U.S. Highway 16 Corridor Study: Rural Sub-Area Analysis

East of Rockerville to west of Neck Yoke Road

Pennington County, South Dakota

March 4, 2024

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Prepared for:

South Dakota Department of Transportation

Office of Project Development

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Abbreviations

AASHTO	American Association of State Highway Transportation Officials
ETT	Experienced Travel Time
FHWA	Federal Highway Administration
F+I	Fatal and Injury Crashes
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HSM	Highway Safety Manual
IHSDM	Interactive Highway Safety Design Module
LOS	Level of Service
M&A	Methods and Assumptions
MEV	Million Entering Vehicles
LT / T / RT	Left turn lane / Through lane / Right turn lane
MVMT	Million Vehicle Miles Traveled
NB/SB/EB/WB	Northbound / Southbound / Eastbound / Westbound
PCN	Project Control Number
PDO	Property Damage Only Crash
RCAMPO	Rapid City Area Metropolitan Planning Organization
RCI	Reduced Conflict Intersection
RCUT	Restricted Crossing U-turn
RIRO	Right-In Right-Out
ROW	Right of Way
SDDOT	South Dakota Department of Transportation
STIP	Statewide Transportation Improvement Program
TDM	Travel Demand Model
TWSC	Two-Way Stop-Control
WCSC	Worst-Case Stop-Control

1.0 Executive Summary

1.1 Background

In 2019, the South Dakota Department of Transportation (SDDOT) initiated a study with the Federal Highway Administration (FHWA), Rapid City Area Metropolitan Planning Organization (RCAMPO), City of Rapid City, and Pennington County to develop a long-range plan for over 16 miles of the U.S. Highway 16 (Highway 16) corridor. The study focused on Highway 16 between the Keystone Wye (U.S. Highway 16A) and Cathedral Drive/Fairmont Boulevard in Rapid City, as well as adjacent service roads and Rockerville area ramps. A key element of the overarching *U.S. Highway 16 Corridor Study* is that it analyzed Highway 16 as a continuous corridor, which recognizes the importance of corridor-wide connectivity and continuity for both local and tourist traffic.

Since release of the final *2021 U.S. Highway 16 Corridor Study Report* (July 2021), the SDDOT identified a need for additional detailed analysis and refinement of alternatives along a Highway 16 segment from east of Rockerville to west of the Neck Yoke Road intersection. The objectives of this 'Rural Sub-Area Analysis' are to:

1. Refine alternatives recommended in the *2021 U.S. Highway 16 Corridor Study Report*
2. Update the traffic forecasts, operations analysis, and alternatives evaluation
3. Determine preliminary recommendations for SDDOT to consider as part of scoping future projects through this segment

Currently, the SDDOT has projects PCN 07Y6 and PCN 08YF planned within this rural sub-area in the 8-year developmental Statewide Transportation Improvement Program (STIP).

The preliminary purpose and need for a future project through this rural sub area entails:

- **The purpose of the project** is to address local and regional trips along the Highway 16 corridor, reduce traffic congestion from continued growth and urbanization, and improve safety by addressing traffic movements at intersections.
- **The need for the project** is to:
    - Address local and regional trips along the Highway 16 corridor: considering the corridor as a continuous roadway segment creating system connectivity for local and tourism traffic
    - Reduce traffic congestion from continued growth and urbanization: reviewing the need for roadway improvements to accommodate existing and future traffic volumes.
    - Improve safety by addressing movements at intersections: realigning movements to reduce angle conflicts and simplify traffic movements.

1.2 Findings and Recommendations

The rural sub-area analysis found that Reduced Conflict Intersections (RCIs) best address short-term and long-term traffic operational and safety needs and provide full access opportunities along the corridor by:

- **Eliminating angle conflicts created by side-street left turn and through movements,** which have a high propensity for serious injury crashes
    - Number of angle (crossing) conflicts are reduced from as many as 24 in a conventional intersection to just 4 in an RCI
- **Simplifying traffic movements** so drivers only need to focus on one direction at a time
- **Increasing arterial corridor efficiency** by creating two, independent one-way streets
- **Providing for a full access** through multiple intersections, which includes a main intersection and downstream U-turn(s)
- **Providing greater median storage** for long and/or multiple vehicles within the median U-turn lanes

RCI resources and design elements pertinent to the conceptual layouts and this study are provided in the following:

- **Section 7.0 Reduced Conflict Intersection Informational Resources**
- **Section 8.0 Reduced Conflict Intersection Design Resources**

Through concept refinement, evaluation, and two sets of public engagement to gather feedback, it is recommended that the following guidance and Highway 16 'Area' scenarios be carried forward to the scoping process for design:

Highway 16 Intersections (General)

- Modify existing full access intersections to RCIs or partial access intersections, as shown in the recommended scenarios, to restrict crossing and left turn movements from the side streets
- Establish a framework for long-range corridor access management and the locations for future full access intersections (RCIs) to guide corridor development

Strato Rim - Busted Five - Wilderness Canyon Area

- Scenario A: Reduced Conflict Intersections (RCIs) on Existing Alignment **(Figure ES-1)**
- Stratobowl Rim Trailhead U-turn: Closest feasible location west of Stratobowl Rim Trailhead **(Figure ES-2)**

HTR Black Hills Resort Area

- Scenario C: RCI with Shifted West U-turn (HTR Black Hills), ¾ Access (House of Scandinavia), and RIRO Access (Sitting Bull Road) **(Figure ES-3)**

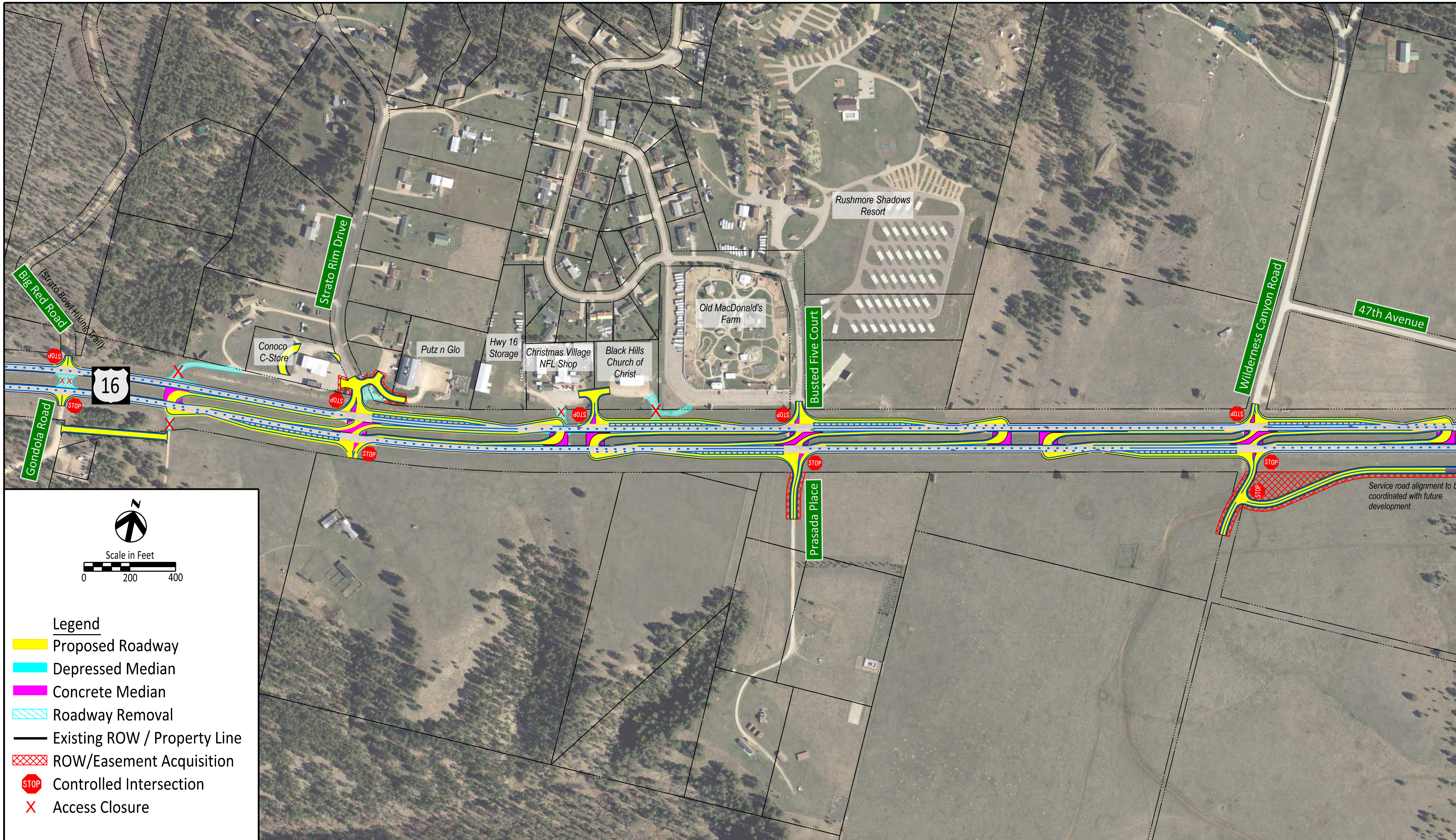
Bear Country USA Area

- Reduced Conflict Intersection (RCI) **(Figure ES-4)**

Rushmore Candy Company Area

- Reduced Conflict Intersection (RCI) **(Figure ES-5)**

Supplemental recommendations include additional Highway 16 considerations, such as frontage road spacing, local street connectivity, roadway lighting, and corridor speed.



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

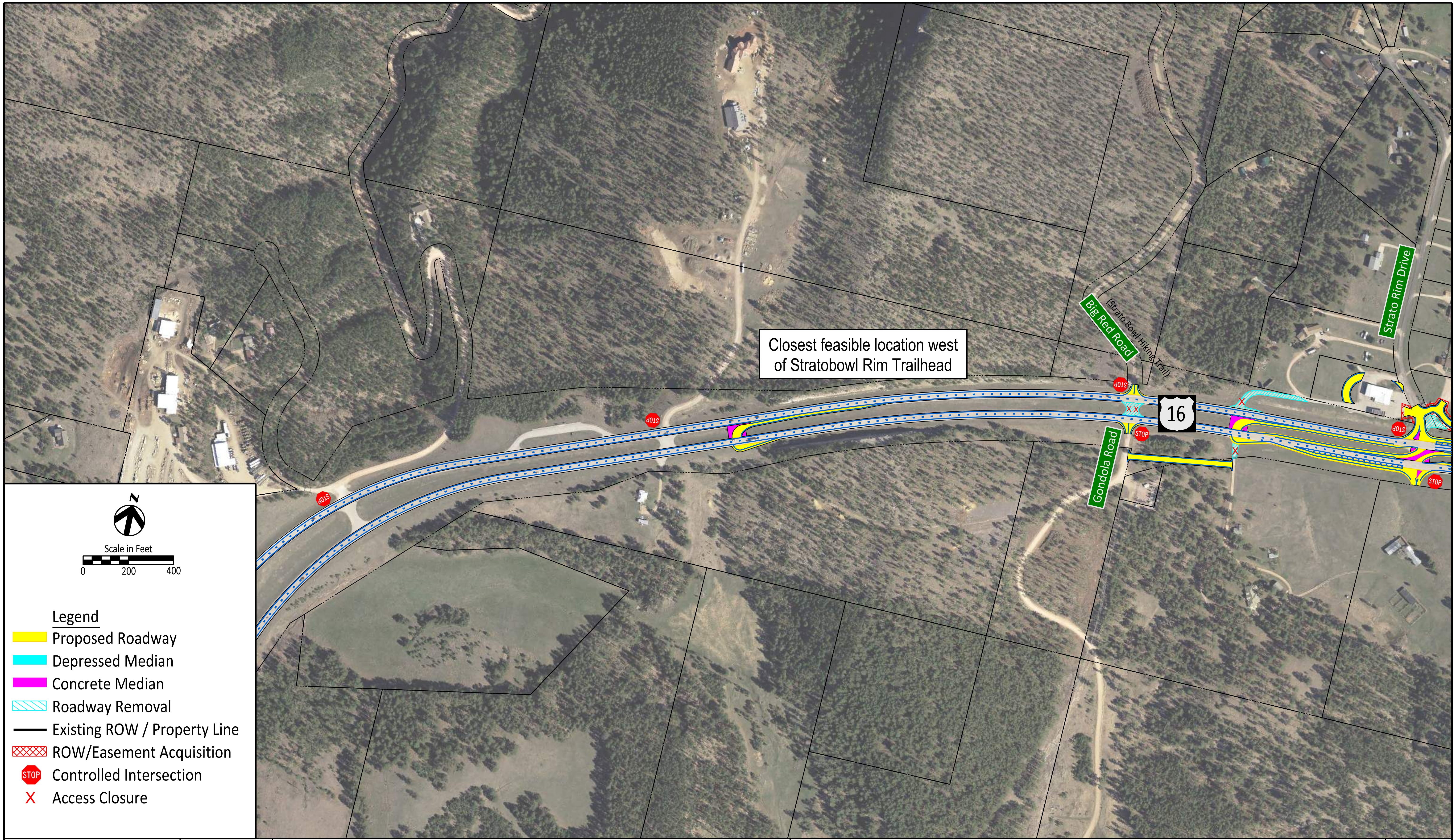
SD DEPARTMENT OF TRANSPORTATION · U.S. Department of Transportation Federal Highway Administration · Rapid City Area Metropolitan Planning Organization · City of Rapid City · Pennington County

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario A: Reduced Conflict Intersections (RCIs) on Existing Alignment

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure ES-1



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Stratobowl Rim Trailhead U-Turn Options

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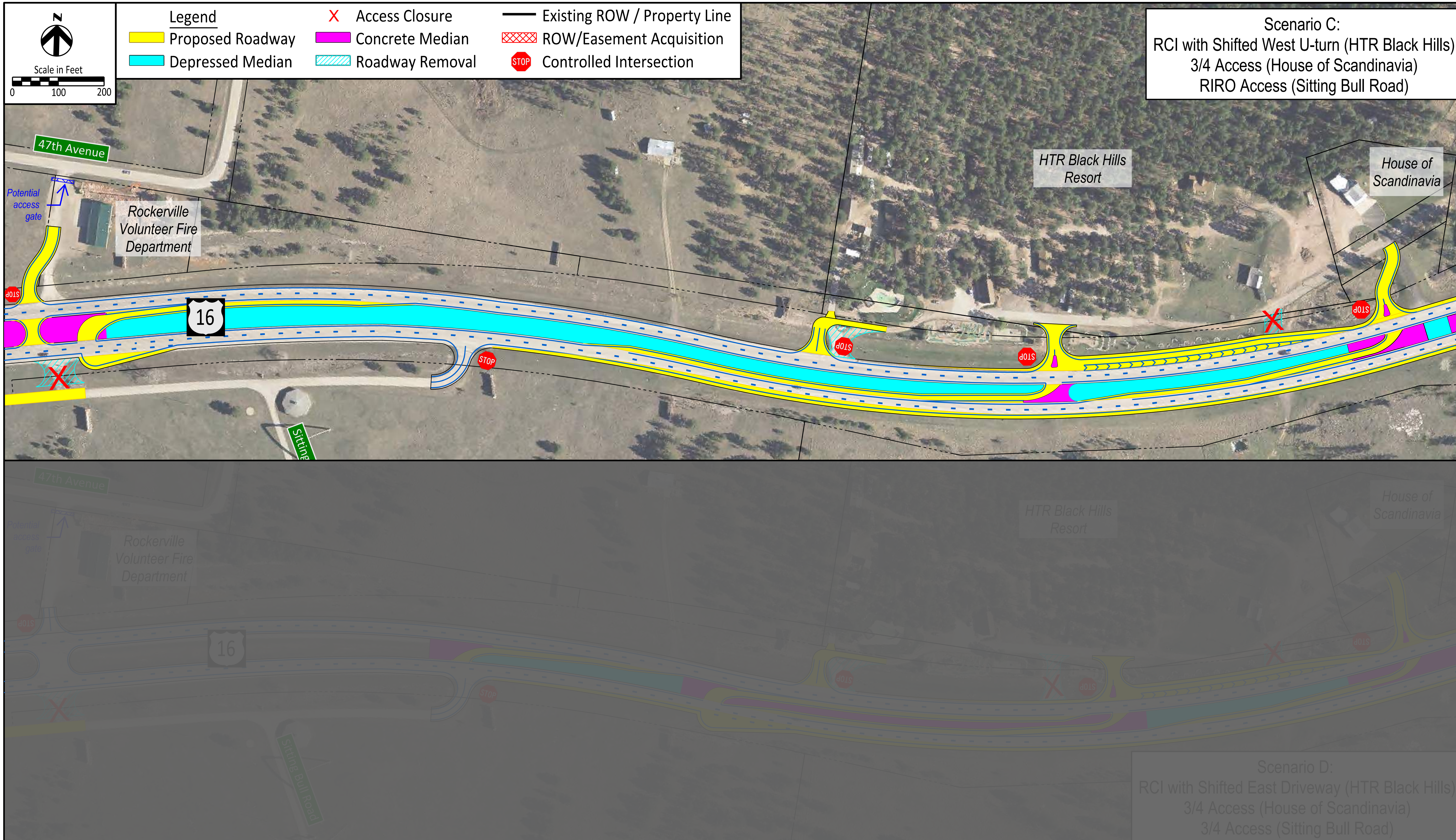
Figure ES-2



Study Recommendation

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HTR Black Hills Resort Area
Access Management Scenario C

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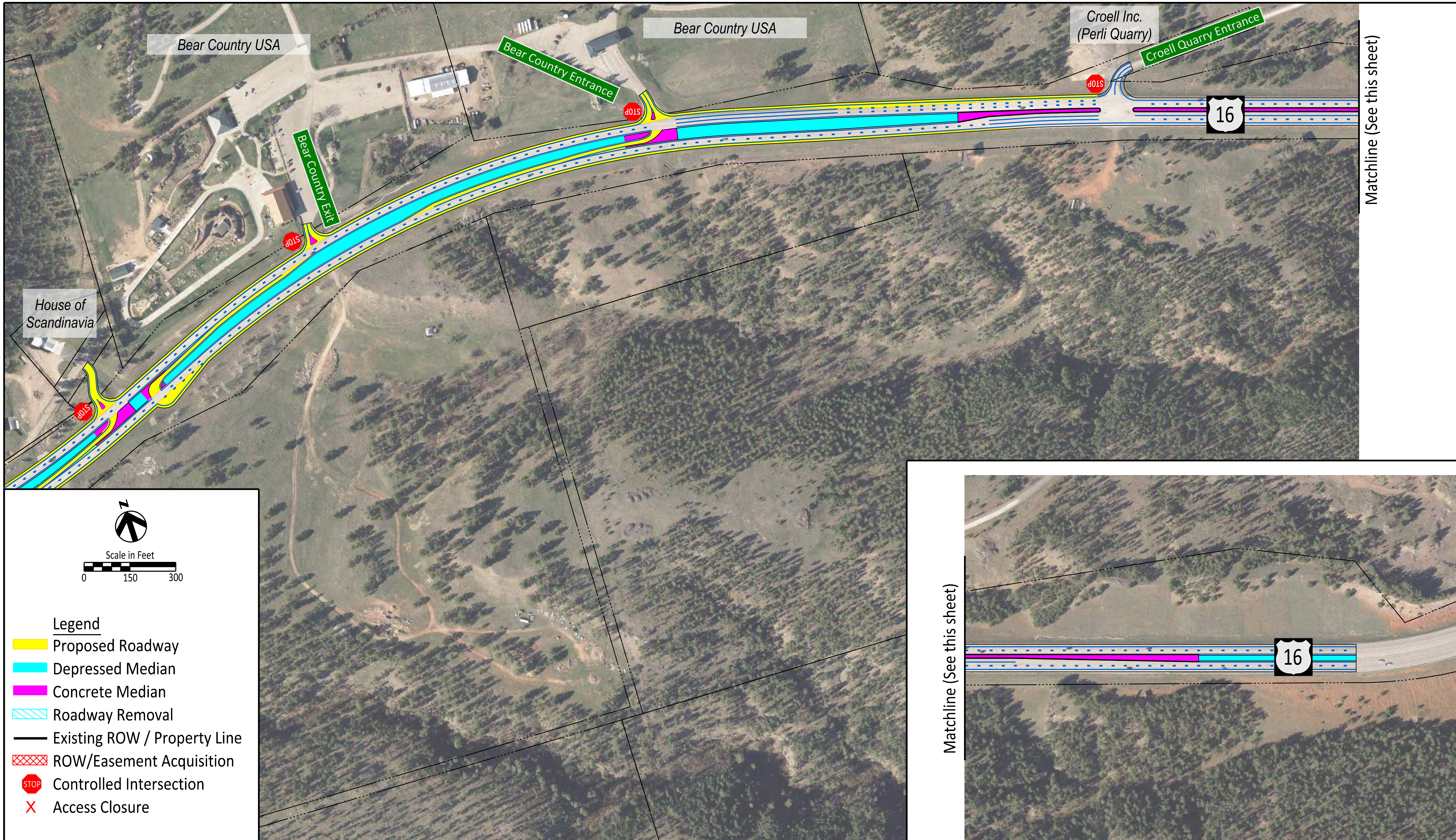
Pennington County, SD

Figure
ES-3



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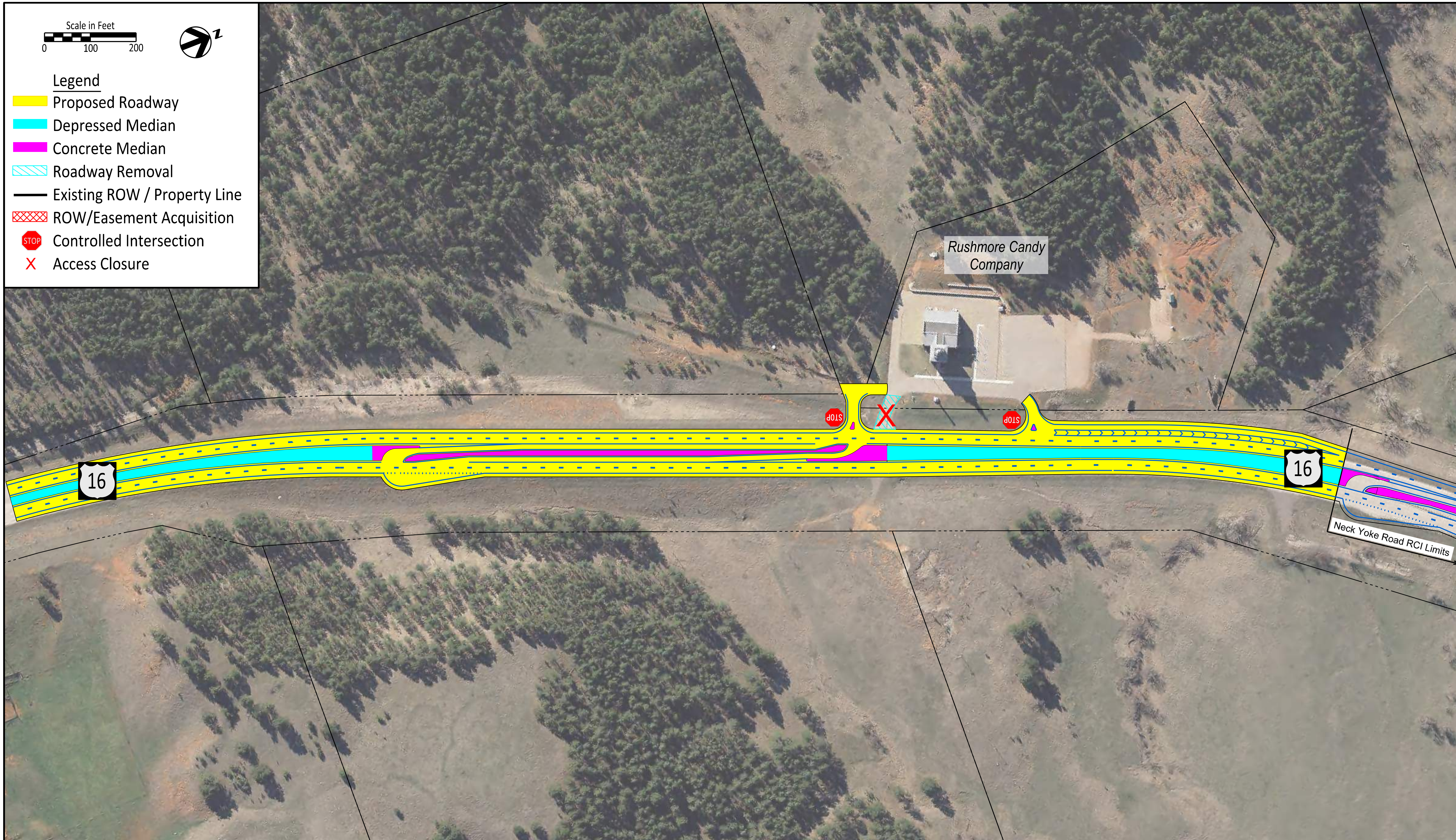
Bear Country USA Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
ES-4



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

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Rushmore Candy Company Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure ES-5

2.0 Introduction

2.1 Background

In 2019, the South Dakota Department of Transportation (SDDOT) initiated a study with the Federal Highway Administration (FHWA), Rapid City Area Metropolitan Planning Organization (RCAMPO), City of Rapid City, and Pennington County to develop a long-range plan for over 16 miles of the U.S. Highway 16 (Highway 16) corridor. The study focused on Highway 16 between the Keystone Wye (U.S. Highway 16A) and Cathedral Drive/Fairmont Boulevard in Rapid City, as well as adjacent service roads and Rockerville area ramps. A key element of the overarching *U.S. Highway 16 Corridor Study* is that it analyzed Highway 16 as a continuous corridor, which recognizes the importance of corridor-wide connectivity and continuity for both local and tourist traffic.

