1 BACKGROUND INFORMATION

The Arizona Department of Transportation (ADOT) initiated this Corridor Development Study (CDS) of State Route 87 (SR 87) between mile post (MP) 191 and MP 250, to define and evaluate proposed improvements to this 59-mile segment of SR 87 between Fountain Hills, Arizona, and Payson, Arizona. The SR 87 corridor location is depicted in **Figure 1.** The corridor study area is shown in detail in **Figure 2**.

ADOT undertook a performance-based evaluation of the study area in the SR 87/SR 260/SR 377 Corridor Profile Study (SR 87 CPS), completed in March 2017. The CPS identified a range of planning-level strategic solutions addressing safety, mobility, and freight needs on SR 87 between MP 191 and MP 250. These high-level solution sets included several potential improvements that required more detailed evaluation and refinement before specific projects can be scoped and programmed. The SR 87 CDS advances the SR 87 CPS recommendations through a more detailed analysis to confirm the need, evaluate feasibility of, and provide more detailed information on the needs identified. Near-term and long-term plans are needed to help guide decisions in the future regarding prioritizing SR 87 corridor improvements.

This Feasibility Report recommends and prioritizes specific projects and implementation strategies, along with their associated costs, that address identified needs. This process was informed by a collaborative process involving a Technical Advisory Committee, stakeholders, and the public.

1.1 Previous Studies and Recommendations

Previous studies and reports applicable to the study are shown in **Appendix A.** These studies served as input to alternatives development and evaluation.

1.2 Upcoming Programmed Projects

The ADOT Five-Year Transportation Facilities Construction Program (2020 to 2024) lists one project within the corridor limits; SR 87 MP 247 Pine Creek Canyon Rd; Tree Removal. The funding for this project is through the Highway Safety Improvement Program ($240,000 in FY 2021 and $1,549,000 in FY 2022).

1.2.1 Land Ownership

SR 87 study limits traverse multiple jurisdictions and land owned or managed by various entities in Maricopa and Gila counties. The southern section of the corridor, MP 191 to MP 193, traverses the Fort McDowell – Yavapai Indian Reservation. From MP 193 to MP 250, SR 87 travels through the Tonto National Forest, though there is a mix of private lands at various locations along the corridor; most notably near Sunflower, Deer Creek, and Rye. An overview of land uses along the corridor is provided below in **Table 1**. A map showing the distribution of land ownership along the corridor is provided in **Figure 7**.

Table 1: Land Use

Land Use	Location	MP
Large-lot residential	Goldfield Ranch	195-198
Commercial	Sunflower	218
Residential and ranch	Deer Creek	237-238
Commercial	Rye	239-241
Residential	Oxbow Estates	248-249
Residential	Round Valley	249-250

