2. TRAFFIC AND ACCIDENT DATA

2.1 Traffic Analysis

2.1.1 Existing Conditions

Existing US 93 between SR 89 and the Santa Maria River is generally a two-lane, rural principal arterial roadway with good horizontal and vertical alignment. The terrain is considered level along US 93 within the study limits except for approximately 15 miles south of the Santa Maria River, which is classified as rolling terrain. Between SR 71 and the Santa Maria River, there are several segments of US 93 that have been improved to include an additional lane for climbing and passing. The paved shoulder width varies from 5-feet near the north end of the study area to 8-feet through the southerly part of the project. US 93 is a divided 4-lane highway near the junction of SR 89 and near the Santa Maria River. The posted speed limit is 65 mph except near the Santa Maria River Bridge where the posted speed limit is 55 mph and near the junction of SR 89 where the posted speed limit is also 55 mph. Travel speeds frequently exceed the posted speed limit through this section of highway.

2.1.2 Study Sections

For traffic analysis purposes, the US 93 corridor from MP 193.90 to 161.7 was divided into six sections based on existing traffic characteristics, roadway widths, number of lanes, functional classification, horizontal and vertical alignment, terrain, topography and access conditions.

2.1.3.1 Section 1: MP 193.50 to 193.22

Section 1 consists of a divided highway through the junction of SR 89 and US 93. This rural principal arterial includes 2 traffic lanes in each direction, with a 4-foot wide inside shoulder, and a 10-foot wide outside shoulder.

2.1.3.2 Section 2: MP 193.22 to 182.88

Section 2 begins at the northerly end of the SR 89 intersection channelization and ends at the junction of SR 71. US 93 is classified as a rural principal arterial. The undivided roadway includes a lane of through traffic in each direction and 8-foot shoulders. Approximately 15 percent of the roadway in this section is designated no-passing zone. This section also includes the SR 71 overpass, Matthie railroad overpass (MP 192.88) and several residential driveways between the railroad overpass and MP 191. The entrance to a large residential subdivision called Vista Royale is located near MP 192.1. The terrain is generally level.

2.1.3.3 Section 3: MP 182.88 to 177.04

This section consists of a rural principal arterial in level terrain beginning at the junction of SR 71. The 40-foot wide undivided roadway section includes a single lane of traffic in each direction with 8-foot shoulders. Beginning at MP 182.68 the roadway section was recently restriped to include two northbound lanes and one southbound lane, each with 2-foot shoulders. This northbound passing lane ends near MP 181.4. A similar southbound passing lane section begins at MP 179.6 and ends near MP 180.6. About 19 percent of the length of the roadway in this section is designated as no-passing. Alamo Road intersects US 93 at MP 178.6 and Date Creek Ranch Road intersects US 93 at MP 177.4. Beginning at MP 180, the road is designated as the Joshua Forest Scenic Road, and continues as such through the balance of the project.

2.1.3.4 Section 4: MP 177.04 to 169.18

This section also consists of a rural principal arterial in rolling terrain. This 34-foot wide undivided section includes one through traffic lane in each direction and 5-foot wide paved shoulders. The existing pavement was re-striped to add a southbound climbing lane from MP 174.3 to MP 175.6 and a northbound climbing lane from MP 173.5 to MP 172.7. About 18 percent of the length of the roadway in this section is designated as no-passing. The section includes the Date Creek Bridge at MP 174.20, and is designated as the Joshua Forest Scenic Road.

2.1.3.5 Section 5: MP 169.18 to 167.74

Section 5 is a 4-lane undivided rural principal arterial in rolling terrain. The 58-foot wide section was constructed in 1998 to provide a mile of passing opportunity, with two 12-foot wide travel lanes in each direction, as well as including 5-foot shoulders.

