BIA Rt 21: SR 86 to Papago Farm Road
Road Safety Assessment

Prepared for:
The Tohono O'odham Nation

Prepared by:

Greenlight Traffic Engineering

KITTELSON & ASSOCIATES

Funded by:

U.S. Department of Transportation
Federal Highway Administration

NOT FOR CONSTRUCTION: Recommendations contained in this document are intended ONLY for use by the local agency determining possible future changes at the RSA location.

May 2023

Table of Contents

Project Request

The Road Safety Assessment (RSA) of the BIA Indian Route 21 was conducted at the request of the Tohono O'odham Nation. It should be noted that this RSA focused specifically on the safety aspects of the BIA Rt 21 corridor from State Route 86 to the end of the road.

RSA Team

Mike Blankenship of Greenlight Traffic Engineering led the independent, multi-disciplinary RSA team. The RSA team included:

- Adam Larsen, Federal Highway Administration
- Jeff King, Federal Highway Administration
- Stacey Begay, Bureau of Indian Affairs
- David Smith, Bureau of Indian Affairs
- Felipe Ladron de Guevara, Kittelson & Associates
- Josh Barger, Greenlight Traffic Engineering

RSA Process

A Road Safety Assessment is a formal examination of user safety of a roadway by an independent, multi-disciplinary team that includes experienced and knowledgeable members. RSAs help promote safety by identifying a range of safety issues; promoting awareness of safer transportation planning, design, construction, and maintenance practices; integrating multimodal interests; and, more directly, considering the effect of human factors, enforcement and education activities, and emergency responder practices.

The RSA team conducted this assessment to the best of its abilities within the time allotted. The initial recommendations for the Nation to consider are based upon background information provided during the Start-Up and Preliminary Findings Meetings, an evaluation of recent crash data, stakeholder and community feedback, and day and night field reviews, as discussed in the following paragraphs. This information helped the RSA team identify potential opportunities to improve the expected safety performance of the BIA Route 21 corridor. While every attempt has been made to identify potential safety issues, it is important to note that the safety performance of the roadway remains the responsibility of the roadway owner and the roadway users.

Start-Up Meeting

The assessment team met with the Nation and stakeholders to discuss background information on December 2, 2021, virtually on a Microsoft Teams conference and in person at the San Simon Elementary School in the Tohono O'odham Nation. In addition to the RSA team members, participants included Damascus Francisco (Planning and Economic Development (PEDD)), Leo Porter (PEDD), Allery Antone (Tohono O'odham Police Department), Ulrick Francisco (Tohono O'odham Fire Department), Bridger Helm (Kittelson), Dr LaRonda Lugo (Santa Rosa Ranch School Principal), Marilyn Cowboy, Kevin Ramirez (Baboquivari Unified School District Transportation Director), Tobias Nez (Tohono O'odham Health Transportation Services), Mike Bethurem (Tohono O'odham Utility Authority), Frank Rogers (San Simon School Principal), Denise Williams (Tohono O'odham Head Start), Jason Celestine (San Simon Community), Andy Lopez (Gu-Achi District), Martin Arnold (Tohono O'odham Fire Department), Samuel Orozco (Planning and Economic Development/Roads), Yuriko Toro (Planning and Roads Program), Marilyn Celestine (Planning and Economic Development Department), Mario Saraficio (Tohono O'odham Police Department), Lizette Magdaleno (San Simon School BIE), Quinton Martinez (San Simon School), Hipolito Mantijo (San Simon School), Ervin Francisco (San Simon School), Reginal Chavez (San Simon School), Stanley Cruz (Pisinemo District), Roy Calabaza (San Simon School), and Don Sneed (ADOT).

Safety concerns that were noted by the stakeholders to be considered in the RSA request include the following:

- Animals in the roadway
- Soil in the roadway
- Roadside vegetation
- Bus stop signage
- Roadway flooding
- Blocked culverts
- Soil erosion
- Road curve signage

Specific priority locations, issues, and concerns noted by stakeholders follow.

The group noted that washes along the roadway are concern areas for excess vegetation and potential cattle hazards. The first road curve heading south on the route to Pisinemo was identified as an area of interest. Excess sand in the roadway by washes was also noted as a concern. Areas south of Santa Cruz have no fencing and typically have lots of livestock in the roadway. Bus stops in Pisinemo do not have signs signifying to drivers of the bus stops. Sight distance concerns were expressed for overhung vegetation on the corridor by washes.

Adam Larsen asked if there are ATVs used on the road. It was noted that the border patrol typically uses these vehicles on the route. Adam asked if wet-surface crashes are an issue. It was concluded that this might be an issue. It was also noted that there should be water gauges in the washes to show how deep a flood is and show if it is safe to proceed.

Frank Rogers asked if wildlife animals and flash floods are an issue. It was noted that there was a crash in a wash that occurred in a work zone near Pisinemo. Road work was done in

the area at the time. Water drainage and flooding is a top concern for the roadway in each wash. It was noted the culverts are getting clogged and are not getting cleaned out. Before Santa Cruz, there is a culvert that is clogged. This develops standing water next to the road that attracts cattle to the side of the roadway. Flooding south of Santa Cruz was mentioned to historically occur during rain events. Signage for the road curves before Pisinemo and a sharp curve outside Santa Cruz was suggested as a potential safety improvement. Additionally, upgrading nighttime visibility for the roadside using reflective devices was suggested.

Adam Larsen showed the 360-degree video of the Rt 21 that was taken earlier in the year and discussed with the group how to use it. Adam noted a curve before Pisinemo that had a fatality monument at the curve. Damascus noted that a tractor-trailer had jackknifed at a sharp turn in the roadway before, where there the road curve had no signage.

It was noted that the maintenance department has typically removed excess dirt on the roadway and placed it on the side of the road. Adding rumble strips to the sides of the roadway for road departure and perpendicular rumble strips where lower speeds are suggested. The additions of turn lanes into the Santa Cruz district office, and Pisinemo turns were suggested. The addition of streetlights to these areas were also noted. Street name signs along the entire route would help emergency services respond and navigate to calls.

Dr. LaRonda Lugo noted that wildlife and flash floods are the biggest issues on the corridor. Allery Antone noted that vegetation on the roadway could hide animals from drivers' vision. Potholes and cracks were also noted to be present on the roadway surface. Jeff King asked if there is cellphone coverage on BIA route 21 that can service emergency communication. It was noted that route 21 has no service south of Santa Cruz. Therefore, increased communication coverage for emergency response events may be considered as a recommendation.

Field Reviews

A daytime field visit was conducted on Tuesday, December 2, starting at approximately 1:00 PM, and an evening/nighttime field visit was conducted the same day at approximately 5:00 PM. The weather was hot and dry. The site review consisted of driving and walking the study area and observing road users.

The RSA team noted several existing and proposed roadway features that appear to enhance safety in the study area, including the following:

- Raised pavement markers (RPMs)
- Roadside gabion baskets
- New pavement sections
- Good sign of retroreflection
- No passing signage
- Speed reductions adjacent to communities

RPMs in road centerline and edge lines

Roadside gabion baskets and refreshed pavement

Evaluation of Crash Data

The most recent ten years of available crash data (2011 through 2020) for this 29-mile section of BIA Route 21 was obtained from ADOT's ACIS crash report database. A total of 66 crashes occurred over the 10-year period. The crashes on the route are broken down by crash severity, crashes by year, and crashes by time of day in **Figure 1** through **Figure 3**.

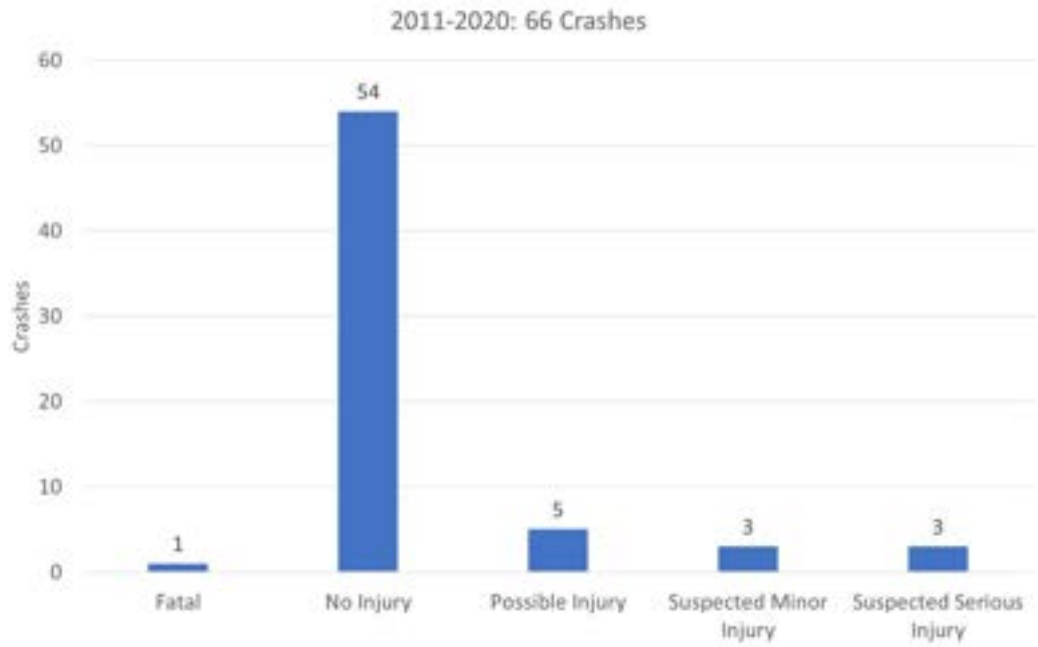


Figure 1: Route 21 Crash Severity

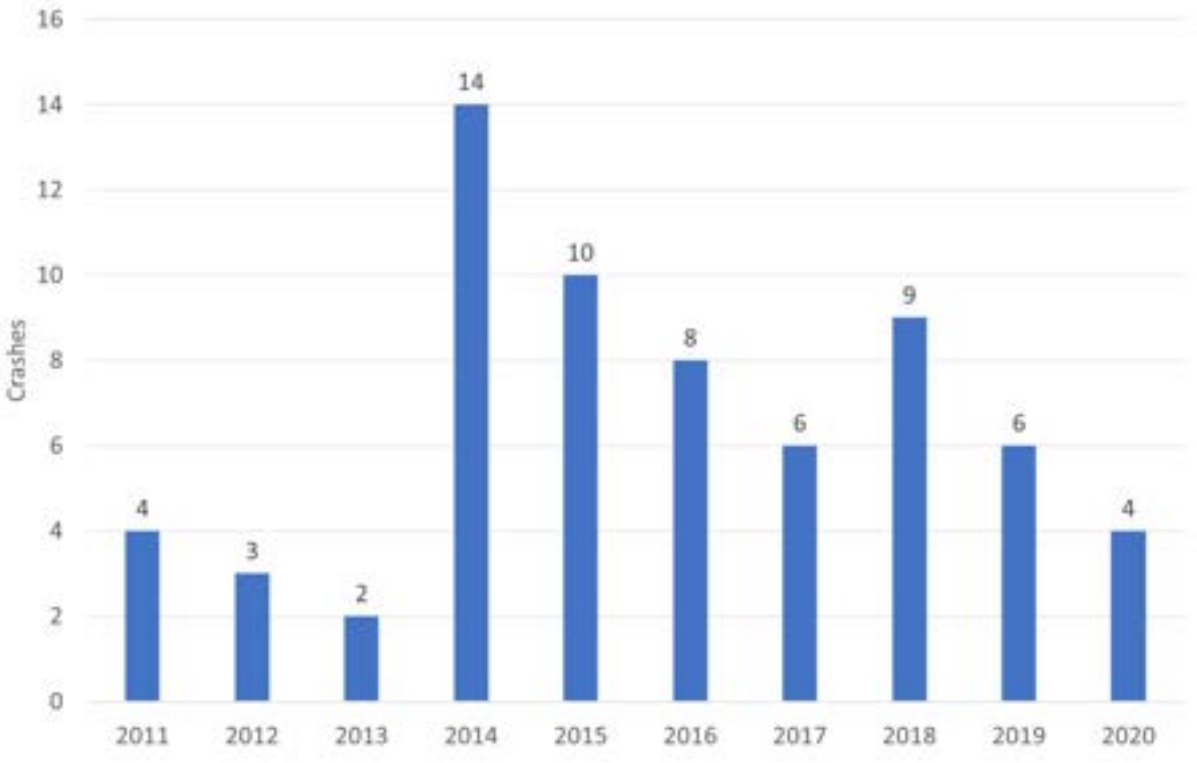


Figure 2: Route 21 Crashes by Year

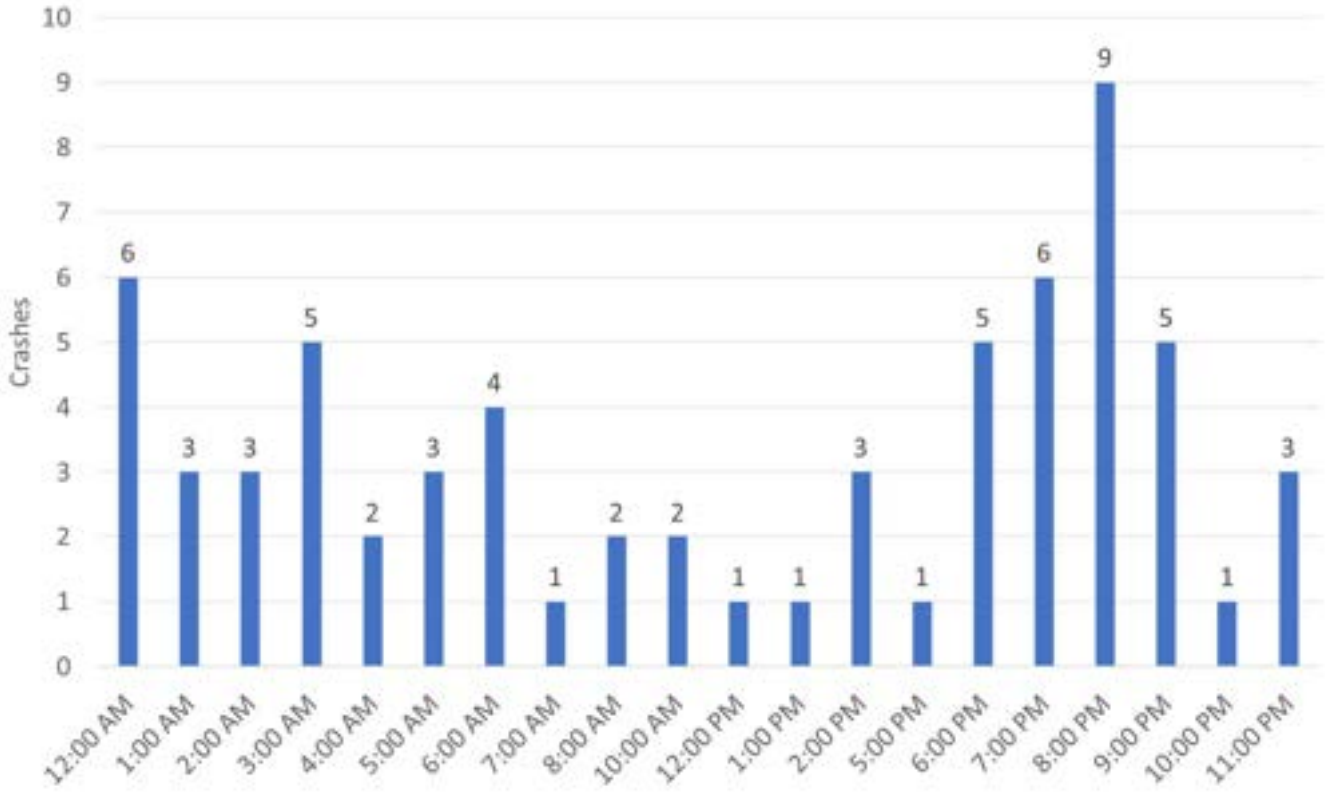


Figure 3: Route 21 Crashes by Time of Day

The crashes on the route by crash manners are shown in **Table 1**.

Table 1: Route 21 Crashes by Collision Manner

Collision Manner	Crashes
Single Vehicle	65
Pedestrian	1
Total	**66**

Crashes by first harmful event are shown in **Figure 4**.

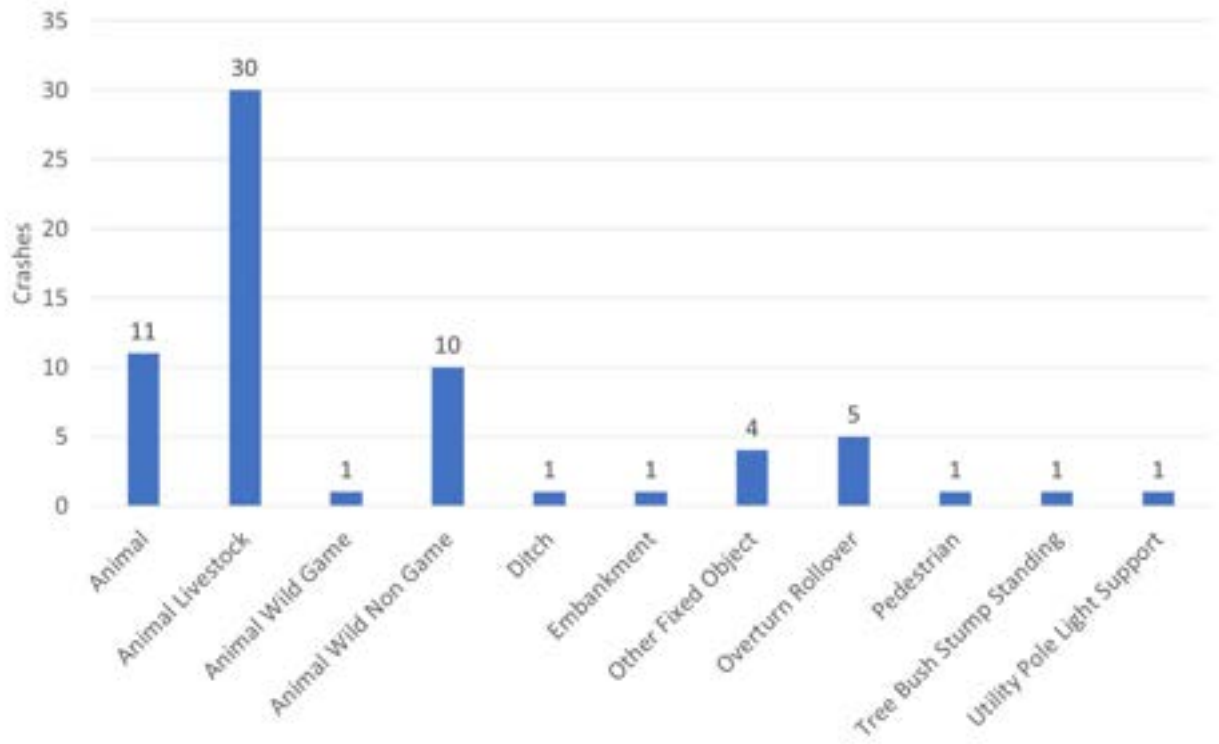


Figure 4: Route 21 Crashes by First Harmful Event

The route's crashes by the first harmful event compared to crash severity are shown in **Table 2**.

Table 2: Route 19 First Harmful Event by Crash Severity

Row Labels	Fatal	No Injury	Possible Injury	Suspected Minor Injury	Suspected Serious Injury	Grand Total
Animal		9	1	1		11
Animal Livestock		26	2	2		30
Animal Wild Game		1				1
Animal Wild Non Game		10				10
Ditch			1			1
Embankment		1				1
Other Fixed Object		3	1			4
Overturn Rollover		2			3	5
Pedestrian	1					1
Tree Bush Stump Standing		1				1
Utility Pole Light Support		1				1

Grand Total	**1**	**54**	**5**	**3**	**3**	**66**

The route's crashes that involved violations related to impaired drivers are shown in **Table 3**.

Table 3: Route 21 Crashes by Impairment

Impairment	Percent of Total
Alcohol	8%
Illness	2%
Fell Asleep/Fatigue	2%

There was 1 fatal crash and 3 suspected serious injury crashes. The crash frequency showed a peak of 14 crashes in 2014 and a low of 2 crashes in 2013 for the ten years considered. The crash locations by severity are shown in **Figure 5,** and the crash density or heat map is shown in **Figure 6**.

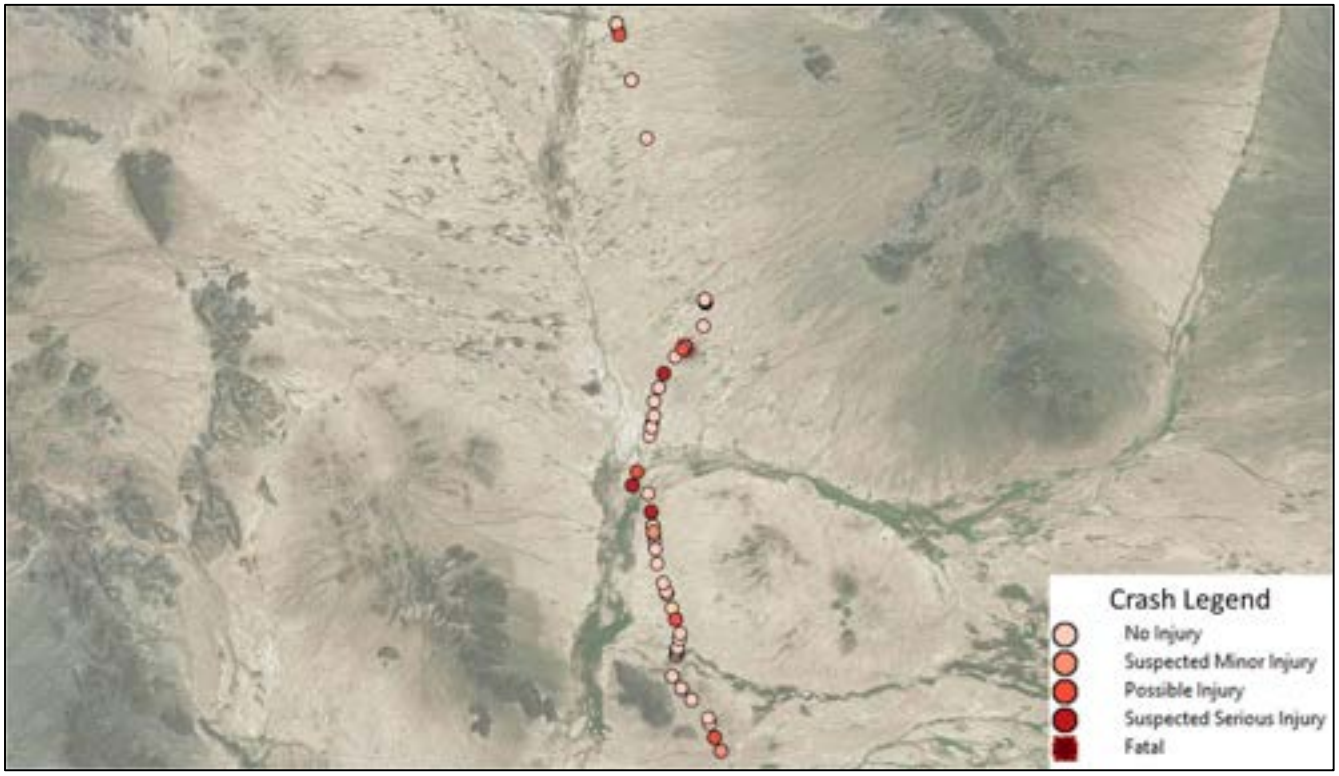


Figure 5: BIA Route 21 crashes between 2011 and 2020 by crash severity

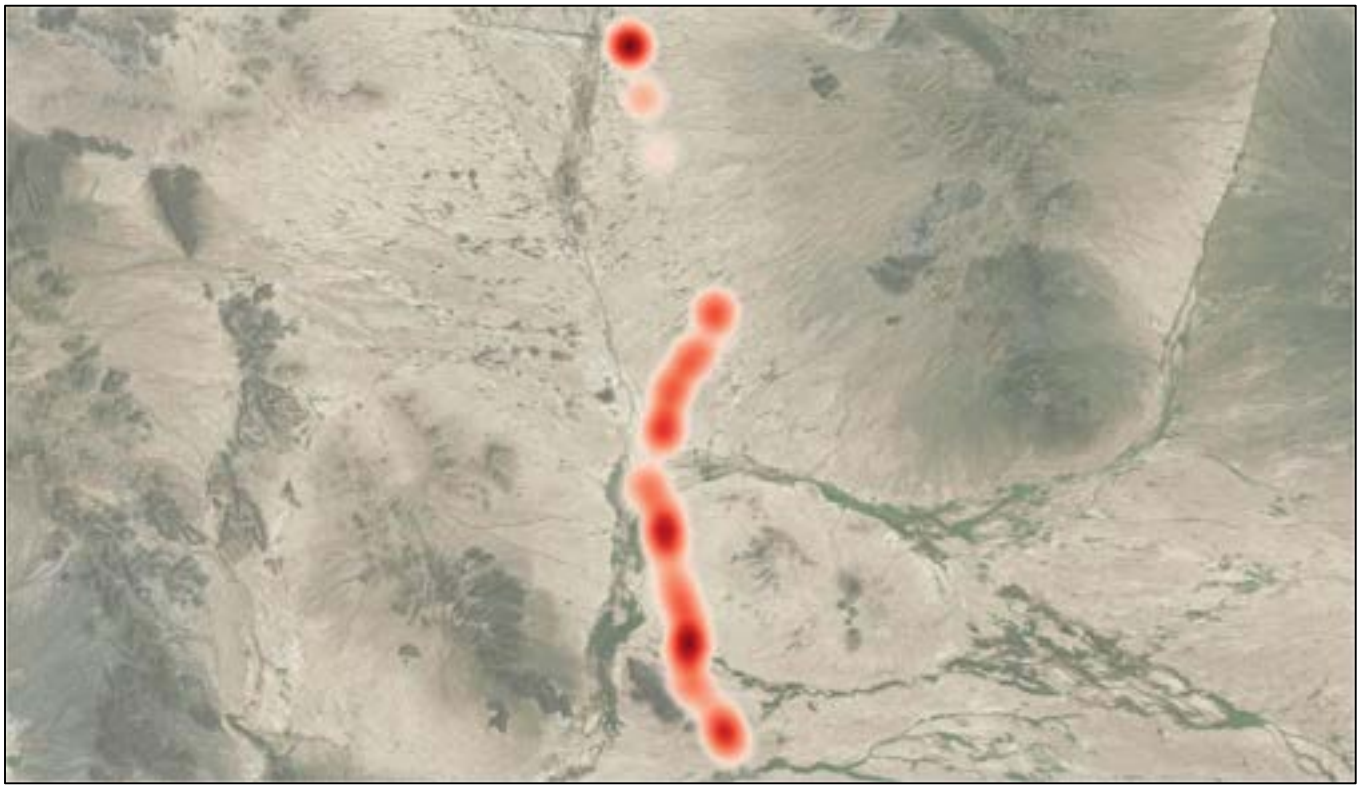


Figure 6: BIA Route 21 crash density (heat map) for crashes from 2011 to 2020

Public Outreach and Comment

Following the team's field review of the corridor, the Nation completed a public outreach initiative to garner public comments regarding safety on the BIA Route 21 corridor.

The public had a chance to review crashes that were reported and take a 360-degree video virtual tour of the route. The public was encouraged to make a comment by clicking on the map at the spot where they have concerns at the following link: https://fhwapolicy.maps.arcgis.com/apps/CrowdsourceReporter/index.html?appid=b09b221dabbc442ab833fd1a6f968f67

The public also had the option to send comments by email to TORoadsProgram@tonationnsn.gov while including the route number, location (nearest milepost), and a brief description of the safety concern. The last day for public comments was Friday, February 18, 2022.

No public comments were ultimately received regarding Route 21.

Additionally, presentations of the RSA's findings were given at District Meetings during their January, February, and March 2023 sessions.

Observations and Recommendations

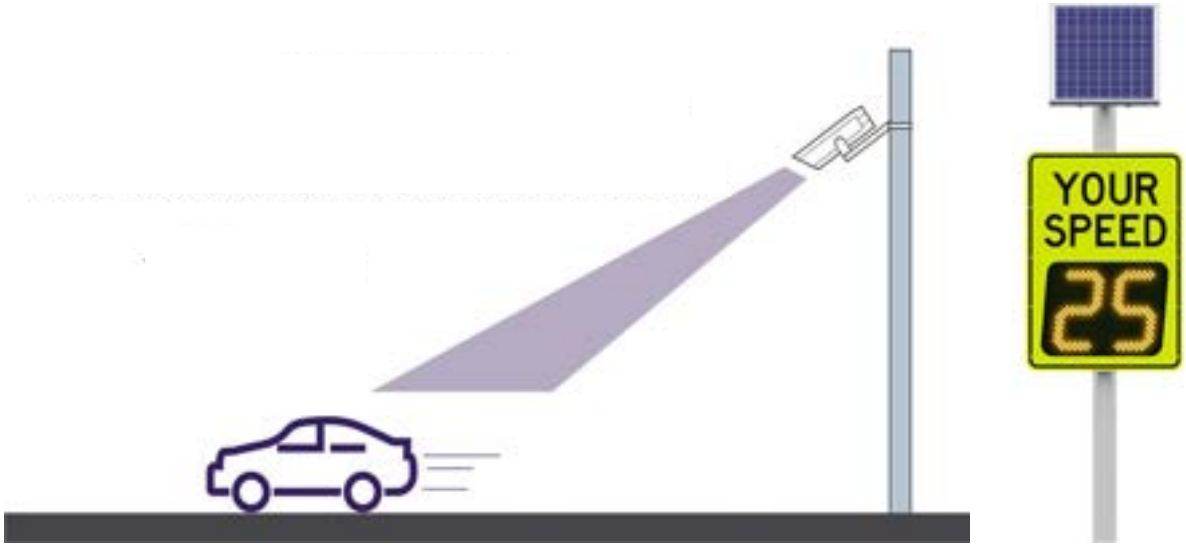
Specific safety issues and recommendations for consideration are discussed in the following sections. Additionally, the locations of the existing safety issues and hazards, as determined by the RSA team, are displayed in the maps found in **Appendix A**.

Corridor Speed

Law enforcement indicated that extremely high vehicle speeds are common on BIA Rt 21, and the Nation has limited resources available for speed enforcement. The posted speed throughout the corridor was observed to be 55 MPH and 35 MPH in the Pisinemo community area. Speeding was a factor in 9% of the crashes and 75% of the fatal and serious injury crashes in this corridor. Several vehicles were also observed traveling above the posted speed limit by the RSA team during both the daytime and nighttime reviews.

Speed management recommendations along the study corridor include:

- Reduce speed limit near communities
    - Add step-down speed limits, including 45 and 35 MPH in the Psinemo community area
- Consider establishing a strategic speed management program
    - Install speed feedback signs
    - Targeted speed enforcement



Speed camera demonstration and speed feedback sign example

Fencing

The RSA team observed intermittent no fencing along both sides of the roadway. In the crash data from 2011 to 2020, animal crashes are the top crash type, with animal crashes occurring throughout the corridor. The locations with animal-related crashes are shown in **Figure 77** below.

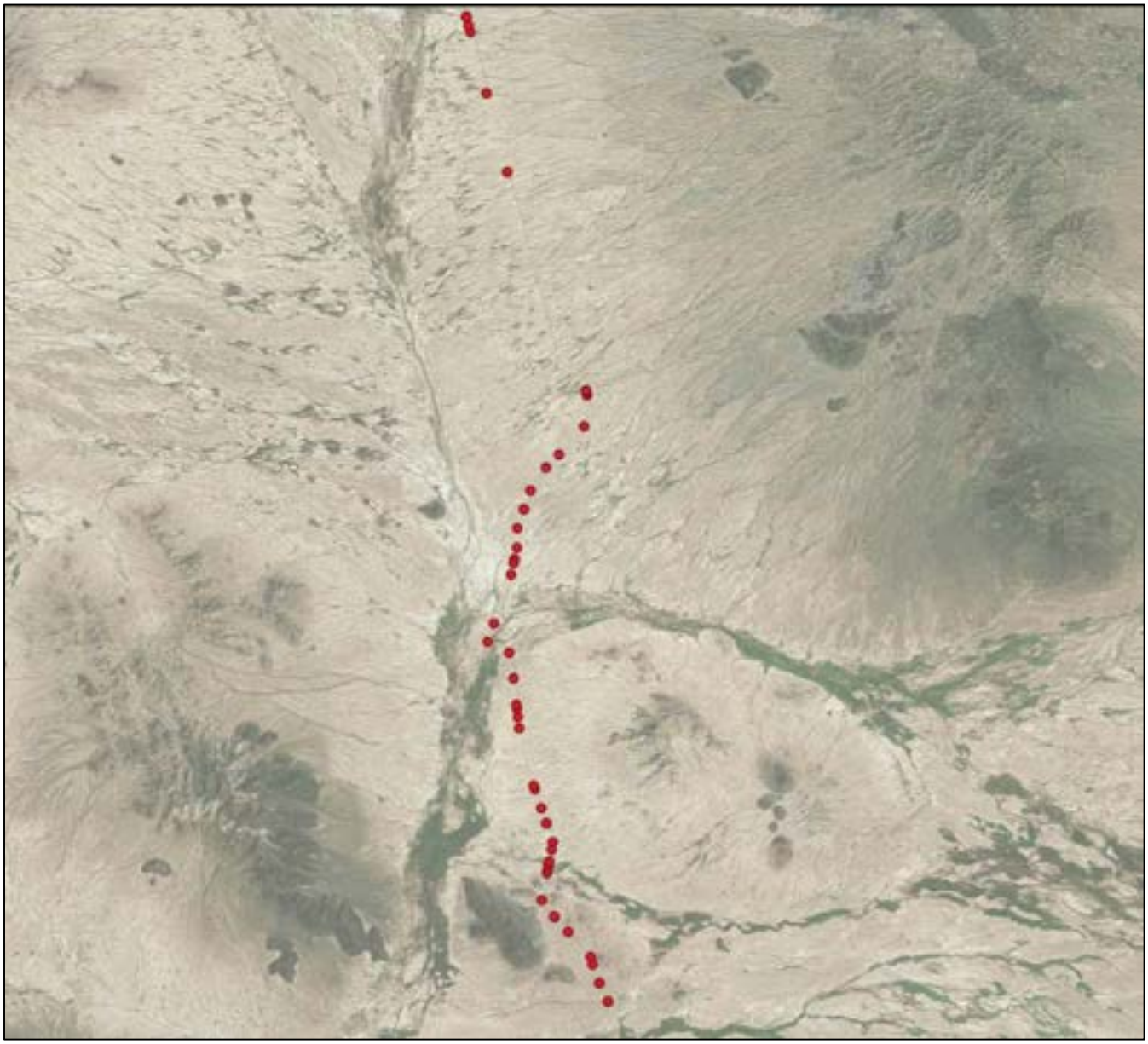


Figure 77: BIA Route 21 2011 to 2020 animal-related crashes

It was observed that cattle and donkeys were periodically wandering in the roadway. The RSA team was able to observe additional cattle and donkeys congregating on the sides of the roadway where vegetation could potentially obstruct the view of them. It was noted that nighttime conditions would potentially exacerbate the risk of animal crashes occurring.