Figure 1: Corridor Study Area

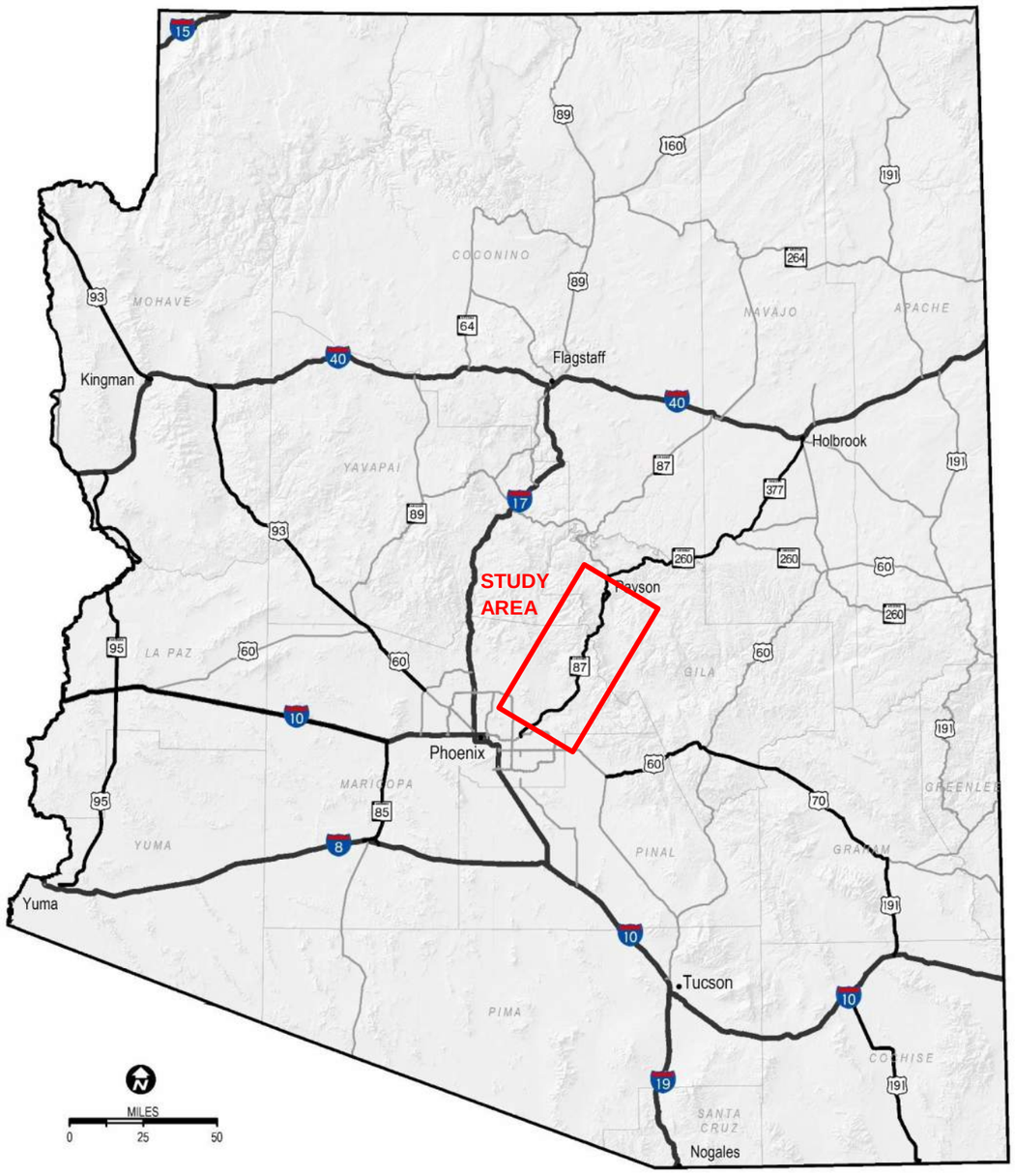
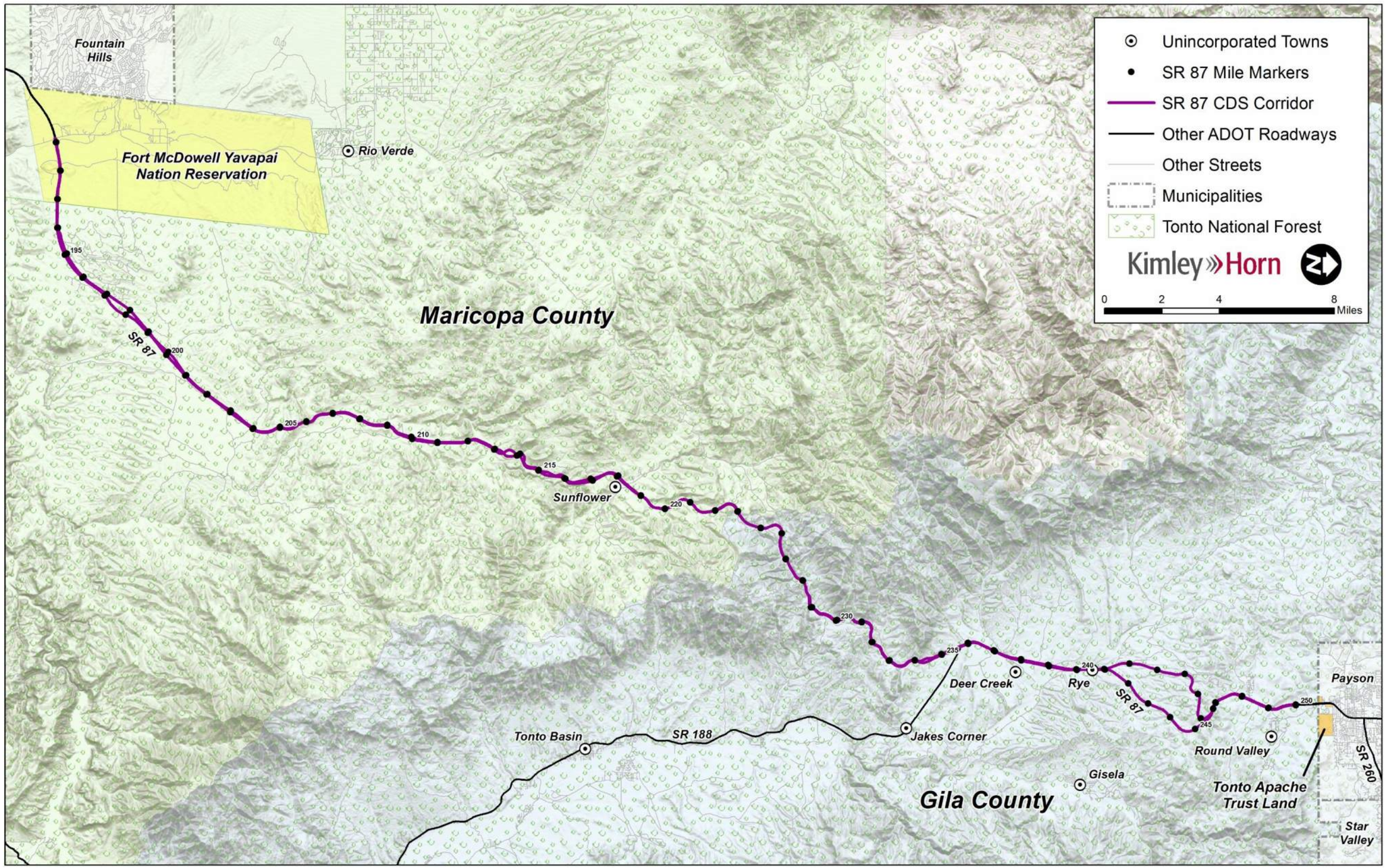


Figure 2: Corridor Development Study Corridor



1.3 Need for the Project

SR 87 is a key link between the Phoenix metropolitan area and the northeast region of the state and serves intrastate, interstate, and international commerce. SR 87, MP 191 to 250 connects cities and towns of Mesa, Fountain Hills, and Payson, along with the Salt River Pima-Maricopa Indian Community, Fort McDowell-Yavapai, and Tonto-Apache Tribes, as well as recreational areas and National Forests.

