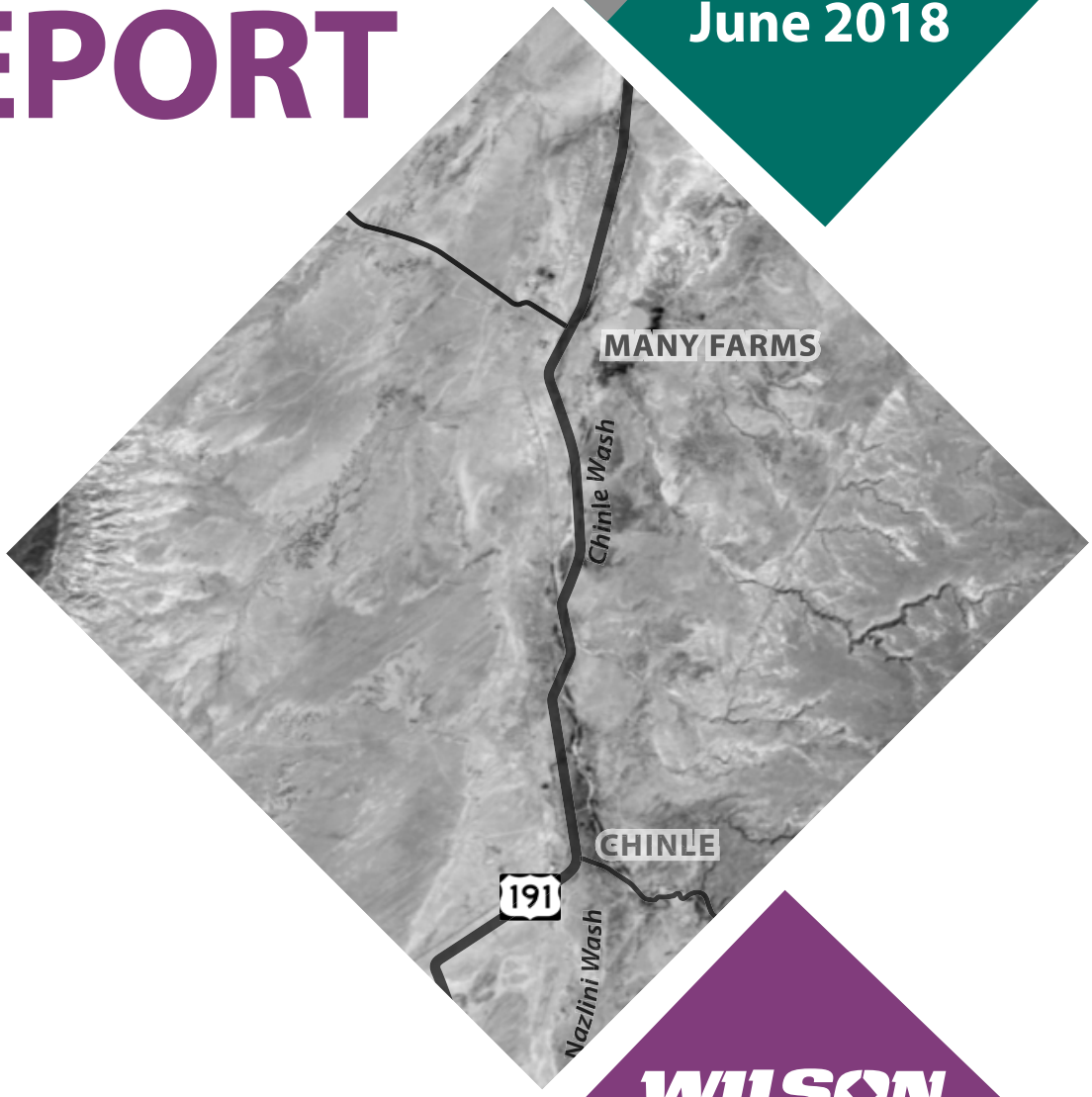
FINAL REPORT

June 2018



US 191

CHINLE TO MANY FARMS SAFETY IMPROVEMENT STUDY

WILSON & COMPANY

US 191

Chinle to Many Farms
Safety Improvement Study

Final Report

Prepared for
Arizona Department of Transportation

& The Navajo Nation Government

Prepared by

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June 2018

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1.0 INTRODUCTION

The US-191 Chinle to Many Farms Safety Improvement Study (Study) has been developed for the Navajo Nation Governments in cooperation with the Arizona Department of Transportation (ADOT) and in partnership with the Navajo Division of Transportation (NDOT) and the Chinle and Many Farms Chapters of the Navajo Nation. The Study represents a focused effort to fully evaluate travel conditions associated with US-191 and identify actions to improve traveler safety through the corridor. It resulted in identifying a program of improvement projects to address identified needs in the US-191 corridor between Mileposts 440 and MP 470. Recommendations draw on investigations, analyses, and resources of established partnerships, as well as previous studies and relevant documents that provided context for developing effective solutions to increase safety within the corridor.

1.1 STUDY AREA

This report describes existing conditions and anticipated future conditions within a study area along US-191 from Milepost (MP) 440, near Navajo Route (N) 4/Pinon Road, and MP 470, north of Many Farms at Chinle Wash. This study area, shown in **Figure 1.1**, includes the communities of Chinle and Many Farms, which are recognized Chapters within the Chinle Agency of the Navajo Nation Tribal Government. These two Chapters are both Census-Designated Places (CDPs). US-191 serves as the primary route of social and economic activity for the Navajo Nation.

US-191 is a Major Collector in the Arizona State Highway System (SHS) that connects I-40 south of the study area to US-160 in the north. It is the only major roadway serving the Chinle Agency of the Navajo Nation and supports direct travel between Chinle and Many Farms. The highway provides access to significant attractions within the Navajo Nation, including: Canyon de Chelly National Monument and the Four Corners Monument. **Figure 1.2** shows the regional setting of the study area.

Figure 1.1
Study Area

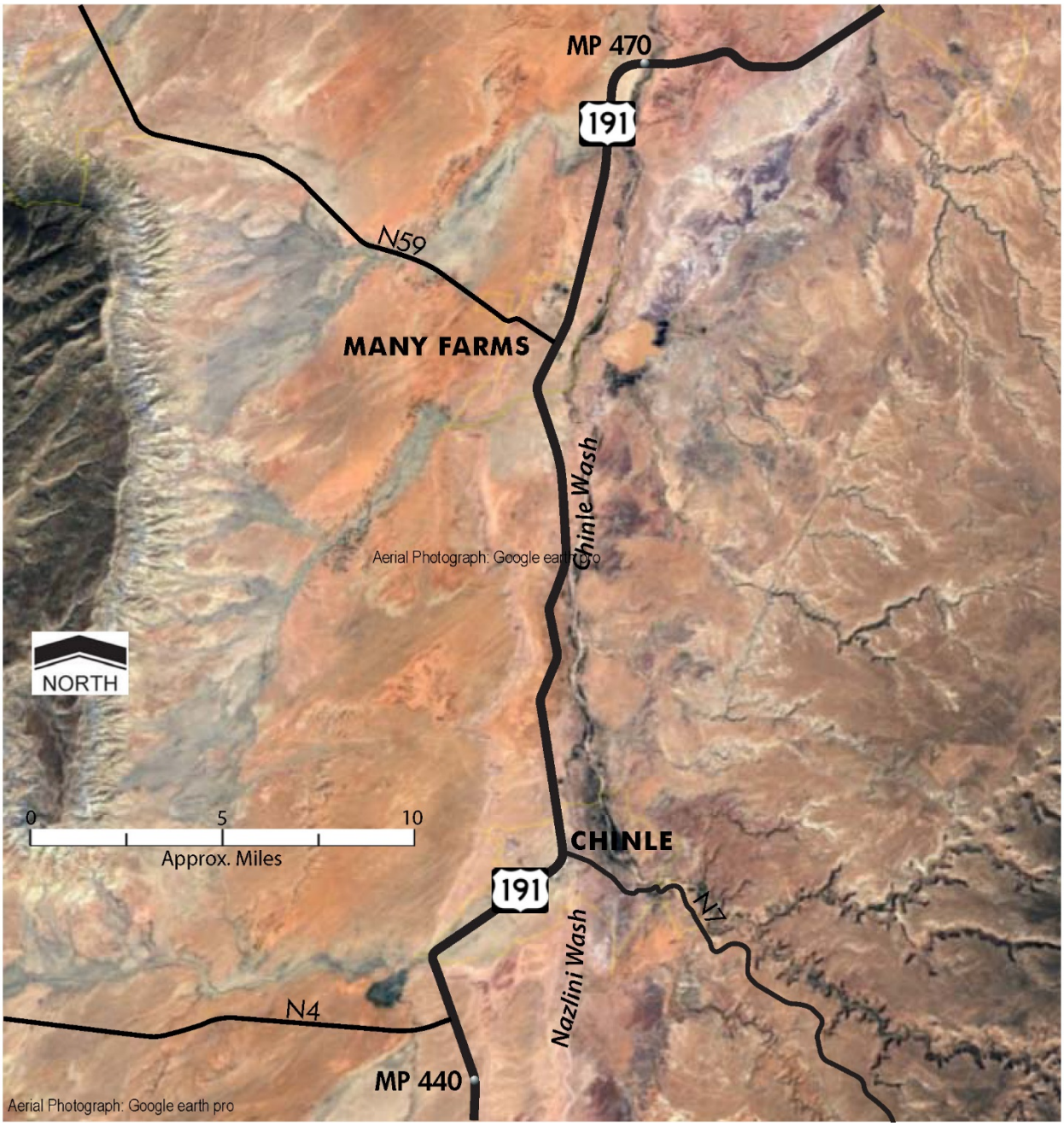
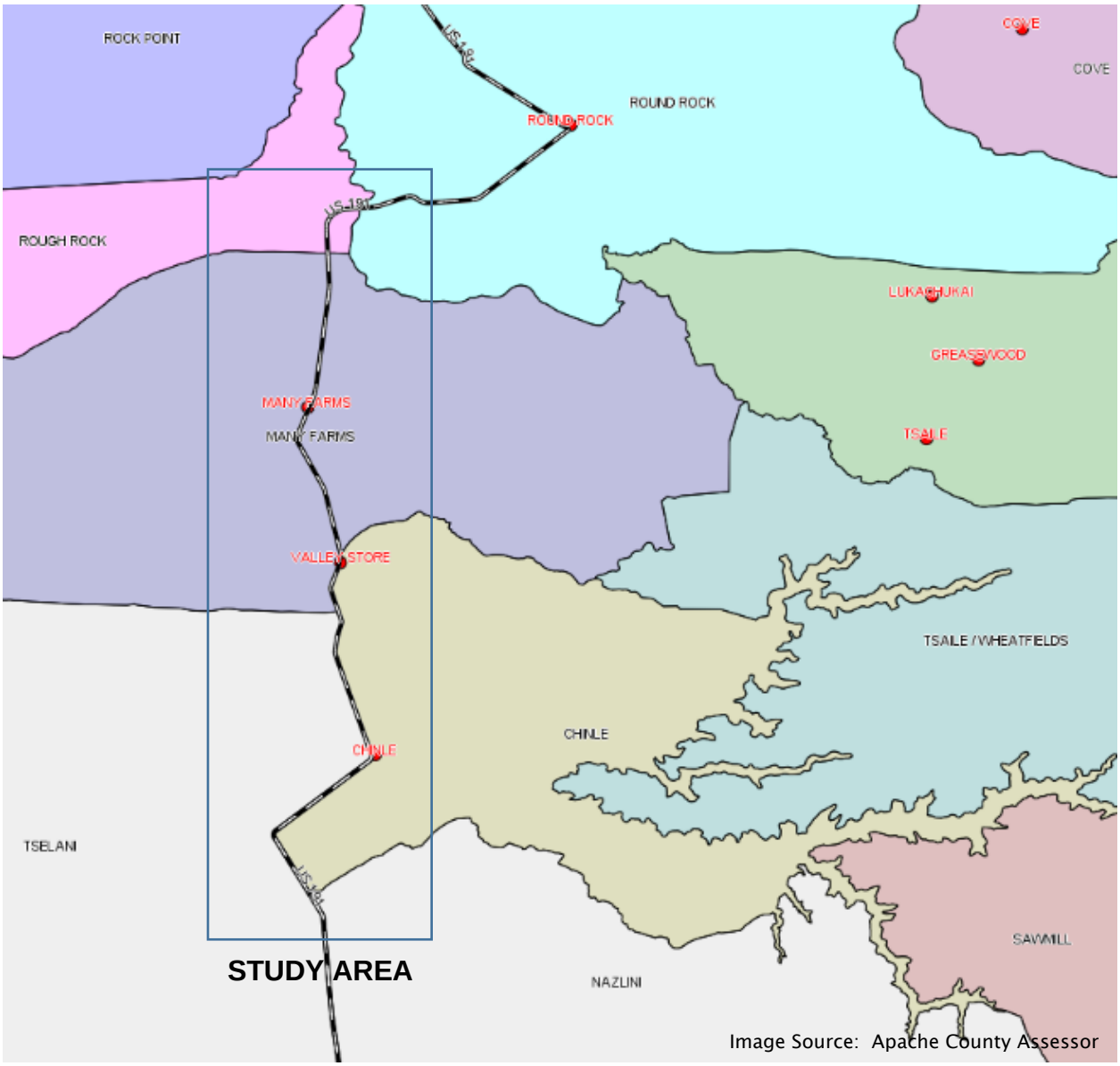


Figure 1.2
Regional Setting



1.2 STUDY PURPOSE

The principal objective of the Study was to create a plan to promote the health, welfare, and mobility of the people of the Navajo Nation, the communities of Chinle and Many Farms, and visitors by addressing critical transportation safety needs. It had a twofold purpose: (1) evaluate existing and expected future travel conditions in the study area, and (2) formulate a program of projects to enhance travel and safety through the corridor. Findings and conclusions of the Study formed the bases for defining an action plan to address specific safety-related needs in the travel corridor. This Safety Improvement Plan will be used to inform the preliminary scoping process of the ADOT Northeast District and assist the District in securing necessary funding for recommended improvements.

1.3 STUDY PROCESS AND PREVIOUS STUDIES

The examination of crashes occurring in recent years in the study area was a central focus of this Study. ADOT and the Navajo Nation share responsibility for the safety of travel through the corridor, and data that inform this Study were provided by both organizations. The Study involved examination of: characteristics of the highway, multimodal infrastructure (public transportation, bicycling, and walking facilities), and socioeconomic and environmental conditions. These factors could be related to safety issues and/or influenced by potential safety improvement projects. The intent of this Study, therefore, was to develop a recommended program of prioritized projects to improve traveler safety, operational efficiency of this vital travel corridor, and overall performance. The Study included identification of access, mobility, and safety needs within the framework of a cooperative planning process involving the following stakeholders: tribal and Chapter transportation staff, public agency staff, elected officials, and the general public.

This Study builds on planning actions first undertaken six years ago with preparation of the "Multimodal Long-Range Transportation Study for

Chinle–Many Farms and St. Michaels–Window Rock–Fort Defiance" (ADOT, June 2012). One report compiled during this Study focused on the Chinle and Many Farms Study Area Corridor (ADOT, May 2012). Also, an earlier "US-191, MP 444 to 465 Road Safety Assessment" (RSA) was conducted for a major portion of the study area by the ADOT Northeast District (formerly Holbrook District), collaborating with NDOT (April, 2012). The RSA, which specifically focused on US-191 between MP 444 and MP 465, included evaluation of crash data, field reviews of the corridor and certain crash sites, and an inventory of the physical characteristics of the roadway. The RSA resulted in suggested improvements and countermeasures to improve safety, which focused on the following elements:

Lane Departure Crashes	Black Mountain Wash Crossing
Pedestrians	N7 Intersection
Livestock in Right-of-Way	Other Intersections
Rear-End Crashes	Maintenance
Speeds	Crash Reporting
Signing	Education and Enforcement

The 2012 transportation study and RSA provided general guidance relating to travel safety and mobility, identified multimodal transportation needs for vehicular, bicycle, and pedestrian travel, and presented an evaluation of intermodal connectivity between and among various travel modes. The subsequent "Navajo Nation Long Range Transportation Plan" (LRTP) addressed short- and long-term improvement strategies for current and future travel and mobility needs of the Navajo Nation (NDOT, 2016). The LRTP identifies the Chinle Chapter as a "Primary" Growth Center and the Many Farms Chapter as a "Secondary" Growth Center. The Chinle Agency, which incorporates the two chapters, is one of three agencies served by US-191.

The LRTP was formulated on the basis of several specific goals; one of those goals was "Enhance Safety." The LRTP notes, regarding this goal: "All crashes are caused by either driver behavior (education and enforcement focused), geographic/geometric issues (engineering focused), or natural events (education and engineering focused)." The engineering components of this causal framework evoke two different responses: "reactive" or "proactive." Reactive safety engineering focuses on fixing "hot spots," i.e., locations where there are a

high number of crashes. The typical proactive engineering practice focuses on Road Safety Audits (RSAs), roadway safety analyses, and roadway and intersections design/operations studies. This aspect of safety studies and engineering solutions relies on historic crash data to understand systemic problems. Both activities identify and implement countermeasures, i.e., measures intended to negate or offset the unsafe circumstance or action.

Subsequent to the 2016 LRTP, a "Strategic Highway Safety Plan" (SHSP) was prepared for the Navajo Nation (ADOT, 2017). The SHSP identified the seven "highest crash areas," and the Chinle area (i.e., Chinle Chapter) was among the seven. This data-driven, proactive report focused on safety crash history, and a crash analysis was produced showing crashes attributed to 13 different causal occurrences, e.g., intersections, speeding, alcohol and drugs, animals, and others. The SHSP presented specific recommendations for safety improvements, i.e., countermeasures to mitigate the effects of identified causes. As such, the SHSP element for Chinle provides a starting point for this current Study. The SHSP also includes reactive safety engineering by identifying actions or countermeasures consistent with the "4 Es of Highway Safety:" **E**ngineering, **E**ducation, **E**nforcement, and **E**mergency **M**edical **S**ervices.

Following this review of previously identified issues documented in the previous study efforts, additional research and analyses were undertaken to assure comprehensive evaluation of current and expected future travel conditions in the US-191 corridor. Study efforts were supported by Study Team meetings in relation to Study milestones, public meetings and outreach activities, field reconnaissance and examination/review of aerial photography, and data collection and organization employing geographic information systems (GIS).

1.4 PUBLIC PARTICIPATION PROCESS

The Study incorporated several opportunities for stakeholder and public input to the study process. Five Study Team meetings were conducted along with two meetings fully open to the public. In addition, public flyers and surveys were disseminated, interviews of select stakeholders were conducted, and a project Web site was maintained.

A May 2107 Public Meeting provided an overview of the study process and a review of identified issues. Common safety-related themes in the US-191 corridor were addressed at this public meeting, including:

- School bus activity
- Speeding
- Livestock
- Roadway characteristics
  - Roadway geometry (i.e., turn lanes, shoulders, curves, etc.)
  - Drainage

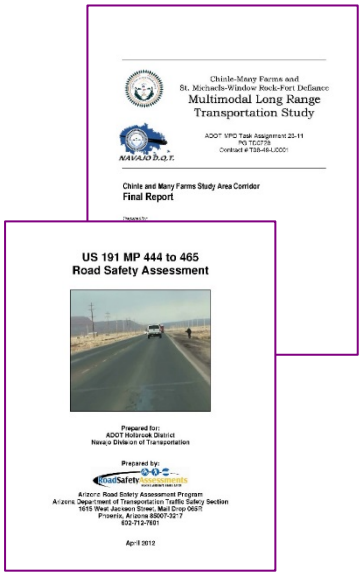


Figure 1.3 provides a compilation of the identified issues/opportunities that were highlighted for the Chinle and Many Farms communities. Also, corridor-wide Issues/opportunities were noted and specific locations were called out, where safety or travel were identified as concerning or problematic.

The meeting provided an opportunity for the public to provide feedback on these identified issues and opportunities, as well as identify additional issues that should be considered during conduct of the Study.

Figure 1.3
Issues/Opportunities Display Board: May Public Meeting

US 191 Chinle to Many Farms Safety Improvement Study
MPD Task Assignment 0026-17

PREVIOUSLY IDENTIFIED ISSUES/OPPORTUNITIES

Many Farms Area

Pedestrians
- Access for students to school/admin
- Evaluate the need for a pedestrian bridge or a Pedestrian Hybrid Beacon (HAWK), and improved shoulders near schools and shopping in Many Farms.
- Install a high visibility crosswalk near schools in Many Farms and ensure beacons on warning signs at Many Farms Elementary are flashing properly.

Safety
- Vehicle, pedestrian, and student safety concerns at the intersection of N-59 & U.S. 191

Traffic Control
- Provide a traffic signal or a roundabout at the intersection of U.S. 191 & N59.
- Eastbound backups may require turn lanes

Lighting
- Need lighting at N59 & US-191.

Other Issues
- Need for cattle guard
- Drainage (west side of road)
- Poor Level of Service (LOS)

Widening/Capacity
- Replace/widen Black Mountain Wash Bridge (MP 460.26)

Drainage at C564 (School Bus Route)
- Replace or relocate small culvert under 191

Drainage
- Potential drainage concerns.

Volume/Capacity
- Request to add 8095 to volume counts. Possible new development and bridge project. 8095 is the north end of detour route if US 191 is closed to the South. Road used for multiple school bus routes.

Horizontal Curve Delineation (4 locations)
- Delineate horizontal curves with flexible delineators, chevrons, and curve warning signs as appropriate.
- Evaluate need for Southbound passing lane and/or deceleration lane near MP 454 (no passing Southbound)

Corridor Wide

Lane Departure Crashes
- Provide paved shoulders with edge line rumble strips.
- Refresh Pavement markings, to include installation of center line raised pavement markers.
- Install center line rumble strips.
- Delineate horizontal curves with flexible delineators, chevrons and curve warning signs as appropriate.

Rear End Crashes
- Evaluate major intersections for the need for turn lanes.
- Install advance intersection signing at major intersections.
- Install cattle guard delineation.

Speeding
- Install solar powered speed feedback signs in Many Farms.
- Evaluate use of photo radar enforcement in Many Farms.
- Conduct speed studies to determine appropriate speed limits in Chinle and Many Farms.

School Bus Pullouts
- Provide and/or formalize more bus pullouts for school buses (as needed).

Widening/Capacity
- Widen US-191 to four lanes.
- Improve roadway geometrics and flatten the near where US-191 is at 7%.
- Widen shoulders; construct turn lanes and larger driveway turnouts.

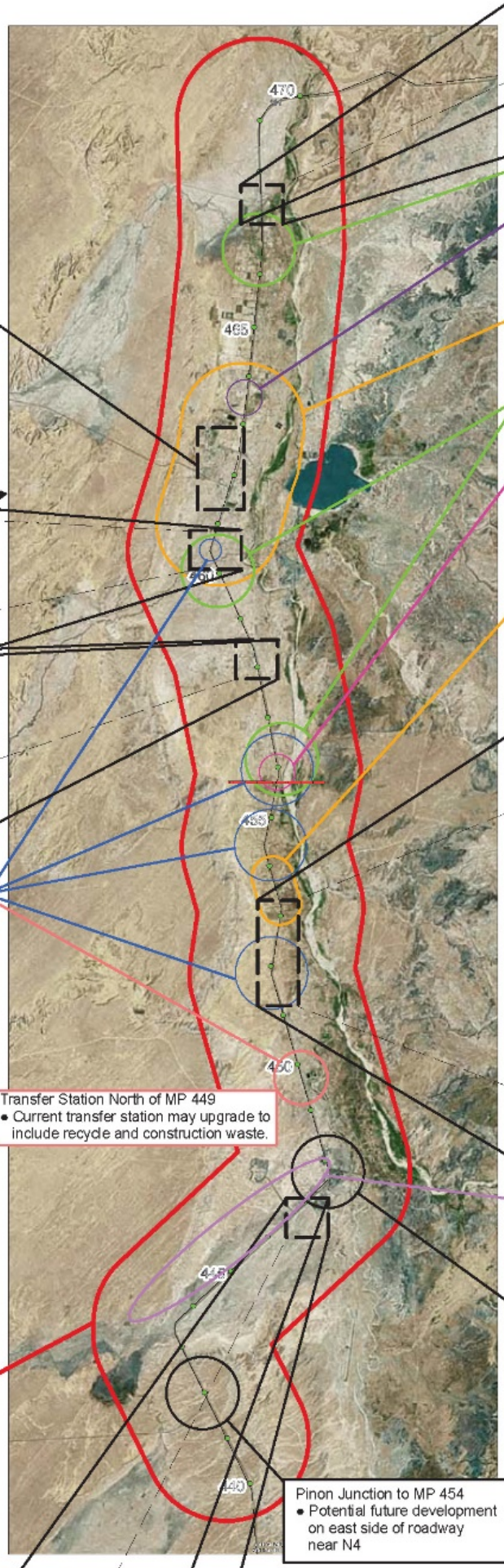
Fencing/Livestock
- Install new fencing, cattle guards, and gates between N7 & N59.

Byway Designation
- Consider extending the byway designation to Chinle.

Shoulder striping, signing, and marking improvements
- Install paved shoulders with edge line rumble strips
- Refresh pavement markings and install centerline raised pavement markers.
- Install centerline rumble strips.
- Install bus ahead signs where needed.
- Remove unused sign posts and replace missing or damaged signs.
- Remove any private signs off of roadway sign posts.
- Install 360 degree retroreflective delineators on sign posts.
- Develop more signs to identify amenities along the corridor.
- Add shoulders and reflective delineators in rural areas.

Install high visibility crosswalks in Chinle and Many Farms.

Drainage/Erosion
- Erosion control/overgrown plants/vegetation along US-191.
- Perform a drainage study in Chinle for storm drain with outflow to Chinle Wash.
- Upgrade 36 undersized culverts and improve roadway profile.
- Adequately size culverts for long range projects.



Transfer Station North of MP 449
- Current transfer station may upgrade to include recycle and construction waste.

Traffic Control
- Possible location for roundabout at N8094

Future South Chinle Developments:
- Route 102 south to cemetery
- New Navajo Technical University Expansion of 35 acres with access to Hospital; Plan available but needs acquisition of right-of-way.
- New Cemetery Road as partnership.

Flood Control
- Berm west of new cemetery prevents flooding but is deteriorating.

Pinon Junction to MP 454
- Potential future development on east side of roadway near N4

Flooding
- Existing: 4 pipes located at the low spot; water pools on the side of the road
- Flooding issue may require a box culvert

Pullouts
- Provide bus pullouts and rest areas for truckers (Segment between MP 466 & 467)

Drainage
- South side of Intersection at N8085 requires larger Culvert due to standing water in the wash.
- Current drainage study and plans to pave N8085

Speeding
- Install solar speed monitors at two locations (shown). Coordinate with a speed study.
- Evaluate use of photo radar enforcement in Many Farms.
- Conduct speed studies to determine appropriate speed limits.

Bus Pullouts
- Design and construct bus pullouts (2 locations shown)

Windmill Site
- Approximate Chapter boundary shown (dashed red)
- Potential future development near the Windmill
- Replace or relocate small culvert under 191 at C564 (School Bus Route)

Speeding
- Install solar speed monitors at two locations. Coordinate with a speed study.

