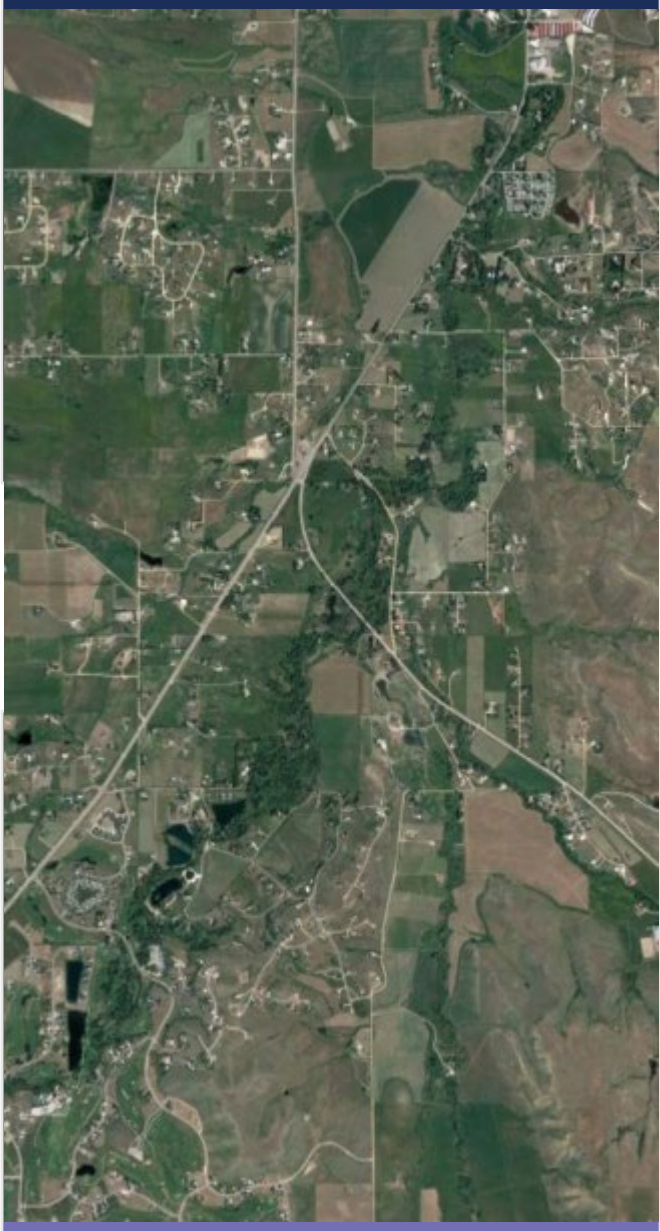
Bighorn Y Intersection Study Report

WYDOT District 4

March 2025



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Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
APE	Area of Potential Effect
AWSC	all-way stop control
EB	eastbound
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
HMVMT	hundred million vehicle miles traveled
HSM	Highway Safety Manual
IHSDM	Interactive Highway Safety Design Model
IPaC	Information for Planning and Consultation
LBS	Location Based Services
LOS	level of service
MPH	miles per hour
MUT	Median U-Turn
MUTCD	Manual on Uniform Traffic Control Devices
NB	northbound
NCHRP	National Cooperative Highway Research Program
NRHP	National Register of Historic Places
RCUT	restricted crossing U-turn
SB	southbound
SHPO	State Historic Preservation Office
SPICE	Safety Performance for Intersection Control Evaluation
TWSC	two-way stop control
TYP.	typical
WB	westbound
WYDOT	Wyoming Department of Transportation

Project Background

The Wyoming Department of Transportation (WYDOT) conducted the Big Horn Y Intersection Traffic Study (study) to identify and evaluate improvements at the intersection of US 87, WY 332, and WY 335, also known as the Big Horn Y intersection. The project (project) and study area are located in Sheridan County, just southwest of Sheridan, Wyoming, as shown in Figures 1 and 2.

Figure 1: Study Area

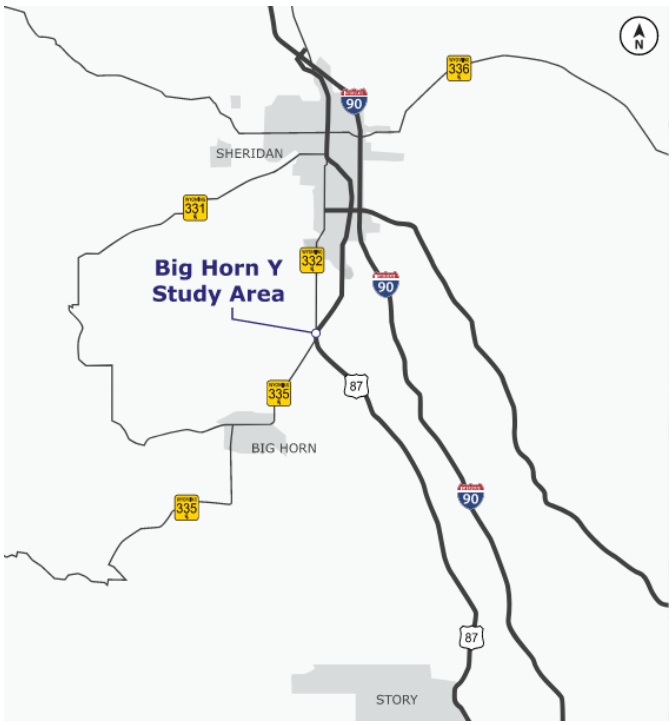
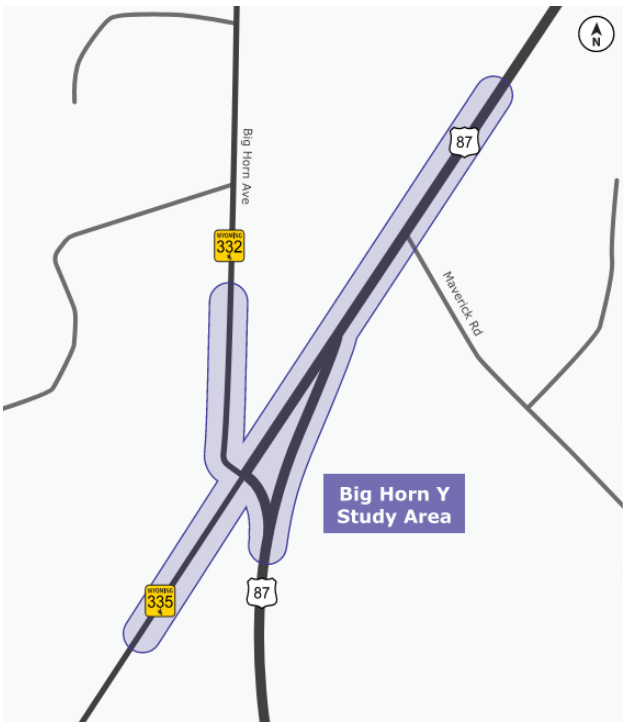


Figure 2: Intersection Study Location



Introduction

The *Big Horn Y Intersection Traffic Study Report* provides an overview of the Big Horn Y Intersection Traffic Study methodology, screening process, public involvement, speed study, and environmental review.

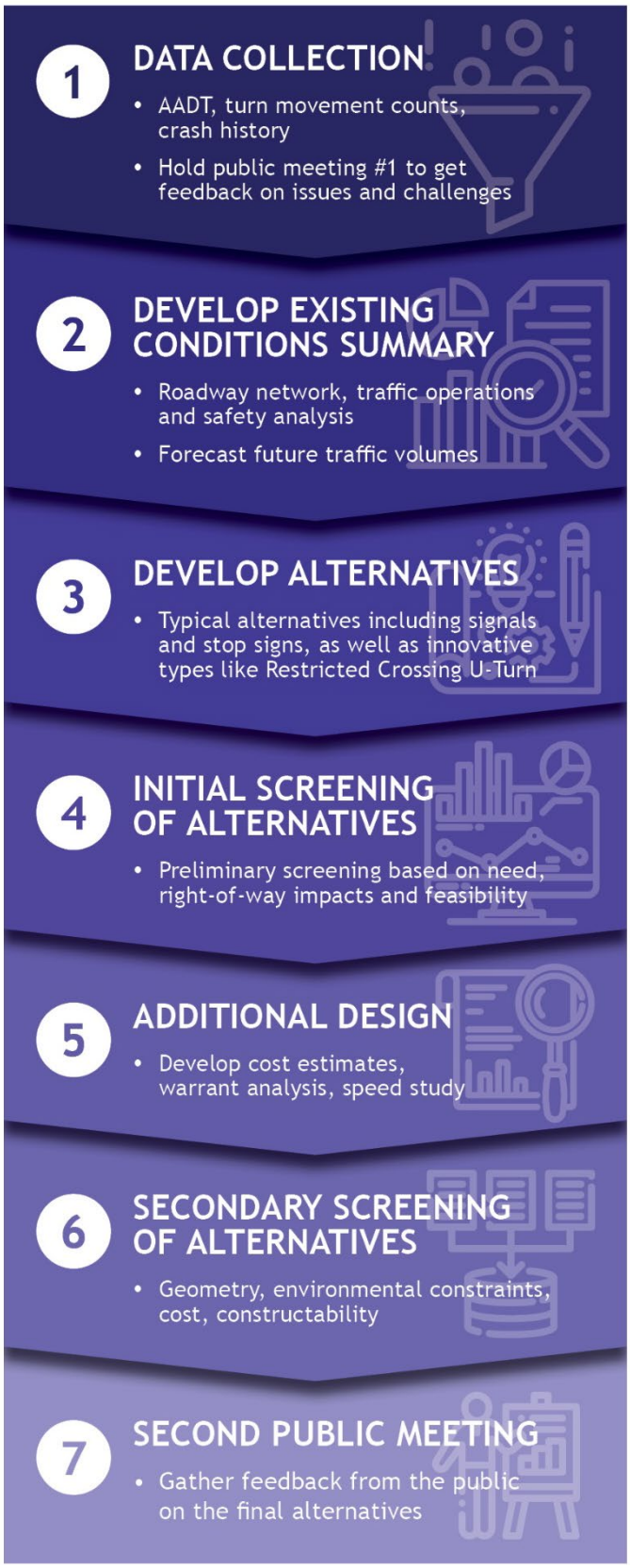
The needs for the project were developed based on data collection, input received through an initial public meeting and previously identified intersection concerns. Generally, the needs focus on the safety and operational issues of the intersection. Public input resulted in concerns at the intersection which include near-miss crashes, failure to yield and yield effectively, speeding, high traffic volumes during peak times, long wait times to enter the highway, difficulty in crossing for pedestrians and cyclists, and difficulty in seeing oncoming traffic.

Planning Process

The study process begins by collecting data to analyze the current conditions and operations of the intersection. For this study data was collected including turn movement counts, crash history, and speeds as well as public input and feedback. The existing traffic volumes collected were used to forecast out what future traffic volumes and operations will be at the intersection in 2045. The existing conditions summary was developed using analysis of the existing roadway network, traffic operations, and safety analysis.

Design alternatives to address the needs were developed and screened to balance public involvement input with data driven solution based on operations and safety. For example, speeding was voiced as a public concern at the intersection, but field collected speed data indicated that most people are generally driving at or under the speed limit, so the primary concern is likely the speed differential between turning movements and through movements at the intersection and the speed differential at the merge point of the intersection.

FHWA recommended policies, tools and screening recommendations were used to evaluate predicted safety impacts for all viable intersection types including roundabouts, traffic signals, in addition to more innovative intersection types including Restricted Crossing U-Turn (RCUT) intersection types. In addition to the safety analysis, preliminary screening of the alternatives considered environmental



and right-of way impacts; traffic volumes were analyzed using traffic software to determine level of service (LOS) and delay.

After initial screening of the alternatives, four were carried forward for additional evaluation and analysis. These included the construction of a roundabout, consideration of lowering the existing speed limit, implementing a traffic signal and installing an all-way stop-controlled intersection. A traffic signal warrant analysis was conducted for the intersection as well as a speed study to determine the appropriate speed limits for the study area. Based on the results from the warrant analysis and speed studies it was determined that neither option was warranted, and these alternatives were screened from further study. Two alternatives were carried forward for preliminary design and cost estimating including a roundabout and an all-way stop-controlled intersection.

These two alternatives, as well as the no-build or do nothing alternative, were then presented to the public for feedback. The second public meeting was available both online and in person. After the public feedback and input was received, a final report summarizing the findings and documenting the recommendations was developed. The roundabout was selected as the preferred alternative because of the safety benefits. Based on the timeline for implementation of the roundabout alternative, an interim concept was developed. This solution may be implemented as a pilot project. It is recommended that the implementation include before and after studies to determine the effectiveness of the short-term solution.