Donkeys in the roadway

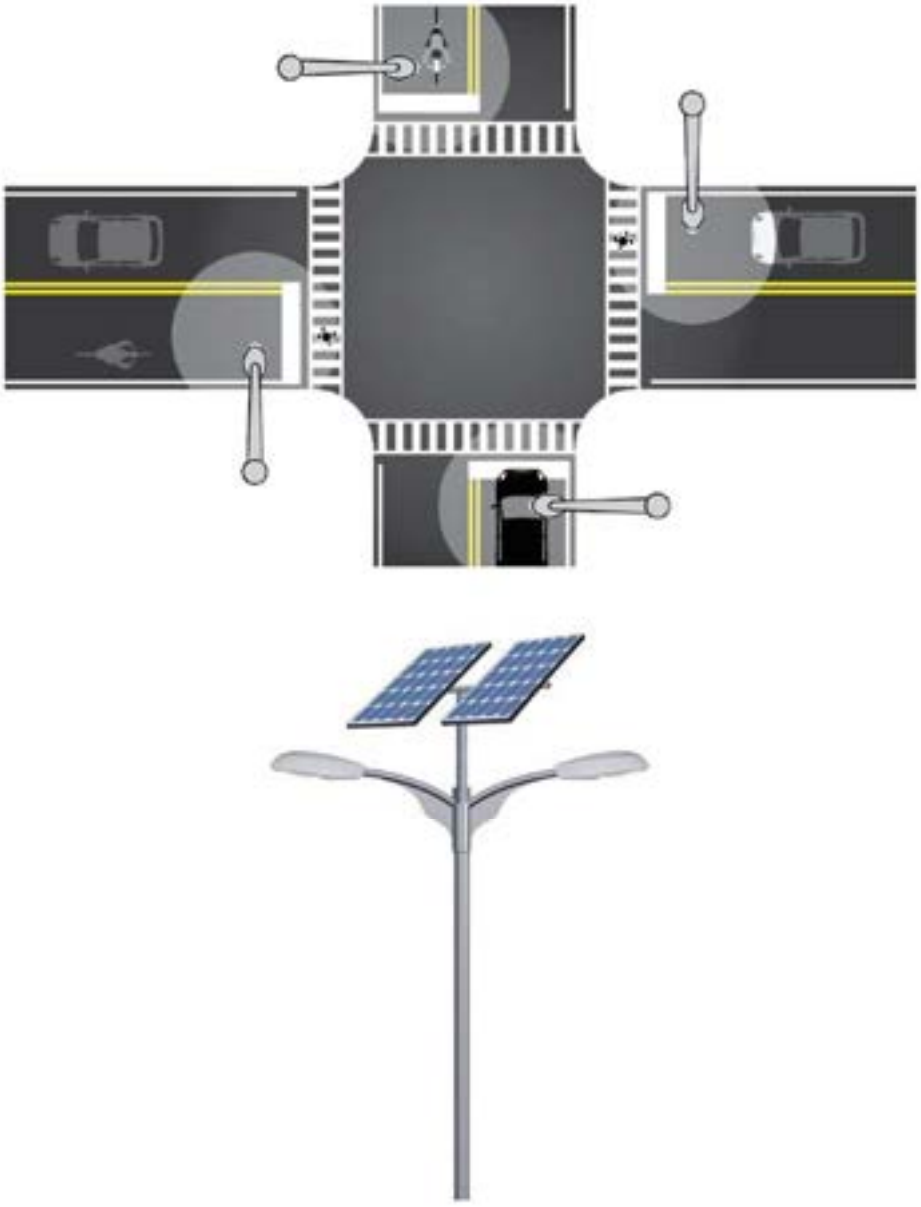
Cow/bull in the roadway

Recommendations include:

- Continuous fencing
- Vegetation control

Lighting

The lighting on the corridor was observed to be absent throughout the team's nighttime review. No driveways or unsignalized intersections were observed to have lighting.



Example of intersection lighting and sample solar-powered streetlight

Recommendations include:

- Install lighting
    - At approaches to communities
    - At approaches to schools and bus stops
    - At major intersections

Pavement Surface and Shoulder

Records indicate the last pavement maintenance that was completed on the corridor was completed in the 1990s. The pavement surface on the route between the SR 86 intersection and mile marker 11.5 appears to have large cracks, superficial cracks, and surface pitting with few or no potholes. Between mile marker 11.5 and the end of the road, the pavement appears to be recently refreshed, with little to no pavement imperfections observed.

During the daytime and nighttime reviews, vegetation was observed obstructing the view of the shoulder of the roadway and signs. The locations at mile markers 13, 17, and 20 were noted to be in the worst condition.

Shoulders throughout the corridor vary from approximately one foot to four feet in width. Edge drop-offs were observed throughout the corridor and specifically at the intersection of SR 86 and Rt 21 and at mile marker 19. It is noted that there are periodic erosion control measures between mile marker 11.5 and the end of the road, including riprap and gabion baskets.

Pavement damage on Route 21

Soil accumulation on Route 21 at mile marker 11

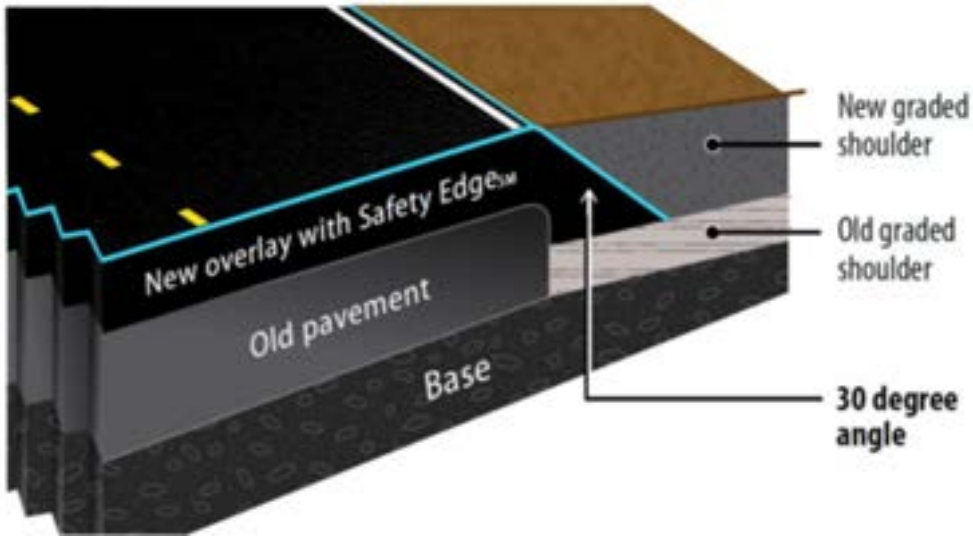
Sand on roadway

Typical pavement edge drop-off on Route 21

Large pavement edge drop-off on Route 21

Recommendations include:

- Conduct pavement maintenance (i.e., Chip Seal) between SR 86 and mile marker 11.5
- Remove soil from the roadway
- Implement Safety Edge or recoverable sloped shoulder
- Remove shoulder vegetation
- Ensure a 4 ft paved shoulder minimum



Example of the use of Safety Edge℠

Drainage

The RSA team observed clogging of existing wash drainage culverts. Culverts at mile markers 19 and 15 appear to be clogged or damaged. In general, the existing culverts on the route appear to be undersized for the apparent volume of drainage that they experience. A five-span box culvert-style bridge at mile marker 12 was observed to be clogged, with three of the spans being completely blocked.

Washes were noted to be crossing the roadway at sag curve locations throughout the corridor. Historically, these washes have flooded the roadway with variable depths of floodwater.

Clogged and blocked 5 span box culverts under Route 21

Existing wash drainage culverts under Route 21

Example of depth gauges at road wash crossings

Recommendations include:

- Install culverts at sag curves that experience flooding at mile markers 15 and 19
- Maintenance on damaged and clogging in culverts and under bridges at mile marker 12
- Depth gauges at wash locations

Signage and Striping

Most signs were visible during the daytime and appeared to have adequate retroreflectivity at night. Signs near mile marker 18 had paint obstructing them. Signs at mile markers 13, 17, and 20 were also obstructed with vegetation.

On approaches to intersections, no advance intersection warning signs were observed on the corridor. Additionally, no bus stop signs or advance warning signs were found near the mile marker 18.25 location. It was noted that the bus stop located near mile marker 18.25 is placed in a roadway curve.

Sample intersection warning sign (W2-2) from the Manual on Uniform Traffic Control Devices (MUTCD)

Roadway signage is obscured with paint.

Damaged signage at the RT 21 and RT 28 intersection

Roadway signage is obscured with vegetation.

The community signs appeared to be intermittent and occasionally in a non-standard form.

No chevron signs were observed at tight curves in the roadway alignment to warn drivers of coming tight curves. Additionally, no edge of roadway delineators is present throughout the corridor. These delineators can help reduce the risk of road departure on the corridor.

At the approaches to sag curves with washes, there were no advanced warning signs. These signs can serve to inform better the driver of large dips in the roadway that should be entered with caution.

Example of existing road curve with a lack of delineation/chevrons

Sample bus stop warning sign (S3-1) from the MUTCD

Sample curve warning signs (W1-8) from the MUTCD

Sample of roadside retroreflective delineators

Sample of dip (sag curve) advanced warning sign (W8-2) from the MUTCD

The roadway striping on the route appears to be in good condition. The nighttime reflectivity appears good on all road markings.

Recommendations include:

- Install intersection warning signs at roadway intersections
- Removal of sign graffiti or replacement near mile marker 18
- Removal of signs obstructing vegetation near mile markers 13, 17, and 20
- Install standard community signs
- Add bus stop warning signs at mile marker 18.25 or the new bus stop location
- Relocate bus stops away from the road curve near mile marker 18.25
- Install advanced sag curve warning dip signs
- Install edge of roadway delineators
- Install RPMs from mile marker 11.5 to the end of the road
- Add chevron signs through sharp curves

Suggested Improvements/Countermeasures for Consideration

The following table summarizes the RSA team's observations and potential opportunities to improve safety. The locations of the recommended improvements are displayed in the maps found in **Appendix B.** These suggested improvements/countermeasures are presented as options for consideration; the road owner may also identify other effective alternative improvements and countermeasures. While every attempt has been made to identify potential safety issues and provide countermeasure options, the safety performance of the roadway remains the responsibility of the roadway owner and roadway users.

LOCATION/ISSUE	DESCRIPTION	COUNTERMEASURES FOR CONSIDERATION

Corridor Speed	• Speeding on the route reported by law enforcement and the community
	• Recorded speed-related crashes on the route
		• Reduce speed limit near communities
		  ○ Add step-down speed limits, including 45 and 35 MPH in the Pisinemo community area
		• Consider installing a roundabout at community intersections to encourage lower speeds
		  ○ Install a roundabout at the intersection of Route 21 and Route 28
		  ○ Install a roundabout at the intersection of Route 21 and State Route 86
		• Consider establishing a strategic speed management program
		  ○ Install speed feedback signs
		  ○ Increase speed enforcement
		  ○ Install reduced nighttime speed limits

Fencing	• Recorded animal-related crashes throughout the route • Cattle and donkeys observed in the roadway	• Install continuous fencing

Lighting	• Dark lighting conditions throughout the route
	• No existing intersection lighting
		• Install lighting
		  ○ At approaches to communities
		  ○ At approaches to schools and bus stops
		  ○ At major intersections

LOCATION/ISSUE	DESCRIPTION	COUNTERMEASURES FOR CONSIDERATION
Pavement Surface and Shoulder	• Cracked and pitted pavement conditions observed • Shoulders appear to be too narrow in some areas • Shoulder vegetation blocking clear zone and shoulder sign throughout • Soil observed in the roadway • Large edge drop-offs observed	• Conduct pavement maintenance (i.e., Chip Seal) between SR 86 and mile marker 11.5 • Remove soil from the roadway • Implement Safety Edge or recoverable sloped shoulder • Remove shoulder vegetation • Ensure a 4 ft paved shoulder minimum. • Install shoulder and centerline rumble strips
Drainage	• Flooding historically experienced at sag curves • Clogging and damage observed in culverts and under bridges • Intermittent placement of flood water depth gauges observed	• Add culverts at sag curves that experience flooding near mile markers 15 and 19 • Repair damaged and clogging in culverts and under bridges at mile marker 12 • Add depth gauges at wash locations
Signage and Striping	• No advanced intersection warning signs observed • Graffiti obstructing signs observed throughout • Vegetation observed obstructing signs throughout • Not all community signs appear standard or present • No bus stop signs or advance warning signs present at a bus stop on mile marker 18.25 • Existing bus stop at mile marker 18.25 is located in a curve • No advance warning signs of large sag curves present	• Install intersection warning signs at roadway intersections • Removal of sign graffiti near mile marker 18 • Removal of signs obstructing vegetation near mile markers 13, 17, and 20 • Install standard community signs • Add bus stop warning signs at mile marker 18.25 or the new bus stop location • Relocate bus stops away from the road curve near mile marker 18.25 • Install advanced sag curve warning dip signs • Install edge of roadway delineators • Install RPMs from mile marker 11.5 to the end of the road • Install chevron signs at sharp curves

LOCATION/ISSUE	DESCRIPTION	COUNTERMEASURES FOR CONSIDERATION
	• RPM's absent between mile marker 11.5 and the end of the road • Road curve warning signs missing at tight curves	

Suggested Projects and Associated Unit Estimates for Consideration

PROJECT	PROJECT TYPE	SCOPE	CONSTRUCTION UNIT COST ESTIMATE
Sign and stripe	Sign and Marking	1 mile of sign and marking Improvements	$180,000 per mile
Round-about intersection	Intersection	Installation of one round-about intersection	$2,300,000 per intersection
Speed feedback signs	Sign and Marking	Installation of one pair of speed feedback signs	$50,000 per sign pair
Fencing and cattle guard	Clear Zone	Installation of 1 mile of continuous fencing inspection, repair, cattle guard repair/replacement	$200,000 per mile
Street lighting	Intersection	Installation of one intersection of street lighting and community area lighting	$ 180,000 per intersection
Pavement maintenance	Pavement	Installation of 1 mile of pavement maintenance (slurry seal)	$210,000 per mile
Rumble strips	Pavement	Installation of 1 mile of centerline rumble strips	$40,000 per mile
Paved shoulders	Pavement	Installation of 1 mile of 4-foot paved shoulders	$1,550,000 per mile
Clear zone maintenance	Clear Zone	1 mile of 32-foot clear zone clearing and grubbing	$80,000 per mile
Culvert maintenance	Drainage	1 wash crossing culvert maintenance	$50,000

PROJECT	PROJECT TYPE	SCOPE	CONSTRUCTION UNIT COST ESTIMATE
			per crossing
Culvert installation	Drainage	1 wash crossing culvert installation	$1,500,000 per crossing
Drainage maintenance	Drainage	1 wash crossing erosion control and riprap gabions	$1,140,000 per crossing
Soil removal and prevention	Drainage	Soil removal and rock placement for 100 feet	$ 30,000 Per 100 feet

Appendix A

Route 21 Existing Issues Map

Existing Issues

Route 21

Potential Safety Concerns

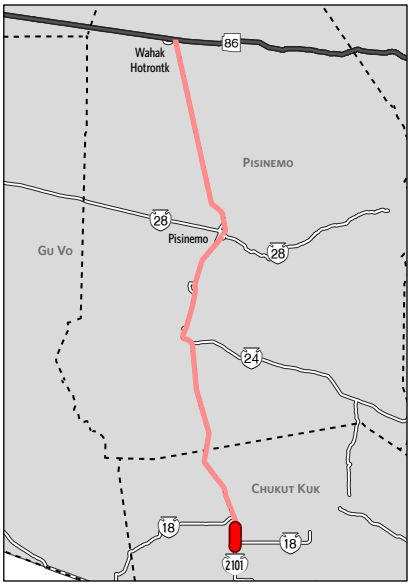
- High Crash Corridor
- Flooding Issue
- No Sidewalks
- Open Range, No Fencing
- No Shoulders
- Deteriorating Striping
- No Lighting
- Poor Pavement
- Curvy Roadway

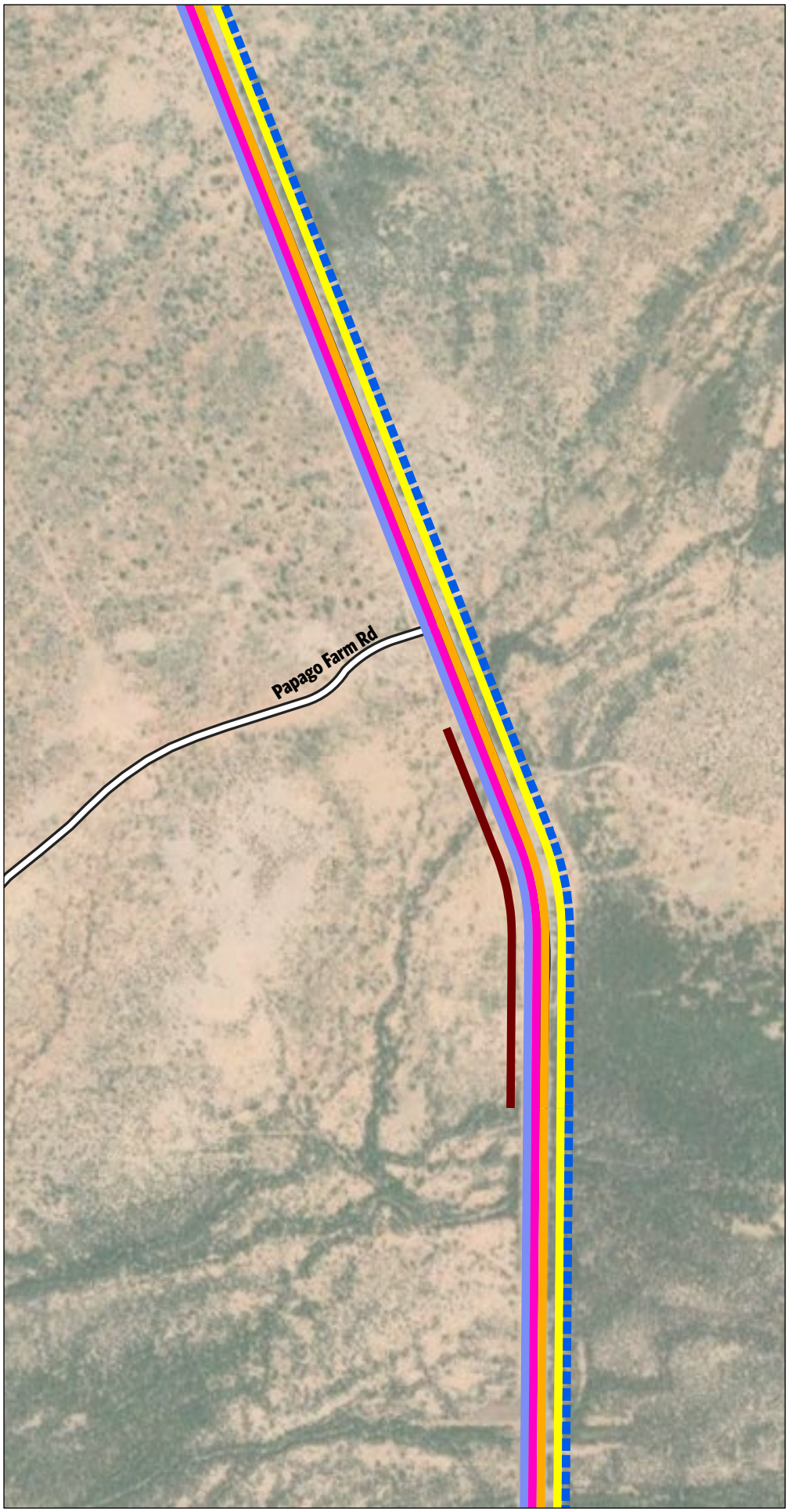
Reference

- Tohono O'odham District Boundary

0 300 600 Feet

1 inch equals 600 feet





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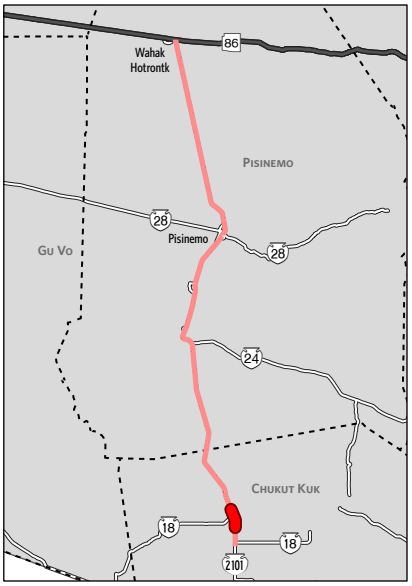

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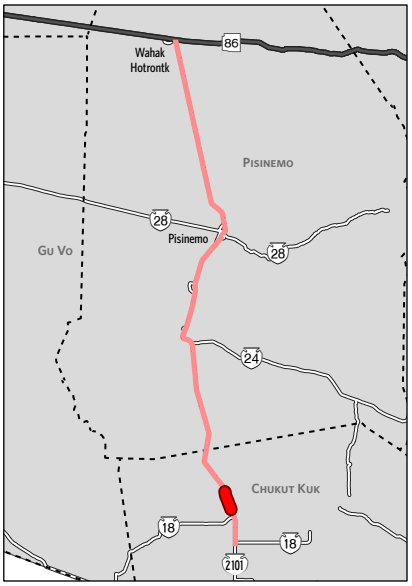

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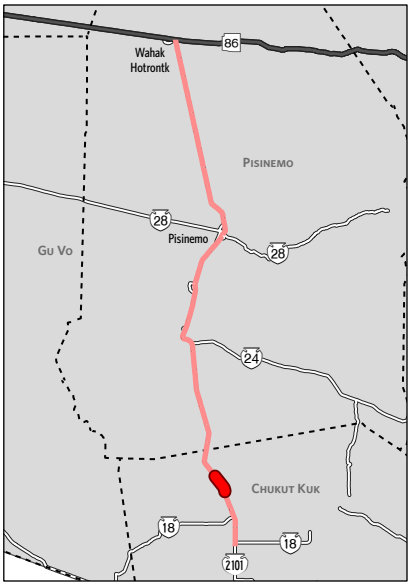

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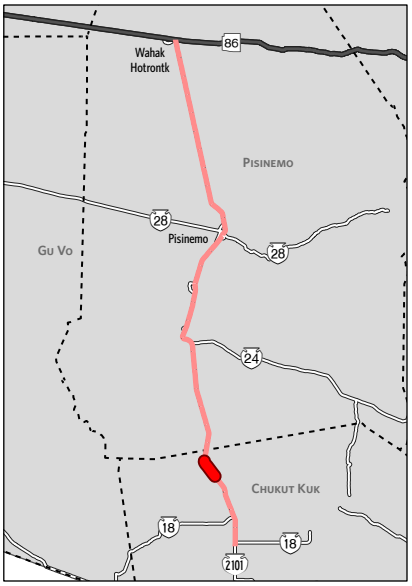

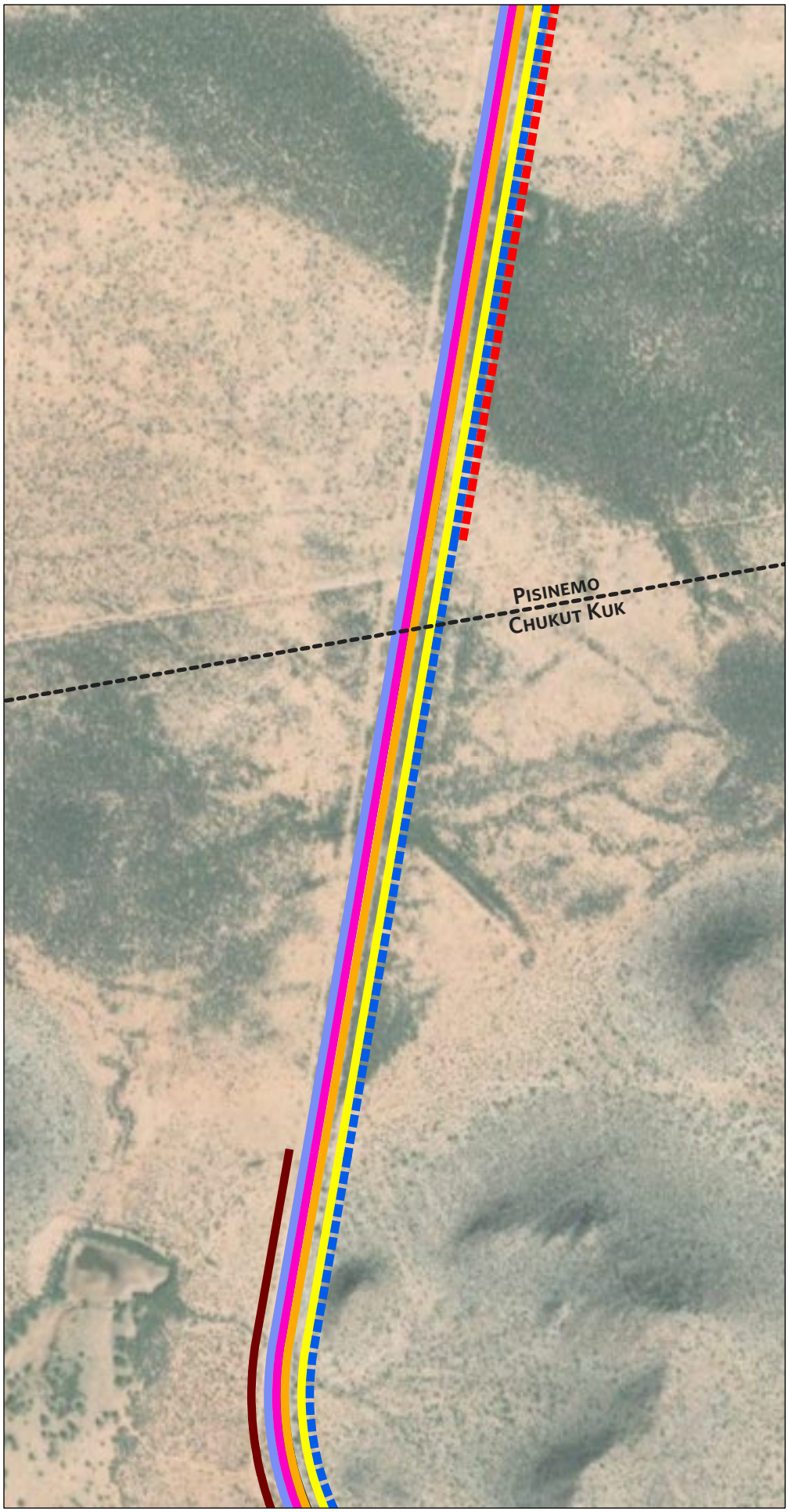

Existing Issues

Route 21

Potential Safety Concerns

- High Crash Corridor
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- No Sidewalks
- Open Range, No Fencing
- No Shoulders
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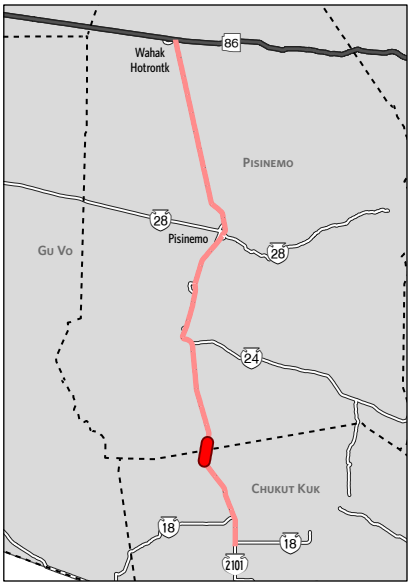
- No Lighting
- Poor Pavement
- Curvy Roadway

Reference

- Tohono O'odham District Boundary

0 300 600 Feet

1 inch equals 600 feet



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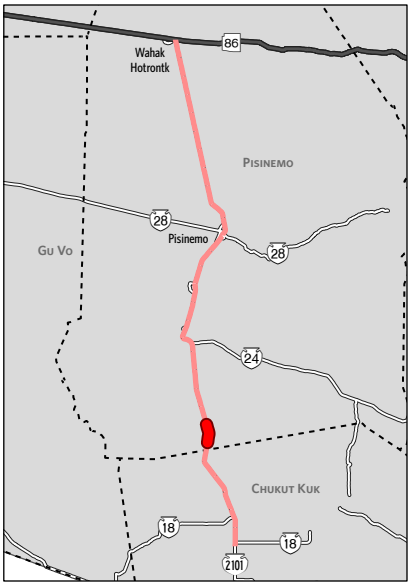

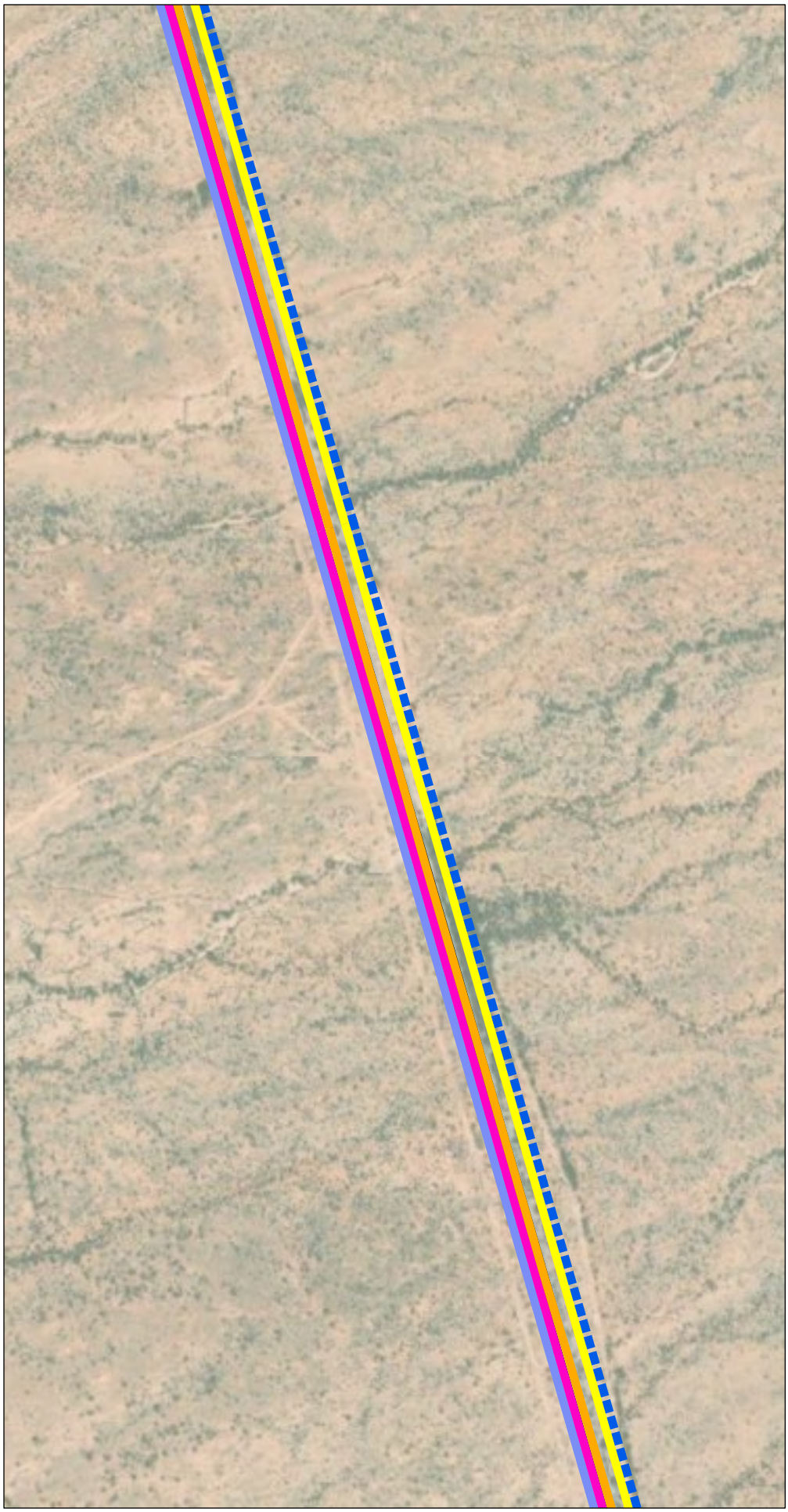

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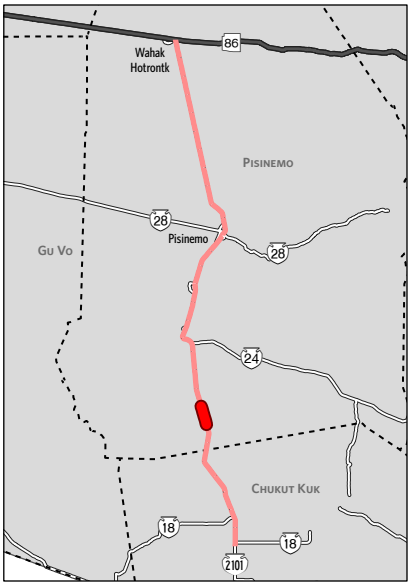