Since release of the final *2021 U.S. Highway 16 Corridor Study Report* (July 2021), the SDDOT identified a need for additional detailed analysis and refinement of alternatives along a Highway 16 segment from east of Rockerville to west of the Neck Yoke Road intersection. The objectives of this 'Rural Sub-Area Analysis' are to:

1. Refine alternatives recommended in the *2021 U.S. Highway 16 Corridor Study Report*
2. Update the traffic forecasts, operations analysis, and alternatives evaluation
3. Determine preliminary recommendations for SDDOT to consider as part of scoping future projects through this segment

Currently, the SDDOT has projects PCN 07Y6 and PCN 08YF planned within this rural sub-area in the 8-year developmental Statewide Transportation Improvement Program (STIP).

2.2 Rural Sub-Area Analysis Study Area

Study limits for the Highway 16 rural sub-area analysis entail Highway 16 from east of Rockerville to west of Neck Yoke Road (see **Figure 1**) and include 11 analysis intersections. The rural sub-area analysis study area is within the RCAMPO planning boundary.

2.3 Methods and Assumptions

A *Methods and Assumptions Document* (M&A) was prepared at the onset of this sub-area analysis to serve as a historical record of the study process and methodologies, dates, and decisions made by study team representatives. Methodology and assumptions from the overarching *U.S. Highway 16 Corridor Study* were updated for this rural sub-area analysis and incorporated into a new M&A document provided in **Appendix A**.

Figure 1: Highway 16 Rural Sub-Area Analysis Study Area

3.0 Study Process

The rural sub-area analysis study process consisted of the four key steps, shown in **Table 1**, to develop recommendations. Study Advisory Team, public, and stakeholder involvement were instrumental in a process that included two sets of public meetings and one-one-on stakeholder meetings.

Table 1: Study Process

Step	Components
1	**Traffic Analysis Update** Data collection Traffic forecasts Traffic operations analysis (No Build and Build conditions) Crash history review
2	**Concept Refinement (1st iteration)** Refinement of concepts carried forward from *2021 U.S. Highway 16 Corridor Study Final Report* Concept evaluation Public/stakeholder meetings #1 – present concepts for feedback
3	**Concept Refinement (2nd iteration)** Concept refinement based on stakeholder, public, and Study Advisory Team feedback Concept evaluation
4	**Recommendations** Preliminary recommendations Public/stakeholder meetings #2 – present refined concepts and preliminary recommendations for feedback Concept refinement based on stakeholder, public, and Study Advisory Team feedback Finalize recommendations and develop final report

4.0 Analysis Update

4.1 Crash History Review

Crash history was reviewed for years 2018 through 2022 using a GIS database of State of South Dakota crash records provided by the SDDOT. The density of crashes within the rural sub-area is shown in **Figure 2**. Injury crash locations are shown in **Figure 3**.

The review focused on intersection crashes and reflects an update to the overarching *U.S. Highway 16 Corridor Study* crash history review. A summary of intersection crash characteristics is provided in **Table 2**. Vehicle-animal crashes are not considered in this analysis.

Crash rates and critical crash rates were calculated in terms of crashes per million entering vehicles (crashes/MEV). Critical crash rates were calculated based on the statistical populations for each crash location using methods presented in the *Highway Safety Manual* (American Association of State Highway and Transportation Officials (AASHTO), 2010). A critical crash rate accounts for a desired level of confidence (95 percent used in this study), vehicle exposure, and similar facility types. Intersections where the critical crash rate exceeds 1.0 (crash rate divided by critical crash rate) were noted for further investigation.

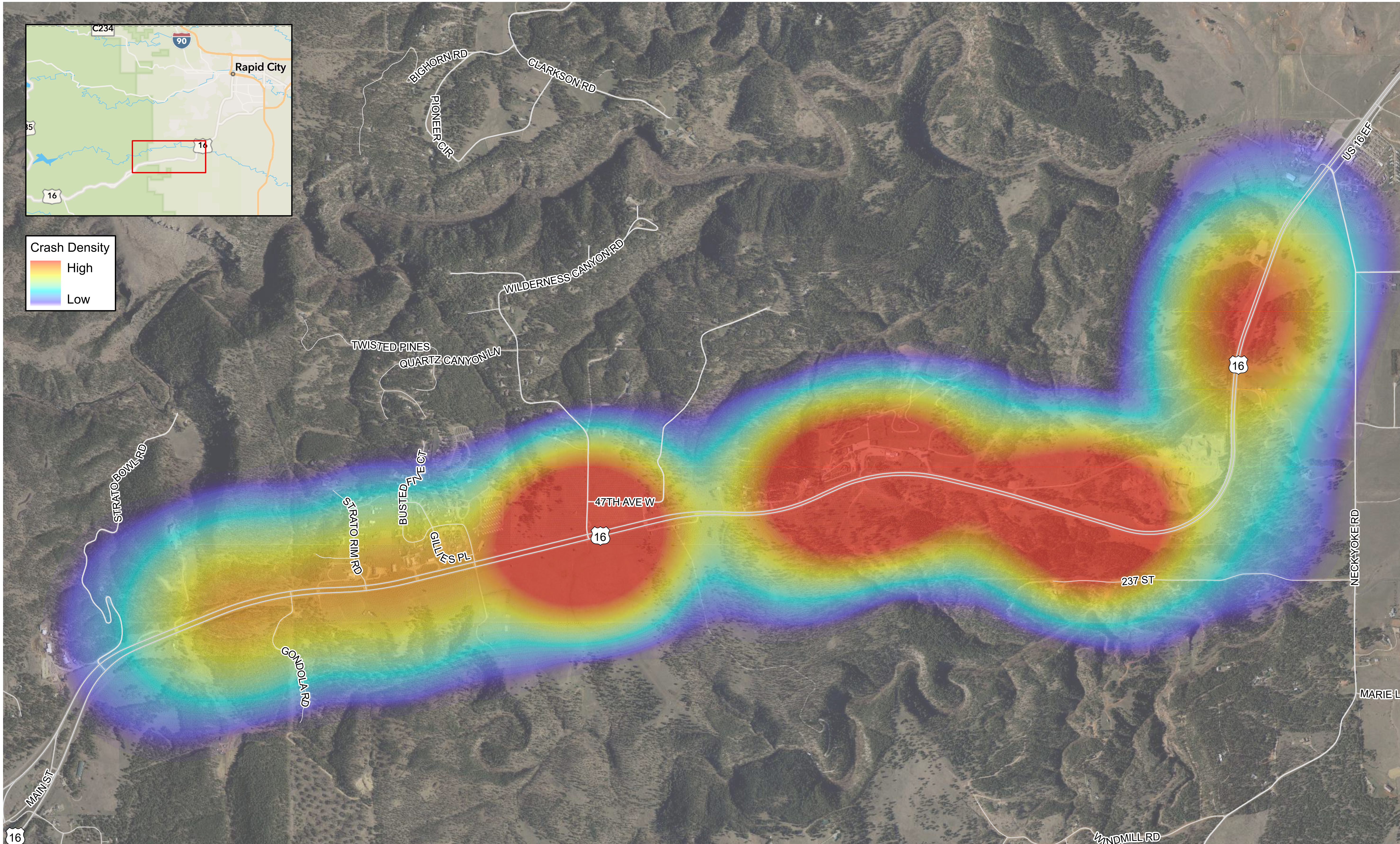
In total, there were 18 reported intersection crashes across 10 intersections within the rural sub-area. Five of those occurred at the Wilderness Canyon Road intersection and four occurred at the Bear Country USA Exit. Both intersections exhibit a crash rate to critical crash rate ratio greater than 1.0. The remaining nine intersection crashes occurred across eight other intersections.

Approximately 45 percent of the intersection crashes resulted in an injury. Twelve of the 18 crashes were angle type crashes, which is the most prominent manner of collision.

Expanding the intersection crash data review to the previous 10 years (2013 through 2022) of reported crashes highlights the severity of angle crashes on rural expressway facilities. Over the last 10 years, there were 29 angle crashes at Highway 16 intersections from Gondola Road eastward through the Bear County USA entrance with:

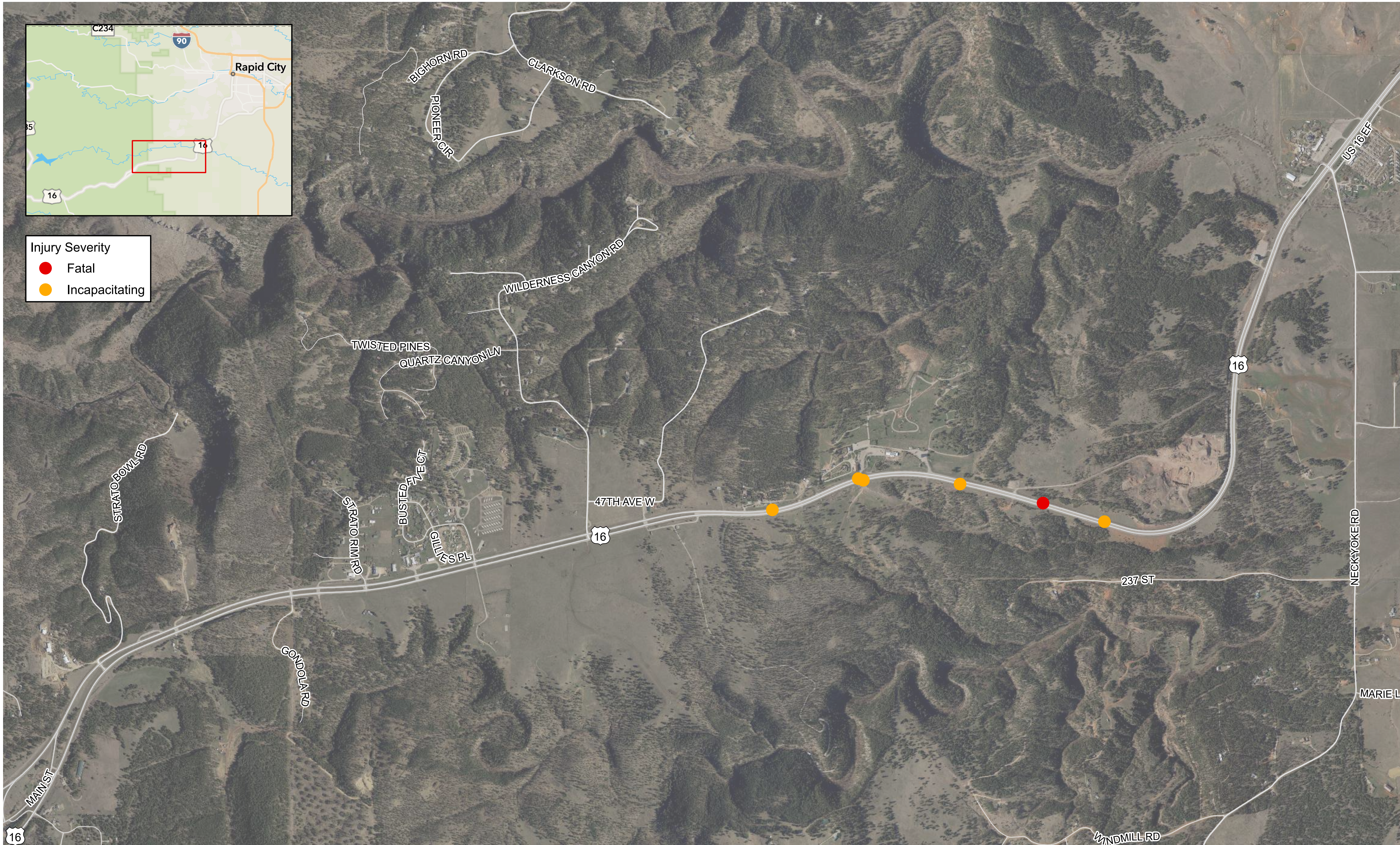
- 19 of the 29 angle crashes resulting in injury (66%)
- 6 of the 29 angle crashes resulting in serious injury or fatality (21%)

Additional information on the crash history review is provided in the *Crash History Review Memo* in **Appendix B**.



CRASH DENSITY [WITHOUT WILD ANIMAL CRASHES] (2018 - 2022)

FIGURE 2



FATAL AND SERIOUS INJURY CRASH HISTORY (2018 - 2022)

FIGURE 3

Table 2: Intersection Crash Summary (2018-2022) – Injury Severity, Manner of Collision

Highway 16 Intersection	Total Crashes	Injury Severity					Manner of Collision				Crash Rates	
		Fatal	Serious Injury	Minor Injury	Possible Injury	No Injury (PDO)	Single Vehicle	Rear-end	Angle	Sideswipe	Crash Rate	Crash Rate to Critical Crash Rate Ratio
Gondola Road	1			1					1		0.06	0.30
Strato Rim Drove	1					1			1		0.05	0.28
Christmas Village Access	1					1			1		0.06	0.29
Busted Five Court	1					1			1		0.05	0.28
Wilderness Canyon Road	5			1	1	3		2	2	1	0.30	1.49
Sitting Bull Road (West)	1					1			1		0.06	0.29
HTR Black Hills Access	1		1				1				0.05	0.28
Bear Country Exit	4		2	1		1	1		3		0.19	1.04
Bear Country Entrance	1			1					1		0.05	0.26
Rushmore Candy Company Exit	2					2	1		1		0.11	0.56
Totals	**18**	**0**	**3**	**4**	**1**	**10**	**3**	**2**	**12**	**1**		
% of Total Crashes			***17%***	***22%***	***6%***	***55%***	***17%***	***11%***	***66%***	***6%***		

All intersections are two-way stop-controlled (stop signs on the minor street approach; free-flow Highway 16)

4.2 Traffic Volume Data Collection

Intersection turning movement counts were collected on Tuesday, July 11, 2023, at eleven study intersections shown in the traffic volume figures. Counts were collected for 12 hours between 7 a.m. and 7 p.m. except for the Highway 16 & Busted Five Court intersection which was counted for a continuous 24 hours. Seasonal factors were applied to factor the July count volumes to a June season, which is consistent with the analysis month in the overarching *U.S. Highway 16 Corridor Study*. Heavy vehicle percentages are based on the collected counts.

4.3 Traffic Volumes

Existing condition (Year 2023) peak hour and daily traffic volumes are provided in **Figure 4**. Intersection peak hours were consistent across the rural sub-area intersections in the AM peak hour, but differed in the PM peak hour as summarized below:

- AM peak hour: 9:15 to 10:15 a.m.
- PM peak hour:
    - Strato Bowl Road to Busted Five Court: 4:15 to 5:15 p.m.
    - Busted Five Court to Rushmore Candy Company: 4:45 to 5:45 p.m.

Directionality was relatively balanced eastbound/westbound in the corridor peak hours, ranging between 45 and 55 percent in the eastbound/westbound directions.

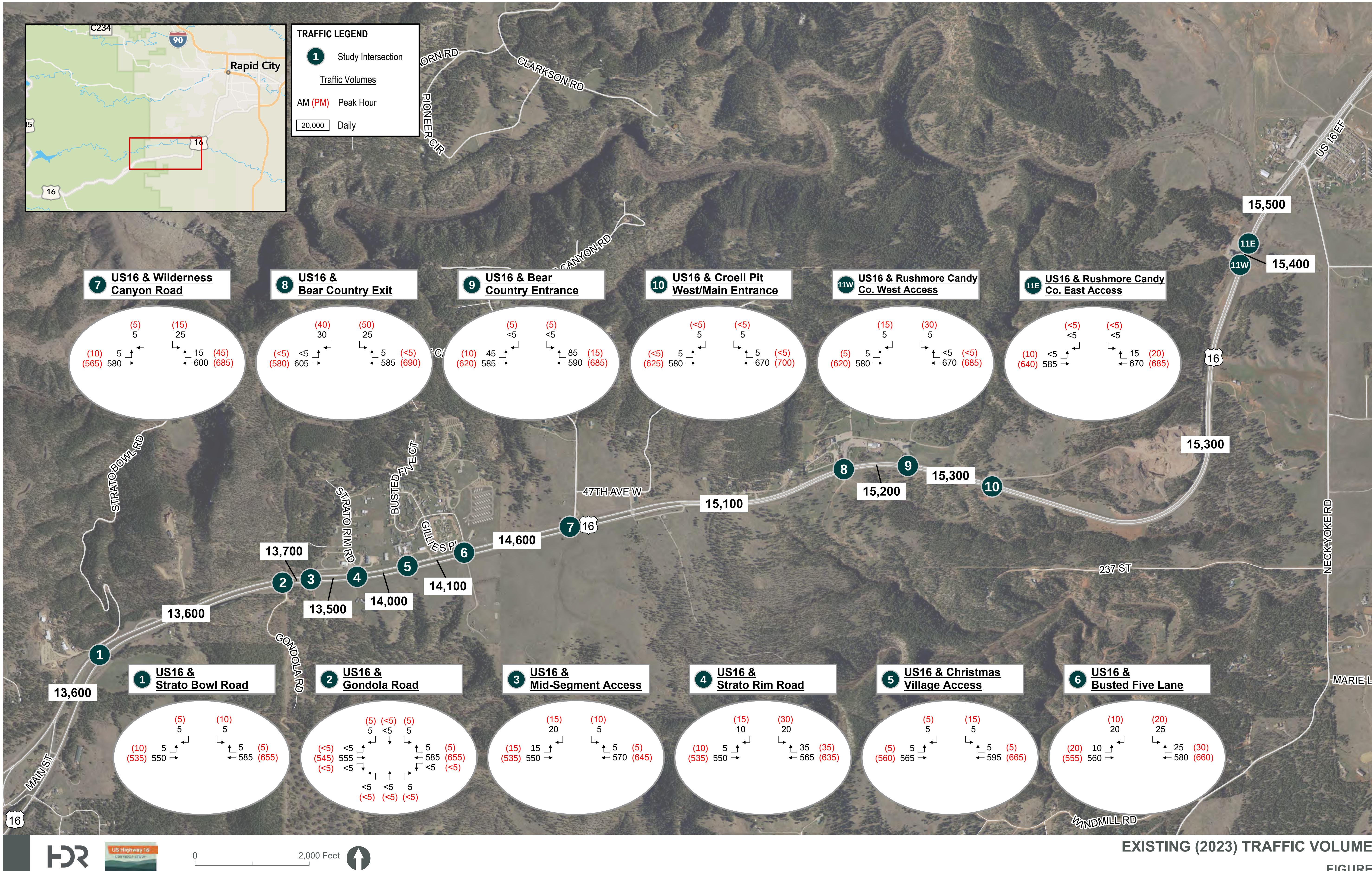
Traffic forecasts were developed for 2028 Opening Year and 2050 Planning Horizon forecast years using *NCHRP 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design* methodology. Two sources of growth rates were reviewed:

- RCAMPO travel demand model (TDM), which includes a 2018 base year and 2045 planning horizon
- SDDOT-derived growth rates maintained by the Office of Inventory Management and Research

The SDDOT-derived growth rates were selected as the basis for future-year traffic growth through the rural sub area segment. The SDDOT-derived growth rates exhibited a higher 27-year equivalent (2023 to 2050) growth factor of 1.8, compared to a TDM-derived growth factor of 1.4. Selecting 1.8 provides a more conservative look at the corridor with higher volumes and accounts for continued development. Additional side-street traffic in the Busted Five Court and Wilderness Canyon Road area was also incorporated through trip generation estimates using *ITE Trip Generation 11th Edition* for future residential development.

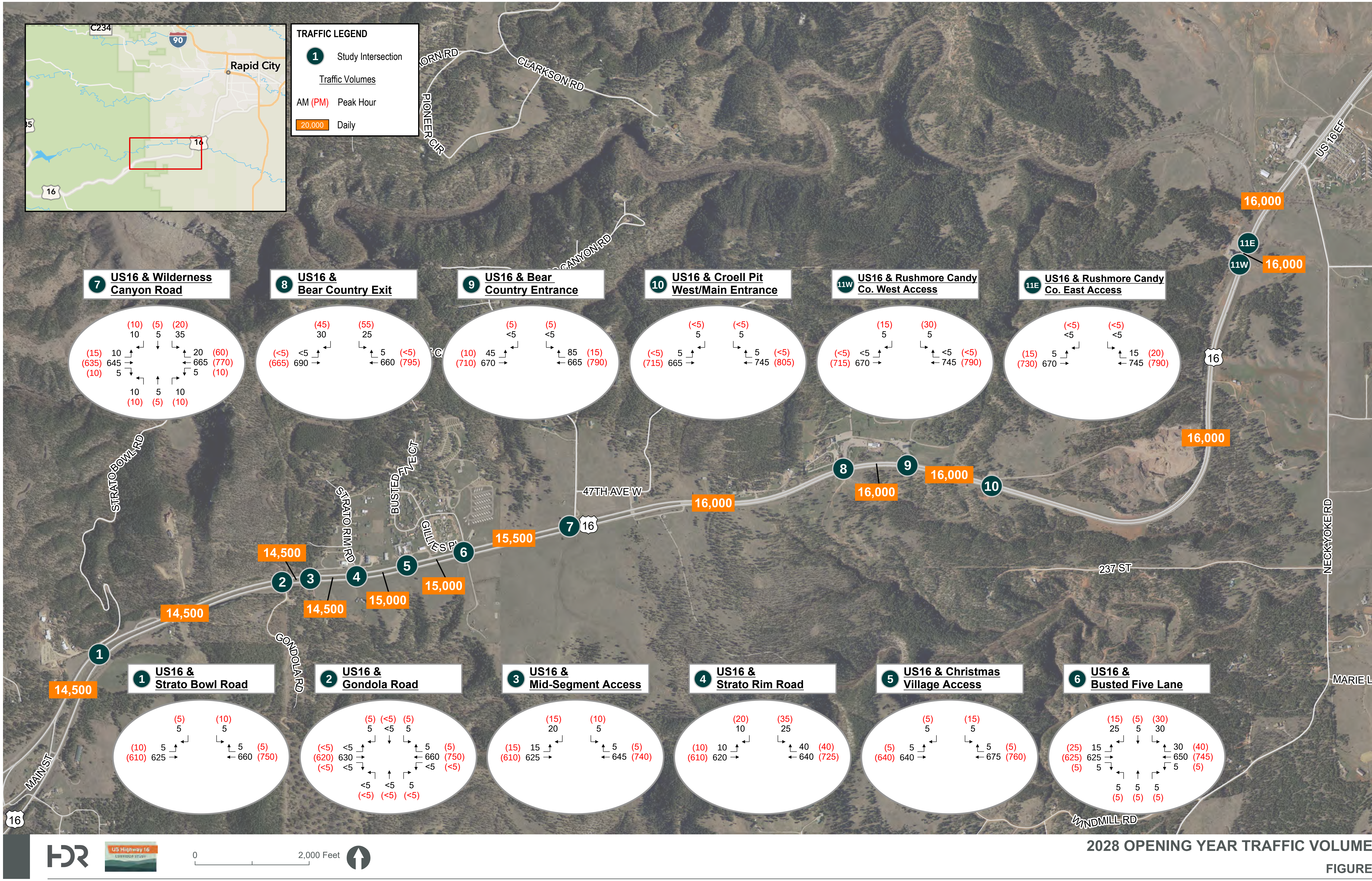
In total, the forecasted 2050 Planning Horizon daily traffic volumes are approximately 65 percent greater than today's (2023) daily traffic volumes during a typical June month. Additional information on the forecasting process is provided in the *Traffic Forecasts Memo* in **Appendix C**.