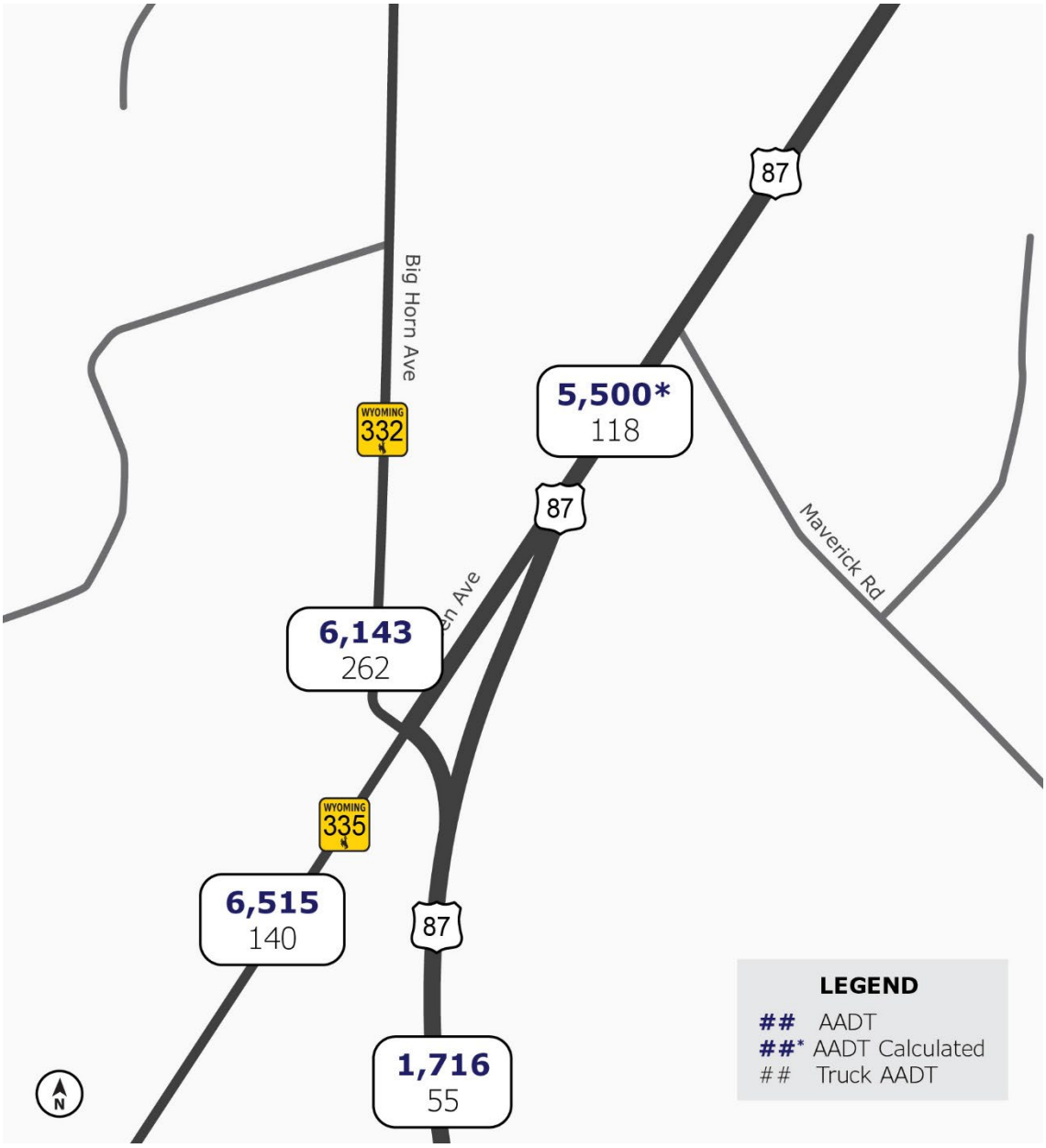
Data Collection

Traffic Volumes

Traffic recording cameras were set up in the field March 12th - 14th, 2024 and April 10th – 11th, 2024 to capture the turn movements for the intersection[1]. In addition to field collected data, historic annual traffic data, collected by WYDOT, was used to develop the Annual Average Daily Traffic (AADT) values[2]. Figure 3 shows the 2023 AADT values.

[1] The second installation of the cameras was completed due to a loss of some data the first time due to sun glare.
[2] *AADTs on some legs were not available, so they were calculated.
https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Planning/VMB/2023VMB.pdf

Figure 3: Existing AADTs



The field cameras were processed to determine individual turn movements for the intersection from 7:00-9:00am and from 3:00-6:00pm. From this collected data it was determined that the peak hours with the highest volume of traffic were from 7-8:00am and from 4:00-5:00pm, Figure 4 shows these peak hour volumes. Figure 5 shows peak hour volumes at the Bighorn Y Gas Station.

Figure 4: AM and PM Peak Hour Volumes in the Study Area

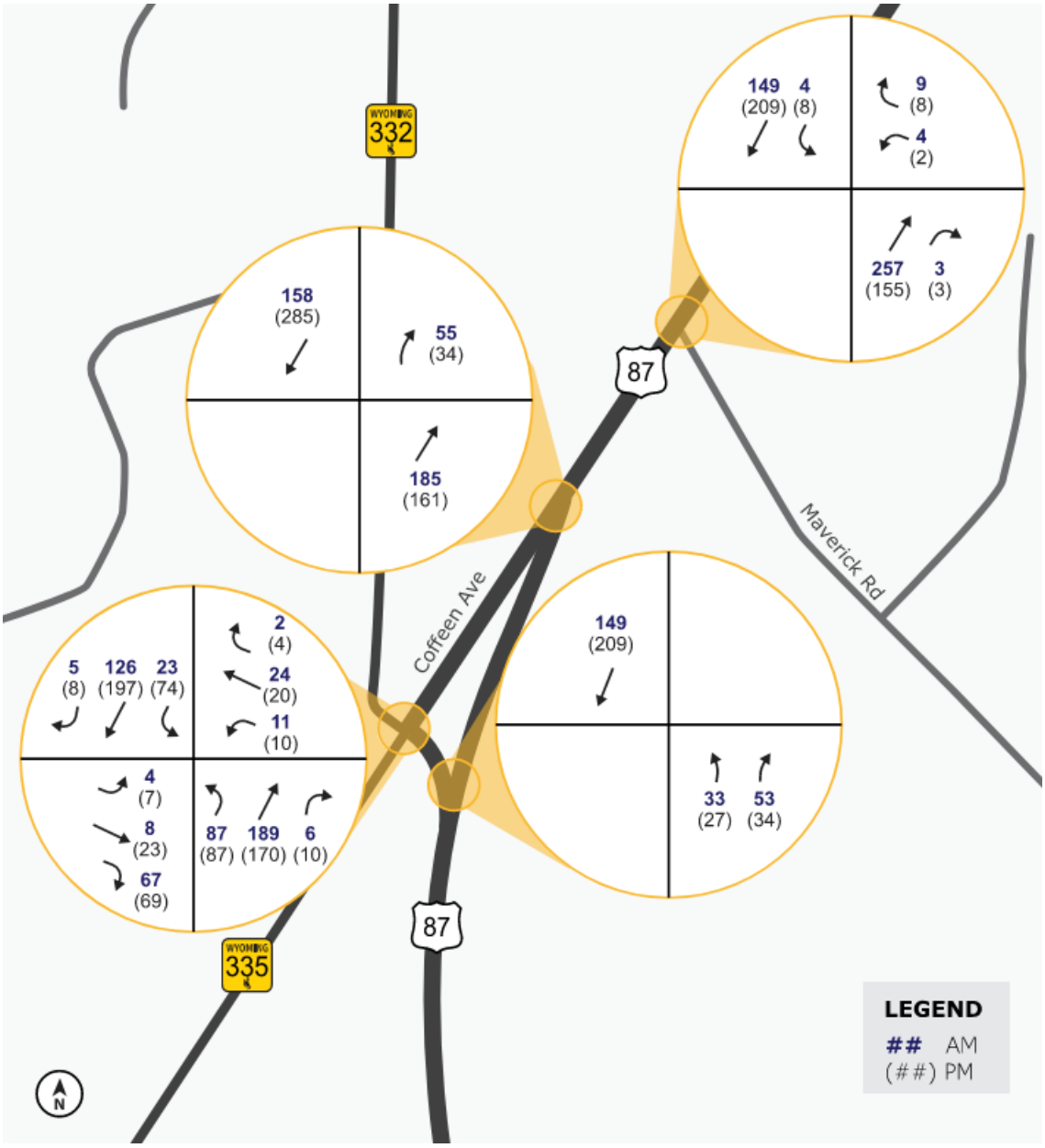
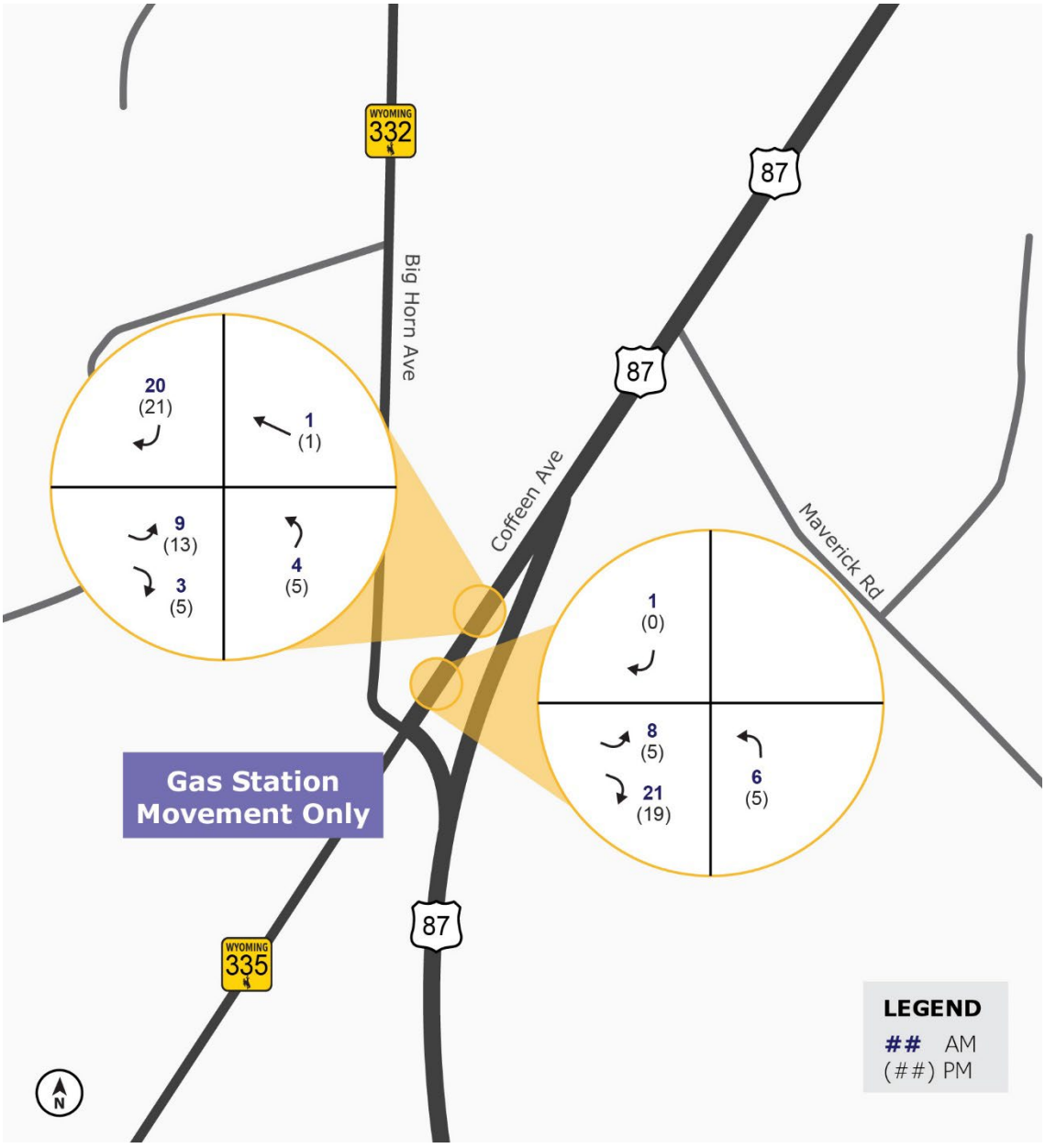


Figure 5: AM and PM Peak Hour Volumes at the Bighorn Y Gas Station



Safety Data Collection

Crash Data

WYDOT provided crash data from 2018 to 2022, including a crash history report detailing pertinent information about each crash at the study intersection and segments. In total, there were 37 crashes in the study area across the analysis period, as shown in Table 1. The crash data collected only reflects crashes for which there are records.

Severity

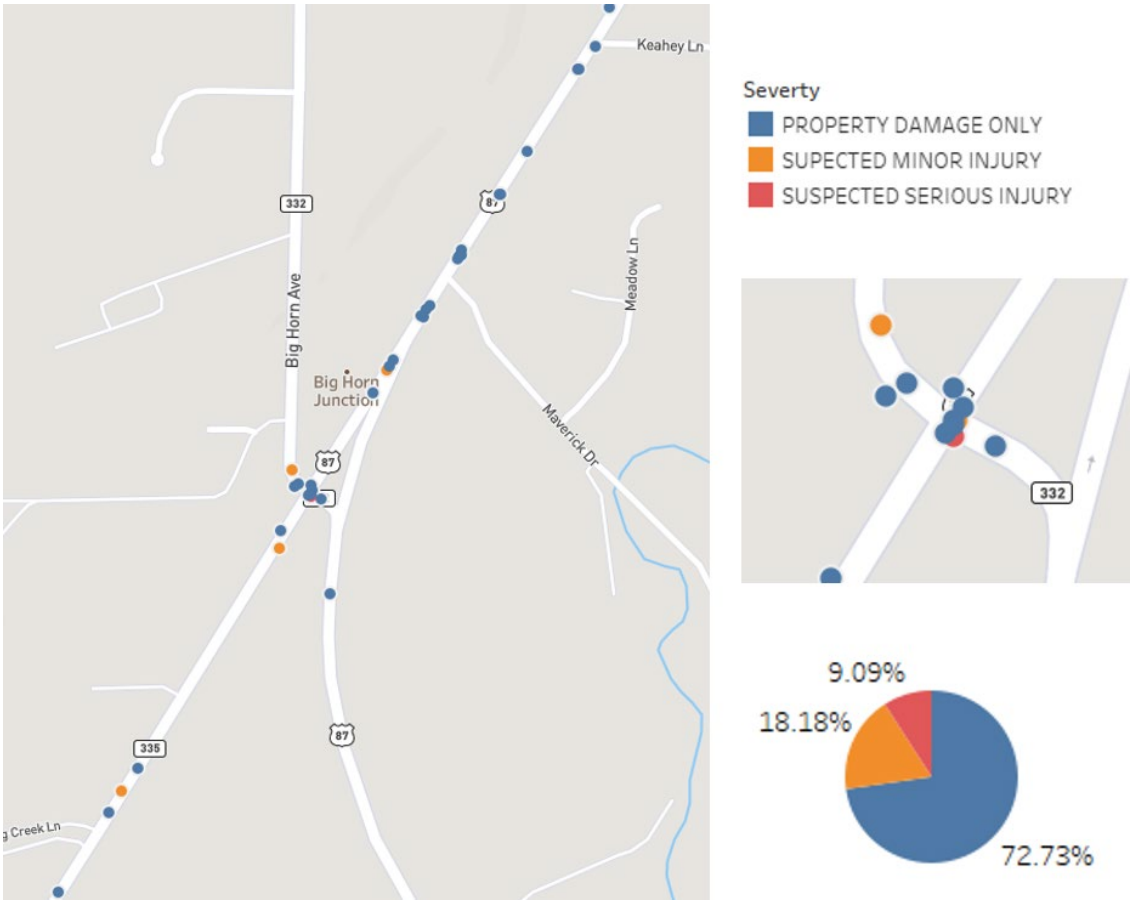
Determining the extent of the severity of crashes informed safety issues relevant for evaluating alternatives. Crash summaries were compiled for the entire study area. Table 1 provides a summary of crash severities by year. Most crashes were property damage only (PDO) crashes, which accounted for 84% of all crashes. Crashes have trended lower in recent years, and there were no statistical outliers of abnormal crash totals or severities for any of the years. Only one suspected serious injury occurred in the timeframe studied at the US 87 and WY 332 intersection. Crash locations and severities are shown in Figure 6.