2.1.3.6 Section 6: MP 167.74 to 161.5

Section 6 begins at the ending of the previous passing lane, and ends at the beginning of the new divided highway section near the Santa Maria River. The section consists of a 2-lane, undivided rural principal arterial highway traversing rolling terrain. The roadway section is 34-feet wide with 12-foot wide travel lanes with 5-foot shoulders. 11 percent of the length is designated as no-passing. The section includes the Big Jim Wash Bridge at MP 165.54 and is within the designated Joshua Forest Scenic Road limits.

2.1.3 Traffic Data

ADOT's Transportation Planning Division provided traffic volume data for existing (2000) and future (2025) design year conditions, peak hour factors (K), directional splits (D), and truck (T) data. Traffic volume information was gathered by Automatic Traffic Recorders (ATR) at MP 169.00 and MP 188.30. Current and projected traffic volumes for US 93 are shown in Table 2-1. The year 2025 is considered the design year for the purposes of this report.

Table 2-1. US 93 Traffic Volumes

Section	2000 ADT	2025 ADT	Growth Rate Per Year (%)
Sections 1& 2	6600	9400	1.42
Sections 3, 4, 5 & 6	6000	8900	1.60

Existing roadway characteristics for each section are summarized in Table 2-2. The K factor was used to determine peak hour volumes (PHVs).

Table 2-2. US 93 Roadway Characteristics

Roadway Characteristics	Section					
	1	2	3	4	5	6
Des. Hr. Factor (K)	14	14	14	14	14	14
Direct. Factor (D)	50	50	50	50	50	50
Truck Percentage	28	28	28	28	28	28
RV Percentage	1.5	1.5	1.5	1.5	1.5	1.5
No Pass Percentage	-	15	19	18	-	11
Pk. Hr. Factor (PHF)	0.94	0.94	0.94	0.94	0.94	0.94
Des. Spd. (mph)	70	70	70	65	65	65
2000 PHV (vph)	920	920	840	840	840	840
2025 PHV (vph)	1320	1320	1250	1250	1250	1250
Terrain	L	L	L	R	R	R
Typical Section	4-ln.	2-ln.	2-ln.	2-ln.	4-ln.	2-ln.

2.1.4 Level of Service Analysis

The method used for describing and determining highway capacity and traffic operating conditions in this study is outlined in the Highway Research Board's Highway Capacity Manual (HCM), 3rd Edition, and has been expressed in terms of Level of Service (LOS). For the analysis of two-lane highways, the LOS is a function of operating speeds, time delays, and passing sight distance. Multilane highway LOS is a function of traffic density – the ability for motorists to maneuver in the traffic stream.

Tables 2-3 and 2-4 briefly describe the different levels of service for two-lane and for multilane highways.

Table 2-3 Levels of Service for Two-Lane Highways

LOS	Two-Lane Highways
A	Average speeds approach 60 mph and passing frequency is not demanding
B	Average speeds of 55 mph can be expected and passing demand becomes significant to maintain speeds; demand equals capacity
C	Noticeable increases in platoon formations with average speeds of 52 mph; flow is stable but susceptible to congestion due to turning
D	Average speeds of 50 mph with unstable traffic flow; passing becomes impossible as demand exceeds capacity
E	Average speeds are below 50 mph with passing virtually impossible
F	Disturbances in flow cause LOS E to rapidly degenerate to LOS F

Table 2-4 Levels of Service for Multilane Highways

LOS	Multilane Highways
A	Free-flow conditions with minor disruptions easily absorbed
B	Average speeds are same as LOS A speeds, but ability to maneuver decreases
C	Affect of density on traffic flow is noticeable; minor disruptions may cause localized deterioration in service
D	Traffic congestion seriously impedes motorists ability to maneuver; minor disruptions cause service to deteriorate to LOS E and F
E	Operations are at or near capacity; flow is unstable and susceptible to queuing
F	Flow breaks down; vehicles experience stop-and-go movements

2.1.4.1 Ideal Conditions

Two-Lane Highways – Ideal conditions for two-lane highways as outlined in the *Highway Capacity Manual* are defined by the following characteristics:

