UTAH DEPARTMENT OF TRANSPORTATION (UDOT)
REGION 4
U.S. ROUTE 89 PASSING LANES STUDY (MP 0-312)

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Executive Summary

U.S. Highway 89 (U.S. 89), spanning central Utah from Arizona to Idaho, is a critical transportation corridor for the movement of freight, vehicle travel and access to recreational opportunities. The project area for this passing lanes study is located between milepost (MP) 0 at the Utah/Arizona state line to MP 312 at the junction with U.S. Highway 6 (U.S. 6) in Spanish Fork Canyon. This analytical report represents the first stage in the implementation of a passing lane project. Through a diagnostic effort that includes a field assessment, analysis of crash data and traffic engineering expertise, proposed new passing lanes have been identified that will enhance safety and improve the long-term efficiency, reliability, and cost competitiveness to move people and freight along U.S. 89. From this study, the table below shows the proposed passing lanes for U.S. 89 between MP 0 and MP 312.

Table 1 – U.S. 89 Recommended New Passing Lanes

Direction	Map Label (Figure 1)	Begin MP	End MP	Total Length (miles)	Comments
Southbound (SB)	SB P-1	292.5	290.0	2.5	Long grade. Narrow back to one lane before turn lanes at top of hill.
	SB P-2	244.1	243.6	0.5	Grade. Narrow back to one lane before turn lanes at top of hill.
	SB P-3	175.5	174.5	1.0	Interval-based. Flat. Start after Cottonwood Canyon National Forest access.
	SB P-4	143.7	143.2	0.5	Grade.
	SB P-5	114.0	113.3	0.7	Grade. Start after bridge structure.
	SB P-6	17.0	16.0	1.0	Interval-based. Flat.
Northbound (NB)	NB P-1	295.0	296.0	1.0	Interval-based. Flat.
	NB P-2	286.7	288.3	1.6	Long grade.
	NB P-3	251.6	252.1	0.5	Grade. Narrow back to one lane before accesses at top of hill.
	NB P-4	232.0	233.0	1.0	Interval-based. Flat.
	NB P-5	170.4	171.4	1.0	Grade. Start as acceleration lane from Piute State Park access.
	NB P-6	155.0	156.0	1.0	Interval-based. Flat. Just outside of Circleville Canyon.
	NB P-7	135.0	137.0	2.0	Interval-based. Flat.
	NB P-8	121.4	122.4	1.0	Interval-based. Avoid Sevier River meandering.
	NB P-9	107.0	108.5	1.5	Switch to northbound. (Differs from Tri-County Coal Study recommendation.)
	NB P-10	99.0	100.0	1.0	Start as acceleration lane at Alton Road.
	NB P-11	50.0	53.0	3.0	Interval-based. Flat.
	NB P-12	38.0	42.0	4.0	Interval-based. Flat.
	NB P-13	15.0	16.0	1.0	Interval-based. Flat.

In addition to new passing lanes, the following improvements are recommended for existing passing lanes. (The notation SB 1, SB 3 refers to the label used for the passing lane notated on Figure 1.)

1. Lengthen Passing Lane SB 1 – This passing lane could be extended to approximately MP 299.3 so as to carry the passing lane beyond the crest of the hill.

2. Lengthen Passing Lane SB 3 – This passing lane could be extended back to approximately MP 106.5. The original passing lane at this location extended over the crest of the hill to the State route 14 (S.R. 14) intersection. In 2007, the end of the passing lane was pulled back from the crest of the hill to improve safety at the intersection, resulting in a short passing lane. Extending the toe of this passing lane would allow for more opportunity to conduct passing maneuvers. This recommendation is consistent with the Tri-County Coal Truck Route Study (October 2011).

3. Connect Passing Lane SB 4 to Passing Lane SB 5, extend Passing Lane SB 5, and consolidate accesses to Coral Pink Sand Dunes State Park – Both Passing Lane SB 4 and Passing Lane SB 5 end well short of the crest of the hill. Additionally, Passing Lane SB 5 is only 0.2 miles long, leaving little time for vehicles to conduct passing maneuvers. Connecting SB 4 to SB 5 and extending SB 5 past the summit to approximately MP 76.5 will create a continuous, 2.3-mile passing lane that extends all the way over the crest of the hill. Finally, there are two accesses to the Coral Pink Sand Dunes State Park in the existing passing lane gap between SB 4 and SB 5. These accesses should be consolidated to simplify traffic maneuvers in this area. Additionally, a northbound left-turn lane should be installed at the consolidated access so that vehicles turning left from U.S. 89, into the access, do not obstruct the single northbound lane of travel. The left-turn lane will also benefit northbound left turns since these vehicles will now be turning across two southbound lanes.

4. Lengthen Passing Lane SB 7 – This passing lane could be extended to approximately MP 44.1 so as to carry the passing lane through most of the subsequent hill, but end before the existing guardrail.

5. Connect Passing Lanes NB 7, NB 6, and NB 5, and extend Passing Lane NB 5 – Each of these three passing lanes end just short of the crests of their respective hills. Additionally, the intervals between these passing lanes are less than one mile. Connecting these passing lanes and extending NB 5 to approximately MP 75.5 would create a continuous, 3.5-mile passing lane that extends past the final hill crest. (Note: Although Passing Lane NB 8 is also less than one mile from NB 7, terrain issues prevent NB 8 from being connected to the subsequent set of passing lanes.)

Using the UDOT Planning process for scoring passing lane projects, all 24 passing lane recommendations are listed in Table 3 in order of decreasing prioritization score.

Table 2 – U.S. 89 Recommended Improvements to Existing Passing Lanes

Direction	Map Label (Figure 1)	Begin MP	End MP	Improvements
Southbound (SB)	SB 1	300.6	299.7	Extend over hill to approximately MP 299.3.
	SB 3	104.5	104.1	Extend start of passing lane to approximately MP 106.5 (adopted from Tri-County Coal Truck Route Study).
	SB 4 & SB 5			Connect these two passing lanes, extend SB 5 to approximately MP 76.5.
	SB 7	45.3	44.9	Extend to approximately MP 44.1
Northbound (NB)	NB 7, NB 6 & NB 5			Connect these three passing lanes, extend NB 5 to approximately MP 75.5.

Table 3 – Combined Passing Lanes Prioritization List

Rank	Map Label	Type	UDOT Planning Prioritization Score
1	NB P-10	New	50
2	Extend SB-7	Improve Existing	47
3	Connect NB 7 & 6, Connect NB 6 & 5, Extend NB 5	Improve Existing	44
4	NB P-11	New	42
5	NB P-12	New	42
6	Extend SB 3	Improve Existing	39
7	NB P-9	New	38
	Connect SB 4 & 5, Extend SB 5	Improve Existing	38
9	NB P-7	New	33
10	SB P-5	New	32
11	SB P-6	New	30
	NB P-8	New	30
	NB P-13	New	30
14	NB P-4	New	28
15	NB P-2	New	23
16	SB P-1	Improve Existing	20
17	NB P-3	New	13
18	SB P-3	New	12
19	NB P-6	New	11
20	SB P-4	New	10
	NB P-5	New	10
22	SB P-2	New	8
	NB P-1	New	8
	Extend SB 1	Improve Existing	8

Finally, improvements to passing lane signage are recommended. Existing passing lane signing schemes are inconsistent with Utah Department of Transportation (UDOT) standard drawings. Part of the reason for inconsistent signage may be due to a lack of detail or changing guidelines in previous versions of the MUTCD. It is recommended that signage be phased into conformity with UDOT standard drawings as part of regular sign maintenance and/or replacement. It is also recommended that the "NEXT PASSING LANE XX MILES" (D17-1) sign begin to be used consistently along the corridor. The consistent use of this sign at the end of each passing lane and between long stretches of passing lanes would be especially beneficial so as to alert drivers of the next passing lane opportunity. Being aware of the distance to the next passing lane can help reduce driver anxiety and over-aggressive passing behavior.

This report was produced for UDOT Region 4 by InterPlan, a transportation planning and engineering firm located in Midvale, Utah.

Introduction

Passing lane and signage improvements are important along the U.S. 89 corridor to enhance safety and improve the long-term efficiency, reliability and cost competitiveness required to move people and freight through a key transportation corridor. Historically, UDOT has programmed transportation improvement projects along U.S. 89 and this current effort will benefit the flow of commercial and recreational traffic to national parks, state parks, and national monuments. Most importantly, commercial motor vehicles will be served by the design and implementation of passing lane projects that will enhance safety on U.S. 89. The goals of passing lanes on U.S. 89 include the following:

- Allow vehicles to pass slower traffic without crossing over into the oncoming lane of traffic.
- Decrease congestion that will help U.S. 89 maintain its function as an important transportation corridor in central Utah.
- Help maintain designated portions of U.S. 89 as a major truck route by enhancing safety and reducing congestion.

Study Area

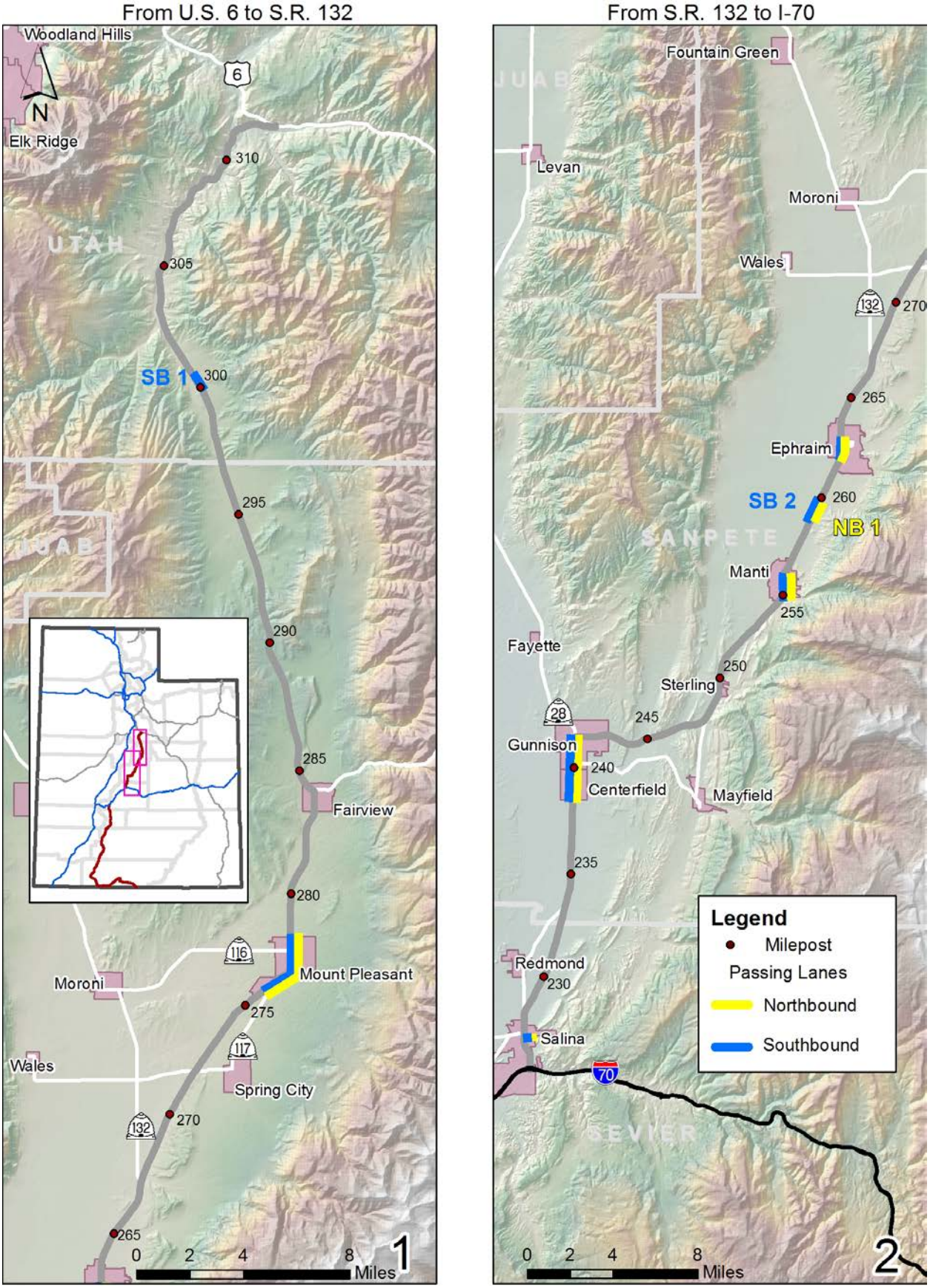
U.S. 89 is a major highway that traverses the entirety of central Utah from Arizona to Idaho, occasionally running concurrently with other routes. The study area consists of the portion of U.S. 89 between the Utah/Arizona state line (MP 0) to the junction with U.S. 6 in Spanish Fork Canyon (MP 312). The description of U.S. 89 within the study area is as follows:

U.S. 89 begins at the Utah/Arizona state line just north of Page, Arizona and the Glen Canyon Dam. From the state line, U.S. 89 proceeds westerly approximately 60 miles to Kanab, Utah. At Kanab, U.S. 89 turns north and proceeds approximately 130 miles to the junction with Interstate 70 (I-70). Along the way, U.S. 89 traverses through several small communities, such as Orderville, Panguitch, Circleville, and Marysvale. From the I-70 junction, U.S. 89 runs northeasterly and concurrent with I-70 until reaching the town of Salina. At Salina, U.S. 89 breaks off from I-70 and proceeds north through several more rural communities to the U.S. 6 junction. This approximately 85 mile portion traverses towns such as Gunnison, Manti, Ephraim, and Mount Pleasant.