Forecasted traffic volumes are shown in **Figure 5** (2028 Opening Year), **Figure 6** (2050 Planning Horizon), and **Figure 7** (daily volume summary).



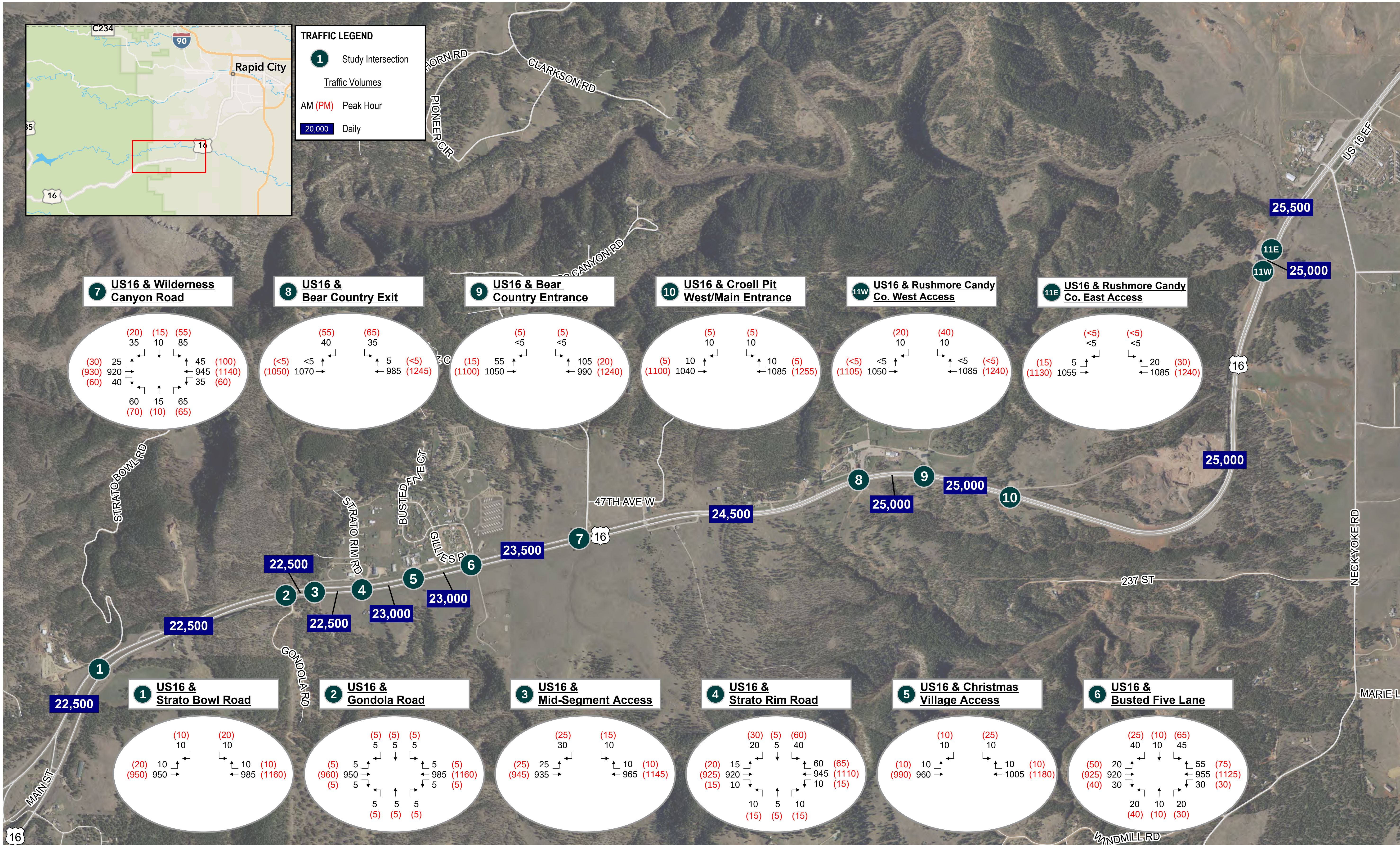
EXISTING (2023) TRAFFIC VOLUMES

FIGURE 4



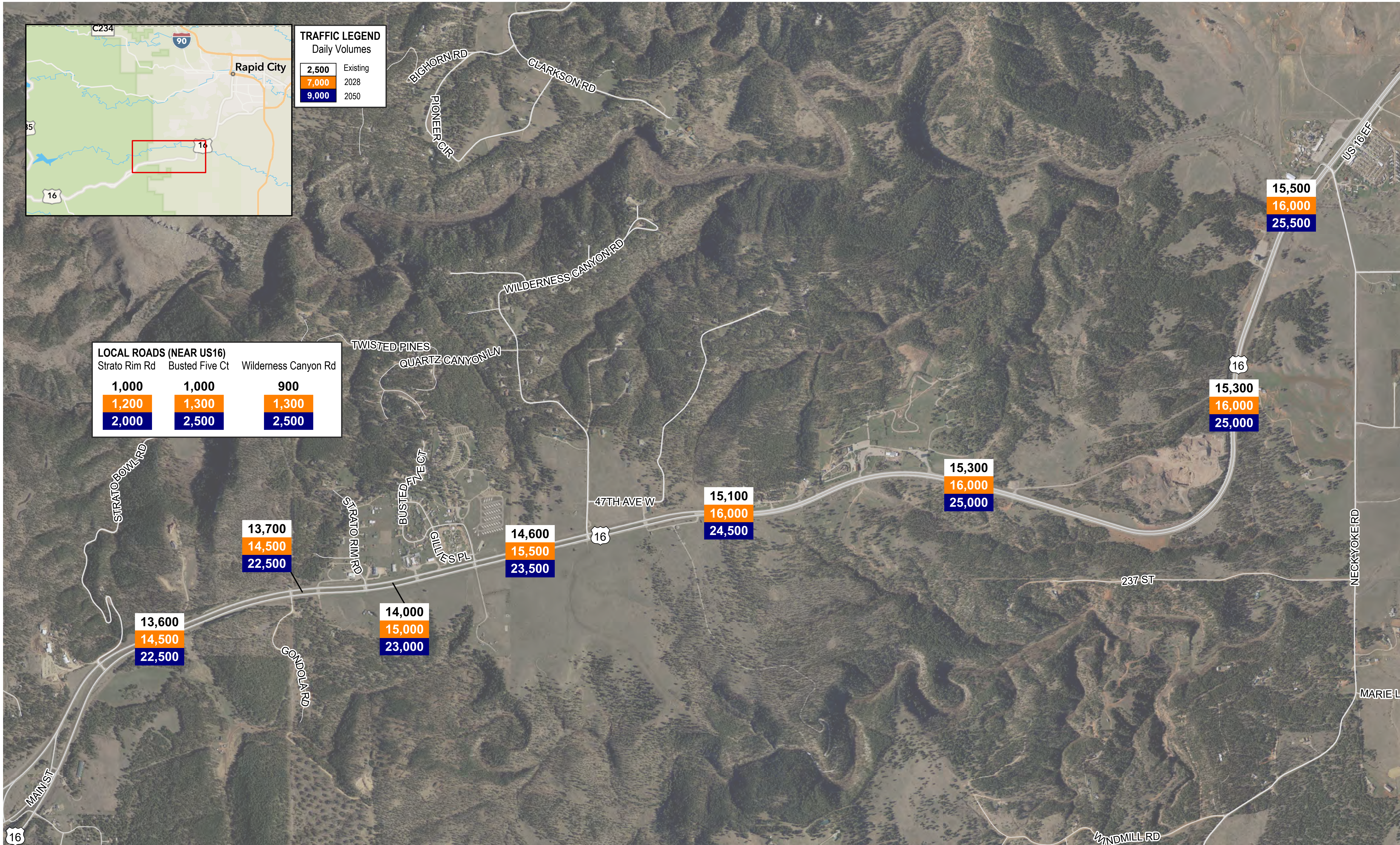
2028 OPENING YEAR TRAFFIC VOLUMES

FIGURE 5



2050 PLANNING HORIZON TRAFFIC VOLUMES

FIGURE 6



EXISTING (2023), 2028, AND 2050 DAILY VOLUMES

FIGURE 7

4.4 Traffic Operations Methodology

Peak hour level of service (LOS) was calculated for study area intersections and roadway segments using 2023 Highway Capacity Software (HCS2023) and *Highway Capacity Manual (HCM) 7th Edition* methodology. Intersection and multilane highway LOS were measured in accordance with thresholds shown in **Figure 8**.

Overall, or 'weighted', intersection delay is also calculated to present a second average delay measure at two-way stop-control intersections. This method accounts for the operational benefits afforded to the major, high volume through movements that do not need to stop through the intersection ('free' movements). A LOS measure is applied to this overall intersection delay value using HCM All-Way Stop-Control LOS thresholds.

	Multilane Highway/Freeway
A	Free-flow operation **Density:** ≤11 passenger cars/mile/lane
B	Reasonably free- flow operation; minimal restriction on lane changes and maneuvers **Density:** >11–18 passenger cars/mile/lane
C	Near free-flow operation; noticeable restriction on lane changes and other maneuvers **Density:** >18–26 passenger cars/mile/lane
D	Speed decline with increasing flows; significant restriction on lane changes and other maneuvers **Density:** >26–35 passenger cars/mile/lane
E	Facility operates at capacity; very few gaps for lane changes and other maneuvers; frequent disruptions and queues **Density:** >35–45 passenger cars/mile/lane
F	Unstable flow; operational breakdown **Density:** >45 passenger cars/mile/lane ***or*** Demand exceeds capacity

Levels Designation Scale:

LOS is presented through a familiar A to F scale, where "A" means the best operating condition and "F" the worst.

LOS Measures and Definitions: Highway Capacity Manual and SDDOT Road Design Manual

	Unsignalized Intersection	Signalized Intersection
A	Queuing is rare **Intersection Control Delay:** ≤10 seconds/vehicle	Very minimal queuing; excellent corridor progression and/or short cycle lengths **Intersection Control Delay:** ≤10 seconds/vehicle
B	Occasional queuing **Intersection Control Delay:** >10–15 seconds/vehicle	Some queuing; good corridor progression and/or short cycle lengths **Intersection Control Delay:** >10–20 seconds/vehicle
C	Regular queuing **Intersection Control Delay:** >15–25 seconds/vehicle	Regular queuing; not all demand may be serviced on some cycles (cycle failure) **Intersection Control Delay:** >20–35 seconds/vehicle
D	Queue lengths increased **Intersection Control Delay:** >25–35 seconds/vehicle	Queue lengths increased; routine cycle failures **Intersection Control Delay:** >35–55 seconds/vehicle
E	Significant queuing **Intersection Control Delay:** >35–50 seconds/vehicle	Long queues, congested conditions; majority of cycles fail **Intersection Control Delay:** >55–80 seconds/vehicle
F	Volume to capacity ratio approaches 1.0; very long queues **Intersection Control Delay:** >50 seconds/vehicle	Volume to capacity ratio near 1.0; very long queues, almost all cycles fail **Intersection Control Delay:** >80 seconds/vehicle

Note: Unsignalized intersection control delay shown for overall (weighted) intersection delay. Two-way stop-control (TWSC) delay is measured from the worst-case stop-controlled approach with the same delay thresholds.

Figure 8: Level of Service Descriptions

The LOS goal for this study is LOS B for two-way stop-controlled intersections (weighted average intersection delay), signalized intersections, and multilane highway segments.

4.5 Existing and Future No Build Condition Traffic Operations Analysis

All analyzed Highway 16 intersections and roadway segments, except for one intersection, were found to meet minimum allowable LOS thresholds through the 2050 Planning Horizon. The lone exception was the Bear Country USA Exit during Year 2050 PM peak hour at LOS C where high volumes of exiting vehicles wanting to turn left during the late afternoon coincide with high Highway 16 volumes.

There were several side street approaches that reach LOS E or worse during Year 2050 No Build conditions, including:

- Rushmore Candy Company west access (Exit) (LOS E in PM peak hour)
- Bear Country USA Entrance (for exiting traffic) (LOS E in AM peak hour and LOS F in PM peak hour)
- Bear Country USA Exit (LOS E in AM peak hour and LOS F in PM peak hour; PM peak hour queue length over ten vehicles)
- Wilderness Canyon Road (LOS F in AM and PM peak hours; PM peak hour queue length nearly eight vehicles)
- Busted Five Court (LOS F in PM peak hour)
- Strato Rim Drive (LOS E in PM peak hour)

These findings illustrate the long-range need to provide opportunities for safe and efficient traffic movements to and from the side streets due to anticipated development and continued traffic growth. As volumes grow on Highway 16, adequate gaps for left turning vehicles from the side streets will decrease and delay will increase. As this delay increases, motorists tend to take more risks to exit the side street, and this creates safety issues at the intersection.

Busted Five Court and Wilderness Canyon Road intersections are examples of where the combination of traffic growth on the Highway 16 corridor and the side street approaches (due to development) contributes to higher levels of side street delay. The Bear Country USA Exit is an example of where growth on the side street approach is anticipated to be minimal but increasing volumes on Highway 16 reduces duration and frequency of gaps in traffic for turning vehicles and thus increases side-street delay.

Additional information on the existing and future No Build condition traffic operations analysis, including analysis results and output reports, is provided in the *Existing and Future No Build Condition Traffic Operations Analysis Memo* in **Appendix D**.

5.0 Preliminary Purpose and Need

The preliminary purpose and need for a future Highway 16 project through this rural sub-area is as follows:

The purpose of the project is to address local and regional trips along the Highway 16 corridor, reduce traffic congestion from continued growth and urbanization, and improve safety by addressing traffic movements at intersections.

The need for the project is to:

- **Address local and regional trips along the Highway 16 corridor:** considering the corridor as a continuous roadway segment creating system connectivity for local and tourism traffic.
- **Reduce traffic congestion from continued growth and urbanization:** reviewing the need for roadway improvements to accommodate existing and future traffic volumes.
- **Improve safety by addressing movements at intersections:** realigning movements to reduce angle conflicts and simplify traffic movements.

6.0 Conceptual Layouts

Three primary intersection types were considered in the rural sub-area analysis:

- **Conventional intersection:** full access intersection where all movements are provided at a single median opening and side-street approaches are typically stop-controlled (stop signs). Conventional intersection modifications in the refined concepts generally include adding turn lanes and/or median acceleration lanes.
- **Partial access intersection:** intersections where certain movements are restricted within the intersection. Partial access intersections generally include modifying the Highway 16 median to restrict turns within the intersection, as described below, and/or adding warranted turn lanes.
  - **¾ access:** crossing and left turn movements from the side-street are prohibited
  - **Right-in Right-out (RIRO):** only right turns into and out of the access are accommodated
- **Reduced conflict intersection (RCI):** full access intersection where all movements are provided at a main intersection and downstream U-turn intersection(s); RCI concepts include turn lanes and raised median modifications. See **Section 7.0 Reduced Conflict Intersection Informational Resources** for additional RCI information.

Field (undeveloped) access locations are assumed to be maintained as RIRO access unless noted in the conceptual layouts. Field access points will be further evaluated during design. When a parcel develops, the existing field access for that parcel will be closed and the development will be required to tie into the full access RCI(s) or local street network to access the RCI(s).

The final set of conceptual layouts considered by the study team were grouped by Highway 16 segment 'area' for the following scenarios.

Strato Rim – Busted Five – Wilderness Canyon Area

- Scenario A: Reduced Conflict Intersections (RCIs) on Existing Alignment **(Figure 9)**
- Scenario B: Full Access Intersection Improvements on Existing Alignment **(Figure 10)**
- Scenario C: Reduced Conflict Intersections (RCIs) on New Alignment (250-ft. Separation) **(Figure 11)**
- Scenario D: Reduced Conflict Intersections (RCIs) on New Alignment (150-ft. Separation, Highway 16 Frontage Road) **(Figure 12)**
- Scenario E: Reduced Conflict Intersections (RCIs) on New Alignment (150-ft. Separation, Highway 16 Frontage Road) **(Figure 13)**
- Stratobowl Rim Trailhead U-turn Options: A) Strato Bowl Road and B) Closest feasible location west of Stratobowl Rim Trailhead **(Figure 14)**

HTR Black Hills Resort Area

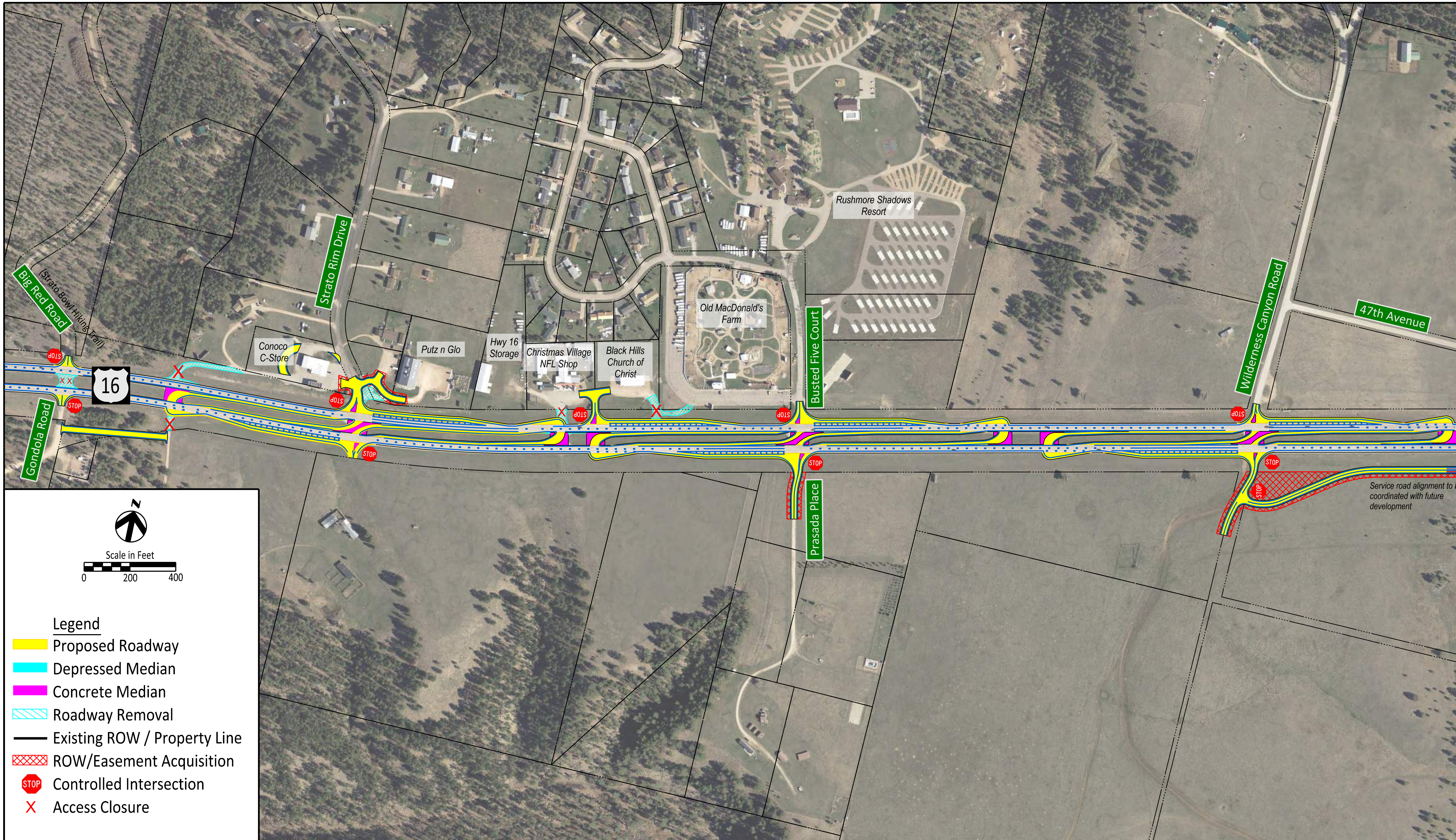
- Scenario A: ¾ Access (HTR Black Hills), RIRO Access (House of Scandinavia), and ¾ Access (Sitting Bull Road) **(Figure 15)**
- Scenario B: RCI (HTR Black Hills), ¾ Access (House of Scandinavia), and ¾ Access (Sitting Bull Road) **(Figure 15)**
- Scenario C: RCI with Shifted West U-turn (HTR Black Hills), ¾ Access (House of Scandinavia), and RIRO Access (Sitting Bull Road) **(Figure 16)**
- Scenario D: RCI with Shifted East Driveway (HTR Black Hills), ¾ Access (House of Scandinavia), and ¾ Access (Sitting Bull Road) **(Figure 16)**