- Capacity of 2,800 passenger cars per hour total, both directions
- Design speeds greater than or equal to 60 mph
- Lane widths greater than or equal to 12 feet
- Clear shoulder width of 6 feet or more
- No "No Passing Zones"
- All passengers cars in the traffic stream
- A 50/50 directional split of traffic
- No impediments to through traffic due to either traffic control or turning vehicles
- Level terrain

Multilane Highways – Ideal conditions for multilane highways as described in the Highway Capacity Manual are defined by the following:

- Capacity of 2,200 passenger cars per hour per lane
- Free flow speeds of 60 mph or greater
- Level terrain
- Lane widths greater than or equal to 12 feet
- Total lateral clearance greater than or equal to 12 feet from the edge of traveled way to obstructions on the edge of pavement or the median (left side plus right side along a roadway in one direction of travel)
- No direct access points along the roadway
- Divided highway
- Only passenger cars in the traffic stream

Ideal highway capacity is adjusted to an actual capacity based on actual roadway characteristics. Highway Capacity Software (HCS) was used to perform highway segment analysis as outlined in Chapters 7 & 8 of the HCM. HCS uses information such as peak hour factor, directional split, heavy vehicle percentages, lane widths and clearances, and access points per mile to determine a roadway's ability to move traffic for actual or real conditions.

The year 2025 was established as the design year for this study with a Level of Service "B" desired for the mainline and at signalized intersections.

2.1.4.2 Year 2000 Existing Conditions

The estimated levels of service for US 93 from SR 89 to the Santa Maria River are presented in Table 2-5.

Table 2-5 Existing (2000) Levels of Service

Roadway Segment (MP Limits)	Existing LOS	Existing # of Lanes
1 – MP 193.90 to MP 193.22	A/A	4
2 – MP 193.22 to MP 182.88	D	2
3 – MP 182.88 to MP 177.04	D (D/A*)	2 (3)
4 – MP 177.04 to MP 169.18	E (E/A*)	2 (3)
5 – MP 169.18 to MP 167.74	A/A	4
6 – MP 167.74 to MP 161.5	E	2

B/B – Level of service for each direction on multilane highway
* Climbing lane or passing lane sections LOS each direction

Table 2-5 shows that the four lane sections of US 93 in the study area are operating at an acceptable level of service (LOS A). The 2-lane sections are generally operating at LOS D or E. Sections 3 and 4 have passing lane and climbing lane sections. The single lane direction opposite the climbing lane generally operates at the same LOS as the adjacent 2-lane highway section. In the passing lane or climbing lane direction, the LOS is A. The 2-lane segments do not meet the corridor improvement criteria of LOS B.

2.1.5 US 93/SR 71 TI Analysis

Interchange capacity features were reviewed for the US 93/SR 71 TI. The approximate capacity of ramp roadways based on free-flow ramp speeds is delineated in Table 5-6 of the HCM (Special Report 209). This table indicates that a single-lane ramp with a free-flow speed as low as 20 mph has a capacity of approximately 1,800 passenger cars per hour per lane (pcphpl). The horizontal and vertical alignment of the ramps meets current design standards, but the ramp width is substantially less than currently required. The width of the ramps is 16-feet while current guidelines require 22-feet. The free-flow speed of each ramp is assumed to be well over 20 mph. Thus, the existing capacity of all ramps is estimated to be at least 1,800 pcphpl. All ramps exhibit adequate capacity for the design-year ADT.

2.1.6 2025 Future Conditions

Future (2025) levels of service were estimated based on future traffic volume projections provided by ADOT (see Table 2-1). The roadway characteristics were assumed to be the same for the 2025 design hour as they currently exist. The results of this analysis provided an estimation of future traffic operations under "no build" conditions. Levels of service for year 2025 conditions are presented in Table 2-6.