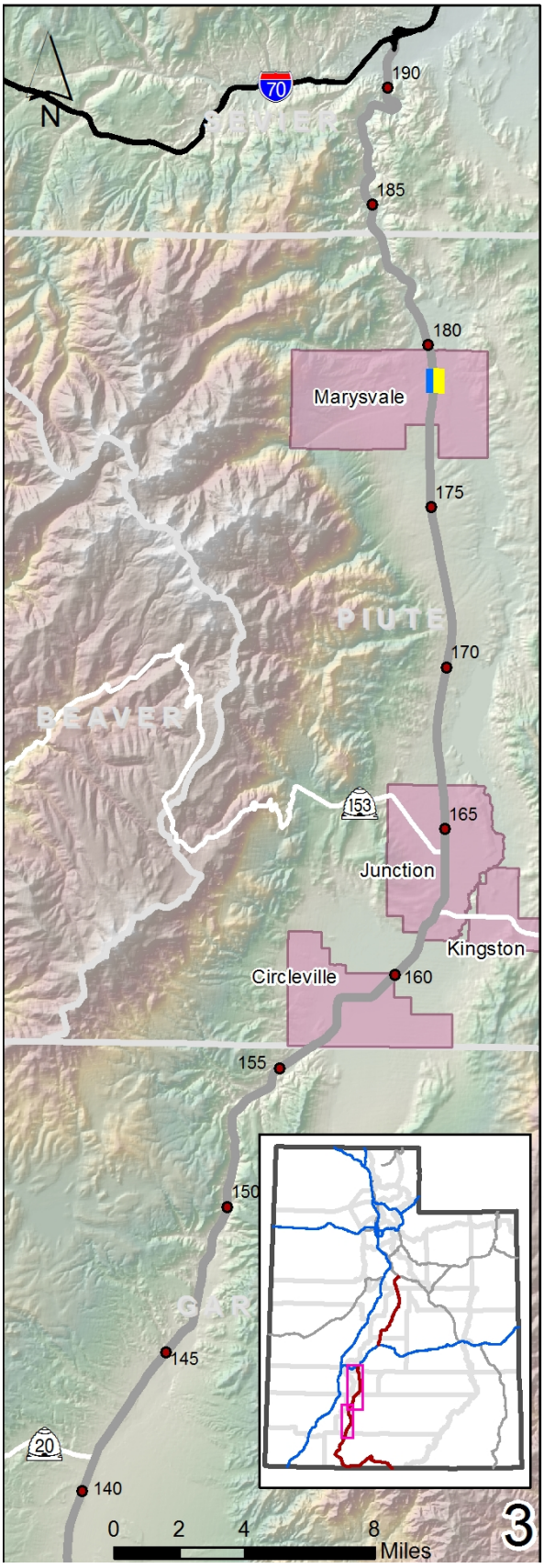
The study area also includes U.S. 89A, a short section of highway between the Utah/Arizona state line and U.S. 89 in Kanab. U.S. 89A is approximately three miles long and is located almost entirely within Kanab city boundaries. As such, U.S. 89A played a minor role in the passing lane analysis.

U.S. 89 serves a major freight and recreational route in central Utah. Besides providing access to Zion National Park and Bryce Canyon National Park, U.S. 89 links southern Utah and the I-15 corridor to Page, Arizona, one of the few Colorado River crossings in the region. U.S. 89 also is an important highway for intra-regional traffic among the industries and small communities in central Utah.

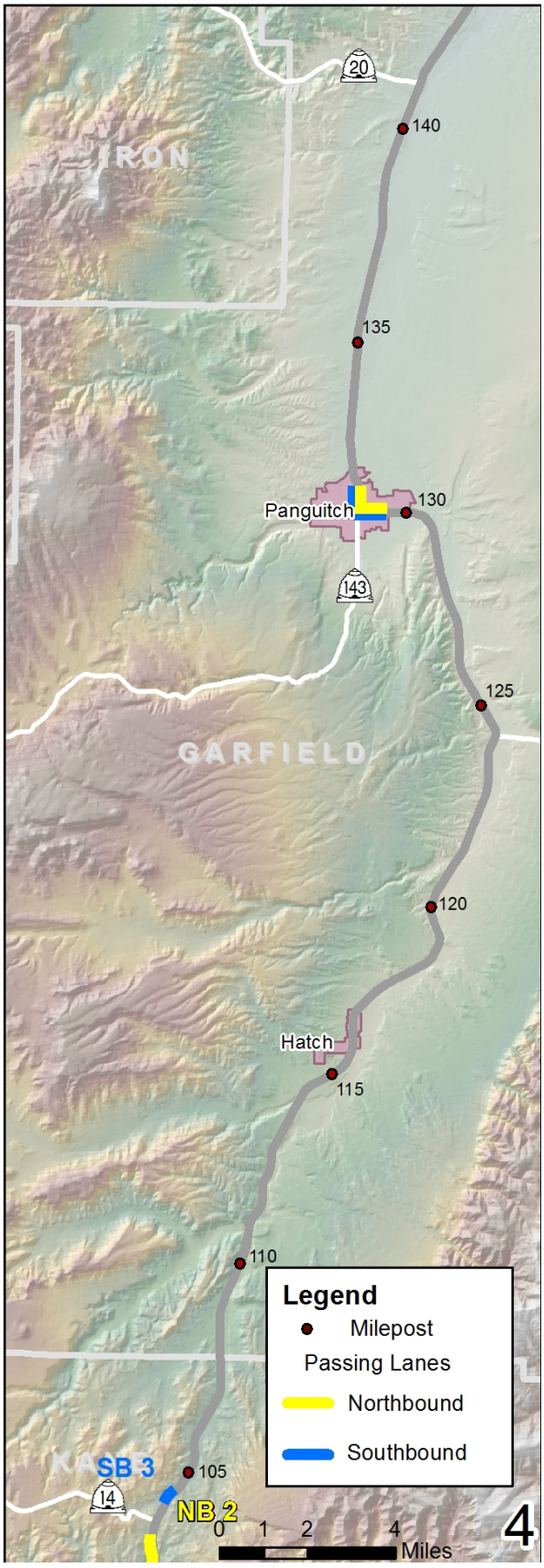
Figure 1 – Existing Passing Lanes on U.S. 89 in the Study Area (MP 0-312)



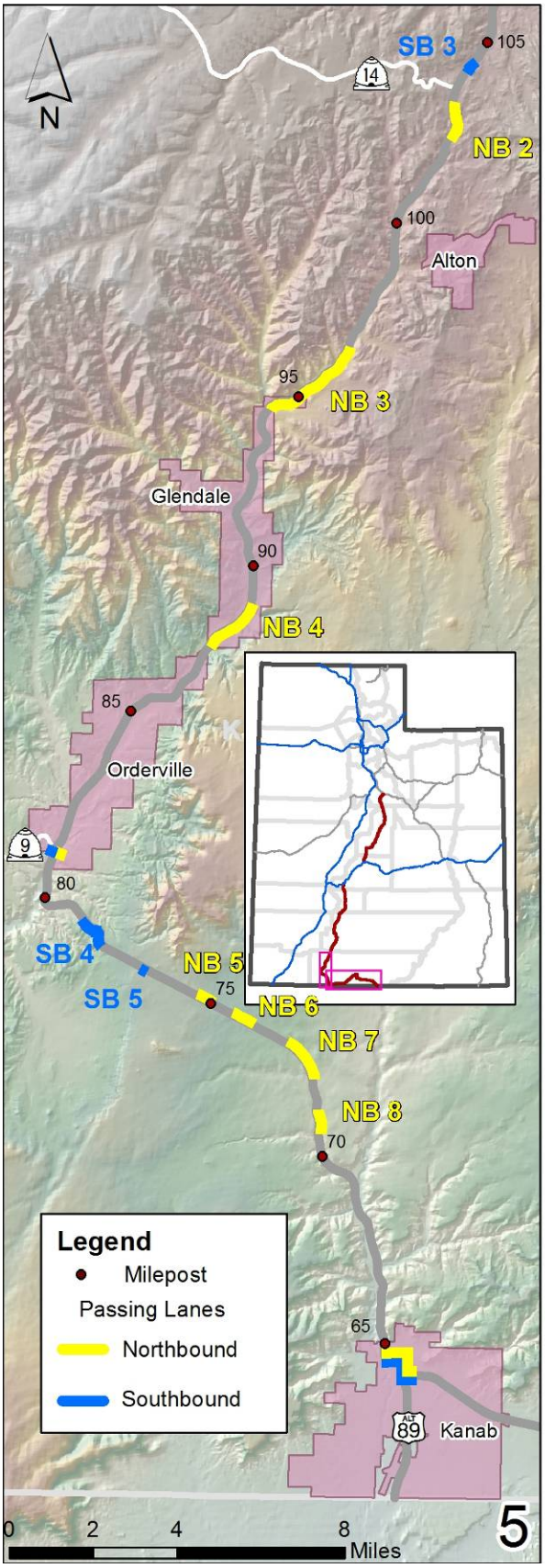
From I-70 to S.R. 20



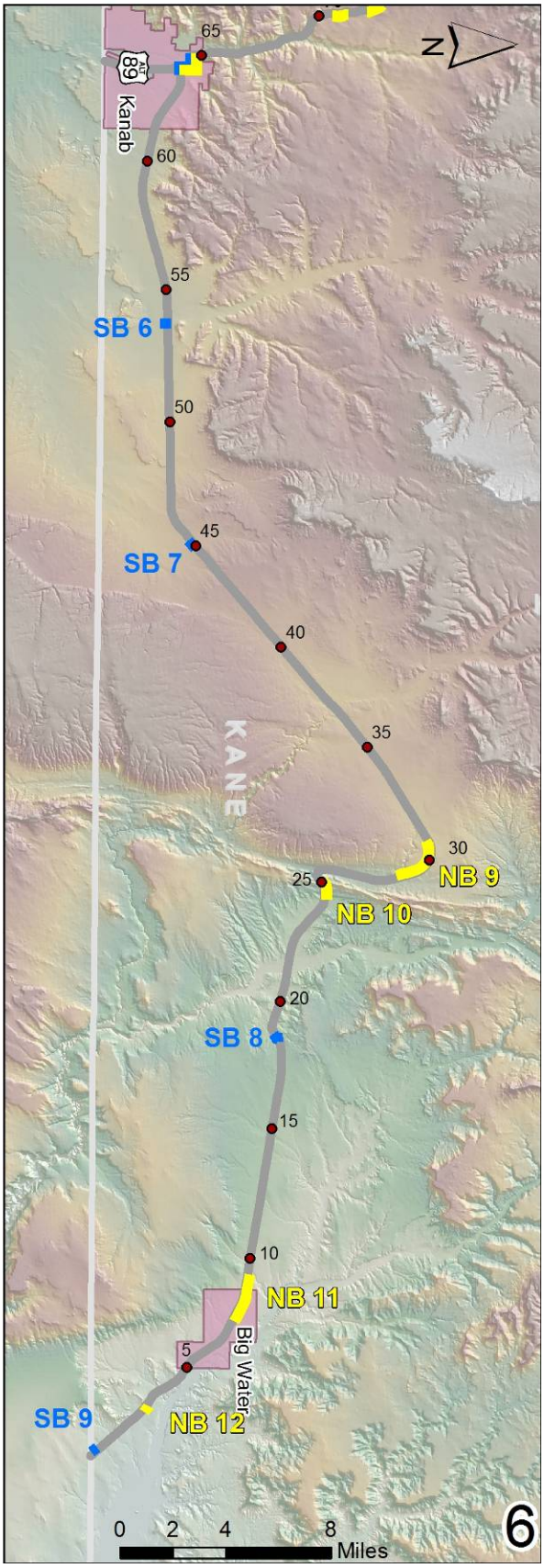
From S.R. 20 to S.R. 14



From S.R. 14 to U.S. 89A



From U.S. 89A to State Line via U.S. 89



Recent Projects

Six passing lane projects were completed on U.S. 89 within the study area in recent years.

1. The southbound passing lane near the State route 14 (S.R. 14) junction was shifted to the north in 2007. This adjustment was made so that passing maneuvers would be completed prior to the S.R. 14 junction and so that left-turning vehicles in the northbound direction and left-turning vehicles from S.R 14 would not have to turn across two lanes of traffic.

2. A pair of northbound/southbound passing lanes was installed between Ephraim and Manti in 2008.

3. The northbound passing lane near MP 30 was extended 1.2 miles in 2008.

4. The cross-section within Ephraim itself was restriped from a two-lane cross-section to a four-lane cross-section in 2009.

5. A northbound passing lane was constructed in 2009 in the town of Big Water, Kane County.

6. Two existing northbound passing lanes between Orderville and Glendale were connected to create a single, 1.5-mile passing lane in 2009.

Passing Lane/Turnout Standards

A Policy on Geometric Design of Highways and Streets 2011

A Policy on Geometric Design of Highways and Streets 2011 (commonly known as the "AASHTO Green Book") published by the American Association of State Highway and Transportation Officials (AASHTO) provides policy and geometric design guidance on highways. The AASHTO Green Book outlines recommendations for both "climbing lane" and "passing lane" facilities.

Climbing lanes provide opportunities for vehicles to pass slower-moving heavy vehicles on significant grades. Climbing lanes are often installed when a grade results in a 10 mph or greater speed reduction for heavy vehicles, since the 10 mph speed differential is correlated with a sharp increase in crash potential (AASHTO Green Book, p.3-120, p.3-127).

Though similar to climbing lanes in that they provide an additional lane for passing opportunities, passing lanes do not have to be installed on significant grades. Passing lanes can be installed on two-lane highways in places of poor passing sight distance, or where traffic volumes result in poor level of service. When used to improve traffic operations, passing lanes should be provided systematically at regular intervals (AASHTO Green Book, p.3-132).

Both climbing lanes and passing lanes should extend an adequate distance before tapering down to one lane. For climbing lanes, ideally, the lane would extend beyond the crest of the hill to where a typical truck could accelerate back to a speed within 10 mph of other vehicles. When impractical, the taper should occur where sight distance is sufficient to allow passing in the absence of oncoming traffic (AASHTO Green Book p.3-128). Passing lanes should

provide a taper that allows at least 1,000 feet of sight distance (AASHTO Green Book p.3-132).