Table 1: Crash Severity by Year

Severity	2018	2019	2020	2021	2022	2023*	Crash Count
Fatal	0	0	0	0	0	0	0
Suspected Serious Injury	0	0	1	0	0	0	1
Suspected Minor Injury	1	1	1	0	2	0	5
Possible Injury	0	0	0	0	0	1	1
Property Damage Only	5	11	6	5	4	2	33
Total	6	12	8	5	6	3	40

*2023 crash data was collected after the analysis was performed, does not include the entire study area, and is provided for information only.

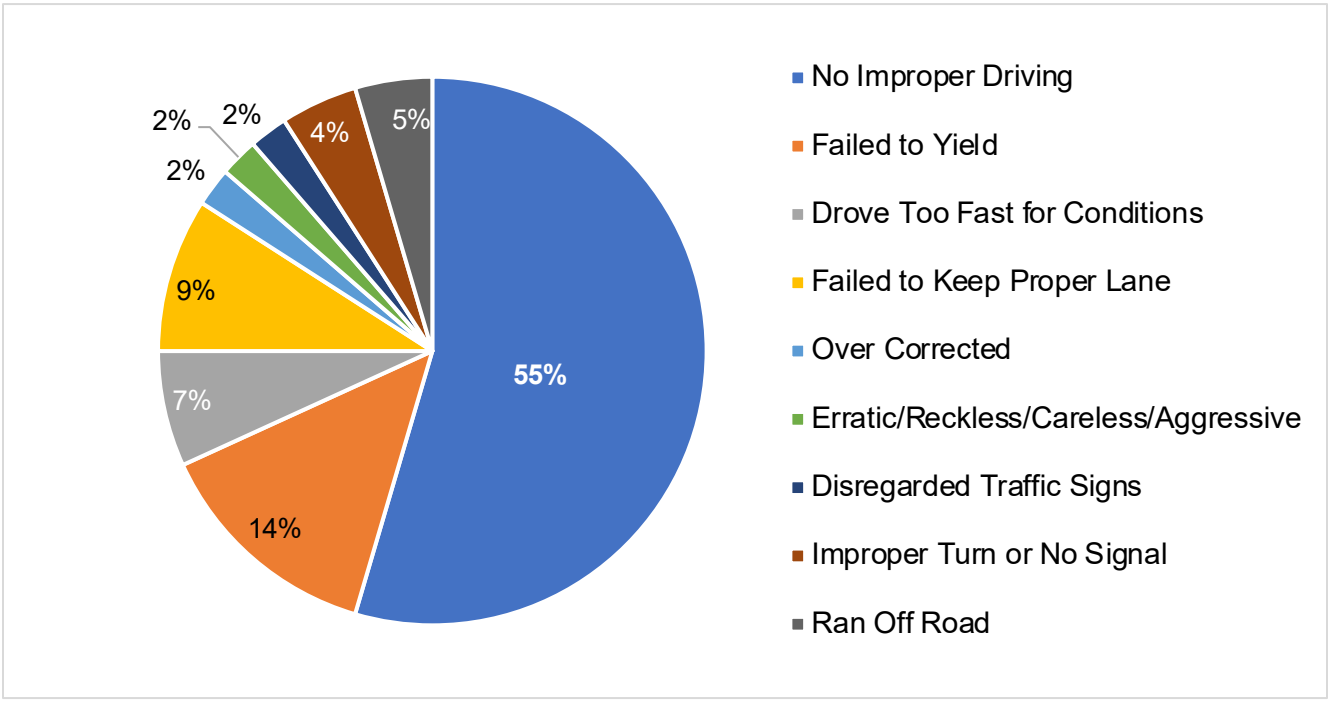
Figure 6: Crash Severity Overview



Driver Behavior

Driver behavior is a contributing factor to crash frequency and severity. The data pertaining to driver-contributing circumstances is summarized in Figure 7. The most prevalent circumstance (55% of the crashes) is that there is no identified improper driving. This indicates that the driver took no improper driving actions at the time of the crash. Failing to yield is the second most prevalent circumstance, contributing to 14% of crashes.

Figure 7: Driver-Contributing Circumstances



The WYDOT Highway Safety Improvement Program (HSIP) 2023 Annual Report[3] provides crash rate data by functional classification of the roadway, which are summarized in Table 2. Crash rates are provided per hundred million vehicle miles traveled (HMVMT). Based on the WYDOT Interactive Transportation System Map, the existing roadway classifications are shown in Figure 8. The westbound and northbound legs are considered Major Collectors, the eastbound leg is considered a Minor Arterial and the southbound leg considered a Principal Arterial[4].

[3] https://highways.dot.gov/sites/fhwa.dot.gov/files/2024-04/HSIP%28Wyoming%29%202023%20Report.pdf
[4] https://apps.wyoroad.info/itsm/index.html

Figure 8: Roadway Classification

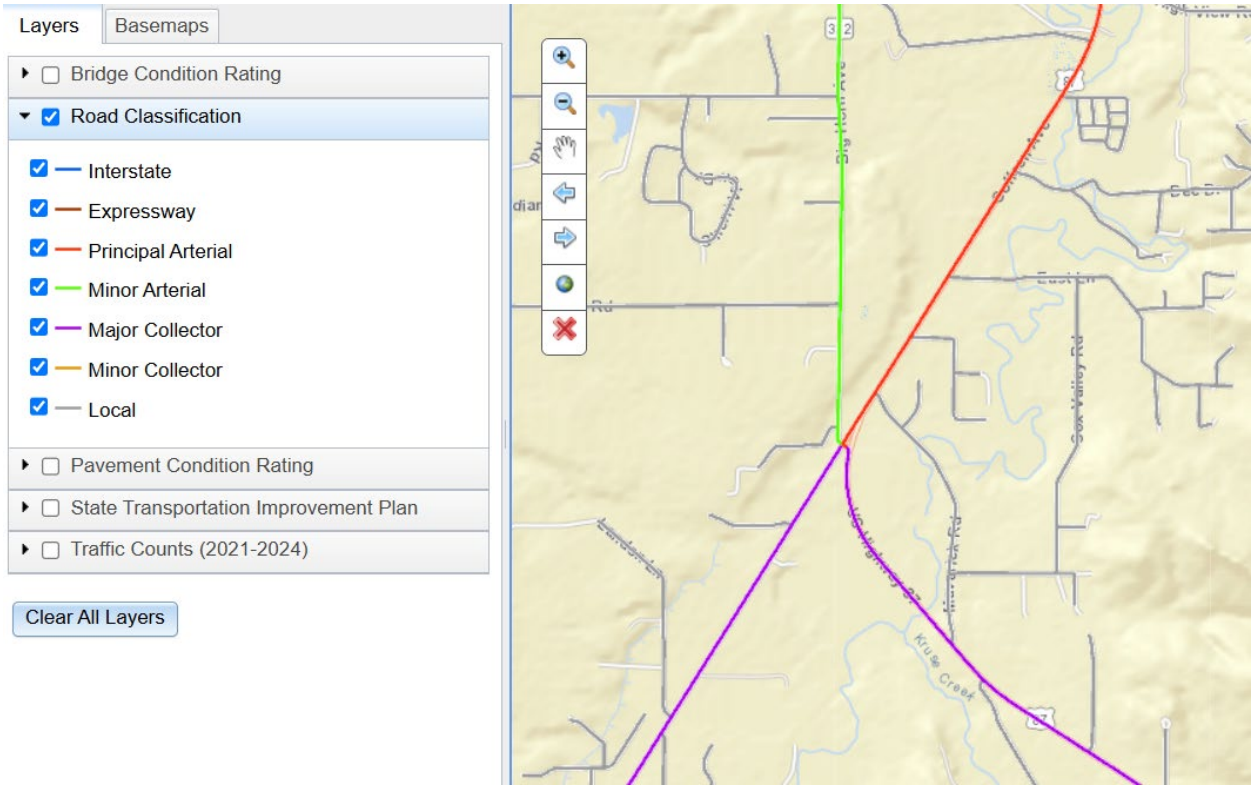


Table 2. Functional Classification and Crash Rates

Functional Classification	Fatality Rate (per HMVMT) (5-year avg)	Serious Injury Rate (per HMVMT) (5-year avg)
Rural Major Collector	2.29	7.13
Rural Minor Arterial	1.59	3.63
Rural Principal Arterial	2.25	5.26

Crash rates for the study area segments were calculated and summarized in Table 3. Each segment has its functional classification, total crash rate, and injury crash rate reported. Each crash rate category is lower than the statewide average or has no crashes to calculate a crash rate. This area does not have a high crash rate of any severity along the segments.

Table 3: Segment Crash Rates

Segment	Functional Classification	Total Crash Rate (HMVMT)	All-Injury Crash Rate (HMVMT)	Serious Injury Crash Rate (HMVMT)	Fatal Crash Rate (HMVMT)
Big Horn Avenue (North Leg)	Rural Minor Arterial	No crashes	No crashes	No crashes	No crashes
US-87 Towards Sheridan (East Leg)	Rural Principal Arterial	4.88	0.26	No crashes	No crashes
US-87 Towards Banner (South Leg)	Rural Major Collector	1.38	No crashes	No crashes	No crashes
WY-335 (West Leg)	Rural Major Collector	2.13	0.71	No crashes	No crashes

Existing Conditions

The existing intersection is two-way stop controlled with a large channelized right turn from US 87 northwest bound. This movement merges onto US 87 northeast bound at the gas station driveway.

Figure 9 labels each leg, as the intersection skew makes the legs different than a traditional intersection. They are as follows:

- The northbound (NB) movement is WY 335, in the southwest area of the intersection.
- The southbound (SB) movement is US 87 in the northeast area of the intersection, also known as Coffeen Avenue.
- The eastbound (EB) movement is WY 332 in the northwest area of the intersection, also known as Big Horn Avenue.
- The westbound (WB) movement is US 87 in the southeast area of the intersection.
- Traffic moving northbound (NB) on US 87 merges with traffic moving northbound (NB) is labeled on the figure as NB 87 merge traffic.

Figure 9: Existing Intersection Movements

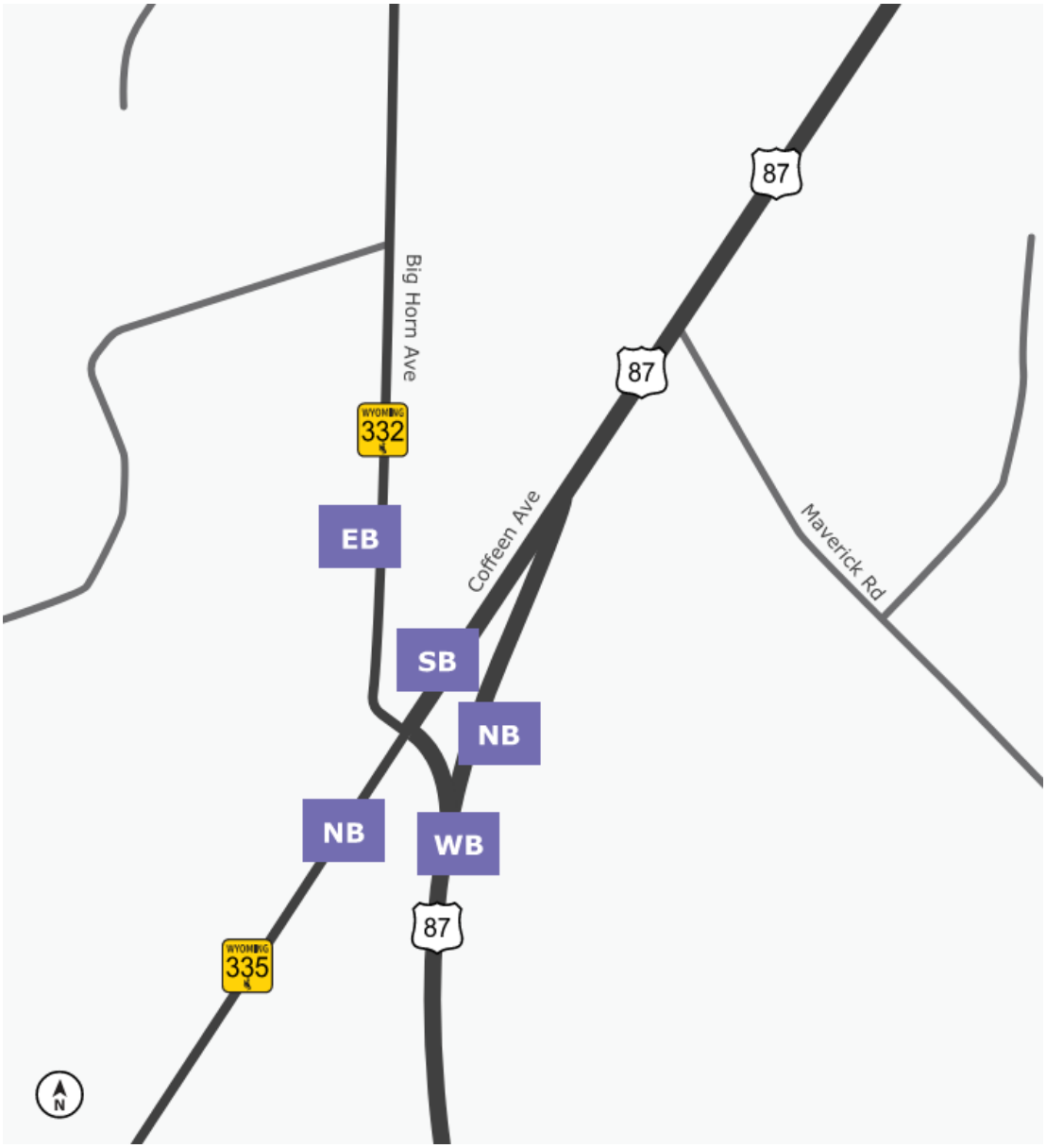


Table 4 summarizes the LOS and delay in seconds for the eastbound and westbound movements, and delay for the overall intersection. Traffic northbound and southbound does not stop at the intersection. Traffic going northbound on US 87 has a yield sign at the merge point with WY 335.

There is no LOS or delay at the northbound and southbound legs, as these movements are not stop controlled and can operate freely. Generally, the intersection operates at a LOS B or C, but the future 2045 PM operations would drop to a LOS D with about 28 seconds of average user delay.

Table 4: Existing/Future No-Build Conditions Operations Results

		Delay (seconds) / LOS				
		EB	NB	SB	WB	Intersection
2023	AM	10.5 / B	-	-	12.0 / B	4.6 / -
	PM	13.7 / B	-	-	14.2 / B	5.1 / -
2045	AM	12.7 / B	-	-	16.9 / C	5.6 / -
	PM	28.6 / D	-	-	28. 7 / D	8.5 / -

Public Involvement

Public involvement was a cornerstone of this study. A Communications Plan guided public engagement for the study. The Communications Plan included a communications strategy with goals and target audiences and engagement tools and tactics, including one online public meeting and a combined in-person and online public meeting.