The SR 87/SR 260/SR 377 Corridor Profile Study (CPS), completed in March 2017, identified corridor needs in the areas of safety and freight mobility. Safety needs were identified as "high" for MP 191-MP 213, MP 213-MP 235, and MP 241-MP 250. Contributing factors identified in the CPS include:

- Speed too fast for conditions
- Improper lane changes
- Clear zone slopes and obstructions
- Slippery/wet pavement surface
- Roadway departure
- Driver inattention and driving under the influence
- Insufficient shoulder/rumble strip condition
- Lack of crossing opportunities

Freight needs were identified as "high" for the entire study limits (MP 191-250), due to the number of highway closures attributed to incidents/crashes, obstructions/hazards, or weather.

1.4 Characteristics of the Corridor

1.4.1 Existing Roadway System

SR 87 within the study limits is generally a four-lane bifurcated and divided rural facility. There is a climbing lane on SR 87 SB between approximately MP 207 and MP 205. The corridor includes one grade-separated traffic interchange (TI) on SR 87 at Bush Highway at approximately MP 199. Intersections are listed below in **Table 2**.

Table 2: SR 87 Intersections

MP	Intersection	Grade Separated	Access	Turn Lanes on SR 87
191.8	Hiawatha Hood Road	-	4-way	Left Only
192.1	Rodeo Drive	-	4-way	Left Only
194.5	Burnt Water Tail	-	3-way	Right and Left
195.2	Vista del Oro	-	3-way	Right and Left
196.0	Goldfield Road	-	3-way	Right and Left
196.3	Pleasant View Road	-	Right-in-right-out	Right Only
196.6	Median Crossover	-	3-way	Left Only
197.3	Meridian Road	-	Right-in-right-out	Right Only
199.1	Bush Highway	Yes	Diamond Interchange	N/A
203.9	Cline Cabin Road	-	4-way	Right and Left
207.8	FR 68 Access Road	-	4-way	Right and Left
209.5	FR 68	-	4-way	Right and Left
210.5	Ballantine Trailhead	-	4-way	Right and Left
212.7	Sycamore Creek	-	4-way	None
217.4	FR 1704	-	3-way	None
218.0	Sunflower	-	4-way	Right and Left
218.5	FR 22	-	3-way	Right and Left
222.7	FR 626	-	4-way	Right and Left
229.6	FR 26	Box culvert under-crossing	Right-in-right-out	Right Only
235.7	SR 188	-	4-way	Right and Left
236.7	Unnamed Road	-	3-way	Right and Left
237.6	Deer Creek Drive	-	4-way	Right (NB) and Left (SB) Only
238.5	FR 1438	-	3-way	Right and Left
239.2	Barnhardt Road	-	4-way	Left (NB) and Right (SB) Only
239.5	Gisela Road	-	3-way	Right and Left
240.0	Matlock Gas	-	3-way	None
240.5	South Rye Crossover	-	4-way	None
240.8	North Rye Crossover	-	4-way	No SB Right
247.8	FR 535	-	3-way	Left Only
248.4	Ox Bow Estates	-	3-way	Left and Right
248.7	FR 375B	-	3-way	Left Only
249.0	Gibson Ranch Road	-	3-way	Left Only

The existing highway was incrementally constructed over several decades. The original SR 87 highway is currently the southbound lanes, while the northbound lanes, constructed in the 1990's, are on new alignment. Through extended corridor segments, the northbound and southbound lanes are bifurcated and follow substantially different paths through mountainous terrain. Between MP 241 and MP 246, the northbound and southbound lanes are over a mile apart. Between MP 213 and MP 216, the southbound lanes cross over the northbound lanes and the carriageways are on opposite sides than that of a typical divided highway.

The existing cross section generally includes two 12-foot wide lanes in each direction, a 4-foot wide inside shoulder, and a 10-foot wide outside shoulder. However, there are several locations where the shoulders are narrower or do not exist; specifically, areas with a concrete center median such as MP 250 to MP 245, and MP 219 to MP 229 where the inside shoulder is often less than four feet.

The posted speed limit is 65 mph for most of the corridor. The southbound lanes have a speed limit of 55 mph between MP 247.4 and MP 243.5 due to tight curves and steep grades.

Assets within the corridor include the rest area (Mazatzal Rest Area at the southeast corner of SR 87 and SR 188, currently closed), dynamic message signs (DMS) located SR 87 NB, MP 191.2; and permanent traffic counters located at, SR 87 MP 235. There is a truck escape ramp on SR 87 NB near MP 227.

1.4.2 Existing Right-of-Way and Land Ownership

ADOT right-of-way width varies within the study corridor. Older sections of the right-of-way (the southbound alignment just north of Rye, for example) are approximately 200 feet in width, with newer alignments generally 400 feet. Due to the rugged terrain, the median width varies and therefore affects the overall right-of-way width.

1.4.3 Existing Structures

There are 20 bridge structures located within the study corridor, as shown below in **Table 3**. According to the CPS, there are no deficient bridges along the corridor.