Table 2-6 Future (2025) Levels of Service

Roadway Segment	Future LOS	Existing # of Lanes (no-build)
1 – MP 193.90 to MP 193.22	A/A	4
2 – MP 193.22 to MP 182.88	E	2
3 – MP 182.88 to MP 177.04	E (E/A*)	2 (3)
4 – MP 177.04 to MP 169.18	F (F/A*)	2 (3)
5 – MP 169.18 to MP 167.74	A/A	4
6 – MP 167.74 to MP 161.5	F	2

B/B – Level of service for each direction on multilane highway
* Climbing lane or passing lane sections LOS each direction

Table 2-6 shows that the four lane rural segments of US 93 in the study area will operate at LOS A in 2025. The 2-lane segments on US 93, including the single lane direction opposite climbing lanes, will generally operate at LOS E or F. In the passing lane or climbing lane direction, the LOS is A. The 2-lane rural segments (2-4, and 6) do not meet the desired LOS B.

2.2 Accident Analysis

Accident data was provided by the Accident Records Branch of the Traffic Engineering Section, Arizona Department of Transportation. The available data was for the time period from May 1st 1997 through April 30th 2002. The accident data was reviewed and analyzed in order to identify potential high accident locations or accident trends. Accident rates were derived for US 93 by section and by milepost. The following equation was used to calculate the accident rates:

R_s = [No. of Accidents x 10^6] / [365 days * No. of years of data * Average Daily Traffic * Length of Roadway Segment]

The units of this equation are in accidents per million vehicle miles traveled (acc/MVM).

2.2.1 Corridor Accident Rates

Table 2-7 and Figure 2-1 summarizes the average annual accident rates calculated for US 93, by section, over the last five years.

Table 2-7. US 93 Accident History for Study Sections (May 1997 through April 2002)

Section & Milepost	Dist. (miles)	ADT	Terrain	Number of Acc.	Acc. Rate*
1- MP 193.90 to MP 193.22	0.68	6,595	Level	6	0.73
2- MP 193.22 to MP 182.88	10.34	6,595	Level	52	0.42
3- MP 182.88 to MP 177.04	5.84	6,016	Level	42	0.66
4- MP 177.04 to MP169.18	7.86	6,016	Rolling	63	0.73
5- MP 169.18 to MP 167.74	1.44	6,016	Rolling	15	0.95
6- MP 167.74 to MP 161.5	6.04	6,016	Rolling	40	0.60

*Number of accidents per million vehicle miles per year

Of the 15 accidents that occurred in Section 5, 8 of them occurred prior to completion of the 4-lane roadway in May 1998. From May 1998 through April 2002, just 7 accidents occurred in that section of roadway.

Of the 6 accidents that occurred in Section 1, 5 of them were collisions with another vehicle. This section is entirely within the area of the US 93/SR 89 intersection.

2.2.2 Corridor Accident Types

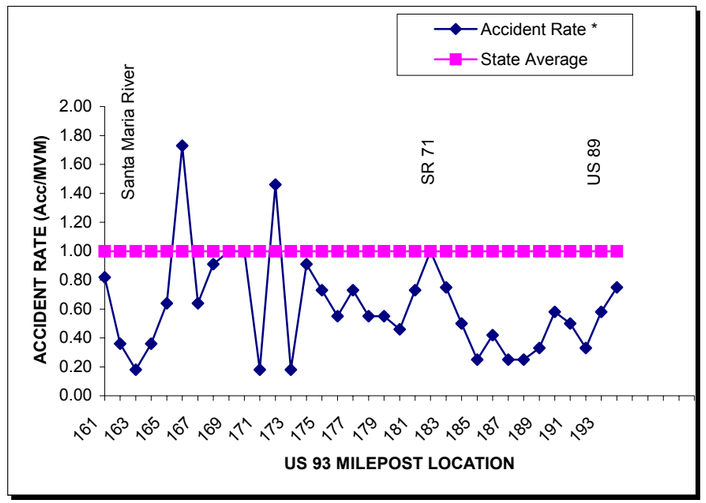
Table 2-8 summarizes selected types of accidents that occurred for each section on US 93 for the time period between May 1997 and April 2002.