Outreach Strategy

The outreach strategy was informed by community demographics from Sheridan County to consider the range of likely users for this intersection. The key demographics and their implications for the outreach strategies are shown in Table 5.

Table 5: Demographics and Outreach Studies

Statistic	Implication
11% of households are below the poverty line	Poverty may impact the ability of individuals and families to participate in public engagement opportunities – all efforts will be made to make opportunities available and accessible to all income levels.
87% of households have access to internet	While digital engagement may not be the only tactic used, much of the target audience can be reached online. Tools and tactics to reach the target audiences will use digital and offline methods.
99% of households have at least one vehicle	Assumptions included that most of the input received comes from individuals and families that use vehicular transportation and would, therefore, have pertinent feedback as to the challenges drivers face at this intersection.
94% of residents have a smartphone	All online engagement opportunities will be mobile friendly.
67% of residents have used Facebook in the last 30 days	Social media efforts focused on existing Facebook audiences.

Goals

- Inform stakeholders and the public to create awareness about the purpose and processes used to study intersections and create recommendations.
- Partner with local jurisdictions, elected officials, and key stakeholders to promote project milestones and input opportunities.
- Provide an opportunity for the public to provide input on the current issues and future opportunities to improve the intersection.
- Engage the public and stakeholders and collect meaningful feedback to inform the technical team during the development of the alternatives and final report.
- Transform complex technical data into easy-to-understand comprehensive graphic communication materials for stakeholders and the public participants.

Target Audiences

Residents

Sheridan

Story

Big Horn

Powder Horn Subdivision

WYDOT Planning Program

WYDOT Traffic Program

WYDOT District 4

Frequent travelers through the intersection

Frequent visitors to nearby gas station

SHERIDAN COUNTY WYOMING EST. 1888

U.S. Department of Transportation Federal Highway Administration

Public Meetings

The public involvement efforts included one online public meeting and one hybrid meeting, which combined an online public meeting with an in-person meeting. The full public involvement summary, including all comment content, is in Appendix E. Each online meeting was accessible using a desktop, smartphone, or tablet. The online meetings operated as a click-through presentation with interactive elements, such as survey questions. The in-person meeting took place in the commons area at Big Horn High School and included a presentation, meeting board displays, and handouts. Attendees were also provided printed surveys and comment forms to provide written feedback.

The public meetings were promoted through a variety of means to reach many members of the public, including newspaper advertisements in the Sheridan Press, a public radio interview during the Public Pulse talk show, Facebook posts, and QR code posters in five establishments close to the intersection.

The online meetings were used to collect comments from the public and stakeholders. Online meetings were located at www.US87IntersectionStudy.com. The online meetings were an interactive, self-guided website that allowed users to click through information and answer a series of questions. The online meeting content included instructions on how to navigate the site, an overview of the study and project location, survey questions, and next steps.

Figure 10. Online Meeting Social Media Post

Figure 11: Public Meeting Summary

Online Meeting #1 (April 2024)

The first online meeting launched on April 1, 2024, with a comment period from April 1 through-April 30, 2024. In total, 230 surveys were completed as part of the first online meeting. Figure 12 summarizes the themes of the comments and the number of comments received for each theme.

Figure 12: Online Meeting #1 Analysis

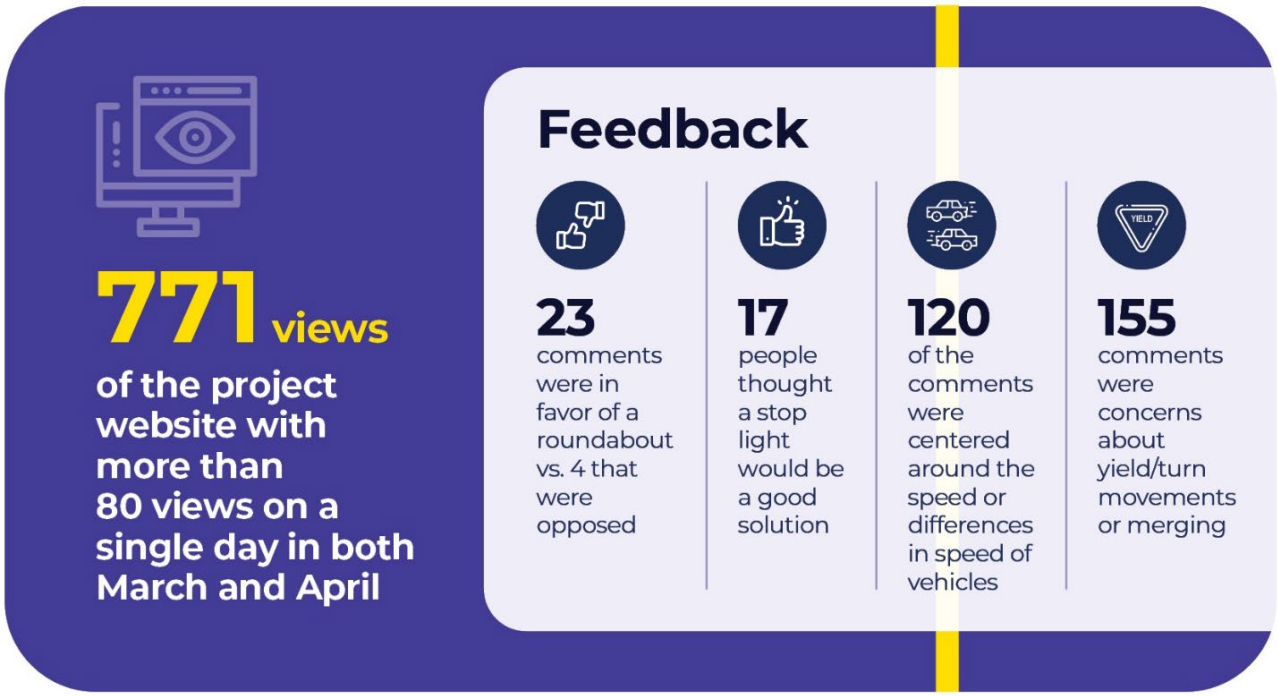
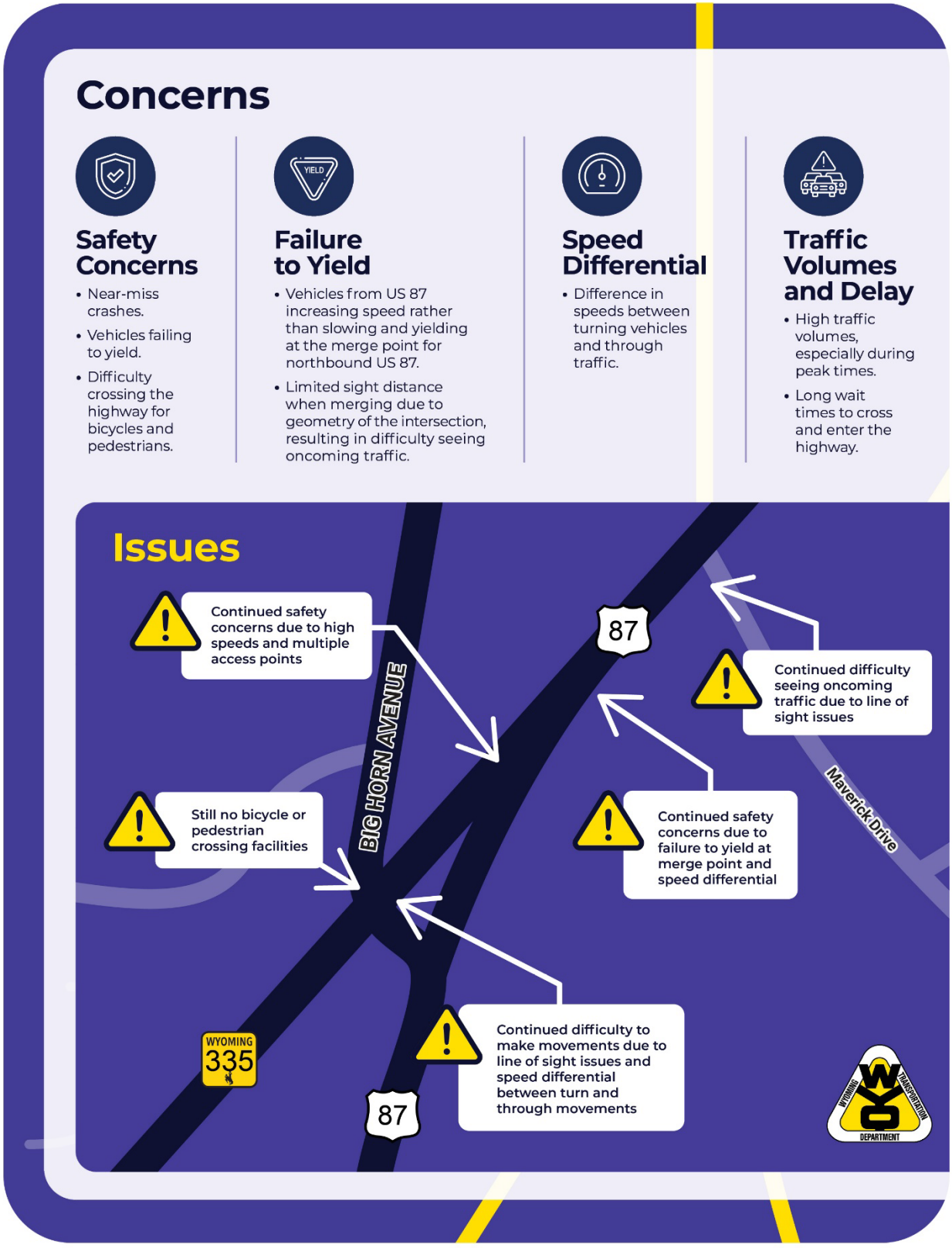


Figure 13: Existing Conditions Concerns and Issues



Traffic Forecasting and Analysis

Traffic Analysis

To forecast traffic volumes in the study area, historical AADT traffic data was compiled based on the WYDOT 2023 Vehicle Miles Book (data for 1970-2023). Annual growth rates over 15-, 20-, and 30-year time periods were reviewed for the roadways serving the Big Horn Y intersection.

Considering the historic growth rates, fluctuations in counts historically, and using best practices, a 2.0% annual growth rate was used to project traffic volumes for all legs of the intersection. This is a conservative estimate with projected volumes on the higher end so alternatives development would result in a preferred alternative that could accommodate potentially higher growth into the future.

The existing conditions (2023) AADTs and future AADTs (2045) are provided in Table 6.

Table 6: Existing and Future Year AADTs

Location (Intersection Leg)	2023 AADT	2045 AADT	% Annual Growth
WY 332 - Big Horn Ave (NW Leg)	6,143	9,500	2.0
US 87 North (NE Leg)	5,550*	8,580	2.0
US 87 South (SE Leg)	1,716	2,650	2.0
WY 335 (SW Leg)	6,515	10,070	2.0

** Estimated AADT*

Safety Analysis

An Intersection Control Evaluation (ICE) approach was utilized to evaluate each of the alternative intersection types. ICE is a data-driven, performance-based framework to screen intersection alternatives and identify optimal solutions[5]. In addition to ICE, FHWA encourages practitioners to use a Safe System approach to enhance intersection safety for all road users, as a result the Safe System Intersection (SSI) evaluation methodology was also used to screen the alternatives.

The safety analysis used the following tools to perform a high-level predictive analysis:

- IHSDM (Interactive Highway Safety Design Model) from FHWA. IHSDM is a predictive model based on the Highway Safety Manual (HSM) and results in a predicted crash frequency.
- SPICE (Safety Performance for Intersection Control Evaluation) from FHWA. SPICE also results in a predicted crash frequency via a spreadsheet, using the HSM and supplemental NCHRP reports.

[5] https://highways.dot.gov/safety/intersection-safety/ice

- National Cooperative Highway Research Program (NCHRP) 17-98 from FHWA. The NCHRP 17-98 uses a conflict point evaluation that results in a safety score from 0-100, with 100 being the safest possible score.

All volumes used in the safety analysis were year 2023 AADT volumes, which the latest available year at the start of the analysis. The results from this analysis were compared and used to determine the predicted safety impacts of the alternatives. A summary of safety analysis results is provided in Appendix A.

The safety analysis revealed that the roundabout and two-way stop-controlled intersection were the highest performing intersections regardless of the analysis method. The roundabout scored the best among all three methodologies while the two-way stop-controlled intersection scored the second best in all three methodologies.

Alternatives Screening

Process

Alternatives were systematically screened in a two-step process from a larger number down to a manageable few. Five alternatives were screened out during the preliminary evaluation process, two more were screened out during the secondary screening process, and 2 designs were carried forward into preliminary design and cost estimating. The alternatives carried forward for a secondary screening were a roundabout and all way stop control intersection as well as a traffic signal warrant analysis and a speed study for the no build alternative.

Preliminary Screening

The preliminary alternatives were evaluated for safety benefits, driver expectancy, and other impacts. The screening matrix in Figure 14 shows the rationale for the evaluation and screening. Full descriptions of the alternatives that were screened out are provided in Appendix B, along with the rationale for why they were screened out.