Further AASHTO guidelines specify that the selection of a location for a passing lane should consider the locations of intersections and high-volume driveways in order to minimize the volume of turning movements on a road section where passing is encouraged. A continuous shoulder should also be present in passing lane lengths. The full documentation of climbing and passing lanes in sections 3.4.3 and 3.4.4 of the AASHTO Green Book should be consulted prior to the design and construction of any passing lanes on U.S. 89.

Manual on Uniform Traffic Control Devices 2009

The *Manual on Uniform Traffic Control Devices 2009* (MUTCD), published by the Federal Highway Administration, establishes national signing requirements and guidelines for public streets. Information regarding passing and/or climbing lane signing in the MUTCD falls within the realm of "Guidance" or "Option" material and thus, reserves some flexibility for individual governing agencies. The MUTCD offers several optional regulatory signs for the beginning of a climbing/passing lane, including a "KEEP RIGHT EXCEPT TO PASS" sign (R4-16), a "SLOWER TRAFFIC KEEP RIGHT" sign (R4-3), and a "TRUCKS USE RIGHT LANE" sign (R4-5). In advance of a climbing/passing lane, the MUTCD provides optional guide signs, such as a "NEXT TRUCK LANE XX MILES" sign (D17-1) and a "TRUCK LANE XX MILES" sign (D17-2). The MUTCD specifies that the words "PASSING" or "CLIMBING" may be used in place of "TRUCK" on such signs. Although not directly discussed with passing lanes, the MUTCD Lane Ends (W4-2) and "LANE ENDS MERGE LEFT" (W9-2) signs are applicable where passing lanes reduce back to one lane of travel. Figures 2, 3, and 4 provide examples of these signs.

Figure 2 – Regulatory Signs (MUTCD, Figure 2B-10)

R4-16 R4-3 R4-5

Figure 3 – Guide Signs* (MUTCD, Figure 2D-21)

*The words "PASSING" or "CLIMBING" may be substituted for the word "TRUCK"

D17-1 D17-2

Figure 4 – Warning Signs (MUTCD, Figure 2C-8)

W4-2 W9-2

UDOT Standard Drawings

UDOT publishes standard drawings for the design, construction and maintenance of the state highway system. In regards to climbing/passing lanes, UDOT standard drawings contain climbing lane installation criteria, pavement marking requirements, and taper length requirements consistent with the AASHTO Green Book. Signing requirements are also in line with MUTCD guidance in the use of the "KEEP RIGHT EXCEPT TO PASS" sign, "PASSING LANE XX MILES" sign, and the "LANE ENDS MERGE LEFT" sign.

UDOT standard drawings address the option of allowing passing maneuvers for the single travel lane in the opposing direction of the passing lane. Signing and roadway striping permitting such passing maneuvers may be installed provided passing zone criteria are met and receive approval from the UDOT region traffic engineer. The UDOT standard drawings relevant to passing lanes, drawing DD 3, drawing ST 5, and drawing ST 6 are provided in the appendix.

Relevant Planning Documents

The UDOT 2011-2040 Long Range Transportation Plan addresses the need for improvement projects on state-owned roads outside the planning jurisdiction of metropolitan planning organizations. These projects may include new roads, additional lanes, passing lanes, and new or upgraded interchanges which UDOT plans to implement by 2040, based on revenue assumptions and a selected funding alternative.

The current UDOT Long Range Transportation Plan specifies a Phase 4 (Unfunded) widening/passing lane project on U.S. 89 from Kanab to S.R. 20. The project description is to add passing lanes at various locations along the corridor.

The Statewide Transportation Improvement Program (STIP) 2013-2018 lists several U.S. 89 projects with future funding sources:

1. MP 21.0 to MP 37.8 – Pavement preservation
2. MP 256.0 to 262.0 – Reconstruction, added capacity
3. MP 263.0 to 267.5 – New construction
4. MP 64.95 to 68.40 – Bituminous pavement, minor widening

The Tri-County Coal Truck Route Study (November 2012), prepared for UDOT Region 4, lists three recommendations for U.S. 89 within the study area in response to the development of the Alton Coal Mine. It should be noted that recommendations two and three were adopted directly from a previous study. The study assumed a maximum of 150 one-way coal trucks per day, if leases are awarded on adjacent public lands.

1. Add a one mile acceleration lane on northbound U.S. 89 at Alton Road.
2. Lengthen existing southbound passing lane between MP 104 to 105.
3. Add a southbound passing lane at MP 107 to 108.5.

Existing Conditions

Site Visit and Data Collection

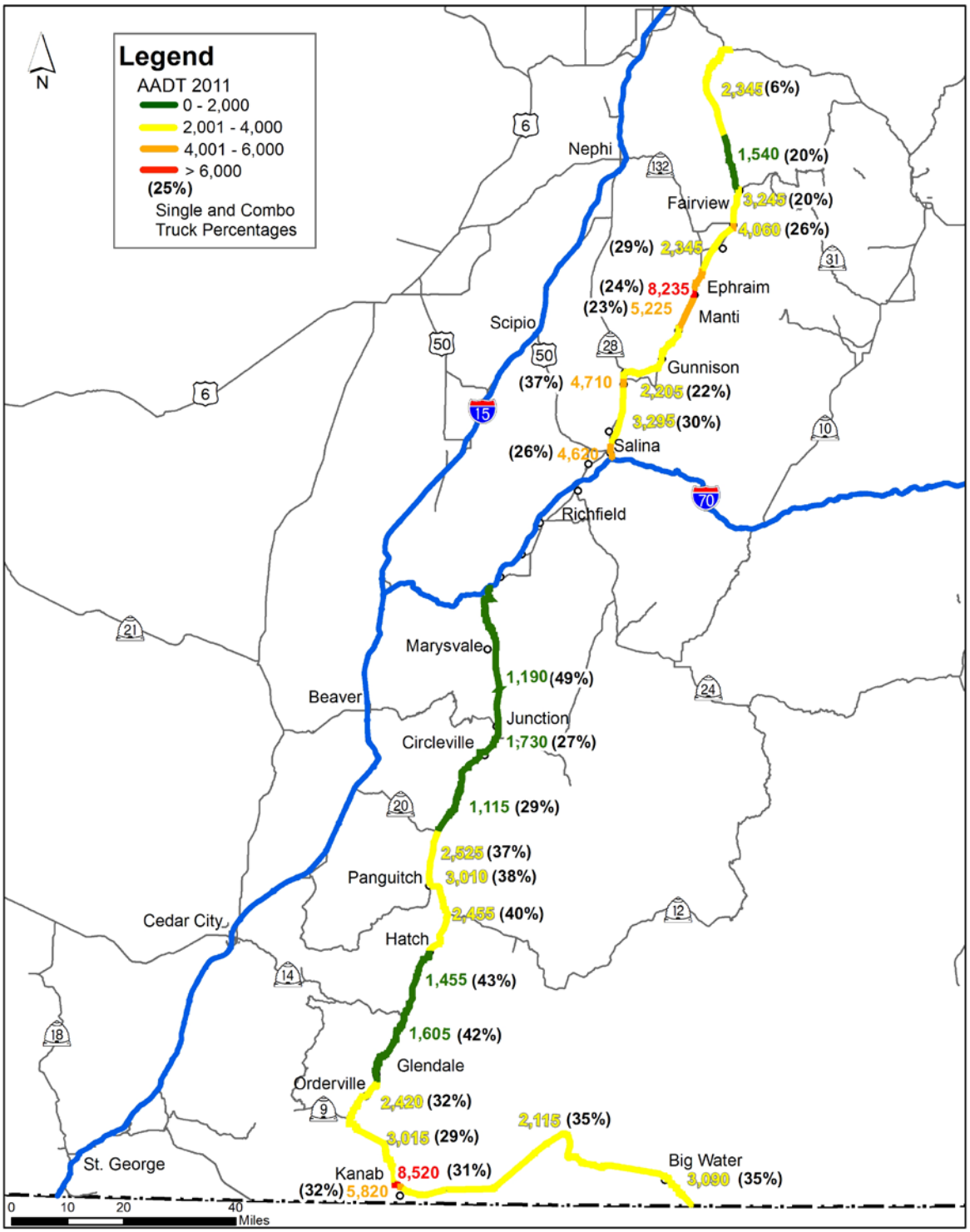
Outside of major towns, such as Kanab, Panguitch, and Manti, U.S. 89, serves as a major, two-lane rural highway, with infrequent access points and high speeds. Within towns, U.S. 89 serves multiple accesses, features lower speeds, and can open up to multiple travel lanes. Due to the more urban nature of U.S. 89 within towns, this analysis was limited to the rural area between towns in its evaluation of passing lane locations. The data gathered and presented for the duration of this report will focus mainly on the rural portions of U.S. 89.

U.S. 89 is generally a high-speed corridor with speed limits of up to 65 miles per hour. In mountainous areas the speed limit may drop to as low as 50 miles per hour. Populated areas can feature a speed limit as low as 35 miles per hour. According to Traffic on Utah Highways 2011, published by UDOT, the average annual daily traffic (AADT) for 2011 ranges from just over 1,000 to vehicles per day north of S.R. 20 to more than 8,000 vehicles per day in Ephraim. Kanab also has more than 8,000 vehicles per day (see Figure 5).

A significant portion of the traffic along U.S. 89 is heavy trucks. Between the Arizona/Utah state line and S.R. 20, U.S. 89 serves as a major truck route on Utah's Primary Freight Network and the percentage of single and combo trucks can reach as high as 40 percent, or just below 1,000 trucks per day. Many trucks use S.R. 20 as the connecting route to I-15 which is evident in the fact that immediately north of S.R. 20, the number of heavy trucks drops by two-thirds. Truck traffic picks up again between I-70 and Gunnison, reaching approximately 1,000 trucks per day in the area. This is primarily due to the proximity of several coal and salt mining locations. North of Gunnison, truck traffic drops by approximately 50 percent as many trucks turn onto S.R. 28 so as to access I-15. Truck traffic does not increase again until the populated areas around Manti and Ephraim. North of this area, and extending to U.S. 6, truck volumes are the lowest along the corridor.

U.S. 89 experiences a strong seasonal fluctuation. Due to the influx of recreational traffic, summer month traffic can be up to 50 percent higher than the annual average, while winter month volumes can be as low as 60 percent of the annual average.

Figure 5 – Study Area Traffic Volumes



A field assessment of U.S. 89 and U.S. 89A passing lanes was conducted on September 25 and 26, 2012. The weather during the field assessment was clear. The assessment inventoried existing passing lanes. Forty-one existing passing lanes were observed and are listed in Table 4. Each passing lane is identified by its starting and ending milepost. The interval between each passing lane is also displayed along with the year of construction.

The table also includes and notes the passing opportunities within towns where U.S. 89 opens up to a four or five-lane cross-section. (There were no passing lanes on U.S. 89A.)

Photo of U.S. 89 south of S.R. 9.

In addition to the passing lane inventory, the following general observations were made.

- Passing lane intervals are not optimized for spacing and length so as to reduce delays caused by inadequate passing opportunities. Certain sections of U.S. 89 feature long intervals with no passing lanes. In the southbound direction, between Marysvale and S.R. 9, there are several 20 to 40-mile stretches with no passing lanes. Another 20-mile stretch exists north of Mount Pleasant. Beyond Kanab, southbound passing lanes are more frequent, but these passing lanes are often quite short, less than 0.5 miles. In the northbound direction, there is also a lack of passing lanes south of Marysvale, but this only extends to S.R. 14, rather than to S.R. 9. Between S.R. 14 and S.R. 9, northbound passing lane intervals tend to be approximately five miles. Other locations of long NB passing lane intervals include 30-mile stretches between Mount Pleasant and U.S. 6, and just south of Kanab.

- Passing lane signage was not consistent among passing lanes throughout the study area, nor with recent guideline updates published in the MUTCD. Specifically, the regulatory signs were placed at irregular intervals prior to individual passing lanes. Also, the guide signs are supposed to be all green with white lettering telling how many miles before the next passing lane. An inventory of existing passing lane signage is contained in the Appendix.

- The start and end points of some passing lanes could be lengthened to improve vehicle speeds and allow for heavy vehicles to safely accelerate to appropriate speeds after cresting a vertical grade.

Table 4 – U.S. 89 and U.S. 89A Passing Lane Inventory

Direction	Map Label (Figure 1)	Begin MP	End MP	Length (Miles)	Distance to Next Passing Lane	Year of Construction
Southbound (SB)	SB 1	300.6	299.7	0.9	21.3	Pre 2006
	Mount Pleasant	278.4	276.2	2.2	13.2	Pre 2006
	Ephraim	263.0	262.0	1.0	2.0	2009
	SB 2	260.0	258.7	1.3	2.7	2008
	Manti	256.0	254.8	1.2	13.4	Pre 2006
	Gunnison	241.4	238.6	2.8	11.5	Pre 2006
	Salina	227.1	226.8	0.3	1.4	Pre 2006
	I-70	225.4	191.7	33.7	12.5	Interstate
	Marysvale	179.2	178.6	0.6	46.8	Pre 2006
	Panguitch	131.8	130.5	1.3	26.0	Pre 2006
	SB 3	104.5	104.1	0.4	22.8	Pre 2006[1]
	Mt. Carmel Jct.	81.3	81.1	0.2	2.3	Pre 2006
	SB 4	78.8	77.9	0.9	1.0	Pre 2006
	SB 5	76.9	76.7	0.2	12.2	Pre 2006
	Kanab	64.5	63.7	0.8	9.8	Pre 2006
	SB 6	53.9	53.5	0.4	8.2	Pre 2006
	SB 7	45.3	44.9	0.4	26.2	Pre 2006
	SB 8	18.7	18.3	0.4	17.9	Pre 2005
	SB 9	0.4	0.1	0.3	AZ border	Pre 2005
Northbound (NB)	Mount Pleasant	276.3	278.3	2.0	34.5	Pre 2006
	Ephraim	262.0	263.0	1.0	13.3	2009
	NB 1	258.8	259.8	1.0	2.2	2008
	Manti	254.9	256.0	1.1	2.8	Pre 2006
	Gunnison	238.6	241.4	2.8	13.5	Pre 2006
	Salina	226.6	227.1	0.5	11.5	Pre 2006
	I-70	191.7	225.4	33.7	1.2	Interstate
	Marysvale	178.5	179.4	0.9	12.3	Pre 2006
	Panguitch	130.5	131.8	1.3	46.7	Pre 2006
	NB 2	102.4	103.4	1.0	27.1	Pre 2007
	NB 3	94.2	96.7	2.5	5.7	Pre 2006
	NB 4	87.6	89.1	1.5	5.1	Pre 2006[2]
	Mt. Carmel Jct.	81.1	81.3	0.2	6.3	Pre 2006
	NB 5	74.9	75.2	0.3	5.9	Pre 2006
	NB 6	73.9	74.4	0.5	0.5	Pre 2006
	NB 7	72.0	73.0	1.0	0.9	Pre 2006
	NB 8	70.5	71.1	0.6	0.7	Pre 2006
	Kanab	63.7	64.5	0.8	6.0	Pre 2006
	NB 9	28.5	30.8	2.3	32.9	Pre 2006[3]
	NB 10	24.3	25.0	0.7	3.5	Pre 2006
	NB 11	7.5	9.4	1.9	14.9	2009
	NB 12	2.6	2.9	0.3	4.6	Pre 2005

[1]Shifted downhill, to the north in 2007.
[2]Originally two passing lanes, connected in 2009.
[3]Extended in 2008.

