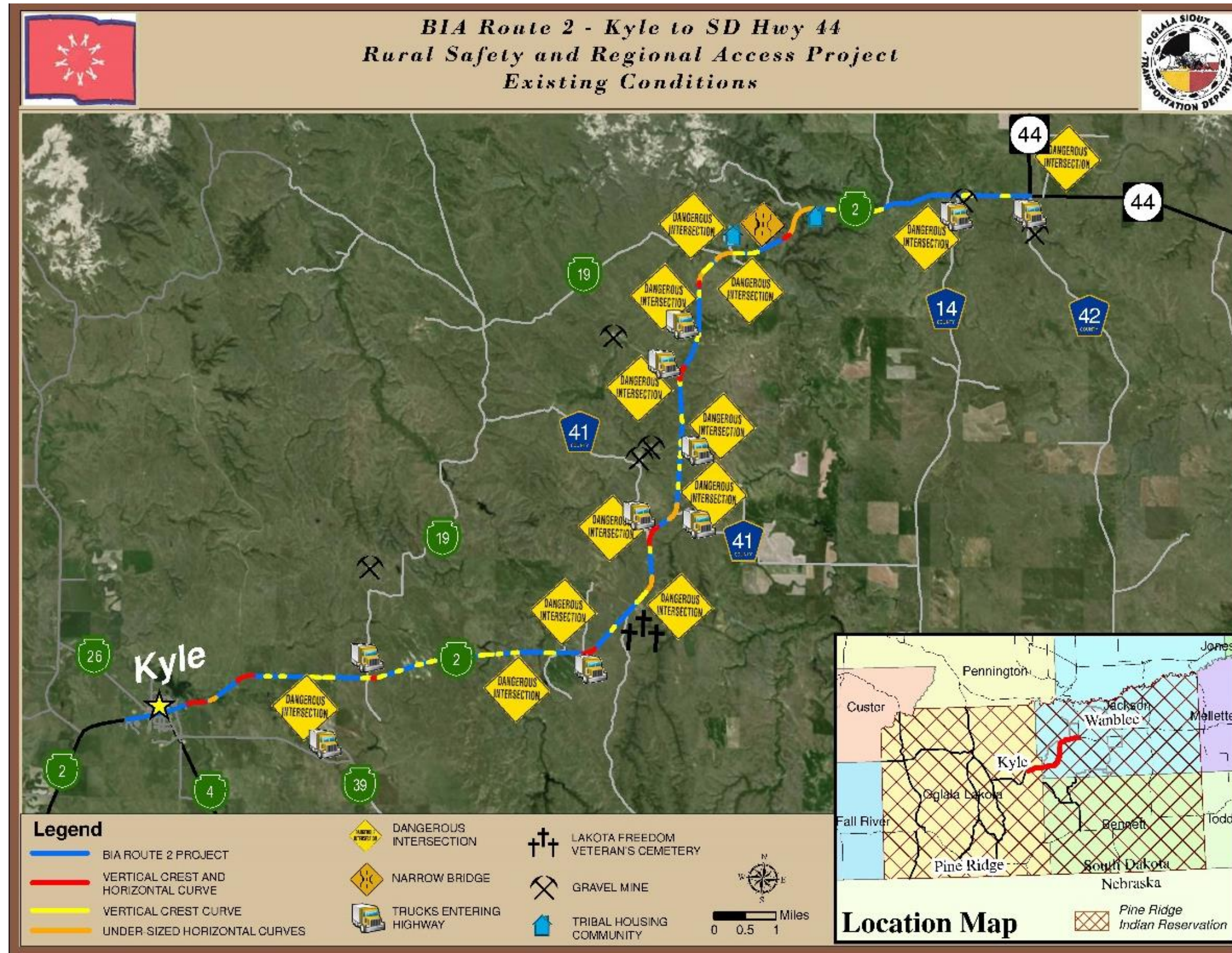
Based on the extent of the alignment issues, continuous narrow road with steep slopes and poor condition of the pavement, it is recommended that the entire route be reconstructed. Below is a more thorough explanation of this conclusion.

Two of the fatalities and one of the injuries identified in the crash data occurred in the rural section of BIA 2 from Kyle to the junction with SD 44. The data also showed some key findings that identify the need to for improvements to address safety. These included:

- The top three crash types were collisions with animals, overturn off road crashes, and fixed object off road crashes.
- The roadway has a high severity rate with a total of 19 of the 36 reported crashes or 53% resulted in fatal or injury crashes.
- Over 40% of the crashes occurred on grade roadway segments or when horizontal alignment changed.

To help to identify the scale of the alignment issues and how it affects intersection sight distance and other safety parameters, locations where vertical and/or horizontal curves were an issue were mapped out. Also included were intersection and locations where trucks could be entering the highway from gravel pits and other locations along the road. These are identified in **Figure 6.5**.

Figure 6.5 Rural Safety Conditions



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Discussions with Tribal Law Enforcement also identified concerns beyond the reported crash data. Both law enforcement and EMT vehicles avoid this section of road if possible due to the narrow, winding character. Based upon the data, input and field review, recommended improvements for the rural section of BIA 2 included the following:

- Install Guardrail
- Install Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Signs
- Install Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Horizontal Alignment
- Add Shoulders and flatten Side Slopes
- Flatten Crest Vertical Curves
- Remove Fixed Objects from Clear Zone

Initially, we looked to see what countermeasures could be installed at specific locations, however due to the narrowness of the roadway and poor condition of the pavement we determined that it was not feasible to install guardrail or rumble strips without widening of the road. Delineators, while they could be installed would be very close to vehicles and would be hit at a high rate and trying to maintain them would be a safety concern. As **Figure 6.5** showed, the nearly continuous alignment issues, as well as the continuous steep slopes and narrow width, makes addressing them a full reconstruction project.

While the signing for the route could be upgraded, it was felt that this in and of itself would be such a minor improvement and not address the significant safety concerns throughout the corridor. So, the RSA team recommends all of these items be included in a reconstruction of the entire rural section.