Preliminary Screening Alternatives (Screened Out)

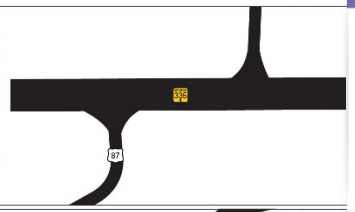
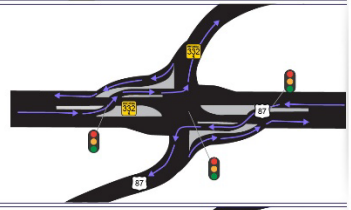
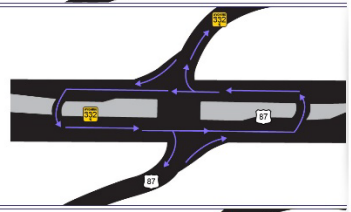
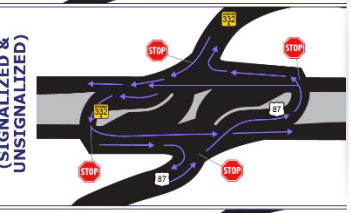
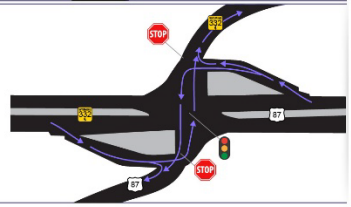
- Offset T
- Displaced Left Turn
- Median U-Turn
- Restricted Crossing U-Turn
- Jughandle

Secondary Screening Alternatives

- Roundabout
- All-Way Stop Control
- Traffic Signal Warrant Analysis
- Lower Speed Limit

Figure 14. Preliminary Screening Matrix

Big Horn Y Screening Alternatives

ALTERNATIVE*	RATINGS	DRIVER EXPECTANCY	SAFETY (PREDICTIVE CRASH PERFORMANCE)**	ENVIRONMENTAL AND RIGHT-OF-WAY	OPERATIONS	DISCUSSION
OFFSET-T (SIGNALIZED & UNSIGNALIZED) 	Driver Expectancy: FAIR Safety: FAIR Environment and Land Usage: POOR Operations: FAIR	FAIR	FAIR	POOR	FAIR	While and offset T intersection is potentially feasible at this location the improvements to safety are minimal and the offset T requires more land acquisition than other alternatives. For these reasons it was not carried forward for further evaluation.
DISPLACED LEFT-TURN 	Driver Expectancy: POOR Safety: GREAT Environment and Land Usage: POOR Operations: FAIR	POOR	GREAT	POOR	FAIR	Displaced left turn intersections provide a significant safety improvement as they reduce the number of conflict points at an intersection and the severity of crashes. However, due to the low traffic volumes, amount of right-of-way required and considering driver expectancy for an intersection of this type in a rural network, this alternative was not carrier forward for further evaluation.
MEDIAN U-TURN (MUT) 	Driver Expectancy: POOR Safety: GREAT Environment and Land Usage: POOR Operations: FAIR	POOR	GREAT	POOR	FAIR	Median U turn intersections provide significant safety improvement as they reduce the number of conflict points at an intersection and the severity of crashes. In particular they have potential to reduce angle and head on crashes. However, due to the low traffic volumes, amount of right-of-way required and considering driver expectancy for an intersection of this type in a rural network, this alternative was not carrier forward for further evaluation.
RESTRICTED CROSSING U-TURN (RCUT) (SIGNALIZED & UNSIGNALIZED) 	Driver Expectancy: POOR Safety: GREAT Environment and Land Usage: POOR Operations: FAIR	POOR	GREAT	POOR	FAIR	Restricted crossing U turn intersections provide significant safety improvement as they reduce the number of conflict points at an intersection and the severity of crashes. In particular they have potential to reduce angle and head on crashes. However, they require a large footprint and the addition of median islands to allow for turning maneuvers. Due to the low traffic volumes, amount of right-of-way required and considering driver expectancy for an intersection of this type in a rural network, this alternative was not carrier forward for further evaluation.
JUGHANDLE 	Driver Expectancy: POOR Safety: GOOD Environment and Land Usage: POOR Operations: FAIR	POOR	GOOD	POOR	FAIR	While providing similar safety improvements as mentioned above, the jug handle intersection requires a large amount of right-of-way and has potential for significant impacts to the business and residents surrounding the intersection. Due to the low traffic volumes, amount of right-of-way required and considering driver expectancy for an intersection of this type in a rural network, this alternative was not carrier forward for further evaluation.

*All movements as expected unless noted.

Secondary Screening

A traffic signal warrant analysis and speed study were conducted after preliminary screening. Traffic signal warrants were not met and ultimately the signalized alternative was dismissed from further consideration. A speed study was conducted during this step. It was determined that most drivers are traveling at or below the posted speed limit at this location and a speed reduction is not warranted. Preliminary design and cost estimates were developed for the all-way stop control and roundabout alternatives. Based on feedback at the public meeting, a solution that could be implemented as a pilot project in the short term prior to the implementation of the preferred alternative was developed.

The following sections provide a summary of preliminary design and layout, traffic operations results, the warrant analysis, and speed study.

Roundabout Alternative

The Roundabout Alternative would remove the US 87 channelized right-turn lane and convert the intersection control to a one-lane roundabout. This roundabout would eliminate the need for all-way stop conditions and would improve traffic flow. Roundabouts have been shown to significantly reduce the number of conflict points while also reducing the severity of those conflicts. Because of the intersection angles, head-on or nearly head-on crashes are eliminated. Figure 15 depicts the layout.

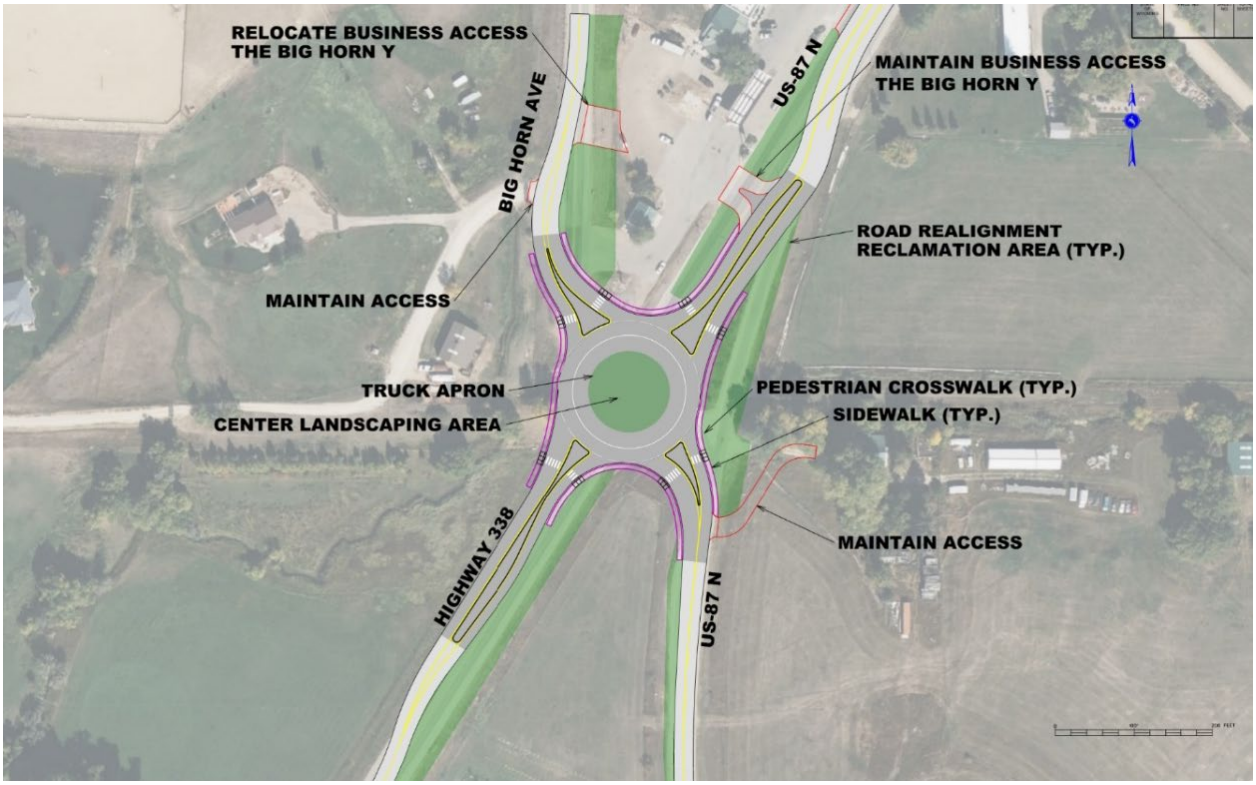
The following design is preliminary and for study purposes only, the final design may differ from the preliminary as additional survey and other data are collected. Like the four-way intersection alternatives, the approach legs would be rotated clockwise from the existing roadway to minimize impacts on landowners and utilize existing right-of-way. The roundabout would maintain three points of access for the Big Horn Y Gas Station, and residential accesses would be maintained along Big Horn Avenue and US 87. The residential accesses located on the east leg of the roundabout (US 87) would be relocated slightly to the south so they don't exit directly into the roundabout. Turning lane and storage lengths were designed per the AASHTO *Roadside Design Guide*[6].

Highway 335 and US 87 leading into the roundabout would have curves to promote deceleration heading into the roundabout and the roundabout would be signed at a speed limit of 20 MPH, based on AASHTO's *Green Book*[6]. A center island with landscaping to limit line of sight would further promote deceleration before entering the roundabout. The lanes are designed to accommodate larger trucks and trailers. The roundabout was designed per the South Dakota Department of Transportation Road Design Manual Chapter 12[7], as there was not a similar roundabout design manual available for WYDOT.

The approximate estimated cost of the Roundabout Alternative, in 2025 dollars, is $2,900,000. A detailed preliminary cost estimate is provided in Appendix C.

[6] Roadside Design Guide, The American Association of State Highway and Transportation Officials, 2011
[7] https://dotfiles.sd.gov/rd/rdmch12.pdf

Figure 155: Roundabout Alternative Layout

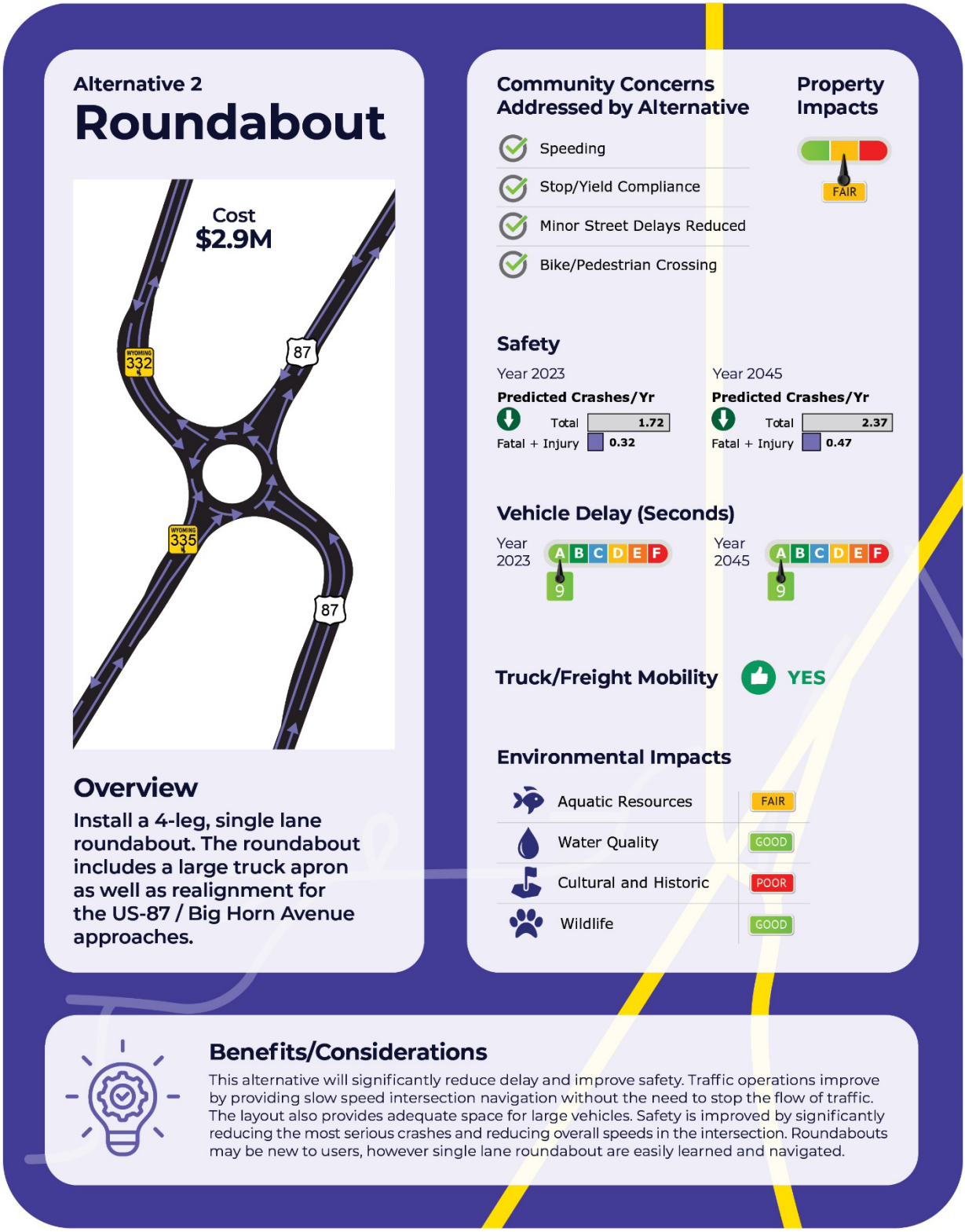


The operation of the Roundabout Alternative was analyzed in Sidra. The LOS and delay results are shown in Table 7. The operations would never drop below LOS A, even with 2045 volumes.