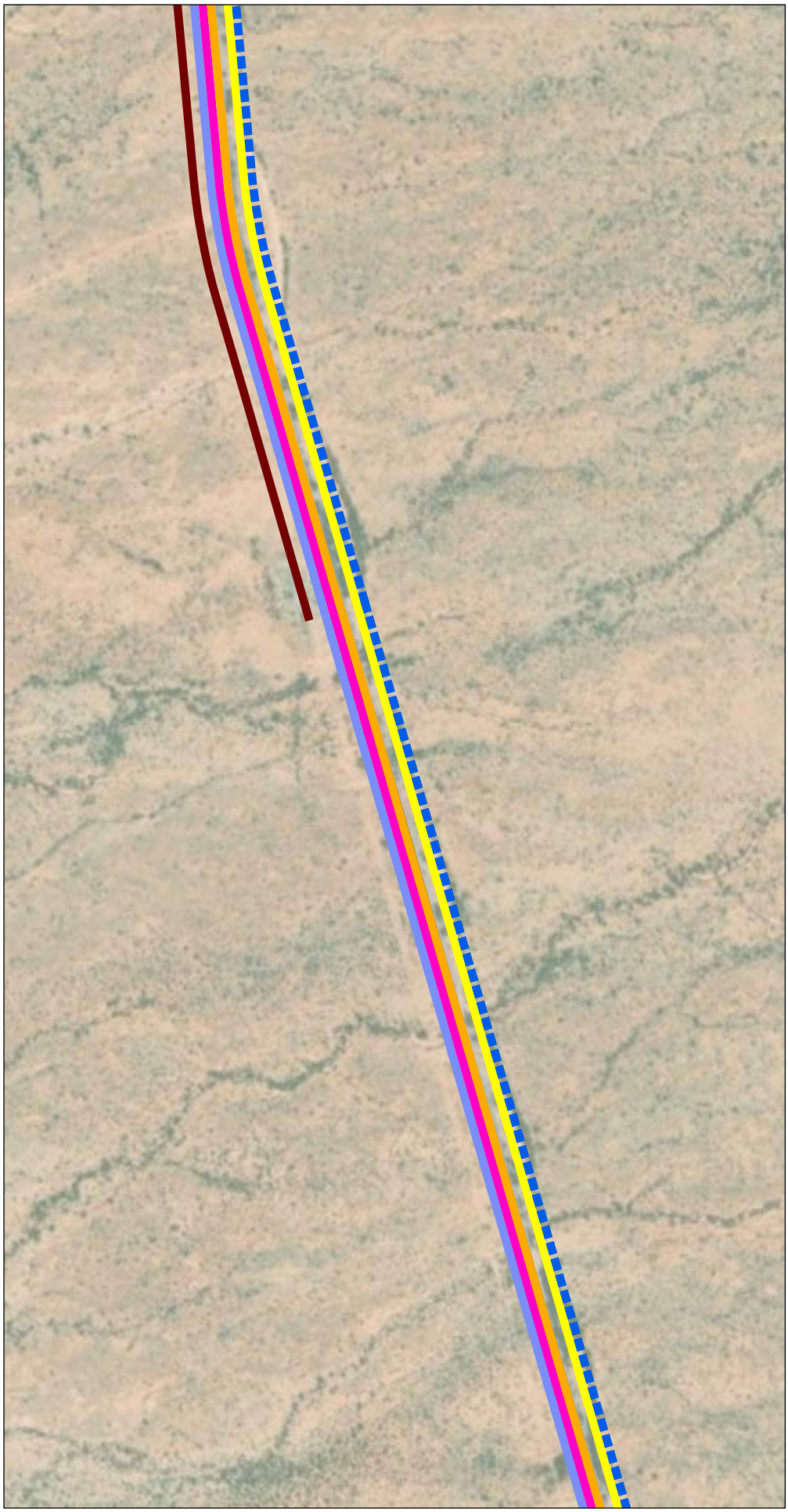

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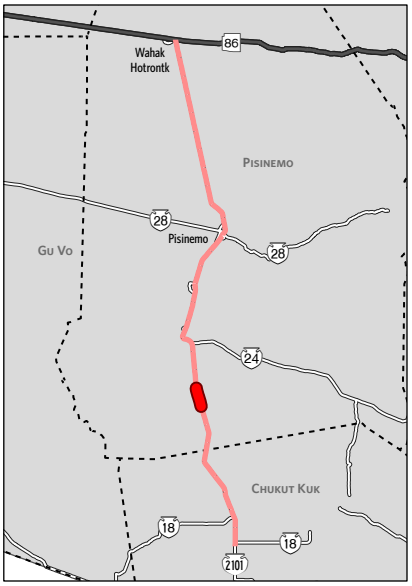

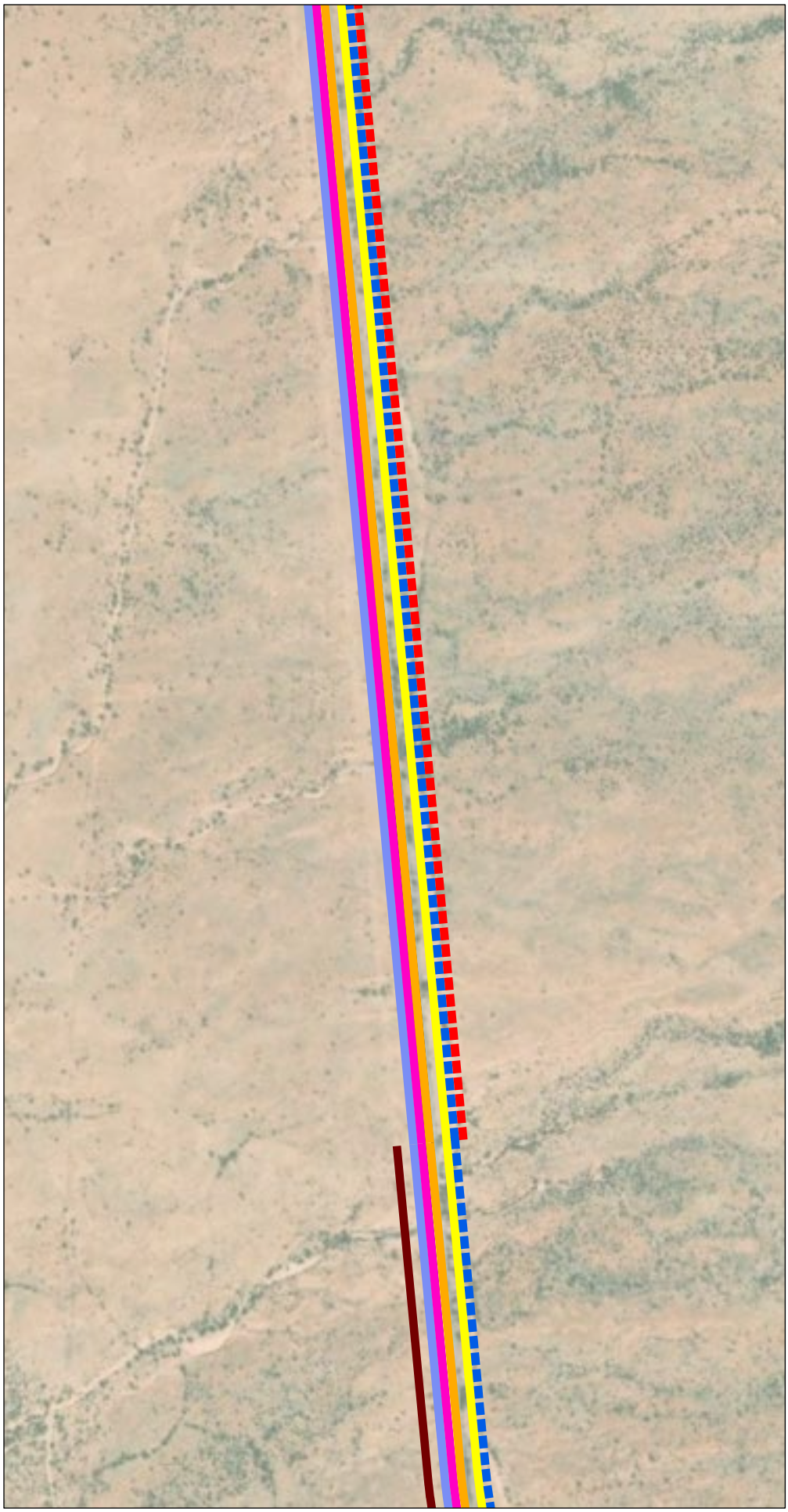

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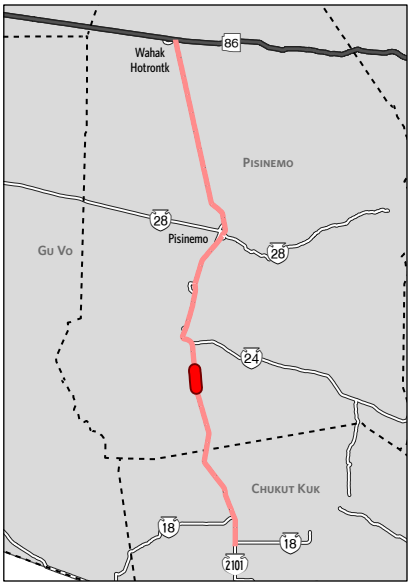

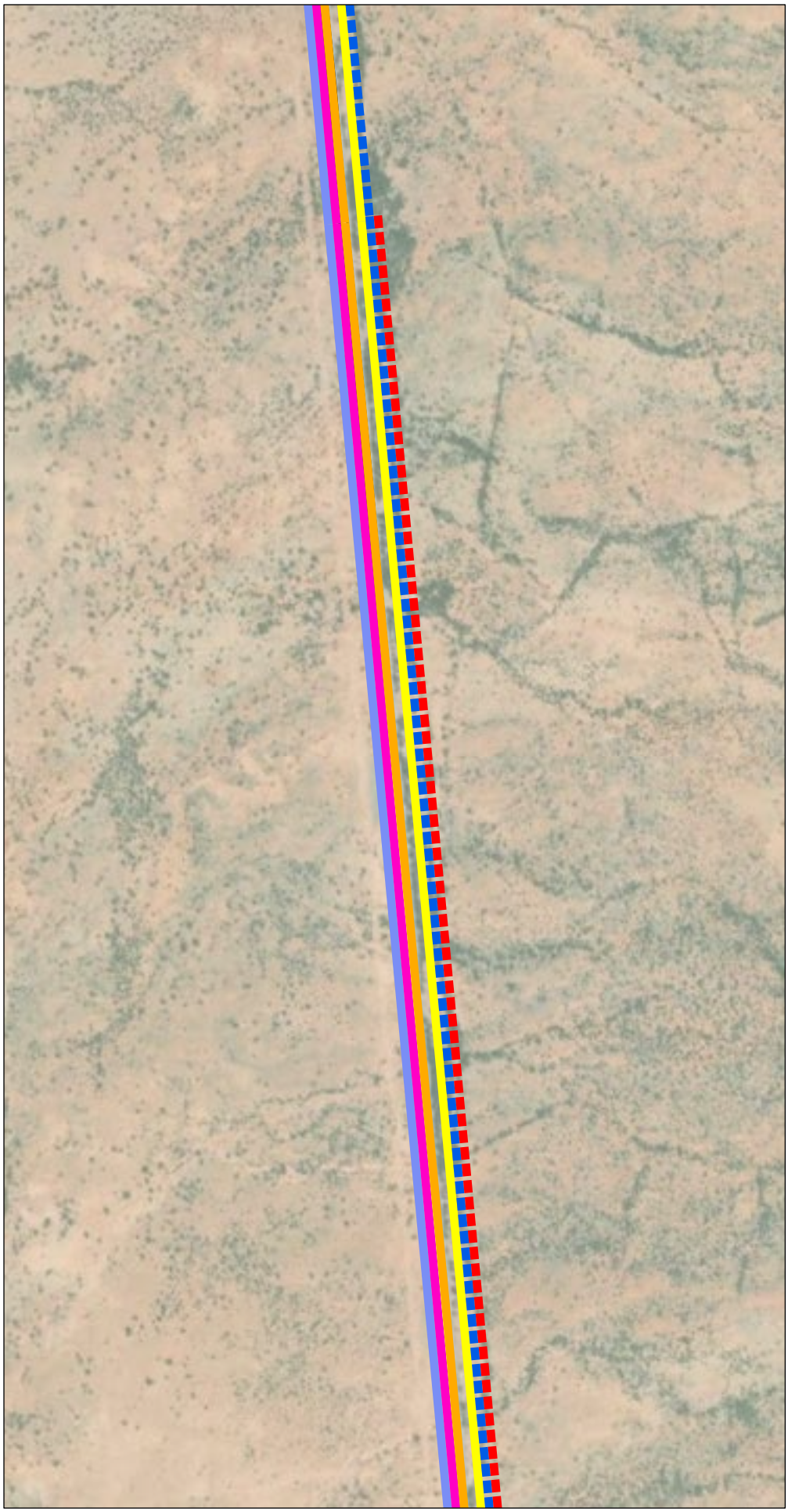

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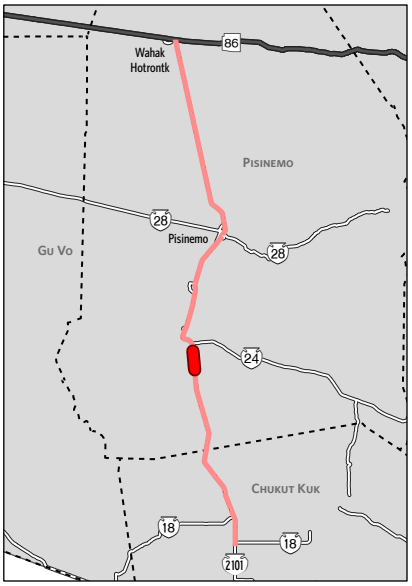

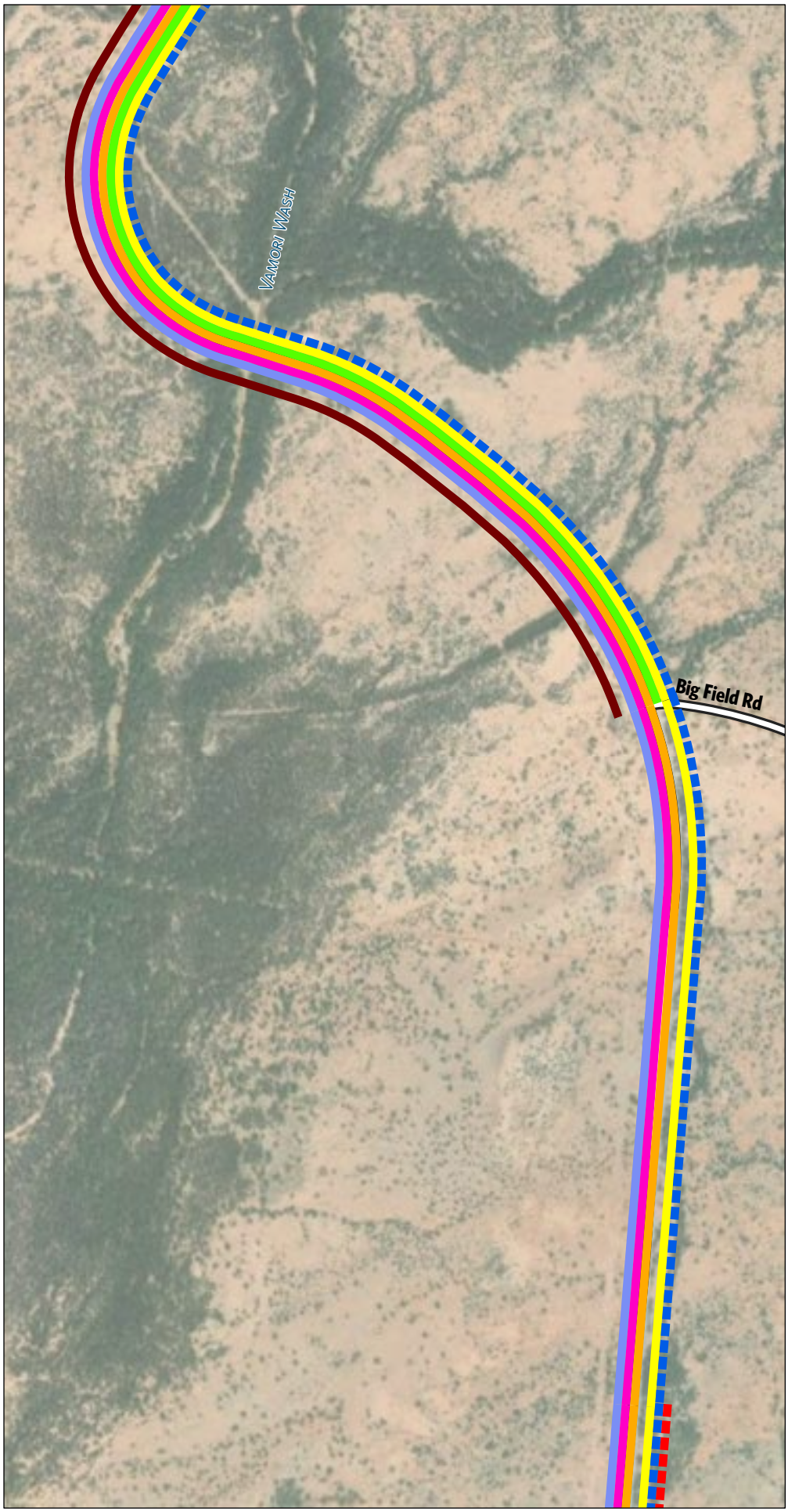

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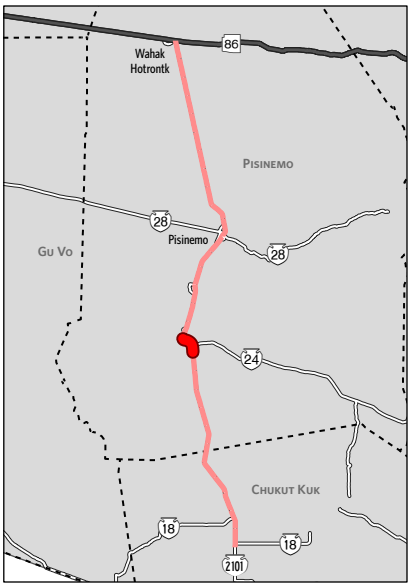

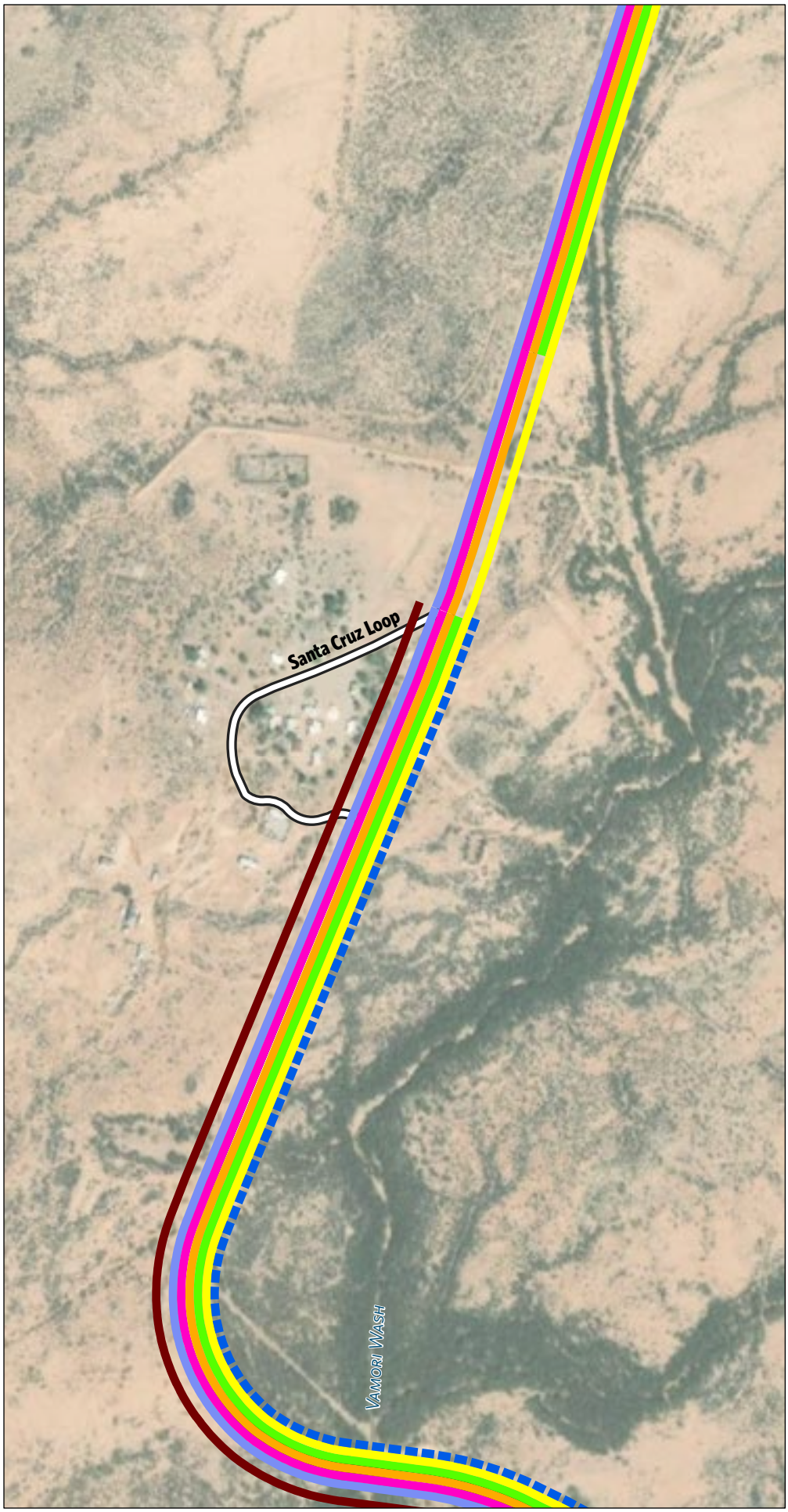

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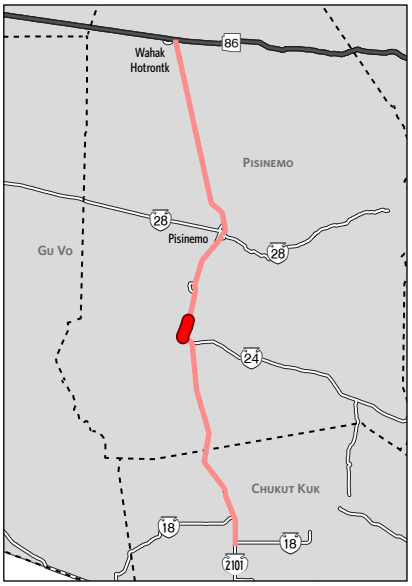

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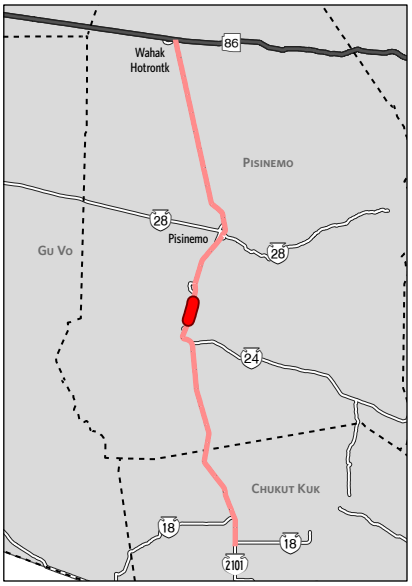

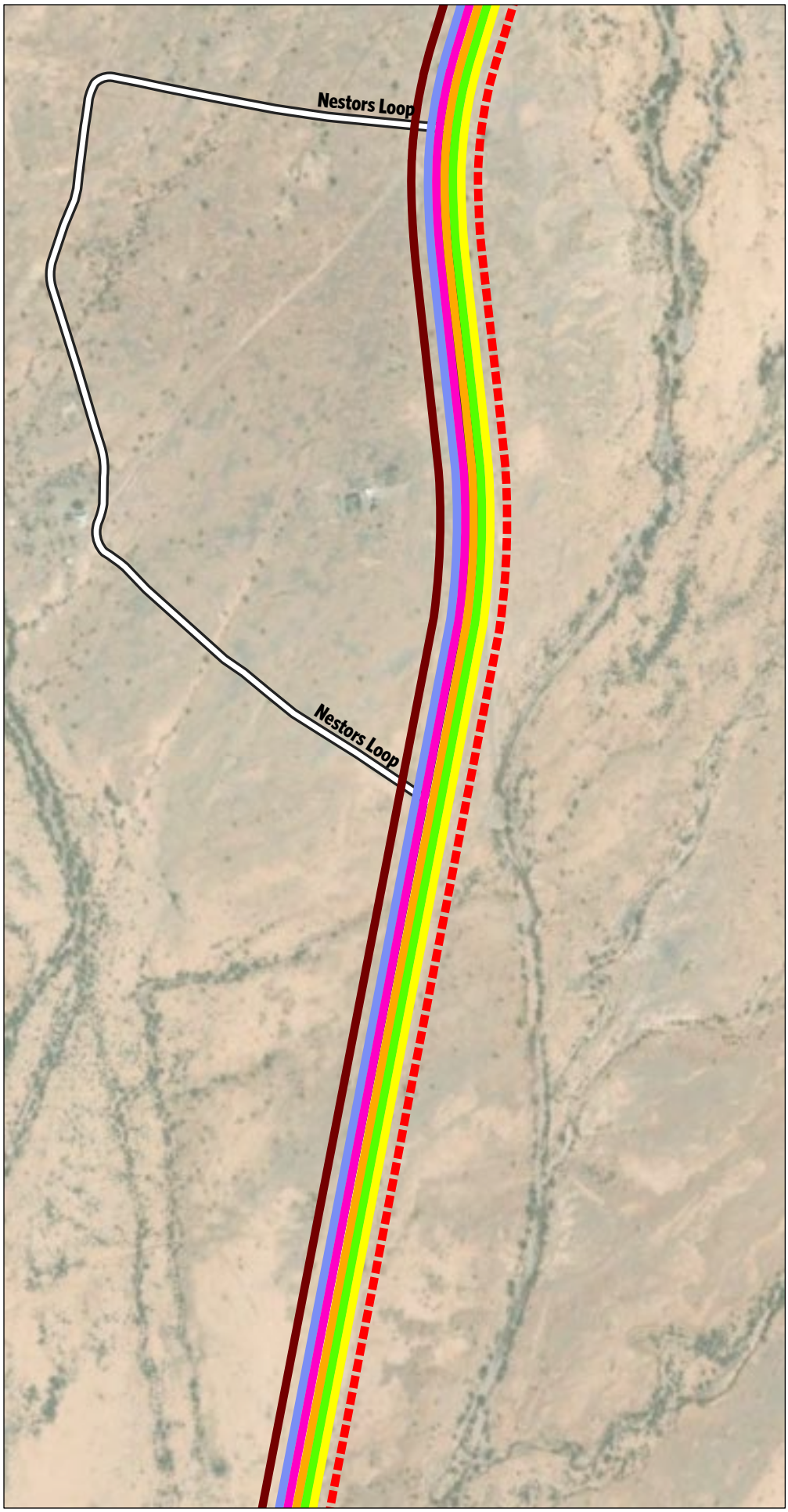

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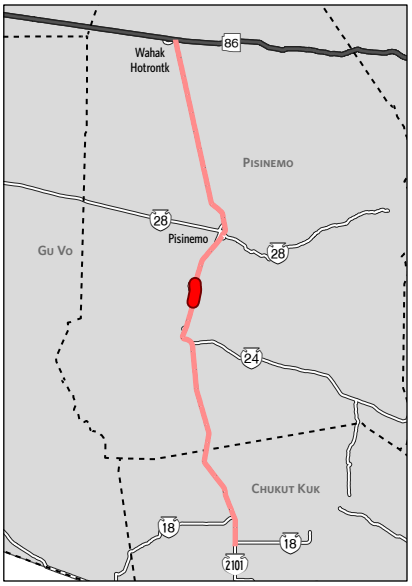

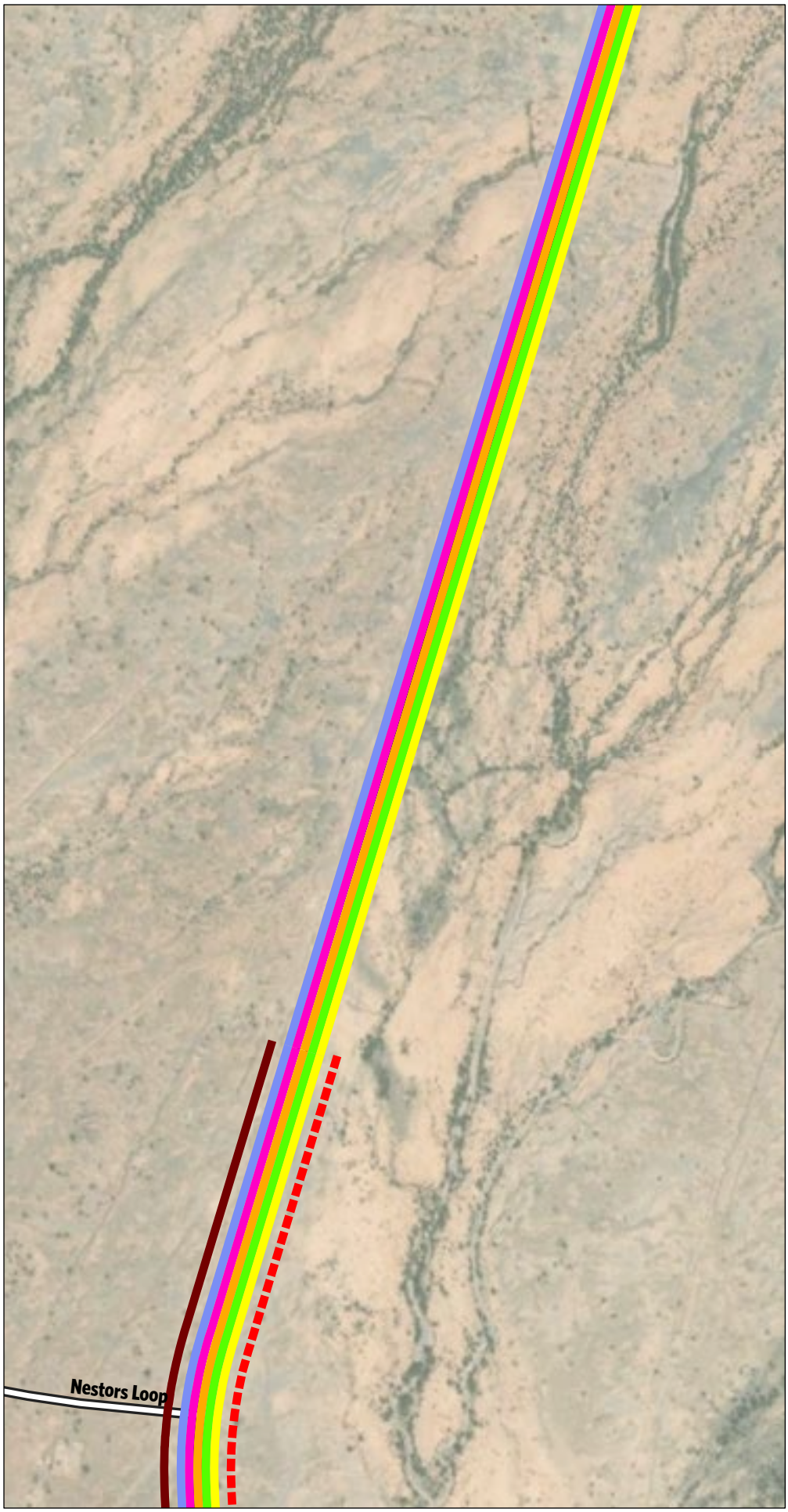

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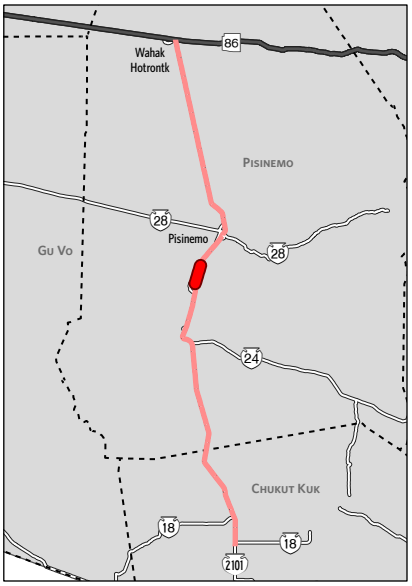