2008-2010 Crash History

Transportation safety is a key component of the transportation system. Top priority is usually given to funding roadway improvements that will reduce crashes.

Manner of Collision and Crash Severity

The two tables below summarize crashes by the manner of collision and crash severity for the U.S. 89 and U.S. 89A study corridors. Due to the impact of accesses, increased volumes and pedestrian activity, the crashes occurring within towns along U.S. 89 are separated from those occurring between towns. As can be seen from Table 5, the contrast in manner of collision is notable. Between towns, single vehicle crashes are clearly the most dominant crash type. Within towns, there are substantially more angle and front-to-rear crashes.

The distribution of crash severity is much more consistent across U.S. 89 and U.S. 89A. Whether within towns or between towns, the percentage of "severe" injury crashes (incapacitation injury or a fatality) ranges from two percent to four percent (see Table 6). Likewise, the percentage of no injury crashes remains around 75 percent throughout the corridor. As a note, the following incorporated areas were considered as towns for the safety analysis: Kanab, Orderville, Glendale, Panguitch, Circleville, Junction, Marysvale, Salina, Centerfield, Gunnison, Sterling, Manti, Ephraim, Mount Pleasant, and Fairview.

Table 5 – Manner of Collision U.S. 89 and U.S. 89A (2008-2010)

Manner of Collision	Between Towns		Within Towns		Total	
	Number	%	Number	%	Number	%
Angle	41	3.8%	68	29.2%	109	8.4%
Front to Rear	71	6.6%	47	20.2%	118	9.0%
Head-on	20	1.9%	1	0.4%	21	1.6%
Sideswipe (same direction)	28	2.6%	17	7.3%	45	3.5%
Sideswipe (opposite direction)	19	1.8%	4	1.7%	23	1.8%
Parked Vehicle	5	0.5%	11	4.7%	16	1.2%
Rear to Side	0	0%	1	0.4%	1	0.1%
Rear to Rear	2	0.2%	0	0%	3	0.2%
Single Vehicle	881	82.6%	84	36.1%	965	74.2%
Total	**1,067**	**100%**	**233**	**100%**	**1,300**	**100%**

Source: UDOT Traffic and Safety Division.

Table 6 – Crash Severity U.S. 89 and U.S. 89A (2008-2010)

Injury	Between Towns		Within Towns		Total	
	Number	%	Number	%	Number	%
No Injury	797	75%	182	78%	979	75%
Possible Injury	119	11%	30	13%	149	12%
Non-incapacitating Injury	108	10%	16	7%	124	10%
Incapacitating Injury	27	3%	3	1%	30	2%
Fatal	16	1%	2	1%	18	1%
Total	**1,067**	**100%**	**233**	**100%**	**1,300**	**100%**

Source: UDOT Traffic and Safety Division.

Crash Statistics

The following safety statistics were gathered for the study area to help summarize roadway safety conditions:

- Crash Rate
- Severe Crash Rate

The Crash Rate is a calculation that normalizes the number of crashes on a road segment against the segment length and traffic volume. Crash rates are typically expressed in units of crashes per year per million vehicle-miles. The Severe Crash Rate also normalizes crashes against length and volume, but only considers "severe crashes" (incapacitating injury and fatal crashes combined). Severe crash rates are expressed in units of severe crashes per hundred million vehicle-miles. Both crash rates and severe crash rates can be compared against the statewide average rates for similar road segments according to volume and functional type.

Table 7 summarizes the overall crash statistics for the U.S. 89 and U.S. 89A study corridors. Due to the more urban nature of U.S. 89 within towns, Table 6 only reports crash statistics for segments between towns. (See the previous section for the list of areas considered towns.)

As can be seen from Table 7, some segments of the study corridor exhibit crash rates and/or severe crash rates above the statewide averages, while some fall below. Of particular note are the segments between Glendale and S.R. 12, which feature the highest crash rates of the corridor. The two sections with the highest severe crash rate are from the Sanpete County line to U.S. 6 and from Marysvale to I-70. These two segments are also some of the most narrow and winding segments of the highway.

The three segments between Sterling and Mount Pleasant exhibit a crash rate above the statewide average, *except* for the section between Manti and Ephraim. This section yields a crash rate of 0.83, which is significantly lower than the segments to the north and south. It is assumed that the northbound/southbound passing lanes installed on this section in 2008 (NB 1, SB 2) had a major role in lowering the crash rate. To further investigate the role of the passing lanes, crash data for previous years was also obtained. Table 8 shows that a general decrease in total crashes and crash rates has occurred since 2007.

Due to its length, the segment between the Arizona state line and Kanab was subdivided into three, 20-mile sections. Subdividing the segments revealed a strong pattern of increasing crash totals, crash rates, and severe crash rates from the Arizona state line towards Kanab. Although the section closest to Kanab (MP 40 to Kanab) is relatively flat and straight, it exhibits higher crash rates than the middle section (MP 20 to MP 40), despite the middle section containing significant grades and horizontal curvature.

Table 7 – Study Area Crash Data 2008-2010 (Segments within Towns Omitted)

Segment (U.S.89)	Begin MP	End MP	2008-2010 AADT	Crashes		Actual Rate		Statewide Average Rate[3]	
				Total	Severe	Crash Rate[1]	Severe Crash Rate[2]	Crash Rate[1]	Severe Crash Rate[2]
Arizona state line to MP 20	0.00	20.00	2,660	18	2	0.31	3.4		
MP 20 to MP 40	20.01	40.00	2,277	55	2	1.11	4.0		
MP 40 to Kanab	40.01	61.00	2,363	96	7	1.77	12.9		
Kanab to S.R. 9	65.01	81.21	3,033	95	4	1.77	7.4		
S.R. 9 to Orderville	81.22	85.50	2,536	17	1	1.43	8.4		
Orderville to Glendale	86.51	89.00	2,270	12	0	1.94	0.00		
Glendale to S.R. 14	90.11	103.68	1,677	105	3	4.21	12.0		
S.R. 14 to S.R. 12	103.69	124.23	1,726	110	4	2.83	10.3		
S.R. 12 to Panguitch	124.24	129.69	2,973	31	0	1.75	0.0		
Panguitch to S.R. 20	132.01	141.10	2,378	39	1	1.65	4.2		
S.R. 20 to Circleville	141.11	157.42	1,213	40	1	1.85	4.6		
Circleville to Junction	158.75	163.07	1,758	8	0	0.96	0.0	1.56	7.6
Junction to Marysvale	165.23	178.34	1,335	22	1	1.15	5.2		
Marysvale to I-70	179.58	191.74	1,443	36	3	1.87	15.6		
Salina to Centerfield/Gunnison	227.79	238.43	3,825	62	2	1.39	4.5		
Centerfield/Gunnison to Sterling	243.01	249.11	3,493	21	0	0.90	0.0		
Sterling to Manti	249.99	254.62	3,522	34	0	1.90	0.0		
Manti to Ephraim	256.43	261.47	7,245	33	0	0.83	0.0		
Ephraim to Mount Pleasant	264.01	276.00	3,884	90	2	1.77	3.9		
Mount Pleasant to Fairview	278.42	283.26	3,262	24	0	1.39	0.0		
Fairview to Sanpete County Line	284.37	297.00	2,150	45	4	1.51	13.5		
Sanpete County Line to U.S. 6	297.01	312.78	2,367	74	6	1.81	14.7		
All Segments Between Towns				1,067	43	1.59	6.4	1.56	7.6
All Segments Within Towns[4]				216	5	1.63	3.8	1.56	7.6
Total Route[4]			**2,354**	**1,283**	**48**	**1.59**	**6.0**	**1.56**	**7.6**

[1]Crashes per million vehicle miles.
[2]Severe crashes per hundred million vehicle miles.
[3]Based on 2006-2010 statewide average rates per functional class and AADT.
[4]U.S. 89A excluded.

Table 8 – Crashes between MP 256.43 and 261.47 by Year

Year	2006	2007	2008	2009	2010	2011
AADT	7,300	7,345	7,155	7,260	7,320	5,225
Crashes	16	29	15	13	5	13
Crash Rate[1]	1.19	2.15	1.14	0.97	0.37	1.35

[1]Crashes per million vehicle miles.

Passing-Related Crashes

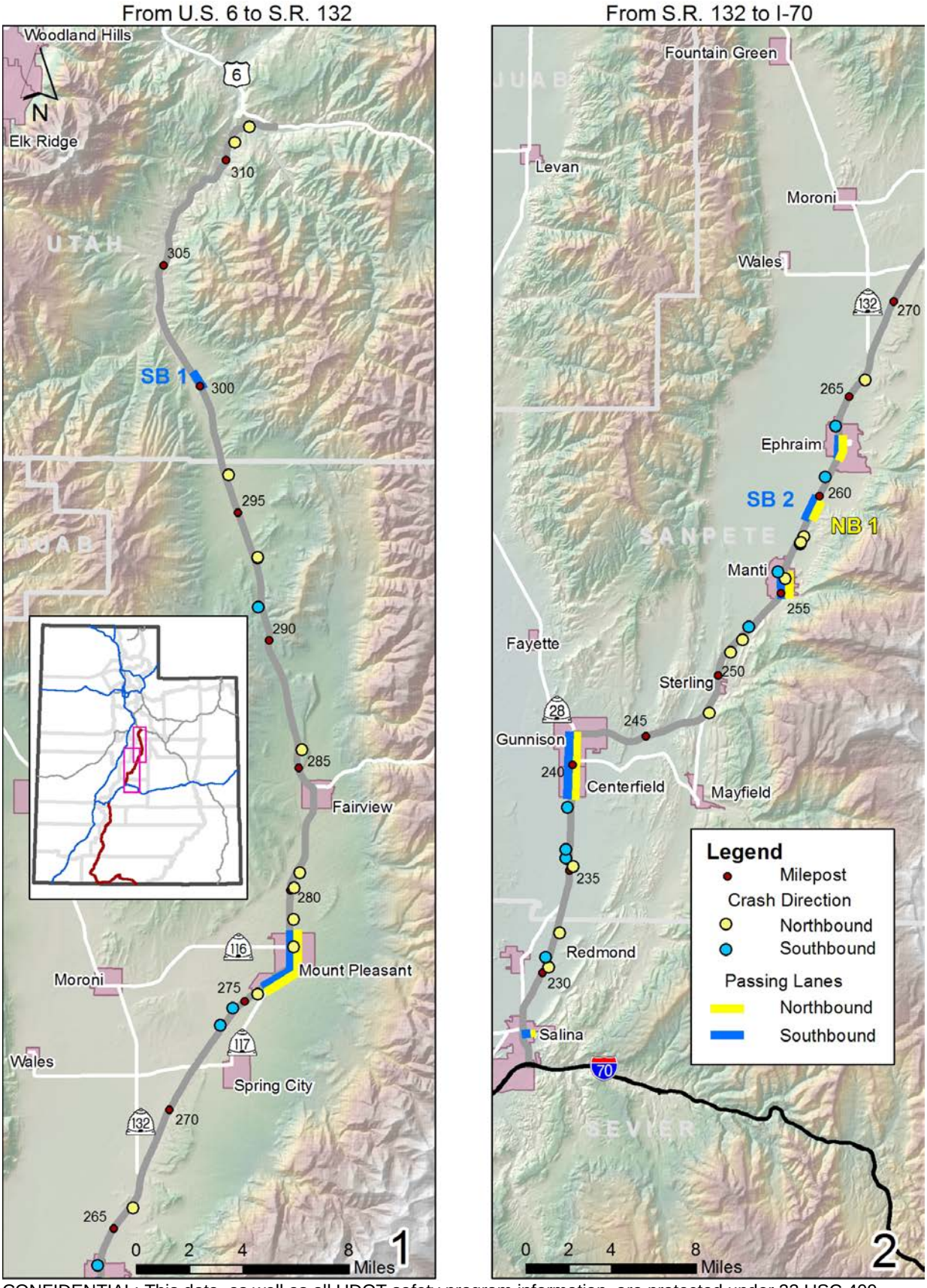
Crash data were further examined to attempt to identify crashes involving passing maneuvers. Crashes within the UDOT Traffic and Safety database maintain a number of quantitative and qualitative attributes. While no single attribute can consistently confirm whether a crash involved a passing maneuver, several factors can provide an indication. Thus, the passing maneuver-related crashes identified in this study represent a best, but not exact, approximation of actual occurrences.