Access
- Residents have created an informal frontage road for access to adjacent property

N8087
- Connects back road to Many Farms (N8084)
- Frequent access to private property

- Drivers appear to use shoulder to turn
- Narrow right-of-way around MP 452

- Flooding often crosses over U.S. 191. Check culvert frequency and size

Drainage
- Lake and wash west side of roadway drains to Chinle

Chinle Area

Pedestrians
- Evaluate the need for a pedestrian bridge or a Pedestrian Hybrid Beacon (HAWK) near Chinle High school/Chinle Elementary School and/or the N7 & US-191 intersection.
- Install a high visibility crosswalk near Chinle High school/ Chinle Elementary School and/or pedestrian countdown signal heads at the N7 & US-191 intersection.

Access Management
- Combine existing driveways in the immediate vicinity of the N7 & US-191 intersection.

Speeding
- Conduct speed studies to determine appropriate speed limits.

N8091 Intersection
- High volumes from 1) the Swap Meet; 2) Use of route as downtown bypass; 3) Use of route to access the hospital. Poor Level of Service
- Drainage issues west side of road.
- Evaluate turn lanes for Eastbound backups.

N7 Intersection
- West leg has utility relocation implications
- Design solution to address parking issues (west side) at Sports Complex events.

Lighting
- Evaluate existing street lighting in Chinle for proper illumination and uniform light pattern for pedestrian safety.

Multi-modal Transportation
- Construct shared use path along US-191
- Local transit service within Chinle and Many Farms – routes to be determined by Navajo Transit System
- Transit Shelters
- Design and construct a Transit Center in Chinle.

At a second public meeting in November 2017, the characteristics or patterns of crashes in the corridor were highlighted for discussion. Crash characteristics of primary concern were "fatal" and "incapacitating injuries" and clusters of crashes in "unlit" conditions.

Based on the findings and conclusions developed during the Study, preliminary recommendations for improvements were presented for three Focus Areas within the US-191 corridor, as shown in **Figure 1.4**. Recommended safety improvements included: widening shoulders, adding lighting to aid nighttime driving, reducing speeds, and reducing the number of access points. The Study Team also recommended installation of slow-vehicles turnouts throughout the corridor, as appropriate, to mitigate the impedance effect of slow-moving vehicles and vehicles slowing to engage in a turn from the flow of traffic.

Figure 1.4
Focus Areas of Preliminary Recommendations

2.0 EXISTING AND FUTURE CONDITIONS

Available data related to existing and anticipated future conditions provides the foundation for identifying deficiencies within the travel corridor and assessment of potential future improvement strategies. This chapter presents the existing and anticipated future conditions in the study area, based on available data sources. It covers the transportation system, land use, socioeconomic (i.e., population and employment) characteristics, and environmental conditions.

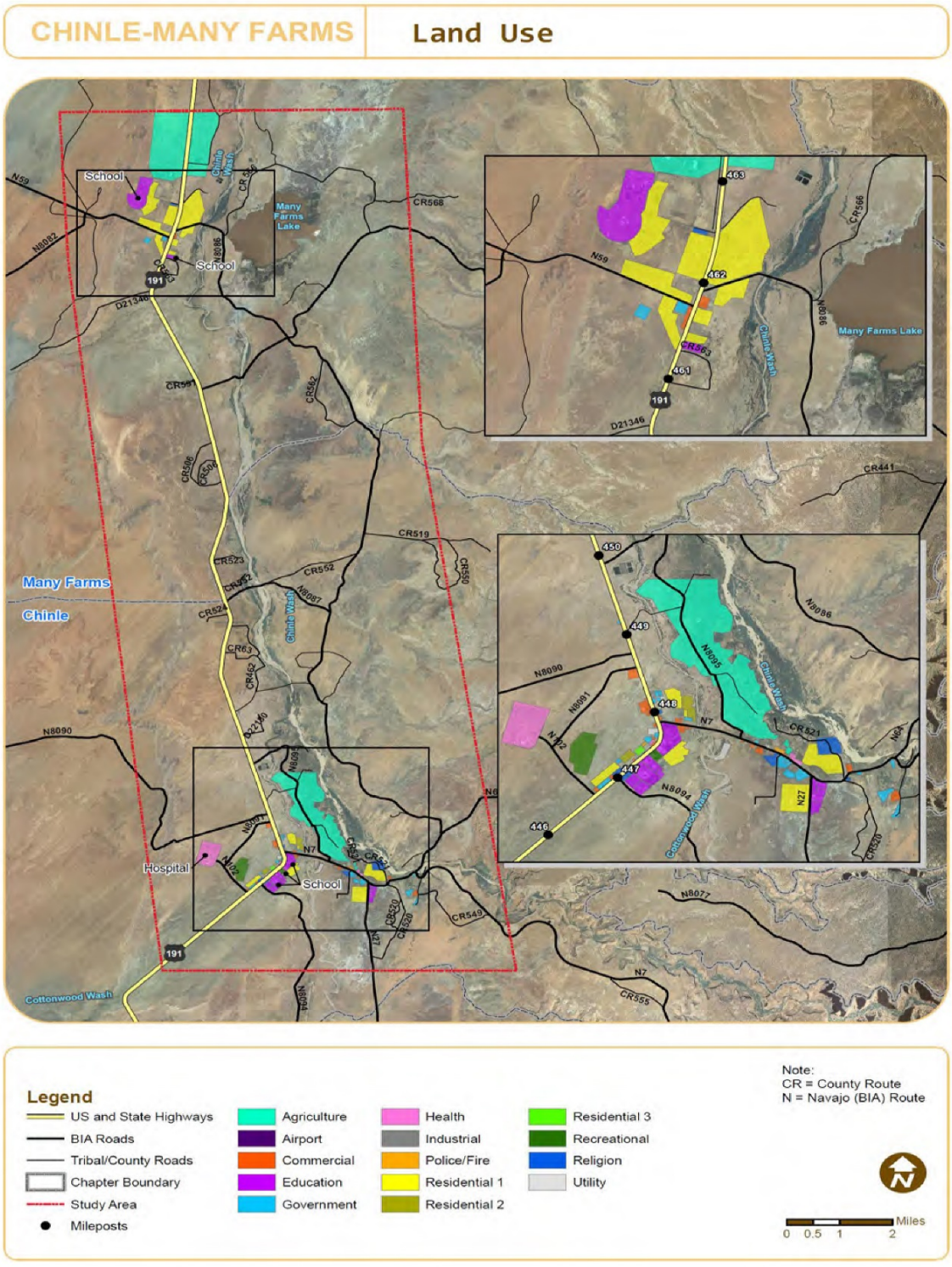
2.1 EXISTING LAND USE

The primary pattern of existing land uses in the study corridor is dominated by two main areas where development is pronounced: Chinle and Many Farms (**Figure 2.1**).

At the south end of the study area, the community of Chinle is developed in two areas. The eastern portion of Chinle is a mix of residential, commercial, public, and semi-public land uses located on the north and south side of N7 and generally east of US-191. The western portion of Chinle is developed around the US-191/N7 intersection. Chinle High School occupies the southeast quadrant of this intersection and the campus stretches approximately two-thirds of a mile south along US-191. It is part of a larger Chinle Unified School District (CUSD) educational complex which includes the high school, Mesa View and Chinle elementary schools, and Chinle Junior High School. A residential subdivision borders the educational complex on the east.

A mixture of commercial and residential land uses has been developed on the west side of US-191 from approximately one mile south of the US-191/N7 intersection to approximately one-half mile north of the intersection. The Chinle Comprehensive Health Care Facility is located one mile west side of US-191. An extensive housing development is located due north of this facility, providing a variety of living accommodations. North of the US-191/N7 intersection, commercial development dominates both sides of US-191 and includes a swap meet site that is the source of considerable activity on Fridays. A residential subdivision is located behind (to the east) of commercial development on the east side of the highway.

Figure 2.1
Current Land Use Pattern



Source: Chinle-Many Farms and St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study, Arizona Department of Transportation (ADOT), May 2012.

Chinle Municipal Airport, a public use, general aviation (GA) airport, is located about seven miles due south of the US-191/N7 intersection. This facility is accessible via: a dedicated, improved access road located approximately 2.2 miles south of the US-191/N7 intersection; N8094/N8181 (unimproved) from US-191 south of the Chinle school complex; N27 (mainly unimproved) from N7 on the east side of the community; and an unnamed, unimproved road on the west side of the highway approximately 0.8 miles south of the US-191/N4 intersection.

The seasonal Nazlini Wash bisects the eastern and western portions of Chinle, flowing from south to north during major summer precipitation events and during times of winter snow melt. Nazlini Wash merges north of Chinle with the larger Chinle Wash, which flows out of Canyon de Chelly from the east of Chinle. Chinle Wash also is seasonal and, generally, defines the northern and eastern limits of the Chinle.

Heading north from the Chinle community, developments are widely scattered, consisting primarily of low-density residential land uses. The Many Farms Chapter House, related government buildings, multiple educational sites, residential developments, and small pockets of commercial development fronting on US-191 are clustered around the US-191/N59 intersection in the northern portion of the study area.

No land within the Navajo Nation is privately held. The land(s) of the reservation are owned in common and administered by the Nation's government. Certain land uses (e.g., homesites, grazing, and other uses) may be developed within the framework of leases. Land(s) may be leased by, for, and to organizations, including the Bureau of Indian Affairs (BIA), other Federal agencies, churches and other religious organizations, and businesses.

2.2 EXISTING TRANSPORTATION SYSTEM

The US-191 travel corridor, which is the focus of this Study, is the central facility tying together numerous minor routes that provide important linkages among origins and destinations to the social and economic vitality of the community. A brief description of the major roadway network serving the study area is

presented in this section as well discussions of other transportation services, such as public transit services and pedestrian and bicycle facilities.

2.2.1 ROADWAY NETWORK

The roadway network of the study area consists of four principal components: State Highways, intersecting Apache County Roads, Navajo Nation Routes, and local streets. The focus of this Study is on the first three categories, although local facilities play an important role in providing access within the community.

STATE HIGHWAY SYSTEM

The SHS is critical to the greater transportation system, contributing to regional mobility, assuring national connectivity, and supporting statewide, national, and international trade.

US-191

US-191 runs continuously from the Mexico Border to the Canada Border. The study area includes the portion of US-191 between MP 440 and MP 470. The entire portion of US-191 within the study area is classified by ADOT as a Rural Minor Collector, except for a short segment in the heart of Chinle designated as a Rural Minor Arterial. In the regional context, US-191 connects in the south to Arizona State Route (SR) 264 and, ultimately, Interstate 40 (I-40). To the north, US-191 connects with US-160.

US-160

This US route serves the northwestern and northern portions of the Navajo Nation. It provides access to US-89 and the Flagstaff urban area to the west and Window Rock and Fort Defiance to the east. It is an important connection to the Red Mesa and Four Corners areas in the northeastern corner of the State. Also, it is an important route for travel to Farmington, New Mexico.

STATE ROUTE 264

SR 264 is a critical east-west highway serving the central portion of the Navajo Nation. It provides access to US-89 and the Flagstaff urban area to the west and Window Rock and Fort Defiance to the east. It also is an important route to Gallup, New Mexico.

COUNTY ROAD SYSTEM

Apache County maintains a number of roads in the study corridor that intersect with US-191. Personnel staffing the County's Chinle Road Yard are responsible for these roads. Four roads play a prominent role in travel within the US-191 corridor: County Road (CR) 462, CR 463, CR 552, and C 553. The County roads facilitate the connection between local streets and US-191.

NAVAJO NATION ROAD SYSTEM

Several routes of the Indian Reservation Road (IRR) network intersect with US-191. These routes serve varying activities east and west of the highway, including rural residential areas, major sections and facilities of the Chinle and Many Farms communities (e.g., schools, subdivisions, and health institutions), agricultural areas, and governmental offices. Significant among these routes (south to north) are: Navajo (N) 7, N8091, N8095, N8084, N59, and N8086. Like County roads, the IRR network facilitates the connection between local streets and US-191 and the County roads. All IRR facilities are administered by the BIA and NDOT.

LOCAL ROADWAY NETWORK

Beyond the three types of major roadway network facilities described above, the study area is served by a roadway network that largely follows terrain features and chapter boundaries. Access largely is uncontrolled with little pedestrian infrastructure and no bicycle facilities. Also, a large portion of this network is unimproved. By definition, local streets generally serve shorter trips of less than one mile. These types of streets provide direct access to adjacent land and facilitate collection and distribution of traffic via the State, County, and Navajo Nation road systems for access to key destinations.

RIGHT-OF-WAY

Right-of-way along US-191 varies from as little as 80 feet to a maximum of 250 immediately west of the bridge at Chinle Wash. For the majority of the corridor, approximately 150 feet of right-of-way exists.

TRAFFIC CONTROL

Traffic control at US-191 intersections with County and IRR facilities includes: signalization at US-191 intersection with N7 and stop signs at US-191

intersections with N59 and N8086. Other intersecting roads have no traffic control mechanism or signage; however, most of the highway is fenced and cattle guards are installed on the great majority of intersecting roads. The fencing and cattle guards conceivably aid in minimizing the presence of larger animals on the roadway, and the cattle guards, in effect, act as a warning for motorists approaching the highway.

BRIDGE STRUCTURES

The study area includes three bridges incorporated in the US-191 alignment. Bridges are maintained by ADOT. Each bridge has very different design characteristics and attributes (e.g., condition, length, width). Therefore, each bridge has different ratings for safety issues and sufficiency. **Table 2.1** provides critical information relating to these three bridges.

Table 2-1
Critical Information for Bridges within the US-191 Study Area

Milepost	Bridge Name	Year Built	Material	Type	No of Spans	Length (Ft)	Roadway Approach Width (Ft)	Bridge Roadway Width (Ft)	Inventory Rating (Tons)[1]	Operating Rating[2]	Sufficiency Rating[3]
443.29	Cottonwood Wash Bridge	1964	Concrete	Channel Beam	1	33	26	28.4	37	62	63.0
460.20	Black Mountain Wash SPP	1964	Steel	Culvert	3	69	26	0.0	99	99	80.0
470.02	Chinle Wash Bridge	1964	Prestress Concrete	Box Beam or Girders-Multiple-Precast	13	658	24	24.0	49	90	51.5

NOTES:
1 Capacity rating, i.e., the load level that can safely utilize existing structure for an indefinite period of time.
2 Capacity rating, i.e., the absolute maximum permissible load level to which the structure may be subjected for the loading type used in the rating.
3 Sufficiency rating, i.e., indicative of bridge sufficiency to remain in service, expressed as a percentage. 100% represents an entirely sufficient bridge and zero percent represents an entirely insufficient bridge. For structures classified as "functionally obsolete" or "structurally deficient," the letter "F" or "S" precedes the rating value.

Source: Bridge Inventory by District, Northeast District, Engineering and Construction, Arizona Department of Transportation (ADOT). Retrieve July 25, 2017, at https://www.azdot.gov/business/engineering-and-construction/bridge/bridge-inventory.

All three bridges were built in 1964 and are experiencing some level of deterioration, but these critical structures are considered not likely to fail or collapse. The last column in the table above is "Sufficiency Rating," which is a qualitative score out of 100 that takes into account lane widths, daily volumes, maintenance, clearance issues, and other factors. This rating typically is used by State transportation agencies to prioritize repair, improvement, and replacement

projects. The Chinle Wash Bridge sufficiency rating has the fifth lowest rating out of 302 bridges in the Northeast Arizona region. Additionally, the National Bridge Inventory produced by the Federal Highway Administration (FHWA) rates four specific safety issues regarding bridge features, as summarized in **Table 2.2**. The Cottonwood Wash Bridge has a failing status with regard to railings, and the Chinle Wash Bridge has a failing status with regard to railings and the transition areas.

Table 2-2
Safety Ratings of US-191 Bridges in the Study Area

BRIDGE NAME	BRIDGE RAILINGS\1	TRANSITIONS\2	APPROACH GUARDRAIL\3	APPROACH GUARDRAIL ENDS\4
Cottonwood Wash Bridge	Fail\5	N/A\6	Pass\7	Pass
Black Mountain Wash SPP	N/A	N/A	N/A	N/A
Chinle Wash Bridge	Fail	Fail	Pass	Pass

NOTES:
1 Railings must be capable of smoothly redirecting an impacting vehicle and meet specific criteria contained in AASHTO Standard Specifications for Highway Bridges.
2 Approach guardrail must be firmly attached to the bridge and gradually stiffen closer to the bridge railing.
3 Approach guardrail with adequate length and structural qualities to shield motorists from the hazards at the bridge site needs to be installed, safely redirecting an impacting vehicle and facilitating a transition to the bridge railing in such a manner as to not cause snagging or pocketing of the vehicle.
4 Ends of approach guardrails to bridges should be flared, buried, made breakaway, or shielded.
5 Fail: Inspected feature does not meet currently acceptable standards or a safety feature is required and none is provided.
6 N/A: Not applicable or a safety feature is not required.
7 Pass: Inspected feature meets currently acceptable standards.

Sources:
Table Information: National Bridge Inventory, Federal Highway Administration/National Bridge Inspection/National Bridge Inventory (NBI)/NBI Regulations, Memos, and Documents/Frequently Requested NBI Tables/Tables of Frequently Requested NBI Information/Download NBI ASCII Files/2016 Data at https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm.
Notes: Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Report No. FHWA-PD-95-001, Office of Engineering Bridge Division, U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), December, 1995.

2.2.2 KEY INTERSECTIONS

Ten intersections were examined to provide additional detail related to operational safety issues. **Table 2.3** lists the ten intersections subject to detailed analysis, in order from south to north. Turning-movement volumes at key intersections during peak periods were measured. The results of this activity are shown in **Figure 2.2**. Additionally, at the N7 and N59 intersections, 24-hour approach volumes and average speeds were collected. This data will provide input in later phases of the study when determining where mitigation projects and countermeasures to alleviate safety concerns should be considered.

Table 2.3
Key US-191 Intersections Analyzed in the Study Area

US-191 & Navajo 7 (N7)
US-191 & N8091
US-191 & N8095
US-191 & N8081
US-191 & County Road (CR) 463
US-191 & N8087/CR 552
US-191 & CR 523
US-191 & N8084
US-191 & N59
US-191 & N8086

2.2.3 TRAFFIC VOLUMES

Performance measures, like level of service (LOS), were not employed during this Study to analyze the volume of traffic on US-191 or intersecting roadways. Instead, daily volumes along major segments and peak volumes at key intersections are reported with general observations. These measures may be used in the future to evaluate the need for site-specific improvements. ADOT publishes Annual Average Daily Traffic (AADT) volume data for every segment on the SHS. **Figure 2.3** shows US-191 segment volumes available within the Study Area for Year 2015. Segments in Chinle (which have more than double the volumes in other segments in the corridor) and the stretch of road just south of Chinle have the most traffic.

Figure 2.2
Intersection Turning-Movement Traffic Counts

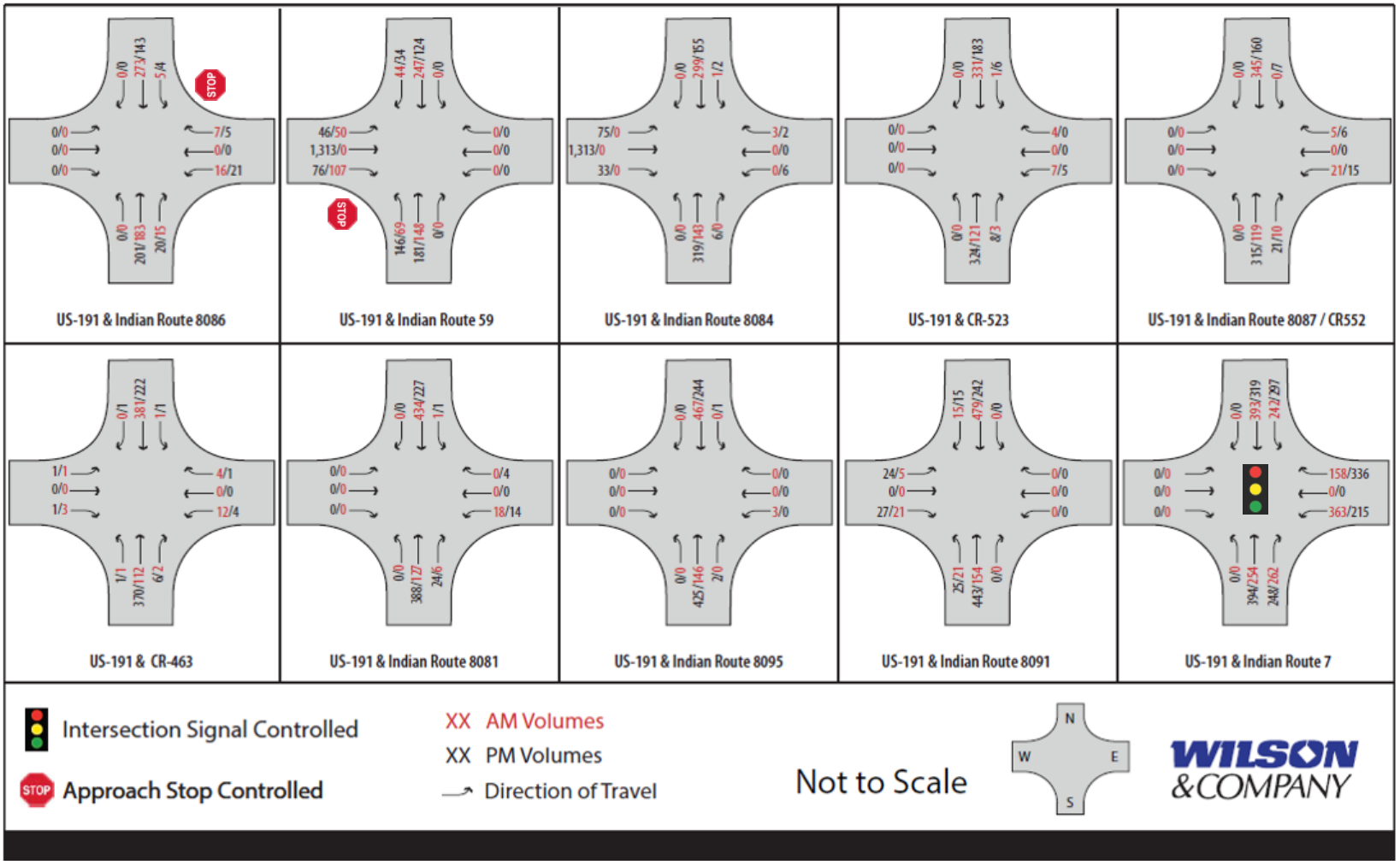
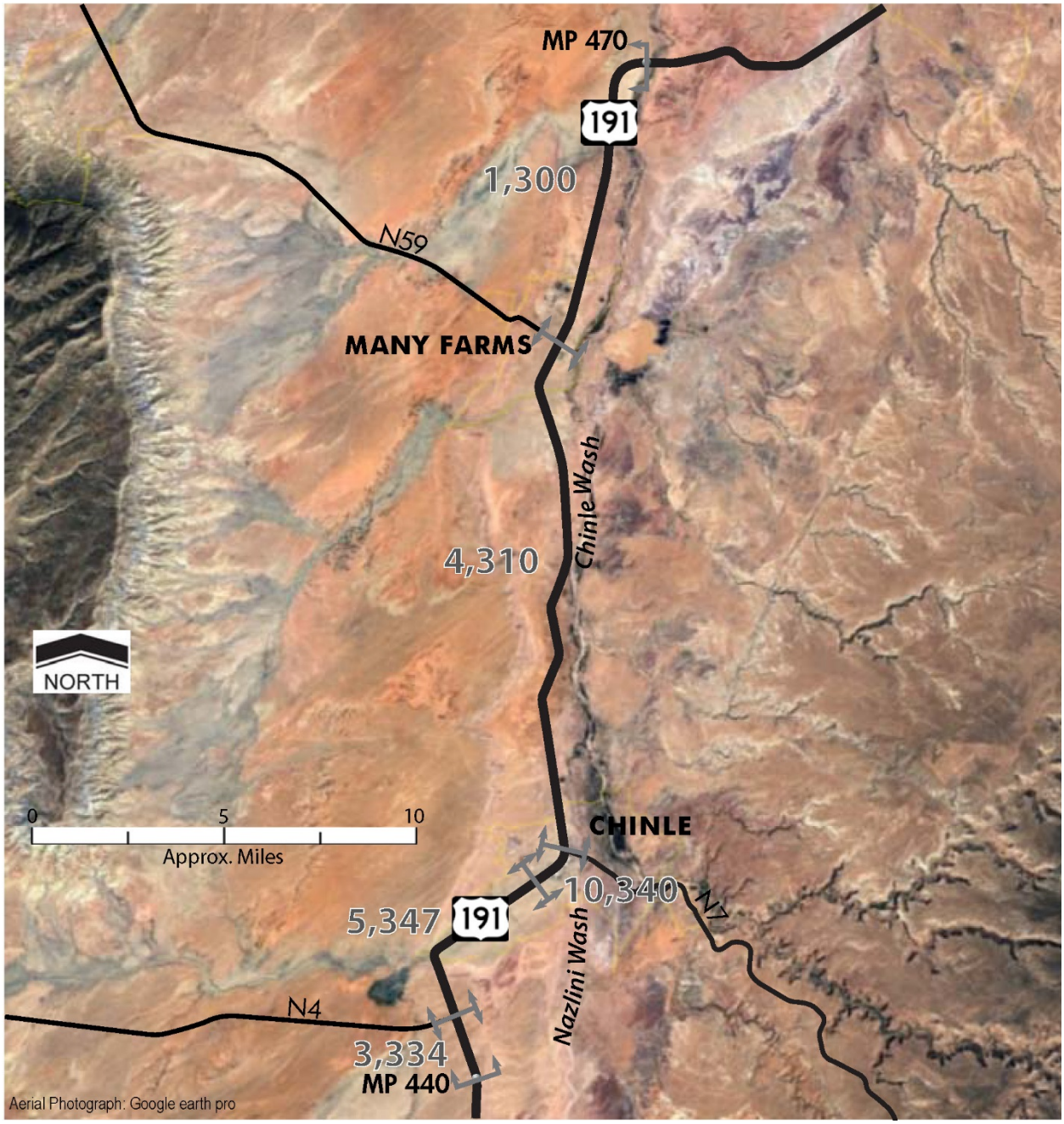


Figure 2.3
Segment Traffic Volumes

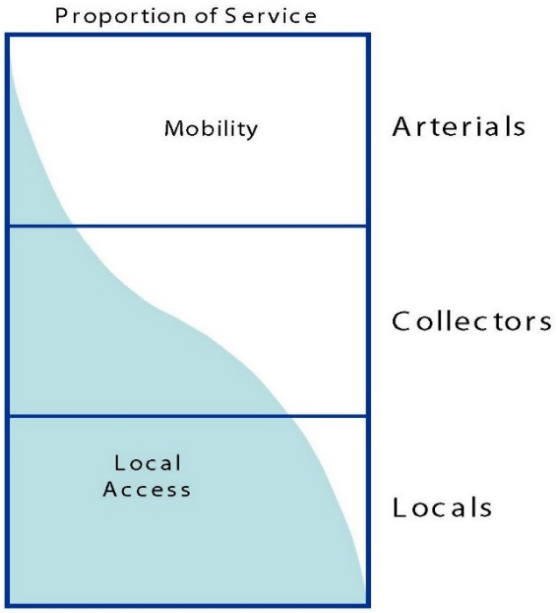


Source: Data Source: Highway Performance Monitoring System (HPMS) Location Report for Year – 2015, Multimodal Planning Division, Arizona Department of Transportation (ADOT).