Bear Country USA Area

- Reduced Conflict Intersection (RCI) **(Figure 17)**

Rushmore Candy Company Area

- Reduced Conflict Intersection (RCI) **(Figure 18)**



U.S. Highway 16 Corridor Study

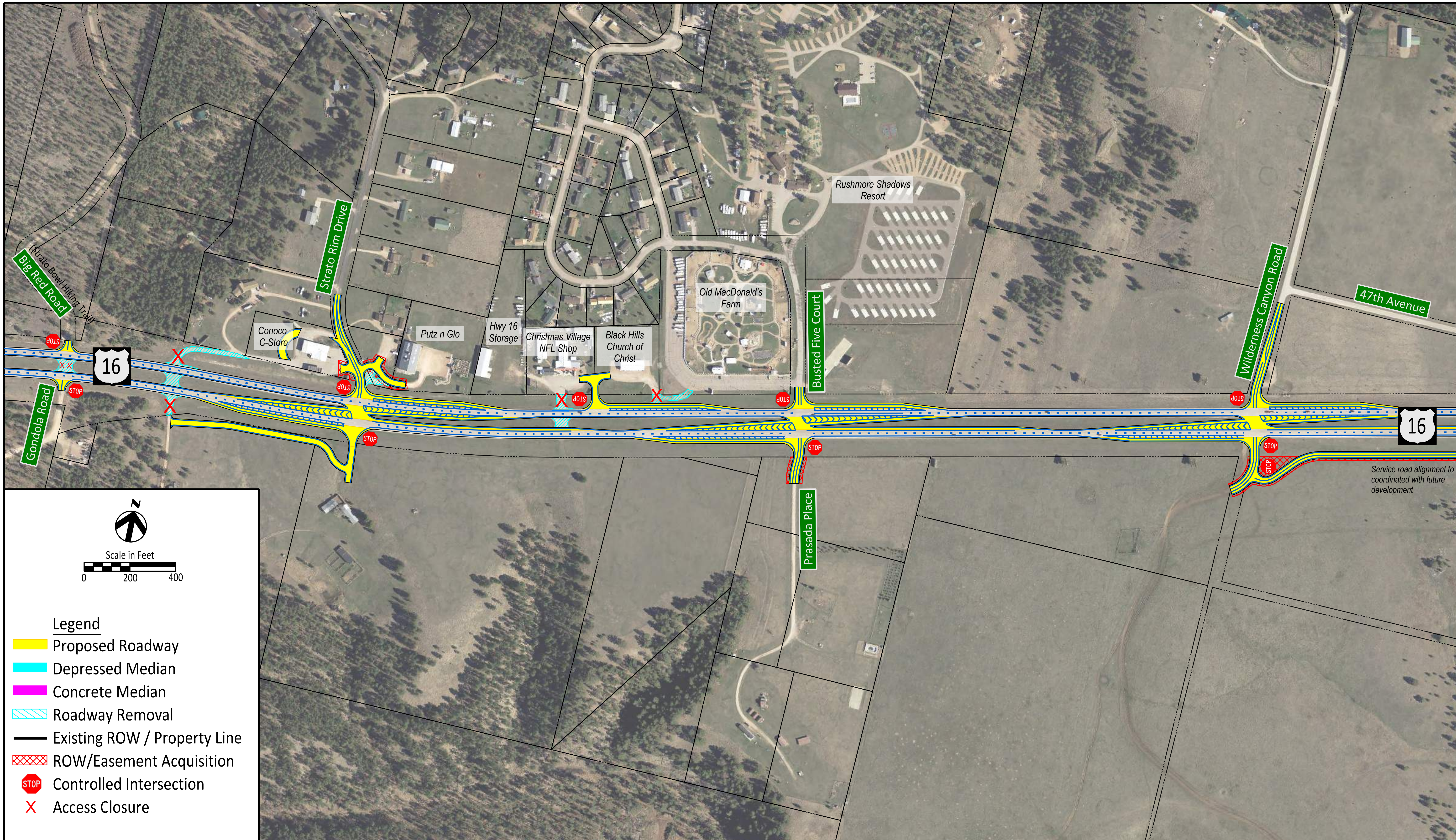
Revised: 1/31/2024

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario A: Reduced Conflict Intersections (RCIs) on Existing Alignment

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 9



U.S. Highway 16 CORRIDOR STUDY

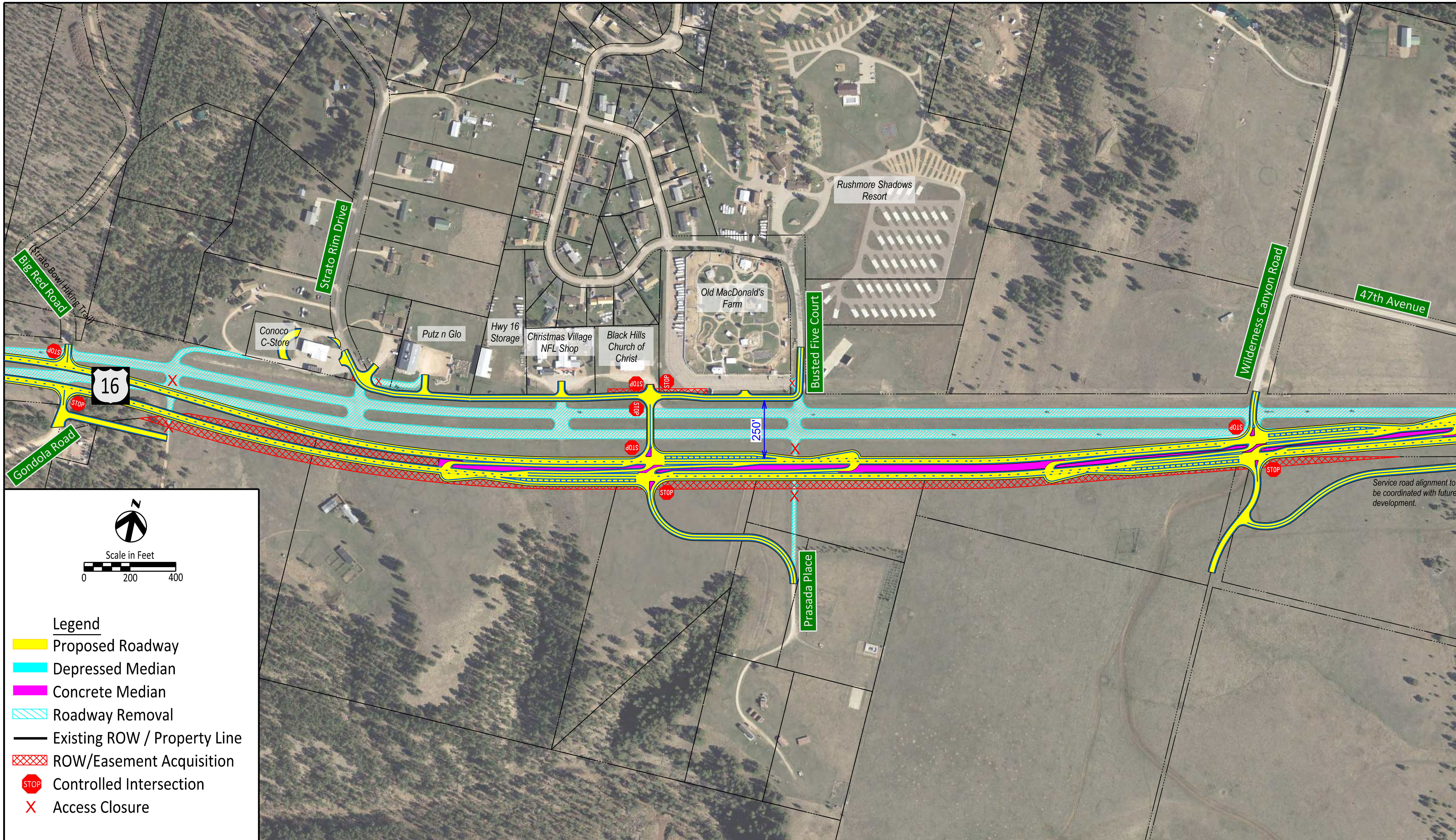
Revised: 1/31/2024

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario B: Full Access Intersection Improvements on Existing Alignment

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 10



U.S. Highway 16 CORRIDOR STUDY

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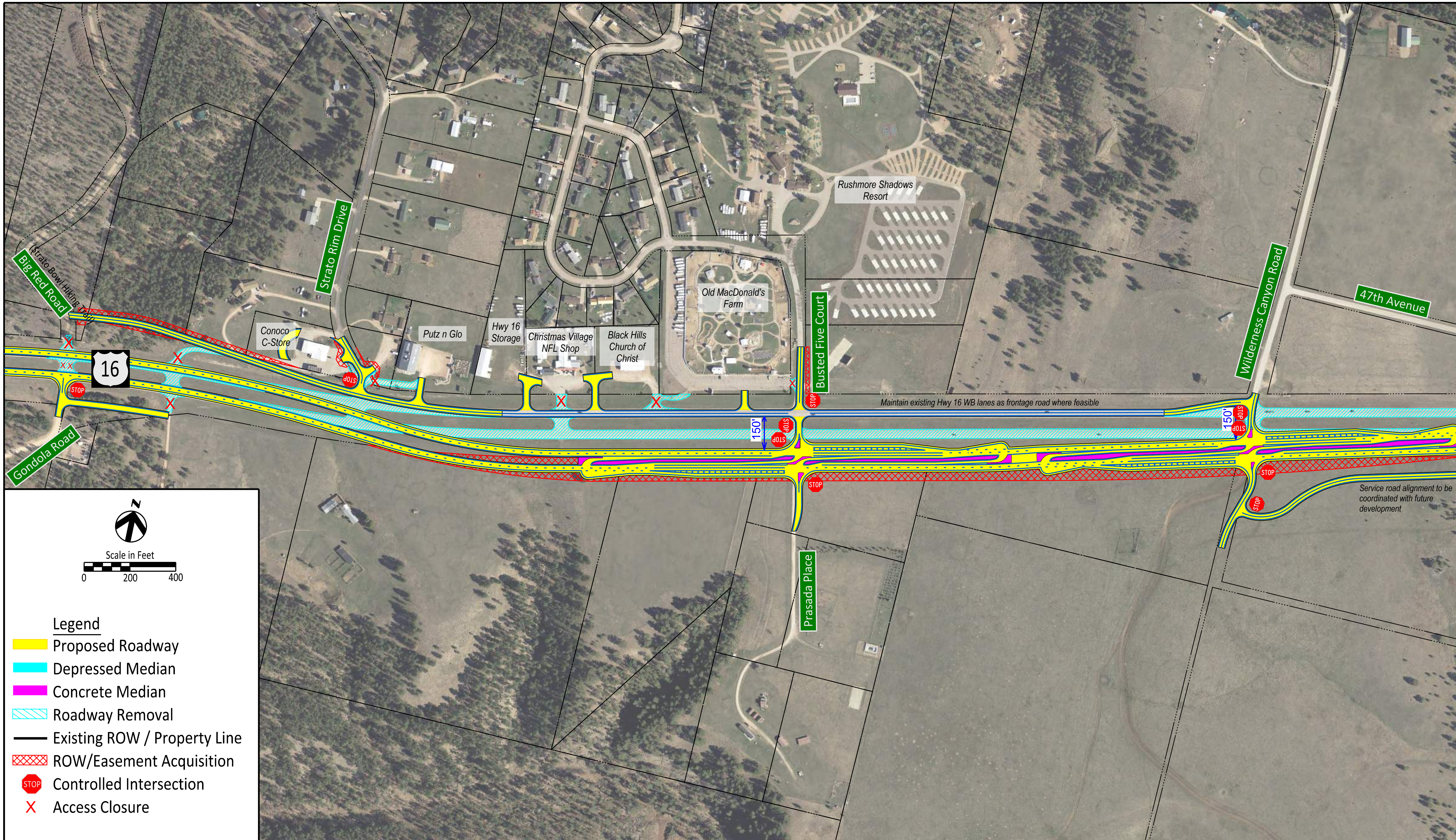
SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | RAPID CITY AREA Metropolitan Planning Organization | RC City of Rapid City LIVE. WORK. GROW. | PENNINGTON COUNTY

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario C: Reduced Conflict Intersections (RCIs) on New Alignment (250' Separation)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 11



U.S. Highway 16 CORRIDOR STUDY

Revised: 1/31/2024

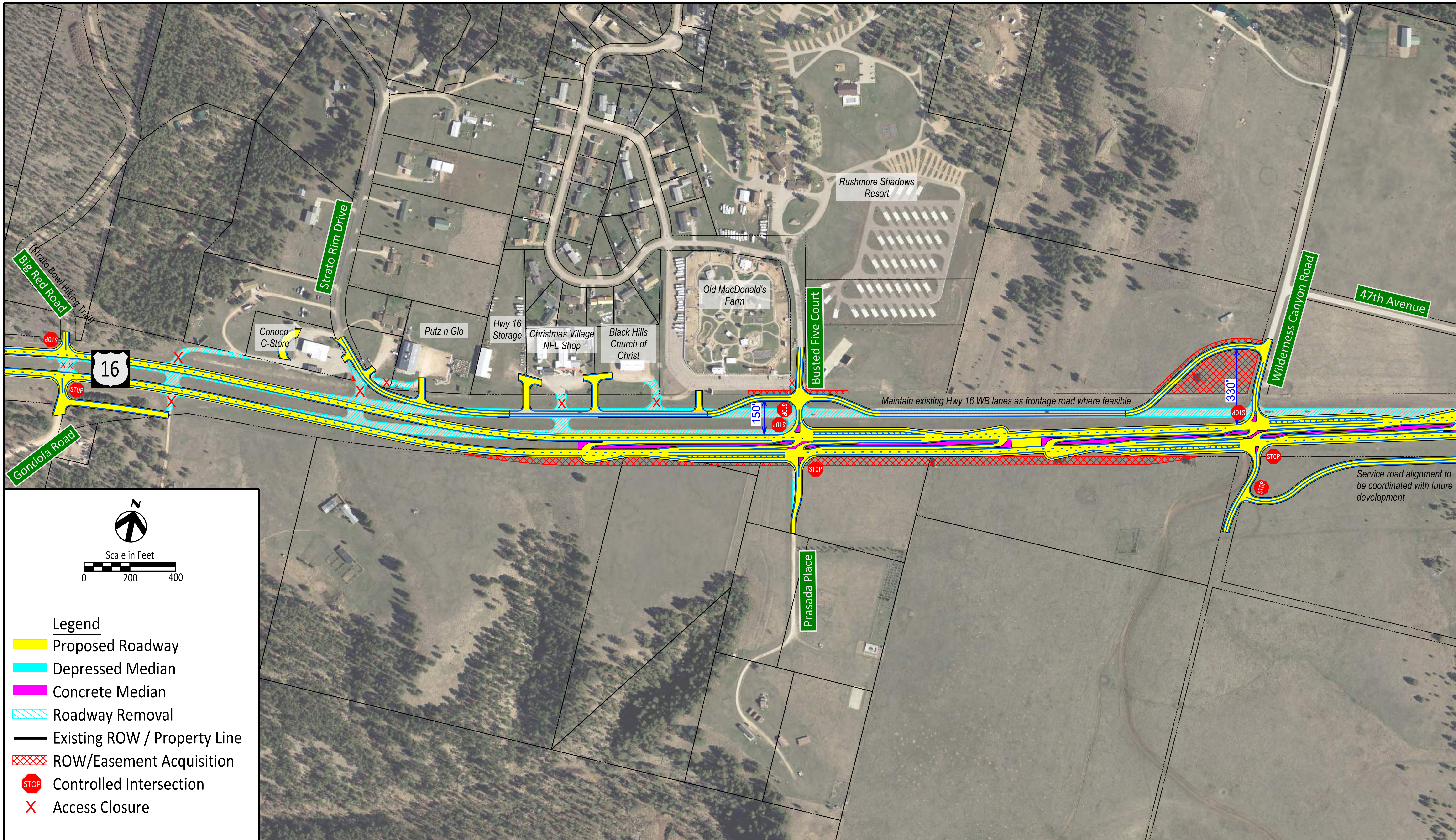
SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | Rapid City Area Metropolitan Planning Organization | City of Rapid City Live. Work. Grow. | Pennington County

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario D: Reduced Conflict Intersections (RCIs) on New Alignment (150' Separation, US16 Frontage Rd)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 12



U.S. Highway 16 CORRIDOR STUDY

Revised: 1/31/2024

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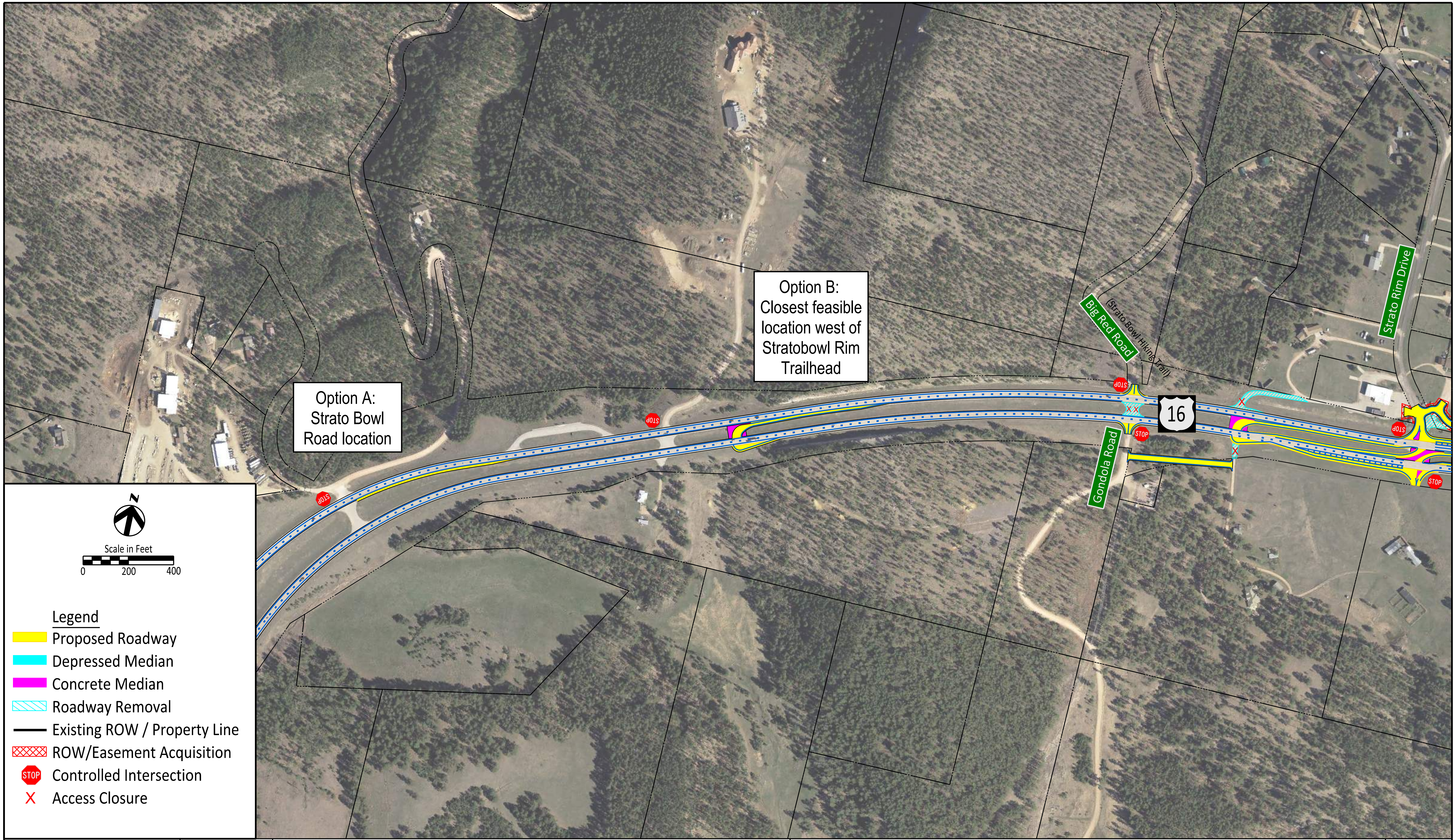
Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario E: Reduced Conflict Intersections (RCIs) on New Alignment (150' Separation, New Frontage Rd)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 13