Figure 6 illustrates the 2006-2010 passing maneuver related-crashes in the study area. Some of the crashes occur where there are existing passing lanes, while others occur in sections where no passing lane is present. A cluster of crashes is evident around the S.R. 14 intersection, with crashes occurring in both the northbound and southbound directions. Frequent passing maneuver-related crashes also occur between Salina and Centerfield and between Sterling and Ephraim. Again, crashes occur in both directions. The long segment between the Utah/Arizona state line and Kanab experiences evenly spaced, but frequent passing maneuver-related crashes. Finally, very few passing maneuver-related crashes have occurred on the 50-mile segment between S.R. 20 and I-70.

The relationship between passing maneuver-related crashes and the location of passing lanes is complex. On one hand, the existence of a passing lane should facilitate safer passing maneuvers, leading to decreased crashes. Yet, at passing lane locations, it could also be expected to see some increase in passing maneuver-related crashes simply because there is a higher-occurrence of passing maneuvers being conducted. The crash data review revealed many crashes which occurred in passing lanes were related to vehicles sideswiping a vehicle being passed or losing control when accelerating to a passing velocity in inclement weather. Furthermore, crashes that occur in locations without a passing lane may be related to illegal passing maneuvers or increased passing maneuvers in legal passing zones. Finally, some passing maneuver-related crashes are more related to driveway and intersection design than the existence of passing lanes. Crash data indicated several crashes occurred when a driver attempted to pass a vehicle turning at an intersection or into a driveway.

Figure 7 illustrates a general trend of decreasing frequency of passing maneuver-related crashes from 2006 to 2010. The trend may be related to a number of factors including increased availability of passing lanes, fluctuating traffic volumes, road construction, or weather patterns. From year to year, passing maneuver-related crashes consistently occur more frequently in the northbound direction. This may be related to the fact the northbound directions features more uphill sections than the southbound direction, and hence, more passing maneuvers.

Figure 6 – Passing Maneuver-Related Crashes on U.S. 89 (2006-2010)



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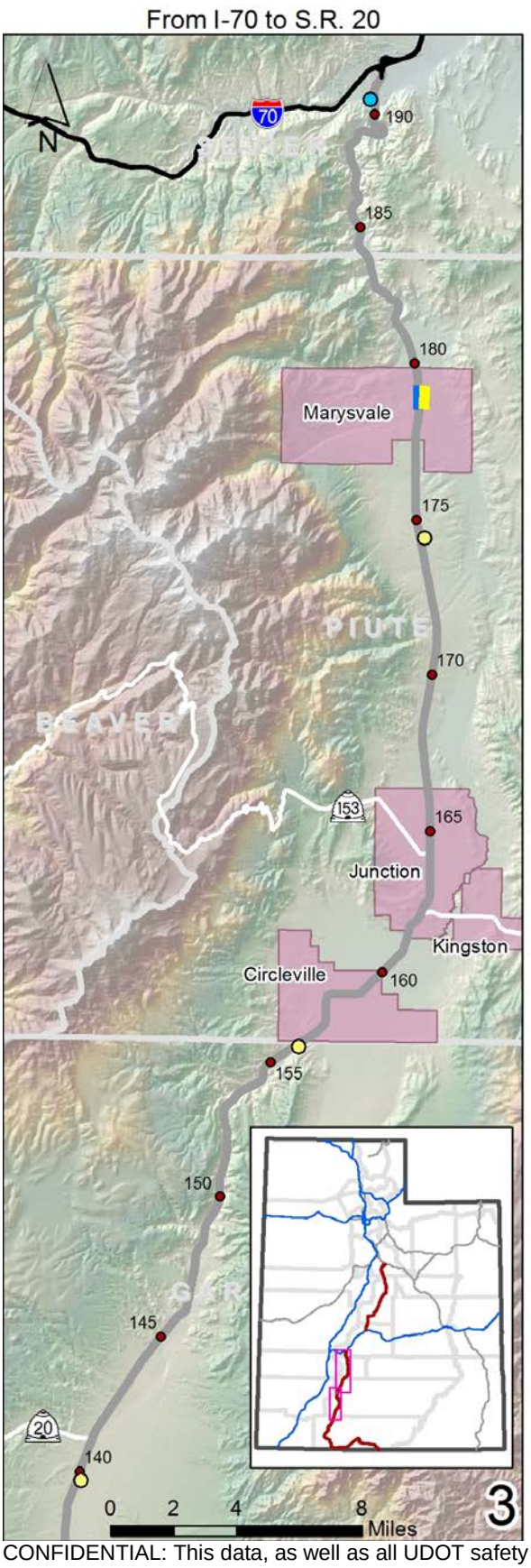

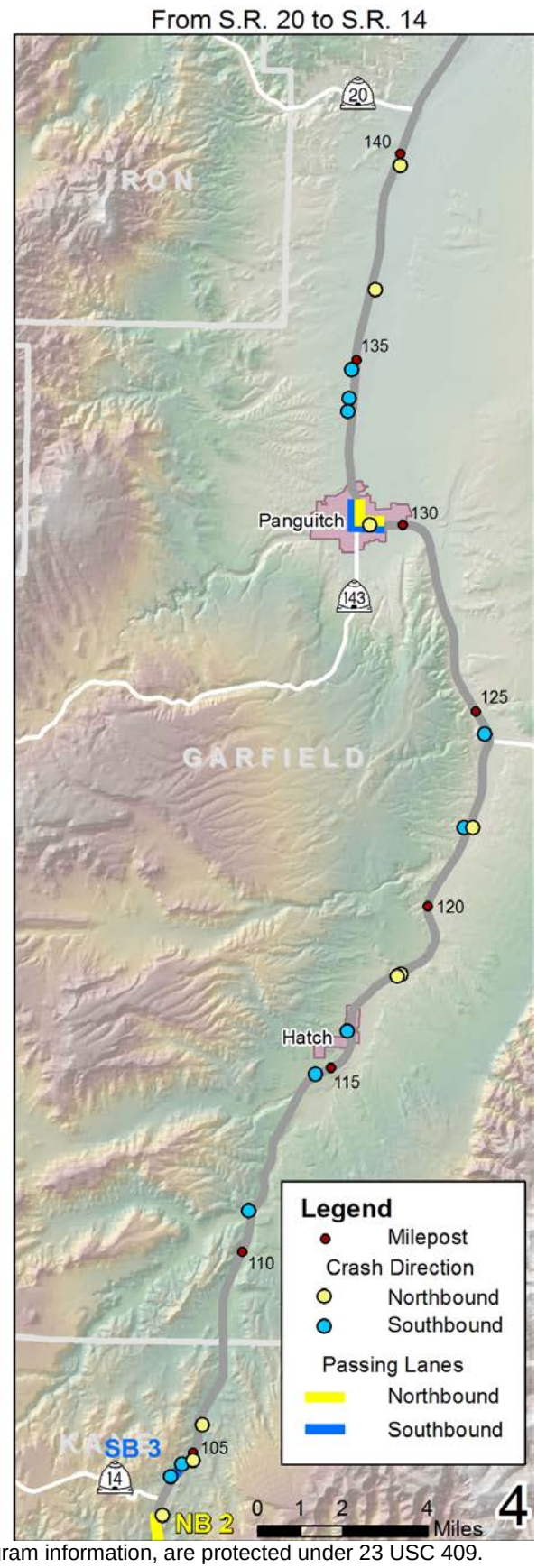

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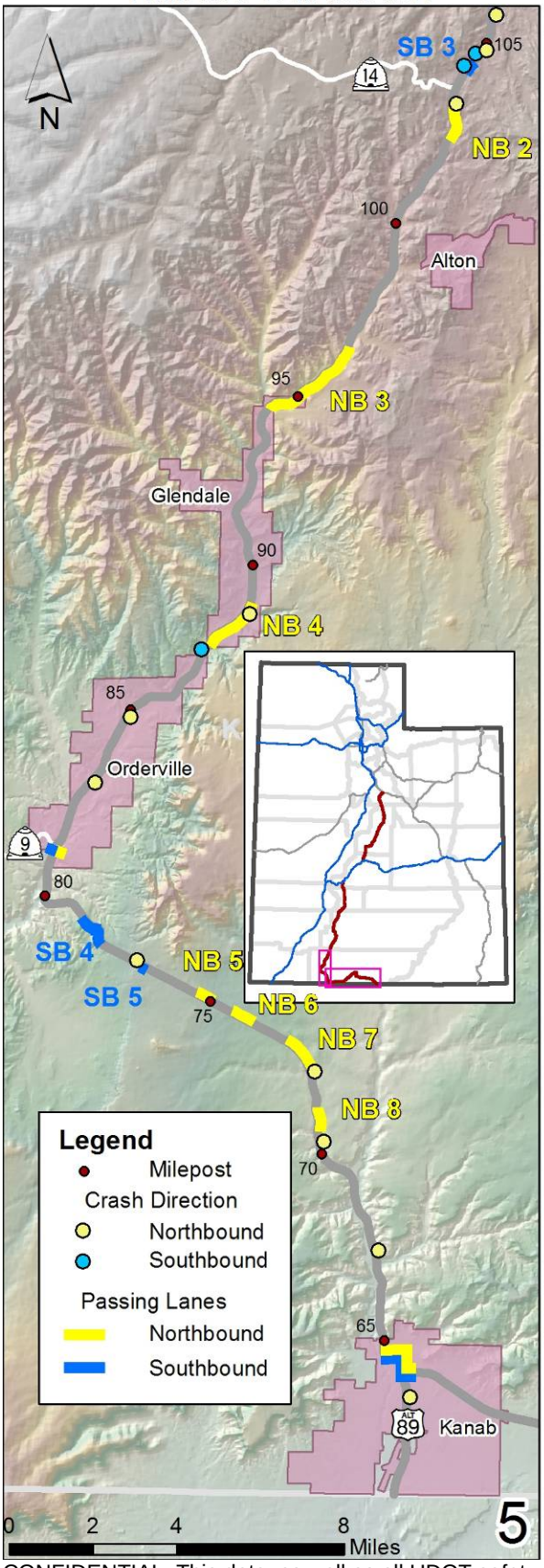
From S.R. 14 to U.S. 89A



From U.S. 89A to State Line via U.S. 89

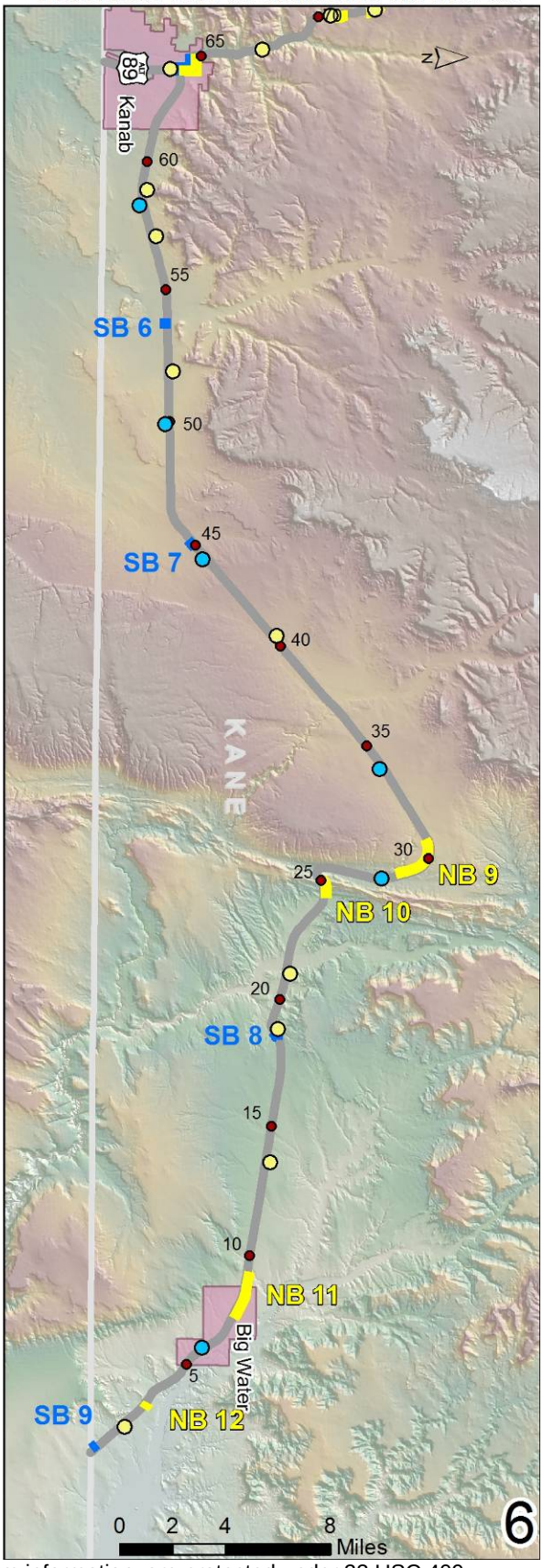


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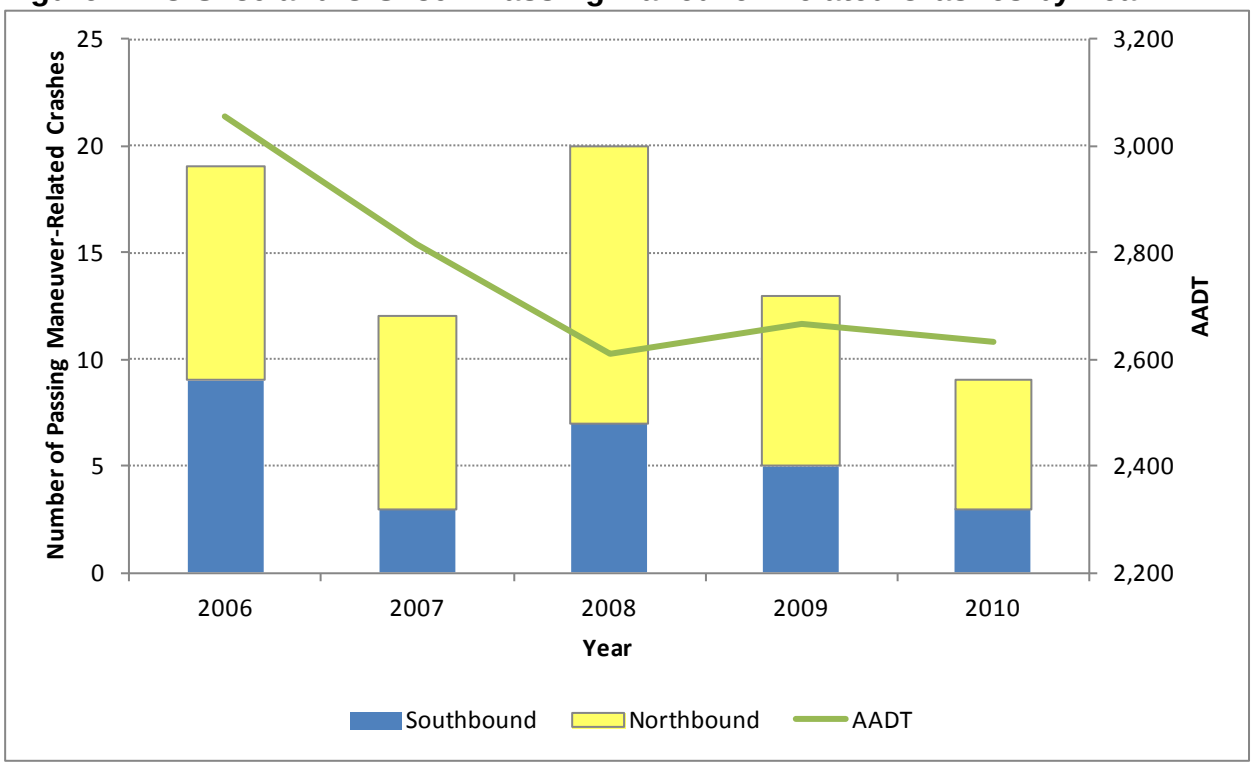
Figure 7 – U.S. 89 and U.S. 89A Passing Maneuver-Related Crashes by Year