2.2.4 FUNCTIONAL CLASSIFICATION OF ROADS

Under the concept of functional classification, roadways are identified and grouped according to generally accepted design and traffic characteristics. The widely recognized functional classification system categorizes roads by how they perform in regard to providing access and mobility (see graphic at right). Arterials provide the greatest mobility for users of the roadway network. A Principal Arterial, for example, supports travel over longer distance trips at higher speeds. Offering minimal access to adjoining properties and, therefore, minimizing traffic impedance, arterials primarily facilitate through movements. Conversely, the function of Locals (i.e., local streets) is to provide greater access to fronting properties by establishing lower speeds and direct access opportunities to neighborhoods and properties in the community.

Relationship of Functionally Classified Systems in Serving Traffic Mobility and Land Access



Source: Safety Effectiveness of Highway Design Features, Volume I, Access Control, FHWA, 1992.

The concept of classifying roadways according to function within the roadway network establishes the basis for a decision/design framework to assess performance (i.e., level of service provided) and set priorities for improvements, upgrades, even new roads. The concept of functional classification is defined below:

> *The level of service required to fulfill [each] function for the anticipated volume and composition of traffic provides a rational and cost-effective basis for the selection of design speed and geometric criteria within the range of values available to the designer (for the specified functional classification). The use of functional classification as a design type should appropriately integrate the highway planning and design process.*[1]

[1] A Policy on the Geometric Design of Highways and Streets (Green Book), American Association of State Highway and Transportation Officials (AASHTO), Chapter 1, pg. 17.

The FHWA provides elaboration of this concept as an important roadway network design tool:

> *Once the functional classification of a particular roadway has been established, so has the allowable range of design speed. With the allowable range of design speed defined, the principal limiting design parameters associated with horizontal and vertical alignment are also defined. Similarly, a determination of functional classification establishes the basic roadway cross section in terms of lane width, shoulder width, type and width of median area, and other major design features.*[2]

ADOT FUNCTIONAL CLASSIFICATION

The functional classification system for Arizona's SHS was adopted by ADOT in May, 2012, and approved by the FHWA in July, 2012. **Table 2.3** shows typical design characteristics of the different classifications, in accordance with the adopted functional classification system. **Figure 2.4** shows the functional classifications of various segments of US-191.

Table 2-3
Typical Characteristics of ADOT Functional Classification System

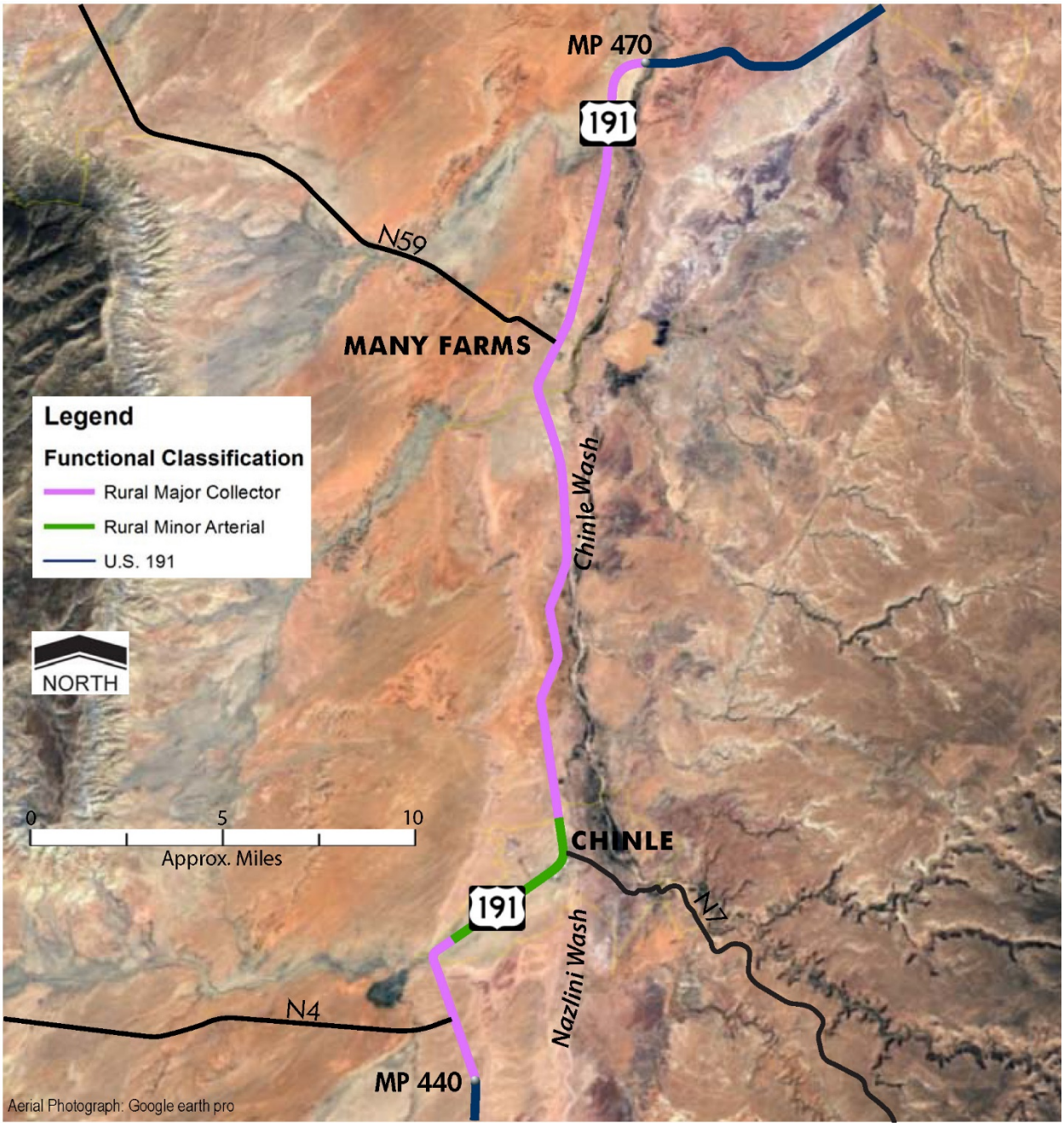
	Arterials				Collectors		
	Interstate	Other Freeway & Expressway	Other Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local
Typical Characteristics							
Lane Width	12 feet	11 - 12 feet	11 - 12 feet	10 feet - 12 feet	10 feet - 12 feet	10 feet - 11 feet	8 feet - 10 feet
Inside Shoulder Width	4 feet - 12 feet	0 feet - 6 feet	0 feet	0 feet	0 feet	0 feet	0 feet
Outside Shoulder Width	10 feet - 12 feet	8 feet - 12 feet	8 feet - 12 feet	4 feet - 8 feet	1 feet - 6 feet	1 feet - 4 feet	0 feet - 2 feet
AADT (Rural)	12,000 - 34,000	4,000 - 18,500	2,000 - 8,500	1,500 - 6,000	300 - 2,600	150 - 1,110	15 - 400
AADT (Urban)	35,000 - 129,000	13,000 - 55,000	7,000 - 27,000	3,000 - 14,000	1,100 - 6,300		80 - 700
Divided/Undivided	Divided	Undivided/Divided	Undivided/Divided	Undivided	Undivided	Undivided	Undivided
Access	Fully Controlled	Partially/Fully Controlled	Partially/Fully Controlled	Uncontrolled	Uncontrolled	Uncontrolled	Uncontrolled

NOTES:
AADT = Average Annual Daily Traffic. Values shown are the combined traffic in both directions of travel.
Yellow highlighting identifies AADT characteristic.
Blue boxes highlight specific characteristics applicable to the US-191 Chinle to Many Farms Safety Improvement Study.

Source: Table 3-5: VMT and Mileage Guidelines by Functional Classification –Arterials, and Table 3-6: VMT and Mileage Guidelines by Functional Classification – Collectors and Locals, Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition, Federal Highway Administration (FHWA).

[2] Flexibility in Highway Design, Federal Highway Administration (FHWA).

Figure 2.4
Functional Classification of US-191: MP 440 to MP 470



Source: Highway Performance Monitoring System (HPMS) Location Report for Year – 2015, Multimodal Planning Division (MPD), Arizona Department of Transportation (ADOT).

As shown in **Figure 2.4**, the majority of the US-191 travel corridor in the study area is classified as a Rural Major Collector. North of the Chinle commercial zone and north to the Many Farms area and beyond, traffic volumes fall into the range of the Rural Major Collector (refer to **Table 2.3**). The short segment north of Cottonwood Wash to the southern end of the study area (MP 440), also is designated a Rural Major Collector. The segments north of the Cottonwood Wash area to N102 (roadway to Chinle Comprehensive Health Care facility and nearby residential developments) and N102 to N7 have traffic volumes placing them more appropriately in the Rural Minor Arterial classification relative to Average Annual Daily Traffic (AADT).

Although reported counts only provide volumes for the long segment from N7 in Chinle to N59 in Many Farms (4,310 AADT), it is likely the preponderance of traffic in this segment of US-191 occurs directly north of Chinle. This is substantiated by the reported traffic volume north of Many Farms, which is only 1,300 AADT. Therefore, immediately north of Chinle also would more appropriately be classified as an Rural Minor Arterial, as the volume likely exceeds parameters established for a Rural Major Collector.

2.2.5 ROADWAY SYSTEM OPERATIONS

This section addresses key operational considerations associated with evaluation of potential safety improvement projects and countermeasures.

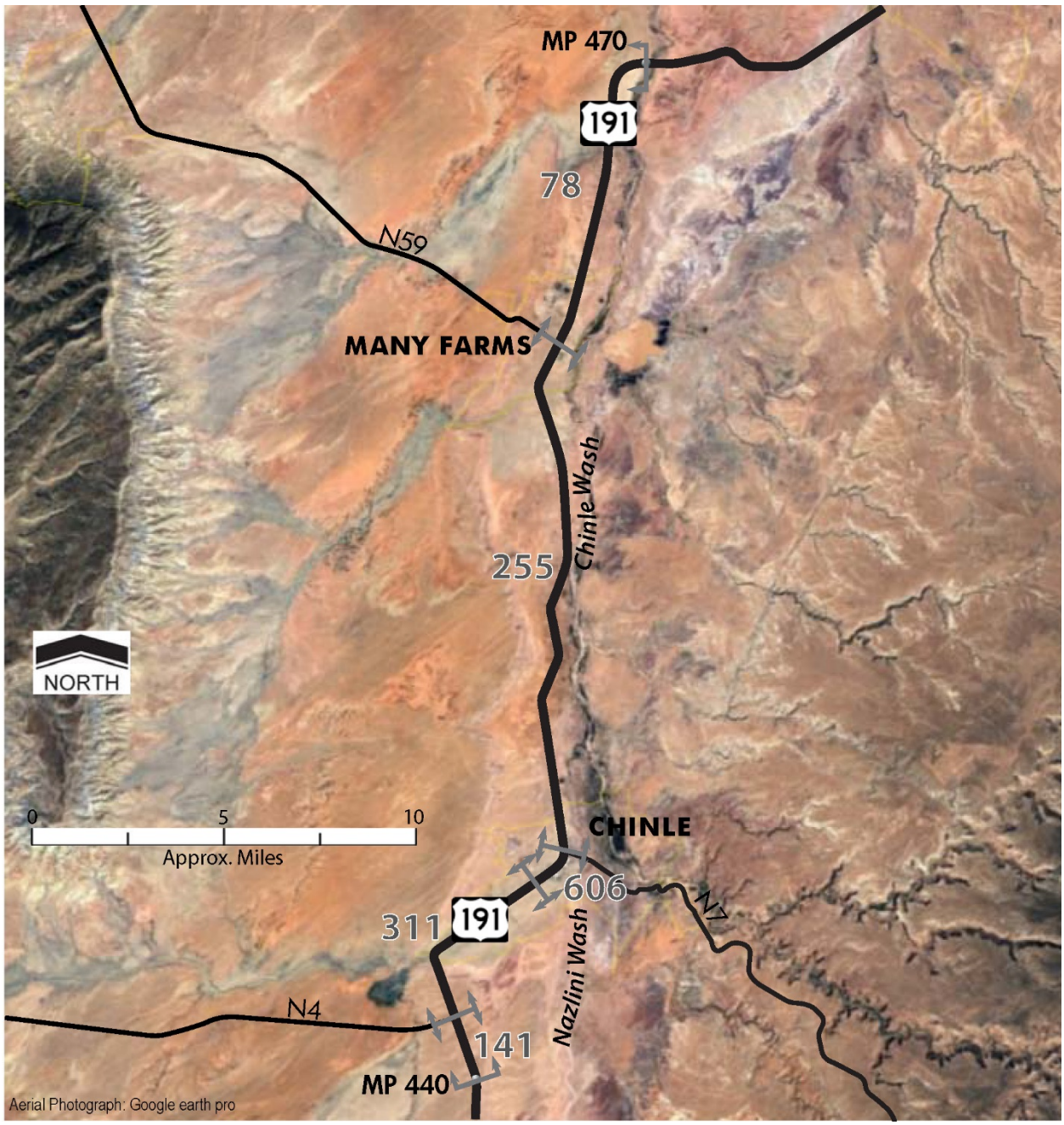
TRUCK TRAFFIC

In addition to the AADT for all traffic, ADOT publishes, as part of its Highway Performance Monitoring System (HPMS), supplemental AADT for truck traffic and other modes. **Figure 2.5** shows the volume of truck traffic that operated in the corridor in 2015.

ACCESS MANAGEMENT CHALLENGES

Access management is a concept that embraces the philosophy of balance that: (1) major roadways serving a community or region operate most safely and efficiently through a process or program that strives to ensure access needs for abutting land uses along the roadway are adequately met, and (2) manages such access to maximize and maintain roadway capacity, manage congestion, and reduce crashes.

Figure 2.5
Average Daily Truck Traffic by Segment



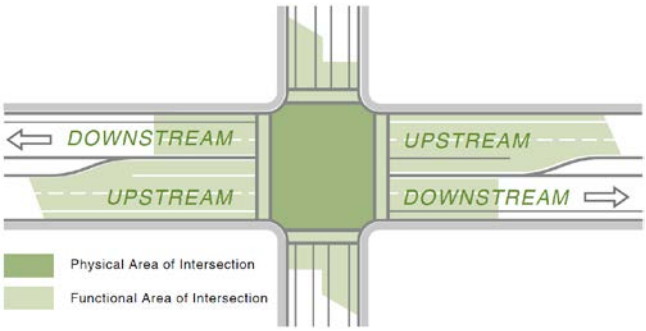
Source: Data Source: Highway Performance Monitoring System (HPMS) Location Report for Year – 2015, Multimodal Planning Division, Arizona Department of Transportation (ADOT).

General policy guidance of the FHWA indicates the absence of access management ultimately will result in the following negative consequences for roadway users:

- Reduction in overall safety reflected by an increase in crashes;
- Greater number of conflicts and potential hazards between vehicular, bicycle, and pedestrian movements;
- Increased congestion with slower travel speeds and delays experienced by arterial traffic;
- Diversion of through traffic into abutting neighborhoods, as drivers attempt to bypass increased congestion; and
- Non-transportation effects, such as increased strip commercial development, less pleasing visual settings, and, ultimately, a poor image for businesses and other uses along the corridor.

CONSIDERATIONS RESPECTING ACCESS MANAGEMENT

Two aspects of access management relevant to the US-191 corridor relate to: (1) the functional areas of intersections, and (2) specific tools and techniques to minimize disruptions to traffic flow on the major roadway. According to the FHWA, "the functional area of an intersection is that area beyond the physical intersection of two roadways that comprises decision and maneuvering distance, plus any required vehicle storage length." The diagram at right shows the locations of these two critical areas of an intersection.



Source: Figure 1: Functional and Physical Area of an Intersection, "Access Management in the Vicinity of Intersections," Technical Summary, Federal Highway Administration, (FHWA), FHWA-SA-10-002.

The tools and techniques of access management include both physical design initiatives and policies relating to land development within a highway corridor. Tools and techniques that could be relevant to the US-191 corridor include:

- Minimize left-turn exits from the highway;
- Introduction of a left-turn lane or two-way, center, left-turn lane, where left-turns cannot be eliminated and where turning volume is high;

- Encourage shared driveways, i.e., access points, for adjacent parcels and developments to reduce the number entry/exit locations along the highway; and
- Provide right-turn lanes, where turning volume is high.

ACCESS MANAGEMENT CHALLENGES IN THE STUDY AREA

A primary issue associated with US-191 within the study area is the numerous access drives on both sides of the highway. Outside the immediate environs of developed areas of Chinle and Many Farms, the population is spread out in a rural setting of individual or small clusters of residences and businesses. In many cases, the clusters satisfy the technique cited above of creating shared drives or access points. The shared drive minimizes the number of access points and, thereby, minimizes the potential number of impacts on US-191 traffic associated with turns into abutting parcels and entrance on to the highway from the abutting parcels. The more favorable conditions of shared drives also reduce the opportunity for conflicts with the traffic stream and, therefore, crashes. US-191 traffic flow and safety would greatly benefit from two actions: (1) additional future rural development oriented to existing access points and (2) consolidation of drives of existing developments, where this can be accomplished feasibly and at reasonable cost.

Within the developed area of Chinle, there are three access drives that potentially impinge on the functional area of the US-191/N7 intersection. **Figure 2.6** shows the potential functional and physical areas of this intersection to illustrate how the existing entry/exit points encroach on the mobility and safety of traffic passing through the intersection. This intersection is the primary focus of travel in the community and, therefore, has critical implications for mobility and safety. An entry/exit drive to the Shell Convenient Mart on the northeast corner upstream of the traffic signal can interfere with northbound traffic passing through the intersection. A second entry/exit drive for this same business is located within the functional area of the westbound approach of N7 and can impact right turning traffic at US-191. Upstream of the traffic signal at the US-191/N7 intersection the entry/exit drive to the Navajo Arts and Craft Enterprise property also is in the functional area of the intersection and can impeded southbound travel through the intersection.

Figure 2.6
Illustrative Intersection Functional Areas: US-191/N7 Intersection

Limiting or, where possible, eliminating the presence of existing entry/exit points within the functional areas of the intersection – upstream, i.e., approaching the intersection, and downstream, i.e., departing the intersection – would help reduce the number of decisions motorists must make while negotiating the intersection. Operational safety in the vicinity of the intersection would be improved, as the existence of entry/exit points within the upstream functional area of the intersection has been shown to correlate to increased crashes, crash severity, and crash costs.[3]

In other locations along US-191 in Chinle, there are multiple access points within yards of each other. Research has consistently revealed that the frequency of crashes increases as driveway density (i.e., number of driveways per mile) increases.[4] Thus, multiple access points clustered tightly together have been determined to present notable potential conflicts for drivers and can become a hindrance to traffic flow. It follows that the potential for crashes increases as the frequency of vehicles entering/exiting the properties increases.

Overall, traffic flow and safety on US-191 would benefit from (1) consolidation of existing access drives, where this can be accomplished feasibly and at reasonable cost, (2) future planning and development of minor roadways to connect multiple properties and complimentary mixed uses, and (3) minimizing the number and frequency of highway entry/exit points.

2.2.6 ALTERNATIVE TRANSPORTATION MODES

Two forms of public transportation are provided in the study area: Navajo Transit System (NTS) and public school bus transportation. There are no formal NTS stops; the system operates on a "flag-stop" basis, i.e., persons desiring to use the service hail the bus driver. In contrast, school bus stop locations are designated, although not usually signed to alert motorists. Motorists and stakeholders note a significant amount of waiting behind stopped buses in the corridor. Wrong-way driving (driving in the opposing lane to bypass buses) by impatient drivers, is especially dangerous on the two-lane highway with a posted speed of 65 miles per hour (mph) outside developed portions of the study area.

[3] "Access Management in the Vicinity of Intersections," Technical Summary, Federal Highway Administration (FHWA), FHWA-SA-1-002.

[4] Ibid.

NAVAJO TRANSIT SYSTEM

The NTS is a department under the Division of General Services within the Navajo Nation Government. It is funded primarily through the New Mexico and Arizona Departments of Transportation. NTS administers and operates inter-community route transportation services for the general public. The transit system provides public transportation services to 41 of the 110 Navajo Chapter communities. Many routes operate along state highways, and, as noted earlier, buses pick up passengers at designated stops or by being hailed.

NTS SERVICE IN THE STUDY AREA

NTS provides public transit services on two routes within the study area between the hours of 6:00 a.m. and 6:50 p.m.:

Route 8 – NTS operates four trips per day as Route 8, Chinle/Ganado/Tsaile, out of the Chinle Transit Sub-Station:

- Trip 1 – roundtrip to Ganado;
- Trip 2 – roundtrip (clockwise) to Tsaile through Many Farms;
- Trip 3 – roundtrip (counter clockwise) to Tsaile through Many Farms; and
- Trip 4 – round trip to Ganado.

Route 10 – NTS operates four trips per day as Route 10, Pinon/Chinle/Tsaile. These trips operate through the Chinle Transit Sub-Station, but originate in the AM and terminate in the PM in Pinon. Route 10 trips are operated from 6:07 a.m. to 7:40 p.m.:

- Trip 1 – runs from Pinon to Chinle;
- Trip 2 – roundtrip to Del Muerto and Tsaile;
- Trip 3 – roundtrip to Del Muerto and Tsaile; and
- Trip 4 – runs from Chinle to Pinon.

NAVAJO TRANSIT SYSTEM FACILITIES

Transit Stops: There are few formal transit stops. **Figure 2.7** shows a typical location, where access to buses may occur. There is no signage, no shelter or bench, and no improved bus pullout area. The stop is located in a No Passing Zone. Many stops are designated at gas stations and shopping centers, although with no signage or improvements. Persons desiring to secure transit services for transportation must hail the bus driver as the bus comes towards them on the highway.

Figure 2.7
Pinon Junction Transit Stop

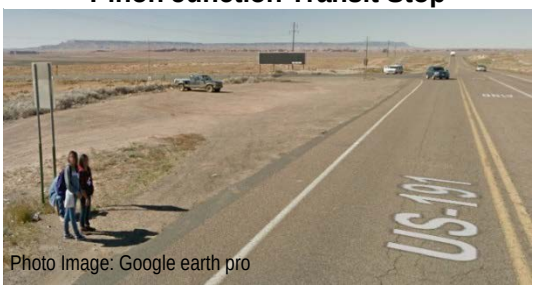


Figure 2.8
Chinle – Transit Sub-Station

Chinle Transit Sub Station: The facility shown in **Figure 2.8** supports maintenance activities associated with the NTS. It houses buses from both routes during different non-service times. The bus shown is typical of the Navajo Transit fleet.

NAVAJO NATION PUBLIC SCHOOL TRANSPORTATION

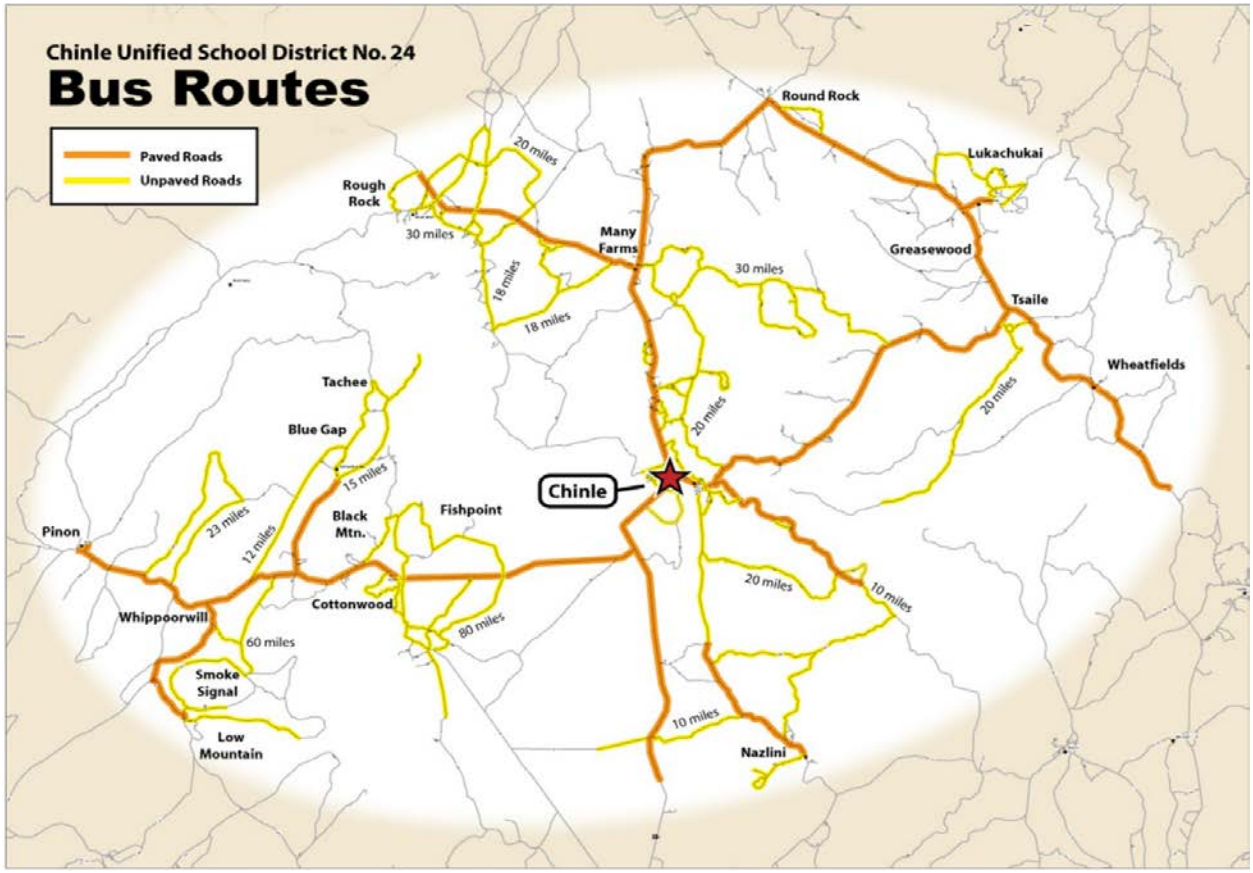
The wide distribution of communities in the central portion of the Navajo Nation requires school buses to travel long distances to transport children to schools in both Chinle and Many Farms, as well as neighboring chapters. **Figure 2.9** shows the school bus routes associated with the CUSD. **Figure 2.10** shows school bus stops along US-191. There are 32 bus stops within the study area and only one bus pullout.

PEDESTRIAN AND BICYCLE MODES

Pedestrian – There are a few locations in Chinle along US-191 that have sidewalks, primarily from N102 to the commercial areas immediately north of the N7 intersection. A designated pedestrian crossing has been recently installed across US-191 to facilitate pedestrian access to the schools. The only formal pedestrian crossing in the study area with pedestrian signals is at the US-191/N7 intersection in Chinle. However, it only accommodates signal-controlled

pedestrian movements between the northeast corner and the west side of US-191 (**Figure 2.11**).