Table 3: Bridge Structures

MP	Direction	Name	Length (ft)	Width (ft)
191.3	NB	Verde River	1,610	44
191.3	SB	Verde River	1,600	44
207.6	NB	Mesquite Wash	275	44
210.9	NB	Pine Creek	245	44
212.6	NB	Sycamore Creek	260	42
212.6	SB	Sycamore Creek	365	44
213.3	SB	South Crossover	130	41
214.0	SB	Unnamed	1,070	44
215.7	SB	Unnamed	690	42
216.0	SB	North Crossover	160	42
218.5	NB	Sycamore Creek	725	42
218.5	SB	Sycamore Creek	720	42
219.5	NB/SB	Kitty Joe Creek	865	84
220.4	NB/SB	Whiskey Springs	495	88
221.5	NB/SB	Kitty Joe Creek	615	85
223.2	NB/SB	Unnamed	265	85
237.3	NB	Deer Creek	140	44
237.3	SB	Deer Creek	175	44
239.3	NB	Rye Creek	325	44
239.3	SB	Rye Creek	340	44

1.4.4 Topography

The SR 87 corridor climbs from the approximately 1,500 feet elevation in Fountain Hills, AZ, to the mountains of Payson, AZ at 4,890 feet. Corridor topography is characterized by mild rolling terrain, with sections of steep elevation gains and climbs, as it heads through Tonto National Forest towards Payson, AZ. Corridor topography is characterized below in **Table 4**.

Table 4: Corridor Topography

Begin	End	Approx. Begin Milepost	Approx. End Milepost	Approx. Length (miles)	Character Description
Fort McDowell Rd	Sycamore Creek	191	213	22	This rural four-lane divided segment with uninterrupted flow has relatively mild rolling topography.
Sycamore Creek	SR 188	213	235	22	This rural four-lane divided segment with uninterrupted flow has steep terrain and a curvy alignment.
SR 188	Rye	235	241	6	This rural four-lane divided segment with uninterrupted flow has mild rolling topography.
Rye	Green Valley Pkwy/BIA 101	241	250	9	This rural segment with uninterrupted flow is a climbing four-lane divided section.

1.4.5 Existing Drainage

Existing drainage consists of median ditches and sheet flow to the outside of the roadway prism. Off-site drainage within the corridor is captured in either bridge structures, box culvert structures, or pipe crossings and carried underneath the existing SR 87 roadway. Bridges and culverts are located at natural drainage crossing areas except for an engineered drainage channel on the east side of the roadway between MP 226 and MP 229, and a drainage structure on the east side of the roadway and within the median between MP 240 and Rye Creek.

The SR 87 corridor traverses several watersheds throughout the approximately 60-mile study limits. The watersheds and approximate locations along the corridor are provided in **Table 5**.

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) indicate 100-year floodplain delineation within the study corridor. **Figure 3** shows floodplains and existing drainage.

Table 5: Watersheds

Watershed	Mileposts	Approx. Drainage Direction
Camp Creek-Lower Verde River	191-194	Northeast to Southwest
Lower Salt River below Saguaro Lake	194-201	Northeast to Southwest
Lower Salt River-Apache, Canyon, and Saguaro Lake	201-204	Northwest to Southeast
Mesquite Wash-Sycamore Creek	204-223	Northeast to Southwest
Gun Creek-Tonto Creek	223-229	West to East
Rye Creek-Tonto Creek	229-250	North to South

1.4.6 Barriers and Guardrails

The existing barriers and guardrails along the SR 87 corridor are shown in **Figure 4**. For clarity, the guardrail and barriers are shown separately for the northbound and southbound directions. The barriers and guardrails were documented from the 2016 ADOT photo log, which is currently the latest data available. There is a total of 49.06 linear miles of guardrail and 13.36 linear miles of concrete barrier throughout the corridor.

Guardrail is most prevalent in the mountainous sections of the roadway between MP 205 and MP 234, and between MP 241 and MP 245, though isolated sections of guardrail exist in other portions of the corridor. There are two significant sections of the corridor that have a central concrete barrier, between MP 218 and MP 222 and between MP 223 and MP 227.5. Most of the concrete barrier on the remainder of the corridor is on bridge structures.

1.4.7 Shoulder Widths

Shoulder widths were documented from the 2016 ADOT photo log. Locations where the shoulder width is less than standard for a divided highway are highlighted in **Figure 5**. Shoulder widths of less than 10 feet on the right side of the road and less than 4 feet on the left side of the road are labeled as “deficient”.

Areas with center concrete barrier are largely deficient on the left side of the roadway in both directions. Additionally, the southbound lanes of SR 87 between MP 250 and MP 246 have no shoulders on either side of the roadway, and the right shoulder on northbound SR 87 between MP 241 and MP 248 is deficient. Other isolated sections of deficient shoulders occur along the corridor sporadically.