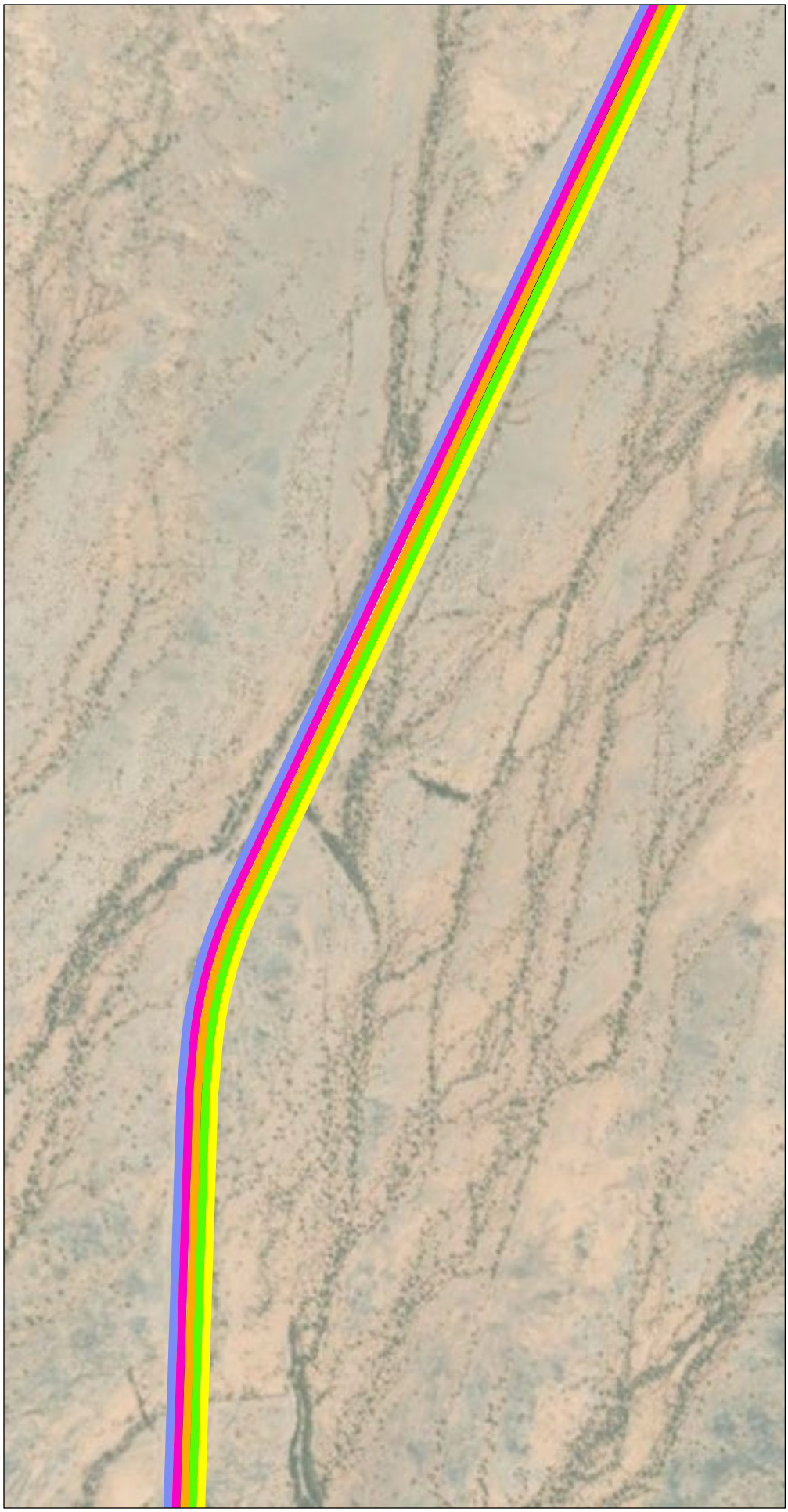

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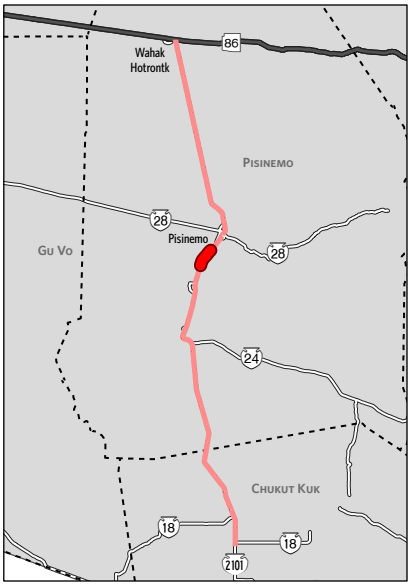

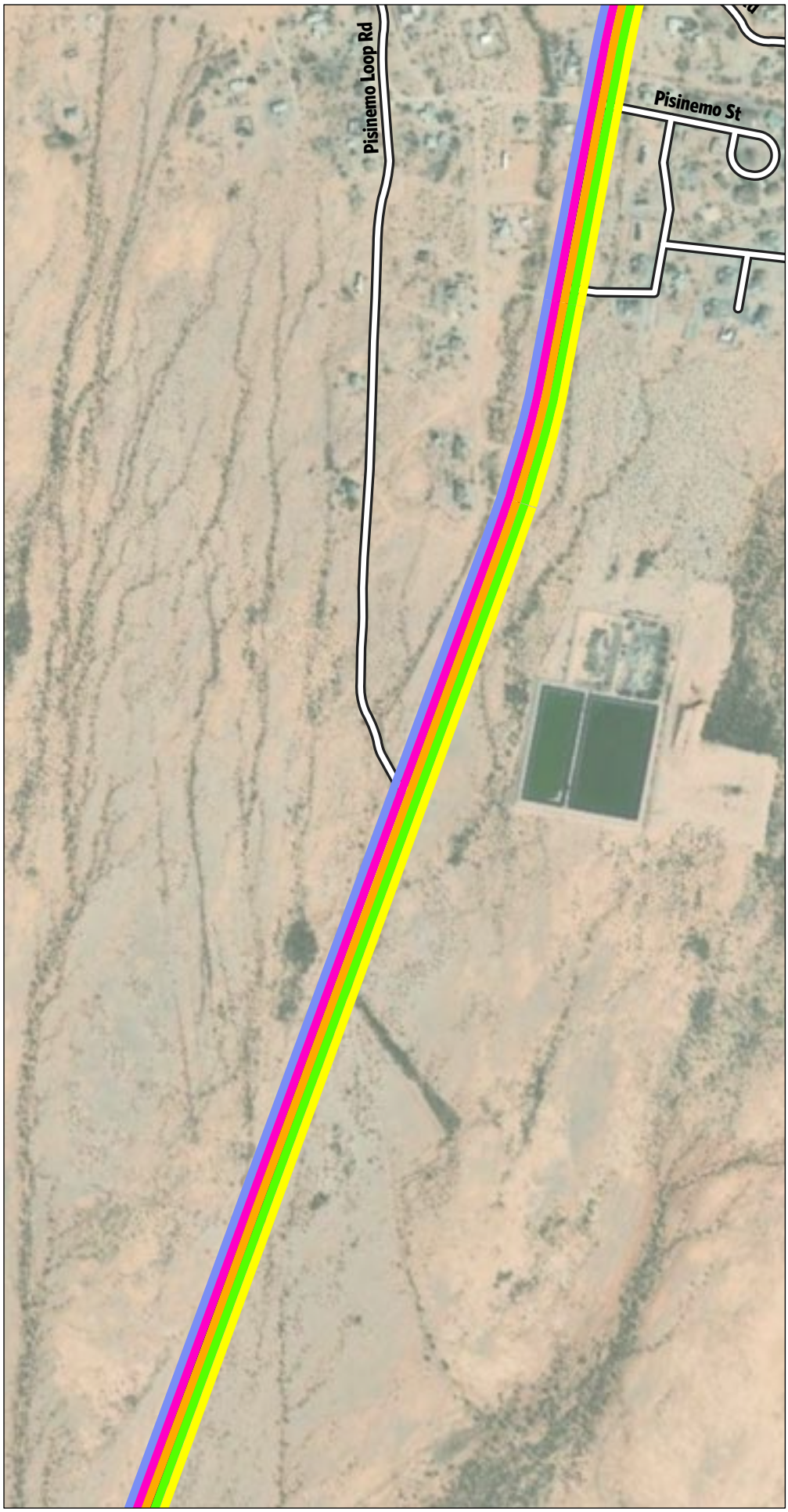

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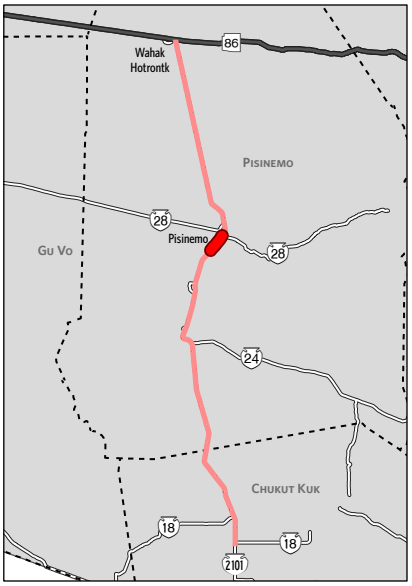

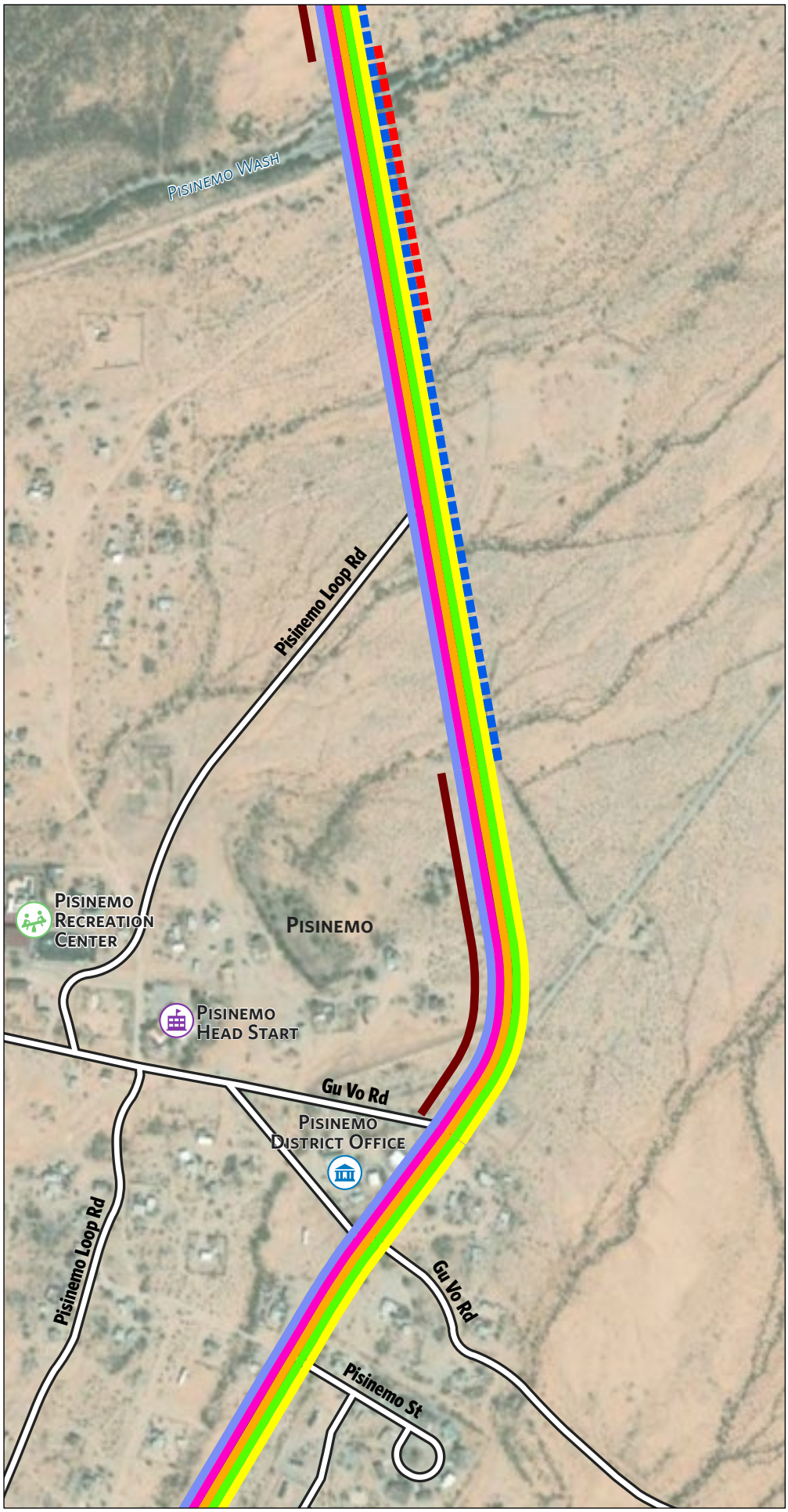

Existing Issues

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Reference

- Government Office
- Recreation
- School
- Tohono O'odham District Boundary

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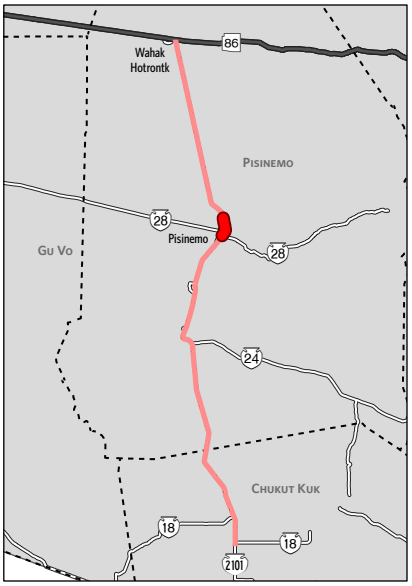

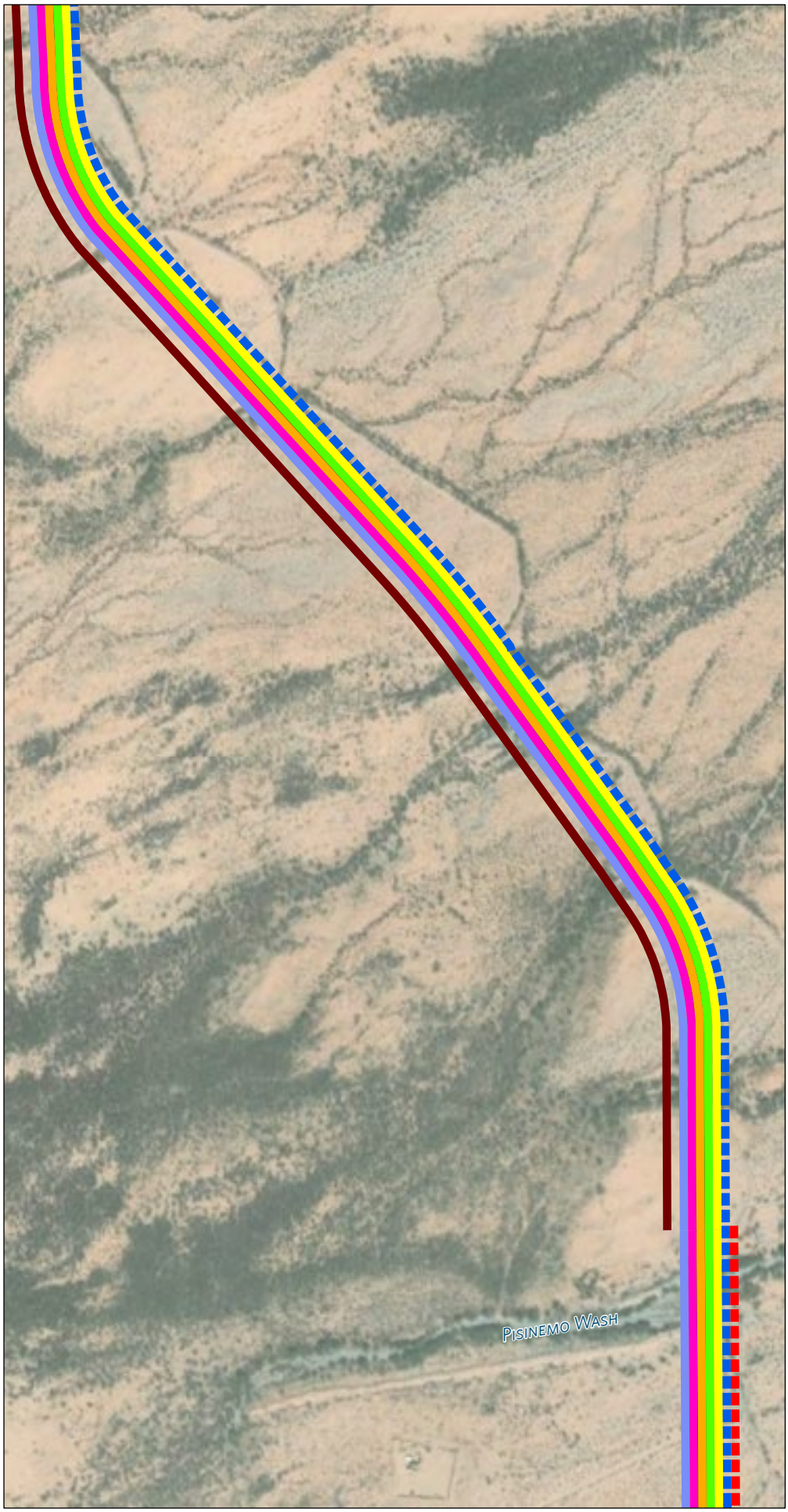

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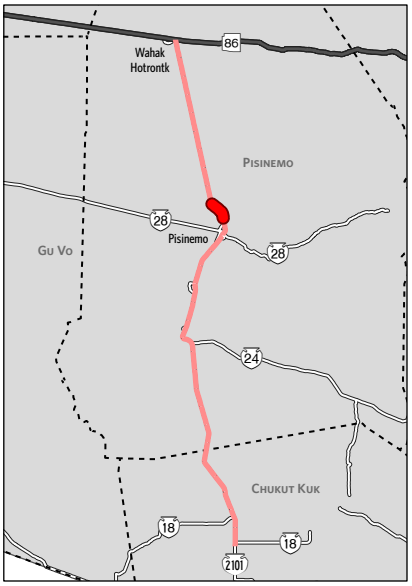

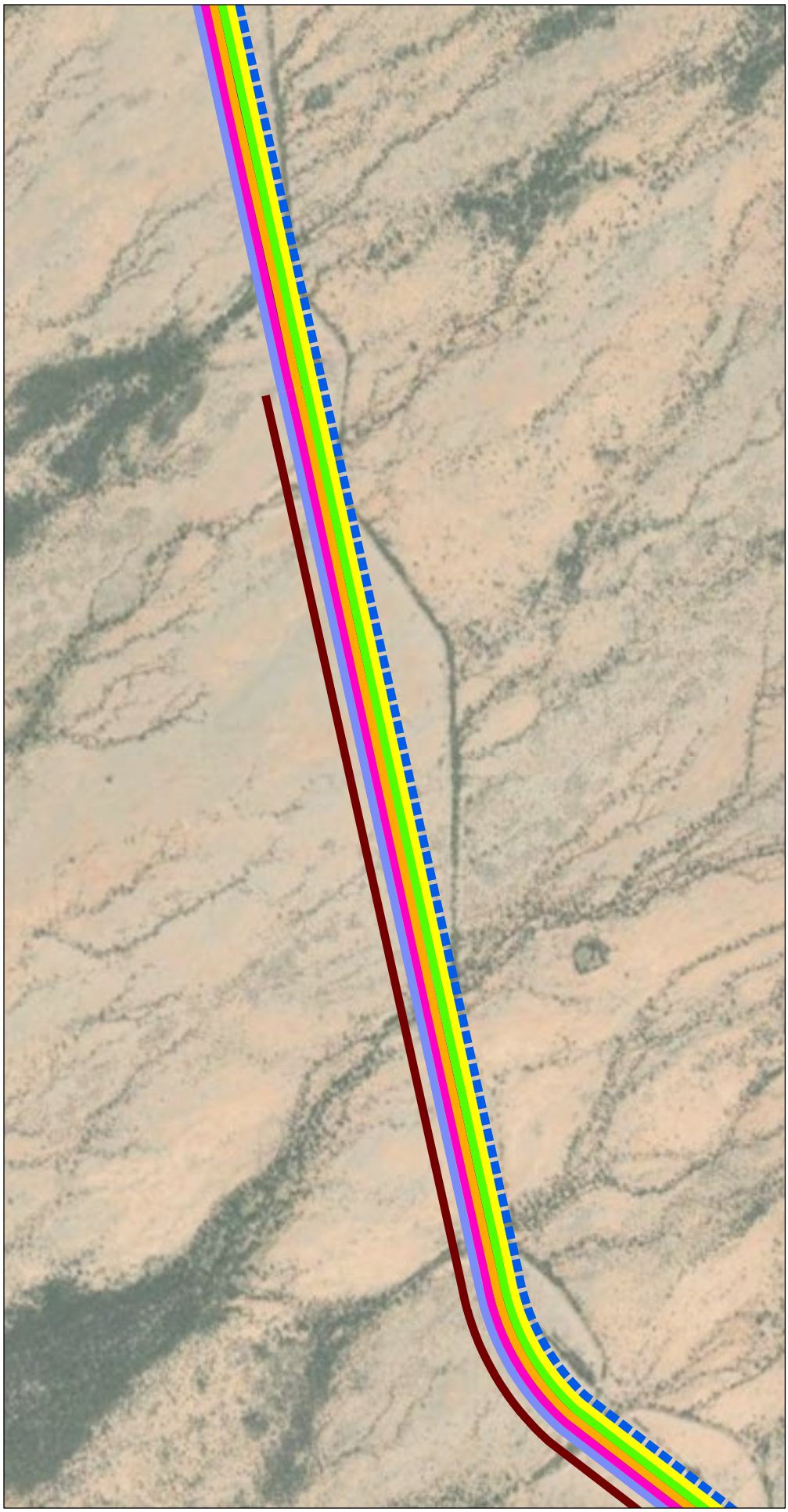

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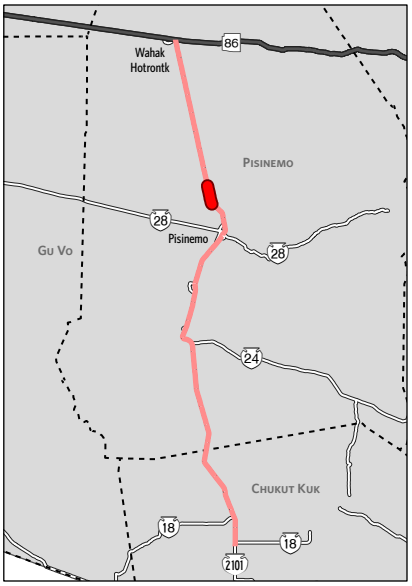

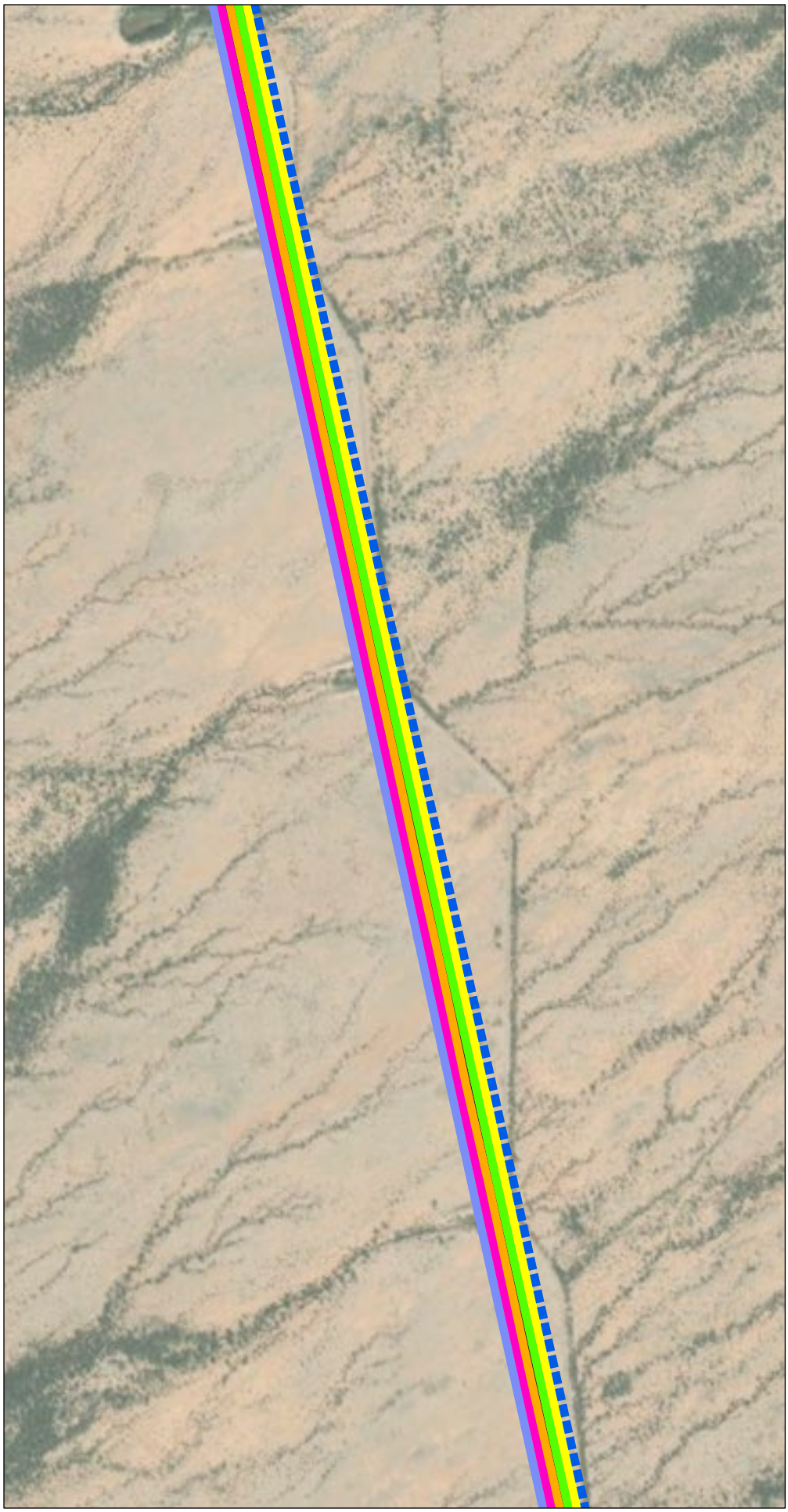

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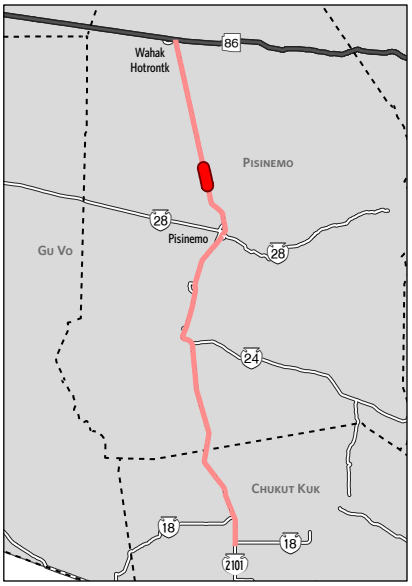

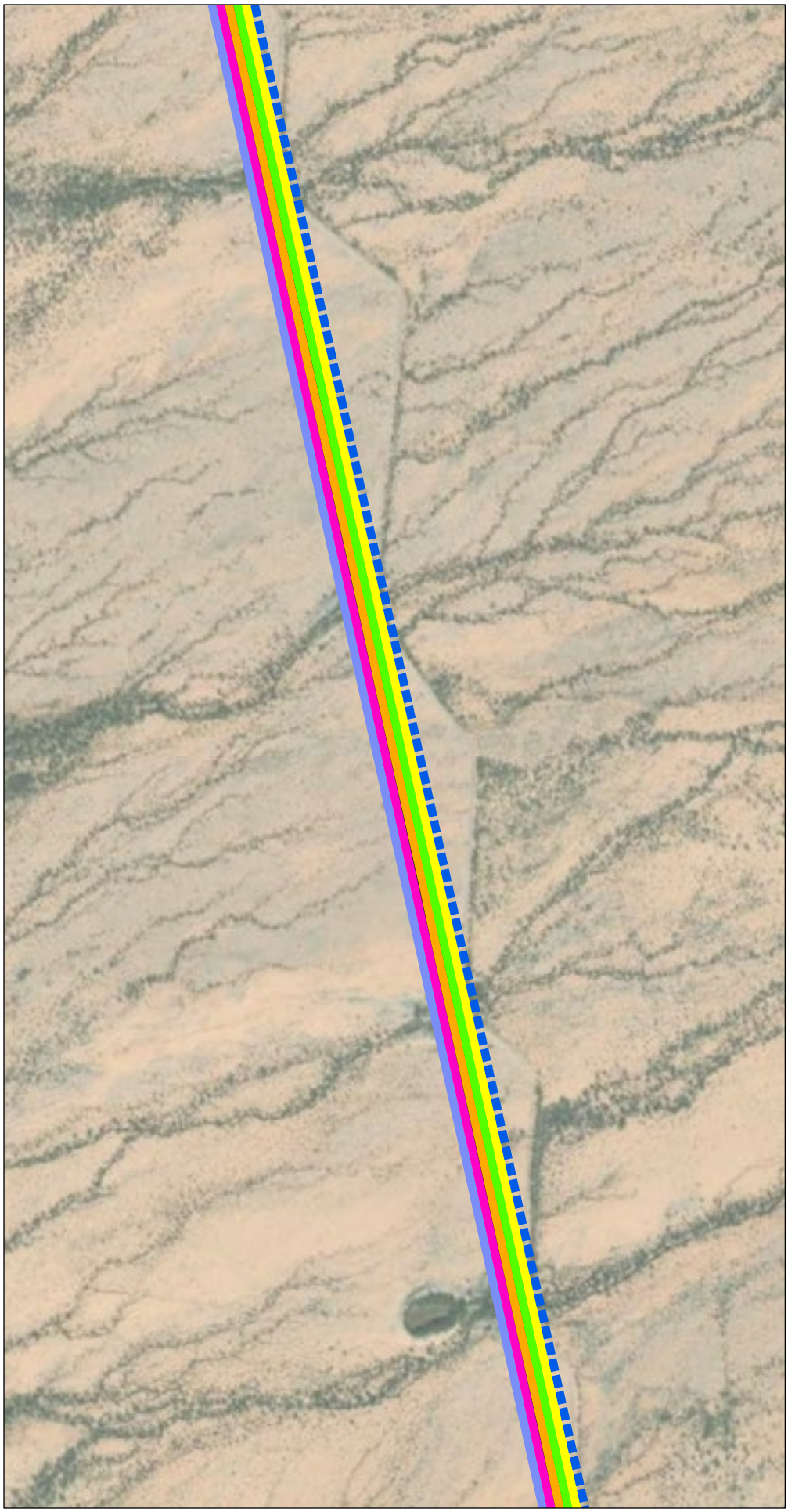

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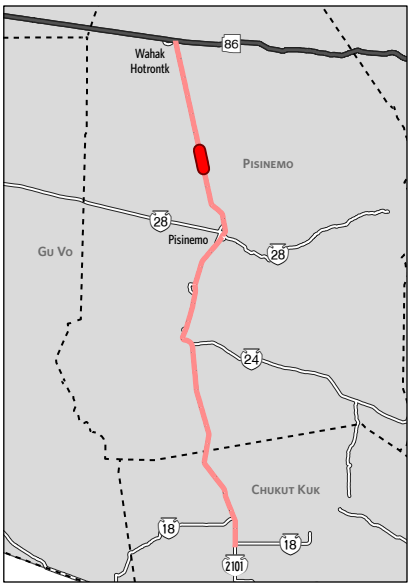