Figure 2.9
School Bus Routes Serving the Study Area



Source: http://www.chinleusd.k12.az.us/departments/transportation/

Figure 2.10
Designated School Bus Stop Locations

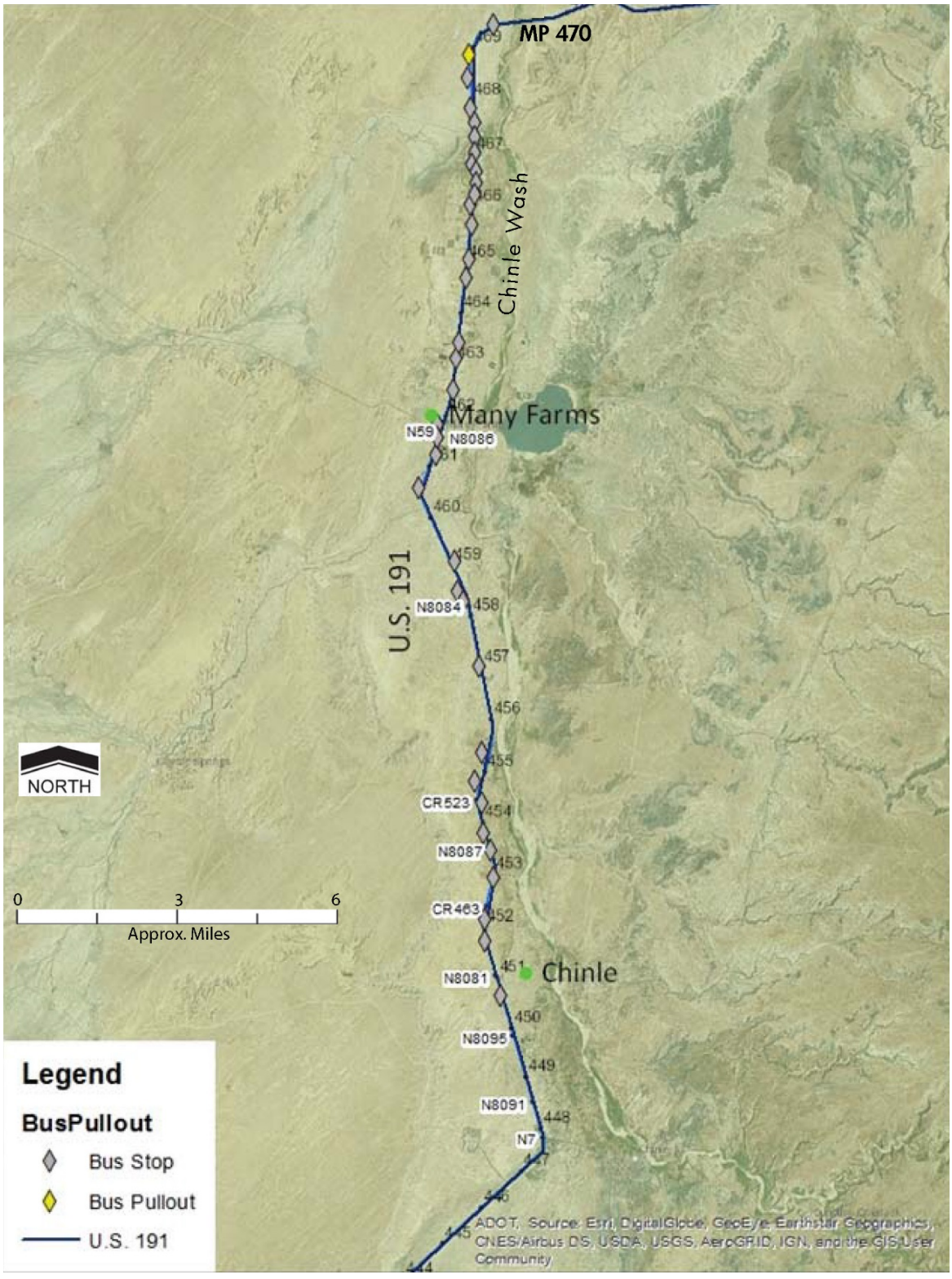


Figure 2.11
Signalized Pedestrian Crossing at US-191/N7 Intersection

Photo Image: Google earth pro

What appears to have been crosswalk stripping between the west side of US-191 and the sidewalk at the southeast corner of the intersection is all but obliterated (**Figure 2.12**). Similarly, extremely faded crosswalk stripping is present for the crossing between the southeast and northeast corners of this intersection (**Figure 2.13**).

Figure 2.12
Faded Crosswalk Northbound Approach

Figure 2.12
Faded Crosswalk Westbound Approach

Photo Images: Google earth pro

Bicycle – The 2016 LRTP designates several routes with shoulders greater than 4 feet as bicycle routes, but none are within the study area. An organization, named Navajo YES, operates the "Diné Bike Project." The mission of this organization is empowerment of youth. It accepts used mountain bike donations, uses volunteers to restore them, and gives them away to kids. The program has given away over 80 bikes across the Navajo Nation, since its inception in 2015. The organization is dedicated also to youth fitness, and it runs several rides and foot races throughout the year in locations that are outside, but not too far from the study area.

2.3 CURRENT SOCIOECONOMIC CHARACTERISTICS

As noted earlier, US-191 through the study area is mostly a Rural Major Collector in Arizona SHS, connecting I-40 in the south to US-160 in the north. It is the only major roadway serving the Central Agency of the Navajo Nation and supports direct travel between Chinle and Many Farms. These two Chapters (similar to counties within a state, i.e., the Central Agency) are both Census-Designated Places (CDPs). However, development associated with the two communities located in the core area of the Navajo Nation is much greater than the CDP delineations would represent, accounting for a significant share of the Nation's population and economic activity. Relevant development associated with Chinle and Many Farms, which heavily relies on US-191 for trade and commerce, includes three Census Tracts comprised of seven Block Groups (**Figure 2.13**). **Figure 2.14** also shows the areas designated as the Chinle and Many Farms CDPs.

2.3.1 POPULATION

The Chinle Chapter is the second largest in population of the 110 Navajo Nation Chapters. In 2010, the population of the Chapter was reported to be 8,005, 89 percent of whom were reported to be Navajo Alone in heritage (**Table 2.6**). The Many Farms Chapter is the seventh largest Chapter with a 2010 population of 2,738. The Navajo Alone category, like the Chinle Chapter, was reported to be 89 percent. The two Chapters accounted for 10.3 percent of the Navajo Nation population within Arizona in 2010 and 38.6 percent of the Central Agency. The Central Agency reported a population of 27,823 in 2010, accounting for 16.0 percent of the population of the Navajo Nation. The Del Muerto CDP, which

is part of the Chinle Agency located approximately eight miles west of Chinle via N64 and 1,000 feet higher in elevation, had a population of 329 in 2010,

2.3.2 DWELLING UNITS

There are approximately 4,000 dwelling units (DUs) within the two Chapters (**Table 2.7**). The Chinle Chapter has almost three times the DUs as the Many Farms Chapter, a fact comparable with the population difference of the two communities. Within the two Chapters, approximately 80 percent are occupied, and 62.6 percent of the occupied DUs are occupied by the owners. As a whole, about 40 percent of DUs in the two Chapters are renter-occupied; however, in Census Tract 9442.01 – Block Group 3, the share of renter-occupied DUs rises to 68.6 percent, and in Census Tract 9443 – Block Group 2, the share of renter-occupied DUs is 64.5 percent. It is notable that the proportion of renter-occupied DUs west of US-191 is significantly higher than the east side of the highway. Del Muerto reported 103 DUs in 2010 with only eight DUs (7.8%) being renter occupied.

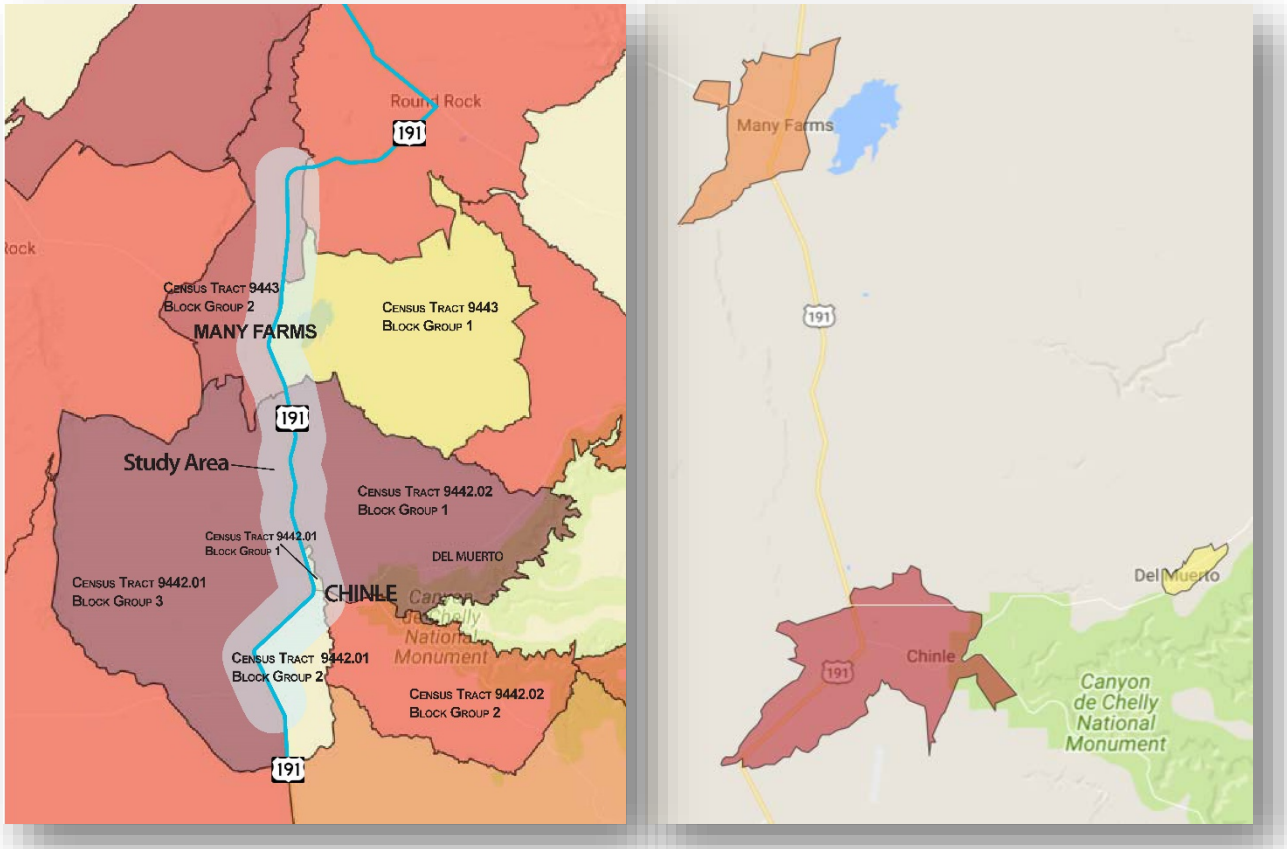
2.3.3 EMPLOYMENT

According to the 2016 LRTP, 45.7% of the people 16 years of age and over were in the labor force in 2010. This represented an increase of 1.4% from the Year 2000. The 2010 labor force participation in the Chinle CDP was 40.1%. The Many Farms CDP labor force participation rate of 53.2% was higher than both the Navajo Nation, as a whole, and Chinle CDP. Nevertheless, both CDPs reported very high unemployment rates: Chinle – 20.3% and Many Farms – 16.5%.

Employment conditions seemingly improved between 2010 and 2015. The Chinle CDP 2015 labor force participation rate improved significantly to 52.0%, and the Many Farms labor participation rate improved to 58.8%. This resulted from an apparent shift in economic activity between the two CDPs. Unemployment stood at 18.6% in the Chinle CDP (an improvement from 20.3% in 2010); however, unemployment increased drastically in the Many Farms CDP to 30.5%. **Table 2.8** shows the current employment in the two CDPs in 13 industry groups.

The 201 Census reported 70 active employees associated with the small, isolated community designated the Del Muerto CDP.

Figure 2.13
Census Tracts, Block Groups, and CDPs for Chinle and Many Farms Chapters



Source: 2010 Census Interactive Population Map.

Table 2-4
2010 Population

Census Unit	Population
Census Designated Place (CDP)	
Chinle	4,518
Del Muerto	329
Many Farms	1,348
TOTAL	6,195
Census Tract 9442.01	
Block Group 1	964
Block Group 2	793
Block Group 3	2,253
Census Tract 9442.02	
Block Group 1	2,566
Block Group 2	1,487
Census Tract 9443	
Block Group 1	839
Block Group 2	1,741
TOTAL	10,643

Source: 2010 U.S. Census, U.S. Census Interactive Population Search, retrieved 6/13/2017.

Table 2-5
2010 Housing Stock

Census Unit	Dwelling Units			
Census Designated Place (CDP)	Total	Occupied	Owner-Occupied	Renter-Occupied
Chinle	2,868	2,302	1,409	893
Many Farms	1,021	757	507	250
Del Muerto	103	88	80	8
TOTAL	3,992	3,147	1,996	1,151
Census Tract 9442.01				
Block Group 1	248	235	27	208
Block Group 2	269	240	32	208
Block Group 3	866	671	398	273
Census Tract 9442.02				
Block Group 1	899	715	599	116
Block Group 2	586	441	353	88
Census Tract 9443				
Block Group 1	372	270	211	59
Block Group 2	649	487	296	191
TOTAL	3,889	3,059	1,916	1,143

Source: 2010 U.S. Census, U.S. Census Interactive Population Search, retrieved 6/13/2017. Note: Census Tracts 9442.01 and 9442.02 roughly correspond to the Chinle Chapter; Census Tract 9443 roughly corresponds to the Many Farms Chapter.

Table 2-6
Employment of Chinle & Many Farms CDPs - 2015

Industry Group	Number of Employees		
	Chinle CDP	Many Farms CDP	Del Muerto CDP
Agriculture, Forestry, Fishing & Hunting, and Mining	23	6	0
Construction	54	13	0
Manufacturing	10	4	0
Wholesale	15	0	21
Retail	79	28	8
Transportation & Warehousing, and Utilities	41	22	0
Information	0	0	0
Financing & Insurance, Real Estate, Rentals, and Leasing	34	0	15
Professional, Scientific, and Management	8	8	8
Educational Services, Health Care, and Social Assistance	766	286	10
Arts, Entertainment, Recreation	160	28	7
Other Services	17	9	0
Public Administration	140	56	9
TOTAL	**1,347**	**460**	**70**

Source: Industry by Sex for the Civilian Employed Population 16 Years and Over (S2403), 2011-2015 American Community Survey 5-Year Summary, American Fact Finder, U.S. Census Bureau.

2.3.4 TITLE VI/ENVIRONMENTAL JUSTICE

Environmental justice is an administrative concept adopted to assure Federal agencies fairly evaluate potential impacts of proposed actions or projects, including interrelated social and economic effects of programs, policies, and activities, on minority and low-income populations in the United States.

BACKGROUND

"Title VI of the Civil Rights Act of 1964" and subsequent related statutes have been passed to prohibit discrimination on the basis of race, color, national origin, age, sex, and disability in association with any program or activity receiving federal financial assistance. Executive Order 12898, *Federal Actions To Address Environmental Justice In Minority Populations and Low-Income Population*, dated February 11, 1994, directs Federal agencies (and programs and activities receiving federal financial assistance) to "…make achieving environmental justice part of its mission by identifying and addressing, as appropriate,

disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." "Disproportionately high and adverse effects" means the effect(s) of a proposed action or project:

- is (are) predominately borne by a minority population and/or a low-income population, or
- will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population.

There are three fundamental environmental justice principles:

1) Ensure full and fair participation by all potentially affected communities in the transportation decision-making process.
2) Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.
3) Prevent the denial of, reduction in, or significant delay in the receipt of benefits to minority and low-income populations.

U.S. DOT Order (5610.2), addressing "*Environmental Justice in Minority and Low-Income Populations*," defines Minority and Low-Income Populations as …"any readily identifiable groups … who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." The Order identifies four minority groups:

- Black (a person having origins in any of the black racial groups of Africa);
- Hispanic (a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race);
- Asian American (a person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands); and

- American Indian and Alaskan Native (a person having origins in any of the original people of North America and who maintains cultural identification through tribal affiliation or community recognition).

Additionally, the U.S. DOT Order specifies "Low Income" to be a person living within a household with median income at or below the Department of Health and Human Services poverty guidelines. It also should be noted that ADOT guidance with respect to this subject, clearly indicates considerations of age, gender, and disability also should be incorporated in this assessment. Age specifically refers to person 60 years old and older. Gender is evaluated in terms of the U.S. Census category Female Heads of Households.

ANALYSIS METHODOLOGY

An assessment of the socioeconomic composition of the study area was conducted by reviewing available U.S. Census Bureau data and reports. Detailed information from the 2010 Decennial Census (2010 Census) is available by Census Tract and Census Designated Place (CDP) for population, housing, and household characteristics. Economic and income information is only available through the American Community Survey (ACS) compilations, which are prepared by the U.S. Census Bureau.

Figure 2.14 (shown earlier) graphically depicts the location of three Census Tracts and seven Block Groups associated with the study area. Census Tracts wholly within or intersecting the study area have been included in this Environmental Justice analysis; Census Tracts not incidental with the study area are shown for reference only.[5] The standard of disproportionate effects generally is examined by comparing the Census Tract representation of sensitive population groups with that of a larger political jurisdiction, such as a county. In the case of the Navajo Nation, the county equivalent for census purposes is the Agency; however, the U.S. Census data is reported only for "Census County Subdivision" or CCD. Nevertheless, the Chinle CCD is a reasonably good surrogate for the Chinle Agency; therefore data for the Chinle CCD has been incorporated for this analysis.

[5] Round Rock data were excluded because only a small sliver of the area is within the study boundary around US-191, and there are no significant areas of interaction relative to the US-191 Chinle-Many Farms Study area.

The potential for disproportionately impacting a sensitive population group has been established by identifying the smaller Block Groups to attain greater relative sensitivity. The potential for disproportionate impact is considered to occur when a sensitive population group represents 125 percent or more of the Block Group compared to the Chinle CCD average for the subject group. This does not assume or impute direct impact on the group. It only indicates that project activity proposed within the Block Group will need to include additional assessment of the potential for impacts that may be adversely disproportionate to the group relative to the general population of the Chinle CCD, which generally reflects the study area as a whole.

POTENTIAL PRESENCE OF ENVIRONMENTAL JUSTICE POPULATION GROUPS IN THE STUDY AREA

The following sections address Environmental Justice as a potential concern within the US-191 study area. Socioeconomic information regarding sensitive or protected population groups is presented for Block Groups by Census Tract.

MINORITY POPULATION GROUPS

Table 2.9 reveals the Chinle CCD is not home to a very diverse population. The population of the CCD is 96.1 percent American Indian/Alaska Native (AIAN). This is not unexpected, as the study area is wholly contained within land of the Navajo Nation. Regarding all other population groups, **Table 2.9** indicates no other sensitive groups located in the Chinle CCD would be disproportionately impacted relative to the others. Interestingly, the White population is a minority group within the Chinle CCD, and this population is disproportionately represented in Block Groups 1 and 2 of Census Tract 9442.01, which accounts for a large portion of the Chinle CDP.

Table 2-7
Sensitive Minority Population Groups in the Chinle CCD (2010)

Census Unit	Population													
	Share of CCD		Share of Chinle Census County Subdivision											
Census Designated Place (CDP)	Total	%	White	%	African American	%	Asian	%	AIAN/1	%	NHPI/2	%	Other Race/3	%
Chinle	4,518	21.6	284	6.3	12	0.3	12	0.3	4,129	91.4	0	0.0	81	1.8
Del Muerto	329	1.6	0	0.0	0	0.0	0	0.0	328	99.7	0	0.0	1	0.3
Many Farms	1,348	6.5	53	3.9	3	0.2	1	0.1	1,265	93.8	1	0.1	25	1.9
Census Tract 9442.01														
Block Group 1	964	4.6	5	0.5	0	0.0	0	0.0	951	98.7	0	0.0	8	0.8
Block Group 2	793	3.8	82	10.3	6	0.8	1	0.1	679	85.6	0	0.0	25	3.2
Block Group 3	2,253	10.8	157	7.0	9	0.4	10	0.4	2,032	90.2	0	0.0	45	2.0
Census Tract 9442.02														
Block Group 1	2,566	12.3	32	1.2	1	0.0	0	0.0	2,510	97.8	0	0.0	23	0.9
Block Group 2	1,487	7.1	27	1.8	0	0.0	3	0.2	1,441	96.9	0	0.0	16	1.1
Census Tract 9443														
Block Group 1	839	4.0	30	3.6	3	0.4	1	0.1	800	95.4	1	0.1	4	0.5
Block Group 2	1,741	8.3	48	2.8	0	0.0	0	0.0	1,660	95.3	0	0.0	33	1.9
Chinle Census County Subdivision (CCD)	20,896	100.0	469	2.2	24	0.1	17	0.1	20,089	96.1	1	0.0	296	1.4
Test Criteria (125% of CCE)	--	--	--	2.8	--	.13	--	.13	--	N/A	--	0.0	--	1.8

/1 AIAN refers to American Indian and Alaskan Native.
/2 NHPI refers to Native Hawaiian & Other Pacific Islander.
/3 Includes Other, who reported two or more races, and Hispanic or Latinos, who also reported being part of seven other groups.

Source: 2010 U.S. Census, U.S. Census Interactive Population Search, retrieved 6/13/2017. Note: Census Tracts 9442.01 and 9442.02 roughly correspond to the Chinle Chapter; Census Tract 9443 roughly corresponds to the Many Farms Chapter.

ELDERLY, FEMALE HEADS OF HOUSEHOLDS, AND DISABLED PERSONS

Arizona also considers with regard to Environmental Justice potential impacts on elderly persons, female heads of households, and disabled persons. "Elderly Persons" refers to individuals 60 years of age and over. "Female Heads of Households" are identified as females with no spouse present, regardless of whether any children younger than 18 years of age are present in the household (HH). Non-Institutionalized Civilians, who are 16 years of age and older, are considered to be a "Disabled Person," if they report a mobility disability, a self-care limitation, or work-related disability. Information is available from the 2010 Census of Population for the first two of these three sensitive population groups. However, only 2000 Census information is available for determining the number of persons with disabilities.

Table 2.10 shows the number of Elderly Persons and Female Heads of Households in Census Tracts associated with the study area. The percentage of Persons 60 Years and Over in the Del Muerto CDP and Census Tract 9442.02, Block Group 1, are notably higher than the Test Criteria for the larger Chinle Census County Subdivision (CCD). With respect to Female Heads of Households, Block Groups 1 and 2 in Census Tract 9442.01 are significantly higher than the Chinle CCD. The percentage of Disabled Persons in four Block Groups is notably higher than the Test Criteria for the Chinle CCD. A more detailed assessment of these data may be necessary to determine whether specific safety improvement projects would directly impact the locations cited here and shown in **Table 2.10**. Mitigating actions may need to be identified and implemented at that time to adhere to the principles and objectives of environmental justice.

Table 2-8
Characteristics of the Population

Census Unit	Persons 60 Years and Over		Female Head of Household		Disabled Persons	
	Total	%	# of HHs	%	Total	%
Census Designated Place (CDP)						
Chinle	505	10.2	384	31.8	382	7.8
Del Muerto	68	16.5	15	14.4	44	10.7
Many Farms	163	9.8	105	27.3	166	10.0
Census Tract 9442.01						
Block Group 1	66	5.9	96	40.9	76	15.4
Block Group 2	27	2.2	128	42.2	61	9.2
Block Group 3	300	14.5	81	14.8	191	14.7
Census Tract 9442.02						
Block Group 1	420	18.3	129	19.9	321	20.0
Block Group 2	182	10.7	102	24.5	177	14.3
Census Tract 9443						
Block Group 1	133	9.8	93	30.3	141	16.5
Block Group 2	191	12.6	77	20.4	202	19.6
Chinle Census County Subdivision (CCD)	2,635	12.2	1,357	26.1	2,659	12.3
Test Criteria (125% of CCD)	**N/A**	**15.3**	**N/A**	**32.6**	**N/A**	**15.4**

Source: 2010 U.S. Census American Fact Finder, 2011-2015 American Community Survey 5-Year Estimates. (Note: Some values reflect Non-Institutionalized population); Disabled persons from 2000 U.S. Census data.

LOW-INCOME

The HH income in the Chinle and Many Farms communities is well above that of Apache County. HH income reported for Apache County in 2015, as presented in the 2011–2015 American Community Survey (ACS) 5-Year Estimates, was $31,757. HH income reported for the Chinle CDP was $41,296. HH income reported for the Many Farms CDP was $48,958. These values are well above the national poverty level. However, it should be noted there may be clusters of HHs in these community areas that are below the poverty level of $24,250 for the Year 2015, particularly in rural portions of the study area. Therefore, additional analyses may be necessary subsequent to the identification and definition of specific project improvements, depending on the extent of potential impacts.

LIMITED ENGLISH PROFICIENCY

Table 2.11 shows how the communities of Chinle and Many Farms compare with the Chinle CCD relative to Limited English Speaking Households, as reported in the 2011-2015 ACS 5-Year Estimates. The table indicates the Chinle and Many Farms communities have lower proportions of Limited English Speaking Households than the Chinle CCD as a whole, except with respect to households speaking Spanish in the Chinle CDP.

Table 2-9 Limited English Speaking Households (HHs)

Subject	Chinle CCD		Chinle CDP		Many Farms CDP	
	Total HHs	% of Total HHs	Total HHs	% of Total HHs	Total HHs	% of Total HHs
All Households	1,068	20.5	140	11.6	46	11.9
Households speaking						
Spanish	20	34.5	20	50.0	0	0.0
Other Indo-European languages	0	0.0	0	0.0	0	0.0
Asian & Pacific Island languages	21	0.0	0	0.0	0	0.0
Other languages	1,048	22.8	120	14.0	46	14.4
Test Criteria (125% of CCD)	--	28.5	--	14.5	--	14.9

Source: Limited English Speaking Households, S1602, 2011-2015 American Community Survey (ACS) 5-Year Estimates, American Fact Finder, U.S. Census Bureau

It is unlikely that persons in this group would be disproportionately impacted by safety improvements. However, it should be noted there may be clusters of HHs in the Chinle CDP with limited English fluency, particularly in rural portions of the study area, which could be impacted by proposed safety improvements. Therefore, additional analyses may be necessary subsequent to the identification and definition of specific project improvements.

3.0 ENVIRONMENTAL OVERVIEW

This section presents an overview of pertinent environmental information relating to the study area, including: principal physical characteristics, known natural resources, cultural resources, and other sensitive issues and/or features relevant to considerations of future transportation system improvements.

3.1 PHYSICAL CONDITIONS OVERVIEW

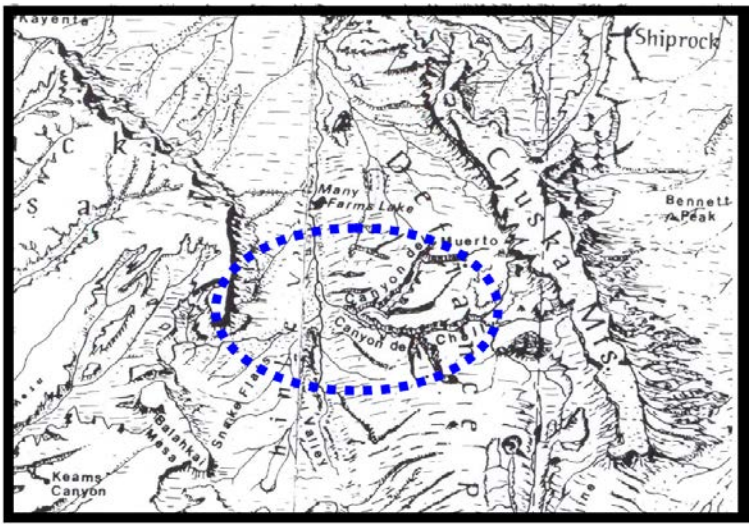
A general description of the physical characteristics of the study area, as defined by topography and soils, is presented in this subsection

3.1.1 TOPOGRAPHY

The study area, which includes Chinle and Many Farms chapters, is located in the midst of the one-hundred-mile-long "Beautiful Valley." Within the study area, the elevation drops from more than 5,900 above mean sea level (AMSL) at the southern end (MP 440) to 5,200 feet AMSL at the northern end (MP 470) near Chinle Wash. The study area lies between two major land forms, both of which have special significance in the traditional view of the Navajo's (Diné) world – Black Mesa to the west and the Chuska and Carrizo mountains to the east.