Table 7: Roundabout Alternative Operations Results

Roundabout		Delay (seconds) / LOS				
		EB	NB	SB	WB	Intersection
2023	AM	5.7 / A	8.4 / A	7.9 / A	8.3 / A	7.9 / A
	PM	6.5 / A	9.0 / A	8.7 / A	8.4 / A	8.5 / A
2045	AM	6.1 / A	8.6 / A	8.3 / A	9.4 / A	8.3 / A
	PM	7.7 / A	9.5 / A	9.3 / A	9.3 / A	9.2 / A

Figure 16: Roundabout Alternative



All-Way Stop Control (AWSC) Alternative

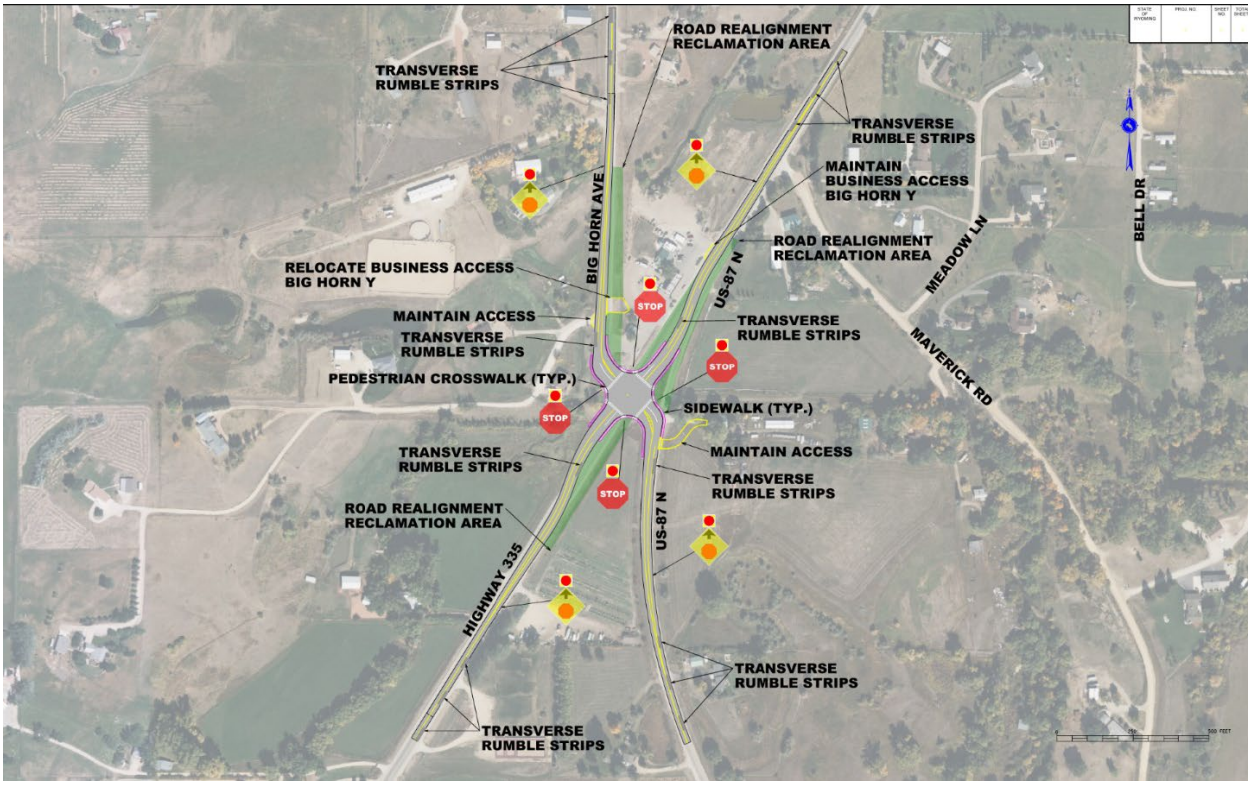
The following design is preliminary and for study purposes only, the final design may differ from the preliminary as additional survey and other data are collected. This alternative includes a four-way intersection with stop signs on all legs. The intersection would be rotated from the existing alignment to promote deceleration coming into the all-way stop condition, and to better use existing right-of-way to minimize impacts to landowners. The approaches would be widened to provide turn lanes, which are designed to accommodate large trucks and trailers. The channelized US 87 right turn lane would be removed. Striped median areas are also shown on the east and west approach legs to provide additional clearance for large turning vehicles. The southernmost access into the Big Horn Y Gas Station would likely not be utilized, as it would interfere with left turn lanes and northernmost access. The northbound and southbound lanes would be comprised of two back-to-back curves based on Table 3-9 from AASHTO's *A Policy on Geometric Design of Highways and Streets (also known as the Green Book)*[8].

Figure 17 depicts the configuration. Side-mounted stop signs would be accompanied by flashing beacons and warning signs placed ahead of the stop signs, as well as transverse rumble strips per the *Manual on Uniform Traffic Control Devices* (MUTCD)[9].

The approximate estimated cost of the AWSC Alternative, in 2025 dollars, is $2,800,000. A detailed preliminary cost estimate is provided in Appendix C.

[8] A Policy on Geometric Design of Highways and Streets, The American Association of State Highway and Transportation Officials (AASHTO Green Book), 2011
[9] https://mutcd.fhwa.dot.gov/kno_11th_Edition.htm

Figure 17: AWSC Alternative Layout

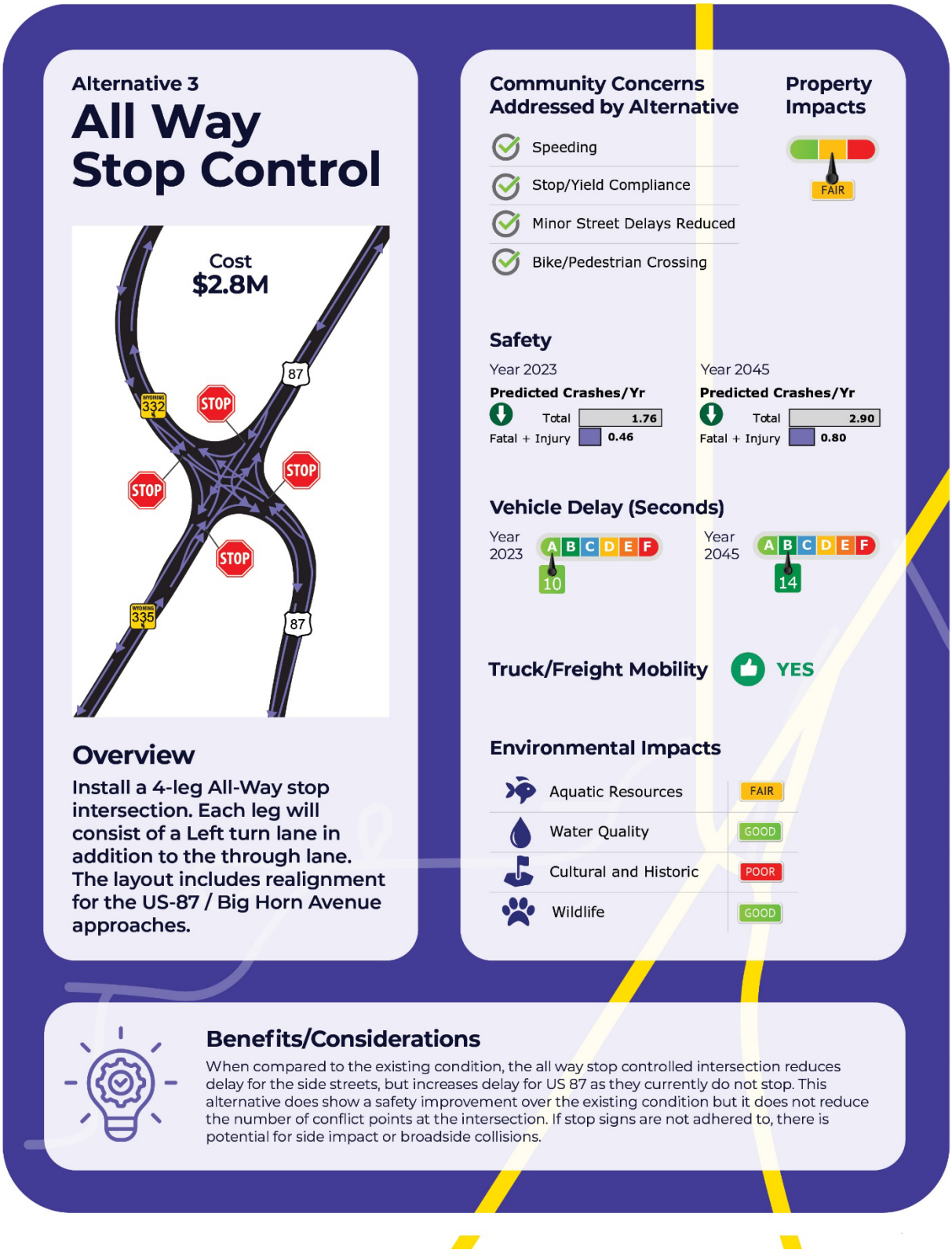


The AWSC Alternative was analyzed in Synchro, and the results are shown in Table 8. Generally, this alternative resulted in LOS A or B, except for the southbound leg PM peak hour with 2045 volumes resulted in C.

Table 8: AWSC Alternative Operations Results

AWSC		Delay (seconds) / LOS				
		EB	NB	SB	WB	Intersection
2023	AM	9.2 / A	10 / A	9.4 / A	8.7 / A	9.5 / A
	PM	9.9 / A	10.1 / B	10.4 / B	9 / A	10.1 / B
2045	AM	11.1 / B	13.7 / B	11.9 / B	10.1 / B	12.4 / B
	PM	12.7 / B	14 / B	15.6 / C	10.6 / B	14.1 / B

Figure 18: All Way Stop Control Alternative



Warrant Analysis

The intersection was evaluated using a traffic signal warrant analysis per the MUTCD[7] and the WYDOT Traffic Studies Manual[10]. These warrants provide criteria based on traffic conditions, pedestrian characteristics, and physical characteristics, which determine whether a traffic signal is appropriate for the location. If the warrants are met, then the final decision to install a signal is based on engineering judgment. If the warrants are not met, then the signal system is not justified and should not be installed. Additionally, the signal system should not be installed as it would increase crashes over time and increase driver delay on the minor road.

The completed worksheet from the WYDOT Traffic Studies Manual is provided in Appendix D. A summary of the analysis is as follows:

Table 9: Summary of Traffic Signal Warrant Analysis

Warrant	Description	Met?
Initial AADT Screening	WYDOT screening to indicate whether it is possible to meet warrants.	Yes, it is possible to meet warrants at the intersection
Warrant 1	Eight-Hour Vehicular Volume	No
Warrant 2	Four-Hour Vehicular Volume	No
Warrant 3	Peak Hour	No
Warrant 4	Pedestrian Volume	No
Warrant 5	School Crossing	Not applicable
Warrant 6	Coordinated Signal System	Not applicable
Warrant 7	Crash Experience	No
Warrant 8	Roadway Network	No
Warrant 9	Intersection Near a Grade Crossing	Not applicable

In addition to the traffic signal warrants provided in the MUTCD, the WYDOT Traffic Studies Manual provides an initial AADT screening which indicates whether it is possible to meet warrants at the intersection and whether a full warrant analysis should be performed. This is based on the number of lanes and the vehicles per hour on each approach. This criterion was met, indicating that warrants could potentially be met and a full signal warrant analysis should be performed.

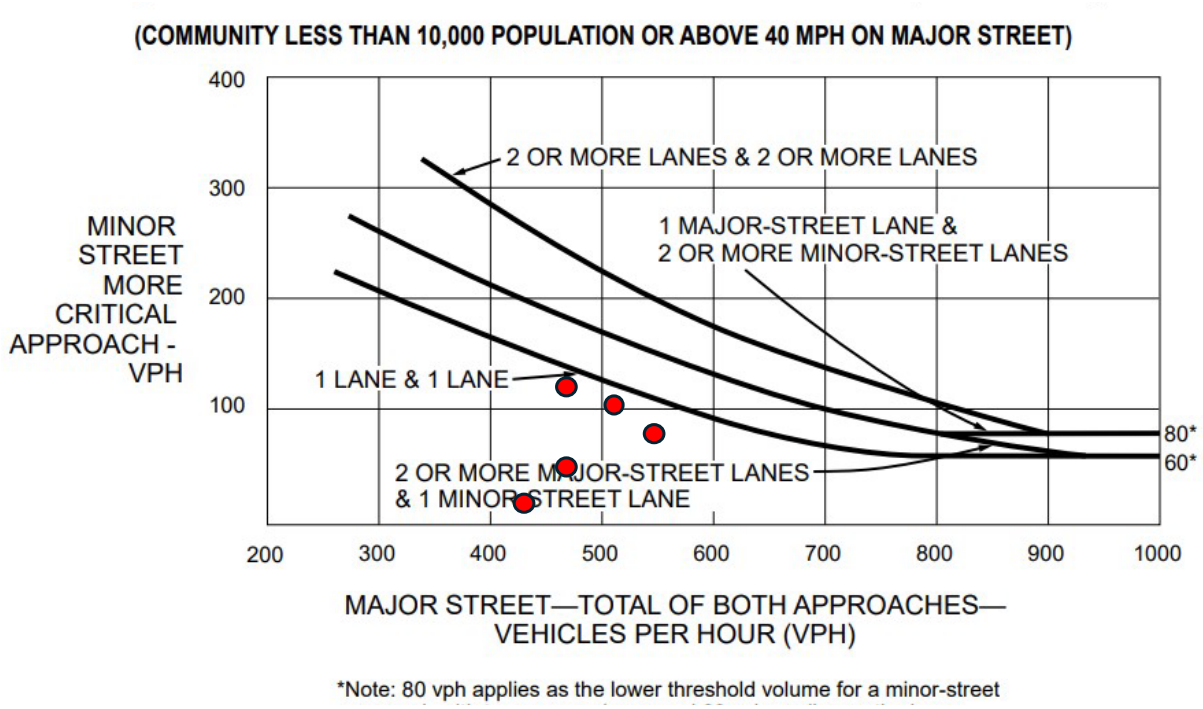
10 https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Traffic%20data/Traffic%20Studies%20Manual.pdf

Warrant 1 is the eight-hour vehicular volume. Per the MUTCD this warrant is intended for an application where a large volume of side street traffic is the principal reason to consider a signal (Condition A), or where volumes on the major street are so high that side street volumes experience excessive delay or conflict (Condition B). Only one of these conditions must be met for each of any eight hours of an average day by exceeding minimum values. Due to the low volumes on both the major and minor streets Warrant 1 is not met.

Warrant 2 is the four-hour vehicular volume. This warrant is intended for applications where the volume of intersecting traffic is the principal reason to consider installing a signal. A signal is warranted if the vehicles per hour on the major street and corresponding vehicles per hour on the minor street fall above an applicable curve for each of any four hours of an average day. Each curve represents different intersection conditions based on the number of approach through lanes. Most rural roads will have one lane traveling in each direction and thus will need to meet the "1 Lane & 1 Lane" curve. Turn lanes do not count towards the number of approach lanes. This intersection has one approach lane in each direction, and the left turn lanes do not count which signifies that the "1 Lane & 1 Lane" curve should be used as the threshold. Alternatively, a 70% factor may be applied to the curve if the 85th percentile speed on the major street exceeds 40 mph or if the intersection lies within a built-up area of an isolated community with a population of less than 10,000. The major street exceeds the 85th percentile speed threshold, so the 70% factor applies[11]. Figure 19 is the 70% Factor curve, which is Figure 4C-2 in the MUTCD, and for which this intersection qualifies for. All volumes were tabulated and plotted on this graph, and all volumes fall below the curve for 1 lane and 1 lane, as shown in Figure 19. Each red dot represents one of the five hours of count data that was collected. Each red dot falls under the "1 Lane & 1 Lane" 70% factor curve. Warrant 2 is not met.

[11] https://mutcd.fhwa.dot.gov/htm/2009/part4/part4c.htm

Figure 19. Volumes Plotted on Figure 4C-2 from the MUTCD



Warrant 3 is peak hour volume, which is applicable where for a minimum of 1 hour of an average day, the minor street suffers undue delay when entering or crossing the major street. This is met when the vehicles per hour on the major street and corresponding vehicles per hour on the minor street fall above an applicable curve for any one hour of an average day. Volumes were plotted on the same graph as the applicable curves (provided in Appendix D), and not one single hour was above the curve. Warrant 3 is not met.