U.S. Highway 16 CORRIDOR STUDY

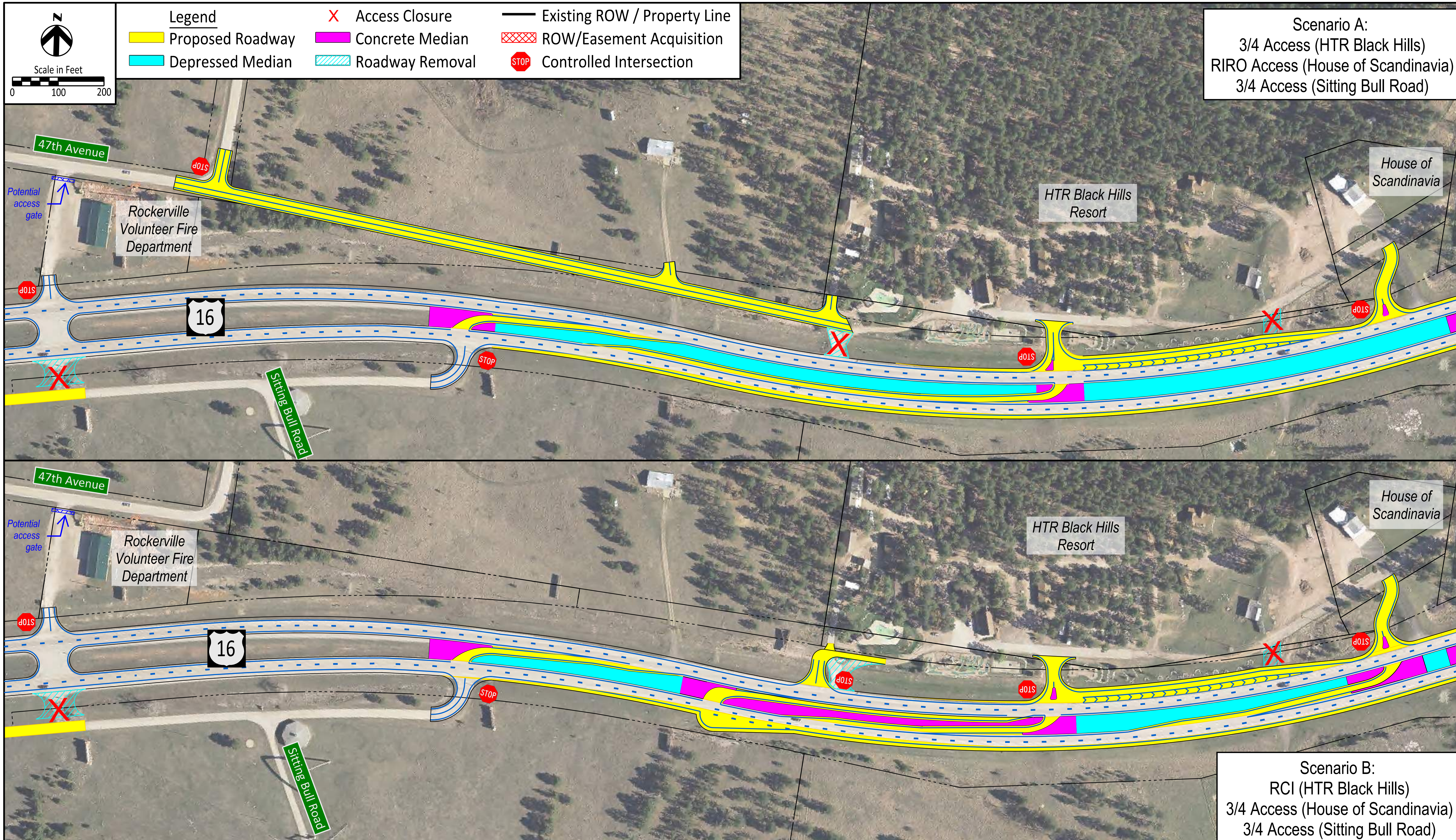
Revised: 1/31/2024

Stratobowl Rim Trailhead U-Turn Options

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 14



U.S. Highway 16 CORRIDOR STUDY

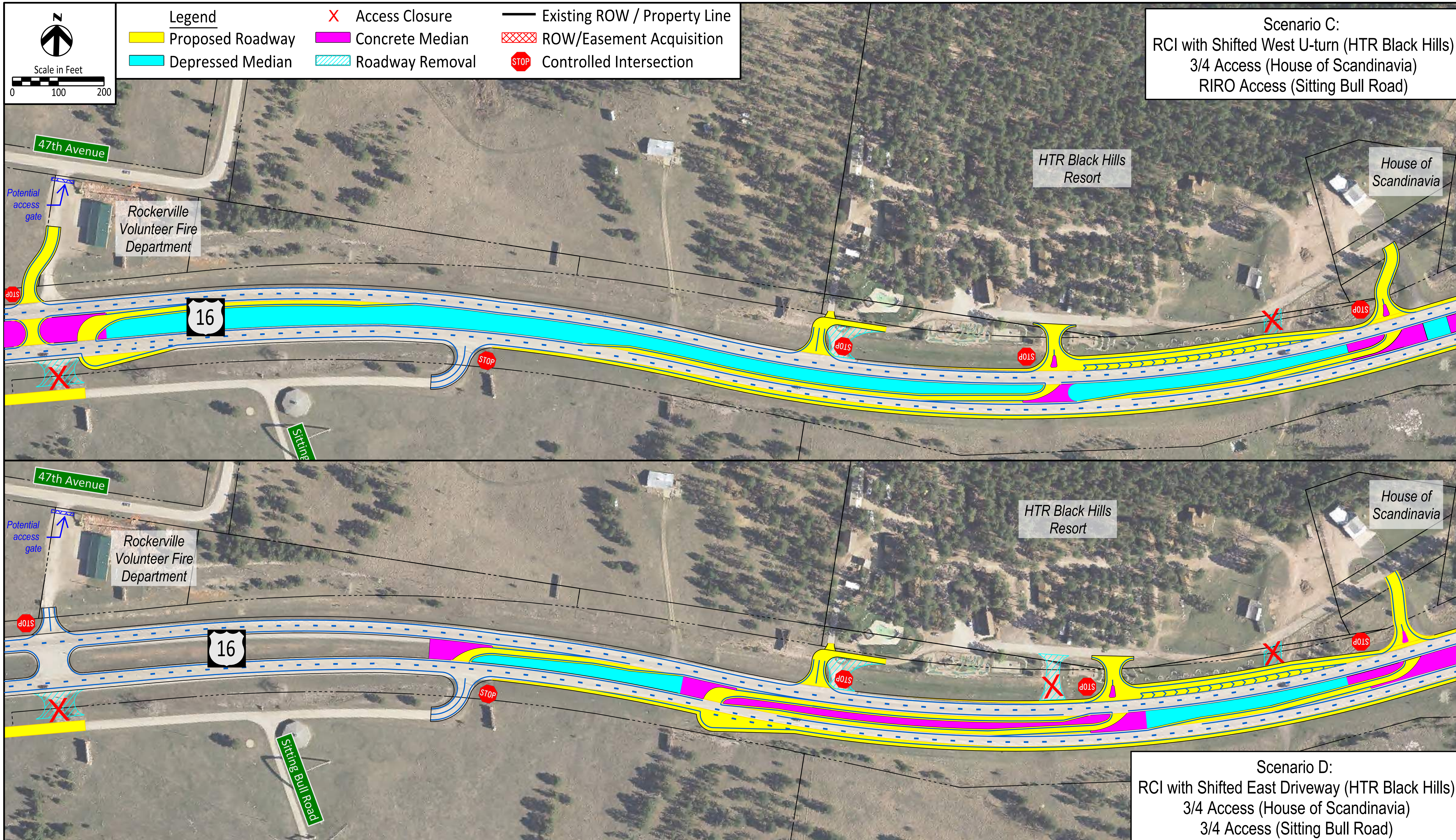
Revised: 1/31/2024

HTR Black Hills Resort Area
Access Management Scenarios A and B

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 15



U.S. Highway 16 CORRIDOR STUDY

Revised: 1/31/2024

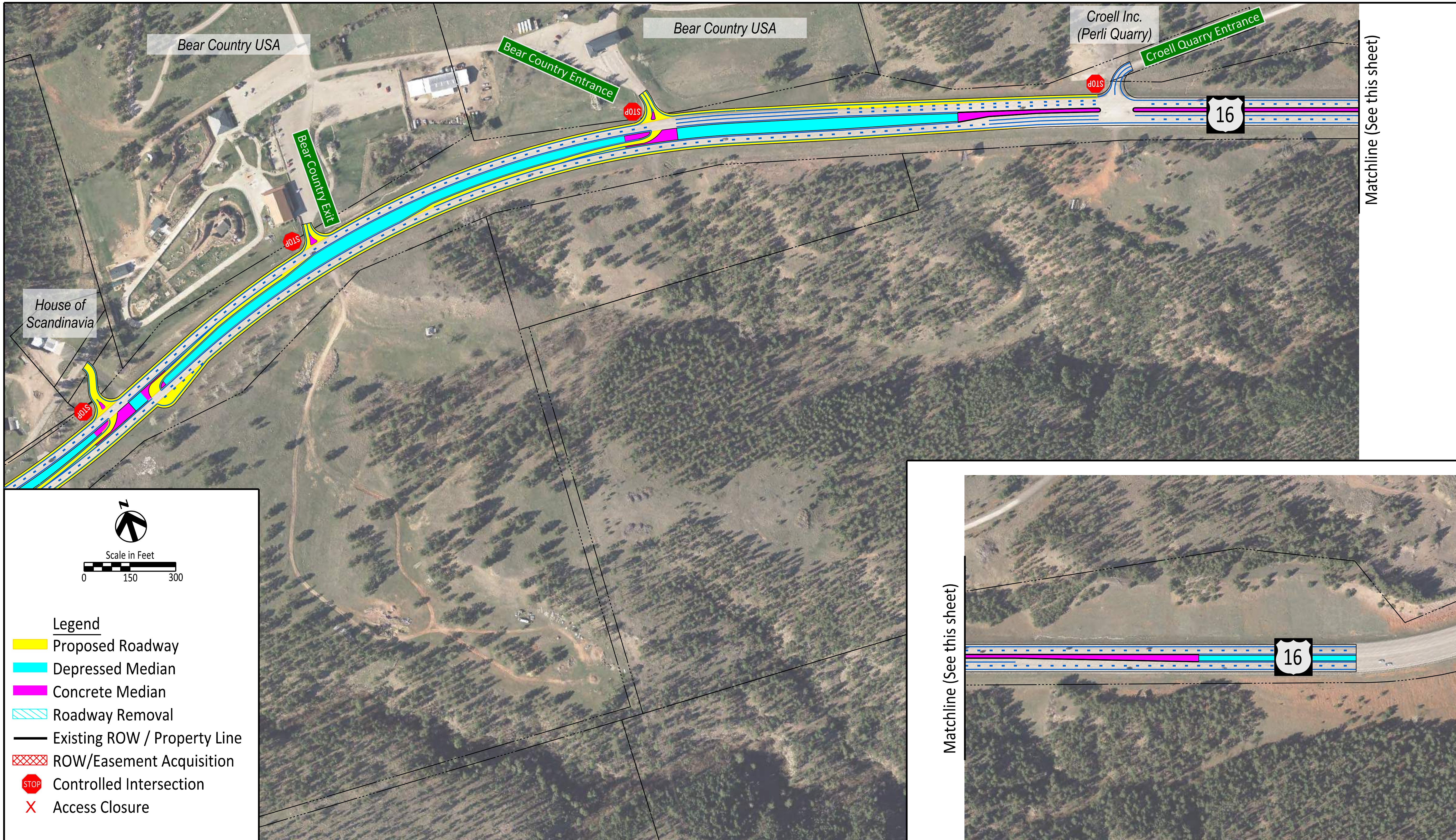
SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | Rapid City Area Metropolitan Planning Organization | City of Rapid City | Pennington County

HTR Black Hills Resort Area
Access Management Scenarios C and D

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 16



U.S. Highway 16 CORRIDOR STUDY

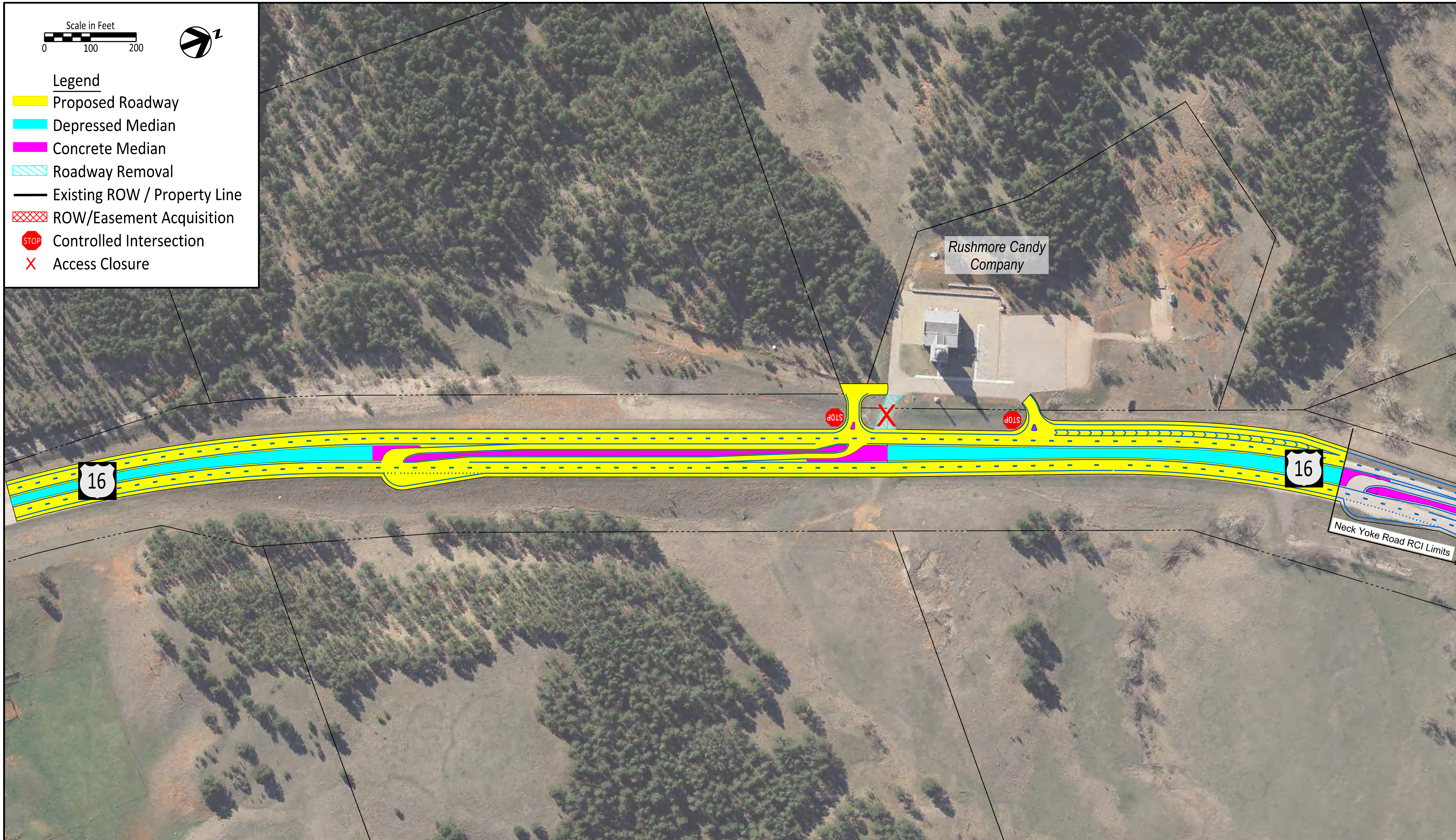
Revised: 1/31/2024

Bear Country USA Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
17



U.S. Highway 16 CORRIDOR STUDY

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Rushmore Candy Company Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

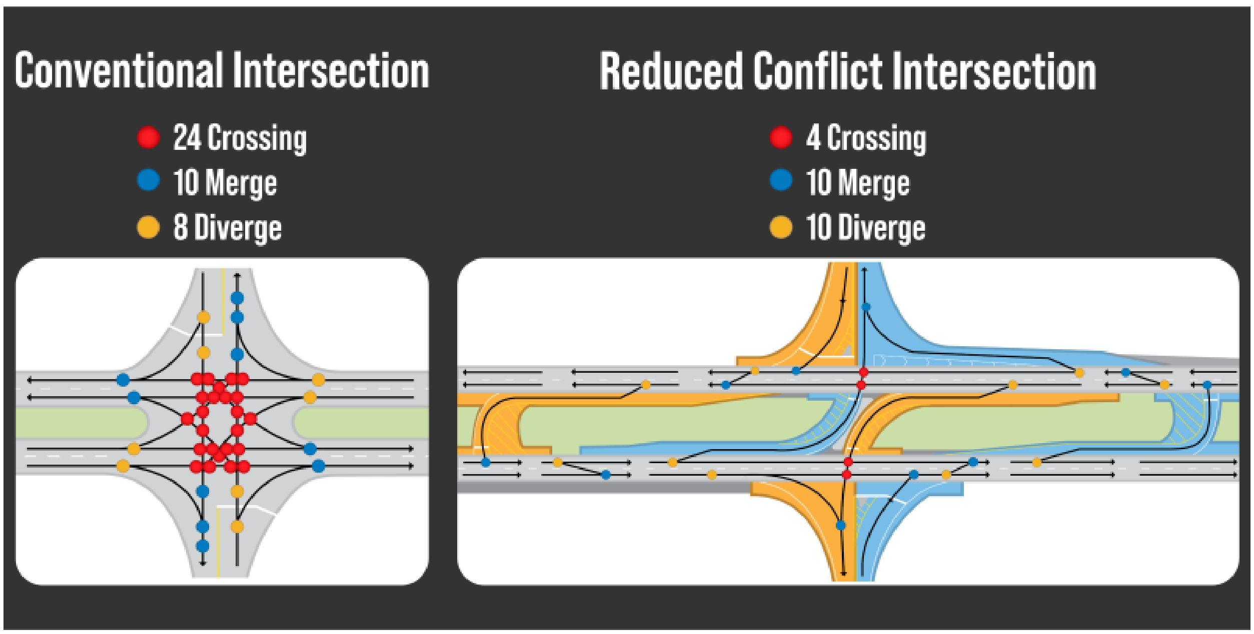
Pennington County, SD

Figure 18

7.0 Reduced Conflict Intersection Informational Resources

An RCI, also referred to as a Restricted Crossing U-turn (RCUT) or J-turn, is an alternative intersection type that improves intersection safety and operational efficiency by:

- **Eliminating angle conflicts created by side-street left turn and through movements,** which have a high propensity for serious injury crashes
    - Number of angle (crossing) conflicts are reduced from as many as 24 in a conventional intersection to just 4 in an RCI (see **Figure 19**)
- **Simplifying traffic movements** so drivers only need to focus on one direction at a time
- **Increasing arterial corridor efficiency** by creating two, independent one-way streets
- **Providing for a full access** through multiple intersections, which includes a main intersection and downstream U-turn(s)
- **Providing greater median storage** for long and/or multiple vehicles within the median U-turn lanes



Source: Iowa Department of Transportation DOT
https://www.transportationmatters.iowadot.gov/2022/09/new-fort-dodge-intersection-developed-to-reduce-number-of-crashes-and-serious-injuries.html

Figure 19: Intersection Conflict Points

An RCI incorporates traffic movements that are commonly used throughout the transportation network. Applicable passenger vehicle and WB-67 semi-truck turn movements within Scenario A's Highway 16 & Busted Five Court RCI are shown in **Figure 20** and **Figure 21**, respectively.

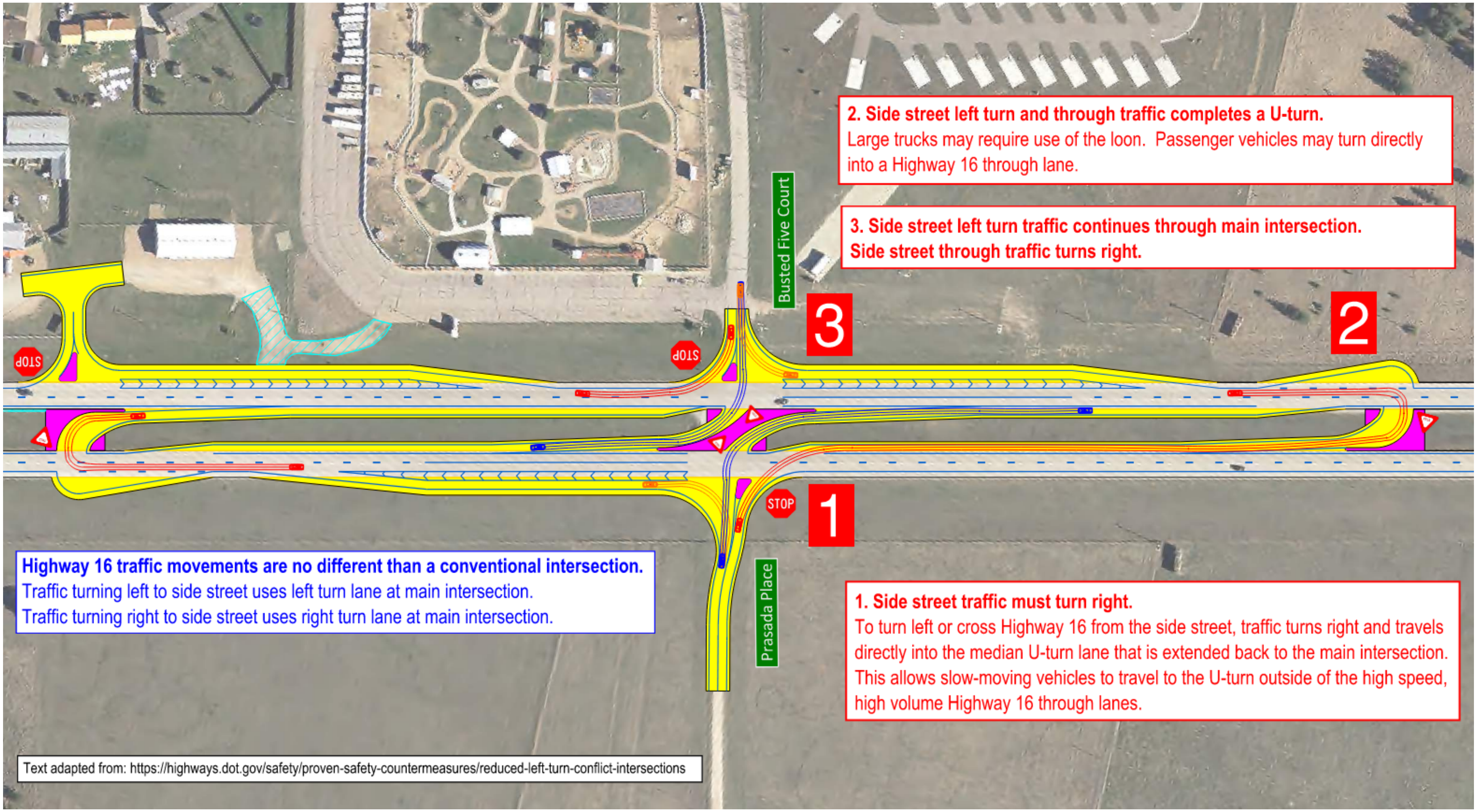


Figure 20: RCI Turn Movements – Passenger Car (Busted Five Court RCI, Scenario A)

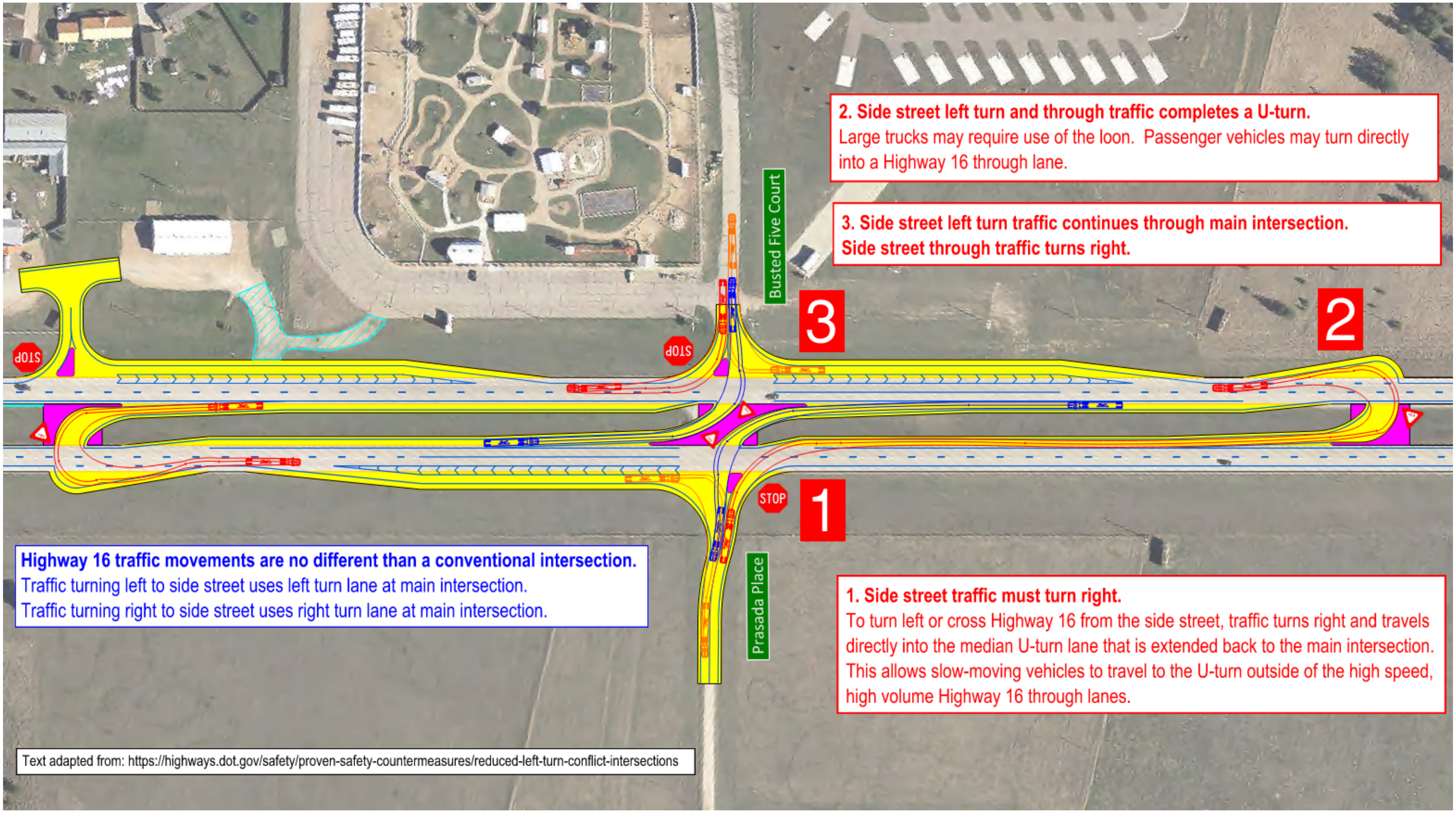


Figure 21: RCI Turn Movements – WB-67 Semi-Truck (Busted Five Court RCI, Scenario A)

Available RCI resources commonly referenced at Study Advisory Team, public, and stakeholder meetings are listed below with links to agency websites. These resources provided informational graphics, benefits/drawbacks, and videos. See **Section 8.0 Reduced Conflict Intersection** Design for information on design resources used in the conceptual layouts.

Federal Highway Administration

An RCI is one of 28 proven safety countermeasure and strategies identified by FHWA as “effective strategies in reducing roadway fatalities and serious injuries on our Nation’s highways.” FHWA Proven Safety Countermeasures and Reduced Conflict Intersection websites include:

Proven safety countermeasures main page: https://highways.dot.gov/safety/proven-safety-countermeasures

Reduced conflict intersection information: https://highways.dot.gov/safety/proven-safety-countermeasures/reduced-left-turn-conflict-intersections

Minnesota Department of Transportation

The Minnesota Department of Transportation’s (MnDOT) J-Turns informational website includes a summary of benefits, navigational videos (overview, semis/farm equipment, pickup truck with load and firetruck), and resources (location map, news articles, and MnDOT studies). J-Turn testimonial videos are not currently linked to the main J-Turn informational website but are hosted on YouTube and often linked to J-turn project websites.