The southern end of the study area is dominated by the deep canyons of Canyon de Chelly complex to the east (**Figure 3.1**). The rim of Canyon de Chelly National Monument at the edge of the Fort Defiance Plateau is a prominent feature. The study area extends north and west to the Lohali Mesa and Bitter Water Basin at the foot of Black Mesa. The rugged eastern boundary gives way to a relatively flat and gently sloping plateau in the middle section

Figure 3.1
General Topographic Features of the Study Area



Note: Chinle Chapter is highlighted with blue dashed line; Many Farms Chapter area is directly north.

Source: Community Based Comprehensive Land Use Plan, Chinle Chapter, Summer, 2006.

cut by the Nazlini and Chinle Washes. Rolling terrain characterizes the western portion of the study area.

3.1.2 SOILS

The Chinle Chapter's "Community Based Comprehensive Land Use Plan", prepared through the Transportation Planning Program of NDOT, contains information regarding soils in the central area of the Chapter (which can be construed to in some degree reflect conditions in the Many Farms area).[6] It is notable that most major development activity has occurred in the relatively flat, gently sloping central area associated with Chinle Wash.

As reported in the Plan, study area soils are of the Torrifluvents-Badlands Soil Association. The floodplain of the Nazlini and Chinle Washes is comprised of four soil types, which are of the mixed mesic family of Typic torrifluvents soils. These soils were derived from alluvial activity of the washes and have thicknesses exceeding 36 inches. The soils consist of clay, silt loam, and sandy clay loam. The clay component of this soil group has a high shrink-swell property. Plasticity of this soil group ranges from high to moderate, especially the subsurface soil. Frost action is found in all soils.

On the slope of Ventana Mesa, west of Chinle, soils are of the mixed mesic family of Typic Camborthids. These soils, primarily yellowish and yellow red sandy loam, are derived from wind-deposited parent material. The soils exceed 36 inches in depth, are moderately permeable, well-drained, and have moderate runoff and erosion rates. The upper layer is non-plastic, but the subsurface layer is slightly plastic. Frost action is apparent.

East of Chinle Wash, soils are of the mixed mesic family of Typic Torripsamments. These reddish, yellow sand soils are the result of wind deposition processes. The soils are very rapidly permeable and excessively drained with no plasticity, resulting in poor runoff and severe erosion rates. The rest of the planning area consists of barren lands, rough broken or stony land, badlands, and sand dunes.

[6] Community Based Comprehensive Land Use Plan, Chinle Chapter, Including the Canyon Communities, Prepared for Chinle Chapter by Takahashi Associates, August 31, 2006.

3.2 NATURAL RESOURCES OVERVIEW

At times, the process of developing planning activities related to transportation systems and safety improvements may identify alternatives that have specific impacts on an area's natural resources. Minimizing potential impacts on natural resources of special concern is part of the procedure followed to assess/evaluate alternatives. However, there are situations in which direct or potential impacts cannot be wholly eliminated. In such cases, identifying mitigating actions to minimize the severity of potential impacts becomes necessary. This overview identifies known sensitive natural resources potentially in the study area, providing a sounder basis for defining alternatives and refining alternatives, as necessary, during the project development process.

The Arizona Department of Water Resources (ADWR) developed and published a list of Threatened and Endangered Species, Protected Areas, and Unique Waters. This information was compiled to aid the Department in its planning in support of its mission to secure and protect the State's water resources. The information focuses on six planning areas and three Active Management Areas (AMAs). The planning areas are an organizational concept adopted to provide a regional perspective on supply, demand, and specific issues relating to water resources. The US-191 corridor and study area is located in the region identified as the Eastern Plateau. The AMAs focus on specific, mandatory management practices associated with the State's largest urbanized areas that are subject to an extensive regulatory framework.

3.2.1 THREATENED AND ENDANGERED SPECIES OF THE EASTERN PLATEAU

The ADWR list is derived from a listing prepared by the U.S. Fish and Wildlife Service (USFWS), which defines an 'endangered species' as "…an animal or plant species in danger of extinction throughout all of a significant portion of its range [or habitat]." A 'threatened species' is defined "…as an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range [or habitat]." The listing prepared by the ADWR is shown in **Table 3.1**.

Table 3-1
Threatened and Endangered Species: ADWR Eastern Plateau Planning Area

Common Name	Threatened	Endangered	Elevation/Habitat
Apache Trout	X		>5000 ft./cold mountain streams
Bald Eagle	X		Varies/large trees or cliffs near water
Black-footed ferret		X	<10,500 ft./grassland plains
California Brown Pelican		X	Varies/lakes and rivers
California Condor		X	Varies/high desert canyonlands and plateaus
Chiricahua Leopard Frog	X		3,300-8,900ft./streams, rivers, backwaters, ponds stock tanks
Little Colorado Spinedace	X		4,000-8,000 ft./moderate to small streams in pools & riffles
Loach Minnow	X		<8,000ft./benthic species of small to large perennial streams
Mexican Gray Wolf		X	4,000-12,000 ft. /chapparal, woodland, forests
Mexican Spotted Owl	X		4,100-9,000 ft./canyons, dense forests with multi-layered foliage structure
Navajo Sedge	X		5,700-6,000ft./silty soils at shady seeps and springs
Peebles Navajo Cactus		X	5,400-5,600 ft/gravely soils of the Shinarump conglomerate
San Francisco Peaks Groundsel	X		10,900ft+/Alpine tundra
Southwestern Willow Flycatcher		X	<8,500 ft./cottonwood-willow and tamarisk along rivers and streams
Zuni Fleabane	X		7,300-8,000 ft./selenium-rich red or gray detrital clay soils derived from the Chinle and Baca formations

Source: Environmental Conditions of the Eastern Plateau Planning Area - Threatened and Endangered Species, Protected Areas and Unique Waters at Arizona Department of Water Resources (ADWR) retrieved July 21, 2017, at http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/EasternPlateau/PlanningAreaOverview/EndangeredandThreatenedSpecies.

3.2.2 WILDLIFE

The study area is dominated by the riparian environments associated with Chinle Wash and Nazlini Wash. The wash environments support a varied population of wildlife. Information presented in this section has been derived from the Arizona Game and Fish Department (AZGFD) HabiMap to afford insight into the potential for impacting sensitive wildlife species and habitats. Additional, more detailed assessments may be required at the time specific safety improvement project actions are contemplated to determine whether the wildlife species identified potential could be impacted.

SPECIES ASSESSMENT

The status of wildlife species in Arizona is maintained in the Heritage Data Management System (HDMS) by the AZGFD. AZGFD publishes two lists identifying the status of wildlife species by county and taxonomy (i.e., classification of organisms). One list identifies all wildlife, and the other identifies Special Status Species. Most publications of these lists are dated October 10, 2013. **Appendices A, B, and C** provide lists of wildlife species potentially in the study area by taxonomy, as identified and displayed geographically via HabiMap, an interactive, Web-based data viewer and planning tool developed by AZGFD to support the Statewide Wildlife Action Plan (SWAP).

SPECIES OF ECONOMIC AND RECREATIONAL IMPORTANCE

The Species of Greatest Conservation Need (SGCN) listing, as developed in support of the SWAP, addresses sensitive game species important to economic and recreational qualities of Arizona. Within the study area, the Mountain Lion (*Puma concolor*), shown at right, was identified as being Species of Economic and Recreational Importance (SERI).

HABITAT ZONES

The Arizona's Wildlife Linkages Assessment was prepared by the Arizona Wildlife Linkages Workgroup (AWLW), which is comprised of representatives from ADOT, AZGFD, Bureau of Land Management (BLM), FHWA, Northern Arizona University (NAU), Sky Island Alliance, U.S. Department of Agriculture (USDA), U.S. Forest Service, USFWS, and the Wildlands Project. The AWLW activities were a collaborative effort between public and private sectors directed toward defining a comprehensive, systematic approach to addressing habitat fragmentation associated with manmade barriers, such as roads, canals, urbanization, and other activities. The AWLW defined the significant threats to Arizona's wildlife populations as: habitat alteration, fragmentation, and loss. The Assessment is not intended to be used to determine site-specific mitigation measures; rather, the report details broad areas of concern to alert planners and engineers of connectivity issues. Ultimately, there is the expectation that availability of information in the Assessment will motivate consultation with resource agencies

and result in a more detailed project review. The Assessment identifies four levels or zones of concern, as defined below:

Habitat Block – Areas of land encompassing important wildlife habitat that reasonably can be expected to remain wild for at least 50 years. **NOTE:** The majority of the study area and the Navajo reservation around the study area falls within this zone.

Fracture Zone – Areas where roads, canals, urbanization, railroads, [and other development activity] limit or prevent animal movement and, therefore, permeability between habitat blocks, or threaten to do so in the foreseeable future. Actions should be taken to protect and enhance wildlife permeability through improvements to culverts and bridges at washes, streams, and rivers, which act as major wildlife corridors. **NOTE:** This type of zone is not present in the study area.

Potential Linkage Zone – Portions or subsets of fracture zones and habitat blocks that have been determined to be critical to wildlife movement, where connectivity needs to be maintained or restored. **NOTE:** The study area includes the valley created by Chinle Wash and runoff from the Chuska Mountains to the east. This has been identified as Linkage Zone 8, and US-191 is considered the primary threat to wildlife movements.

Riparian Habitat/Linkage Zone – Streams that support riparian communities, potentially providing essential habitat and wildlife connectivity. Riparian areas are defined as consisting of "vegetation, habitats, or ecosystems that are associated with bodies of water (streams or lakes) or are dependent on the existence of perennial, intermittent, or ephemeral surface or subsurface water drainage." **NOTE:** Chinle Wash is considered to be a Riparian Habitat/Linkage Zone in the study area.

The information developed by the AWLW and presented herein is intended to provide a starting point. Detailed consultation and coordination activities among the affected organizations, agencies, and stakeholders may be necessary, as safety improvement projects are more clearly defined for implementation and the design process initiated.

3.2.3 WATER RESOURCES

There are three types of water resources of primary concern when planning transportation improvements: watersheds, floodplains, and wetlands. Watersheds are large regional features defined by a ridge of land dividing the drainage of one area from another. Floodplains and wetlands are environmentally sensitive resources that are regulated by various government agencies with protection and preservation responsibilities supported by state and federal regulatory authority.

CHINLE WATERSHED

The Chinle watershed extends across northeastern Arizona; portions of the headwaters are located in northwestern New Mexico, and the mouth is in southeastern Utah (**Figure 3.2**). A 2010 report published by the U.S. Environmental Protection Agency (USEPA) indicated that no data were available for this watershed.

Figure 3.2
Chinle Wash Watershed

FLOODING HAZARD

Direct information on this subject is available for the Chinle Chapter in the "Community Based Comprehensive Land Use Plan" (2006). The primary issue associated within the Chinle Chapter is flooding from surface water drainage and occurrences of flooding and flash flooding associated with Nazlini and Chinle washes. Some secondary washes also are prone to seasonal flash floods. Water flowing in these washes moves fairly quickly downstream. Flooding creates major problems in the urbanized area of the Chapter, with people being isolated in their homes or cut off from access to their homes, as well as, damage to properties, buildings and businesses. The Land Use Plan identifies two zones related to flooding in the community. Zone 1 identifies areas with the 100-year flood plain of streams, washes, and creeks. The document states that most planned development in the Chapter area is outside Zone 2, which is the most flood prone.

Flooding impacts on the sewage lagoons serving the community wastewater system is a special concern. The lagoons, located on the west side of US-191 approximately 3.8 miles north of the US-191/N7 intersection, are situated within 500 feet of Nazlini Wash. Severe flooding conditions can result in the lagoons overflowing, resulting in untreated sewage flowing into Nazlini Wash and, ultimately, into Chinle Wash.

In the canyon areas to the east, erosion of stream channels is a major problem. Some locations in Del Muerto Canyon have eroded 20 plus feet over a 30 – 40 year period. A few earthen dams have been created to capture some of the runoff for livestock ponds. However, these features do little to retain the majority of the flow or mitigate the erosion.

WETLANDS

A search using the National Wetland Inventory (NWI) database revealed no wetlands or areas of interest within the study area. However, the NWI does identify Nazlini Wash and Chinle Wash as Riverine resources, which are defined as environments created along permanent and semi-permanent (e.g., seasonal) streams resulting from increased soil moisture from precipitation events. As safety improvement projects are defined in greater detail, particularly in the vicinity of the two washes, early coordination with the U.S. Army Corps of Engineers (USACE) is encouraged to maximize communication to the permitting agency and minimize review time. Many Farms Lake is located one mile east of US-191 and Chinle Wash. This 1.4-Square-mile lake retains runoff from the Chuska Mountains to the east. Chinle Wash runs between the lake and US-191.

3.2.4 AIR QUALITY CONSIDERATIONS

An air quality report for the air monitoring station at Chinle, Arizona (July 19, 2017) indicates Moderate conditions.[7] Moderate air quality is acceptable; however, very sensitive people may experience coughing or shortness of breath. The major pollutant – Ozone (O_3) – was recorded at a level of 71. The forecast for the following day was 100, which is at the top of the Moderate Air Quality Index (AQI). The AQI for Many Farms registered 64 for July 19th, which is Moderate,

[7] WeatherBug by Earth Networks, retrieved July 17, 2017.

and the major pollutant was O_3. No historic air quality information is available for these locations.

3.3 CULTURAL RESOURCES OVERVIEW

There are two known properties in the study area listed on the National Register of Historic Places (NRHP), which are maintained by the National Park Service (NPS):

- Canyon de Chelly National Monument, located a few miles east of the eastern portion of Chinle; and
- Chinle Franciscan Mission Historic District (shown at right), located on N7, diagonally across the road and southwest of the Chinle Judicial Complex and Police Station.

Source: National Register of Historic Places listing in Apache County, Arizona, Listing County-Wide, posted December 16, 2016.

4.0 IDENTIFICATION OF ROADWAY NETWORK NEEDS

The purpose of this chapter is to present an assessment of safety needs associated with the US-191 travel corridor within the study area, as defined by available data, previous studies, and public and stakeholder input. The incidence of crashes is emphasized.

4.1 INFORMATION SOURCES AND PREVIOUSLY IDENTIFIED ISSUES

The Study Team assembled historical information to ensure previously identified issues were considered and appropriately addressed. These issues, in addition to field observations, were presented at public meetings and stakeholder interviews as a baseline to which residents and stakeholders could contribute additional and more recent concerns for consideration in the study. A summary table showing these information sources and the issues revealed during this process is presented in **Appendix D**. Reproductions of the posters used in these meetings are provided as **Figure 4.1** through **Figure 4.4**.

4.1.1 DATA SOURCES

Two sources of data were used to support analyses of crash history, crash patterns, and crash types that have occurred in the study area for the 2011-2015 reporting period.

- ADOT provided geographic information system (GIS) shapefiles[8] for all crashes statewide during the 2011-2015 reporting period. ADOT tracks a variety of crash characteristics, including: date and time; collision manner; vehicle, injury, and fatality counts; roadway, lighting, and weather conditions; causes; a case number; etc. The ADOT data indicates there were 92 crashes in the study area during the selected reporting period.
- NDOT provided data for the same time period, which included much of the same information; but, reported crash characteristics varied from those used by ADOT. The files provided indicated 54 crashes occurred in the study area during the selected reporting period.

8 A "shapefile" provides a format for storing geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas).

Figure 4.1
Previously Identified Issues/Opportunities: Roadway Characteristics

US 191 Chinle to Many Farms Safety Improvement Study
MPD Task Assignment 0026-17

PREVIOUSLY IDENTIFIED ISSUES/OPPORTUNITIES

Roadway Characteristics

Many Farms Area

Safety
- Vehicle, pedestrian, and student safety concerns at the intersection of N-59 & U.S. 191.

Traffic Control
- Provide a traffic signal or a roundabout at the intersection of U.S. 191 & N59.
- Eastbound backups may require turn lanes.

Safety
- Need for cattle guard.

Capacity
- Poor Level of Service (LOS).

Speeding
- Install solar speed monitors. Coordinate with a speed study.
- Evaluate use of photo radar enforcement in Many Farms.
- Conduct speed studies to determine appropriate speed limits.

Widening/Capacity
- Replace/widen Black Mountain Wash Bridge (MP 460.26).

Access
- Residents have created an informal frontage road for access to adjacent property.

N8087
- Connects back road to Many Farms (N8084)
- Frequent access to private property.

Horizontal Curve Delineation (4 locations)
- Delineate horizontal curves with flexible delineators, chevrons, and curve. warning signs as appropriate.
- Evaluate need for Southbound passing lane and/or deceleration lane near MP 454 (no passing Southbound).

Volume/Capacity
- Possible new development and bridge project. 8095 is the north end of detour route if US 191 is closed to the South. Road used for multiple school bus routes.

Corridor Wide

Lane Departure Crashes
- Provide paved shoulders with edge line rumble strips.
- Refresh Pavement markings, to include installation of center line raised pavement markers.
- Install center line rumble strips.
- Delineate horizontal curves with flexible delineators, chevrons and curve warning signs as appropriate.

Rear End Crashes
- Evaluate major intersections for the need for turn lanes.
- Install advance intersection signing at major intersections.
- Install cattle guard delineation.

Speeding
- Install solar powered speed feedback signs in Many Farms.
- Evaluate use of photo radar enforcement in Many Farms.
- Conduct speed studies to determine appropriate speed limits in Chinle and Many Farms.

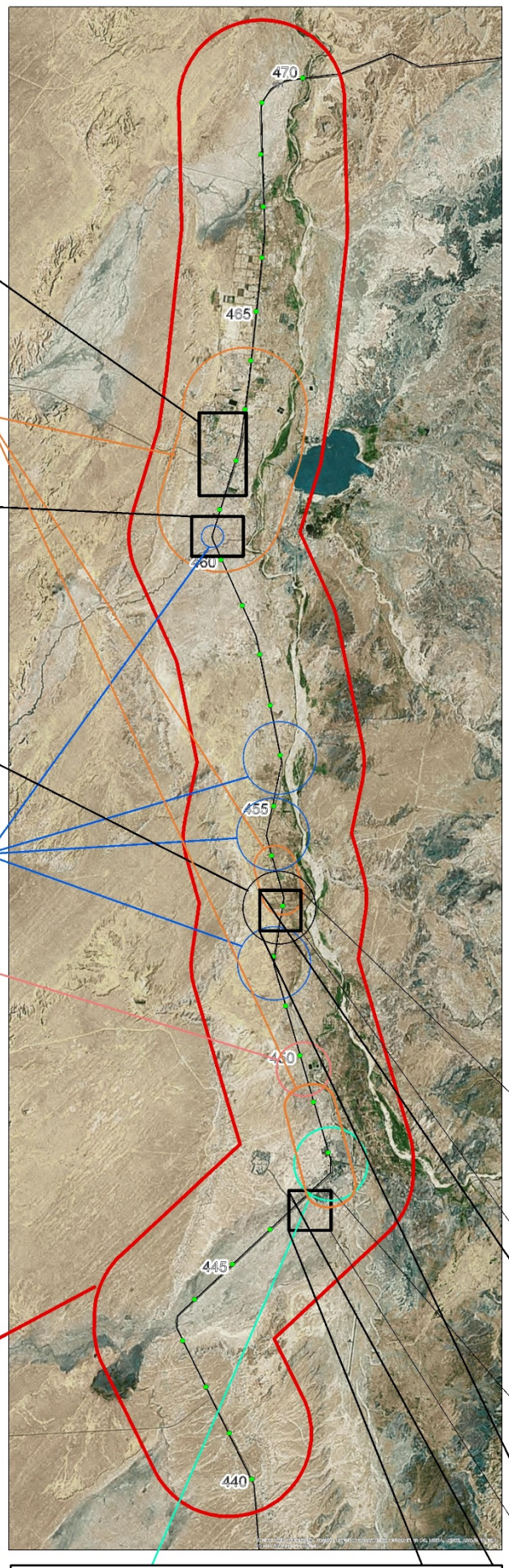
School Bus Pullouts
- Provide and/or formalize more bus pullouts for school buses (as needed).

Widening/Capacity
- Widen US-191 to four lanes.
- Improve roadway geometrics and flatten the near where US-191 is at 7%.
- Widen shoulders; construct turn lanes and larger driveway turnouts.

Fencing/Livestock
- Install new fencing, cattle guards, and gates between N7 & N59.

Shoulder striping, signing, and marking improvements
- Install paved shoulders with edge line rumble strips.
- Refresh pavement markings and install centerline raised pavement markers.
- Install centerline rumble strips.
- Install bus ahead signs where needed.
- Remove unused sign posts and replace missing or damaged signs.
- Remove any private signs off of roadway sign posts.
- Install 360 degree retroreflective delineators on sign posts.
- Develop more signs to identify amenities along the corridor.
- Add shoulders and reflective delineators in rural areas.

Install high visibility crosswalks in Chinle and Many Farms.



Additional Comments

Please add any additional comments, and draw any diagrams here or on the map where they occur to show additional ROADWAY CHARACTERISTICS issues not already reflected on this poster.

- Drivers appear to use shoulder to turn.
- Narrow right-of-way around MP 452.

Chinle Area

Access Management
- Combine existing driveways in the immediate vicinity of the N7 & US-191 intersection.

N8091 Intersection
- High volumes from 1) the Swap Meet; 2) Use of route as downtown bypass; 3) Use of route to access the hospital. Poor Level of Service
- Evaluate turn lanes for Eastbound backups.

N7 Intersection
- West leg has utility relocation implications.
- Design solution to address parking issues (west side) at Sports Complex events.

Traffic Control
- Possible location for roundabout at N8094.

Figure 4.2
Previously Identified Issues/Opportunities: Pedestrian/Bike/Transit Safety and Lighting

US 191 Chinle to Many Farms Safety Improvement Study
MPD Task Assignment 0026-17

PREVIOUSLY IDENTIFIED ISSUES/OPPORTUNITIES

Pedestrian/Bike/Transit Safety and Lighting

Pullouts
- Provide bus pullouts (and rest areas for truckers) - Segment between MP 466 & 467.

Many Farms Area

Pedestrians
- Access for students to school/admin.
- Evaluate the need for a pedestrian bridge or a Pedestrian Hybrid Beacon (HAWK), and improved shoulders near schools and shopping in Many Farms.
- Install a high visibility crosswalk near schools in Many Farms and ensure beacons on warning signs at Many Farms Elementary are flashing properly.

Safety
- Vehicle, pedestrian, and student safety concerns at the intersection of N-59 & U.S. 191.

Lighting
- Need lighting at N59 & US-191.

Bus Pullouts
- Design and construct bus pullouts.

Corridor Wide

School Bus Pullouts
- Provide and/or formalize more bus pullouts for school buses (as needed).
- Install bus ahead signs where needed.

Pedestrian Safety
- Install high visibility crosswalks in Chinle and Many Farms.

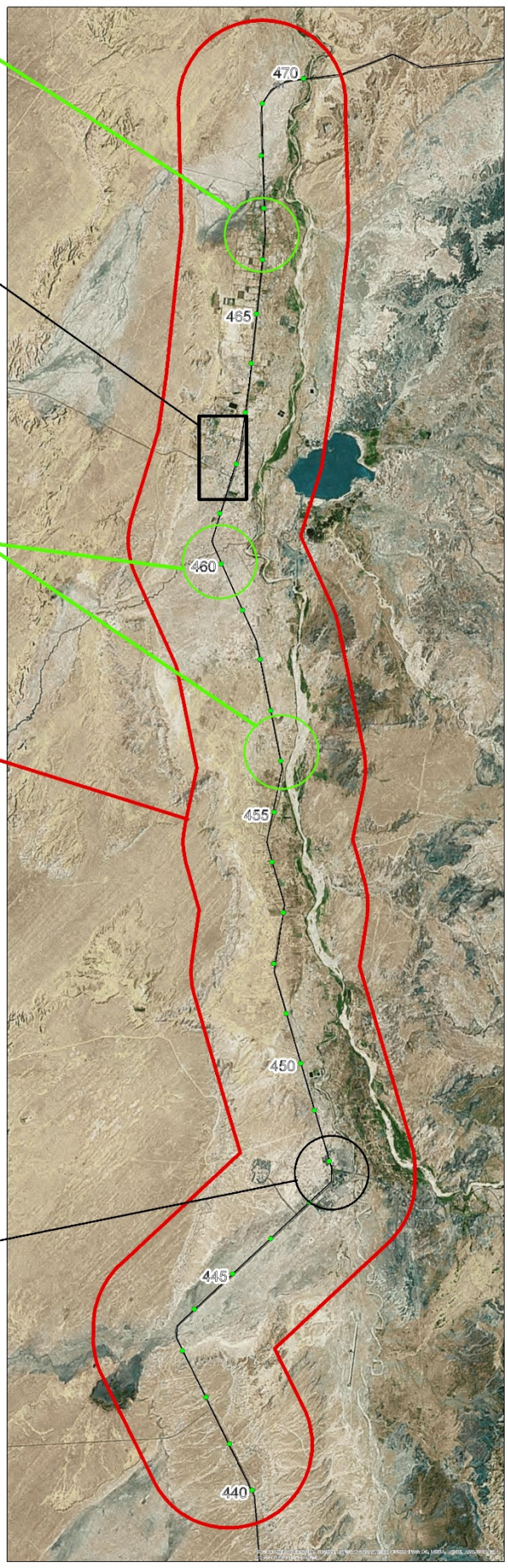
Chinle Area

Pedestrians
- Evaluate the need for a pedestrian bridge or a Pedestrian Hybrid Beacon (HAWK) near Chinle High school/Chinle Elementary School and/or the N7 & US-191 intersection.
- Install a high visibility crosswalk near Chinle High school/ Chinle Elementary School and/or pedestrian countdown signal heads at the N7 & US-191 intersection.

N7 Intersection
- Design solution to address parking issues (west side) at Sports Complex events.

Lighting
- Evaluate existing street lighting in Chinle for proper illumination and uniform light pattern for pedestrian safety.

Multi-modal Transportation
- Construct shared use path along US-191.
- Local transit service within Chinle and Many Farms – routes to be determined by Navajo Transit System.
- Transit Shelters.
- Design and construct a Transit Center in Chinle.



Additional Comments

Please add any additional comments, and draw any diagrams here or on the map where they occur to show additional PED/BIKE/TRANSIT SAFETY AND LIGHTING issues not already reflected on this poster.