Recommendations

New Passing Lanes

Using information and observations gathered during the site visit and data collection process, new passing lane recommendations were prepared for the study area. A total of 19 potential locations for new passing lanes were identified, 13 for the northbound direction of travel and six for the southbound direction. Some of the passing lane recommendations are located along a steep or gradual, but sustained, grade. Other recommendations do not accompany a grade, but serve to separate a long interval between passing lanes. Table 9 and Figure 8 summarize and illustrate the recommendations.

Three northbound passing lanes and one southbound passing lane are recommended between the Arizona/Utah state line and Kanab. Each of these recommendations is located on a straight and relatively flat section of U.S. 89. However, these recommendations help break up long sections of U.S. 89 with no passing lanes. Furthermore, this is a heavily travelled portion of U.S. 89 with a significant proportion of truck traffic and recreational traffic due to the proximity to Lake Powell.

The two new passing lanes recommended by the Tri-County Coal Truck Route Study were adopted in the recommendations of this study, with one significant change. Our study recommends reversing the recommended new southbound passing lane from MP 107 to 108.5 to be a northbound passing lane (NB P-9), which is consistent with the current U.S. 89 Passing Lanes and Alton Intersection Improvements Project (PIN 10675). Changing it to be a northbound passing lane is made for two reasons. First, coal-hauling trucks from the Alton

Coal Mine will travel with full loads northbound, away from the mine, and will return to the mine empty, heading southbound. Thus coal-hauling trucks will travel slower, and create a greater need for passing lanes, in the northbound direction. Second, field observation shows there is no significant grade in this vicinity to warrant a preference of a southbound passing lane over a northbound passing lane. No documentation within the Tri-County Coal Truck Route Study could be found to support the decision of a passing lane in the southbound direction.

Looking north on U.S. 89 at access to Alton Road.

Loaded coal truck turning north onto U.S. 89 at Alton Road access.

As truck and recreational traffic remain heavy on U.S. 89 up to the S.R. 20 intersection, several more passing lanes are recommended for this area. They include two additional northbound passing lanes and one southbound passing lane.

Between S.R. 20 and I-70, three more passing lane recommendations are provided. While traffic and truck volumes are relatively low in this area, these recommendations do address some sustained grades and long passing lane intervals.

North of I-70 a northbound passing lane is recommended between Salina and Centerfield to address the increase in truck traffic due to the nearby mining operations. Two additional passing lanes are recommended between Gunnison and Manti to address steep grades. Finally, despite relatively low traffic volumes north of Mount Pleasant, three more passing lanes are recommended to address grades and long passing lane intervals.

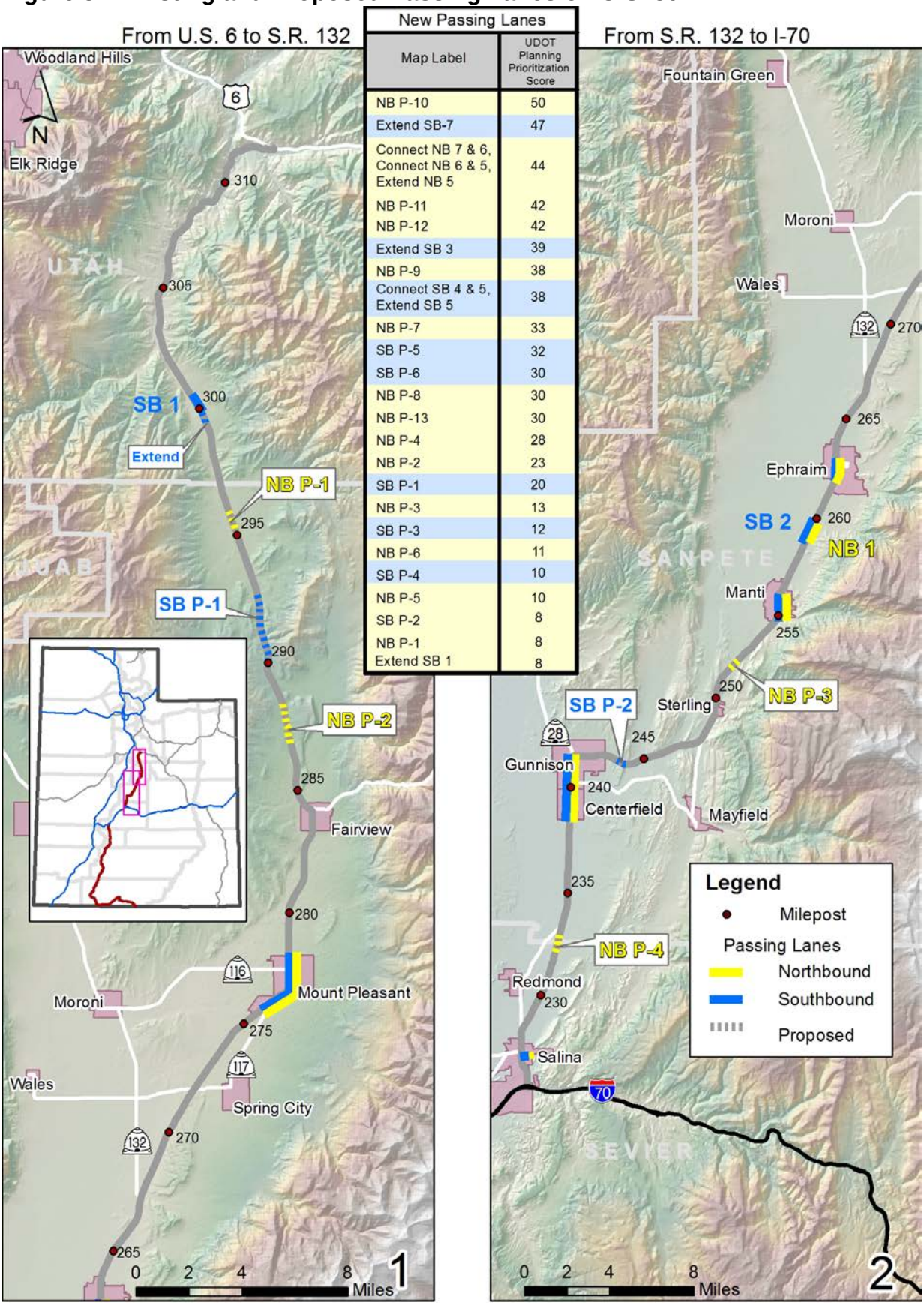
The new passing lane recommendations serve to reduce some of the longest passing lane intervals on the corridor. As shown in Tables 10 and 11, most of the 20 to 40-mile intervals are broken into smaller segments, providing more regular passing opportunities for motorists.

Besides specifying new passing lanes, this study provides recommendations for improvements to existing passing lanes that will improve passing opportunities. These recommendations are discussed in a subsequent section.

Table 9 – U.S. 89 Recommended New Passing Lanes

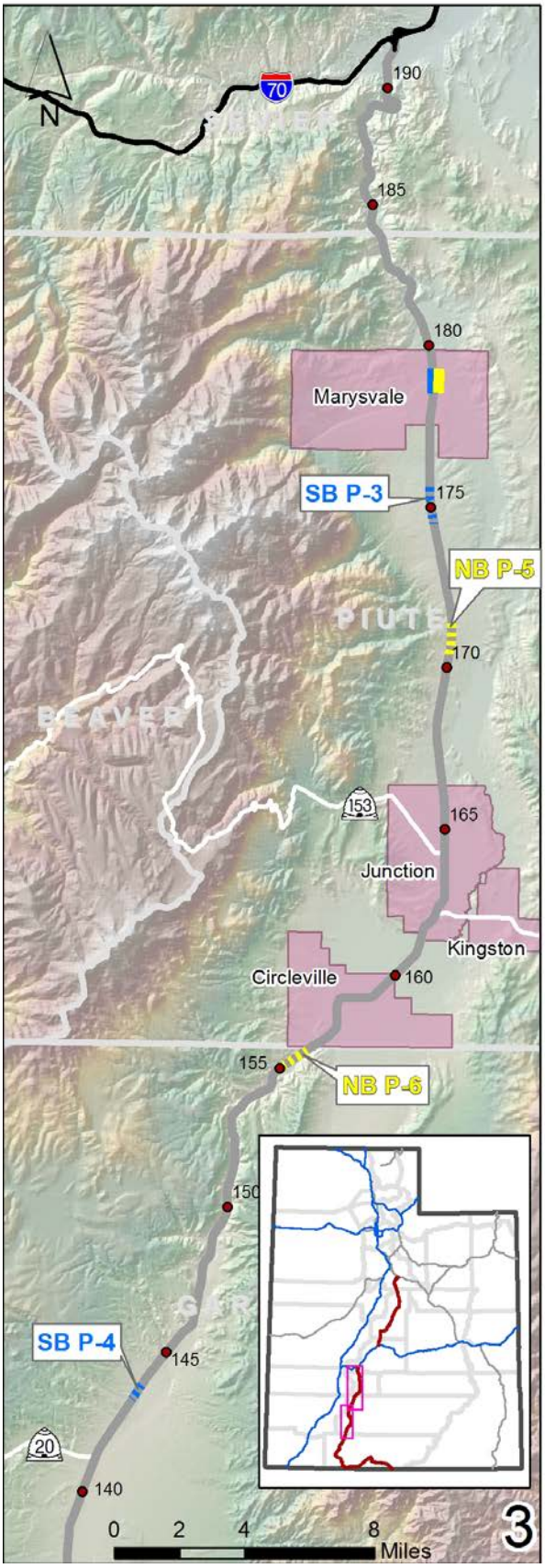
Direction	Map Label (Figure 7)	Begin MP	End MP	Total Length (miles)	Comments
Southbound (SB)	SB P-1	292.5	290.0	2.5	Long grade. Narrow back to one lane before turn lanes at top of hill.
	SB P-2	244.1	243.6	0.5	Grade. Narrow back to one lane before turn lanes at top of hill.
	SB P-3	175.5	174.5	1.0	Interval-based. Flat. Start after Cottonwood Canyon National Forest access.
	SB P-4	143.7	143.2	0.5	Grade.
	SB P-5	114.0	113.3	0.7	Grade. Start after bridge structure.
	SB P-6	17.0	16.0	1.0	Interval-based. Flat.
Northbound (NB)	NB P-1	295.0	296.0	1.0	Interval-based. Flat.
	NB P-2	286.7	288.3	1.6	Long grade.
	NB P-3	251.6	252.1	0.5	Grade. Narrow back to one lane before accesses at top of hill.
	NB P-4	232.0	233.0	1.0	Interval-based. Flat.
	NB P-5	170.4	171.4	1.0	Grade. Start as acceleration lane from Piute State Park access.
	NB P-6	155.0	156.0	1.0	Interval-based. Flat. Just outside of Circleville Canyon.
	NB P-7	135.0	137.0	2.0	Interval-based. Flat.
	NB P-8	121.4	122.4	1.0	Interval-based. Avoid Sevier River meandering.
	NB P-9	107.0	108.5	1.5	Switch to northbound as defined by the U.S. 89 Passing Lanes and Alton Intersection Improvements Project (PIN 10675)
	NB P-10	99.0	100.0	1.0	Start as acceleration lane at Alton Road.
	NB P-11	50.0	53.0	3.0	Interval-based. Flat.
	NB P-12	38.0	42.0	4.0	Interval-based. Flat.
	NB P-13	15.0	16.0	1.0	Interval-based. Flat.