Figure 3: FEMA 100-Year Floodplain and Existing Drainage

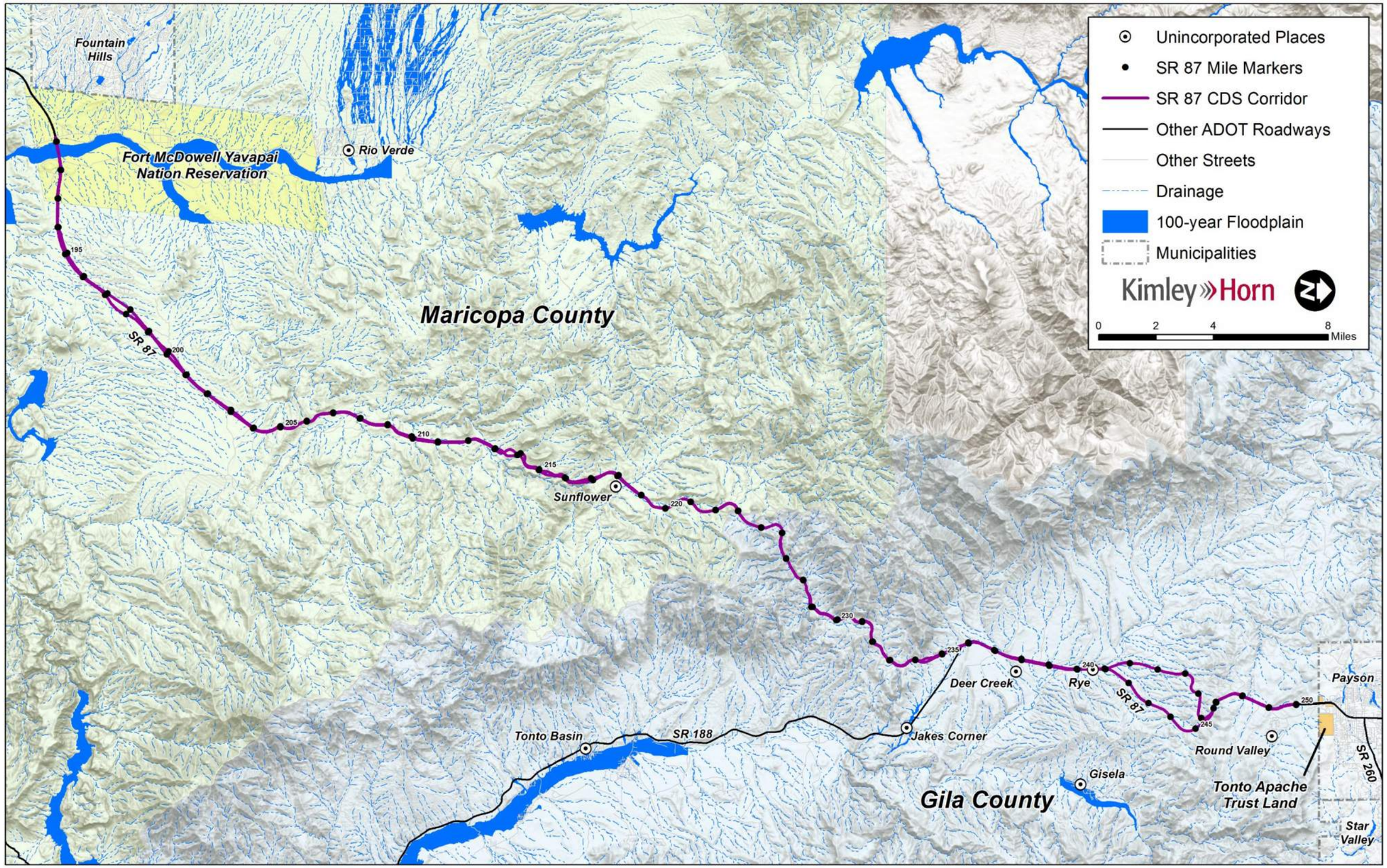
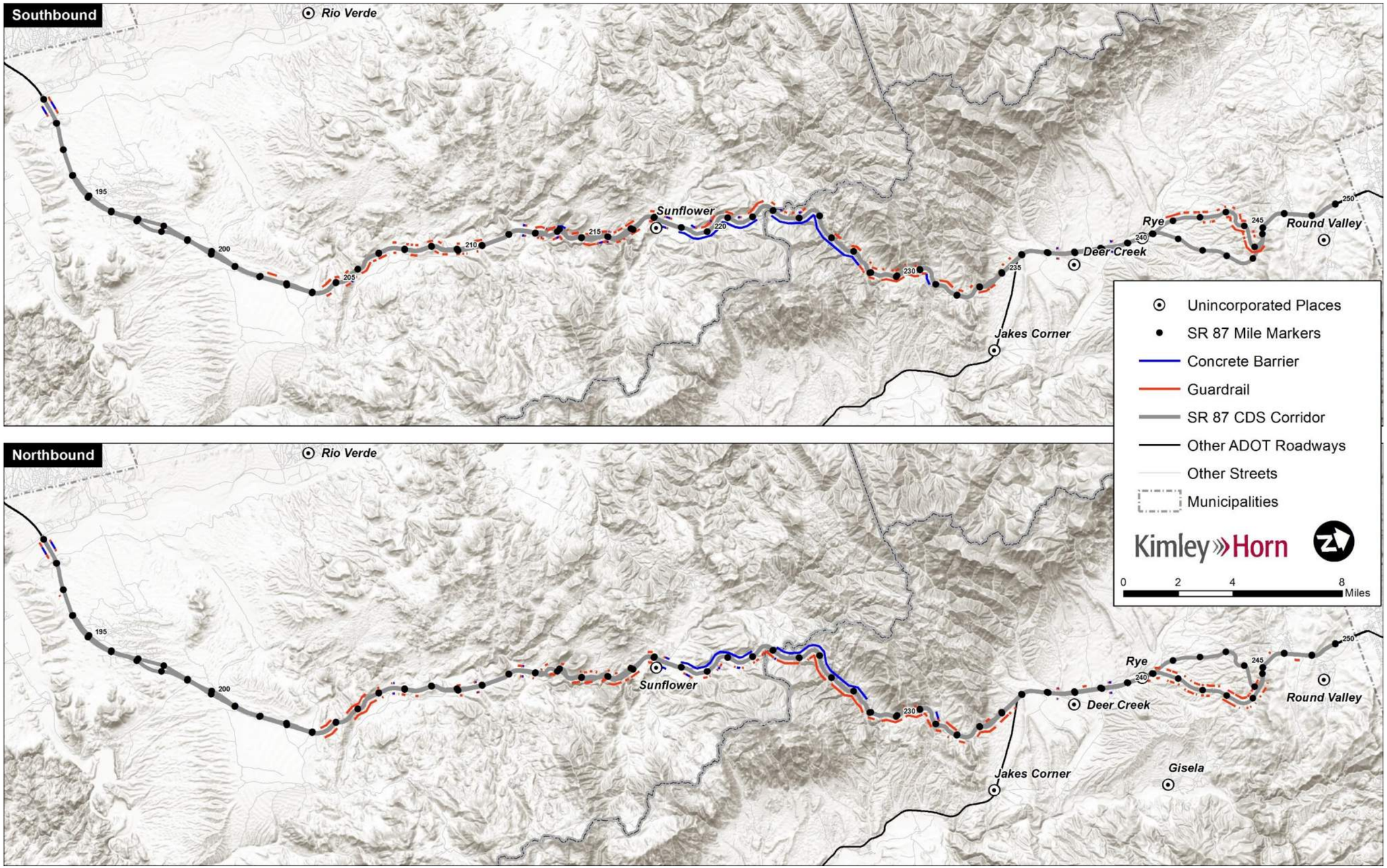