J-turn main page: https://www.dot.state.mn.us/roadwork/j-turns/

Testimonial videos (study site): https://talk.dot.state.mn.us/hwy-14-co-rd-9-rci/widgets/58026/key_links

Virginia Department of Transportation

The Virginia Department of Transportation (VDOT) provides information and resources on 20 innovative intersections and interchanges through their Virginia Intersection and Interchange Control Assessment Program (iCAP). The main Virginia iCAP website includes a map of where innovative intersections have been implemented throughout the state. The RCUT page includes a description of an RCUT, when it should be considered, benefits, conflict point schematic, and additional resources.

VDOT iCAP main page: https://www.vdot.virginia.gov/about/our-system/highways/innovative-intersections/virginia-icap/

RCUT information: https://www.vdot.virginia.gov/about/our-system/highways/innovative-intersections/restricted-crossing-u-turn/

8.0 Reduced Conflict Intersection Design Resources

8.1 RCI Design Resources

Conceptual RCI layouts incorporate current design guidelines and best practices from the following sources:

- **American Association of State Highway and Transportation Officials (AASHTO)**
    - *A Policy on Geometric Design of Highways and Streets*
- **South Dakota Department of Transportation**
    - *Road Design Manual* https://dot.sd.gov/doing-business/engineering/design-services/forms-manuals#listItemLink_1188
- **Minnesota Department of Transportation**
    - *Best Practices for Design and Operation of Reduced Conflict Intersections* https://www.dot.state.mn.us/roadwork/j-turns/resources.html
- **Nebraska Department of Transportation**
    - *Policy for Reduced Conflict Intersections, Policy Number DES 23-01* https://dot.nebraska.gov/media/bksl1vjp/des-2301-reduced-conflict-intersections.pdf
    - *Roadway Design Manual* https://dot.nebraska.gov/media/by4be54v/rdm.pdf
        - See Chapter 4 (Intersections, Driveways, and Channelization) Reduced Conflict Intersections, section 1.A.4
- **North Carolina Department of Transportation**
    - *Roadway Design Manual* https://connect.ncdot.gov/projects/Roadway/Roadway%20Design%20Manual/09.%20At%20Grade%20Intersections.pdf
        - See Chapter 9 (Intersections), section 9-4 Directional Crossovers with Median U-turns

8.2 RCI Design Elements Incorporated into Conceptual Layouts

Notable RCI design elements incorporated into the conceptual layouts include:

- 65-mph design speed for Highway 16
- WB-67 semi-truck design vehicle
- 800 to 850-foot spacing between the main intersection and downstream U-turns, which is primarily a function of turn lane design (deceleration and traffic queue). It was desired to provide as much deceleration distance as feasible within the turn lane for operational and safety benefits while still minimizing out-of-the-way travel to the U-turn locations. The spacing can be further evaluated during design.
- Turn lane geometrics based on *SDDOT Road Design Manual* Figure 12-12 for warranted turn lanes, and include:
    - Deceleration distance that accounts for grade
    - Positive offset between opposing left turn lanes
    - Offset right turn lanes (parallel design shown in layouts)

- Extending U-turn lanes back to the main intersection
  - Allows side street traffic to cross Highway 16 into the U-turn lane and travel to the U-turn outside of the high-speed, high-volume Highway 16 through lanes
  - Careful attention to the travel path of side street traffic crossing Highway 16 and turning into the U-turn lane is important to not reintroduce angle conflict points with approaching Highway 16 traffic
    - Raised islands, pavement markings, and starting the U-turn lane slightly downstream of the main intersection are all designed to direct side-street traffic to cross Highway 16 closer to a 30 to 45 degree angle. If there were to be a conflict, this vehicle path would result in a lower severity sideswipe or rear-end conflict
- No driveway/side-street access located within the U-turn loons
  - 100-ft. separation between a driveway/side-street access and a loon is desired
- Distinct separation between U-turn loon and downstream right turn lane
  - Loon ties back into Highway 16 mainline before the right turn taper begins
  - No acceleration lane extending out of the loon; acceleration will occur in the outside through lane
- Lighting was not included in the conceptual layouts, but will be evaluated as part of design using *SDDOT Road Design Manual* lighting warrants
- Side-street right turn channelizing islands, main intersection channelizing islands, and raised medians at the U-turn locations are shown in the layouts; extent of these elements will be evaluated during design
- Intersection sight distance based on Nebraska Department of Transportation *Policy for Reduced Conflict Intersections* guidance
  - RCI U-turn (**Figure 22**)
    - Left Turn from Stop on the Minor Road, Case B-1 (*A Policy on Geometric Design of highways and Streets*)
  - Right turn from stop at main intersection (**Figure 23**)
    - Right Turn from Stop on the Minor Road, Case B-2 (*A Policy on Geometric Design of highways and Streets*)
  - Left turn from major road at main intersection (**Figure 23**)
    - Left Turn from the Major Road, Case F (*A Policy on Geometric Design of highways and Streets*)

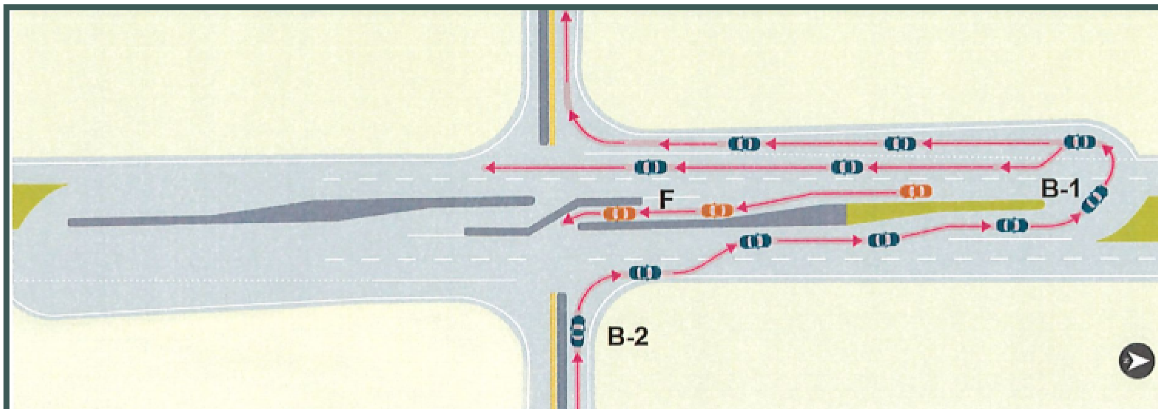
8.3 Crest Vertical Curves and U-turn Sight Distance

Two locations were flagged for further evaluation of U-turn sight distance during design:

- Vertical curve through Gondola Road intersection (Strato Rim Drive RCI)
- Vertical curve through Sitting Bull Road intersections (Wilderness Canyon Road RCI)

In both locations, flattening the Highway 16 vertical curve will likely be required to provide ‘Left Turn from Stop on the Minor Road’ U-turn sight distance for passenger cars and WB-67 trucks at a 65-mph design speed. Both locations appear to meet stopping sight distance for a 65-mph design speed.

An exploratory analysis of various sight distance criteria, Wilderness Canyon Road RCI locations, HTR Black Hills Resort RCI locations, and vertical curve modification combinations was conducted to better understand what may or may not need further evaluation during design. Conceptual profiles, sight distance information, and findings are summarized in **Appendix E**.



Intersection Sight Distance Left Turn from Stop on the Minor Road Case B-1, *Green Book*, page 9-43			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck** ②	**Passenger Car** ③
55 mph	990 feet	825 feet	650 feet
60 mph	1075 feet	900 feet	705 feet
65 mph	1165 feet	975 feet	765 feet
70 mph	1255 feet	1050 feet	825 feet
75 mph	1345 feet	1125 feet	880 feet

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

$ISD = 1.47\ V_{MAJOR}\ t_g$

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

Assumption: Turning vehicle is crossing two lanes of traffic to enter Loon

① t_g = <u>12.2 sec</u> (11.5 sec + 0.7 sec for additional lane, *Green Book* Table 9-6, page 9-44)

② t_g = <u>10.2 sec</u> (9.5 sec + 0.7 sec for additional lane, *Green Book* Table 9-6, page 9-44)

③ t_g = <u>8.0 sec</u> (7.5 sec + 0.5 sec for additional lane, *Green Book* Table 9-6, page 9-44)

Note: "Furthermore, a departure sight triangle for left turns from the median roadway should be provided for the largest design vehicle that can be stored on the median roadway with adequate clearance to the through lanes." *Green Book*, page 9-47

Exhibit 2a Intersection Sight Distances for a RCI
Case B-1, Left Turn from Stop on the Median to the Loon

Source: Nebraska Department of Transportation Policy for Reduced Conflict Intersections, Policy Number DES 23-01. https://dot.nebraska.gov/media/bksl1vjp/des-2301-reduced-conflict-intersections.pdf

Figure 22: Intersection Sight Distance Guidance (Downstream U-Turn)

Intersection Sight Distance Right Turn from Stop on the Minor Roadway Case B-2, *Green Book*, page 9-47			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck ②**	**Passenger Car ③**
55 mph	850 feet	690 feet	525 feet
60 mph	925 feet	750 feet	575 feet
65 mph	1005 feet	815 feet	645 feet (SSD)
70 mph	1080 feet	875 feet	730 feet (SSD)
75 mph	1160 feet	940 feet	820 feet (SSD)

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

$ISD = 1.47\ V_{MAJOR}\ t_g$

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

SSD = Stopping Sight Distance (*Green Book* Table 9-9, page 9-48). SSD will be used as the minimum condition when it exceeds the computed ISD.

① t_g = 10.5 sec (*Green Book* Table 9-8, page 9-47)
② t_g = 8.5 sec (*Green Book* Table 9-8, page 9-47)
③ t_g = 6.5 sec (*Green Book* Table 9-8, page 9-47)

Exhibit 2b Intersection Sight Distances for a RCI
Case B-2, Right Turn from Stop on Minor Road

Intersection Sight Distance Left Turn from the Major Road Case F, *Green Book*, page 9-56			
Design Speed	**Design Vehicle**		
	WB-67 ①	**Single-Unit Truck ②**	**Passenger Car ③**
55 mph	625 feet	540 feet	495 feet (SSD)
60 mph	680 feet	590 feet	570 feet (SSD)
65 mph	735 feet	645 feet (SSD for car)	645 feet (SSD)
70 mph	790 feet	730 feet (SSD for car)	730 feet (SSD)
75 mph	850 feet	820 feet (SSD for car)	820 feet (SSD)

Intersection Sight Distance is calculated using Equation 9-1 from the *Green Book*, page 9-45:

$ISD = 1.47\ V_{MAJOR}\ t_g$

V_{MAJOR} = Design Speed of major road (mph)

t_g = time gap for minor road vehicle to enter the major road (sec)

SSD = Stopping Sight Distance (*Green Book* Table 9-17, page 9-57). SSD will be used as the minimum condition when it exceeds the computed ISD.

Assumption: Turning vehicle is crossing an additional four-foot median (.3333 equivalent lane)

① t_g = 7.7 sec (7.5 sec + 0.2 sec for equivalent lane, *Green Book* Table 9-16, page 9-57)
② t_g = 6.7 sec (6.5 sec + 0.2 sec for equivalent lane, *Green Book* Table 9-16, page 9-57)
③ t_g = 5.7 sec (5.5 sec + 0.2 sec for equivalent lane, *Green Book* Table 9-16, page 9-57)

Note: "Sight distance design should be based on a left turn by a stopped vehicle, since a vehicle that turns left without stopping would need less sight distance." *Green Book*, page 9-56

Exhibit 2c Intersection Sight Distances for a RCI
Case F, Left Turn from Expressway

Source: Nebraska Department of Transportation Policy for Reduced Conflict Intersections, Policy Number DES 23-01. https://dot.nebraska.gov/media/bksl1vjp/des-2301-reduced-conflict-intersections.pdf

Figure 23: Intersection Sight Distance Guidance (Main Intersection Left and Right Turns)

9.0 Alternatives Evaluation

9.1 Build Condition Traffic Operations Analysis

9.1.1 Methodology

The Build condition peak hour LOS was calculated using HCS2023 and *HCM 7th Edition* methodology, similar to the No Build conditions. With inclusion of the RCI alternative intersection, the Experienced Travel Time (ETT) is also calculated and compared to the minimum allowable LOS threshold. The ETT considers intersection delay plus the extra distance travel time of an entire origin-destination path through the multiple 'intersections' of an RCI. A comparison of intersection delay and ETT measures for the respective LOS values is provided in **Table 3**.

Table 3: Intersection Level of Service Thresholds

LOS	Intersection Delay per Vehicle (sec/veh)		Experienced Travel Time (ETT) (sec/veh)
	Signalized Intersections	Two-Way Stop-Control* and All-Way Stop-Control	Alternative Intersections *(Reduced Conflict Intersections)*
A	≤ 10	≤ 10	≤ 10
B	> 10 – 20	> 10 – 15	> 10 – 20
C	> 20 - 35	> 15 - 25	> 20 - 35
D	> 35 – 55	> 25 – 35	> 35 – 55
E	> 55 – 80	> 35 – 50	> 55 – 80
F	Demand exceeds capacity; > 80	Demand exceeds capacity; > 50	Demand exceeds capacity; > 80

Source: Transportation Research Board, HCM 7th Edition.
** Two-way stop-control LOS reflects worst-case stop-controlled approach.*

For RCIs, the overall ETT, worst-case origin-destination ETT [WC ETT], and worst-case stop-controlled approach delay (WCSC Delay) are provided. The worst-case origin-destination ETT [WC ETT] reflects the travel route through the RCI that experiences the greatest travel time. This is typically a minor approach through or left turn movement that requires the vehicle to turn right, travel to the downstream U-turn, and travel back to the main intersection to turn right onto the side street or continue straight on Highway 16.

For the more conventional intersection types, the overall intersection delay and worst-case stop-controlled approach delay (WCSC Delay) are presented. For Strato Rim – Busted Five – Wilderness Canyon Area Scenario 2, conventional intersection alternatives with a median acceleration lane include a range of measures that reflect anywhere from full use to only partial use of the median acceleration lane. This illustrates the impact of acceleration lane non-compliance.

Applicable measures for comparison across the different scenarios in the analysis tables include:

- Overall intersection: **RCI ETT** and **Intersection Delay**
- Specific movements: **[WC ETT]** and (**WCSC Delay)**

9.1.2 Analysis Results and Findings

Year 2050 Planning Horizon Build condition intersection operations are summarized in the following tables:

- Strato Rim – Busted Five – Wilderness Canyon Area: **Table 4 through Table 7**
- Bear Country USA Area: **Table 8**
- Rushmore Candy Company Area: **Table 9**

Table 4: Highway 16 & Strato Rim Drive Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
A	Single RCI	RCI ETT: [WC ETT]: (WCSC Delay):	1.6 / A [34.7 / C] (14.4 / B)	2.3 / A [38.6 / D] (17.9 / C)
B*	Turn Lanes + Median Acceleration Lanes	Intersection Delay: (WCSC Delay):	1.9 - 2.1 / A (27.1 - 28.2 / D)	4.0 - 4.9 / A (52.6 - 67.6 / F)
NB	No Build	Intersection Delay: (WCSC Delay):	1.6 / A (28.7 / D)	3.1 / A (49.2 / E)

Table 5: Highway 16 & Christmas Village Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
A and B	RIRO	Intersection Delay: (WCSC Delay):	0.1 / A (12.9 / B)	0.2 / A (14.6 / B)
NB	No Build	Intersection Delay: (WCSC Delay):	0.4 / A (20.6 / C)	0.7 / A (32.6 / D)

Table 6: Highway 16 & Busted Five Lane Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
A	Single RCI	RCI ETT: [WC ETT]: (WCSC Delay):	2.3 / A [31.4 / C] (14.5 / B)	3.1 / A [39.2 / D] (16.8 / C)
B*	Turn Lanes + Median Acceleration Lanes	Intersection Delay: (WCSC Delay):	2.2 - 2.3 / A (27.2 - 31.0 / D)	4.0 - 5.1 / A (52.1 - 74.9 / F)
C, D, and E	Single RCI (Combined intersections)	RCI ETT: [WC ETT]: (WCSC Delay):	2.6 / A [34.4 / C] (17.7 / C)	3.7 / A [51.6 / D] (27.7 / D)
NB	No Build	Intersection Delay: (WCSC Delay):	2.7 / A (31.1 / D)	6.3 / A (67.3 / F)

Table 7: Highway 16 & Wilderness Canyon Road Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
A, C, D, and E	Single RCI	RCI ETT: [WC ETT]: (WCSC Delay):	4.4 / A [37.6 / D] (16.1 / C)	3.5 / A [34.5 / C] (16.9 / C)
B*	Turn Lanes + Median Acceleration Lanes	Intersection Delay: (WCSC Delay):	4.8 - 5.7 / A (43.3 / E - 60.0 / F)	5.5 - 6.1 / A (58.3 - 74.6 / F)
NB	No Build	Intersection Delay: (WCSC Delay):	8.4 / A (64.3 / E)	13.4 / B (144.8 / F)

** Scenario 2 conventional intersection options include performance measure ranges that reflect the uncertainty of minor-street vehicle time gaps with the presence of eastbound acceleration lanes.*

Table 8: Highway 16 & Bear Country USA Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
RCI	Exit: Single (Partial) RCI	RCI ETT: [WC ETT]: (WCSC Delay):	1.0 / A [27.9 / C] (14.0 / B)	1.7 / A [35.3 / D] (19.0 / C)
RCI	Entrance: ¾ access	Intersection Delay: (WCSC Delay):	0.3 / A (12.5 / B)	0.1 / A (14.4 / B)
NB	Exit: No Build	Intersection Delay: (WCSC Delay):	2.1 / A (57.4 / E)	17.6 / C (354.0 / F)

Table 9: Highway 16 & Rushmore Candy Company Intersection Operations (2050)

Scenario	Description	Measure	AM *Measure / LOS*	PM *Measure / LOS*
RCI	Single RCI *(consolidated)*	RCI ETT: [WC ETT]: (WCSC Delay):	0.3 / A [30.8 / C] (13.6 / B)	1.0 / A [39.9 / D] (16.4 / C)
RCI	RIRO	Intersection Delay: (WCSC Delay):	0.2 / A (13.6 / B)	0.5 / A (16.4 / C)
NB	No Build	Intersection Delay: (WCSC Delay):	0.3 / A (22.4 / C)	1.2 / A (42.1 / E)

Overall, RCIs were found to perform better than conventional intersections due to lower measured delay and ETT. This is consistent across overall intersection and individual movement measures.

RCIs highlight the benefits associated with allowing drivers to focus on one direction of travel at a time when completing intersection turn movements, particularly during high volume periods such as the summer tourist season. The 2050 Planning Horizon traffic operations analysis demonstrates that RCIs are expected to manage these peak fluctuations and long-range Highway 16 corridor traffic growth considerably better than a conventional intersection.

The RCI WC ETT and WCSC Delay measures are typically less than the corresponding movement or intersection approach WCSC Delay measures in a conventional intersection. It is expected that a vehicle turning left or crossing Highway 16 from the side street will be able to turn right, travel through the downstream U-turn, and back to the main intersection in an RCI before that same vehicle would be able to find an acceptable gap in two directions of traffic and turn left or cross Highway 16 in a conventional intersection.

As Highway 16 volumes continue to increase, the available gaps in Highway 16 traffic for a left turn or crossing movement from the side street in a conventional intersection will continue to become smaller and less frequent. Further, development on both sides of the Highway 16 corridor introduces new conflict points and impacts to traffic operations due to opposing side traffic on the side street. RCIs best address these impacts by separating movements to focus on one direction of traffic at a time.

The following information is also provided in the *Intersection Build Condition Traffic Operations Analysis Memo* in **Appendix F**:

- 2050 Planning Horizon intersection queue lengths incorporated into the conceptual layout turn lane design
- 2028 Opening Year intersection operations and queue lengths

9.2 Predictive Safety Analysis

A predictive safety analysis was completed for the No Build condition and several Build condition scenarios using AASHTO's *Highway Safety Manual* (HSM) method to evaluate expected safety of proposed intersection and roadway modifications. As stated in the HSM, "*The predictive method provides a quantitative measure of expected crash frequency under both existing conditions and conditions which have not yet occurred. This allows proposed roadway conditions to be quantitatively assessed…*" (HSM, 2010 version).

9.2.1 Methodology

FHWA's *Interactive Highway Safety Design Model* (IHSDM) was the tool used to evaluate safety in the No Build and Build scenario conditions. Output includes the predicted average annual crash frequency over the analyzed timeframe (2026 – 2050). Crashes are categorized as fatal and injury crashes (F+I) and property damage only (PDO) crashes for both intersections and roadway segments.

The predictive safety analysis findings from the *2021 U.S. Highway 16 Corridor Study* were carried forward to this rural sub-area analysis to quantify safety-related improvements across the No Build, RCI, and median acceleration lane alternatives. The previous results were deemed applicable for the comparison of alternatives as part of this update.

9.2.2 Analysis Results and Findings

The IHSDM predictive safety analysis results are shown in **Table 10** through **Table 12**. It should be noted that the HTR Black Hills Area scenarios previously analyzed do not directly align with the updated scenarios revised as part of this sub-area analysis. However, elements within t hose scenarios are applicable for the comparison of intersection types within each of the conceptual layouts.

Table 10: Strato Rim – Busted Five – Wilderness Canyon Area Predicted Crashes (2026-2050)

Scenario	Description	F&I Crashes *+/- from baseline*	% Increase / Decrease	Total Crashes *+/- from baseline*	% Increase / Decrease
NB	No Build (baseline)	159	-	330	-
A	3 RCIs on existing alignment	-49	*-29%*	-72	*-22%*
B	3 conventional intersections plus median acceleration lanes	-21	*-14%*	-40	*-12%*
C, D, and E	2 RCIs with frontage road on shifted south alignment	-51	*-33%*	-96	*-29%*

Table 11: HTR Black Hills Resort Area Predicted Crashes (2026-2050)

Scenario Description	F&I Crashes *+/- from baseline*	% Increase / Decrease	Total Crashes *+/- from baseline*	% Increase / Decrease
No Build (baseline)	20	-	45	-
Full Access	0	*0%*	-2	*-4%*
Right-in Right-out plus frontage road	-2	*-10%*	-7	*-16%*
RCI	-2	*-10%*	-7	*-16%*

Table 12: Bear County USA Area Predicted Crashes (2026-2050)

Scenario	F&I Crashes *+/- from baseline*	% Increase / Decrease	Total Crashes *+/- from baseline*	% Increase / Decrease
No Build (baseline)	57	-	130	-
RCI	-8	*-14%*	-19	*-15%*

No Build condition includes 2020 intersection improvements at Croell Quarry main intersection.

Overall, the predictive safety analysis demonstrates safety benefits of constructing RCIs and modifying conventional full access intersections through closure or turn restrictions along Highway 16. RCIs eliminate many of the angle conflict points within a conventional intersection that are susceptible to crashes that have propensity to result in serious injury. In each Area, scenarios with RCIs exhibit a greater crash reduction than those with conventional full access intersections.

For the Strato Rim – Busted Five – Wilderness Canyon Area, RCI scenarios A, C, D, and E all provide a notable reduction of around 30 percent in predicted Fatal & Injury crashes. Scenario B with conventional intersections with median acceleration lanes exhibits some safety benefit, but not at the levels of the RCI scenarios. This is primarily due to side street left turn and crossing movement angle conflicts still being present on the near side of Highway 16 and the expected varying levels of median acceleration lane usage on the far side of Highway 16. Non-compliance with median acceleration lane presents issues with far-side angle crashes.

The predictive safety analysis shows similar RCI safety benefits in the HTR Black Hills Resort Area and Bear Country USA Area when compared to conventional intersections.