Figure 8 – Existing and Proposed Passing Lanes on U.S. 89

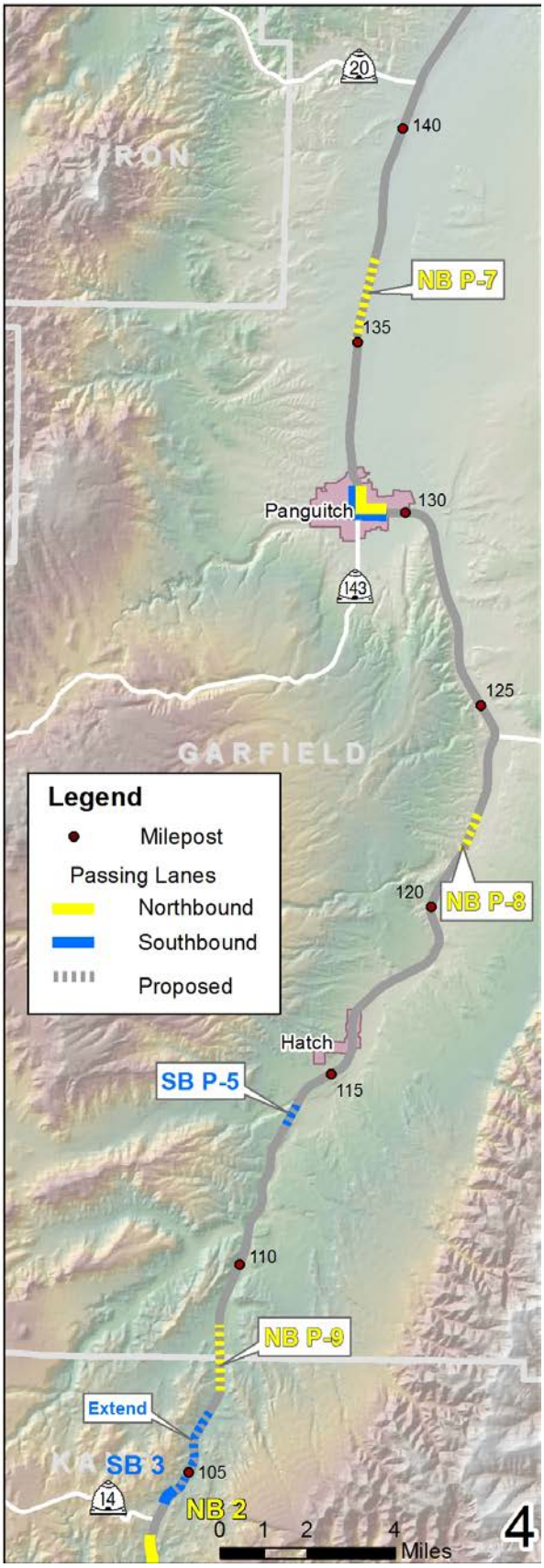


New Passing Lanes	
Map Label	UDOT Planning Prioritization Score
NB P-10	50
Extend SB-7	47
Connect NB 7 & 6, Connect NB 6 & 5, Extend NB 5	44
NB P-11	42
NB P-12	42
Extend SB 3	39
NB P-9	38
Connect SB 4 & 5, Extend SB 5	38
NB P-7	33
SB P-5	32
SB P-6	30
NB P-8	30
NB P-13	30
NB P-4	28
NB P-2	23
SB P-1	20
NB P-3	13
SB P-3	12
NB P-6	11
SB P-4	10
NB P-5	10
SB P-2	8
NB P-1	8
Extend SB 1	8

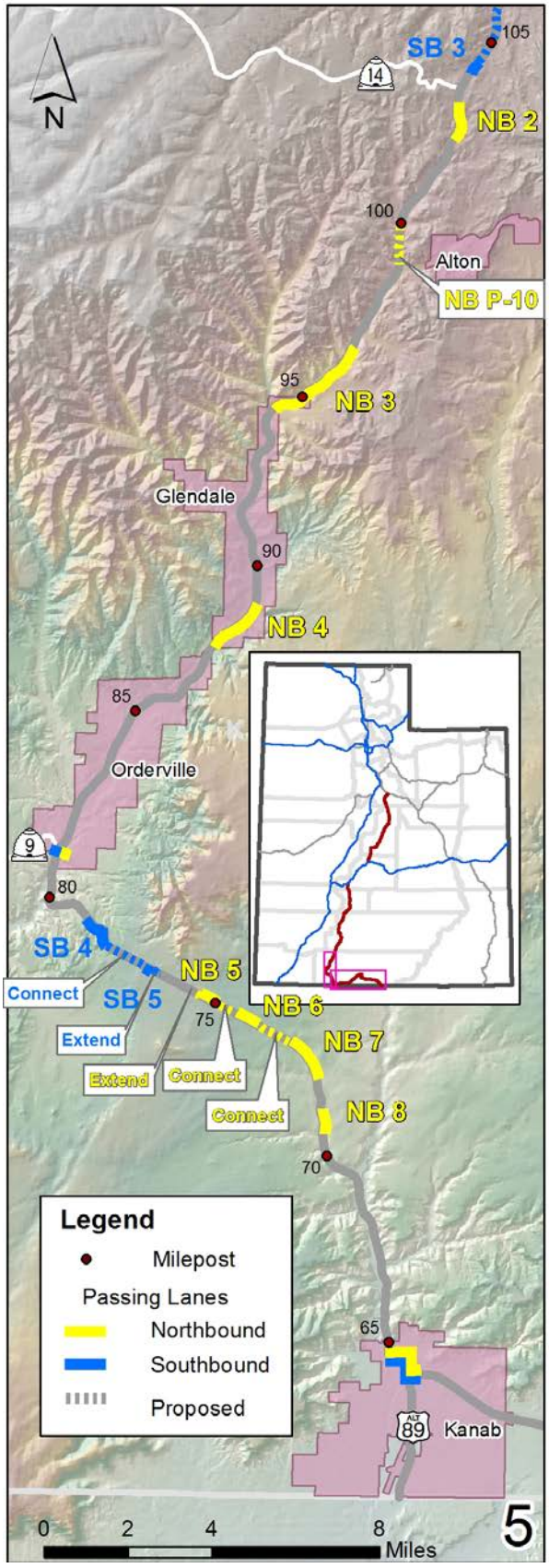
From I-70 to S.R. 20



From S.R. 20 to S.R. 14



From S.R. 14 to U.S. 89A



From U.S. 89A to State Line via U.S. 89

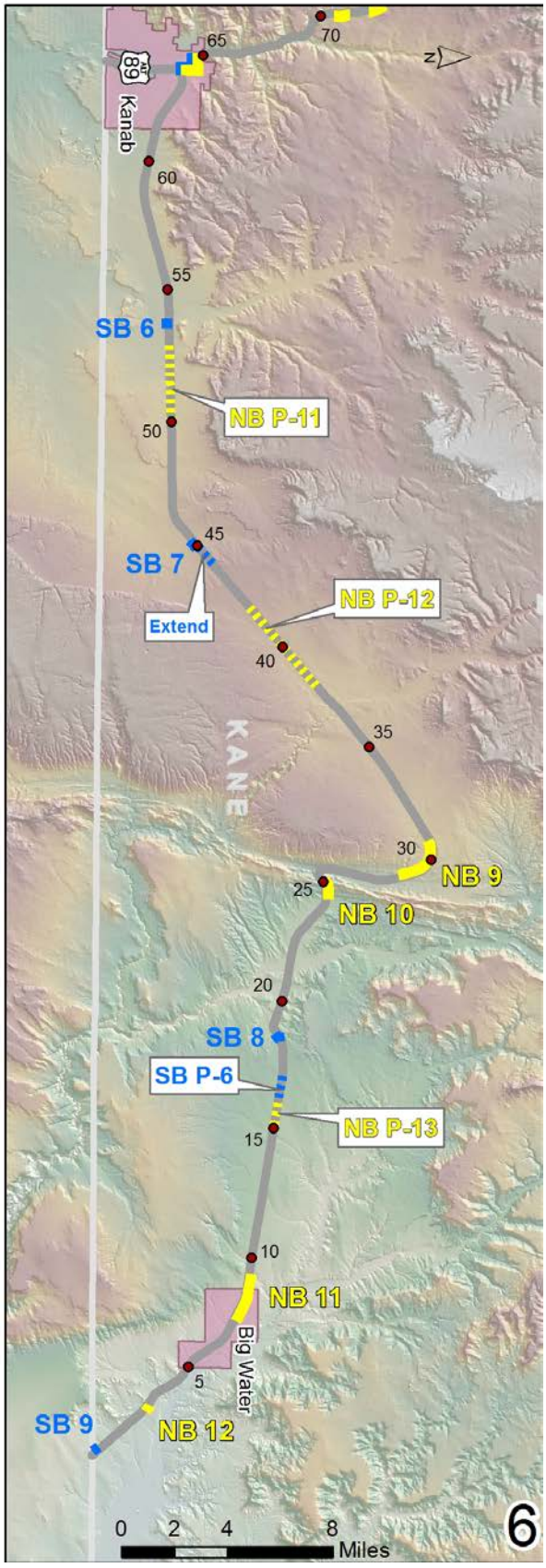


Table 10 – Southbound Passing Lane Interval Comparison

Direction	Map Label	Begin MP	End MP	Total Length (miles)	Existing Interval	Proposed Interval
Southbound (SB)	SB 1	300.6	299.7	0.9	21.3	7.2
	SB P-1	**292.5**	**290.0**	**2.5**		**11.6**
	Mount Pleasant	278.4	276.2	2.2	13.2	13.2
	Ephraim	263.0	262.0	1.0	2.0	2.0
	SB 2	260.0	258.7	1.3	2.7	2.7
	Manti	256.0	254.8	1.2	13.4	10.7
	SB P-2	**244.1**	**243.6**	**0.5**		**2.2**
	Gunnison	241.4	238.6	2.8	11.5	11.5
	Salina	227.1	226.8	0.3	1.4	1.4
	I-70	225.4	191.7	33.7	12.5	12.5
	Marysvale	179.2	178.6	0.6	46.8	3.1
	SB P-3	**175.5**	**174.5**	**1.0**		**30.8**
	SB P-4	**143.7**	**143.2**	**0.5**		**11.4**
	Panguitch	131.8	130.5	1.3	26.0	16.5
	SB P-5	**114.0**	**113.3**	**0.7**		**8.8**
	SB 3	104.5	104.1	0.4	22.8	22.8
	Mt. Carmel Jct.	81.3	81.1	0.2	2.3	2.3
	SB 4	78.8	77.9	0.9	1.0	1.0
	SB 5	76.9	76.7	0.2	12.2	12.2
	Kanab	64.5	63.7	0.8	9.8	9.8
	SB 6	53.9	53.5	0.4	8.2	8.2
	SB 7	45.3	44.9	0.4	26.2	26.2
	SB 8	18.7	18.3	0.4	17.9	1.3
	SB P-6	**17.0**	**16.0**	**1.0**		**15.6**
	SB 9	0.4	0.1	0.3	AZ Border	AZ Border

Table 11 – Northbound Passing Lane Interval Comparison

Direction	Map Label	Begin MP	End MP	Total Length (miles)	Existing Interval	Proposed Interval
Northbound (NB)	**NB P-1**	**295.0**	**296.0**	**1.0**	34.5	**16.8**
	NB P-2	**286.7**	**288.3**	**1.6**		**6.7**
	Mount Pleasant	276.3	278.3	2.0		8.4
	Ephraim	262.0	263.0	1.0	13.3	13.3
	NB 1	258.8	259.8	1.0	2.2	2.2
	Manti	254.9	256.0	1.1	2.8	2.8
	NB P-3	**252.0**	**252.4**	**0.4**	13.5	**2.5**
	Gunnison	238.6	241.4	2.8		10.6
	NB P-4	**232.0**	**233.0**	**1.0**	11.5	**5.6**
	Salina	226.6	227.1	0.5		4.9
	I-70	191.7	225.4	33.7	1.2	1.2
	Marysvale	178.5	179.4	0.9	12.3	12.3
	NB P-5	**170.0**	**171.3**	**1.3**	46.7	**7.2**
	NB P-6	**155.0**	**156.0**	**1.0**		**14.0**
	NB P-7	**135.0**	**137.0**	**2.0**		**18.0**
	Panguitch	130.5	131.8	1.3		3.2
	NB P-8	**121.0**	**122.0**	**1.0**	27.1	**8.5**
	NB P-9	**107.0**	**108.5**	**1.5**		**12.5**
	NB 2	102.4	103.4	1.0		3.6
	NB P-10	**99.0**	**100.0**	**1.0**	5.7	**2.4**
	NB 3	94.2	96.7	2.5		2.3
	NB 4	87.6	89.1	1.5	5.1	5.1
	Mt. Carmel Jct.	81.1	81.3	0.2	6.3	6.3
	NB 5	74.9	75.2	0.3	5.9	5.9
	NB 6	73.9	74.4	0.5	0.5	0.5
	NB 7	72.0	73.0	1.0	0.9	0.9
	NB 8	70.5	71.1	0.6	0.9	0.9
	Kanab	63.7	64.5	0.8	6.0	6.0
	NB P-11	**50.0**	**53.0**	**3.0**	32.9	**10.7**
	NB P-12	**38.0**	**42.0**	**4.0**		**8.0**
	NB 9	28.5	30.8	2.3		7.2
	NB 10	24.3	25.0	0.7	3.5	3.5
	NB P-13	**15.0**	**16.0**	**1.0**	14.9	**8.3**
	NB 11	7.5	9.4	1.9		5.6
	NB 12	2.6	2.9	0.3	4.6	4.6

Prioritization

A prioritization process was utilized to rank the recommended new passing lane locations in this study. The process was based on the prioritization scoring methods the UDOT Planning Division uses to rank statewide passing lane projects for the Utah Transportation Commission. The Planning Division methodology reports a 0-100 score and utilizes the following four criteria and weighting to rank passing lane projects:

1. AADT – 30 percent
2. Truck AADT – 20 percent
3. Crash History – 30 percent
4. Freight Corridor – 20 percent

Because the Planning Division methodology is targeted towards comparing corridor to corridor, and because of the homogeneous nature of the study area, a fifth criterion was added to help further refine the passing lane recommendations. This criterion is defined as "Passing Lane Interval" and scores the existing interval between passing lanes where the passing lane is proposed. Road segments with greater distance between passing lanes receive higher scores to reflect a greater need for a passing lane. The new criterion was assigned a maximum value of 20 points to bring the maximum potential score up to 120 points. The breakdown of individual scoring schemes is provided in the appendix.