Figure 4: Existing Guardrail and Barriers



1.4.8 *Existing Utilities*

The utility companies and agencies which have facilities within or nearby the study corridor are provided in **Table 6**. Additional investigation is required during project development to identify the locations and limits of these utilities.

Table 6: Existing Utilities

Owner	Facility Type
Arizona Public Service	Electric
City of Phoenix Water Services Dept.	Reclaimed Water, Sewer, Water
Cox Communications	CATV, Fiber
CenturyLink	Coaxial Cable, Fiber
Fountain Hills Sanitary District	Fiber, Reclaimed Water, Sewer
Salt River Project	Communication, Electric, Fiber, Irrigation
TDS Telecom/AZ Telephone	Fiber Optic, Telecom
Town of Fountain Hills	Conduit, Storm Drain

1.4.9 *Geotechnical Considerations*

Several geotechnical and rock-fall issues were identified in the CPS, which have been re-evaluated and supplemented with additional locations upon further analysis. Each location is described in detail below and a map of identified geotechnical issues is provided in **Figure 6**.

1.4.9.1 *Northbound MP 213.9-214.0*

On the west side of the roadway is a rock cut in weathered and heavily fractured and faulted granite. Erosion and raveling have caused fractured rock and decomposed granite to come right to the edge of pavement. The ditch width is questionably sufficient to keep this material out of the travel lanes.

1.4.9.2 *Northbound MP 214.2-214.6*

This is a through cut on the original alignment of SR 87 and was not involved in the mid-1990's reconstruction. Most of the rock-fall concern relates to the cut slopes on the north side, which is on the inside of a super-elevated curve. The cut slopes that are on the south side of the highway at this location are not as tall and have slightly more favorable rock structure and ditch width.

There are two rock cuts within this stretch, a western reach (MP 214.2-214.3), and an eastern reach (MP 214.4-214.54), which are different in rock-fall character. The westernmost is comprised chiefly of heavily jointed and fractured granite which adjoins a very steep cut slope exhibiting decomposed granite overlain by colluvium forming the west end of the cut. A steep faulted contact between the two lithologies is several feet wide and is raveling and eroding. There are bodies of colluvium and old terrace gravels at places on the slope crest that release cobble size to gravel size material with some small boulders. No major kinematic instabilities were noted in this stretch, although no systematic studies were conducted to identify kinematic failure mechanisms. The chief concern is raveling of cobbles, small boulders, and jointed fragments.

The eastern reach within this interval is comprised entirely of moderately to heavily fractured, blocky granite. Despite the lack of systematic studies to identify kinematic instabilities, wedge sliding and toppling behaviors are apparent. The fractured, blocky granite is interspersed with zones of saprolite (decomposed granite) that encloses fragments of hard, angular to sub-rounded granite boulders. In this reach, the crest and face are eroding, particularly along faulted zones.

Throughout this stretch, the ditch is relatively narrow in proportion to the slope height and does not grade appreciably back toward the toe of the cut slope. Consequently, material that is released from the slope face or crest is more inclined to roll out onto the roadway shoulder or travel lanes than at other locations.

1.4.9.3 *Northbound MP 215.0-216.0*

This stretch extends from MP 215 to the north crossover bridge and was not included in the mid-1990s reconstruction. The cut slopes in this reach are not very high but exhibit many different mechanisms of erosion and loosening. Near MP 215.8, on the west side, a small rockslide encroaches on the ditch. Because of the limited cut slope height, the rock fall run out potential is limited; the ditch is also quite narrow.

1.4.9.4 *Southbound MP 216.2-216.5*

This is a section of road that was built as part of the mid-1990s reconstruction. At this location, a sequence of Tertiary Period valley fill sediments overlie granite above an ancient and weathered erosional surface. The depth of granite weathering below the sediment contact varies, and the cut slope was configured to ensure that the lower, steeper section was excavated entirely within the rock, and not the sediments. In this reach, several faults and dikes were encountered making high angles to the slope face. Recently, a wedge failure of moderate size has been released and sits in the ditch. Shortly after the 1990s reconstruction, the dikes and faults were already tending to erode, and consideration was given to reinforcing them with anchored shotcrete, although ultimately this treatment did not occur. The ditch seems to contain the material released from the slope, but the irregularity of the face and the amount of cleanup that has occurred in this reach is apparent.