9.2.3 Other State DOT Before/After Findings

The RCI safety benefits measured in the predictive safety analysis are considerably less than what other states have experienced following RCI implementation. **Table 13** summarizes findings from several before and after studies conducted by other states, which highlights the considerable reduction in fatal and serious injury crashes after implementing RCIs. Based on these findings, it could be concluded that safety benefits beyond what is shown in the predictive safety analysis **Table 10** through **Table 12** would be expected with the implementation of RCIs on Highway 16.

Table 13: Other State DOT Crash Reduction Experience

State Department of Transportation	*# of RCIs Statewide*	# of RCIs in Study (Study Year)	RCI Crash Reduction
Minnesota	75+	*25 (2021)*	*Fatal & serious injury crashes: 69% reduction* *Angle crashes: 70% reduction* *Fatal & serious injury angle crashes: 100% reduction*
North Carolina	400+ (full or partial)	*31 (2023)*	*Total crashes: 50% reduction* *Angle and head-on crashes: 80% reduction*
Missouri	43+	*19 (2015)*	*Fatal injury crashes: 88% reduction* *Serious injury crashes: 78% reduction* *Left turn, right angle crashes: 100% reduction*
South Carolina	14+	*6 (-)*	*Fatal injury crashes: 100% reduction* *Injury crashes: 73% reduction* *Angle crashes: 96% reduction*
Indiana	7+	*7 (-)*	*Fatal and injury crashes: 81% reduction*

Sources:
Minnesota DOT: https://storymaps.arcgis.com/stories/13ec2731843e464db326504ae313c010
North Carolina DOT: https://www.ncdot.gov/initiatives-policies/Transportation/safety-mobility/reduced-conflict-intersections/Pages/default.aspx
Missouri DOT: https://www.modot.org/j-turns
South Carolina DOT: https://www.scdot.org/travel/reduceconflict-safety.aspx
Indiana DOT: https://www.in.gov/indot/traffic-engineering/reduced-conflict-intersections/

9.3 Evaluation

The alternatives evaluation process included a review of analysis findings, potential impacts, and benefits/drawbacks. A detailed evaluation was conducted for the Strato Rim – Busted Five – Wilderness Canyon Area scenarios. Overarching findings and considerations were then applied to the other three Areas.

9.3.1 Strato Rim – Busted Five – Wilderness Canyon Area Evaluation

Strato Rim – Busted Five – Wilderness Canyon Area traffic operations and predicted safety analysis measures are summarized in **Table 14**. An evaluation matrix that considers 2050 Planning Horizon traffic operations, predicted safety, right-of-way impacts, and cost is provided in **Table 15**. A summary of key, differentiating findings from this evaluation includes:

Safety

- RCI scenarios (A, C, D, and E) provide a 29-33% reduction in predicted Fatal & Injury crashes compared to the No Build condition
- This compares to a 14% reduction for the conventional intersection with turn lane and median acceleration lane improvements (Scenario B)
- RCIs reduce the number of angle (crossing) conflicts from as many as 24 in a conventional intersection to just 4 in an RCI

Operations

- RCIs consistently perform better than conventional intersections with 2050 Planning Horizon traffic volumes
- RCI Scenario A, C, D, and E exhibit up to 50% less worst-case movement ETT than the comparable Scenario B and No Build conventional intersection movements
- Scenario B and No Build conventional intersections exhibit LOS F movements
- Scenario A provides the best intersection operations when traffic is spread across three RCIs
- RCI Scenarios A, C, D, and E provide a 2-stage crossing with the significant median storage as the median U-turn lanes store vehicles turning left or crossing Highway 16 from the side-street approaches. This addresses the current issue with longer vehicles sticking out into Highway 16 lanes when storing in the median.

Long-Range Traffic Growth

- RCIs are better suited to accommodate future traffic growth than a conventional intersection
- RCIs prolong the need for signalization because motorists only need to focus on one direction of travel at a time
- RCI movements may be signalized individually, when warranted, while other movements are maintained as unsignalized

ROW Impacts and Cost

- Scenarios that maintain the existing Highway 16 corridor alignment result in the least right-of-way impact and potential cost

Table 14: Strato Rim - Busted Five - Wilderness Canyon Area Traffic Operations and Predicted Safety Analysis Measures Summary

Scenario	2050 Planning Horizon Traffic Operations						Predicted Safety (2026 - 2050)	
	Strato Rim Drive Intersection		Busted Five Court Intersection		Wilderness Canyon Road Intersection		Fatal & Injury Crashes	Total Crashes
	Experienced Travel Time (sec)* AM / PM	RCI Stop-Controlled Delay (sec)** AM / PM	Experienced Travel Time (sec)* AM / PM	RCI Stop-Controlled Delay (sec)** AM / PM	Experienced Travel Time (sec)* AM / PM	RCI Stop-Controlled Delay (sec)** AM / PM	% Increase (+) or Decrease (-) from No Build	% Increase (+) or Decrease (-) from No Build
Scenario A *RCIs (3) on Existing Alignment*	35 / **39**	14 / 18	32 / **39**	15 / 17	**38 / 35**	16 / 17	**-29%**	**-22%**
Scenario B *Full Access Intersection Improvements (3) on Existing Alignment*	**27-28** / **53-68**	-	27-31 / 52-75	-	43-60 / **58-75**	-	-14%	-12%
Scenarios C, D, and E *RCIs (2) on New Alignment*	-	-	34 / 52	18 / 28	**38 / 35**	16 / 17	**-33%**	**-29%**
No Build	**29** / 49	-	31 / **67**	-	**64 / 145**	-	**Baseline**	**Baseline**

Notes:
Differentiating ***benefits noted in green*** *and* ***drawbacks noted orange***
** Experienced Travel Time (ETT) measure reflects the worst-case condition within the intersection, which is typically a vehicle turning left from the side-street (Strato Rim Drive, Busted Five Lane, or Wilderness Canyon Road) with the following considerations:*
- *RCI ETT: includes delay at the stop sign for a motorist to identify a gap in near-side Highway 16 traffic approaching the intersection to turn right and cross into the median U-turn lane PLUS travel time for the vehicle to travel to the U-turn and back to the main intersection*
- *Conventional intersection ETT: includes delay at the stop sign for a motorist to identify an adequate gap in Highway 16 traffic approaching the intersections from both directions and complete the left turn*

*** RCI stop-controlled delay includes just the delay at the stop sign for a motorist to identify a gap in near-side Highway 16 traffic approaching the intersection and turn right onto Highway 16*

Table 15: Strato Rim - Busted Five - Wilderness Canyon Area Evaluation Summary

Scenario	2050 Traffic Operations		Predicted Safety (2026 - 2050)	Access vs. Mobility Priority		Right-of-Way Impacts	Cost
	Long-Range Intersection Operations	Worst-Case Experienced Travel Time	Reduction in Future Crashes	Highest level of (managed) access	Highest Levels of Mobility	Acres	Highway 16 Corridor Considerations
Scenario A	5	5	5	5	4	<3	• **Potential to overlay existing Highway 16 lanes**
Scenario B	3	3	3	4	3	<3	• **Potential to overlay existing Highway 16 lanes**
Scenario C	5	4	5	4	5	>10	• Full Highway 16 reconstruction required
Scenario D	5	4	5	4	5	>10	• Full Highway 16 reconstruction required • Maintain existing Highway 16 lanes as frontage road
Scenario E	5	4	5	4	5	3-5	• Full reconstruction required • Maintain existing Highway 16 lanes as frontage road
No Build	2	2	2	2	1	-	-

Rating notes:
- *1 (worst) to 5 (best)*
- *3 or better meets study baseline criteria*
- *Key differentiators:*
  - ***Benefits: 4 and 5 (green)***
  - ***Drawbacks: 1 and 2 (orange)***

9.3.2 HTR Black Hills Area Evaluation

The HTR Black Hills Area scenarios build upon findings from the Strato Rim – Busted Five – Wilderness Canyon Area to address the following objectives:

- Incorporate long-range traffic operational and safety-related modifications
- Provide full access for HTR Black Hills Resort and House of Scandinavia parcels
- Maximize deceleration within eastbound Highway 16 left turn lanes on the 6% downgrade to help remove slow-moving traffic from the through lanes
- Work with adjacent property and business owners to incorporate access management to reduce overall access density and conflict points, particularly crossing conflicts

Public and stakeholder feedback supported enhanced sight distance for the westbound to eastbound RCI U-turn and recommended the U-turn be located at the top of the hill near the Rockerville Volunteer Fire Department access.

An evaluation matrix with consideration of the objectives identified for this area is provided in **Table 16**.

Table 16: Strato Rim – Busted Five – Wilderness Canyon Area Evaluation Summary

	Traffic Operations	Predicted Safety	Full Access to Existing Businesses	Maximize Left Turn Lane Length on Downgrade	Access Management
Scenario A	5	5	4	5	5
Scenario B	5	4	4	3	4
Scenario C	5	5	5	5	5
Scenario D	5	4	5	4	4
No Build	2	1	2	1	1

Rating notes:

- *1 (worst) to 5 (best)*
- *3 or better meets study baseline criteria*
- *Key differentiators:*
  - ***Benefits: 4 and 5 (green)***
  - ***Drawbacks: 1 and 2 (orange)***

9.3.3 Bear Country USA Area and Rushmore Candy Company Area

RCI scenarios were the lone Build condition scenarios carried forward from the *2021 U.S. Highway 16 Corridor Study Report* at both the Bear Country USA Area and Rushmore Candy Company Area. RCI operational and safety benefits were found to best address needs within both areas.

There was strong public and stakeholder support to simplify the Bear Country USA Exit and not require motorists to gauge two directions of traffic to turn left and head towards Rapid City. Similar sentiment was expressed for the Rushmore Candy Company Area RCI.

9.4 Future Development

Potential development is a notable consideration throughout much of the rural sub-area. Based on findings within this analysis and from national best practices, RCIs were found to be the best intersection type to grow with traffic to provide safe and efficient full access opportunities.

Field (undeveloped) access locations are assumed to be maintained as RIRO access unless noted in the conceptual layouts and will be further evaluated during design. When a parcel develops, the existing field access for that parcel will be closed and the development will be required to tie into the full access RCI(s) or local street network to access the RCI(s).

Access beyond what is shown in the conceptual layouts may be analyzed as part of a development's Traffic Impact Study to add or modify access.

10.0 Public Involvement

Two sets of public and stakeholder meetings were held as part of the rural sub-area analysis. An informational handout, display boards, recorded presentation, and opportunity to submit written comments were provided at both sets of meetings. A virtual option to review study materials and submit comments was provided on the study website https://www.us16corridor.com/.

Summary reports with submitted comments and stakeholder meeting minutes are provided in **Appendix G**.

10.1 Stakeholder Meetings

One-on-one and small group stakeholder meetings were held in conjunction with each of the two public meetings to meet with adjacent land and business owners that may be impacted by potential corridor modifications. Primary stakeholder meeting topics included potential impacts to access, property, and potential modifications to mitigate these impacts and concerns. Stakeholder meeting minutes are included in the public meeting summary reports.

10.2 Public Meeting #1: Updated Analysis and Refined Conceptual Layouts

DATE: THURSDAY, NOV. 2, 2023

LOCATION: BLACK HILLS ENERGY, RAPID CITY, SD

The first public meeting presented the updated traffic analysis information and refined conceptual layouts carried forward from the *2021 U.S. Highway 16 Corridor Study Report* for feedback. Approximately 60 people, plus Study Advisory Team members, attended the public meeting. Overarching themes from the submitted comments include:

- Long-range safety and operational needs
- Support for turn lanes
- Posted speed limit and travel speeds

- RCI elements, such as large vehicles accommodations, intersection travel time, Highway 16 grades and curvature, winter maintenance, driver confusion/expectancy, intersection complexity, location of U-turns, and whether there is a need for that level of modification
- Access, frontage roads, and local network connectivity
- Support, opposition, and/or preferences for the various conceptual layouts

10.3 Public Meeting #2: Refined Conceptual Layouts and Preliminary Recommendations

Date: Thursday, Dec. 14, 2023

Location: Black Hills Energy, Rapid City, SD

The second public meeting presented refined conceptual layouts and preliminary recommendations. Conceptual layout refinement considered public, stakeholder, and Study Advisory Team input. Approximately 30 people, plus Study Advisory Team members, attended the public meeting. Overarching themes from the submitted comments include:

- Support, opposition, and/or preferences for the various conceptual layouts
- Questions and feedback on RCI elements such as U-turns, large vehicles, grade, and future corridor speeds
- Access

11.0 Recommendations

The following rural sub-area analysis recommendations are based on design considerations, evaluation measures, and Study Advisory Team, stakeholder, and public feedback.

11.1 Highway 16 Intersections

It is recommended that existing full access intersections be modified to RCIs or partial access to restrict crossing and left turn movements from the side street as shown in the recommended Area scenario layouts.

- RCIs were found to best address short-term and long-term traffic operational and safety needs and provide full access opportunities along the corridor

The recommended scenario layouts present a framework for long-range corridor access

- Additional or modified access desired by future development may be considered through a Traffic Impact Study
- Field (undeveloped) access locations are assumed to be maintained as RIRO unless noted in the recommended Area scenario layouts. Field access points are recommended to be further evaluated during design.
- When a parcel develops, it is recommended that the existing field access be closed and development tie into the full access RCI(s) or local street network to access an RCI

11.2 Strato Rim - Busted Five - Wilderness Canyon Area

Recommendation: Scenario A, RCIs on Existing Alignment (Figure 25)

- *RCIs (3) at Strato Rim Drive, Busted Five Court, and Wilderness Canyon Road intersections*
- *Right-in right-out at Highway 16 Storage/Christmas Village/NFL Shop/Black Hills Church of Christ access*
- *Westbound to eastbound U-turn located approximately 1,750 feet west of Gondola Road intersection for Stratobowl Rim Trailhead parking* ***(Figure 26)***
- *Access management to reduce conflict points and remove all side-street crossing and left turn movements*

Scenario A was found to best provide the desired balance of mobility and access while incorporating the notable safety benefits of RCIs and access management.

Area recommendations include the following:

C-Store property modifications

- Close existing RIRO between Gondola Road and Strato Rim Drive (north side of Highway 16) to eliminate conflict points and reduce access density
- Expand C-store parking lot surfacing on west side of building to provide internal vehicular/truck circulation (see **Figure 24**) and maintain parking adjacent to building
  - Extent of the parking lot improvements will be refined during design

Overhead power on north side of Highway 16 at Strato Rim Drive RCI

- Address impacts to existing poles during design (see **Figure 24**), including the following poles located:
    - In the Strato Rim Drive & C-Store/Putz n Glo access intersection
    - Directly southwest of C-store building, which may impact internal circulatory routing if maintained in current location

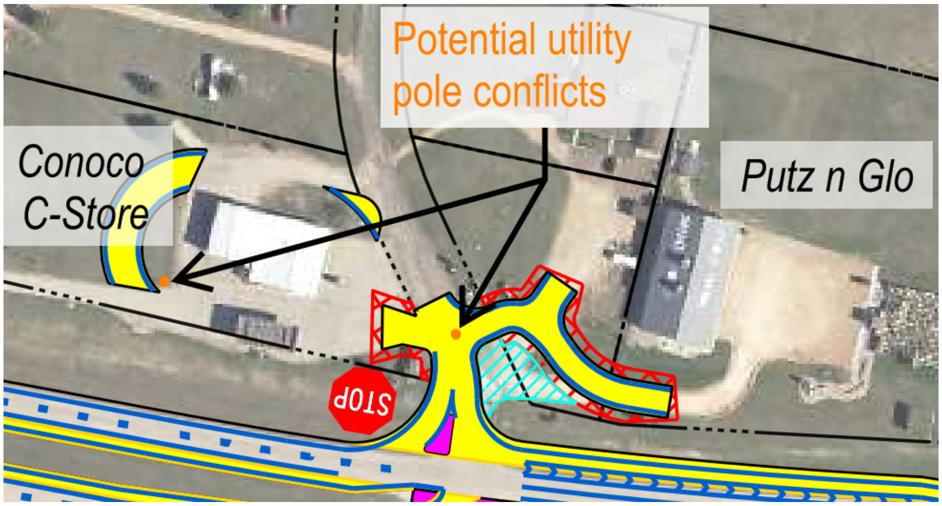


Figure 24: Scenario A C-Store Parking Modifications and Potential Overhead Power Pole Impacts

Ehlers Family parcels on south side of Highway 16 at Strato Rim Drive RCI

- Extend existing residential driveway west to Gondola Road to not impact existing agricultural fields south of the Strato Rim Drive RCI main intersection
    - Landowner's preferred route to access their residence
    - Landowners anticipated to use the Strato Rim Drive RCI to access their fields
- If the agricultural area south of Highway 16 develops in the future, that development will need to tie into Strato Rim Drive RCI

Hwy 16 Storage/Christmas Village/NFL Shop/Black Hills Church of Christ Access

- Locate existing RIRO access 100 feet east of the Strato Rim Drive RCI U-turn loon
- Based on this recommended spacing, it will be important to:
    - Construct RIRO raised island to channelize entering/exiting access traffic
    - Extend a raised median between the westbound through lane and U-turn lane to restrict RIRO traffic from crossing Highway 16 and directly accessing the Busted Five Court U-turn.
- Full access provided via Strato Rim Drive RCI and Busted Five Court RCI U-turns

Old Macdonald's Farm access

- Maintain Old MacDonald's Farm access to Busted Five Court located approximately 120 feet north of the existing Highway 16 westbound lane

Wilderness Canyon Road intersection location

- Future location has some flexibility to shift east if desired, but intersection sight distance is a controlling measure and will need to be evaluated when gauging feasibility

Mid-Segment RIRO access between Busted Five Court and Wilderness Canyon Road

- The current landowner supported an additional RIRO access on the south side of Highway 16, between Busted Five Court and Wilderness Canyon Road, to help separate RV/campground traffic from the high-volume commercial traffic at the Wilderness Canyon Road RCI
- Any additional access request will need to be submitted by the developer and analyzed as part of a Traffic Impact Study when development plans are available

Sitting Bull Road (Frontage Road)

- Coordinate Sitting Bull Road frontage/rearage road alignment with future development to enhance local network connectivity and provide direct access to the Wilderness Canyon Road RCI
- Alignment shown in recommended layout is illustrative

U-turn sight distance

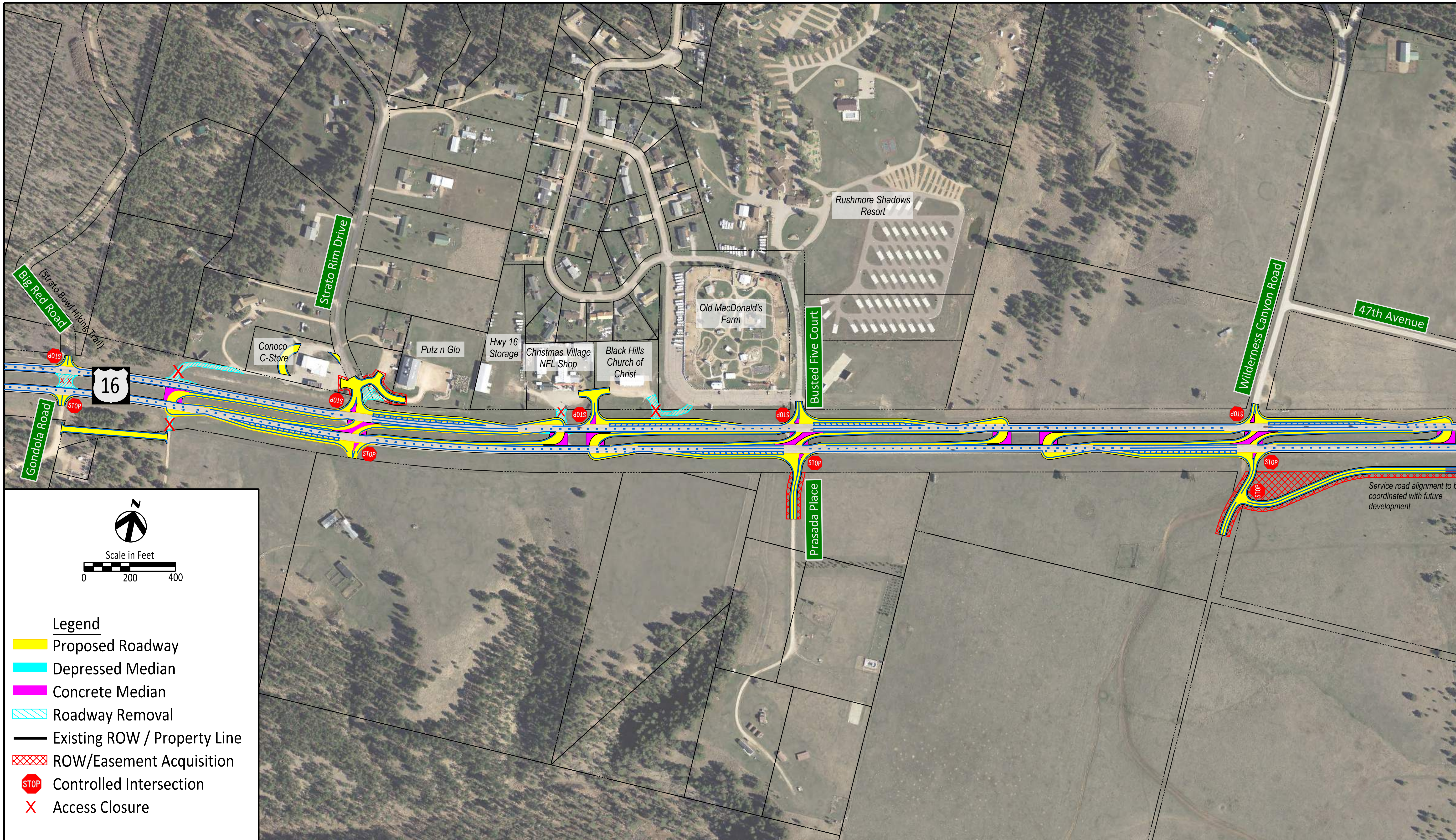
- Review U-turn sight distance at the following locations during design:
    - Strato Rim Drive RCI westbound to eastbound U-turn (western U-turn) and the crest vertical curve near the Gondola Road intersection
    - Wilderness Canyon Road RCI eastbound to westbound U-turn (eastern U-turn) and the crest vertical curve through the Sitting Bull Road intersections
- Vertical curves at both locations may need to be flattened to meet ‘Left Turn from Stop on the Minor Road’ U-turn sight distance guidance previously shown in **Figure 22**

Big Red Road / Gondola Road (Stratobowl Rim Trailhead) intersection

- Close median to eliminate crossing and left turn movements from the side street
- Full access provided via the Strato Rim Drive RCI and a westbound to eastbound U-turn located approximately 1,750 feet west of the Stratobowl Rim Trailhead

Turn lane queue storage

- RCI left turn and U-turn lanes provide for 150 to 225 feet of vehicle storage (plus deceleration distance)
    - Accommodates up to 3 RV+trailer combinations or 9 passenger cars
- Accounts for 2050 Planning Horizon analysis-measured queue lengths, large vehicles typical to the summer tourist season, and propensity for multiple vehicles to arrive at once