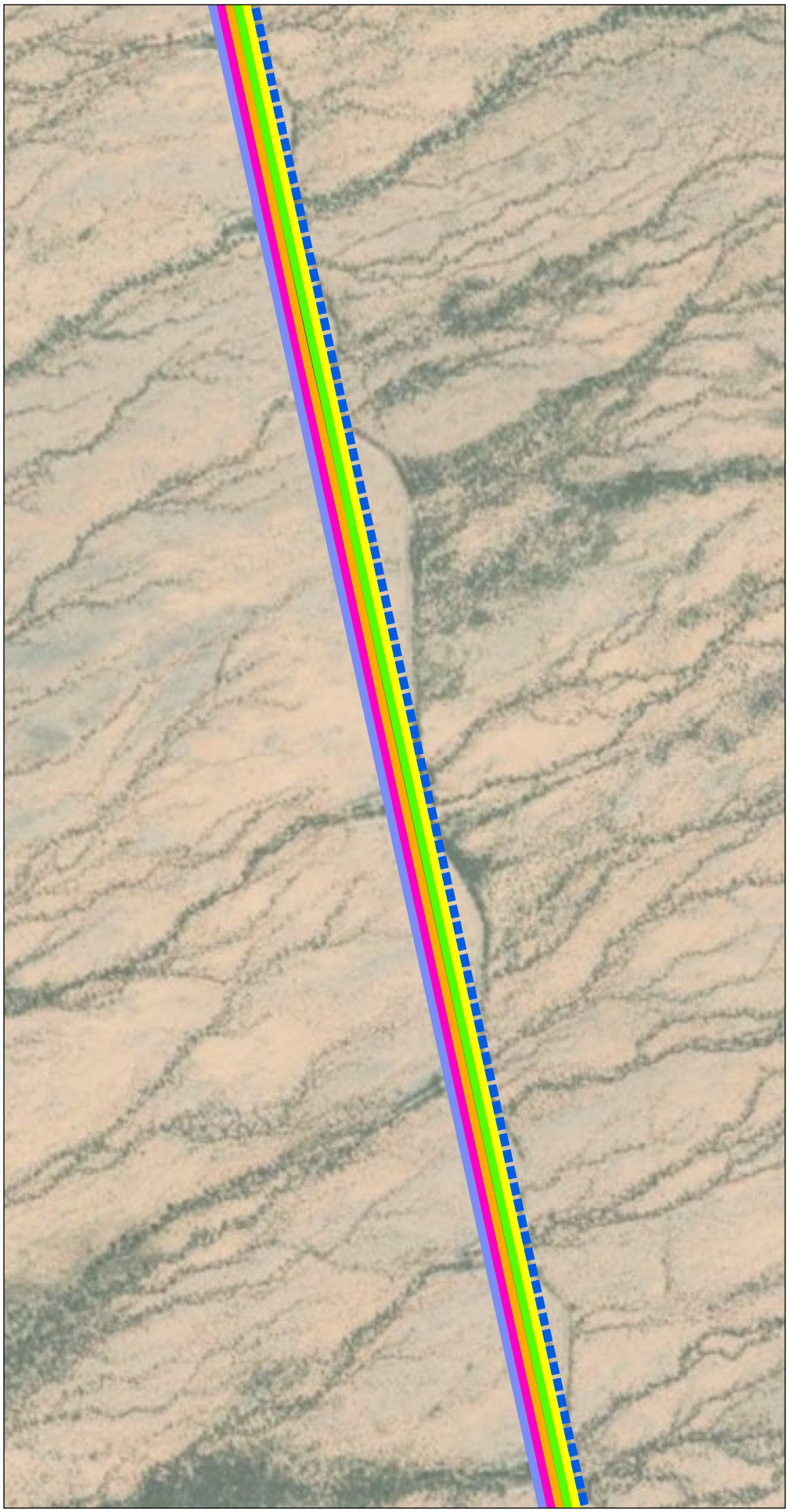

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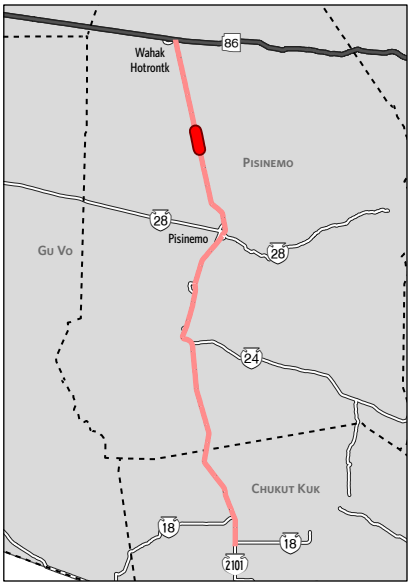

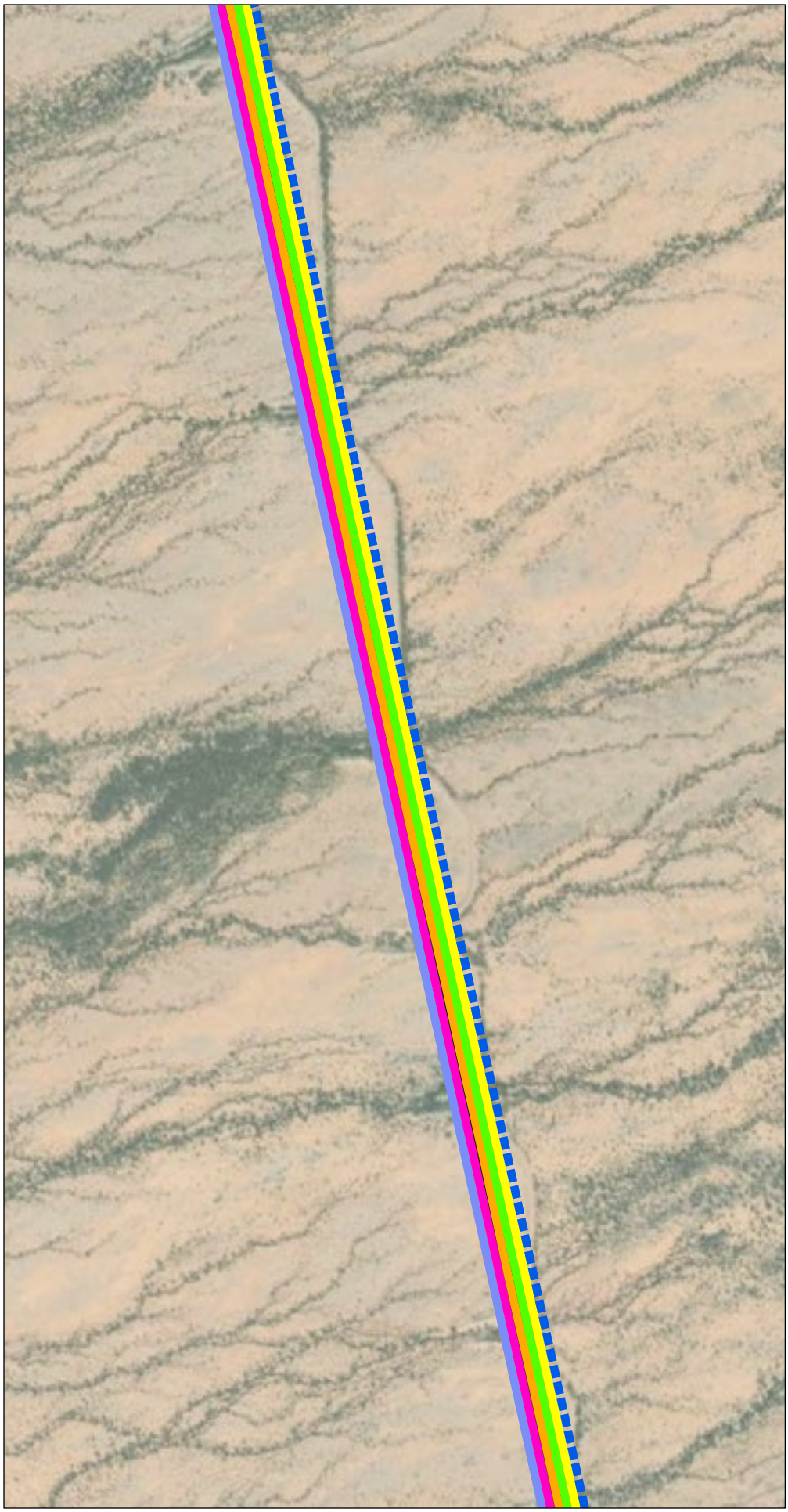

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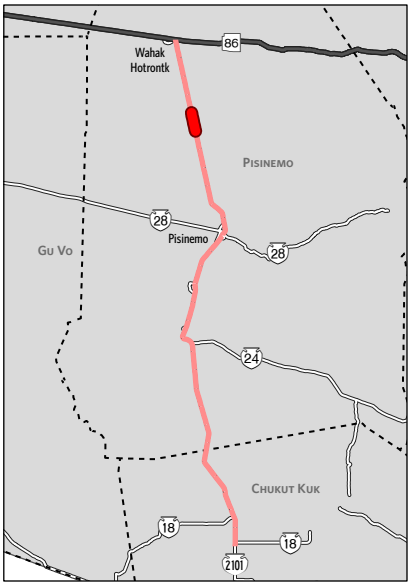

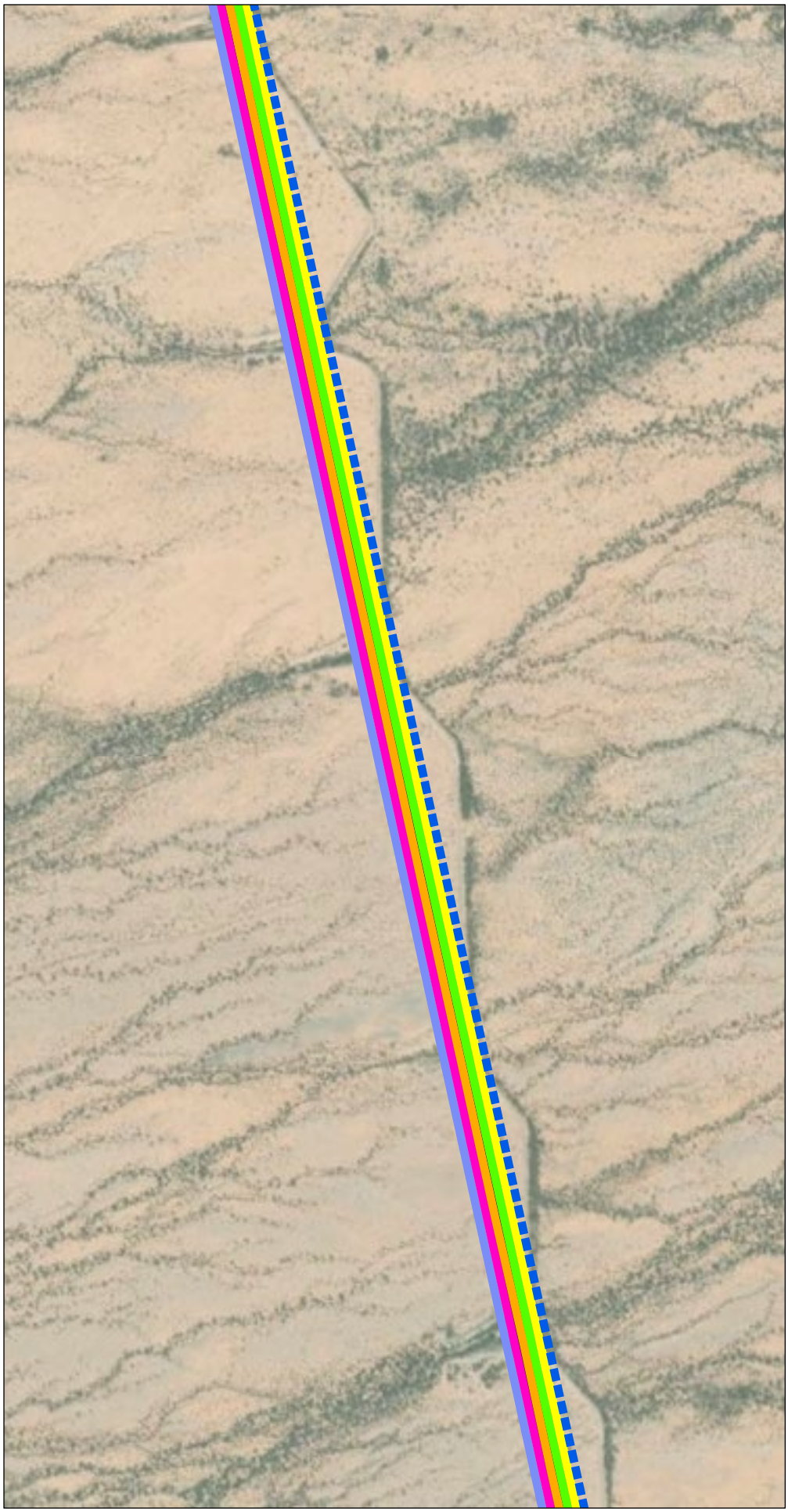

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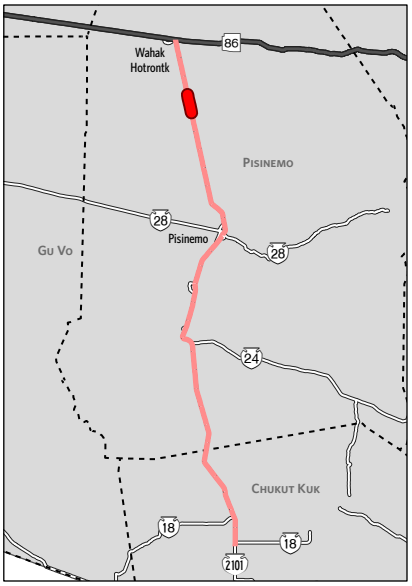

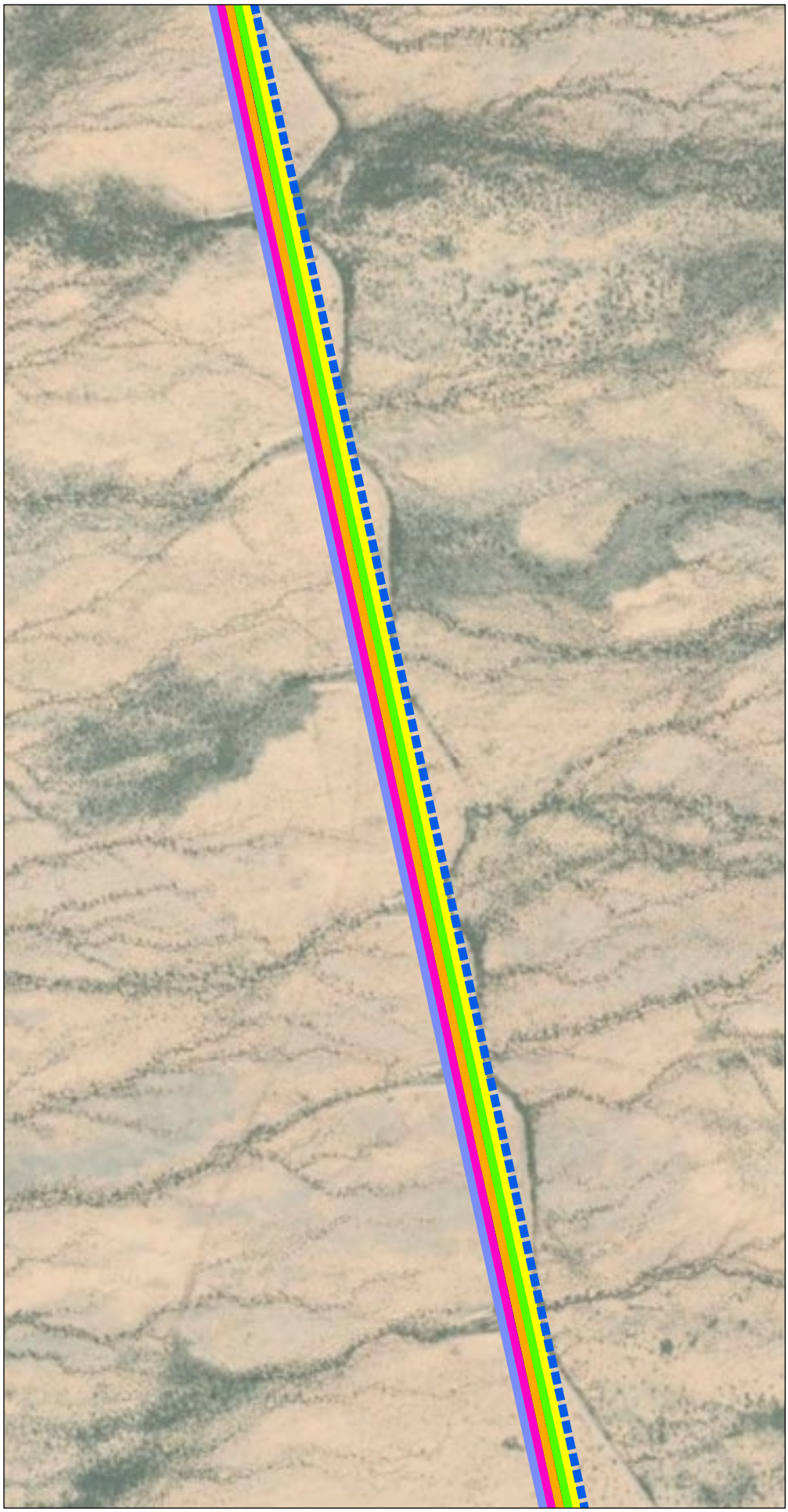

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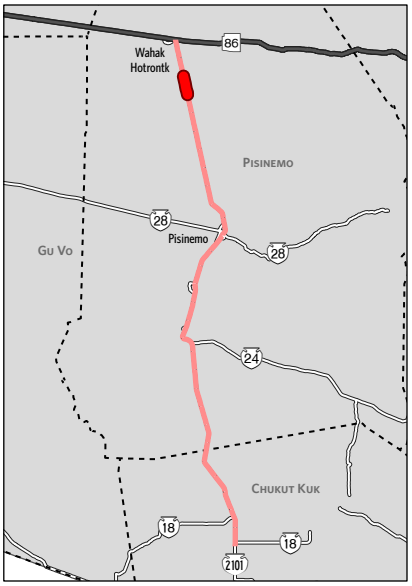

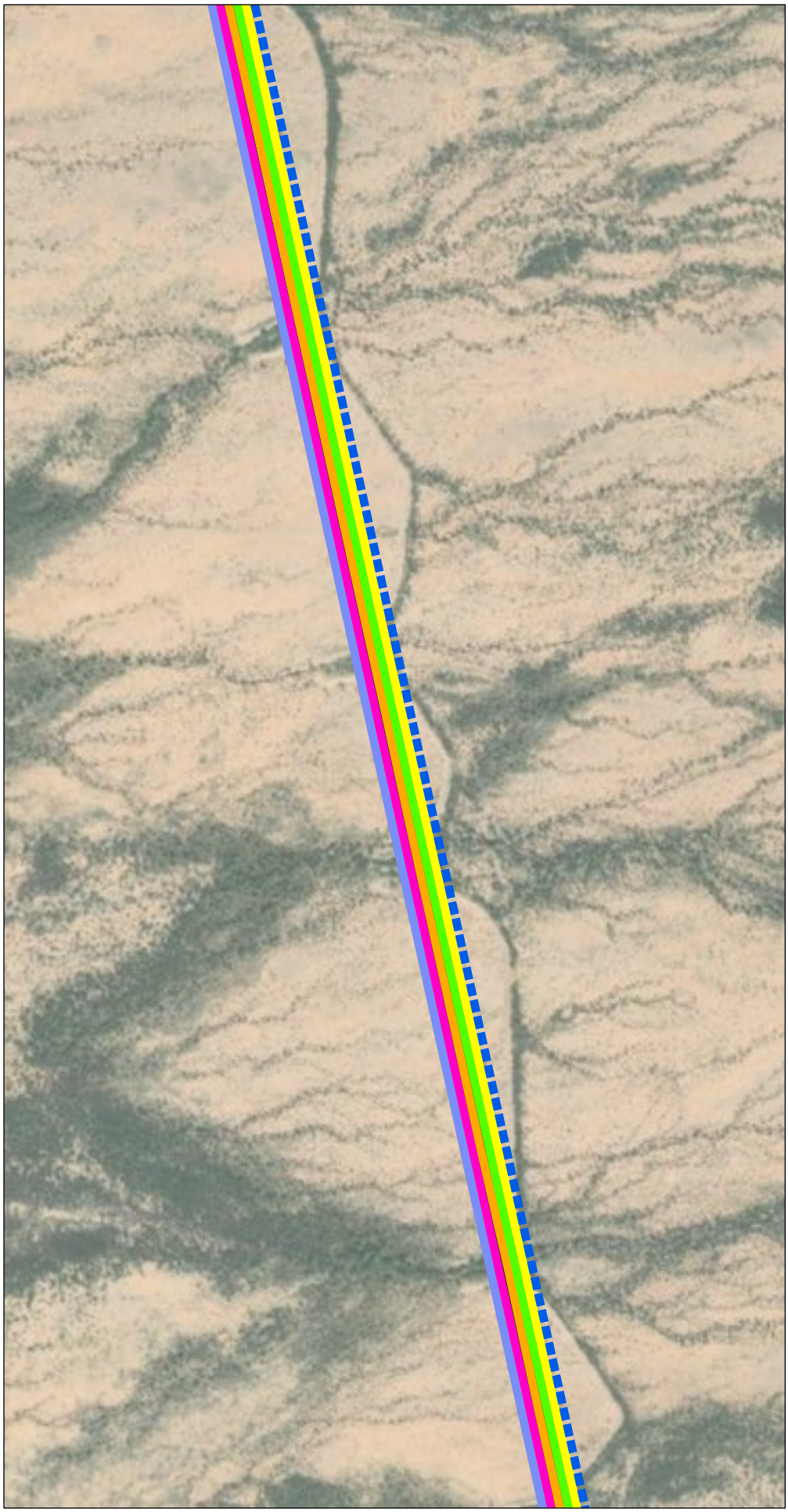

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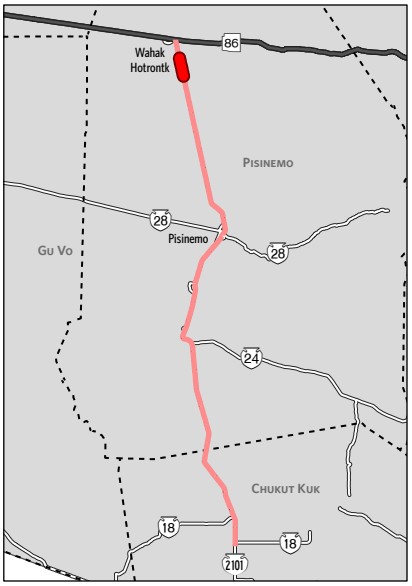

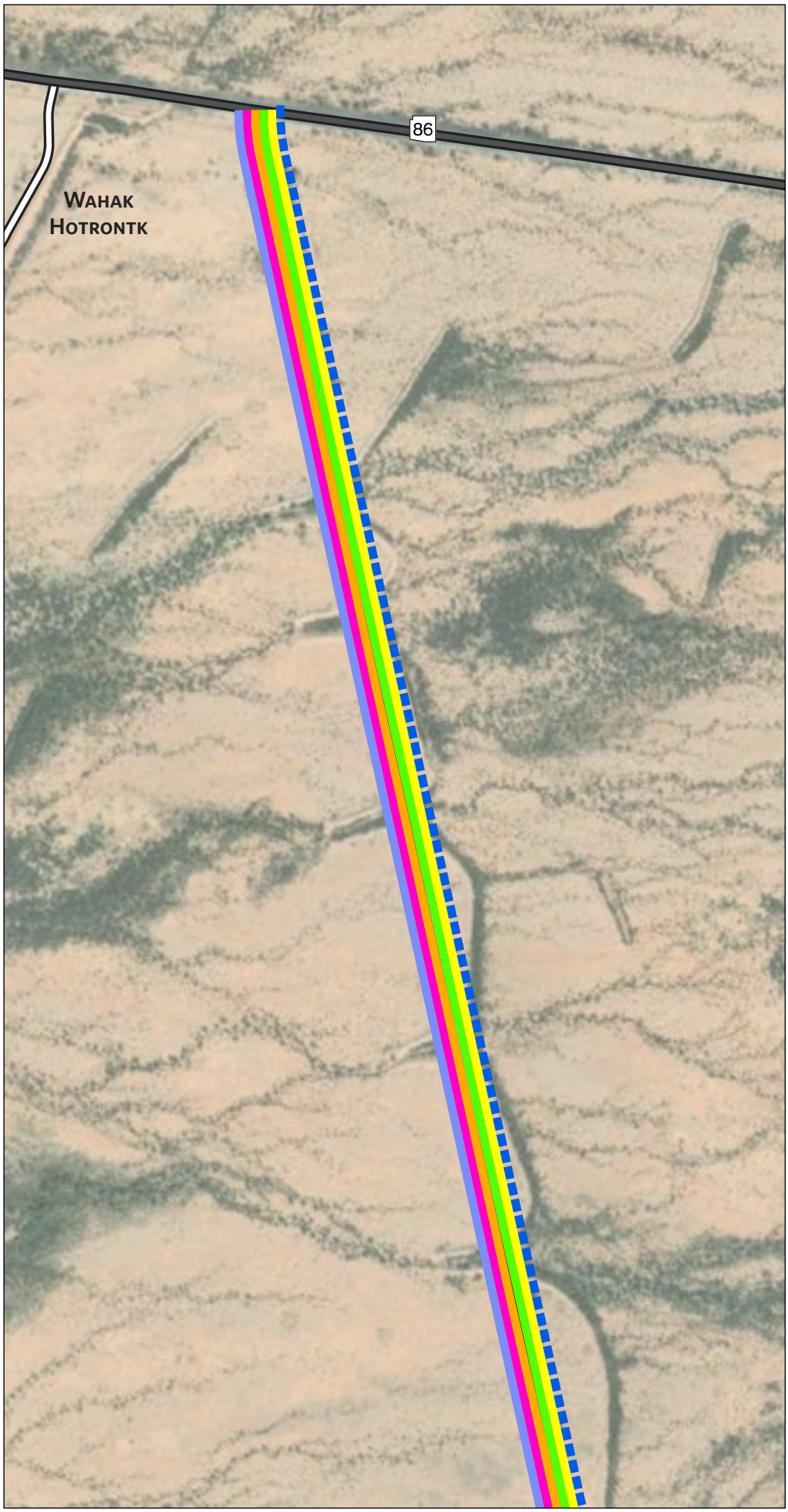

Existing Issues

Route 21

Potential Safety Concerns

- High Crash Corridor
- Flooding Issue
- No Sidewalks
- Open Range, No Fencing
- No Shoulders
- Deteriorating Striping
- No Lighting
- Poor Pavement
- Curvy Roadway

Reference

- Tohono O'odham District Boundary

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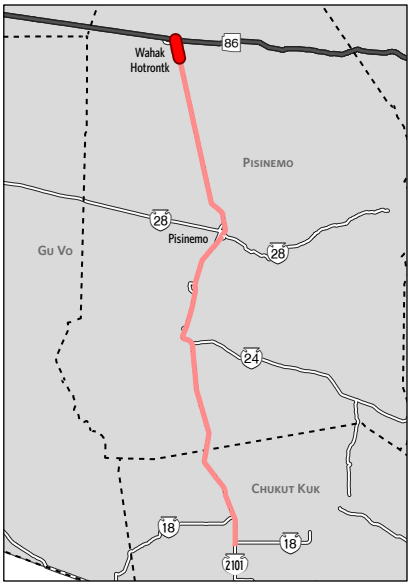


Appendix B

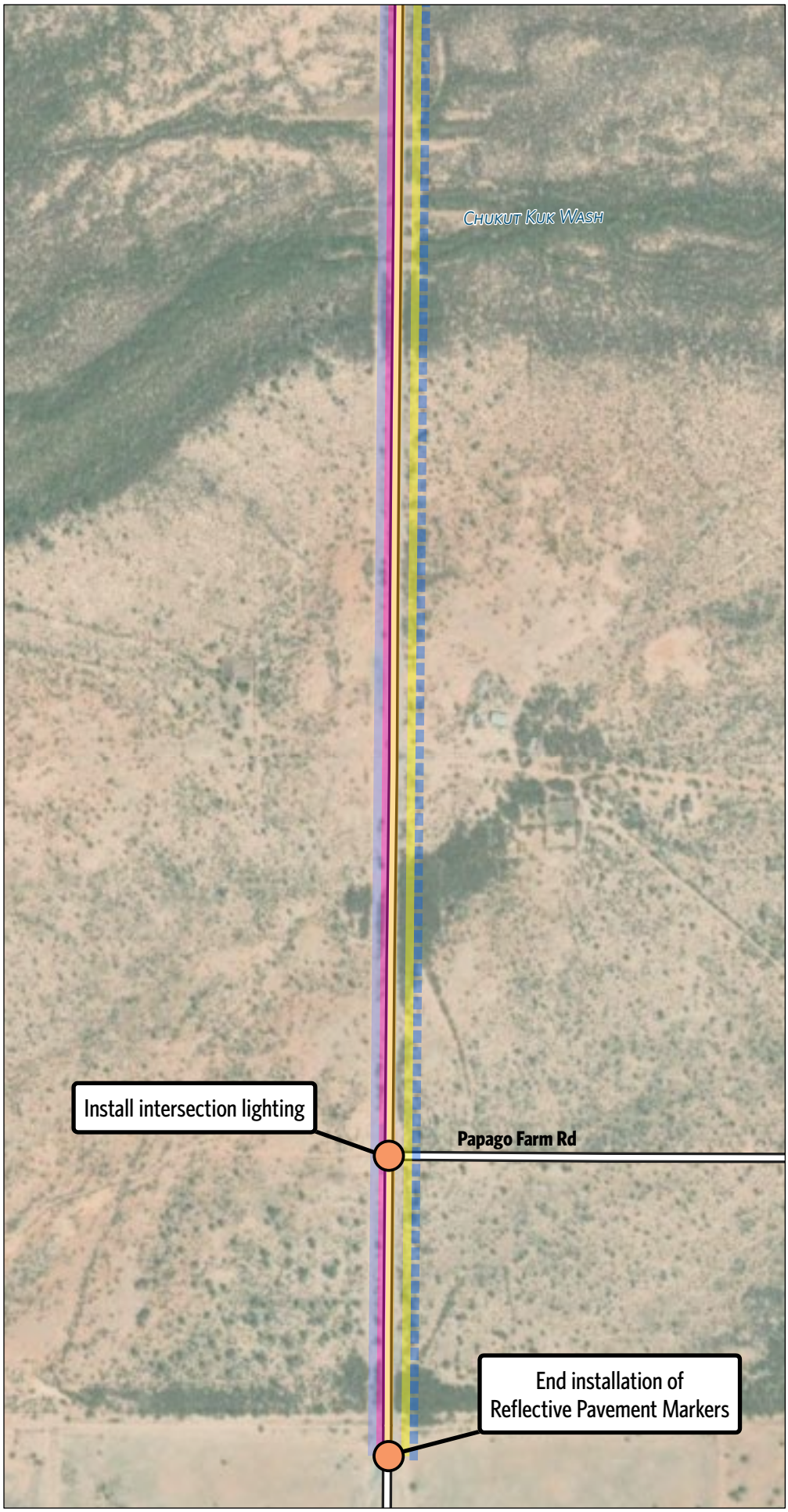
Route 21 Recommended Improvements Atlas

Recommended Improvements - Overview Map

Route 21

Recommended Corridor-wide Improvements

- Install continuous fencing along the corridor
- Complete chip seal in poor pavement areas
- Install 4 foot shoulders with Safety - Edge throughout
- Replace damaged signage and undersized signage per current MUTCD sizing criteria
- Install edge of roadway flexible delineators throughout
- Install standard community signs
- Install W11-4 (Cow) and W11-19 (Donkey) warning signs with supplemental plaque W7-3aP every 10 miles
- Install centerline rumble strips
- Remove all vegetation and soil buildup in the clear zone
- Consider installing R2-3P (night speed limit) below all R2-1 (speed limit) sings showing reduced night speeds



Recommended Improvements

Route 21

Potential Safety Concerns

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Recommended Improvement *

- Spot Improvement

* Also reference overview page for corridor-wide improvement recommendations

Reference

- Tohono O'odham District Boundary

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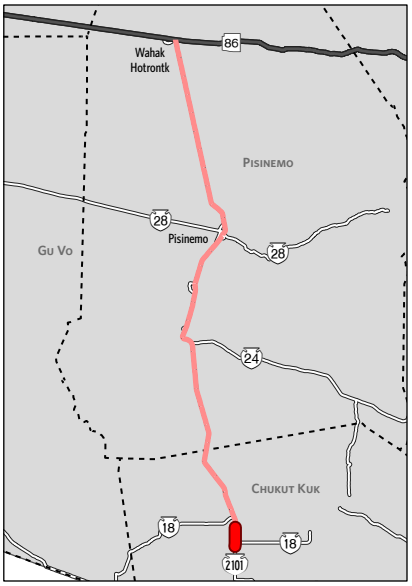

Recommended Improvements

Route 21

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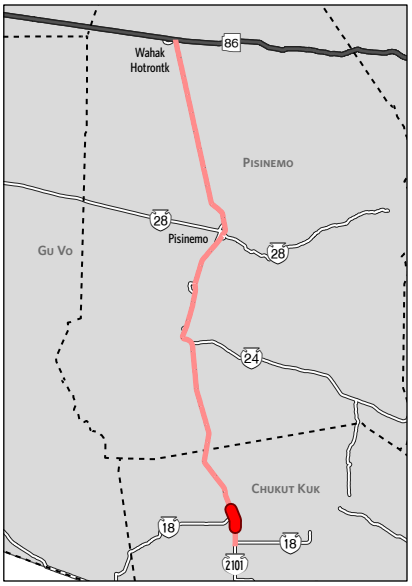