1.4.9.5 *Northbound MP 216.4-216.8*

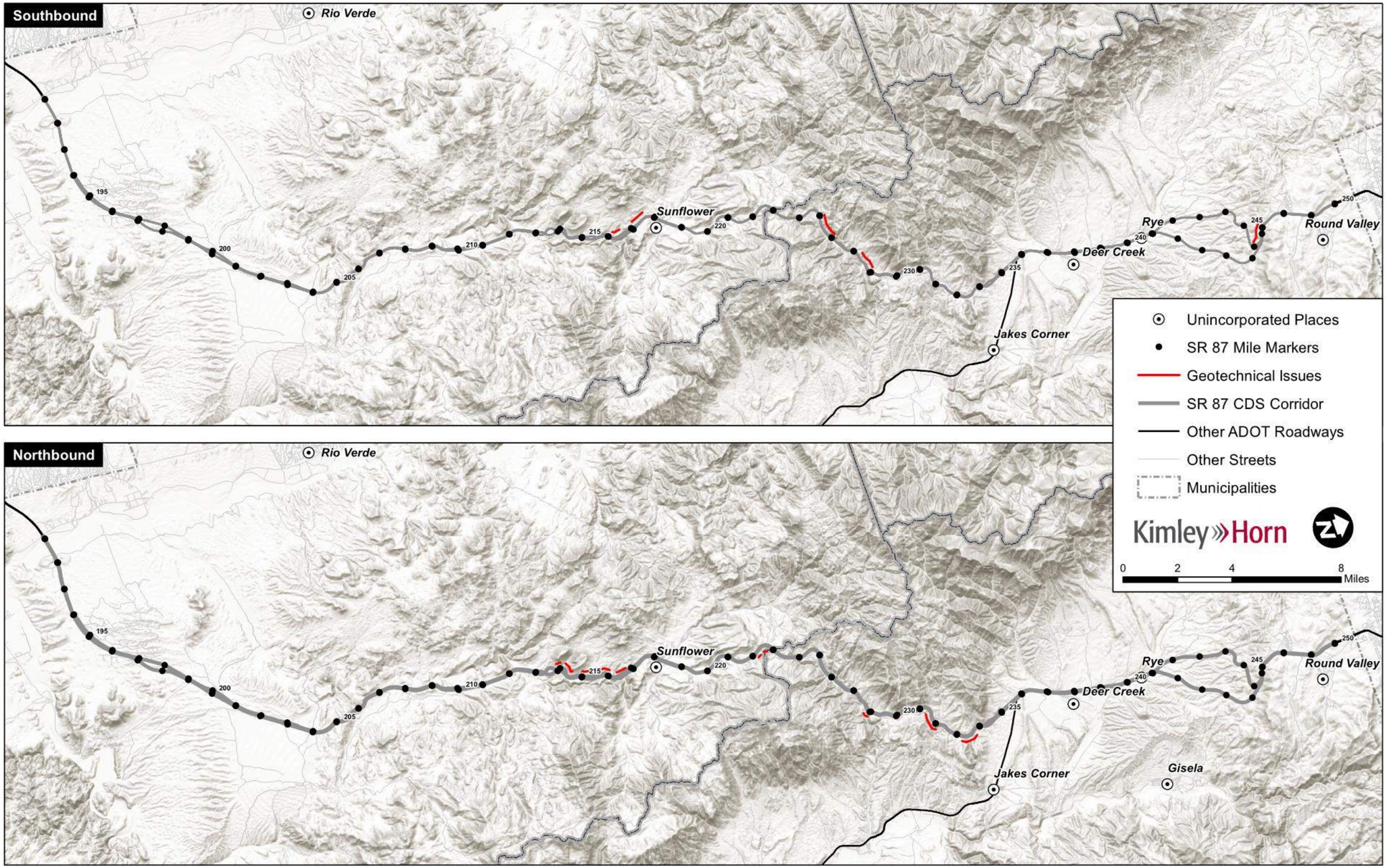
There is a relatively short cut in granite between MP 216.45 and 216.52 with a crosscutting dike exhibits plane shear failure as well as raveling from the densely fractured dike material. The ditch at this location is narrower than elsewhere along the highway. A short distance ahead, at MP 216.77 also on the northbound side, the west side rock cut contains a deeply eroded fault zone that is undercutting over-steepened material from the adjoining granite and intrusive dike assemblage.

1.4.9.6 *Southbound MP 217.3-217.6*

Within this area is a feature known in the 1990s reconstruction as the "Red Cut". The east side of the northbound is comprised of unconsolidated colluvium and valley fill sediments, but the west side, on the southbound side, exhibited sediments only at the very top. Below it is a granite mass intruded by a dike and cut by a fault. During construction, this rock area failed several times, and was laid back. It has failed again along wedge forming features and has some over steepened areas. However, the ditch is quite wide, with a good cross slope, which has contained the failed material. Additional studies would be required to determine the stability of this cut area, and what, if any, action is merited.

Figure 5: Shoulder Width Deficiencies

Figure 6: Identified Geotechnical Issues



1.4.9.7 Southbound MP 226.0-227.0

The cuts along Slate Creek between approximately MP 226 and 227 on the north side appear generally stable, with localized raveling along zones of geologic discontinuities as well as erosion of small bodies of unconsolidated sediments close to the slope crests. However, because of the steepness of the terrain, any rockfall originating from the outcrops above the catch point limits could present a hazard.