Warrant 4 is pedestrian volume, which would be met if pedestrian volumes meet a certain threshold. To meet this warrant, pedestrian volumes would need to be in the range of 125 pedestrians within a four-hour segment, or 150 pedestrians for a single hour. Due to the low number of pedestrians at this intersection, this warrant is not met.

Warrant 5 is school crossing, which does not apply to this intersection. This would be met if there were school crossings nearby, or more than 20 schoolchildren crossing the intersection during the highest crossing hour. The nearest schools are Woodland Park School, which is 2.6 miles from the intersection, and Big Horn High School, which is 3.4 miles away. Therefore Warrant 5 is not applicable.

Warrant 6 is coordinated signal system, which would be met if the intersection is part of a coordinated corridor of other signalized intersections. This warrant is not applicable, since this is an isolated intersection in a rural area.

Warrant 7 is crash experience, which is met if the number of angle and pedestrian crashes exceeds a certain threshold, an adequate trial of alternatives have failed to improve safety, and vehicle and pedestrian volumes meet a certain threshold. The number of crashes does meet one of the criteria for fatal and injury crashes within a 3-year period; however, the

volume criteria is not met and no remediation alternatives have been applied to improve safety. Warrant 7 requires that all three conditions are met, so this warrant is not met.

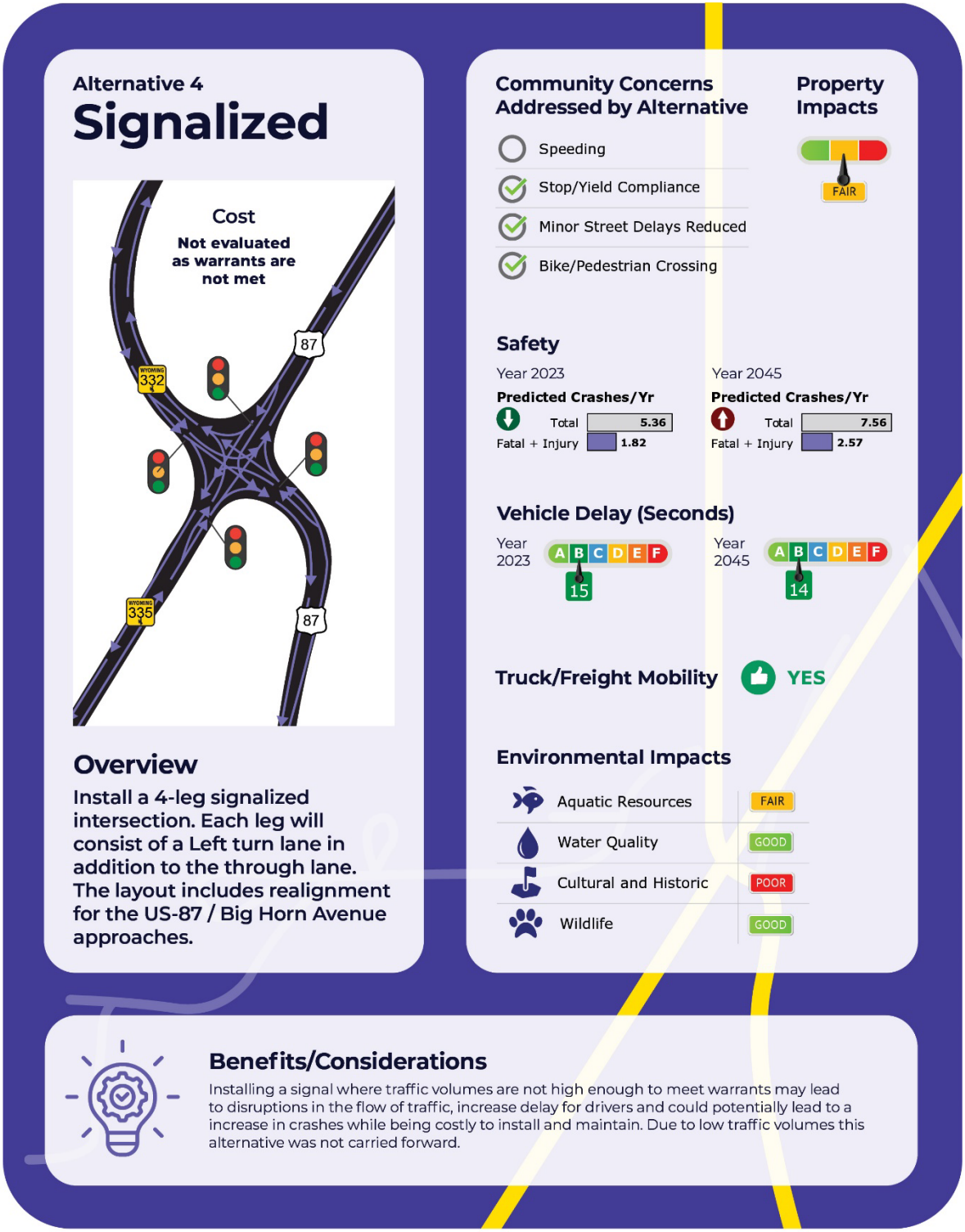
Table 10. Warrant 7 Summary

Condition	Criteria Description	Condition Met		Warrant 7 Met
A	Adequate remediation	No	No	No
B	1-year Total Crash	No	Yes	
	1-year FI Crash	No		
	3-Year Total Crash	Yes		
	3-Year FI Crash	No		
C	Volumes Met	No	No	

Warrant 8 applies when installing a signal at an intersection would encourage concentration and organization of traffic flow on a roadway network. This would be met if the typical weekday peak hour or weekend peak hours meet certain volume thresholds. The intersection is considered part of a larger roadway network, but volumes do not the threshold of 1,000 vehicles per hour entering the intersection. This warrant is not met.

Warrant 9 is intersection near a grade crossing, which applies when an intersection is close to a railroad crossing. This warrant does not apply, as there are no nearby railroad grade crossings that would impact operations or safety of the intersection.

Figure 20: Signalized Alternative



Speed Study

A speed study was conducted to determine if the existing speed limit at this intersection should be modified. Speed limits must be realistic to gain compliance. Research indicates about 85 percent of all drivers travel at a reasonably safe speeds for the road conditions they encounter regardless of speed limit signs. Posting proper speed limits smoothes the flow of traffic and aids effective law enforcement. Unrealistically low speed limits invite violation by responsible drivers. Enforcing unreasonably low limits creates the perception of a "speed trap"[12].

Data Collection

Speed and volume data was collected by radar detectors at four locations near the intersection from March 11 to March 15, 2024. Radar detector locations are shown in Figure 21.

Figure 21. Radar Data Collection Locations

12 https://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Traffic%20data/2016%20Speed%20Limits%20booklet.pdf

Study Methodology

The process for determining reasonable and safe speed limits is divided into two phases: the engineering investigation, which looks at the geometric design of the road, and the traffic investigation, which involves gathering and analyzing traffic volumes, prevailing vehicle speeds, crash numbers and traffic control devices affecting or affected by vehicle speeds[2].

The collected vehicle speed data was entered into the WYDOT Standard Form TR-11 using the WYDOT Traffic Studies Manual. The Speed Study Form TR-11 resulted in a speed frequency distribution, average and various percentile speeds, pace data, standard deviation, percentage of vehicles exceeding the posted speed limit, and the recommended speed limit. The completed forms are included in Appendix F.

Additionally, data for each radar detector was entered into USLIMITS2, which is an online tool by FHWA that assists with setting reasonable and safe speed limits. This intersection was assumed to be a road section in an undeveloped area. Data entered for each radar detector location included 85th and 50th percentile speed, section length, AADT, presence of adverse alignment, statutory speed limit, whether the corridor was transitioning to a developed area, roadside rating, whether it was divided or undivided, number of through lanes, and crash statistics. Crash statistics were unavailable for these locations, which was optional.

Results

Figure 22 summarizes of the 85th percentile speeds, current posted speeds, and recommended speed limits from Form TR-11 and USLIMITS2[13]. Generally, both the WYDOT forms and USLIMITS2 made similar recommendations that aligned with the 85th percentile speeds. Most of the recommended speed limits are the same or relatively close to the existing posted speed limits.

Some locations have different recommended speed limits in different directions, particularly the US 87 RM29.21 location. At this location, southbound traffic is traveling much slower than the northbound traffic, which is increasing in speed to merge onto WY 335/US 87. However, one posted speed limit that applies to both directions would generally be recommended for consistency.

Recommendations

Studies show reducing a speed limit will not cause speeding motorists to slow down. Then determining speed limits, engineers attempt to set a realistic limit that the majority of drivers will obey and that can be reasonably enforced. Therefore, lowering the speed limit without some other geometric, traffic control device, or roadway change would not influence the speed at which drivers travel. The speed study conducted for this project indicates that the existing speed limits are appropriate for this segment of the roadway; therefore, no reduction in speed limits are recommended.

A fact sheet was developed to share with the public to address frequently asked questions related to speed limits and speed studies, shown in Figure 23.

[13] https://safety.fhwa.dot.gov/uslimits/

Figure 22: Speed Study Summary

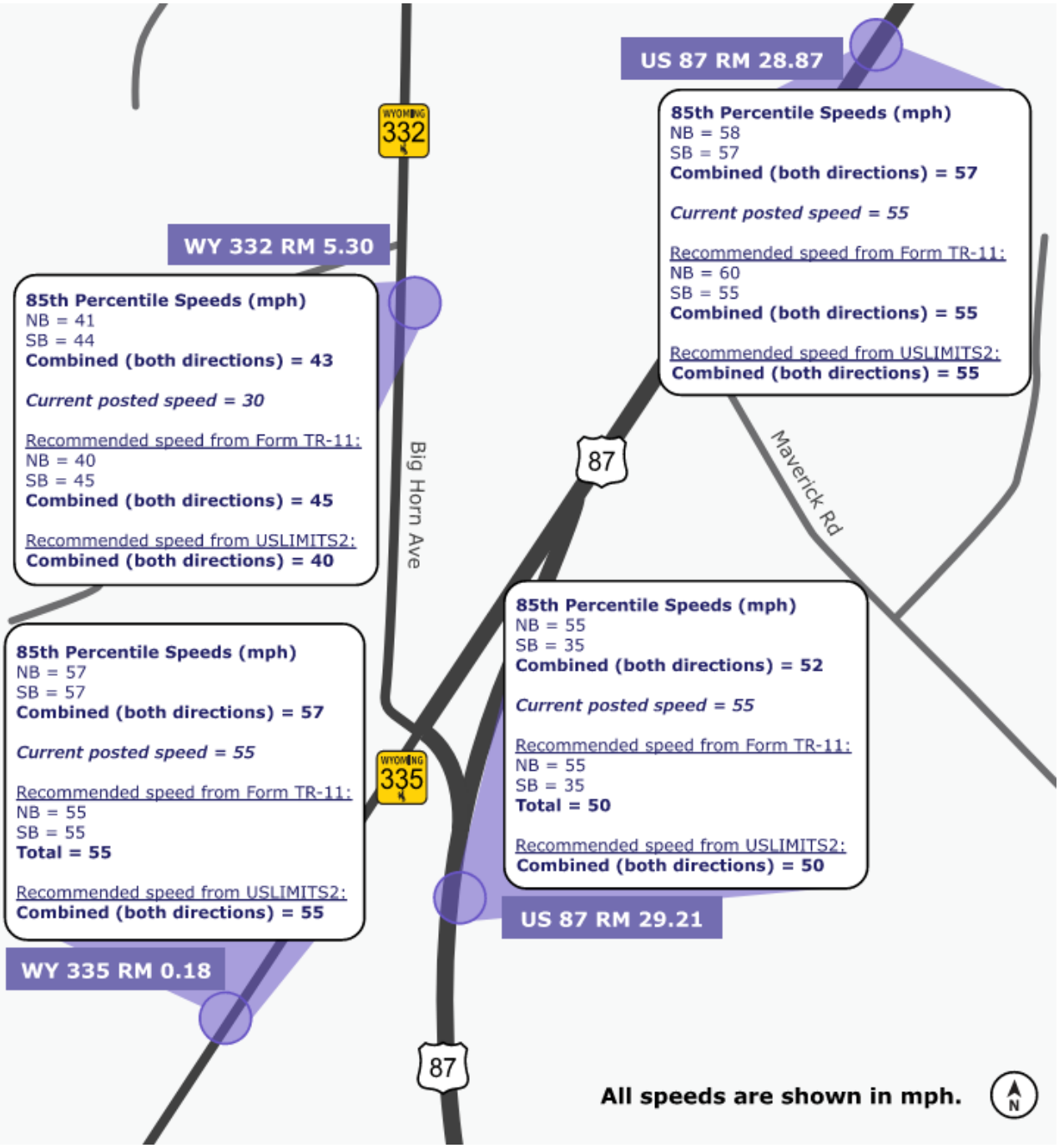


Figure 23: Speed Limit Fact Sheet

UNDERSTANDING SPEED LIMITS

How are speed limits set?

Speed limits are set by determining a reasonable and safe speed through a traffic investigation.

A traffic investigation includes:

- Observing driver behavior and speeds
- Evaluating crash history
- Considering roadway design, alignment, terrain, width, and land uses

The State Legislature has set maximum limits for roads in Wyoming. Wyoming Department of Transportation (WYDOT), cities, towns, and counties also have authority to establish speed limits on roads in their jurisdiction after an engineering and traffic study is completed by a licensed engineer.

For more information contact the WYDOT public involvement specialist in your area of the state:

Southeast: 307-745-2142
Central: 307-473-3303
Southwest: 307-352-3065
Northeast: 307-674-2356
Northwest: 307-856-1341

Speed concepts

Design speed, posted speed, and operating speed all play a role in how drivers use the roadway. Design speed is determined by engineers to guide the planning and construction of a new road, while posted speed is the legal limit displayed on signs. Operating speed reflects the speed drivers feel comfortable with, based on road conditions.

Drivers often choose speeds based on what feels reasonable given the conditions, rather than strictly following the posted limit. Modifying road conditions can encourage slower, more consistent speeds, resulting in smoother traffic flow and a reduced risk of crashes.

Speed Limit FAQs: Beyond The Sign

Will lowering the speed limit reduce speeds?

No, simply lowering the speed limit without some other roadway change does not ensure that drivers will reduce their speeds. Studies have shown that most drivers will choose a speed they feel is reasonable for the given road and traffic conditions regardless of the posted speed.

Isn't a slower speed limit safer?

While drivers all traveling together at a slower speed can be considered safer, lowering the speed limit in an area alone does not guarantee that a certain roadway will be safer. In fact, lowering the speed limit may cause issues due to the speed difference between drivers who are continuing to drive at high speeds. Unrealistically low speed limits invite violation by responsible drivers and create the perception that law enforcement is setting "speed traps."