Figure 4.3
Previously Identified Issues/Opportunities: Drainage and Flooding

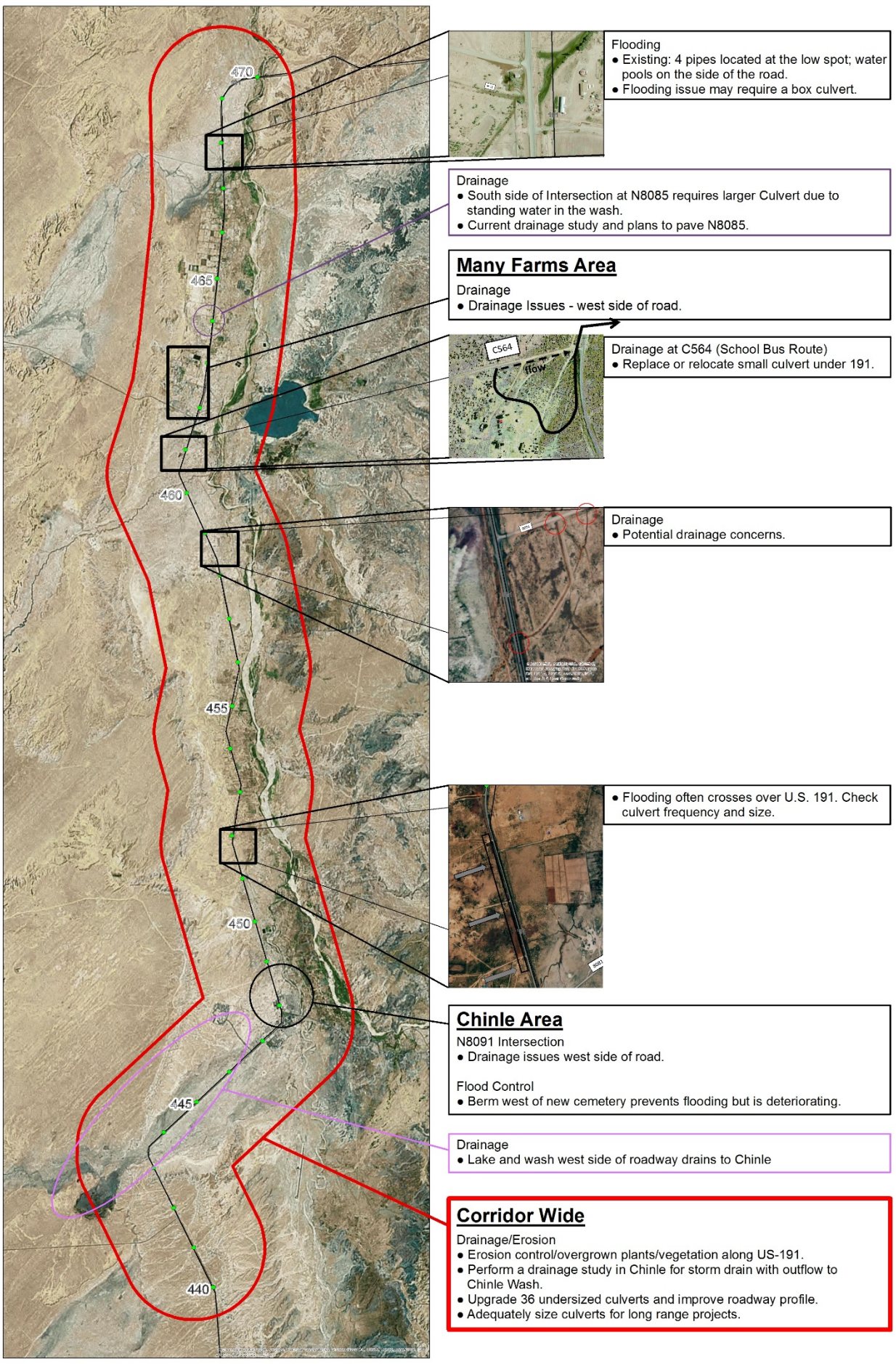
US 191 Chinle to Many Farms Safety Improvement Study
MPD Task Assignment 0026-17

PREVIOUSLY IDENTIFIED ISSUES/OPPORTUNITIES

Drainage And Flooding

Additional Comments

Please add any additional comments, and draw any diagrams here or on the map where they occur to show additional DRAINAGE AND FLOODING issues not already reflected on this poster.



Flooding
- Existing: 4 pipes located at the low spot; water pools on the side of the road.
- Flooding issue may require a box culvert.

Drainage
- South side of Intersection at N8085 requires larger Culvert due to standing water in the wash.
- Current drainage study and plans to pave N8085.

Many Farms Area

Drainage
- Drainage Issues - west side of road.

Drainage at C564 (School Bus Route)
- Replace or relocate small culvert under 191.

Drainage
- Potential drainage concerns.

- Flooding often crosses over U.S. 191. Check culvert frequency and size.

Chinle Area

N8091 Intersection
- Drainage issues west side of road.

Flood Control
- Berm west of new cemetery prevents flooding but is deteriorating.

Drainage
- Lake and wash west side of roadway drains to Chinle

Corridor Wide

Drainage/Erosion
- Erosion control/overgrown plants/vegetation along US-191.
- Perform a drainage study in Chinle for storm drain with outflow to Chinle Wash.
- Upgrade 36 undersized culverts and improve roadway profile.
- Adequately size culverts for long range projects.

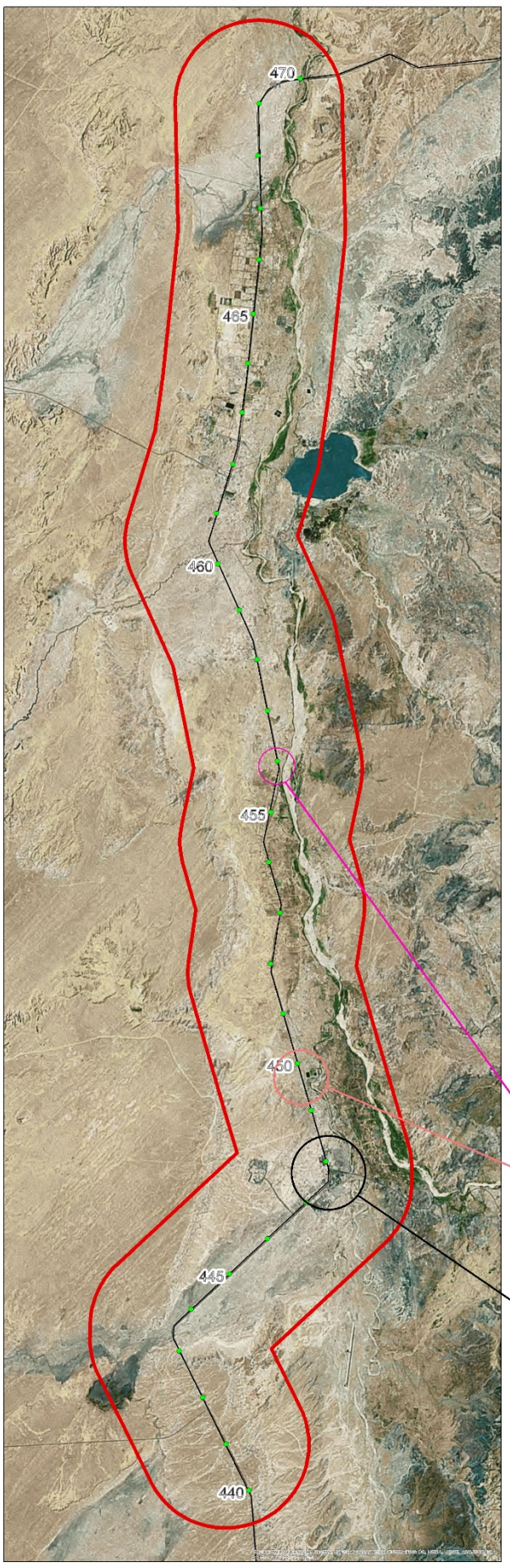
Figure 4.4
Previously Identified Issues/Opportunities: Development Impacts

US 191 Chinle to Many Farms Safety Improvement Study
MPD Task Assignment 0026-17

PREVIOUSLY IDENTIFIED ISSUES/OPPORTUNITIES

Development Impacts

Additional Comments
Please add any additional comments, and draw any diagrams here or on the map where they occur to show additional DEVELOPMENT issues not already reflected on this poster.



Additional Comments

Windmill Site
- Potential future development near the Windmill.

8095 Developments
- Possible new development and bridge project.

Transfer Station North of MP 449
- Current transfer station may upgrade to include recycle and construction waste.

Chinle Area Development

N8091 Intersection
- Swap Meet and Hospital Traffic.

N7 Intersection
- West leg has utility relocation implications.

Pinon Junction to MP 454
- Potential future development on east side of roadway near N4.

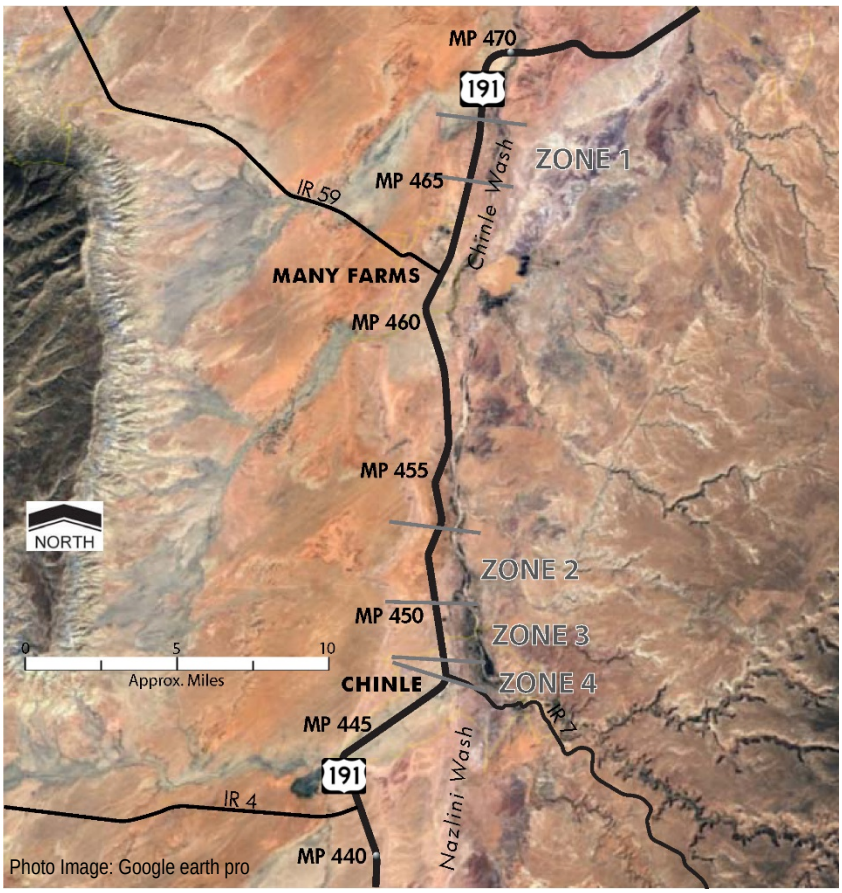
Future South Chinle Developments:
- Route 102 south to cemetery.
- New Navajo Technical University Expansion of 35 acres with access to Hospital; Plan available but needs acquisition of right-of-way.
- New Cemetery Road as partnership.

The data for many of the NDOT crash records matched (or were very similar to) crash records provided by ADOT. The Study Team created a cross-referenced data set that merged the two datasets. Data validation was conducted to ensure matched records were really the same incident, i.e., crash. This process compared dates, locations, vehicles involved, severity, and causes. The final merged data included 128 crashes in the study area during the selected reporting period.

4.1.2 FOCUS AREAS

The study area covers 30 miles of the US-191 travel corridor. The merged crash data files revealed that a statistically significant 44 percent of the crashes occurred within only 7.5 miles of the corridor and were associated with two segments: the segment between the intersection of N7 and MP 453 in the Chinle community, and the segment between MP 465 and MP 467 north of the Many Farms community. This report further subdivides the N7-to-MP 453 segment within and north of Chinle into three contiguous zones, due to differences in safety issues which will be described further in the following sections of the report (**Figure 4.5**). Each section presents crash data with reference to these four focus areas or "zones" to highlight the conditions/needs that demand safety improvement actions.

Figure 4.5
Crash Focus Areas



4.2 CRASH HISTORY AND ANALYSIS

This section presents analyses of the US-191 corridor crash history within the study area, emphasizing the type or character of crashes and conditions under which crashes have occurred.

4.2.1 CRASH SEVERITY AND TRENDS

The ADOT dataset contained a field with a code for each of the following categories: fatal, incapacitating injury, non-incapacitating injury, possible injury, and property damage. Data provided by NDOT indicated how many injuries occurred, and whether or not a fatality occurred. Because no field in the NDOT data set identifies severity of injuries, all crashes involving more than zero injuries were counted as non-incapacitating injury crashes. As a result, the number of incapacitating injury crashes likely was low. It is important to note that

only the most severe injuries were captured in this analysis. It is possible that a crash might have had four total injuries; but, if one of them resulted in a fatality, the crash would not appear in either the non-incapacitating or incapacitating injury categories – only the fatal category. **Figure 4.6** displays the location and severity of crashes in the corridor. A little more than one-half of all crashes occurred in the greater Chinle area, with the remaining crashes distributed fairly evenly over the study area, except for the concentration north of Many Farms.

Almost two-thirds of crashes resulted in property damage only (PDO) or in "possible" injuries. The remaining third involved an injury of some nature (refer to **Figure 4.7**). Thirteen percent of crashes resulted in one or more fatalities, which is extraordinarily high, as less than one percent of crashes statewide involved fatalities.[9] Apache County fatalities also were considerably lower, although notably higher than the State as a whole; there were only 38 fatal crashes (resulting in 46 fatalities) associated with 398 crashes in 2015 or 9.5 percent. The higher incidence of fatalities in Apache County, as well as the study area, can be attributed to a number of factors largely associated with operating vehicles in rural areas, including: speed, poor lighting, two-lane roadways, and inability to effect rapid emergency responses to the crash scenes.

The number and severity of crashes declined steadily from 2011 to 2014 in each category (**Figure 4.7**). Then, every category increased in 2015, except Possible Injury, which continued to decline. Property Damage increased, but only slightly. **Figure 4.7** reveals 35% of crashes resulted in a certain injury of some severity (13% Fatal + 5% Incapacitating Injury + 17% Non-Incapacitating Injury). Twelve of the 23 crashes resulting in either fatal or incapacitating injuries occurred in the focus areas. They were proportionally distributed through Zones 1, 2, and 3, where the speed limit is higher. No fatal or incapacitating injury crashes occurred in Zone 4, which is much smaller and the volume of traffic is higher, but vehicle speeds are lower and more lanes create better traffic flow.

[9] "2015 Motor Vehicle Crash Facts for the State of Arizona," Arizona Department of Transportation (ADOT), February 1, 2018.

4.2.2 TYPE AND SEVERITY OF CORRIDOR CRASHES

Figure 4.6
US-191 Crash Locations, Severity, and Lighting Conditions: 2011 – 2015

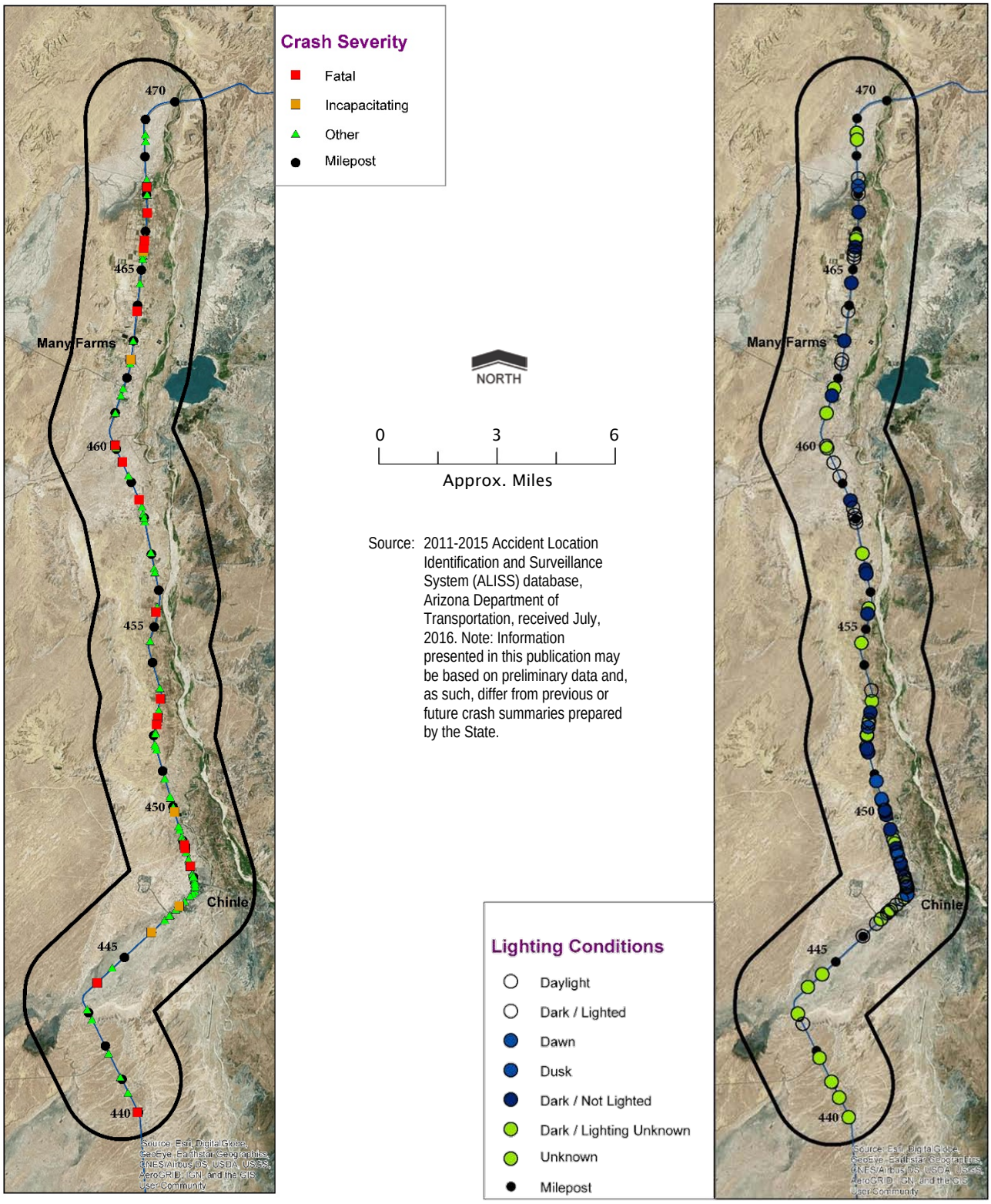
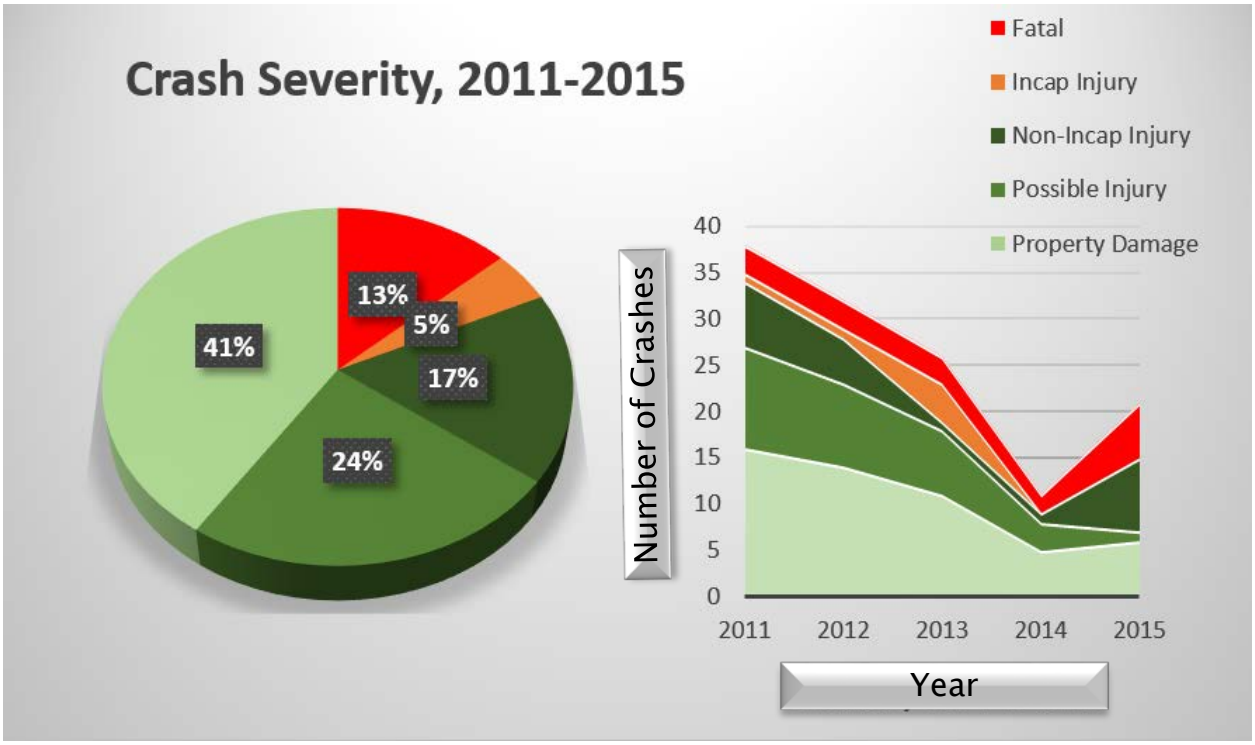


Figure 4.7
US-191 Crash Severity and Trends: 2011 – 2015



Source: 2011-2015 Accident Location Identification and Surveillance System (ALISS) database, Arizona Department of Transportation, received July, 2016. Note: Information presented in this publication may be based on preliminary data and, as such, differ from previous or future crash summaries prepared by the State.

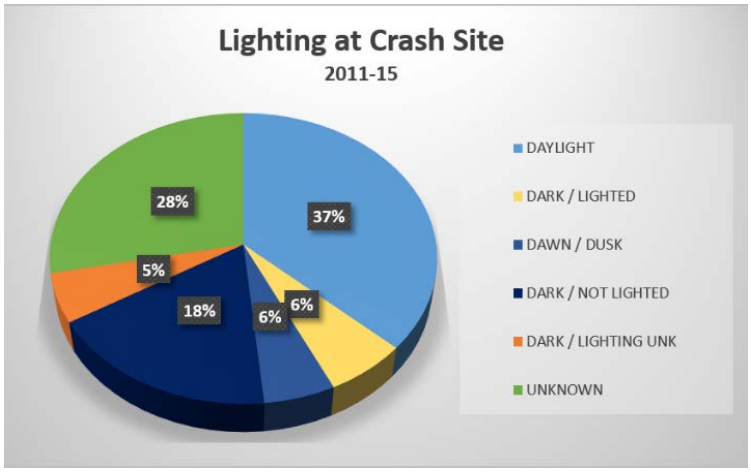
4.2.3 LIGHT CONDITIONS ASSOCIATED WITH ALL CRASHES

The majority of reported data includes either the lighting condition of the time of the crash, which was correlated to lighting condition based on following criteria:

- Crashes occurring between 7 a.m. and 7:59 p.m. were placed in the "Daylight" category;
- Crashes between 6:00 p.a. and 6:59 a.m. and between 8:00 a.m. and 8:59 p.m. were placed in the "Dawn/Dusk" category; and
- All other crashes were placed in the "Dark/Lighting Unknown" category.

Figure 4.8 shows the proportion of crashes occurring during the 2011–2015 reporting period that were associated with varying light conditions. The location of these crashes in the corridor was depicted previously in **Figure 4.6**.

Figure 4.8
Crash Light Conditions, 2011-15

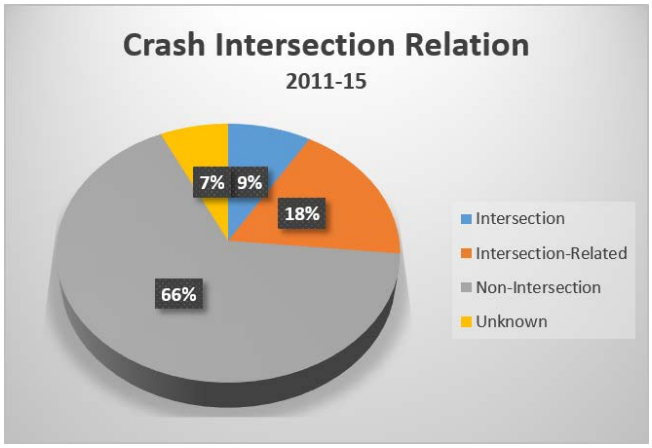


Source: 2011-2015 Accident Location Identification and Surveillance System (ALISS) database, Arizona Department of Transportation, received July, 2016. Note: Information presented in this publication may be based on preliminary data and, as such, differ from previous or future crash summaries prepared by the State.

US-191 within the study area has artificial lighting covering only the most developed part of Chinle (Zone 4). Outside this segment of the highway, crash data revealed 53 percent of crashes occurred in Zones 1-3, where there is no street lighting. The data indicated 29 percent of crashes in these zones happened either in "Dawn/Dusk," "Dark/Not Lighted," or "Dark/Lighting Unknown" conditions. Additionally, 28 percent Zones 1-3 crashes occurred in "Unknown Light" conditions. So, it is potentially possible that the actual proportion of crashes that occurred under no or low-light conditions falls between 29 and 57 percent.

4.2.4 INTERSECTION-RELATED CRASHES

Figure 4.9
Locational Attributes of Crashes



Source: 2011-2015 Accident Location Identification and Surveillance System (ALISS) database, Arizona Department of Transportation, received July, 2016. Note: Information presented in this publication may be based on preliminary data and, as such, differ from previous or future crash summaries prepared by the State.

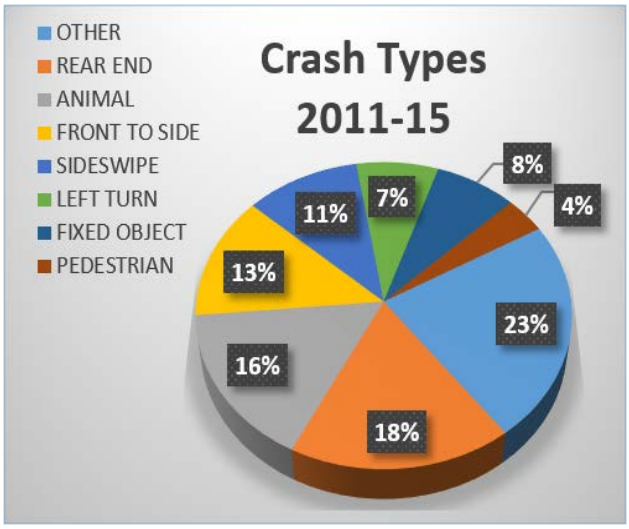
Both data sources examined had similar fields for reporting intersection-related crashes. The data reveal that at least two thirds of all crashes in the study area occurred away from access points, i.e., locations where vehicles can enter the traffic stream on US-191, not necessarily just intersecting roadways (**Figure 4.9**). However, that being said, 43 percent of crashes in Zone 4, the commercial and social hub of the Chinle community, were intersection-related. **Figure 4.9** provides a chart showing the overall proportions of crashes associated with intersections relative to those crashes that were outside of intersections. Those items are included in the chart's "Unknown"

category. "Intersection-Related" indicates crashes did not necessarily occur in an intersection, but the reporting Officer determined that a nearby intersection influenced the crash or contributed to the crash.

4.2.5 TYPE OF CORRIDOR CRASHES

Figure 4.10 shows the types and relative proportion of crashes that occurred in the study area during the 2011-2015 reporting period. The preponderance of collision crashes involved two or more vehicles, as opposed to those involving a fixed object, pedestrian, or animal. The greatest proportion of collision crashes involved a vehicle being rear-ended. The second most common accident involved an animal. Other types of crashes occurring at a high rate included angle, sideswipes, fixed-object, and left-turn crashes.