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

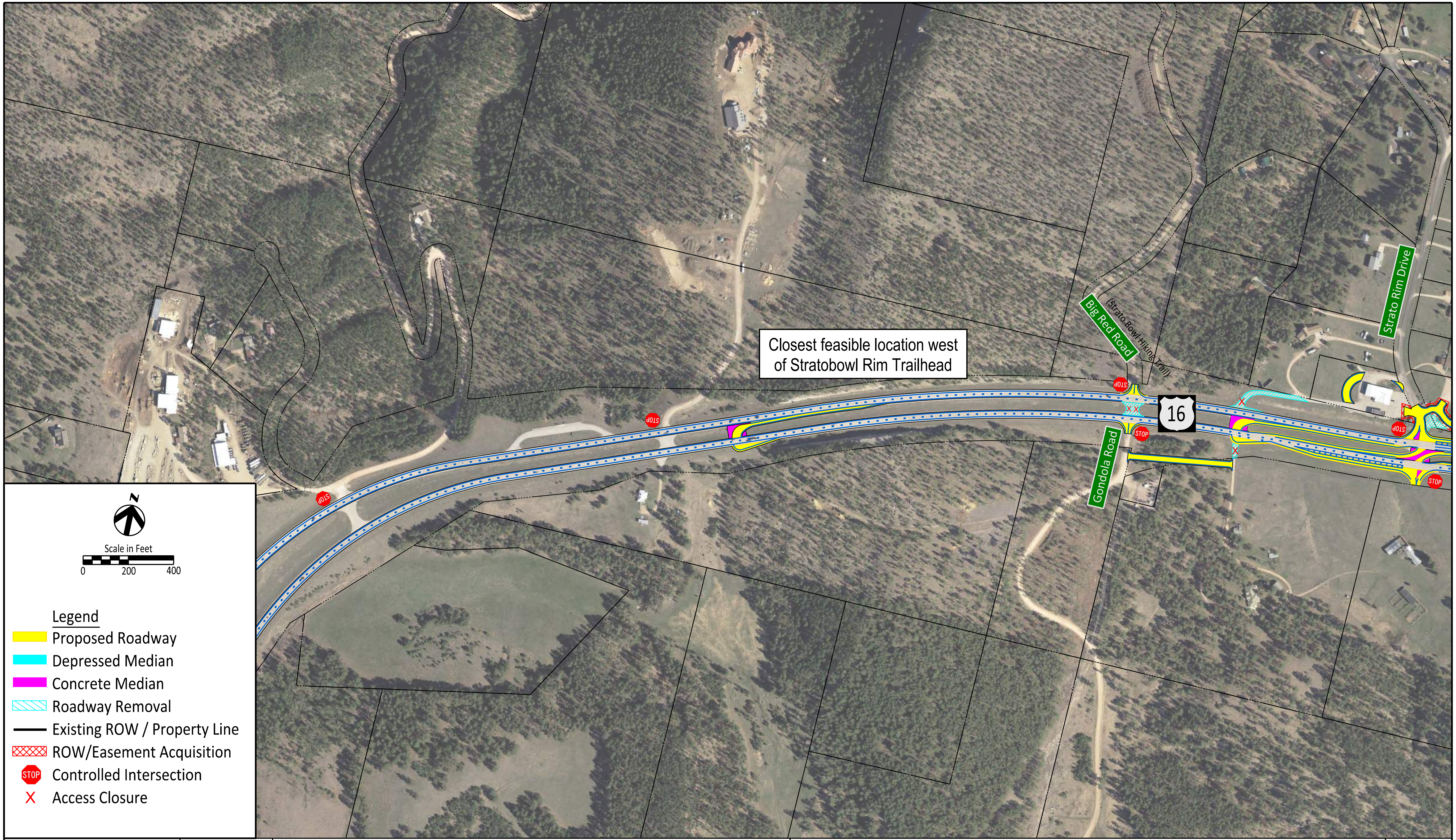
SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | RAPID CITY AREA Metropolitan Planning Organization | CITY OF Rapid City LIVE. WORK. GROW. | PENNINGTON COUNTY

Strato Rim Drive - Busted Five Lane - Wilderness Canyon Road Area
Scenario A: Reduced Conflict Intersections (RCIs) on Existing Alignment

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
25



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | Rapid City Area Metropolitan Planning Organization | City of Rapid City | Pennington County

Stratobowl Rim Trailhead U-Turn Options

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure 26

11.3 HTR Black Hills Resort Area

Recommendation: Scenario C, RCI with Shifted West U-turn (HTR Black Hills), ¾ Access (House of Scandinavia), and RIRO Access (Sitting Bull Road) (Figure 27)

- Westbound to eastbound U-turn at top of the hill to enhance sight distance
- Maintain full access for Rockerville Volunteer Fire Department
- Access management

Scenario C was found to best provide the desired balance of mobility and access through this segment and incorporates the notable safety benefits of RCIs and access management.

Area recommendations include the following:

RCI westbound to eastbound U-turn

- Provides full access for HTR Black Hills Resort and House of Scandinavia traffic
- Locate at the top of the hill to enhance sight distance based on 'Left Turn from Stop on the Minor Road' U-turn sight distance guidance previously shown in **Figure 22**
  - While Scenario D also provides adequate U-turn sight distance, considerable stakeholder and public feedback requested additional sight distance due to the crest vertical curve and high travel speeds on the 6% downgrade

Sitting Bull Road intersections

- West intersection: closed
- East intersection: RIRO
  - ¾ access is not recommended due to:
    - Median break would provide an opening for westbound motorists to attempt a U-turn at this intersection in lieu of traveling to the designated U-turn location at the top of the hill
    - U-turn sight distance is not adequate at this intersection
  - If the intersection needs to shift east or west, the existing crest vertical curve may impact 'Right Turn from Stop on Minor Road' sight distance

Rockerville Volunteer Fire Department access

- Maintain full access with median opening to support response time
- Consider installing a gate across the north driveway approach to 47th Avenue to address parking lot cut-through traffic
- Consider installing colored median and/or partial raised median to give the appearance of a continuous raised median for Highway 16 traffic

Eastbound driveway access left turn lane lengths

- Provide full deceleration distance for HTR Black Hills Resort access left turn lane
  - Maintaining the HTR Black Hills Resort main access in its current location truncates the House of Scandinavia access left turn lane
- HTR Black Hills Resort: 1,025 ft. total length

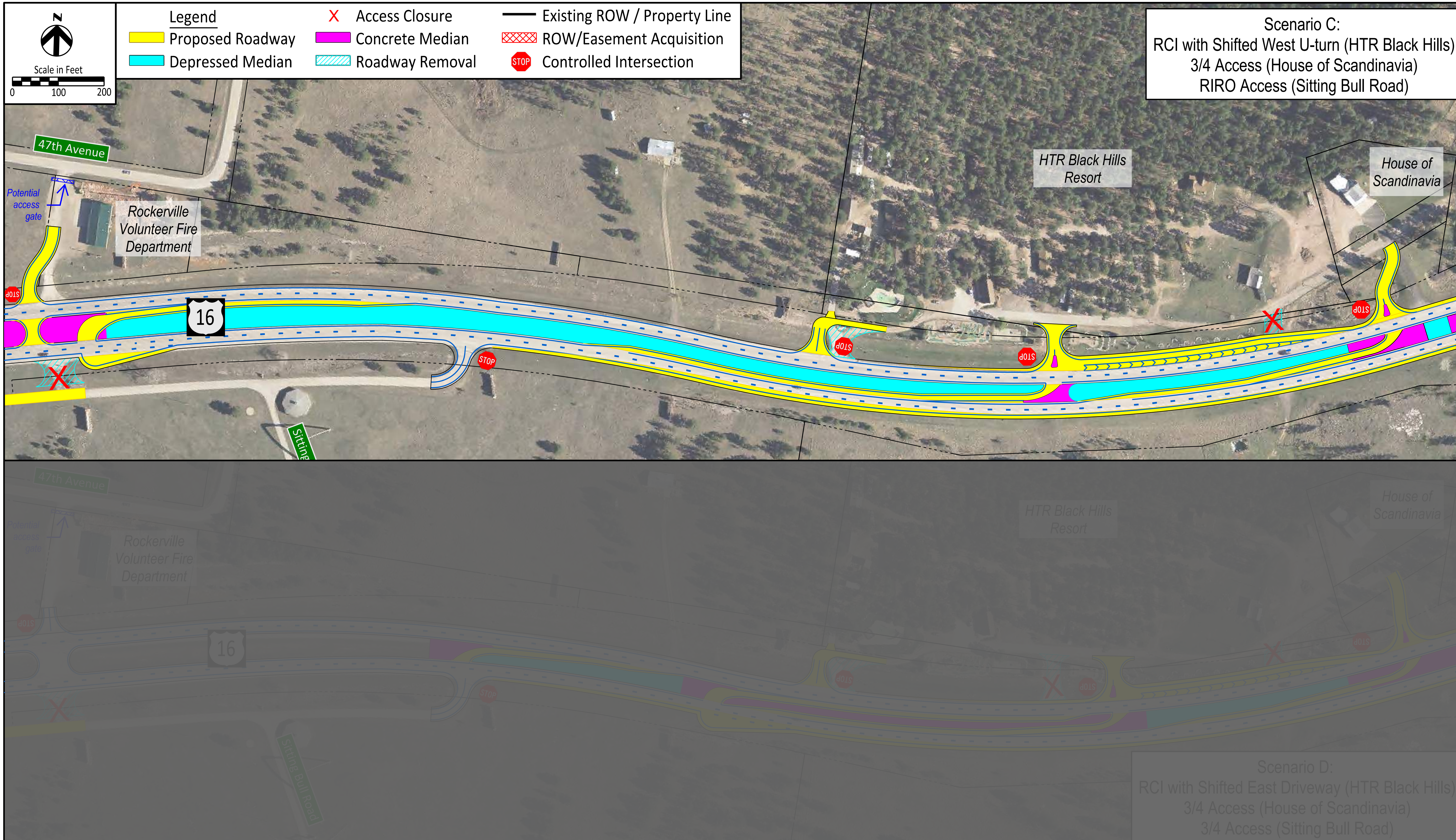
    - 800 ft. deceleration (6% grade adjustment factor) and 225 ft. queue for up to three RVs with trailer
- House of Scandinavia: 700 ft. total length
    - Provides approximately 87% of the full 800 ft. deceleration distance; limited by spacing with HTR Black Hills Resort main access

Future development recommendations

- No additional median breaks on the 6% grade segment
- Coordinate with Highway 16 LLC development to locate future development's main, full access intersection(s) on the flatter grade west of the Rockerville Volunteer Fire Department access
- Development-requested Sitting Bull Road access modifications (e.g., eastbound right turn lane, westbound left turn lane) or new access will require a Traffic Impact Study
- Review intersection sight distance to gauge feasibility of all access modifications

Long-range recommendations

- Extend 47th Avenue east to tie into the HTR Black Hills Resort property to enhance local network connectivity and provide an opportunity for RV traffic to use a local road to travel the steep upgrade to the Wilderness Canyon Road RCI
    - Close shared RIRO access with Highway 16
    - Aligns with the frontage road connection shown in HTR Black Hills Resort Area Scenario A in **Figure 15**



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | Rapid City Area Metropolitan Planning Organization | City of Rapid City | Pennington County

HTR Black Hills Resort Area
Access Management Scenario C

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
27

11.4 Bear Country USA Area

Recommendation: Reduced Conflict Intersection (Figure 28)

- *RCI elements incorporated at Entrance and Exit access points to provide full access for Bear Country USA*
- *¾ access at Bear Country USA Entrance*
- *Westbound to eastbound U-turn at Bear Country USA Exit*

The RCI scenario was the lone scenario carried forward from the 2021 U.S. Highway 16 Corridor Study. It best addressed the angle crash history and long-range traffic operations at the Bear Country USA access points.

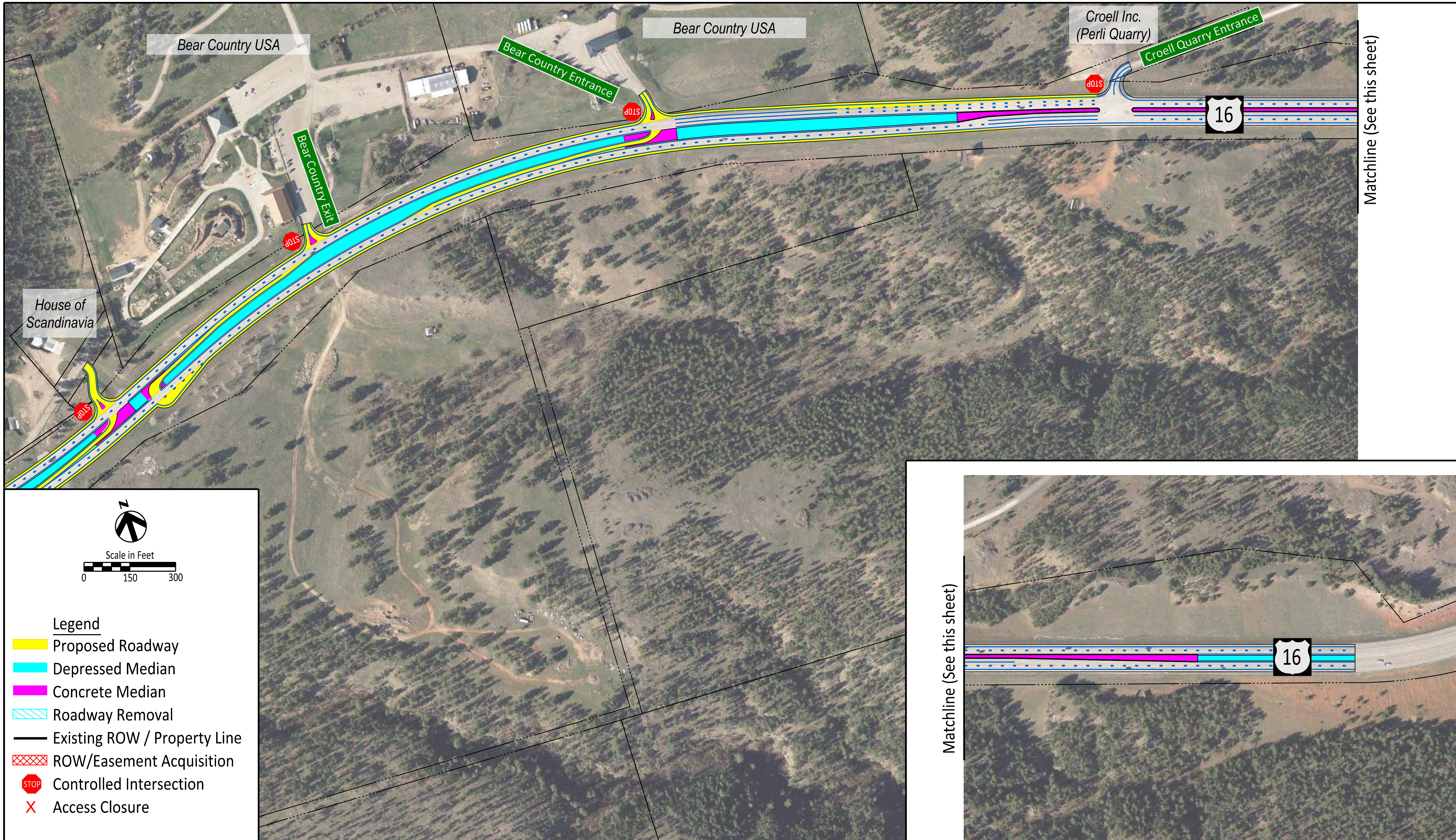
The recommended RCI at the Bear Country USA access points provides full access for entering and existing traffic. The U-turn is part of the Bear Country USA Exit access. While elements of the RCI are split across the Entrance and Exit access points, traffic using the Entrance to leave the facility will only need to travel west approximately 1,800 feet (1/3-mile) to access the Exit U-turn location.

Public comment recommended the distance between the Bear Country USA Exit and the downstream westbound to eastbound U-turn should be reviewed when topographic survey is received. Considerations noted during conceptual design for a U-turn in this area include intersection sight distance, other access points, and constructability of the U-turn loon.

No changes to the Croell Inc. quarry intersection are recommended as part of this study. Public and stakeholder feedback has indicated good compliance with trucks using the eastbound median acceleration lane. If compliance decreases, education on the importance of using the median acceleration lane with owners and drivers is recommended.

During study discussions, it was noted that there were no eastbound to westbound U-turn opportunities between Wilderness Canyon Road and Neck Yoke Road. The long-range need for considering this movement was identified with the potential for future development on the south side of Highway 16 and general traffic patterns where tourist traffic misses a turn and then attempts a U-turn at a downstream median opening.

While much of Highway 16 is on a steep downgrade (eastbound) between Wilderness Canyon Road and Neck Yoke Road that is not advantageous for an eastbound to westbound U-turn, the Bear Country USA Entrance area is the flattest Highway 16 mainline location through this segment. Pavement widening for an unofficial U-turn is recommended at this intersection for further consideration during design due to the flatter grade and minimal vehicle conflicts with traffic exiting the Bear Country USA Entrance.



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | Rapid City Area Metropolitan Planning Organization | City of Rapid City | Pennington County

Bear Country USA Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
28

11.5 Rushmore Candy Company Area

Recommendation: Reduced Conflict Intersection (Figure 29)

- *RCI at south access*
- *RIRO at north access*

The RCI scenario was the lone scenario carried forward from the 2021 U.S. Highway 16 Corridor Study. RCIs best address long-range operations and safety needs at the access points.

Area recommendations include the following:

- Shift the southern access southward to provide combined access to the three parcels that come to a point
- westbound right turn lane at the north access
    - Based on discussions with property owner, most westbound Highway 16 traffic uses, and will continue to use, the north access

11.6 Supplemental Highway 16 Corridor Recommendations

Additional recommendations to support the Area-specific recommendations include the following:

Highway 16 minimum frontage road spacing

- For new development: 300 feet spacing between Highway 16 and first intersection (SDDOT desirable separation)
- For existing development: 150 feet between Highway 16 and first intersection (SDDOT minimum separation)

Enhance local street (internal) connectivity between Highway 16 intersections

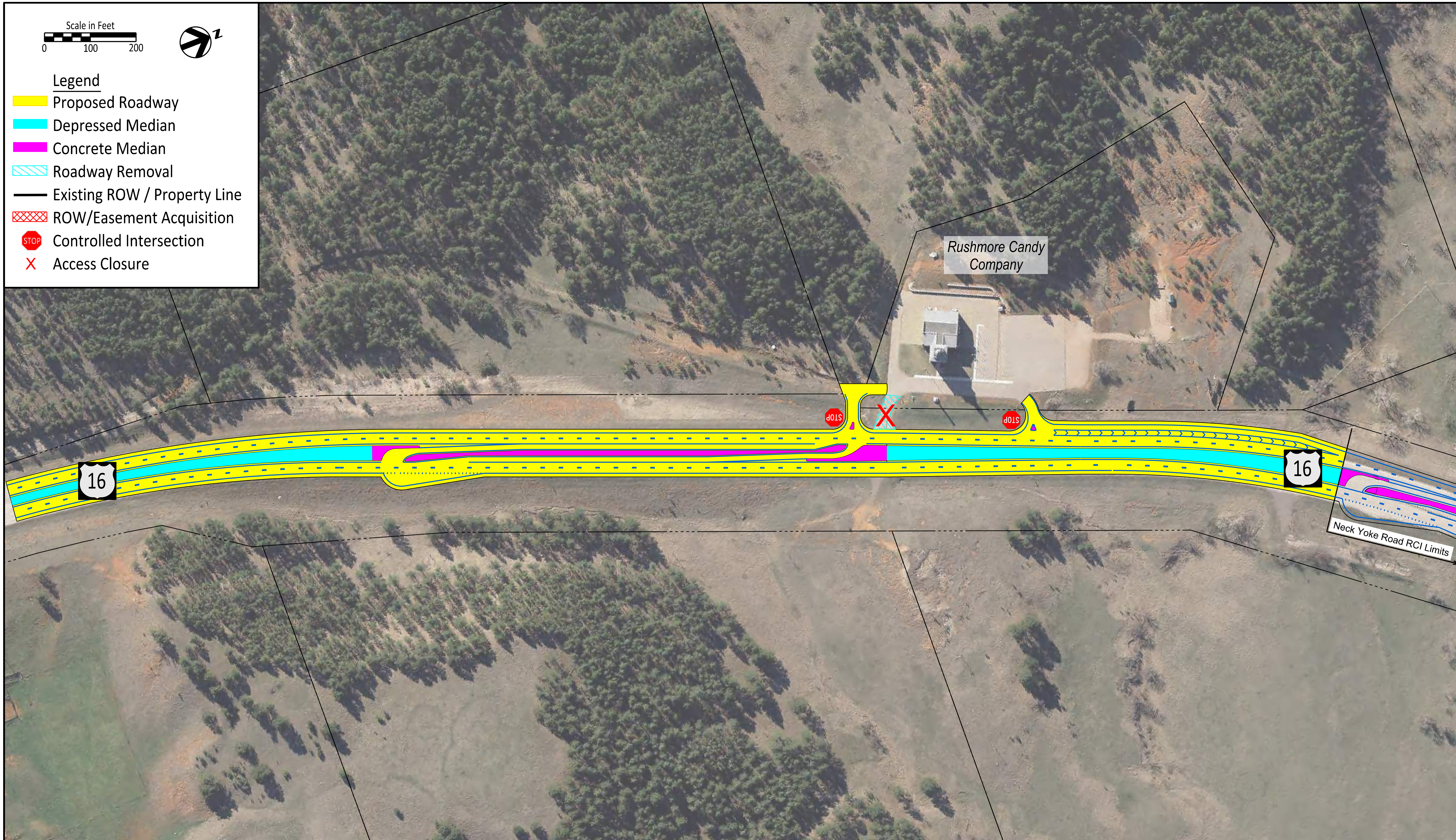
- As opportunities arise through future development, redevelopment, and local street reconstruction, connect local streets to decrease the dependency of Highway 16 for short-duration trips
    - Enhances neighborhood and community feel
    - Reduces vehicle conflicts on Highway 16 by removing local trip turning movements to/from Highway 16
    - Spreads traffic across multiple access points, which is particularly beneficial during periods of peak traffic fluctuations
    - Enhances emergency response and provides redundant access

Roadway lighting

- Evaluate the need for Highway 16 segment and intersection lighting during design

Speed

- Evaluate future corridor segment design speed and posted speed limits as part of design
    - Key considerations noted during the study include posted speeds for Highway 16 segments east and west of this rural sub-area segment, access density (including U-turn locations), existing and future vertical curve design criteria, traffic volumes, vehicle mix, and adjacent land use
    - Ultimately, drivers will drive at the speed they feel comfortable driving. With the magnitude of changes to the Highway 16 corridor recommended in this report, speed will be an important consideration during the design process.
- Consider variable speed limit on Highway 16
    - While not specifically analyzed or evaluated as part of this sub-study, transportation needs that may benefit from a variable speed limit were identified through this rural sub-area analysis:
        - Notable fluctuations in traffic volumes between tourist/non-tourist season as well as day of the week during the tourist season
        - Weather and roadway conditions, with contributing factors such as winter weather, fog, topography, and variability throughout the corridor



U.S. Highway 16 CORRIDOR STUDY

Study Recommendation

Revised: 1/31/2024

SD DEPARTMENT OF TRANSPORTATION | U.S. Department of Transportation Federal Highway Administration | RAPID CITY AREA Metropolitan Planning Organization | CITY OF Rapid City LIVE. WORK. GROW. | PENNINGTON COUNTY

Rushmore Candy Company Area
Reduced Conflict Intersection (RCI)

US16 Corridor Study: Rural Sub-Area Analysis

Pennington County, SD

Figure
29

Appendix A. Methods and Assumptions Document

Appendix B. Crash History Review Memo

Appendix C. Traffic Forecasts Memo

Appendix D. Existing and Future No Build Condition Traffic Operations Analysis Memo

Appendix E. Sight Distance Review: Wilderness Canyon Road RCI, HTR Black Hills Resort RCI, and Crest Vertical Curve through Sitting Bull Road Intersections

Appendix F. Intersection Build Condition Traffic Operations Analysis Memo

Appendix G. Public Involvement Summary Reports

Public Meeting No. 1 Summary Report

Public Meeting No. 2 Summary Report