Table 2-8 US 93 Accident Type Summary by Study Section

Roadway Section	1	2	3	4	5	6
Total Accidents	6	52	42	63	15	40
Single Vehicle	1	31	27	40	7	25
Sideswipe	1	6	2	8	0	6
Collision	0	5	2	3	0	3
Rear End	0	8	9	8	7	6
Head On	0	1	2	4	1	0
Left Turn	1	0	0	0	0	0
Angle	3	1	0	0	0	0
Total Injuries	4	21	44	47	3	28
Total Fatalities	0	2	3	4	3	0

The most common type of accident for US 93 within the study limits is the single vehicle accident, which accounts for approximately 60 percent of the total number of accidents. Many of the single vehicle accidents (approximately 17%) involved wild game or livestock.

Figure 2-1 Accident Rate by Milepost Location 1997-2002



The accident rates calculated for each milepost indicate areas with relatively high accident rates (greater than 1.0 acc/MVM). These areas are summarized as follows:

- US 93 MP 166 – 1.73 acc/MVM: There are no obvious physical features that could contribute to accident hazard except perhaps the long continuous grade at 3 to 5 percent. Most of the accidents were single vehicle type. Rear-end and sideswipe accidents also occurred. 19 injuries resulted from accidents.

- US 93 MP 172 – 1.46 acc/MVM: Mile 172 includes a rest stop on the inside of a horizontal curve. Most of the accidents were single vehicle. Rear-end and sideswipe accidents also occurred.

The number of accidents in each of the years from 1997 to 2002 remained fairly constant with an average 44 accidents per year on US 93.

2.3 Conclusions

US 93 between the intersection with SR 89 and the crossing of the Santa Maria River consists primarily of a undivided, rural 2-lane highway. Without improvement, the 2-lane roadway sections will deteriorate to a LOS of either E or F by the year 2025. Widening the existing 5-foot paved shoulder width to 8 feet in Sections 4 and 6 will improve the LOS to level E, which would still be below the desired LOS of B.

Passing lanes are provided and assist in the dispersal and breakup of traveling platoons of vehicles on the 2-lane highway. If located appropriately, they can improve the overall level of service of the highway. While the HCM methodology does not quantify the affects to LOS of climbing lanes and passing lanes on the 2-lane rural highways as a whole, the localized effects can be quantified. Climbing lanes have been added to Section 4 on either side of Date Creek and passing lanes have been striped in Section 3. Adding a southbound climbing lane in Section 6 from the Santa Maria River south would help traffic flow up a long continuous incline and improve LOS in the southbound direction, as well as improve safety by avoiding the need to make the potentially hazardous passing movement against opposing traffic. However, the LOS of the northbound traffic may decrease due to the installation of no-passing striping adjacent to the southbound climbing lanes.

The existing 2-lane segments of US 93 generally have adequate horizontal and vertical alignments and the no-passing zones are minimal (11 to 34 percent). The only way to improve the level of service on these sections is to add an additional traffic lane in each direction. The result achieves LOS A for the entire study area of US 93 (Sections 1-6) for 2025 traffic.

2.4 Recommendations

US 93, from the Junction of SR 89 to the Santa Maria River, is essentially an undivided, two-lane rural highway. The level of service analysis and review of accident data indicate that the highway already performs at LOS D and E, and will deteriorate to LOS E and F without improvement. It is recommended that the roadway be widened to a four-lane divided highway. A divided facility is a safer roadway than a non-divided roadway as it separates opposing traffic and does not necessitate passing opportunities using opposing lanes. The divided roadway also offers the opportunity to control turning traffic (median crossovers) for increased safety and operational efficiency. Finally, the divided highway provides better access control than a non-divided highway, which will accommodate the ultimate desire of ADOT to make US 93 a fully access-controlled facility in the future.