Recommended Improvements

Route 21

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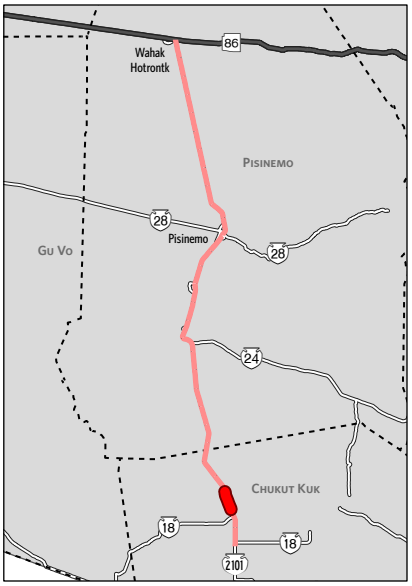

Recommended Improvements

Route 21

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Recommended Improvement *

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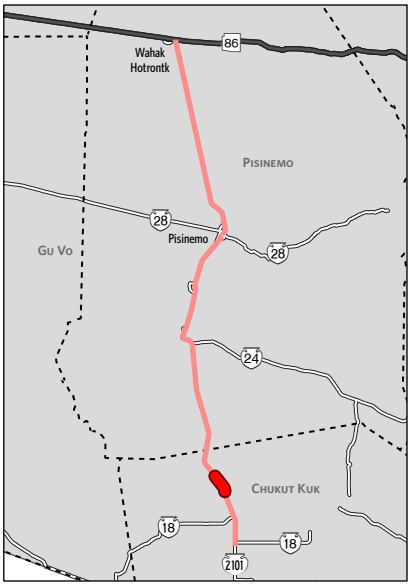

Recommended Improvements

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- Linear Improvement

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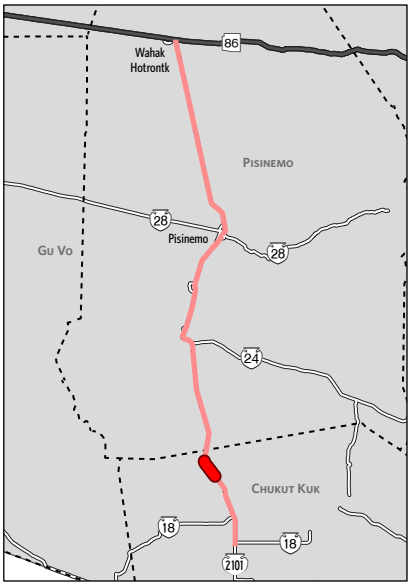

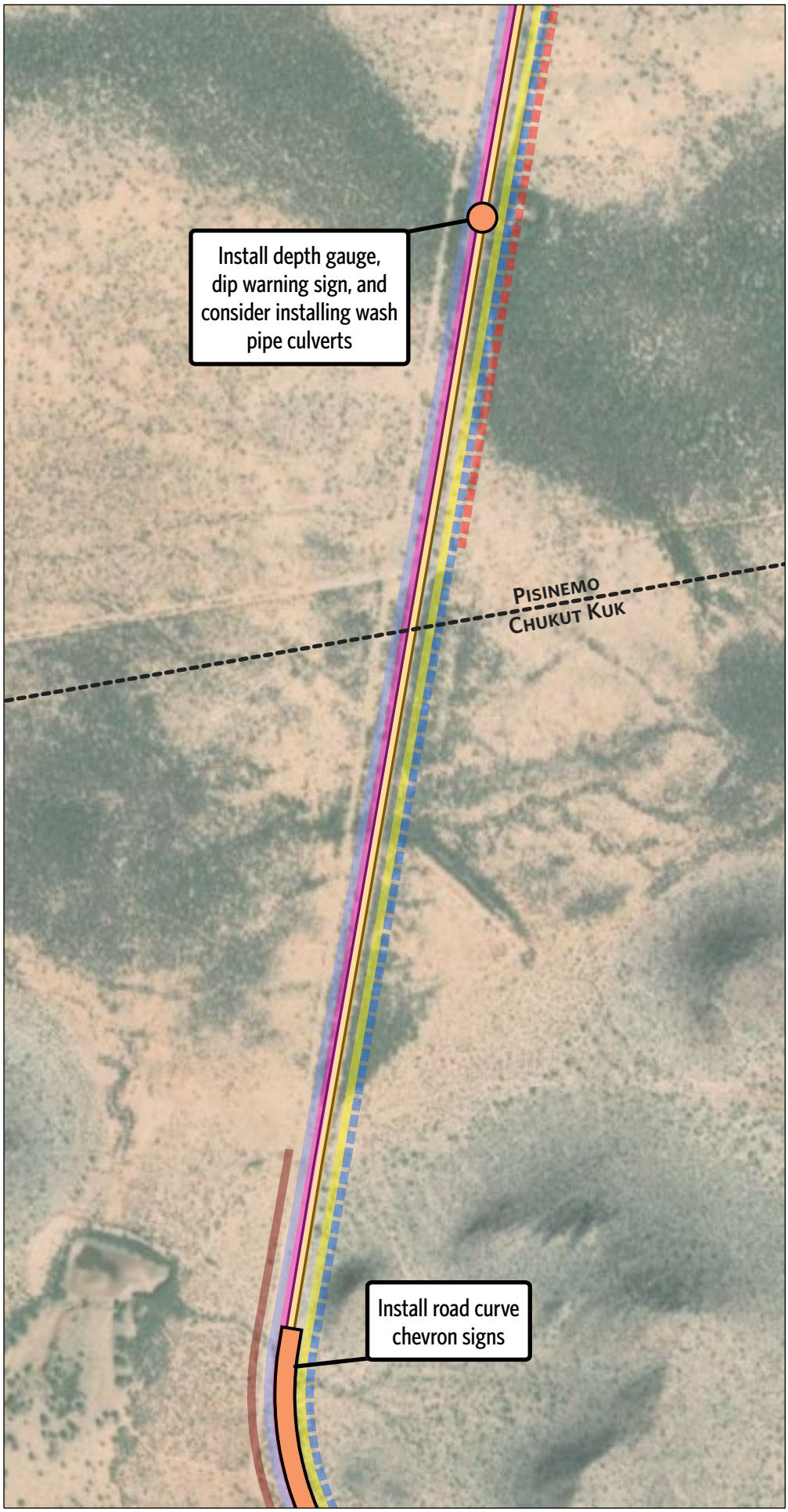

Recommended Improvements

Route 21

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Recommended Improvement *

- Spot Improvement
- Linear Improvement

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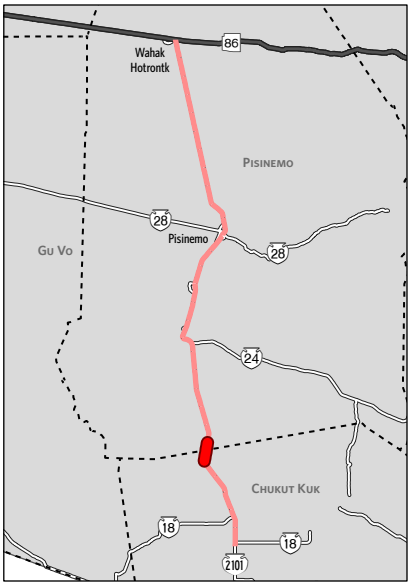

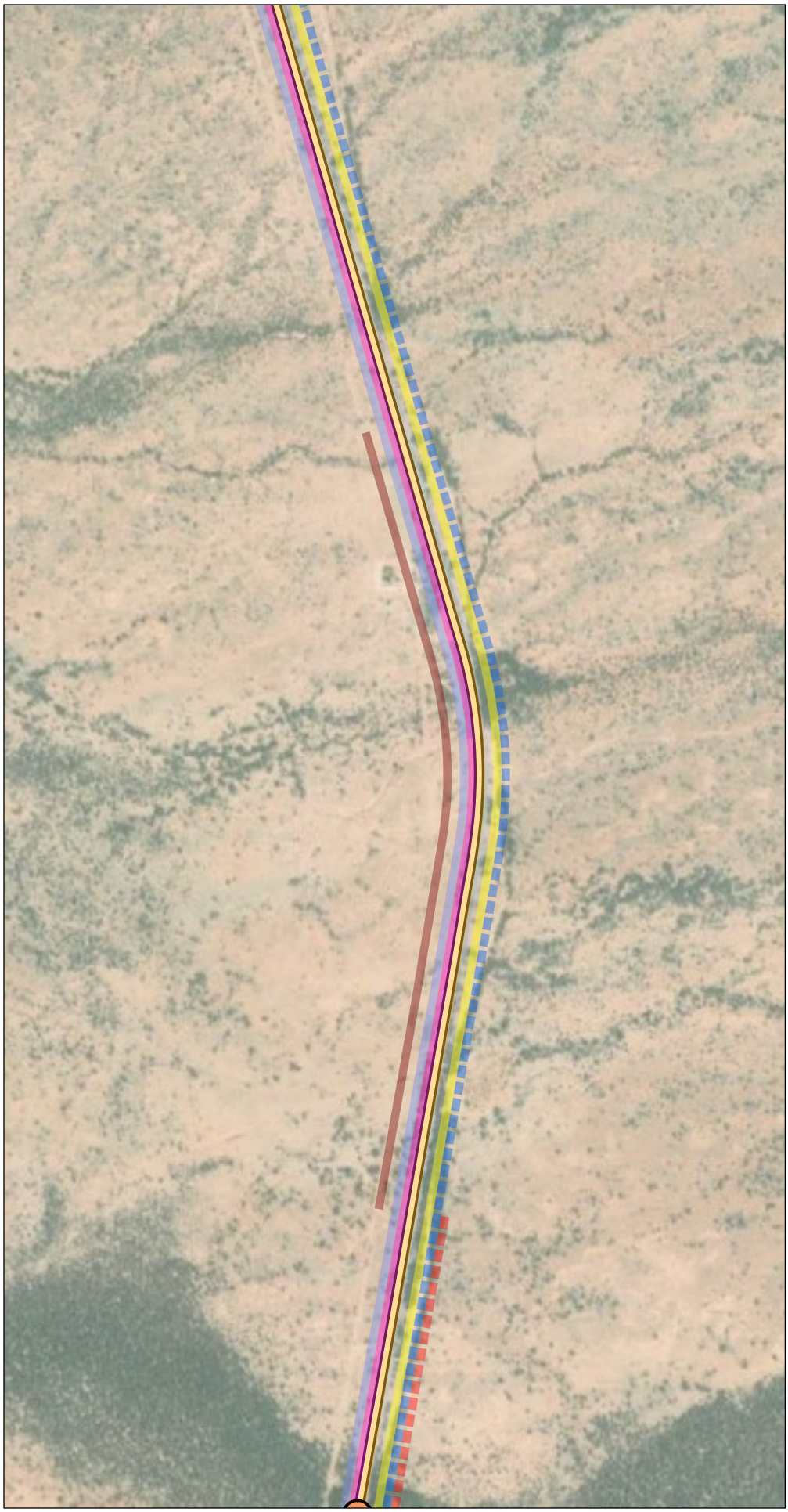

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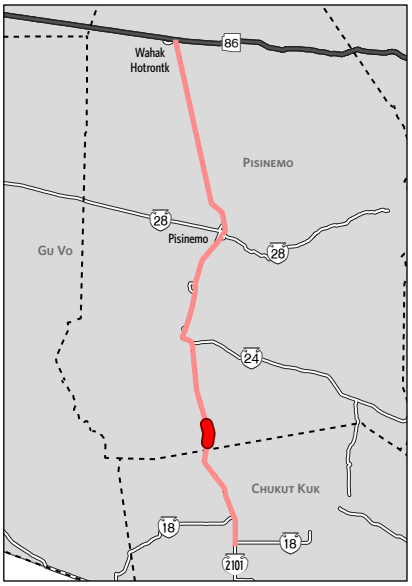

Recommended Improvements

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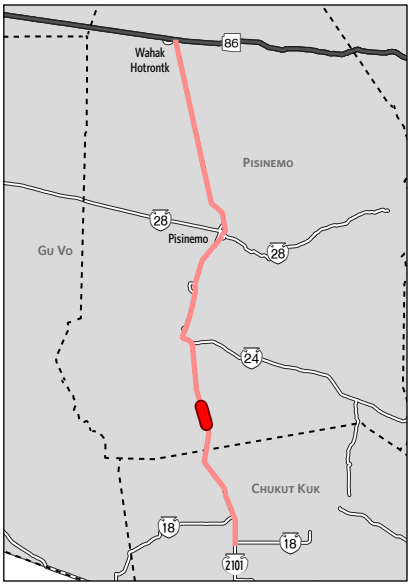

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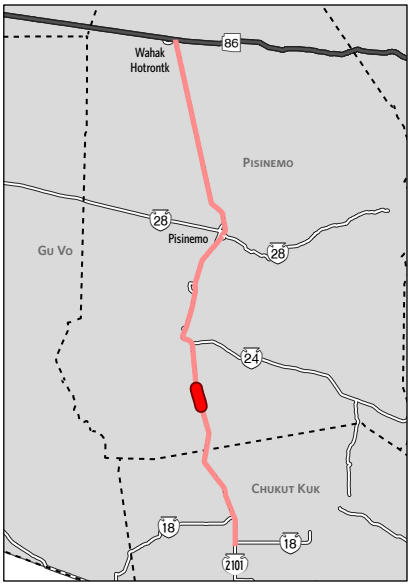

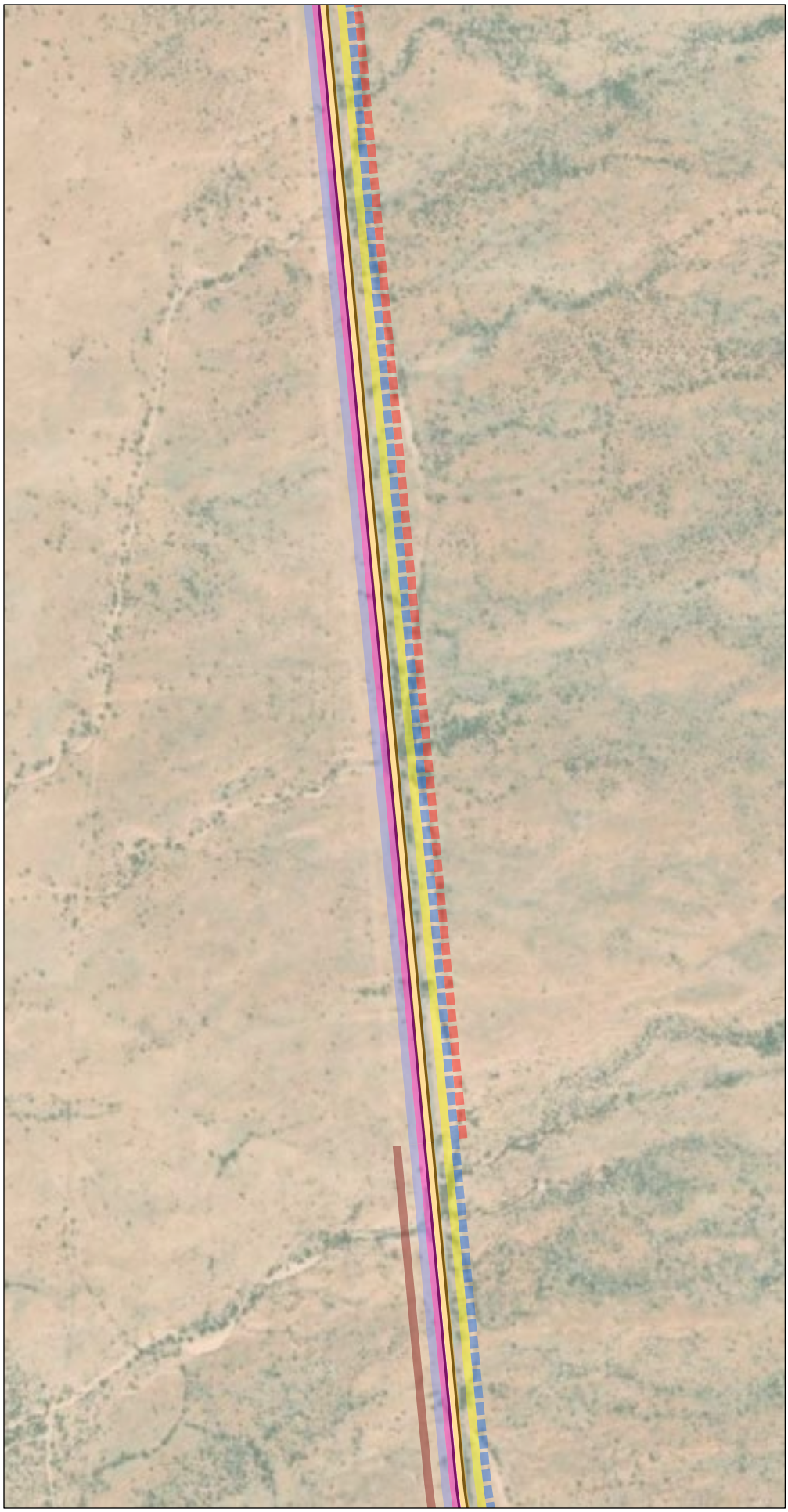

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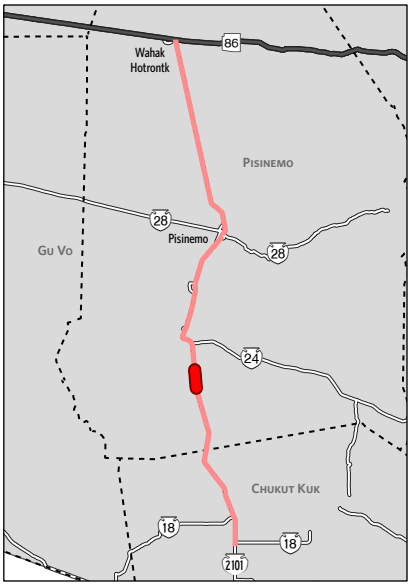

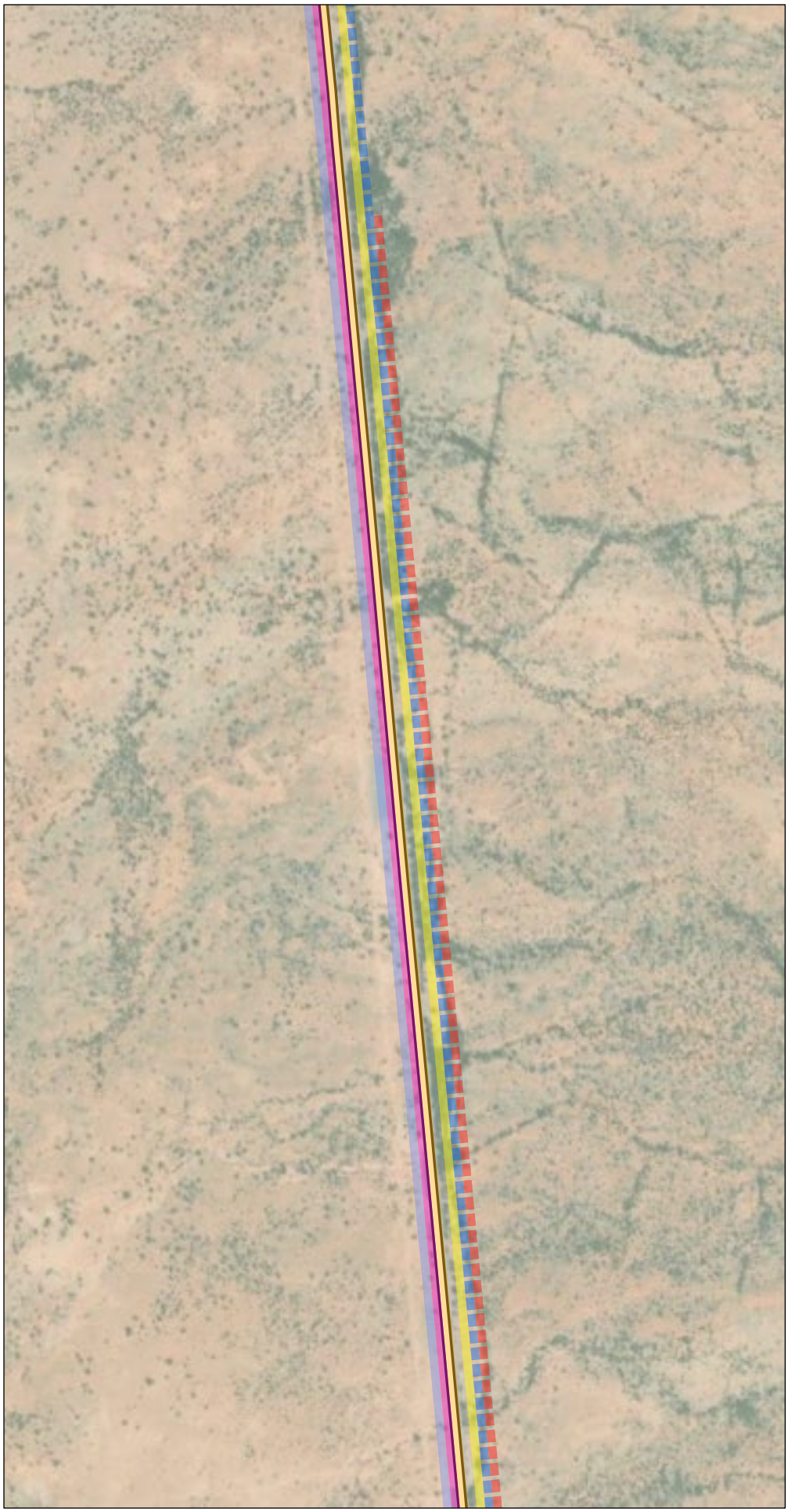

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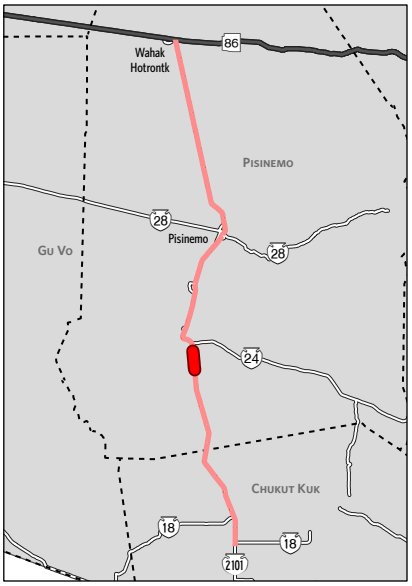

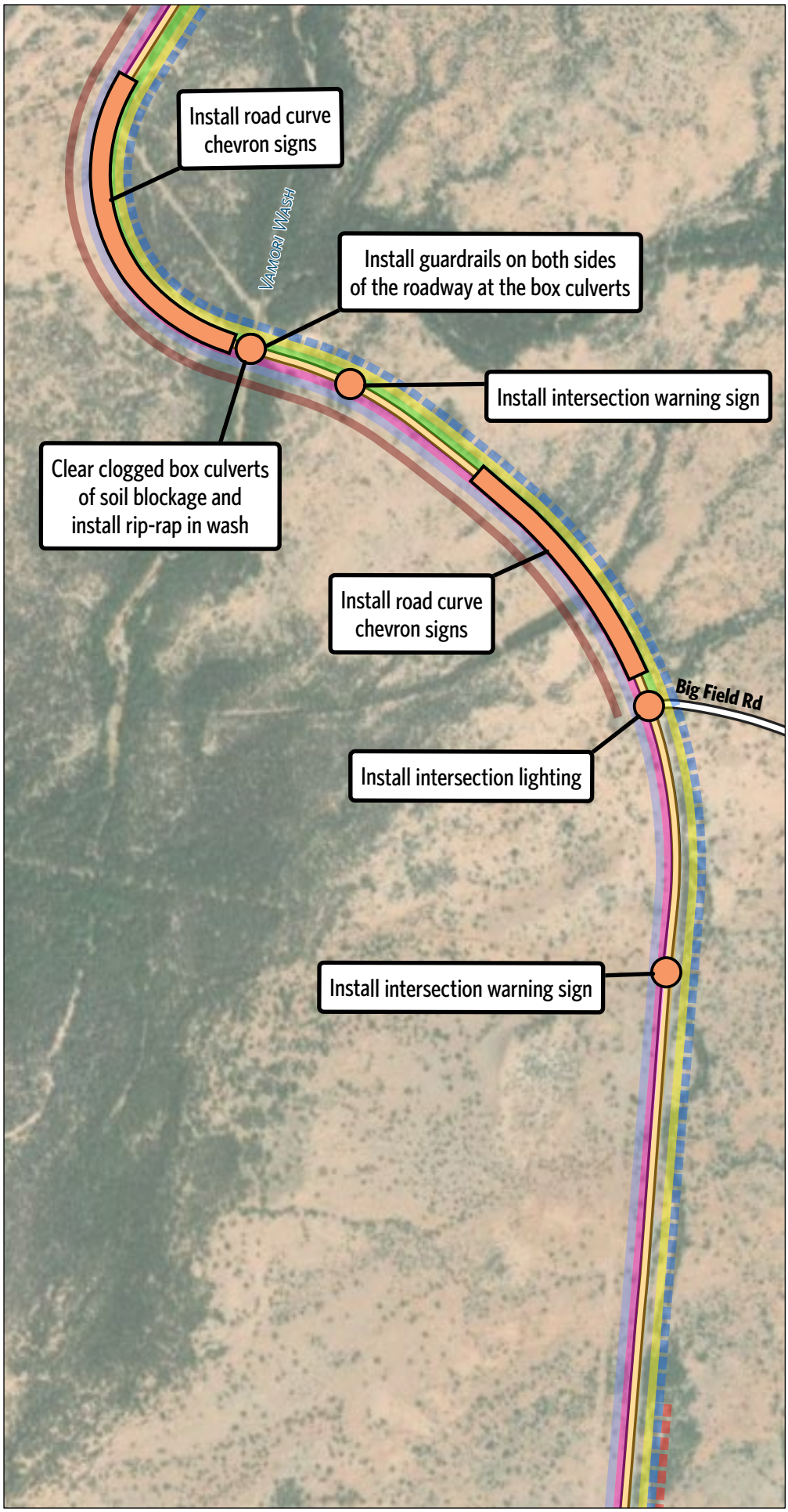

Recommended Improvements

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Recommended Improvement *

- Spot Improvement
- Linear Improvement

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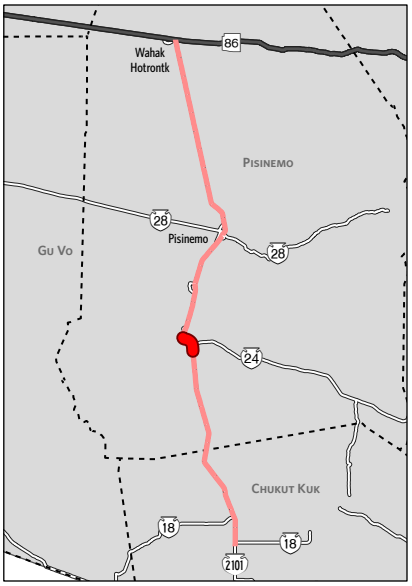

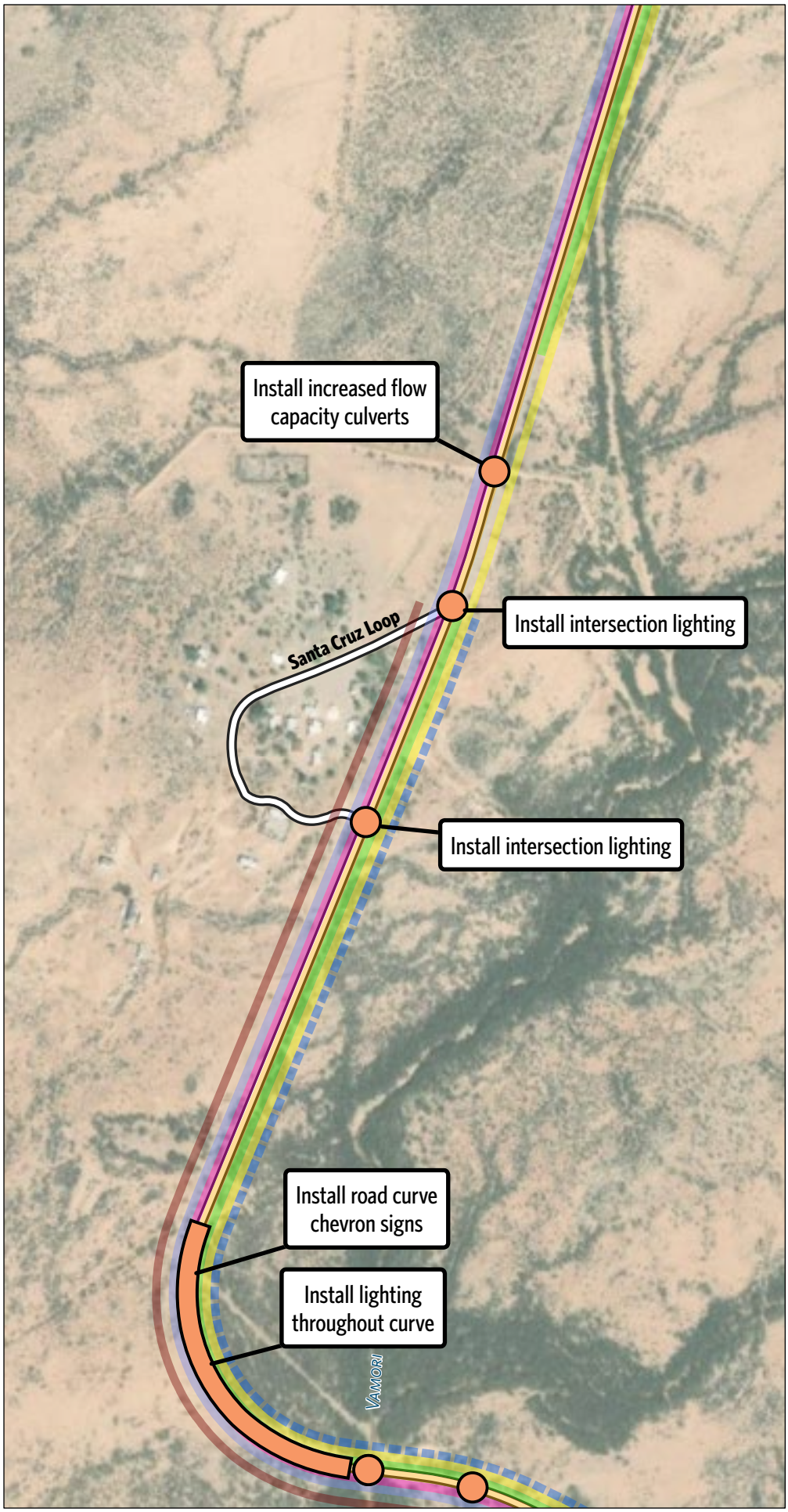

Recommended Improvements

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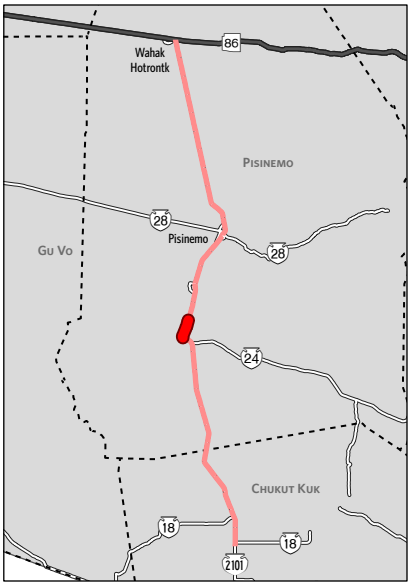

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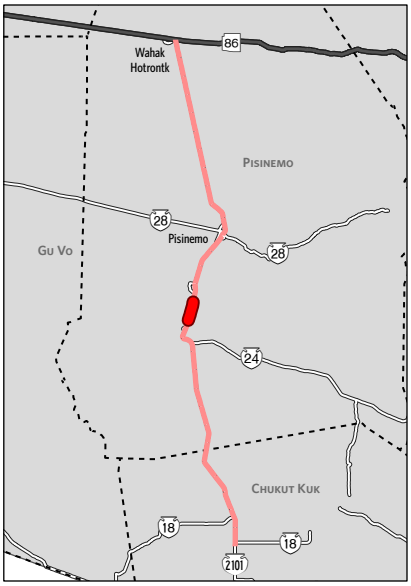