Figure 4.10
Crash Types, 2011-15

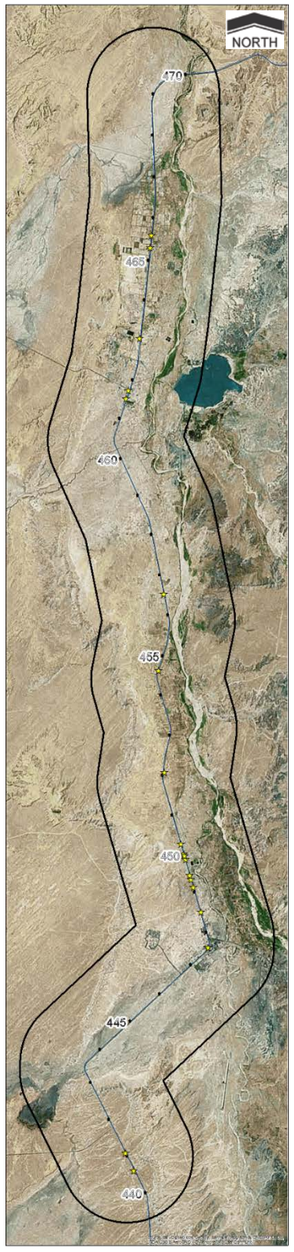


Source: 2011-2015 Accident Location Identification and Surveillance System (ALISS) database, Arizona Department of Transportation, received July, 2016. Note: Information presented in this publication may be based on preliminary data and, as such, differ from previous or future crash summaries prepared by the State.

This study focused on types of crashes in an effort to reveal improvements that potentially can improve vehicle and pedestrian safety at specific locations. Selected crash types are mapped in **Figure 4.11**, identifying the general location of crashes, providing focused analyses and descriptions of existing conditions that may contribute to the prevalence of each crash type.

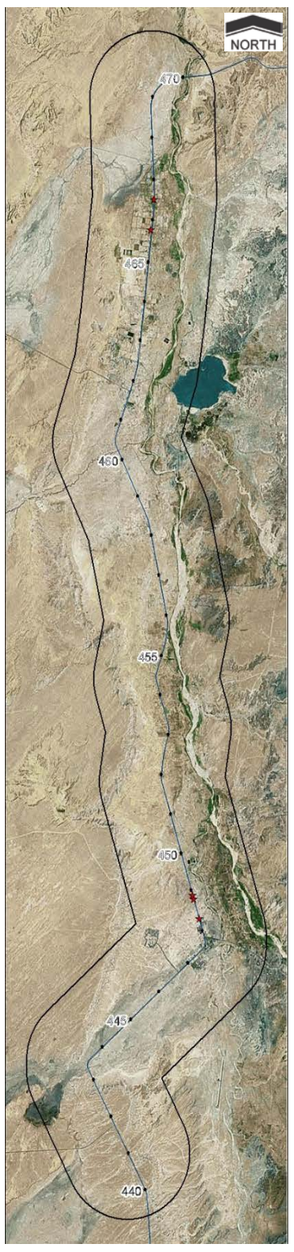
As will be highlighted later in this report, all pedestrian-involved crashes resulted in the pedestrian becoming a fatality. Pedestrian safety along the roadways of the study area clearly is problematic for all communities. For example, in Apache County as a whole, six crashes in 2015 involved pedestrians, and all six pedestrians became fatalities. However, this high rate of fatalities in the study area and the County is extraordinary. By contrast, 193 pedestrians became fatalities as a result of 1,643 vehicle/pedestrian conflicts statewide, meaning only 11.8 percent of vehicle/pedestrian conflicts resulted in a fatality.

Figure 4.11
Analyses of Three Crash Types



HEAD-ON AND SIDESWIPE CRASHES

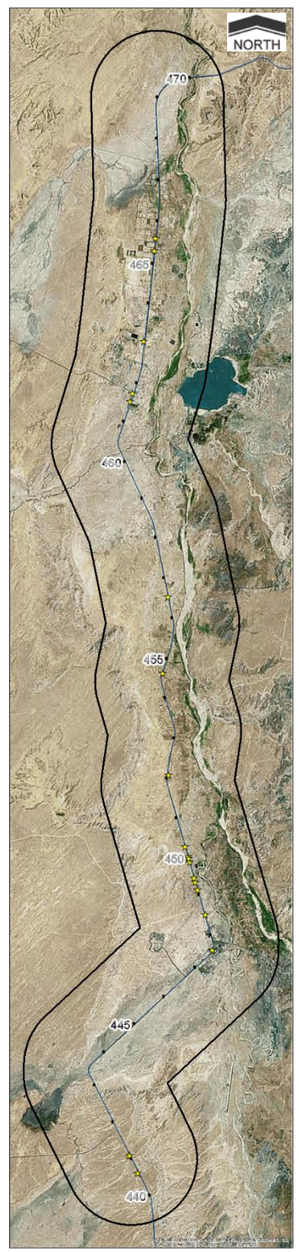
Twenty crashes classified as "head-on" or "sideswipe" occurred during 2011-2015 reporting period (**Figure A**). Thirteen occurred in the focus areas, with eleven clustered in the three zones associated with Chinle community. Nine crashes occurred in relation to vehicles entering or exiting the highway where three was no access control, i.e., driveways, access roads to fields, parking lots. The occurrence of this type of crash



PEDESTRIAN-INVOLVED CRASHES

Although crashes involving pedestrians do not necessarily result in serious injury to the pedestrian, vehicle/pedestrian conflicts favor the vehicle. All such crashes in the study area during the 2011-2015 reporting period resulted in a fatality. In both the ADOT and Navajo Nation data, the presence of a pedestrian was listed as a cause of the crash. Unfortunately, the data do not specify how the pedestrian was involved.

During the reporting period, there were five pedestrian-involved crashes in two clusters located north of Many Farms and north of Chinle in Zones 1 and 3, respectively



ANIMAL-INVOLVED CRASHES

During the 2011-2015 reporting period, there were nineteen crashes involving animals. Although these incidents were spread throughout the study area, twelve out of the nineteen animal-involved crashes occurred within the focus areas. Eight of the twelve occurred in Zone 1 (refer to **Figure 5.1**), where the posted speed limit location is 65 mph.

- Fourteen of the nineteen crashes occurred between 7 p.m. and midnight.*
- Three of the locations were reported to have artificial lighting.
- None of the crashes resulted in a fatality.

Source: 2011-2015 Accident Location Identification and Surveillance System (ALISS) database, Arizona Department of Transportation, received July, 2016.
Note: Information presented in this publication may be based on preliminary data and, as such, differ from

4.2.6 ACCESS MANAGEMENT ISSUES

At present there is no formal Access Management Plan in place at the State or local level. Access control at the State level is integrated with "Roadway Design Guidelines", which provides the following general guidance:

> *Access control is achieved by regulating public access rights to and from properties abutting highways. … Partial access control still gives preference to through traffic but permits some crossings at grade and some private driveway connections. Without access control, abutting properties are permitted access to the highway, but the number, location and geometrics may be regulated.*[10]

The Guidelines provide further that –

> *Traffic entering or leaving a highway via side roads or driveways has a detrimental effect upon highway capacity, operational speed and user safety. Direct access from abutting properties should be limited. In rural areas, parcels fronting only on the highway may be given access to another public road or street by constructing suitable connections if such access can be provided at reasonable cost. Where direct access is provided in rural areas, the intersections should be improved to a level consistent with design traffic volumes.*

The Guidelines continue with guidance that indicates turnout (including driveway) locations for access to property abutting the highway "…should be kept to a minimum to enhance capacity and safety of the through roadway." However, there is no specific guidance regarding the preferred distance between turnouts or access points. The occurrence and frequency of turnouts can become a significant issue with respect to rural highways with high posted speed limits. No document in NDOT references or provides for enforcement of any access standards relative to land development practices, when access could be controlled.

Despite this critical aspect of turnouts on rural highways, intersection-involved crashes associated with roadway connections and turnouts or access points

[10] "Roadway Design Guidelines," Roadway Engineering Group, Arizona Department of Transportation, May 2012.

ascertained through this study are relatively low. Ten of thirty crashes involving intersections occurred at or near US-191/N7 intersection in Zone 4. The remaining crashes were distributed throughout the study area. No other access point was involved in more than two crashes during the 2011-2015 reporting period.

Nevertheless, guidance provided through the National Cooperative Highway Research Program (NCHRP) indicates there are identifiable safety impacts associated with the frequency of intersections or driveways. The NCHRP reports the "each additional private driveway per kilometer in both urban and rural areas increased accident rates about 1.5 percent for 2-lane roads and 2.5 percent for 4-lane roads. These [rates] translate into 2.4 and 4.0 percent increases per private driveway on a per mile basis. In urban areas, each commercial driveway had about five times the effect of a private driveway on accident rates."[11] This highway safety guidance is particularly relevant for US-191 through the study area.

[11]

5.0 SAFETY STRATEGIES AND IMPROVEMENT OPTIONS

This chapter presents three categories of proposed improvements intended to mitigate roadway network needs and, thereby, improve or enhance traveler safety in the study area:

The first category of improvements maintains the current geometric characteristics of the roadway itself, focusing rather on elements that could improve driver reaction times.

The second category of improvement recommendations concentrates on the central portion of the Chinle community and highlights crash types that suggest the need for Access Control.

The third category identifies areas where road widening would improve safety. It also includes improvement recommendations focused on slow moving traffic situations that contribute to unsafe conditions by creating concentrations of vehicles in bottlenecks.

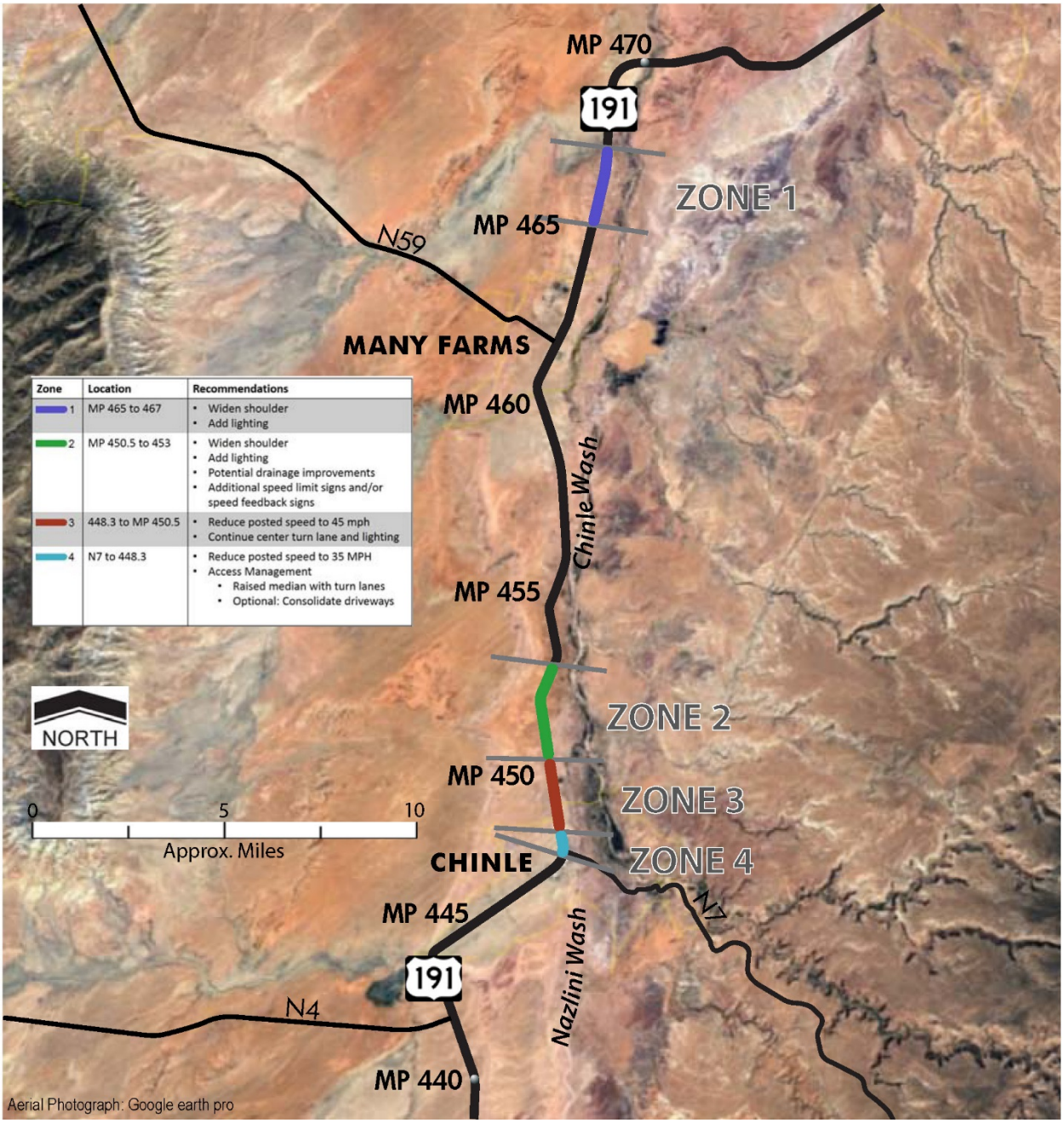
Mitigating solutions are presented for each category, as ascertained through findings and conclusion of this current safety improvement study, and, wherever possible, linked to safety needs identified in previous studies, as identified in **Appendix D**. **Figure 5.1** provides a map of the four focus areas and a summary of improvements recommended for each focus area.

The final section addresses the need to continue to review and evaluate other improvements that have been identified in previous studies.

5.1 IMPROVEMENTS TO COUNTERACT HISTORICAL CRASH TRENDS

Chapter 4 presented trends from crash data collected from ADOT and NDOT for the 2011–2015 reporting period. This section identifies proposed safety improvements for the study area relating to three existing operational characteristics, and explains how recommended improvements would positively impact safety. Zones where the following improvement recommendations would be applicable are highlighted in **Figure 5.1**.

Figure 5.1
Safety Improvement Recommendations



Zone	Location	Recommendations
1	MP 465 to 467	• Widen shoulder • Add lighting
2	MP 450.5 to 453	• Widen shoulder • Add lighting • Potential drainage improvements • Additional speed limit signs and/or speed feedback signs
3	448.3 to MP 450.5	• Reduce posted speed to 45 mph • Continue center turn lane and lighting

4	N7 to 448.3	• Reduce posted speed to 35 MPH
		• Access Management
		  • Raised median with turn lanes
		  • Optional: Consolidate driveways

5.1.1 ADD LIGHTING

As described in Chapter 4, a significant proportion of crashes occurred in low-light or no-light conditions. Providing street lights in Zones 1-3 would increase driver reaction times to slow-moving vehicles and vehicles entering the highway, as well as animals, pedestrians, and other non-vehicular roadway hazards.

5.1.2 REDUCE SPEED

Like improved lighting, reducing the posted speed in zones that historically have had clusters of crashes would increase the amount of time drivers have to react to varying conditions. Increasing time available to drivers would afford them more opportunity to gain control of the vehicle and avert hazardous conditions, even a crash that appears probable or imminent. Improving time available to drivers also would have the benefit of potentially reducing the severity of vehicle and property damage as well as the severity of injuries incurred in crashes.

Therefore, a reduced posted speed is recommended in the commercial sector of Chinle north of the US-191/N7 intersection (Zone 4) and directly north of Chinle (Zone 3), where there is a transition from more densely developed land uses to a rural setting. Previous studies in 2012 and 2013 also called for analysis of speed limits north of Chinle.

5.1.3 ADDITIONAL SPEED CONTROLS

In Zone 2, where speed was revealed as a frequent factor in reported crashes, multiple options for speed control exist. The low-cost option would be simply to add additional speed limit signs. Currently, there are very few speed limit signs along US-191, and adding speed limit signs in both directions in this zone is recommended. Solar-powered signs exist that would reduce the cost and maintenance over time, but these signs would have a higher initial cost. This recommended improvement action partially would satisfy findings of previous studies that specified this type of improvement over longer segments of the highway and more types of signage along with speed controls. Other studies recommended solar feedback sign solutions in various places including Zone 3.

5.2 ACCESS CONTROL

As noted in Chapter 4, neither ADOT nor NDOT have formal design or development standards to assure access management practices are considered during development actions. The lack of access management practices during development has contributed to the head-on and sideswipe crashes that have occurred at access points, i.e., driveways and ingress/egress points to/from commercial areas and activities in Zone 4. **Figure 5.2** and **Figure 5.3** show two possible solutions to reduce the number of conflicting access points. Both options would include construction of a raised, center median with left-turn bays. The 2012 LRTP called for access management and raised medians in exactly the areas of Zone 4 for which the same is recommended by this study.

- **Option A: Install Raised Median, Relocate and Consolidate Driveways** – This option, would consolidate driveways/access points and constrain movements at other access points to right-in/right-out (RI/RO) turns only. The three, southern-most, ingress and egress access points for commercial properties on the west side of US-191would be consolidated into two new access points. These access points, which would allow both ingress and egress, would connect with a circulation drive internal to the developments and outside public right-of-way. The two new access points would be located at points in the median with dedicated left-turn bays and paired with an access point to property on the east side of US-191. In combination with the RI/RO restrictions, this option would eliminate drivers making left turns across through traffic at four locations on the west side of the highway and three locations on the east side of the highway. By eliminating these potential conflict points associated with closely spaced access points, this option would create safer traffic flow through the commercial zone. In addition, the median would eliminate southbound left turns into the Shell station, as this access point is located with the functional area of the US-191/N7 intersection.

Figure 5.2
Option A: Install Raised Median, Relocate and Consolidate Driveways

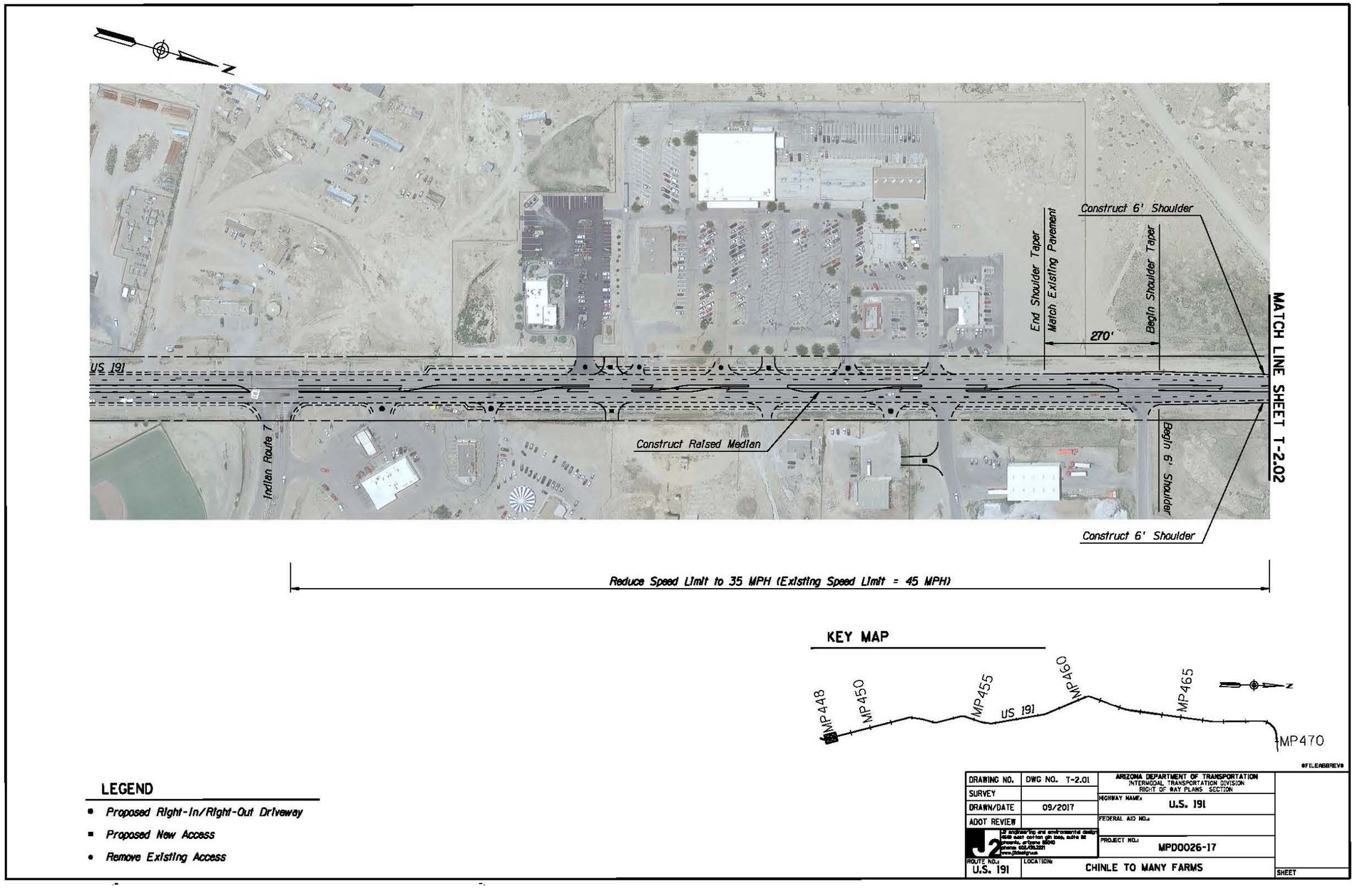
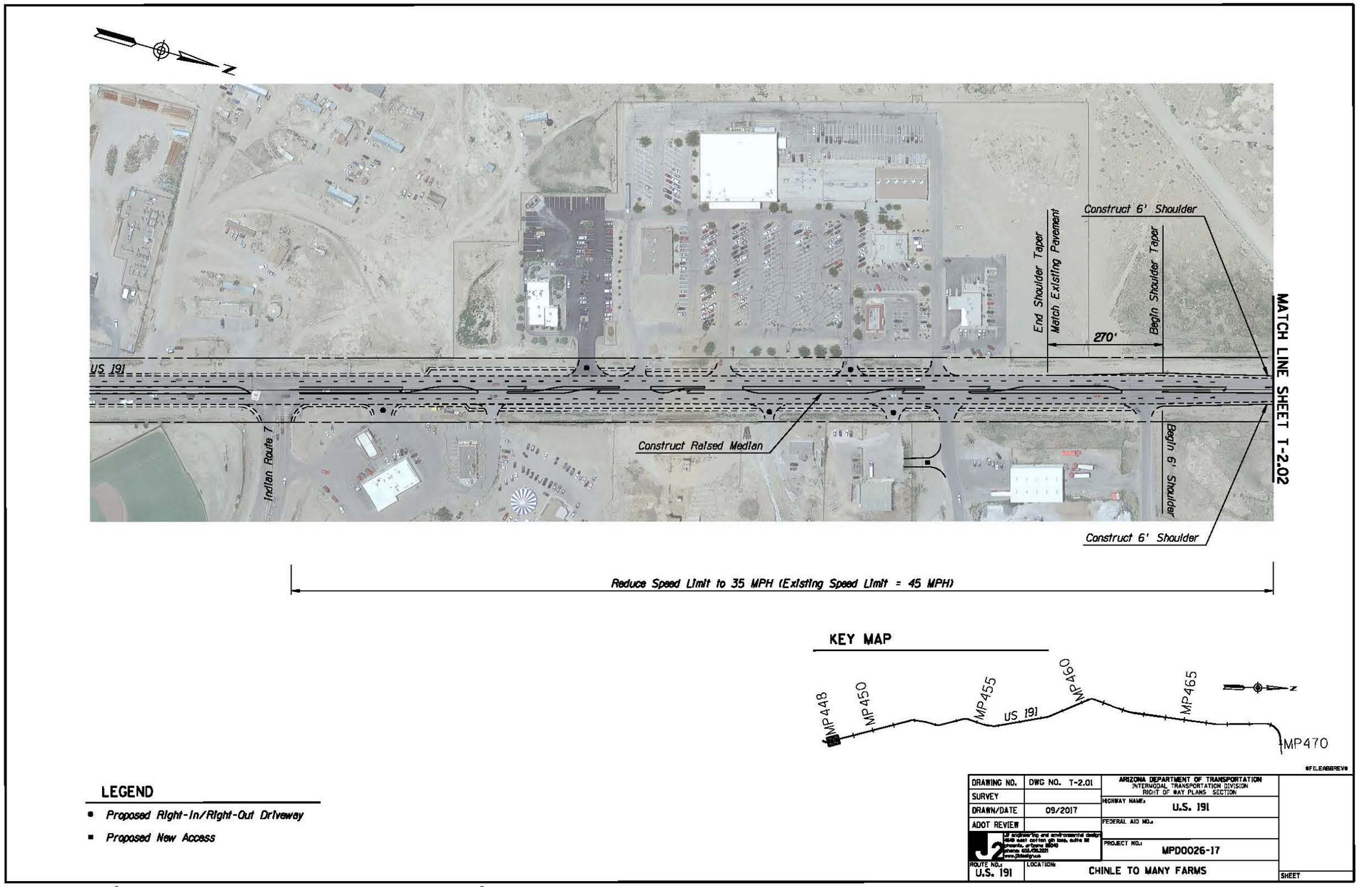


Figure 5.3
Option B: Install Raised Median



- **Option B: Install Raised Median** – This option does not include the recommendation to consolidate driveways or eliminate driveways. It does include recommendations to establish RI/RO restrictions at five access points. The median, under this option, would be constructed with dedicated left-turn bays at key locations, which would aid in maintaining through traffic movements and give left-turning vehicles a refuge location and point of decision. Access to the Shell station by southbound vehicles could be accommodated at a left-turn bay with access to the A&W Root Beer driveway leading to a circulation drive to the Shell station. This design of the median would eliminate left turns in the functional area of the US-191/N7 intersection, although detailed study would be necessary to verify the viability and impacts of this recommendation. This option was generally be more favorable to the public, as it would not as significantly reduce drivers' options for accessing commercial activity west of the highway as with Option A.

5.3 ROADWAY IMPROVEMENTS

There are three types of roadway improvement recommendations for the US-191 travel corridor through the study area: widening for a continuous left-turn lane, widening of shoulders, and pullouts for slow moving vehicles.

5.3.1 CONTINUE CENTER LEFT-TURN LANE OUTSIDE OF CITY LIMITS

There are a number of commercial and residential land uses with access to US-191 directly north of the Chinle Community, including the swap meet and transfer station. An existing center left-turn lane ends directly north of the community's commercial node, approximately one-third of a mile north of the US-191/N7 intersection. As a two-lane highway through Zone 3, the occurrence of left-turning vehicles can impeded high-speed traffic in an area where the posted speed is 65 mph. In light of this physical roadway conditions, it is recommended that the center left-turn lane be continued into Zone 3. In a segment where operating speeds are increasing, this improvement would aid in creating a safer flow of traffic by eliminating left-turn impedance/interference.