Of all the rock cuts within the Slate Creek segment, the short one between MP 226.0 and 226.1 one appears to have the greatest potential for consistent production of rock fall. This stretch is characterized by a sequence of poorly stratified sediments containing a large percentage of small to large boulders in a weakly cemented sand gravel cobble matrix. Despite the wide shoulder setback, the height of the slope and the shape of the fragments that reach the shoulder enhance run out of released fragments.

1.4.9.8 Southbound MP 228.2-228.5

This stretch is at the base of the "Slate Creek" segment which was constructed in the 1970s. The cut slopes are on the north side of the roadway. The lithologies represented appear to be densely fractured and faulted bodies of granite, and metamorphic rock. The ditch has little cross slope, and typically appears to be about 25 feet wide. Additional ditch width and cross slope would aid in containment of rockfall material.

The cuts are quite high and steep. A close inspection revealed numerous plane shear and wedge geometries, for example one at about MP 228.45 where a very large wedge of rock fell out leaving a defile whose headwall exposes embedded fanglomerate or colluvial material at the crest. At other locations, prominent erosion along faults and shears, especially toward the west end of the cut before the guard rail, has resulted in isolated masses, blocks, and pinnacles.

1.4.9.9 Southbound MP 228.7-229.0

This is a through cut in a sequence of moderately to weakly cemented, somewhat stratified valley fill sands, gravel, cobbles, and small boulders. Its counterpart through cut on the northbound is almost entirely in heavily cemented fanglomerate, which was excavated with narrow catch benches, most of which have now filled up with detritus, although the bench faces themselves mostly appear quite stable and intact. The northbound slope contains the less cemented valley fill material only at the top. Therefore, it appears that the contact between the fanglomerate and valley fill material dips steeply to the northwest. On the southbound side, which was the stretch recommended for action, catch benches are no longer clear/evident, if they ever existed.

On both sides of this cut, the weakly cemented valley fill sediments exhibit some erosion and delivery of cobbles and small boulders to the ditch, especially on the left side, but there appears to be sufficient ditch width to contain the resulting rock fall. The slope on the right side is taller, but there does not appear to be much rock in the ditch, which seems to be of adequate width and cross slope. There is no evidence of large-scale rotational instability. Additional studies would be necessary to quantify the adequacy of the catchment ditches.

1.4.9.10 Northbound MP 228.9-229.0

Although the near-vertical bench faces in the cemented fanglomerate generally appear stable, the catch benches are filling up, and there is a layer of less cemented material at the top. It does not appear to be eroding extensively, as there is no slope above it to contribute drainage, but the catch benches are not adequate to attenuate the fall of any material released from the slope crest area. Material that does release from the slope face could be projected away from the face due to impact on the benches.

1.4.9.11 Northbound MP 233.2-233.7

This stretch contains through cuts in valley fill colluvium. An informal discussion with an ADOT employee who was involved in the original construction in this area observed some waste rock disposal in this area. Whether or not these cuts represent disposed waste rock is unclear but should be verified. Some of the fills show clear stratification, but others appear amorphous. The crest area is well vegetated, but the slope faces exhibit only spotty development of scrub brush. Heavy rill erosion is occurring, especially on the east side. Some very large slip outs have occurred during wet events, and have required re-contouring the slope, with additional erosional development within the re-contoured sections. Because the shoulder is so wide, there is little potential for rock-fall reaching the roadway, unless additional slip outs and mudslides take place.

1.4.9.12 Southbound MP 242.0-247.0

Although this section of roadway (Corvair Curve area) does not appear in the list of reaches of concern and does not exhibit significant rock-fall tendencies at present, the site distances are very short, and any realignment of the roadway to alleviate the sharp curvature would require cutting into the mountainside, increasing its height and possibly producing a rock-fall issue. This area was not field checked in any detail because of heavy traffic and time constraints, but the existing slopes appear to be relatively flat (1:1) and well vegetated, in deeply weathered Payson granite. Elsewhere, when steeper slopes have been attempted in the more weathered sections of Payson granite, they have often resulted in localized erosion and rock fall problems.

In the area MP 242 to MP 244.5, there are six cuts and rocks roll out into travel lanes during significant rainfall or snowmelt events.

In the area within MP 246.4 to 246.6 there are boulders at crest eroding out, and maintenance activity has occurred in the milepost range.

1.4.9.13 Additional Heavy Rill Erosion

Additional heavy rill erosion is exhibited at other locations along the corridor, among them MP 231.5 to 232.1, 222.2, and 222.5 on the east side of the northbound lanes.

Various strategies have been tried within the SR 87 corridor to control erosion in the prominent slope cuts within unconsolidated material. One of the largest of these is immediately south of Sycamore Creek on the west side. It was originally constructed in the early 1990s with sinuous, lined catchment ditches, in lieu of crown ditches, extending across the slope face. Over time, heavy rill erosion developed that cut through these interceptor ditches. In the late 2000's, the reconstruction of southbound SR 87 between DOS S Ranch and Four Peaks Rd. also contained a provision to repair the eroded slope south of Sycamore Creek. A different style of catchment ditch was tried. It may be worth evaluating these different approaches in formulating an alternative strategy for control of rill erosion within the corridor.

1.4.9.14 Other Issues

stretches added subsequently, such as southbound 242-244.5 and 246.45-246.55? Or just refer the reader to the rock fall project packages for other sites?

Figure 7: Land Ownership