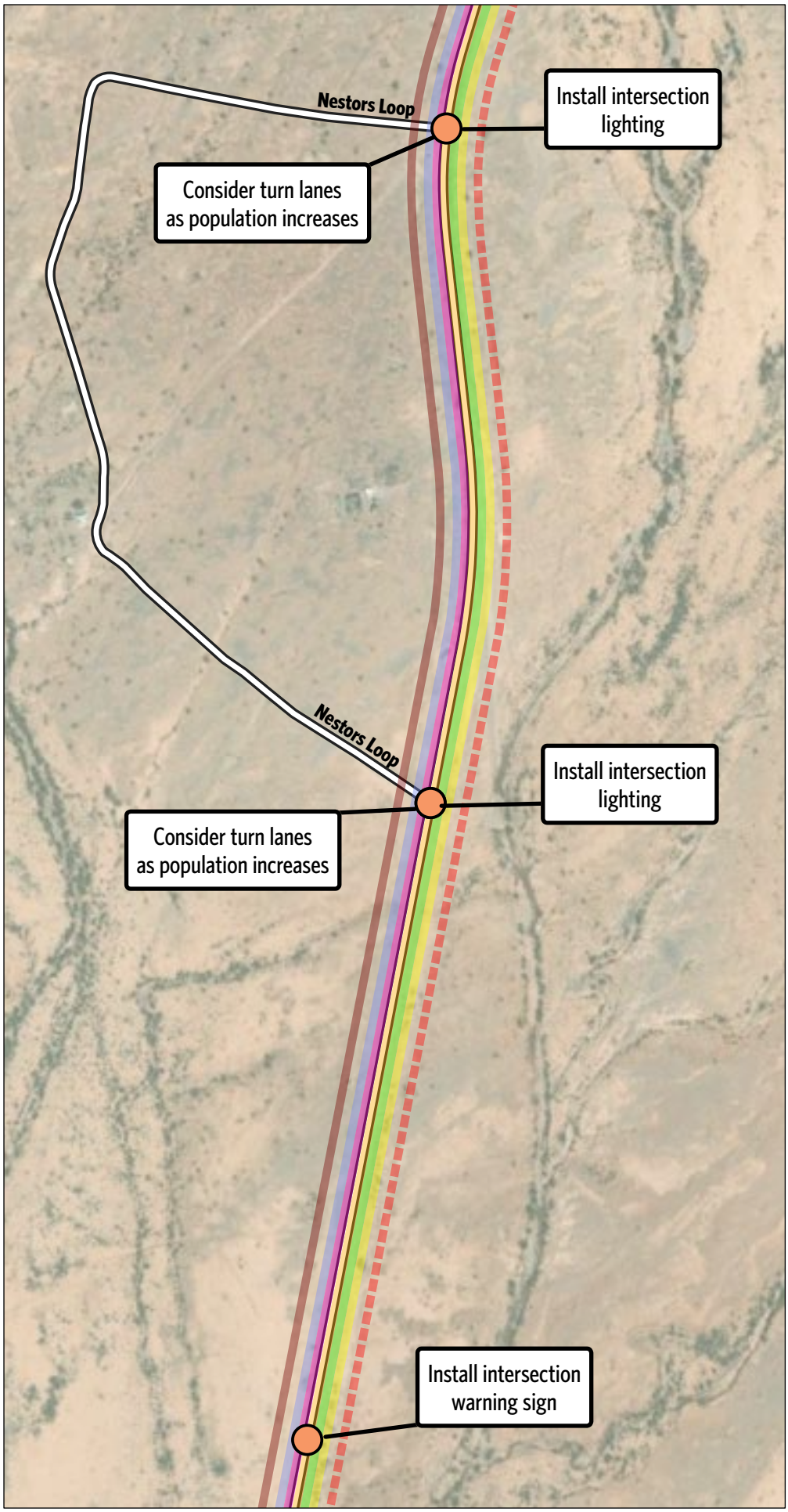

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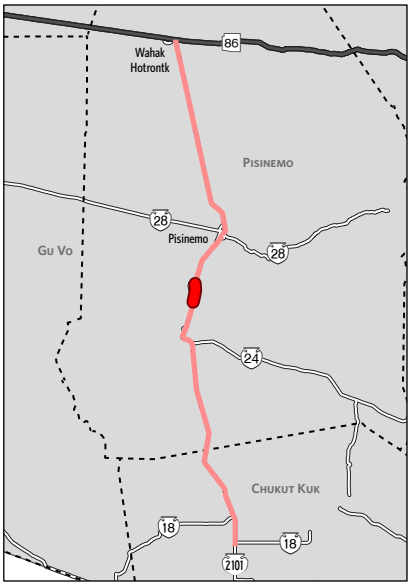

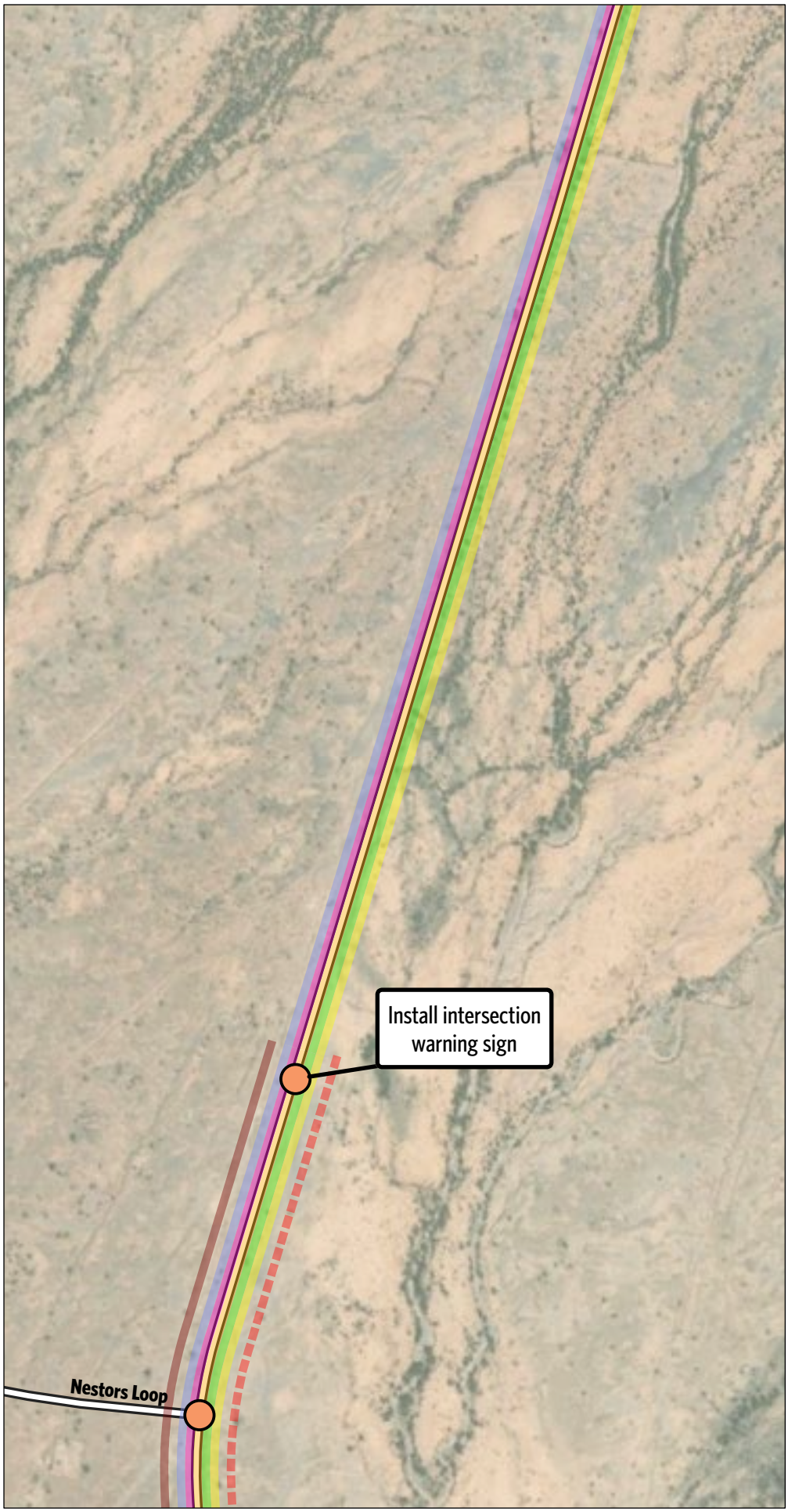

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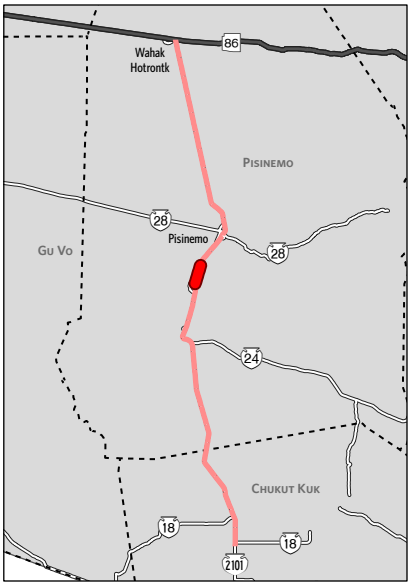

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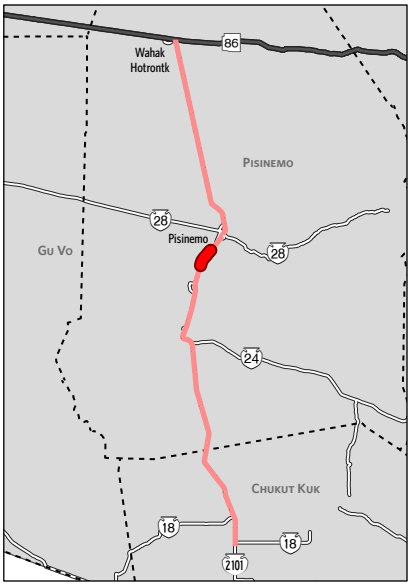

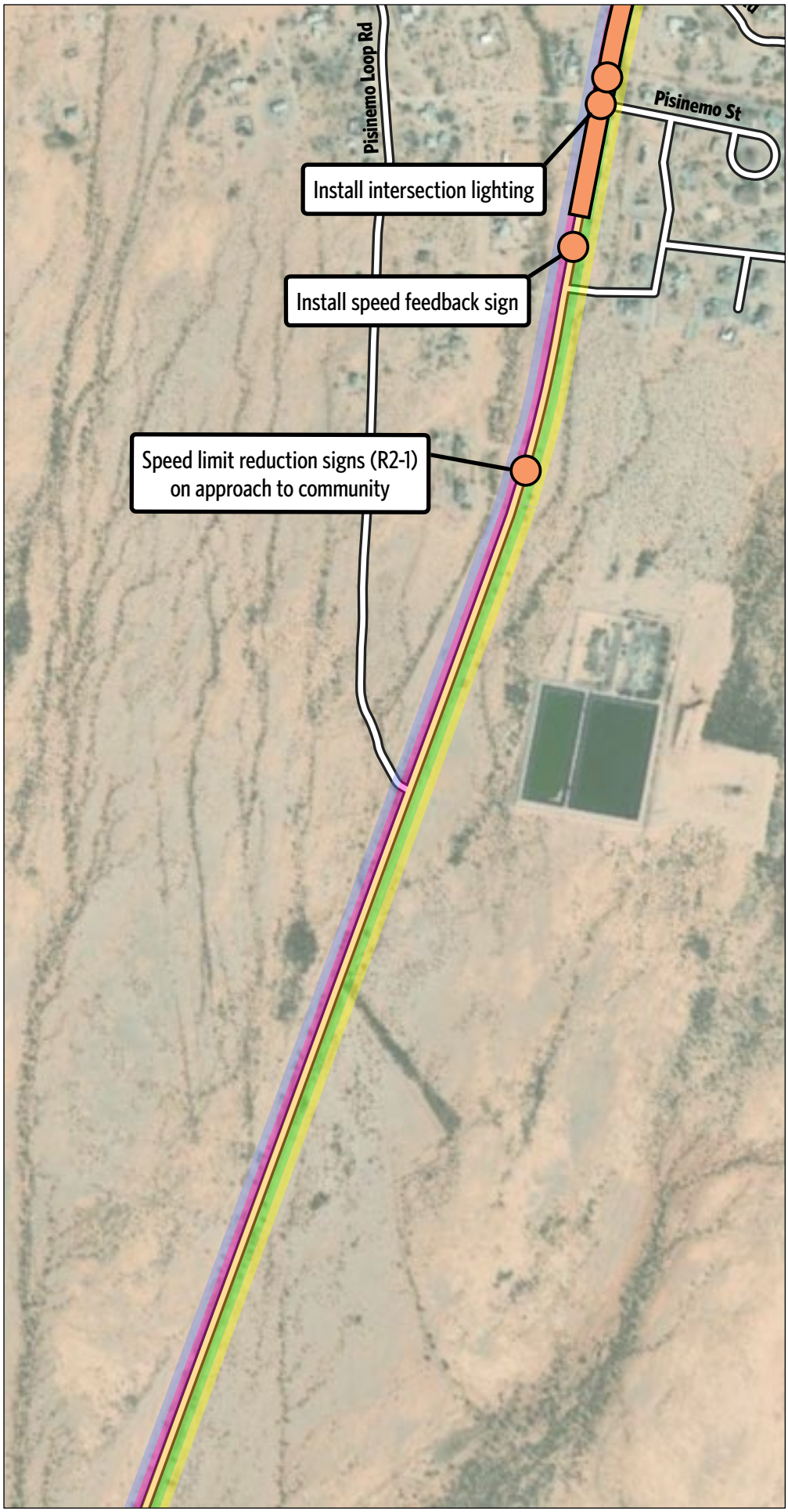

Recommended Improvements

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- Spot Improvement
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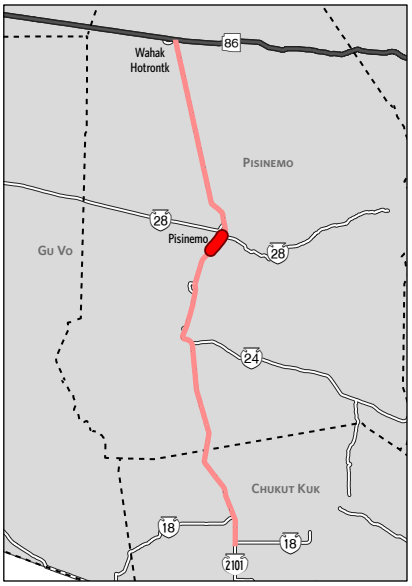

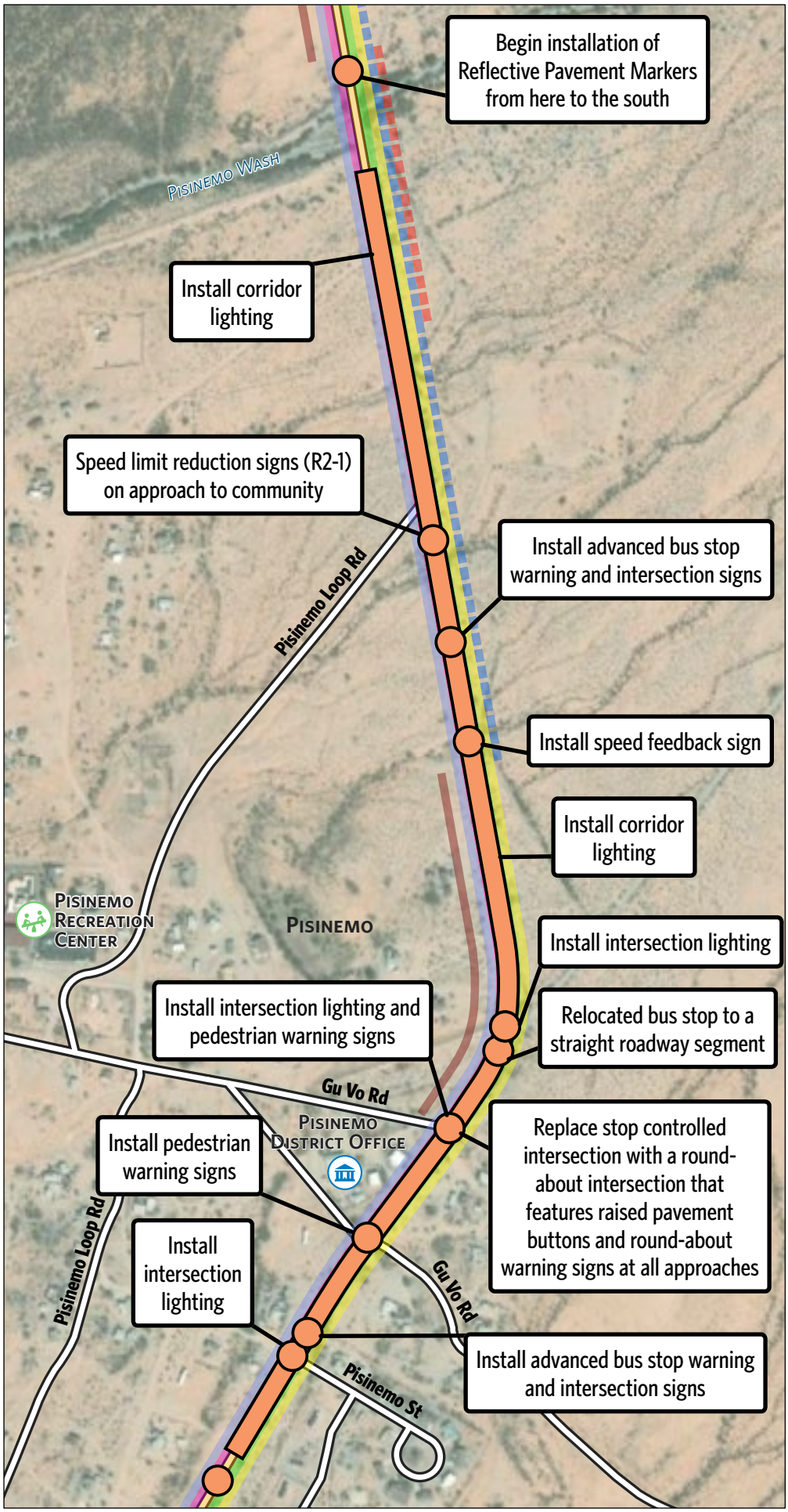

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- Spot Improvement
- Linear Improvement

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Reference

- Government Office
- Recreation
- School
- Tohono O'odham District Boundary

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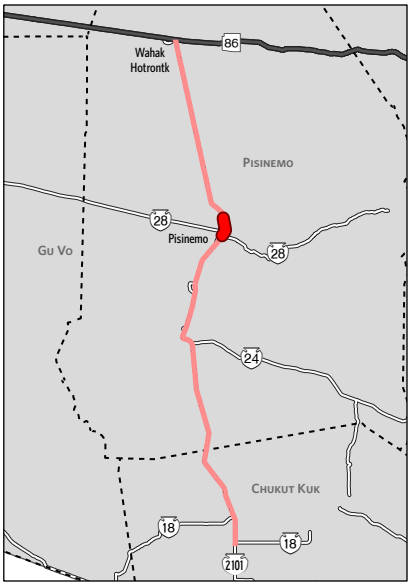

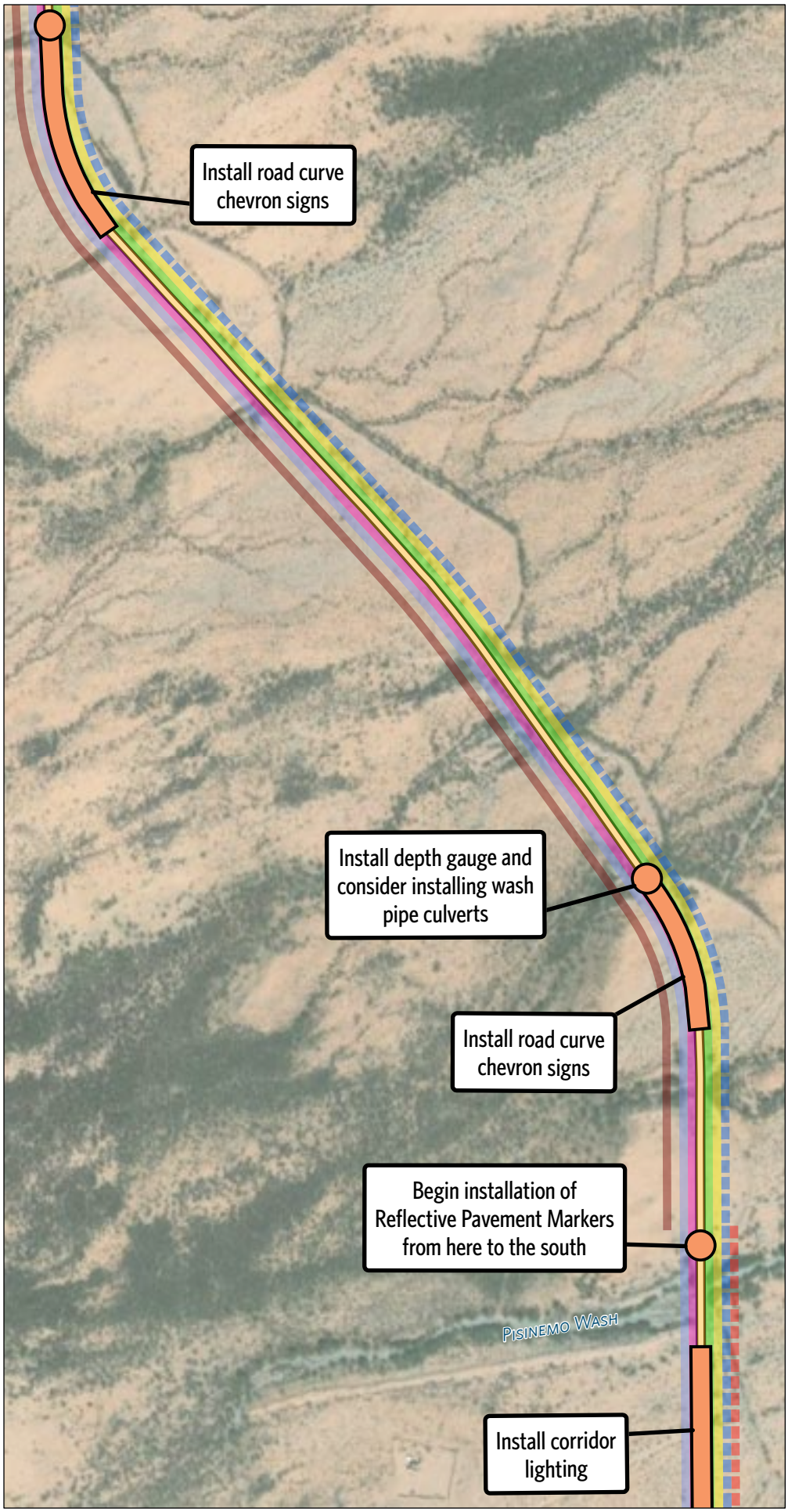

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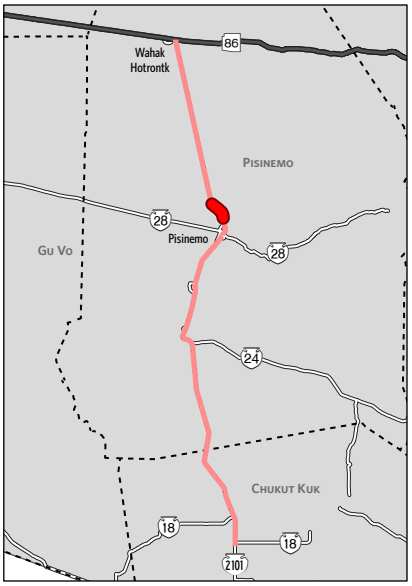

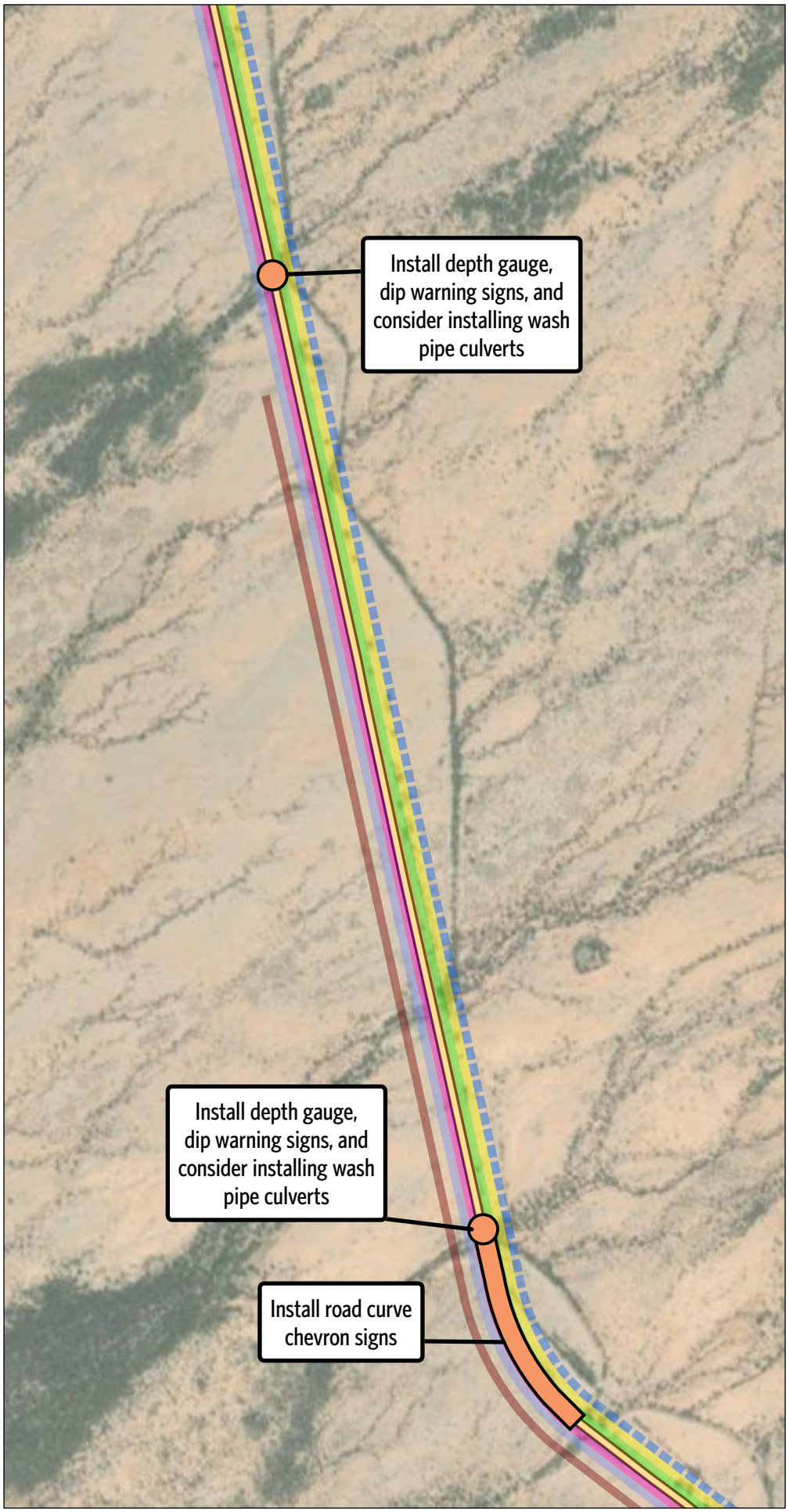

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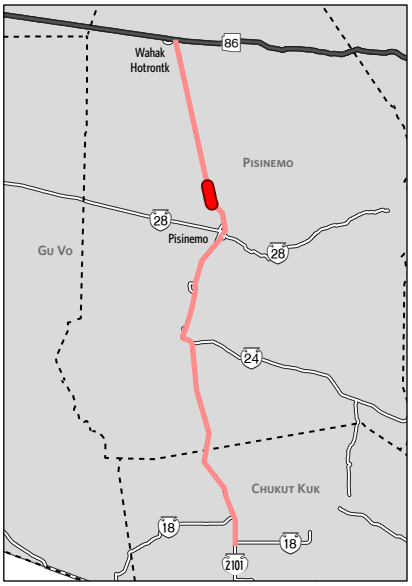

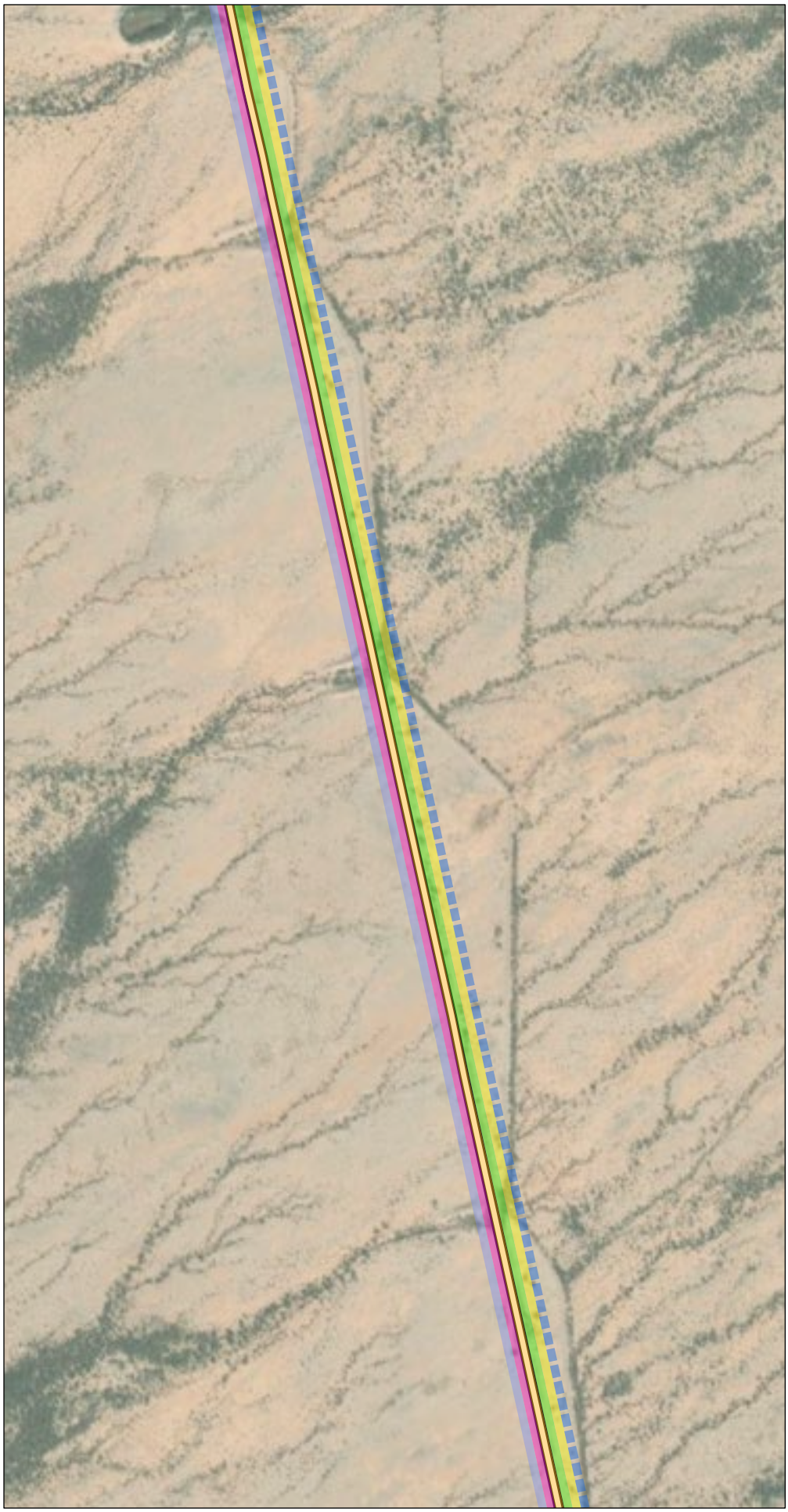

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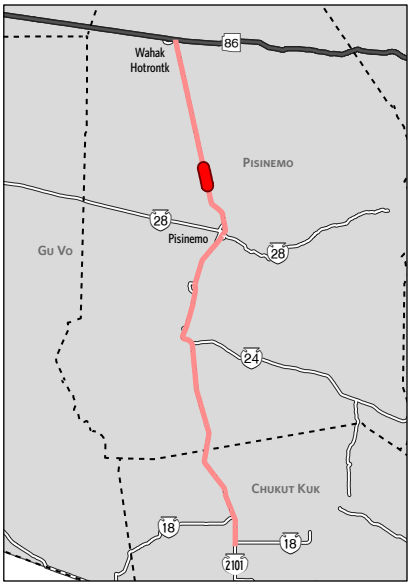