5.3.2 SHOULDER WIDENING

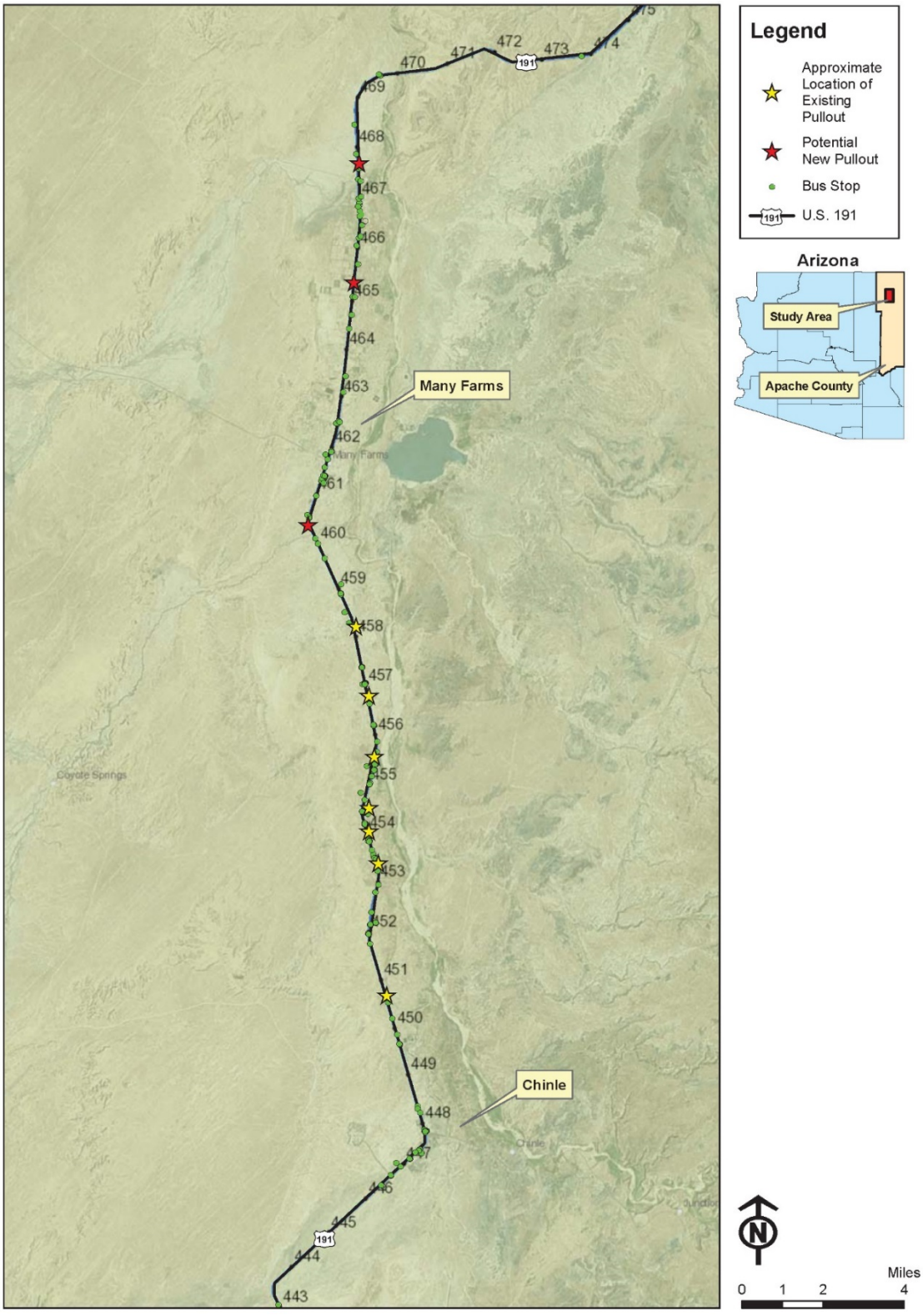
Shoulders on both sides of the majority of US-191 in the study area are less than two feet wide, which is inadequate for stopping a vehicle out of the traffic flow in the case of an emergency. ADOT's design guidelines require six to eight feet of paved shoulder on each side of a State highway, depending on the hourly volume. Shoulder widening for several reasons was noted in previous studies. Additionally, approximately 13 percent of crashes within the study area during the 2011-2015 reporting period involved a fixed object in the right-of-way. Examples include: fences, guard rails, sign posts, and parked cars. Some additional crashes involved a vehicle that ran off the road, but remained in the right-of-way. These facts support widening the shoulders in Zones 1 and 2 (refer to **Figure 5.1**). It is assumed that center turn lane improvements recommended in Zone 3 would also include widening of shoulders.

5.3.3 SLOW VEHICLE/ PULLOUTS

Slow moving vehicles can cause delays in the flow of traffic. This mode of operation potentially can result in crashes caused by drivers, who might choose to pass where the highway is only two lanes and the available sight distance is not adequate for safe passage. Slow-moving vehicles utilizing US-191 include: Recreational Vehicles (RVs), large commercial freight vehicles, agriculture-related equipment, and school buses. School buses, which make frequent and lengthy stops, create unique conditions during the boarding and deboarding of children. With little or no shoulder space for slow moving vehicles to pull aside, and no-passing laws covering a stopped school bus, long queues of other vehicles accumulate.

To mitigate unsafe conditions associated with vehicles stopped in the traffic lane, it is recommended that additional slow vehicle pullouts be constructed at strategic locations throughout the US-191 travel corridor in the study area. Several vehicle pullouts exist informally in the southern half of the corridor; these should be formalized to match construction of three new pullouts in the northern half. The locations of the existing informal pullouts and three proposed locations for new pullouts are shown in **Figure 5.4.** Additional slow vehicle/"bus" pullouts should be considered for the following locations: MP 452, MP 461.5, and MP 466.

Figure 5.4
Existing and Proposed Bus Stops and Slow Vehicle Pullouts



5.3.4 POTENTIAL DRAINAGE IMPROVEMENTS

Zone 2 includes a segment just south of MP 452 that is subject to over-the-road flooding during major precipitation events (refer to **Figure 4.3**). Previous studies identified this problem, which is noted on the last page of **Appendix D**. It is recommended that further analysis of flooding frequency, flooding magnitude, and culvert size be carried out to determine if an appropriate solution can be incorporated with the above recommended improvements.

5.4 FUTURE IMPROVEMENTS

Previous studies identified several improvements that are not part of the near-term recommendations defined in this study (see **Appendix D**). Nevertheless, these earlier proposals should be valued and continue to inform future improvement initiatives. Some specific improvements that merit future consideration in response to continued population growth include: additional travel lanes, turn lanes, and signalization of intersections. Additional signage, crosswalks, and crossing signals in school zones and other pedestrian areas, as well as shade structures at bus and transit stops also have been proposed. These improvements would provide protection not only from traffic, but, also, from the heat and potentially aid to increase transit use. Other recommendations from previous studies call for drainage improvements and signage at curves. These have not been included here, as they have not been prioritized as near-term solutions based on the crash data examined for the 2011-2015 reporting period.

5.5 RECOMMENDATIONS

Within the study area (between mileposts 447.8 to 467), there are several recommendations for safety improvements. Combined, the recommendations include: Median installation and driveway relocation/consolidation; widening the shoulders; repairing, replacing, and/or extending culverts;; clearing sediment and debris from culverts; adding reflective striping throughout project limits; providing larger signs; improving roadway lighting; repairing damaged culvert inlets and outlets on mainline and under driveways; repairing roadside erosion where needed; reseeding after construction; and installing rumble strips along newly widened shoulders. Table 5-1 displays the specific recommendations for each of the four zones within the study area. The timeframe for the recommendations are all near-term (within 0-5 years).

Table 5-1: Recommended Action

Zone	Milepost(s)	Recommended Action	Timeframe	Cost ($1,000s)
1	MP 465 – MP 467	WIDEN SHOULDER; REPAIR, REPLACE, AND/OR EXTEND 2 MAINLINE LATERAL CULVERTS; REPLACE AND/OR EXTEND 3 SIDELINE CULVERTS; ADD REFLECTIVE STRIPING THROUGHOUT PROJECT LIMITS; PROVIDE LARGER SIGNS; IMPROVE ROADWAY LIGHTING; REPAIR DAMAGED CULVERT INLETS AND OUTLETS ON MAINLINE AND UNDER DRIVEWAYS; REPAIR ROADSIDE EROSION WHERE NEEDED; RESEED AFTER CONSTRUCTION; INSTALL RUMBLE STRIPS ALONG NEWLY WIDENED SHOULDERS	Near-Term	1,513.0
2	MP 450.5 – MP 453	WIDEN SHOULDER; REPAIR, REPLACE, AND/OR EXTEND 8 MAINLINE LATERAL CULVERTS; REPLACE AND/OR EXTEND 4 SIDELINE CULVERTS; ADD REFLECTIVE STRIPING THROUGHOUT PROJECT LIMITS; PROVIDE LARGER SIGNS; IMPROVE ROADWAY LIGHTING; REPAIR DAMAGED CULVERT INLETS AND OUTLETS ON MAINLINE AND UNDER DRIVEWAYS; REPAIR ROADSIDE EROSION WHERE NEEDED; RESEED AFTER CONSTRUCTION; INSTALL RUMBLE STRIPS ALONG NEWLY WIDENED SHOULDERS	Near-Term	3,782.5
3	MP 448.3 – MP 450.5	WIDEN ROADWAY TO INCLUDE CENTER TURN LANE AND WIDER SHOULDERS; REPAIR, REPLACE, AND/OR EXTEND MAINLINE LATERAL CULVERTS; CLEAR SEDIMENT AND DEBRIS FROM CULVERTS; ADD REFLECTIVE STRIPING THROUGHOUT PROJECT LIMITS; PROVIDE LARGER SIGNS; IMPROVE ROADWAY LIGHTING; REPAIR DAMAGED CULVERT INLETS AND OUTLETS ON MAINLINE AND UNDER DRIVEWAYS; REPAIR ROADSIDE EROSION WHERE NEEDED; RESEED AFTER CONSTRUCTION; INSTALL RUMBLE STRIPS ALONG NEWLY WIDENED SHOULDERS	Near-Term	3,389.5
4	MP 447.8 – MP 448.3	INSTALL RAISED MEDIAN AND RELOCATE/CONSOLIDATE ACCESS AS NEEDED; REPAIR, REPLACE, AND/OR EXTEND MAINLINE LATERAL CULVERTS; CLEAR SEDIMENT AND DEBRIS FROM CULVERTS; ADD REFLECTIVE STRIPING THROUGHOUT PROJECT LIMITS; PROVIDE LARGER SIGNS; IMPROVE ROADWAY LIGHTING; REPAIR DAMAGED CULVERT INLETS AND OUTLETS ON MAINLINE AND UNDER DRIVEWAYS; REPAIR ROADSIDE EROSION WHERE NEEDED; RESEED AFTER CONSTRUCTION; INSTALL RUMBLE STRIPS ALONG NEWLY WIDENED SHOULDERS	Near-Term	999.3

APPENDICES

APPENDIX A

Heritage Data Management System (HDMS) Species List

SENSITIVE SPECIES - Chinle Quad

Quad Name	Scientific Name	Common Name	USESA	USFS	BLM	STATE	GRANK	SRANK	SGCN
CHINLE	Aletes macdougallii	Vagabond Parsnip					G3	S2	
CHINLE	Aster pauciflorus	Marsh Alkali Aster					G4	S1	
CHINLE	Athene cunicularia hypugaea	Western Burrowing Owl	SC	S	S		G4T4	S3	1B
CHINLE	Carex chihuahuensis	Chihuahuan Sedge		S			G3G4	S3	
CHINLE	Carex specuicola	Navajo Sedge	LT			HS	G2	S2S3	
CHINLE	Cirsium arizonicum var. chellyense	Navajo Thistle					GNR	S2	
CHINLE	Lithobates pipiens	Northern Leopard Frog		S	S		G5	S2	1A
CHINLE	Mentzelia	Holmgren's Stickleaf					GH	SH	
CHINLE	Mentzelia longiloba var. yavapaiensis	A Stickleaf					G5T2T3	S2S3	
CHINLE	Nama retrorsum	Betatakin Nama					G3	S2	
CHINLE	Oreoxis alpina	Alpine Acid Umbell					G4G5	S1	
CHINLE	Phacelia crenulata var. corrugata	Cleftleaf Scorpion-weed					G5TNR	S2S3	
CHINLE	Pica hudsonia	Black-billed Magpie					G5	S3	1B
CHINLE	Rorippa sinuata	Spreading Yellowcress					G5	S1S2	
CHINLE	Rosa woodsii ssp. puberulenta	Plateu Rose					G5TNR	S1	

Sources:
- Heritage Data Management System (HDMS) from HabiMap, Arizona State Wildlife Action Plan, Arizona Game and Fish Department (AZFGD).
- https://www.azgfd.com/wildlife/planning/wildlifeguidelines/rankdefinitions/
- https://www.azgfd.com/wildlife/planning/wildlifeguidelines/statusdefinitions/

SENSITIVE SPECIES DEFINITIONS

USESA - US Endangered Species Act

LT - Listed Threatened: In imminent jeopardy of becoming Endangered.

SC - Species of Concern: Proposed for Listing. The terms "Species of Concern" or "Species at Risk" should be considered as terms-of-art that describe the entire realm of taxa whose conservation status may be of concern to the US Fish and Wildlife Service, but neither term has official status (currently includes all former C2 and delisted species).

USFS - US Forest Service & BLM - Bureau of Land Management

S - Sensitive: Those taxa occurring on National Forest and BLM Field Office Lands in Arizona, which are considered sensitive by the Arizona State Office.

STATE - State of Arizona

HS - Highly Safeguarded: No collection allowed.

GLOBAL RANK (GRANK): Priority ranking (1 to 5) based on the number of occurrences* throughout the entire range of the element.

G2 - Imperiled: Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences* or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 30).

G3 - Vulnerable: Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences* or between 3,000 and 10,000 individuals.

G4 - Apparently Secure: Uncommon but not rare (although it may be in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences* of the species and more than 10,000 individuals.

G5 - Secure: Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences* of the species and more than 10,000 individuals.

G#G# Range Rank: A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty about the exact status of a taxon. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).

G#T# - Range Rank: T# Infraspecific Taxon (trinomial): The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species, for example, a G1T2 subrank should not occur. A vertebrate animal population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as infraspecific taxon and given a T rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status. **NR:** Not Ranked.

SRANK - Subnational Heritage Status Rank Definitions (Arizona)

S1 - Critically Imperiled: Critically imperiled in the subnation because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the subnation. Typically 5 or fewer occurrences* or very few remaining individuals (<1,000).

S2 - Imperiled: Imperiled in the subnation because of rarity or because of some factor(s) making it very vulnerable to extirpation from the subnation. Typically 6 to 20 occurrences* or few remaining individuals (1,000 to 3,000).

S3 - Vulnerable: Vulnerable in the subnation either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences* or between 3,000 and 10,000 individuals.

SH - Possibly Extirpated (Historical): Element occurred historically in the subnation, and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An Element would become SH without such a 20-year delay if the only known occurrences* in a subnation were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, SH-ranked Elements would typically receive an S1 rank. The SH rank should be reserved for Elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all Elements not known from verified extant occurrences.

SGCN - Species of Greatest Conservation Need

1A: Scored "1" for Vulnerability in at least one of the eight categories and matches at least one of the following: Federally listed as endangered or threatened under the Endangered Species Act (ESA); Candidate species under ESA; Is specifically covered under a signed onservation agreement (CCA) or a signed conservation agreement with assurances (CCAA); Recently removed from ESA and currently requires post-delisting monitoring; Closed season species (i.e., no take permitted) as identified in Arizona Game and Fish Commission Orders 40, 41, 42 or 43.

1B: Scored "1" for Vulnerability in at least one of the eight categories, but match none of the above criteria.

* The term occurences refers specifically to element occurrences, i.e., recognition of habitat, stressors, etc.

Sources:
- Heritage Data Management System (HDMS) from HabiMap, Arizona State Wildlife Action Plan, Arizona Game and Fish Department (AZFGD).
- https://www.azgfd.com/wildlife/planning/wildlifeguidelines/rankdefinitions/
- https://www.azgfd.com/wildlife/planning/wildlifeguidelines/statusdefinitions/

APPENDIX B

Species of Greatest Conservation Need (SGCN) List

SPECIES OF GREATEST CONSERVATION NEED LIST

This is a list from the Arizona State Wildlife Action PLLan (SWAP) idetnifying which Species of Greatest Conservation Need (SGCN) potentially occur with the US-191 corridor/study area.

Grid ID	Taxa	Common	Scientific	Tier*
3746	Mammal	Abert's Chuska Squirrel	Sciurus aberti chuscensis	1b
3746	Mammal	American Beaver	Castor canadensis	1b
3746	Bird	American Peregrine Falcon	Falco peregrinus anatum	1a
3746	Mammal	Arizona Myotis	Myotis occultus	1b
3746	Bird	Bald Eagle	Haliaeetus leucocephalus	1a
3746	Mammal	Banner-tailed Kangaroo Rat	Dipodomys spectabilis	1b
3746	Bird	Black-billed Magpie	Pica hudsonia	1b
3746	Mammal	Black-footed Ferret	Mustela nigripes	1a
4350	Mammal	Colorado Chipmunk	Tamias quadrivittatus	1b
3746	Bird	Common Nighthawk	Chordeiles minor	1b
3746	Bird	Ferruginous Hawk	Buteo regalis	1b
3746	Bird	Golden Eagle	Aquila chrysaetos	1b
3746	Mammal	Gunnison's Prairie Dog	Cynomys gunnisoni	1b
3746	Mammal	Kit Fox	Vulpes macrotis	1b
3746	Bird	Lincoln's Sparrow	Melospiza lincolnii	1b
3746	Mammal	Mexican Free-tailed Bat	Tadarida brasiliensis	1b
4660	Bird	Mexican Spotted Owl	Strix occidentalis lucida	1a
3746	Mammal	Mexican Vole	Microtus mexicanus	1b
3746	Amphibian	Northern Leopard Frog	Rana pipiens	1a
3746	Bird	Pacific Wren	Troglodytes pacificus	1b
3746	Mammal	Pale Townsend's Big-eared Bat	Corynorhinus townsendii pallescens	1b
3746	Bird	Pinyon Jay	Gymnorhinus cyanocephalus	1b
3746	Mammal	Red Fox	Vulpes vulpes	1b
3746	Mammal	Rock Mouse	Peromyscus nasutus (difficilis)	1b
3746	Mammal	Spotted Bat	Euderma maculatum	1b
4350	Mammal	Stephen's Woodrat	Neotoma stephensi	1b
3746	Bird	Western Burrowing Owl	Athene cunicularia hypugaea	1b
3746	Bird	Yellow Warbler	Dendroica petechia	1b
3746	Mammal	Yuma Myotis	Myotis yumanensis	1b

*Tiers:

1A - Scored "1" for Vulnerability in at least one of the eight categories and matches at least one of the following:
- Federally listed as endangered or threatened under the Endangered Species Act (ESA); Candidate species under ESA;
- Is specifically covered under a signed conservation agreement (CCA) or a signed conservation greement with assurances (CCAA);
- Recently removed from ESA and currently requires post-delisting monitoring;
- Closed season species (i.e., no take permitted) as identified in Arizona Game and Fish Commission Orders 40, 41, 42 or 43.

1B - Scored "1" for Vulnerability in at least one of the eight categories, but match none of the above criteria.

Source: Species of Greatest Conservation Need Query at selected locations along the US-191 corridor in HabiMap, Arizona State Wildlife Action Plan, Arizona Game and Fish Department (AZFGD).

APPENDIX C

Arizona Breeding Bird Atlas List: US-191 Corridor

ARIZONA BREEDING BIRD ATLAS LIST: US-191 Corridor

This list is based on the results of surveys at a block level (approx. 10 sq. miles) and displayed at a quad level. It includes all detections of bird species determined to be possible, probable, or confirmed breeding within each block.The list identifies breeding bird species potentially occurring in the Chinle Quad.

Quad Name	Species Name	Breeding Code
CHINLE	American Crow	Possible
CHINLE	American Kestrel	Confirmed
CHINLE	Ash-throated Flycatcher	Possible
CHINLE	Bendire's Thrasher	Possible
CHINLE	Black-billed Magpie	Confirmed
CHINLE	Black-chinned Hummingbird	Possible
CHINLE	Blue Grosbeak	Possible
CHINLE	Brewer's Sparrow	Possible
CHINLE	Brown-headed Cowbird	Probable
CHINLE	Bullock's Oriole	Confirmed
CHINLE	Burrowing Owl	Confirmed
CHINLE	Cliff Swallow	Confirmed
CHINLE	Common Raven	Confirmed
CHINLE	Cooper's Hawk	Possible
CHINLE	European Starling	Confirmed
CHINLE	Horned Lark	Possible
CHINLE	House Finch	Possible
CHINLE	House Sparrow	Confirmed
CHINLE	Killdeer	Possible
CHINLE	Lark Sparrow	Confirmed
CHINLE	Mourning Dove	Probable
CHINLE	Northern Mockingbird	Confirmed
CHINLE	Rock Pigeon	Confirmed
CHINLE	Rock Wren	Confirmed
CHINLE	Say's Phoebe	Confirmed
CHINLE	Western Kingbird	Probable
CHINLE	Western Wood-pewee	Possible
CHINLE	Yellow Warbler	Possible
CHINLE	Yellow-breasted Chat	Possible

Source: Arizona Breeding Bird Atlas Query, Chinle Quad in HabiMap, Arizona State Wildlife Action Plan, Arizona Game and Fish Department (AZFGD).

APPENDIX D

Information Sources and Previously Identified Issues and Proposals for Improvement

Information Sources and Previously Identified Issues and Proposals for Improvement

Document(s)	Date	Location (MP or Intersection)	Identified Issue	Previous Recommendations
US-191 Roadway Safety Assessment (RSA)	June 2012	MP 444 - 465	Lane Departure Crashes	• Provide paved shoulders with edge-line rumble strips. • Refresh pavement markings, to include installation of raised center-line pavement markers. • Install center-line rumble strips. • Highlight/identify horizontal curves with flexible delineators, chevrons and curve warning signs, as appropriate.
Many Farms Chapter Planning and Zoning Committee Notes US-191 RSA Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study US 191, Junction of N4 to Many Farms: Final Feasibility Report	July 2013 June 2012 May 2012 Nov. 2006	MP 444 - 465	Pedestrians	• Evaluate the need for a High intensity Activated crossWalK (HAWK) Pedestrian Hybrid Beacon near the high school/elementary school and/or near Bashes Grocery in Chinle. • Install pedestrian crossing warning signs in Many Farms in the vicinity of N59. • Evaluate the need for a school crosswalk at Many Farms Elementary School. • Install pedestrian countdown signal heads at the US-191/N7 intersection in Chinle. • Evaluate the existing street lighting in Chinle and determine the proper illumination and uniform light pattern design for pedestrian activity. • Check beacons that warning signs at Many Farms Elementary are flashing properly. • Provide more accommodations for pedestrian movements, including school crossings, Pedestrian Hybrid Beacons (or Pedestrian Bridges), paths along US-191, and high visibility crosswalks near schools and shopping areas.
Many Farms Chapter Planning and Zoning Committee Notes US-191 RSA	July 2013 June 2012	MP 444 - 465	Rear End Crashes	• Evaluate major intersections to determine the need for turn lanes. • Install advance intersection signing at major intersections. • Install cattle guard delineation notices.
Many Farms Chapter Planning and Zoning Committee Notes US-191 RSA	July 2013 June 2012	MP 444 - 465	Speeding	• Install solar-powered, speed feedback signs in Many Farms. • Evaluate use of photo radar enforcement in Many Farms. • Conduct speed studies to determine appropriate speed limits in Chinle and Many Farms.
US-191 RSA	June 2012	N59 & US-191	Lighting	• Evaluate the need for lighting at US-191/N59 intersection.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012	MP 465 - 444	Byway Designation	• Consider extending the byway designation to Chinle.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study US-191, Junction of N4 to Many Farms: Final Feasibility Report	May 2012 Nov. 2006	N59 & US-191	Traffic Control	• Provide a traffic signal or a roundabout at the US-191/N59 intersection.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012	MP 446.6 – 448.2	Lighting	• Evaluate existing street lighting in Chinle for proper illumination and uniform light pattern for pedestrian safety.
Many Farms Chapter Planning and Zoning Committee Notes Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	July 2013 May 2012	MP 451.8, 454.4, 455.3, 460.3	Horizontal Curve Delineation	• Highlight/identify horizontal curves with flexible delineators, chevrons, and curve warning signs, as appropriate.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012	MP 446.6 – 448.2	Multi-modal Transportation	• Construct shared-use path along US-191. • Local transit service within Chinle and Many Farms – Routes to be determined by Navajo Transit System (NTS). • Evaluate potential locations for Transit Shelters. • Design and construct a Transit Center in Chinle.
Letter to ADOT from Navajo Office of Legislative Services	March 2016	Varies	Planning Needs	• Establish short- and long-range plan needs for US-191.
Many Farms Chapter Planning and Zoning Committee Notes Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study US-191, Junction of N4 to Many Farms: Final Feasibility Report	July 18, 2013 May 2012 Nov. 2006	MP 446-463	Shoulder striping, signing, and marking improvements	• Provide paved shoulders with edge-line rumble strips • Refresh pavement markings and install raised center-line pavement markers. • Provide center-line rumble strips. • Install bus stop ahead signs, where needed. • Remove unused sign posts and replace missing or damaged signs. • Remove any private signs from roadway sign posts. • Install 360 degree retroreflective delineators on sign posts. • Develop more signs to identify amenities along the corridor. • Add shoulders and reflective delineators in rural areas. • Provide high visibility crosswalks in Chinle and Many Farms.

Information Sources and Previously Identified Issues and Proposals for Improvement (Continued)

Document(s)	Date	Location (MP or Intersection)	Identified Issue	Previous Recommendations
Many Farms Chapter Planning and Zoning Committee Notes	July 18 & August 22, 2013	MP 452 and 460.3	Bus Pullouts	• Design and construct bus pullouts.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012	MP 466, 467		• Provide bus pullouts and rest areas for truckers (MP 466 & 467).
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006			• Provide bus pullouts for school buses.
Many Farms Chapter Planning and Zoning Committee Notes	July 18, 2013	MP 460 – 463 and MP453	Speeding	• Install solar speed monitors at two locations – Coordinate with a speed study.
Many Farms Chapter Planning and Zoning Committee Notes	April 18, 2016	MP 441 - 463	Widening/ Capacity	• Replace/widen Black Mountain Wash Bridge (MP 460.26) • Widen US-191 to four lanes. • Improve roadway geometrics and flatten roadway where US-191 is at 7%.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012			• Widen shoulders; construct turn lanes and larger driveway turnouts.
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006			
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006	MP 441 - 463	Passing Lanes	• Add passing/climbing lanes, where US-191 is at 7% or greater.
Chinle-Many Farms & St. Michaels-Window Rock-Fort Defiance Multimodal Long Range Transportation Study	May 2012	MP 444 - 465	Access Management	• Construct medians and assert greater access management through Chinle. • Develop detailed Access Control Plan for opportunities to plan new access points to US 191. • Combine existing driveways in the immediate vicinity of US 191/ N7 intersection.
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006	MP 441 - 463		
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006	Between N7 & N59	Fencing/Livestock	• Install new fencing, cattle guards, and gates, where needed.
Letter to ADOT from Navajo Office of Legislative Services	March 2016	MP 446 - 462	Drainage/Erosion	• Design and initiate erosion control in US-191 right-of-way, where needed. • Trim overgrown plants and vegetation along US-191.
US-191, Junction of N4 to Many Farms: Final Feasibility Report	Nov. 2006			• Perform a drainage study in Chinle to ascertain routing of needed storm drain with outflow to Chinle Wash. • Upgrade 36 undersized culverts and improve roadway profile of US-191. • Adequately size culverts for long-range projects.