SOURCES

FHWA, 2017, *(Speed Limit Basics)*
WYDOT, 2016, *(Quick Facts Speed Limits)*
WYDOT, 2012, *(Procedures for Locally Establishing Speed Limits Ch 30)*

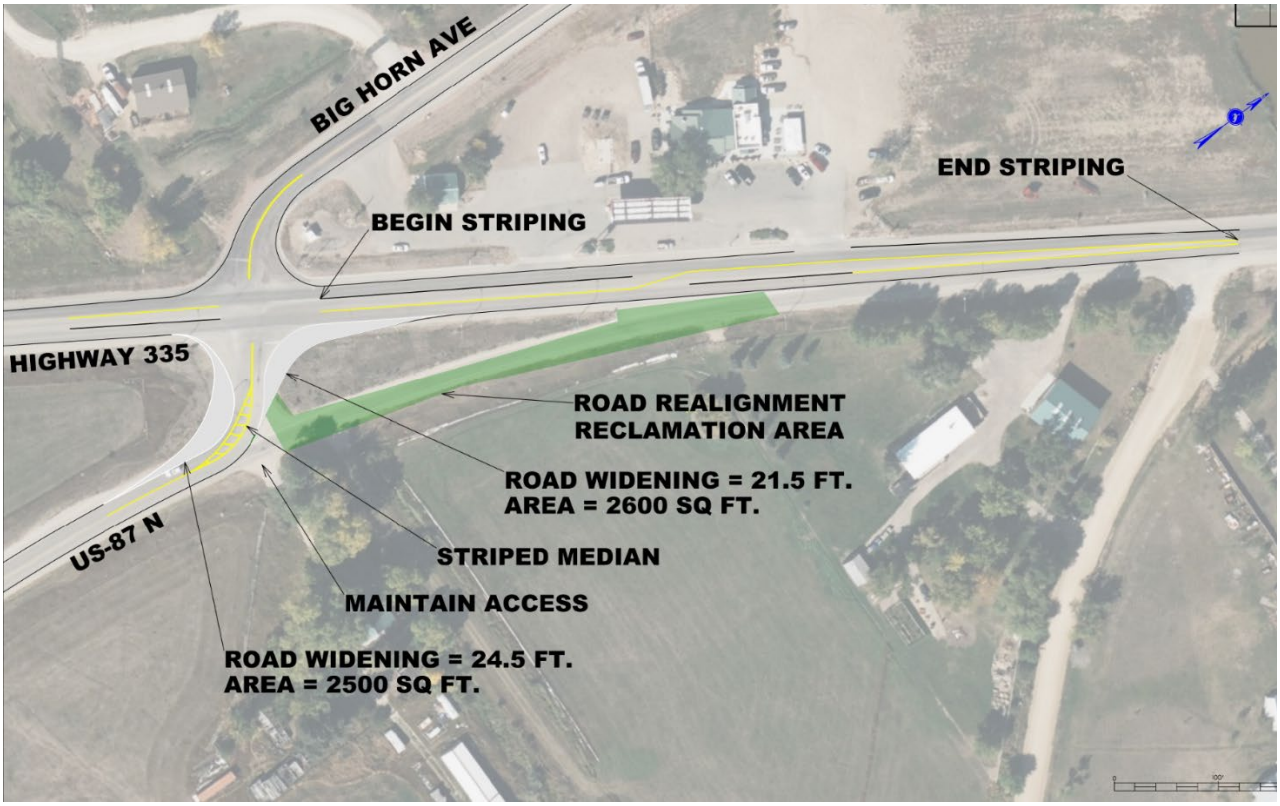
Interim Solution

An interim solution was proposed as a short-term alternative that would maintain the current intersection layout, widen the outer lanes of the east leg of the intersection, add a striped median area, and abandon the acceleration lane from US 87 north. The striped median turning area was designed to accommodate larger trucks and trailers.

The northbound bypass lane that connects both legs of US 87 would be abandoned and reclaimed, omitting a small part near the intersection to maintain landowner access (road realignment reclamation area in Figure 24). Striping changes along the north leg of the intersection clearly establish left-turn lanes for the northernmost access to the Big Horn Y Gas Station and the intersection; storage lengths were designed to comply with the AASHTO *Roadside Design Guide*[11].

The approximate estimated cost of the interim condition, in 2025 dollars, is $107,000. A detailed preliminary cost estimate is provided in Appendix C.

Figure 24: Interim Condition



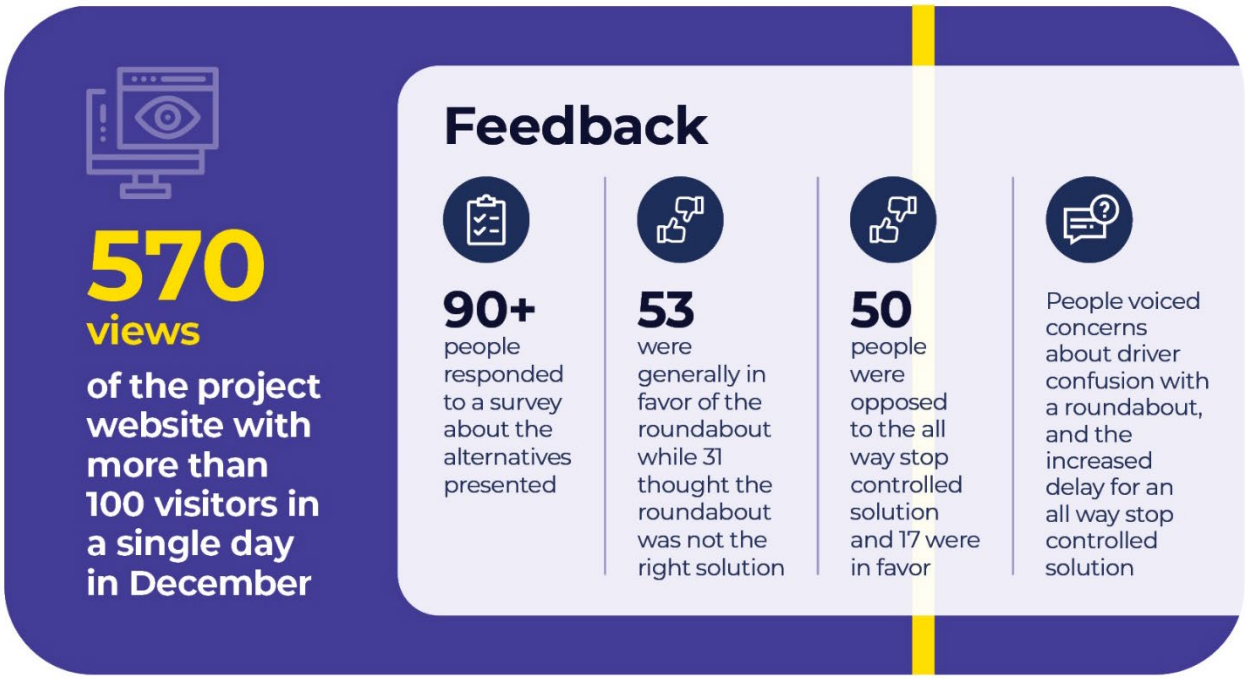
Public Involvement

Online and In-Person Meeting #2 (December 2024 and January 2025)

The roundabout and all-way stop control alternatives were presented at the second public meeting included an in-person meeting on December 11, 2024, concurrent with the launch of an online meeting with a comment period that took place December 11, 2024 - January 11,

2025. Approximately 16 people attended the in-person meeting. In total, 92 surveys were completed as part of the second online meeting. Figure 25 summarizes the themes of the comments and numbers of comments received for each theme.

Figure 25: Online Meeting #2 Analysis



Environmental Review

Potential environmental impacts of the alternatives were evaluated through a desktop delineation, Federal Emergency Management Agency (FEMA) floodplain review, cultural and historical file search, Information for Planning and Consultation (IPaC) determination, Natural Resource and Energy Explorer, and aerial photography. The study area for the environmental overview includes a 300-foot buffer from the road centerline and the potential extents of the alternatives.

The evaluation of all environmental resources can be found in Appendix G. The following summarizes those environmental resources that have a potential to be impacted by the project.

Aquatic Resources

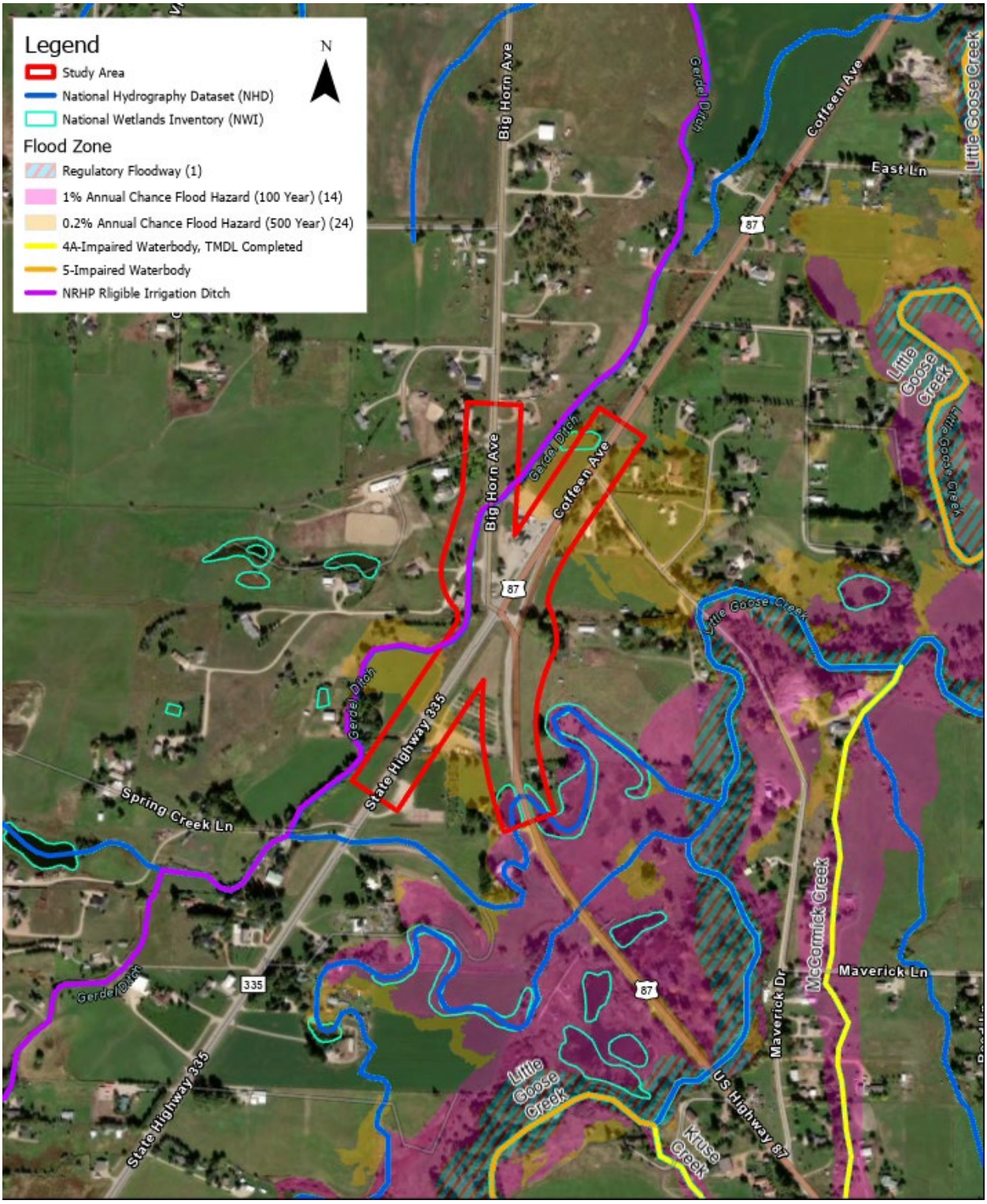
Aquatic resources were evaluated by conducting a desktop evaluation of National Wetland Inventory, Web Soil Survey, and aerial imagery available on Google Earth. Three wetlands and two streams (the perennial Gerdel Ditch and an unnamed intermittent stream) are within the study area. Aquatic resources in the study area are shown in Figure 26.

The unnamed intermittent stream is a tributary of the nearby McCormick Creek, classified as a fish passage by Wyoming Game and Fish, indicating it is a crucial stream corridor.

There are no impaired stream segments within the study area. Three streams with impairment status lie within 0.5 mile of the study area and have a surface connection to the streams that pass through the study area.

FEMA floodplain data shows portions of the intersection reside within the 100-year floodplains. A Section 404 permit may be necessary if waters of the U.S. will be crossed by the modification of Big Horn Avenue. It is recommended that an onsite field delineation be conducted prior to any ground-disturbing activities.

Figure 26: Aquatic Resources Within the Study Area



Cultural and Historic Resources

Cultural and historic resources were evaluated by conducting a file search from the Wyoming State Historic Preservation Office (SHPO) on September 11, 2024. Previous surveys identified seven sites within 0.5 mile of the study area, consisting mostly of irrigation ditches. Two previously identified sites (two segments of Gerdel Ditch) are within the Area of Potential Effect (APE), one of which is eligible for inclusion in the National Register of Historic Places (NRHP).

Approximately 80% of the study area has not previously been surveyed for cultural resources and two of the surveys covering portions of the APE are over 10 years old and may not meet current SHPO survey standards, a Class III cultural survey is recommended to be conducted for undisturbed portions of the APE to identify historical properties.

Threatened and Endangered Species

Threatened and endangered species were evaluated by running a IPaC determination. The study area is within Ute ladies' tresses range, and one bald eagle nest has been recorded within two miles of the study area. It is recommended that habitat surveys for the Ute ladies'-tresses, eagles, and raptors be conducted during later project phases.

Approximately 1.2 acres of the study area contain trees. The project will likely result in some tree removal. It is recommended that raptor nest surveys be conducted during the active nesting season, preferably March through May.

Conclusion

Based on safety and traffic analysis and other criteria, the preferred alternative for the intersection is the roundabout alternative. The roundabout ranks highest in terms of safety, as it would eliminate head-on crashes and reduce the potential for serious injury and fatal crashes by 90%. Additionally, the curved approaches would guide traffic in one direction and encourage slower approach speeds, as well as lower speeds traversing the roundabout. This alternative would address concerns expressed through public involvement, including accommodation of pedestrians and bicyclists, yielding issues, and speeding. Input received during the second online and in-person public meeting demonstrated support of a roundabout. Right-of-way acquisition would be required, but any alternatives that realign the intersection would require some additional space, and this alternative would balance that consideration with its benefit.