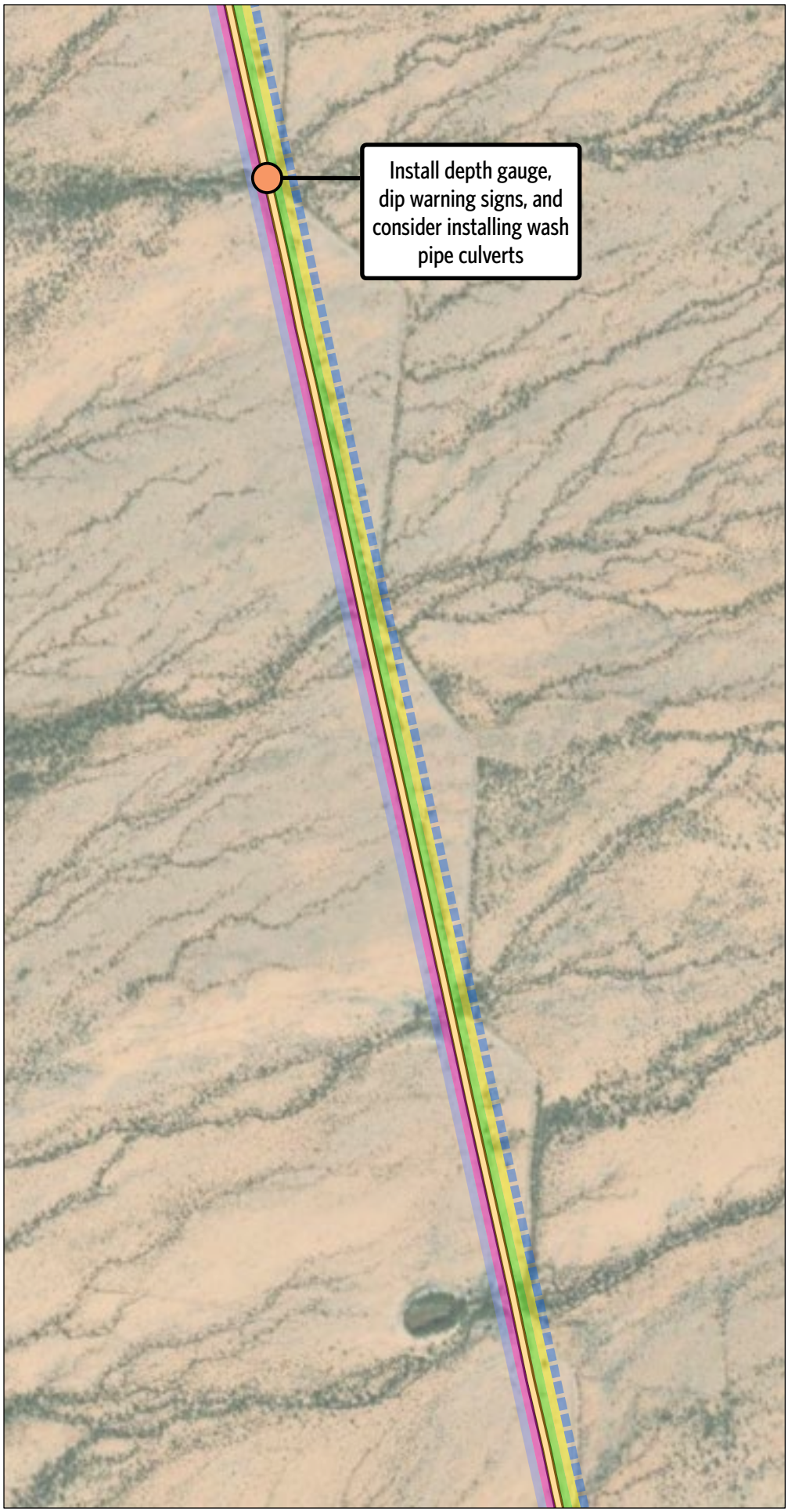

Recommended Improvements

Route 21

Potential Safety Concerns

- High Crash Corridor
- Flooding Issue
- No Sidewalks
- Open Range, No Fencing
- No Shoulders
- Deteriorating Striping
- No Lighting
- Poor Pavement
- Curvy Roadway

Recommended Improvement *

- Spot Improvement

* Also reference overview page for corridor-wide improvement recommendations

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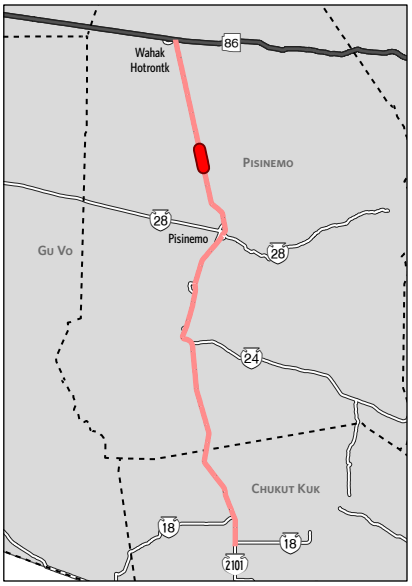

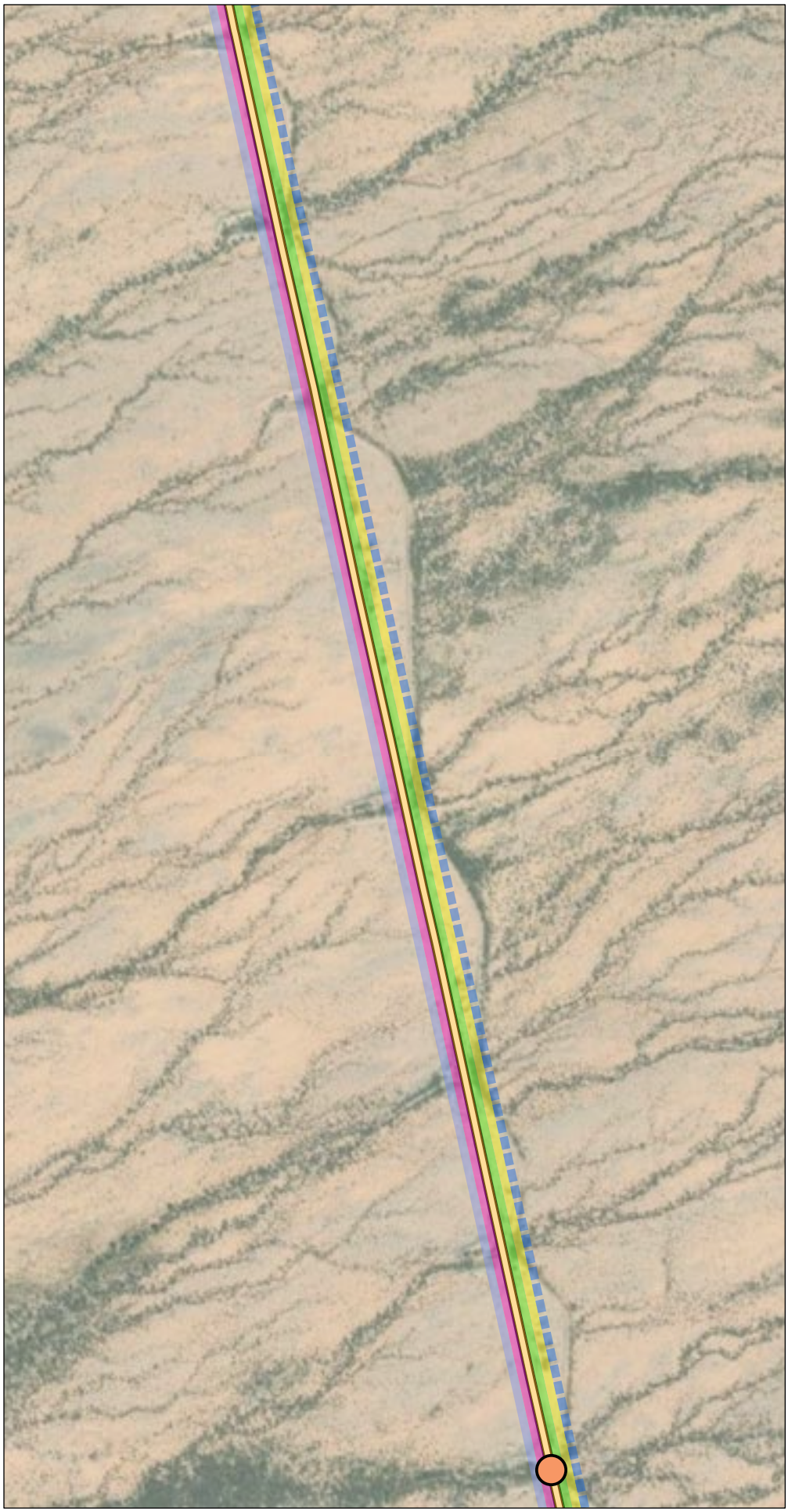

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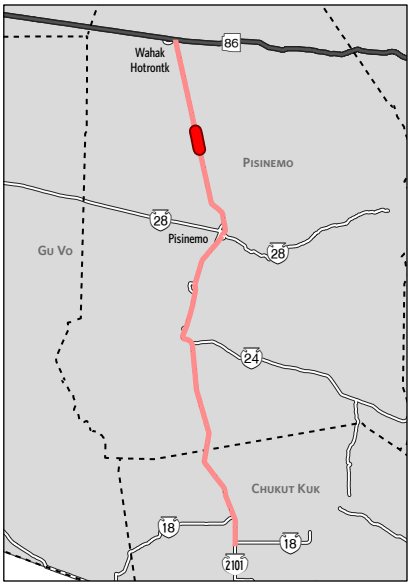

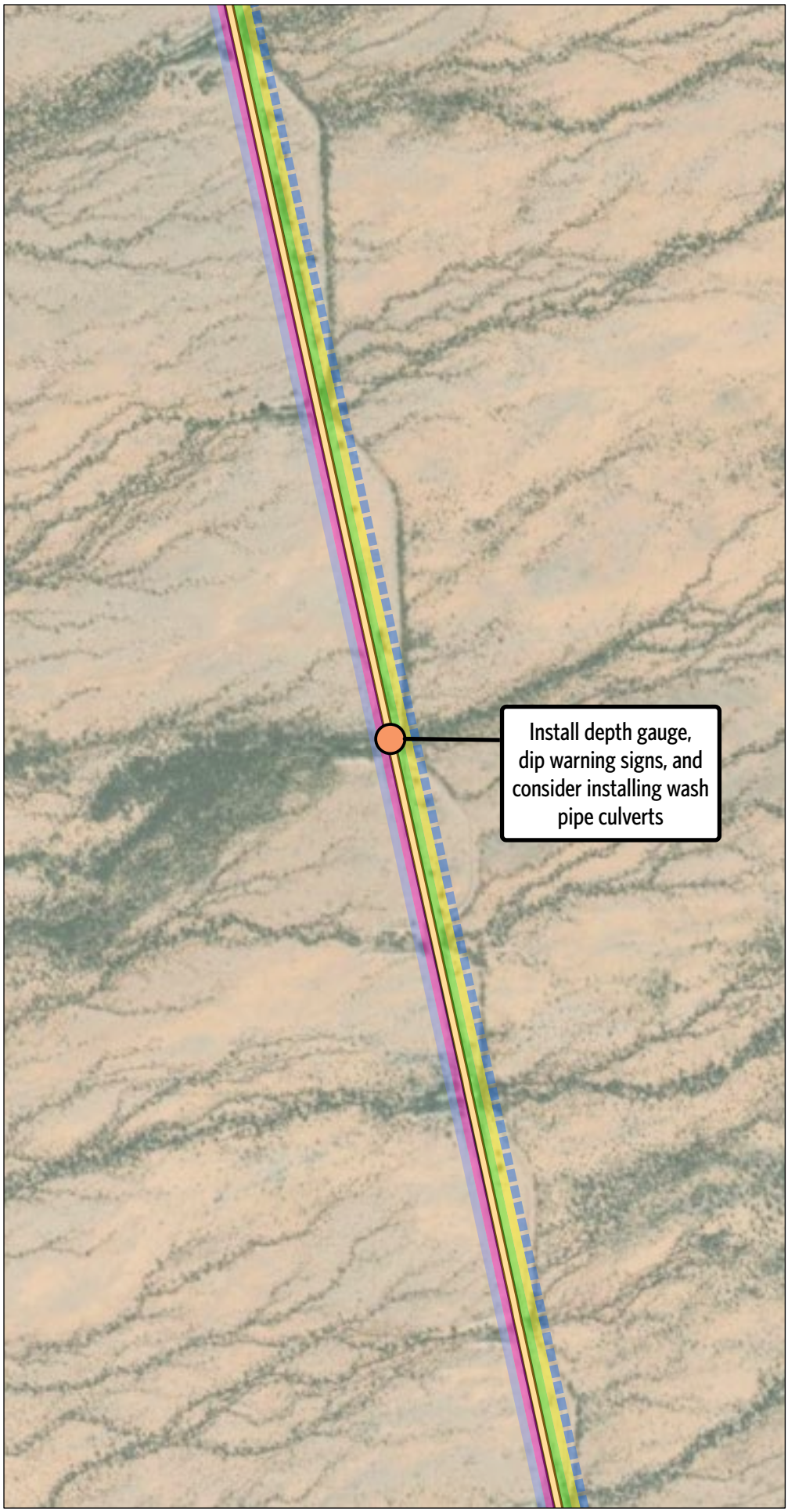

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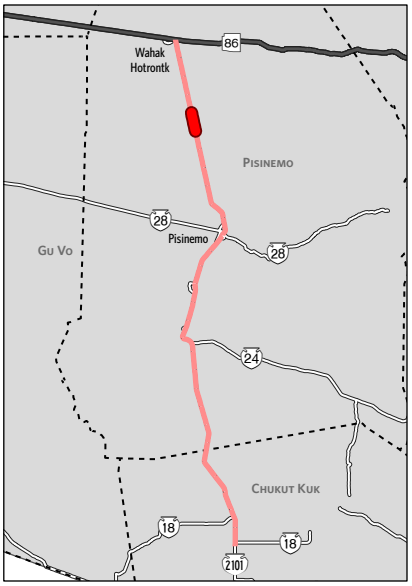

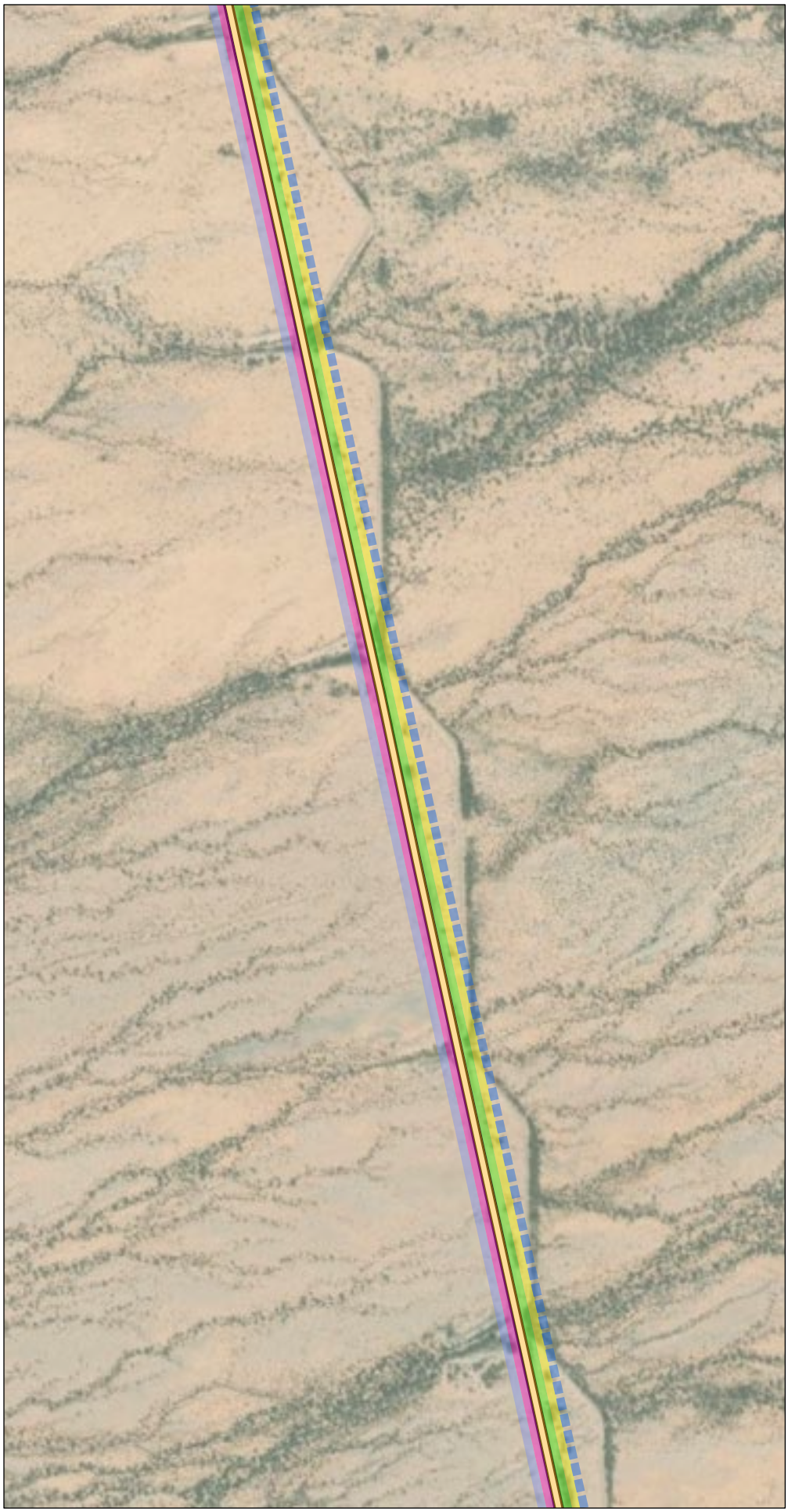

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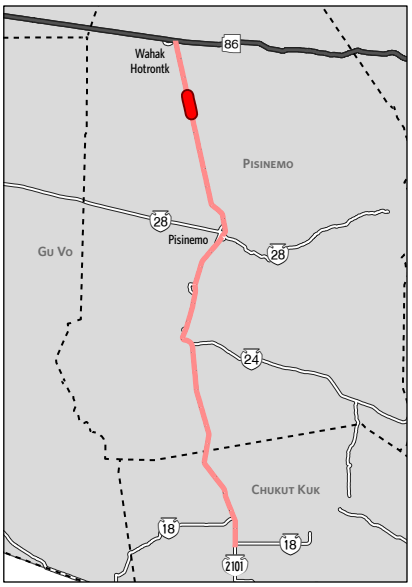

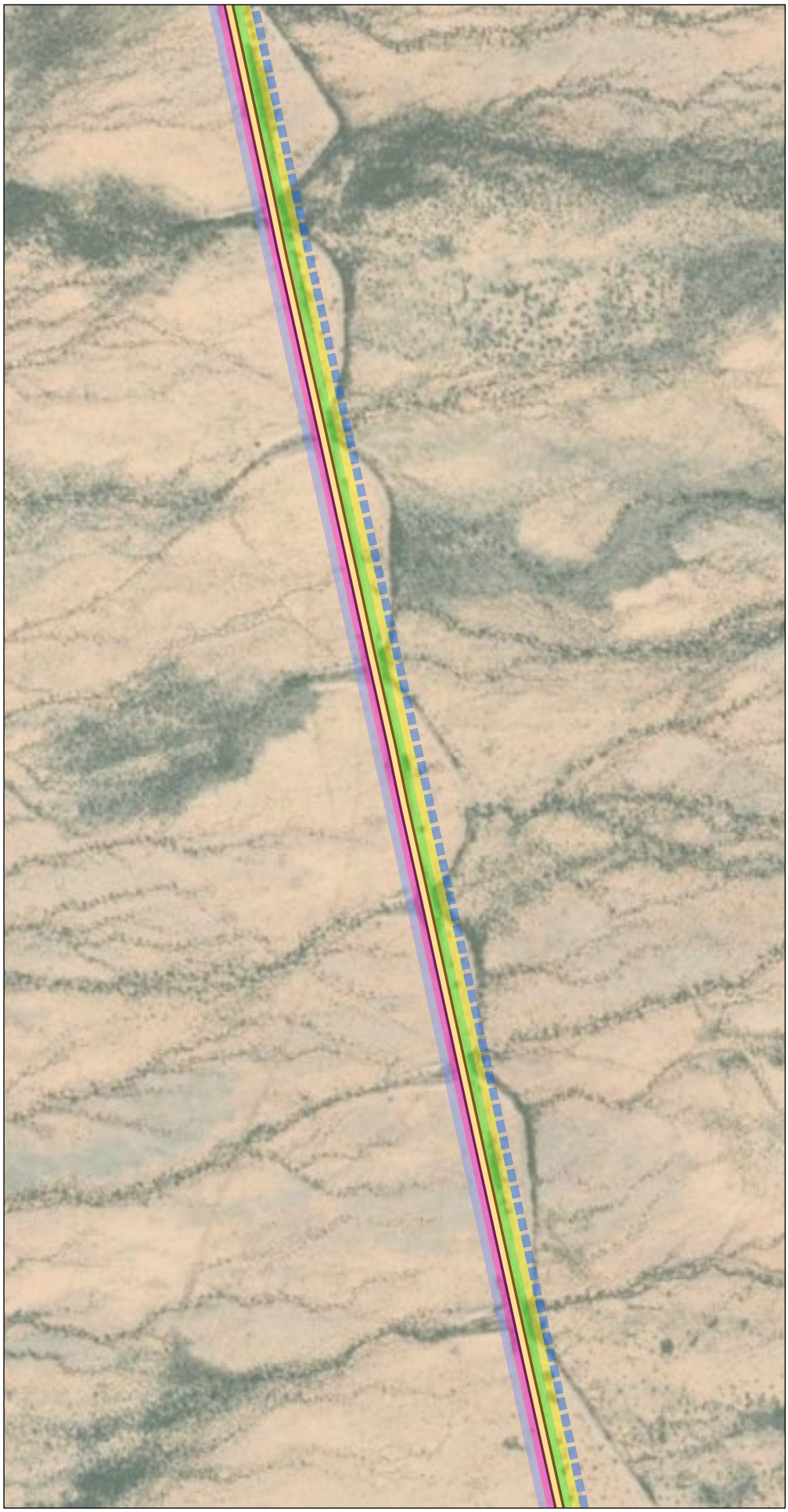

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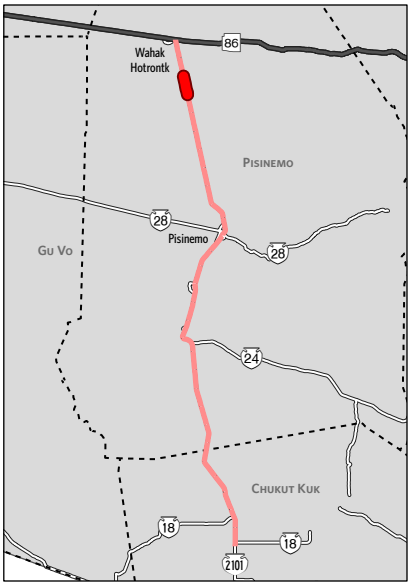

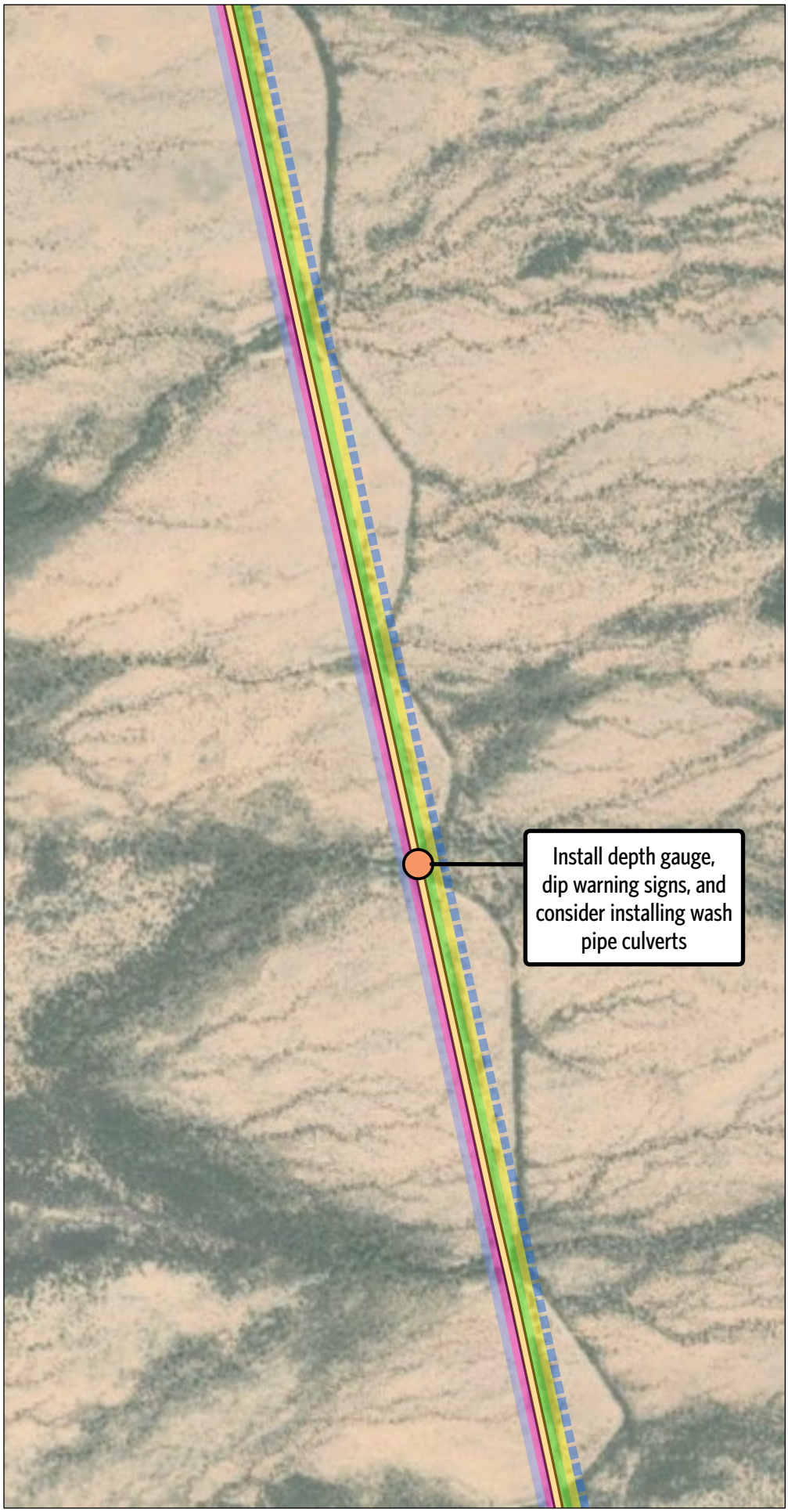

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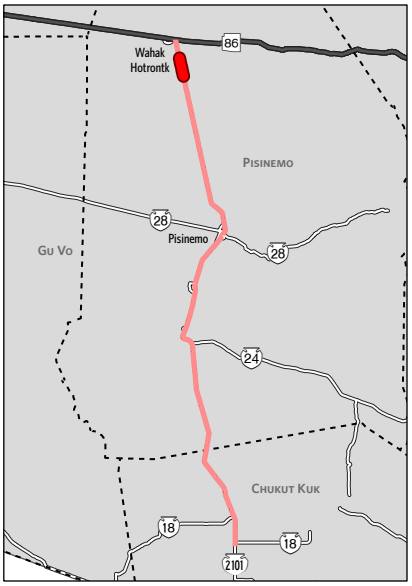

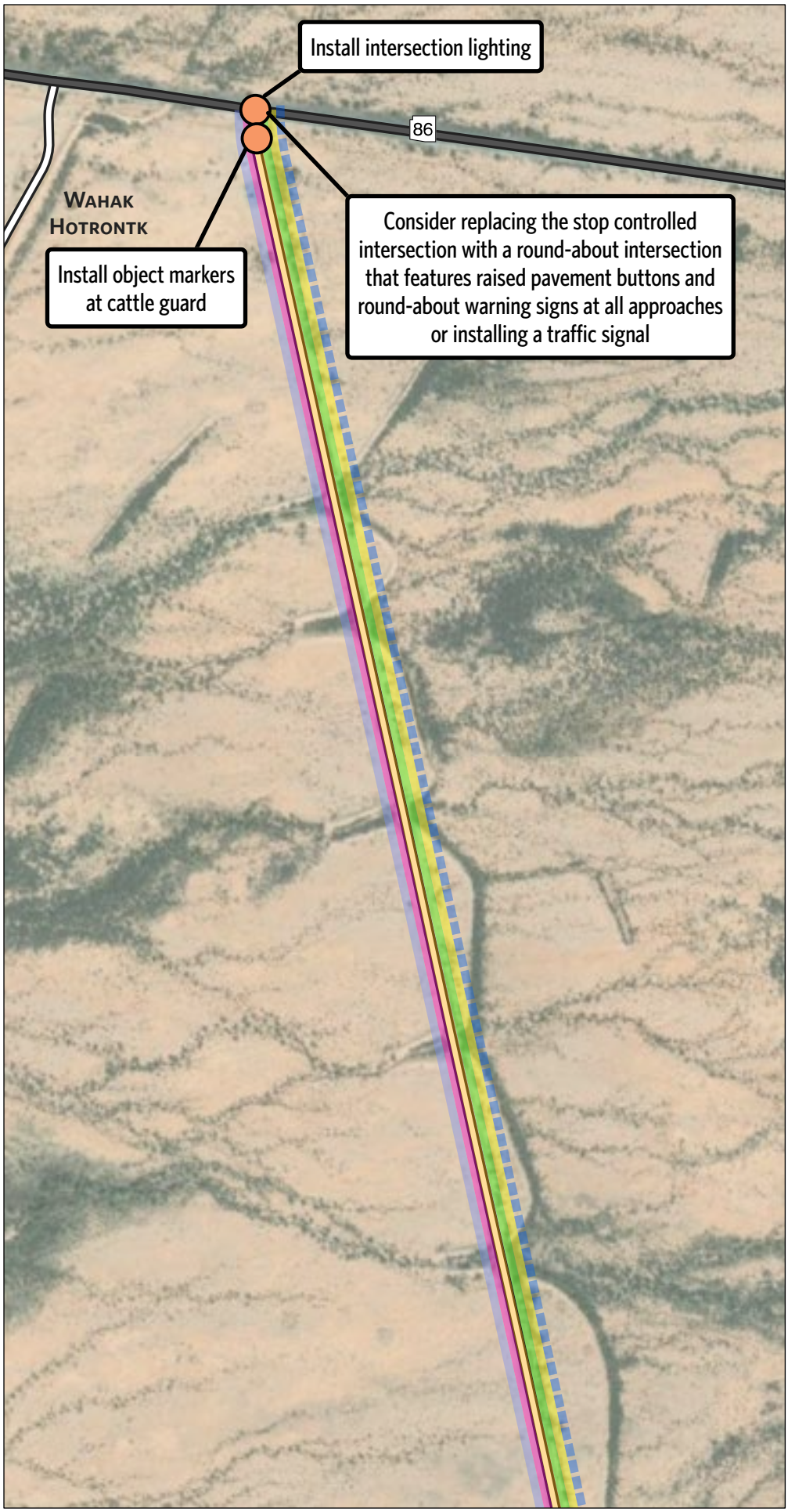

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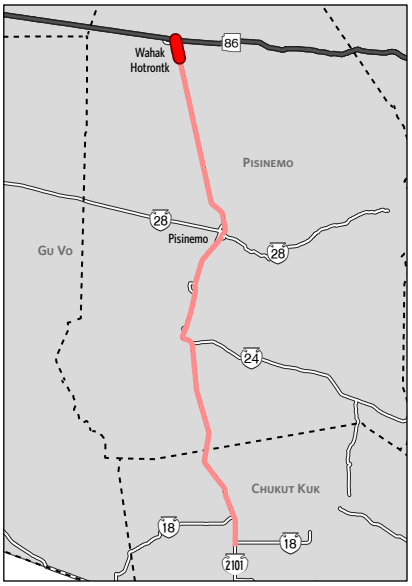

Appendix C

Agency Response to Suggested Projects

Suggested Projects and Associated Unit Estimates for Consideration

PROJECT	PROJECT TYPE	SCOPE	CONSTRUCTION UNIT COST ESTIMATE	TOHONO O'ODHAM NATION RESPONSE
Sign and stripe	Sign and Marking	1 mile of sign and marking Improvements	$180,000 per mile	In agreement with suggested projects. Projects will be considered for future Tribal Transportation Improvement Plan and/or Grant Applications
Round-about intersection	Intersection	Installation of one round-about intersection	$2,300,000 per intersection	
Speed feedback signs	Sign and Marking	Installation of one pair of speed feedback signs	$50,000 per sign pair	
Fencing and cattle guard	Clear Zone	Installation of 1 mile of continuous fencing inspection, repair, cattle guard repair/replacement	$200,000 per mile	In agreement with suggested project. 2023 Tribal Transportation Program Safety Fund Grant Application has been submitted for this project. Currently awaiting notification from funding source.
Street lighting	Intersection	Installation of one intersection of street lighting and community area lighting	$ 180,000 per intersection	In agreement with suggested project. Project will be considered for future Tribal Transportation Improvement Plan and/or Grant Applications
Pavement maintenance	Pavement	Installation of 1 mile of pavement maintenance (slurry seal)	$210,000 per mile	In agreement with suggested project. Project will be addressed through the Road Maintenance Program.
Rumble strips	Pavement	Installation of 1 mile of centerline rumble strips	$40,000 per mile	In agreement with suggested projects. Projects will be considered for future Tribal Transportation Improvement Plan and/or Grant Applications
Paved shoulders	Pavement	Installation of 1 mile of 4-foot paved shoulders	$1,550,000 per mile	
Clear zone maintenance	Clear Zone	1 mile of 32-foot clear zone clearing and grubbing	$80,000 per mile	In agreement with suggested projects. Projects will be addressed through the Road Maintenance Program.
Culvert maintenance	Drainage	1 wash crossing culvert maintenance	$50,000 per crossing	
Culvert installation	Drainage	1 wash crossing culvert installation	$1,500,000 per crossing	In agreement with suggested projects. Projects will be considered for future Tribal Transportation Improvement Plan and/or Grant Applications
Drainage maintenance	Drainage	1 wash crossing erosion control and riprap gabions	$1,140,000 per crossing	
Soil removal and prevention	Drainage	Soil removal and rock placement for 100 feet	$ 30,000 Per 100 feet	In agreement with suggested project. Project will be addressed through the Road Maintenance Program.