Table 12 summarizes the prioritization scores for the recommended new passing lanes. Generally, northbound passing lane recommendations result in higher scores than southbound passing lane recommendations. The two highest scoring recommendations (NB P-11 and NB P-12, both scoring 62) are northbound passing lanes just east of Kanab. Interestingly this area is relatively flat and straight. However, the relatively high traffic and truck volumes, as well as the very large distance between existing passing lanes contribute to the high scores. Additionally, this portion of U.S. 89 is a major truck route on Utah's Primary Freight Network. The next set of high scoring recommendations is SB P-5, NB P-7, NB P-8, NB P-9, and NB P-10. Except for NB P-5, these new passing lanes are either related to the Alton Coal Mine or are generally located between S.R. 9 and S.R. 20 on U.S. 89. Again, high traffic and truck volumes, long existing passing lane intervals, as well as being on Utah's Primary Freight Network, contribute to the high scores.

It should be noted that this prioritization process is intended to be used for planning-level decisions. Other factors, such as cost, constructability, pavement condition, or grade may be considered in any final decision-making process. Furthermore, the proposed new passing lane locations are generic. Actual passing lane locations could be extended or shortened based on engineering analysis of structures, culverts, horizontal and vertical curvature, or cut and fill parameters.

Table 12 – U.S. 89 Recommended New Passing Lanes Prioritization

Potential Passing Lane Locations			UDOT Planning Prioritization Criteria								Added Criteria		
			AADT		Truck AADT		Crash History		Freight Corridor		Passing Lane Interval		
Map Label	Begin MP	End MP	2011	Score	2011	Score	Safety Index[1]	Score	Type	Score	Total Sub-Score	Interval (miles)	Score	Total Score
SB P-1	292.5	290.0	1,540	3	308	2	5.0	15	None	0	**20**	21.3	20	**40**
SB P-2	244.1	243.6	2,205	3	485	2	1.0	3	None	0	**8**	13.4	10	**18**
SB P-3	175.5	174.5	1,190	3	583	4	1.5	5	None	0	**12**	46.8	20	**32**
SB P-4	143.7	143.2	1,115	3	323	2	1.5	5	None	0	**10**	46.8	20	**30**
SB P-5	114.0	113.3	1,455	3	626	4	1.5	5	Major Route	20	**32**	26.0	20	**52**
SB P-6	17.0	16.0	2,155	3	754	4	1.0	3	Major Route	20	**30**	17.9	15	**45**
NB P-1	295.0	296.0	2,345	3	141	2	1.0	3	None	0	**8**	34.5	20	**28**
NB P-2	286.7	288.3	1,540	3	308	2	6.0	18	None	0	**23**	34.5	20	**43**
NB P-3	251.6	252.1	3,280	6	590	4	1.0	3	None	0	**13**	13.5	10	**23**
NB P-4	232.0	233.0	3,295	6	989	4	1.0	3	Energy Route	15	**18**	11.5	10	**38**
NB P-5	170.4	171.4	1,190	3	583	4	1.0	3	None	0	**10**	46.7	20	**30**
NB P-6	155.0	156.0	1,115	3	323	2	2.0	6	None	0	**11**	46.7	20	**31**
NB P-7	135.0	137.0	2,525	6	934	4	1.0	3	Major Route	20	**33**	46.7	20	**53**
NB P-8	121.4	122.4	2,020	3	808	4	1.0	3	Major Route	20	**30**	27.1	20	**50**
NB P-9	107.0	108.5	1,455	3	626	4	3.5	11	Major Route	20	**38**	27.1	20	**58**
NB P-10	99.0	100.0	1,605	3	674	4	7.5	23	Major Route	20	**50**	5.7	5	**55**
NB P-11	50.0	53.0	2,155	3	754	4	5.0	15	Major Route	20	**42**	32.9	20	**62**
NB P-12	38.0	42.0	2,155	3	754	4	5.0	15	Major Route	20	**42**	32.9	20	**62**
NB P-13	15.0	16.0	2,155	3	754	4	1.0	3	Major Route	20	**30**	14.9	10	**40**
Points Possible				**30**		**30**		**30**		**20**	**100**		**20**	**120**

[1]Safety Index calculated for proposed passing lane extents +/-0.5 mile (2006-2010).

Improve Existing Passing Lanes

During the field review, passing lane start and end points were examined to determine whether they provide adequate service for traveling vehicles. Based on the review, the following improvements to existing passing lanes are recommended:

1. Lengthen Passing Lane SB 1 – This passing lane could be extended to approximately MP 299.3 so as to carry the passing lane beyond the crest of the hill.

2. Lengthen Passing Lane SB 3 – This passing lane could be extended back to approximately MP 106.5. The original passing lane at this location extended over the crest of the hill to the S.R. 14 intersection. In 2007, the end of the

passing lane was pulled back from the crest of the hill to improve safety at the intersection, resulting in a short passing lane. Extending the toe of this passing lane would allow for more opportunity to conduct passing maneuvers. This recommendation is consistent with the Tri-County Coal Truck Route Study.

3. Connect Passing Lane SB 4 to Passing Lane SB 5, extend Passing Lane SB 5, and consolidate accesses to Coral Pink Sand Dunes State Park – Both Passing Lane SB 4 and Passing Lane SB 5 end well short of the crest of the hill. Additionally, Passing Lane SB 5 is only 0.2 miles long, leaving little time for vehicles to conduct passing maneuvers. Connecting SB 4 to SB 5 and extending SB 5 past the summit to approximately MP 76.5 will create a continuous, 2.3-mile passing lane that extends all the way over the crest of the hill. Finally, there are two accesses to the Coral Pink Sand Dunes State Park in the existing passing lane gap between SB 4 and SB 5. These accesses should be consolidated to simplify traffic maneuvers in this area. Additionally, a northbound left-turn lane should be installed at the consolidated access so that vehicles turning left from U.S. 89, into the access, do not obstruct the single northbound lane of travel. The left-turn lane will also benefit northbound left turns since these vehicles will now be turning across two southbound lanes.

4. Lengthen Passing Lane SB 7 – This passing lane could be extended to approximately MP 44.1 so as to carry the passing lane through most of the subsequent hill, but end before the existing guardrail.

5. Connect Passing Lanes NB 7, NB 6, and NB 5, and extend Passing Lane NB 5 – Each of these three passing lanes end just short of the crests of their respective hills. Additionally, the intervals between these passing lanes are less than one mile. Connecting these passing lanes and extending NB 5 to approximately MP 75.5 would create a continuous, 3.5-mile passing lane that extends past the final hill crest. (Note: although Passing Lane NB 8 is also less than one mile from NB 7, terrain issues prevent NB 8 from being connected to the subsequent set of passing lanes.)

Passing Lane SB 3 ending prior to crest of hill.

Passing Lane SB 4 ending prior to crest of hill.

Passing Lane SB 5 ending prior to crest of hill.

Platoon of vehicles between Passing Lanes SB 4 and SB 5.

Table 13 – U.S. 89 Recommended Improvements to Existing Passing Lanes

Direction	Map Label (Figure 7)	Begin MP	End MP	Improvements
Southbound (SB)	SB 1	300.6	299.7	Extend over hill to approximately MP 299.3.
	SB 3	104.5	104.1	Extend start of passing lane to approximately MP 106.5 (adopted from Tri-County Coal Truck Route Study).
	SB 4 & SB 5			Connect these two passing lanes, extend SB 5 to approximately MP 76.5.
	SB 7	45.3	44.9	Extend to approximately MP 44.1.
Northbound (NB)	NB 7, NB 6 & NB 5			Connect these three passing lanes, extend NB 5 to approximately MP 75.5.

Table 14 – U.S. 89 Improvements to Existing Passing Lanes Prioritization

Potential Passing Lane Locations			UDOT Planning Prioritization Criteria									Added Criteria
			AADT		Truck AADT		Crash History		Freight Corridor			
Map Label	Begin MP	End MP	2011	Score	2011	Score	Safety Index[1]	Score	Type	Score	Total Sub-Score	N/A
Extend SB 1	299.7	299.3	2,345	3	141	2	1.0	3	None	0	**8**	
Extend SB 3	106.5	104.5	1,455	3	626	4	4.0	12	Major Route	20	**39**	
Connect SB 4 & 5, Extend SB 5	77.9	76.5	3,015	6	874	4	2.5	8	Major Route	20	**38**	
Extend SB 7	44.7	44.1	2,115	3	740	4	6.5	20	Major Route	20	**47**	
Connect NB 7 & 6, Connect NB 6 & 5, Extend NB 5	73	75.5	3,015	6	874	4	4.5	14	Major Route	20	**44**	
Points Possible				**30**		**30**		**30**		**20**	**100**	

[1]Safety Index calculated for proposed passing lane extents +/-0.5 mile (2006-2010).

Table 15 combines the new passing lane and improvements to existing passing lane recommendations. The recommendations are listed in order of decreasing prioritization score to provide an overall comparison of which all the recommendations receive the best scores. The UDOT Planning Prioritization score is reported rather than the modified score because the passing lane interval sub-score is not valid for passing lane improvements projects.

Table 15 – Combined Passing Lanes Prioritization List

Rank	Map Label	Type	UDOT Planning Prioritization Score
1	NB P-10	New	50
2	Extend SB-7	Improve Existing	47
3	Connect NB 7 & 6, Connect NB 6 & 5, Extend NB 5	Improve Existing	44
4	NB P-11	New	42
5	NB P-12	New	42
6	Extend SB 3	Improve Existing	39
7	NB P-9	New	38
	Connect SB 4 & 5, Extend SB 5	Improve Existing	38
9	NB P-7	New	33
10	SB P-5	New	32
11	SB P-6	New	30
	NB P-8	New	30
	NB P-13	New	30
14	NB P-4	New	28
15	NB P-2	New	23
16	SB P-1	Improve Existing	20
17	NB P-3	New	13
18	SB P-3	New	12
19	NB P-6	New	11
20	SB P-4	New	10
	NB P-5	New	10
22	SB P-2	New	8
	NB P-1	New	8
	Extend SB 1	Improve Existing	8

Taper Length

Tapers can be used in the transition from a passing lane to a general purpose lane after passing a slow-moving vehicle. According to Section 6C.08 of the MUTCD 2009 Edition, a merging taper requires the longest distance because drivers are required to merge into a general purpose lane. On U.S. 89 the current taper lengths in the study area looked correct, and any new passing lanes will need to meet the MUTCD specifications.

Signage

Currently, passing lane signing schemes are inconsistent through the study area. While all passing lanes regularly feature the "LANE ENDS MERGE LEFT" sign, the use of the advance warning signs is irregular. Some passing lanes have a one or two mile advance warning sign, while others have a 500 foot advance warning sign. Part of the reason for inconsistent signage may be due to lack of detail or changing guidelines in previous versions of the MUTCD. While the advance warning irregularity is not anticipated to significantly diminish passing lane functionality, it is recommended that signage be phased into conformity with UDOT standard drawings as part of regular sign maintenance/replacement.

Other insufficiencies include wrong size of sign and the sign's dissipation of the retro-reflectivity. An inventory of existing passing lane signage is available in the Appendix.

It is also recommended that the "NEXT PASSING LANE XX MILES" (D17-1) sign begin to be used consistently along the corridor. The consistent use of this sign at the end of each passing lane and between long stretches of passing lanes would be especially beneficial so as to alert drivers of the next passing lane opportunity. Being aware of the distance to the next passing lane can help reduce driver anxiety and over-aggressive passing behavior.

Finally, given the length of passing lanes that would be created by combining SB 4 and SB 5 and also NB 5, NB 6, and NB 7, (as per study recommendations) the "KEEP RIGHT EXCEPT TO PASS" sign (R4-16) should be repeated at one mile intervals to remind drivers of the function of the passing lane as per UDOT Standard Drawing ST 6.

Cost Estimates

Passing lane construction costs can vary widely due to a number of site-specific factors, such as terrain, pavement condition, cut and fill, structures, drainage, and traffic mitigation. Nevertheless, a basic, planning-level cost estimate of $1.3 million per mile was assumed to provide some context for the decision-making process. This estimate was derived from a brief examination of previous passing lane projects and Region 4 consultation.

Table 16 – New Passing Lane Cost Estimate

Direction	Map Label (Figure 7)	Begin MP	End MP	Total Length (miles)	Prioritization Score	Planning-Level Cost Estimate ($)
Southbound (SB)	SB P-1	292.5	290.0	2.5	40	$ 3,250,000
	SB P-2	244.1	243.6	0.5	18	$ 650,000
	SB P-3	175.5	174.5	1.0	32	$ 1,300,000
	SB P-4	143.7	143.2	0.5	30	$ 650,000
	SB P-5	114.0	113.3	0.7	52	$ 910,000
	SB P-6	17.0	16.0	1.0	45	$ 1,300,000
Northbound (NB)	NB P-1	295.0	296.0	1.0	28	$ 1,300,000
	NB P-2	286.7	288.3	1.6	43	$ 2,080,000
	NB P-3	251.6	252.1	0.5	23	$ 650,000
	NB P-4	232.0	233.0	1.0	38	$ 1,300,000
	NB P-5	170.4	171.4	1.0	30	$ 1,300,000
	NB P-6	155.0	156.0	1.0	31	$ 1,300,000
	NB P-7	135.0	137.0	2.0	53	$ 2,600,000
	NB P-8	121.4	122.4	1.0	50	$ 1,300,000
	NB P-9	107.0	108.5	1.5	58	$ 1,950,000
	NB P-10	99.0	100.0	1.0	55	$ 1,300,000
	NB P-11	50.0	53.0	3.0	62	$ 3,900,000
	NB P-12	38.0	42.0	4.0	62	$ 5,200,000
	NB P-13	15.0	16.0	1.0	40	$ 1,300,000

Note: Planning-level costs only. Actual passing lane costs can vary due to a number of individual factors.

Appendix

1. UDOT DD 3 Standard Drawing for Climbing Lanes
2. UDOT ST 5 Standard Drawing for Painted Median and Auxiliary Lane Details
3. UDOT ST 6 Standard Drawing for Passing/Climbing Lanes
4. Existing Passing Lane Signage Inventory
5. Passing Lane Prioritization Criteria

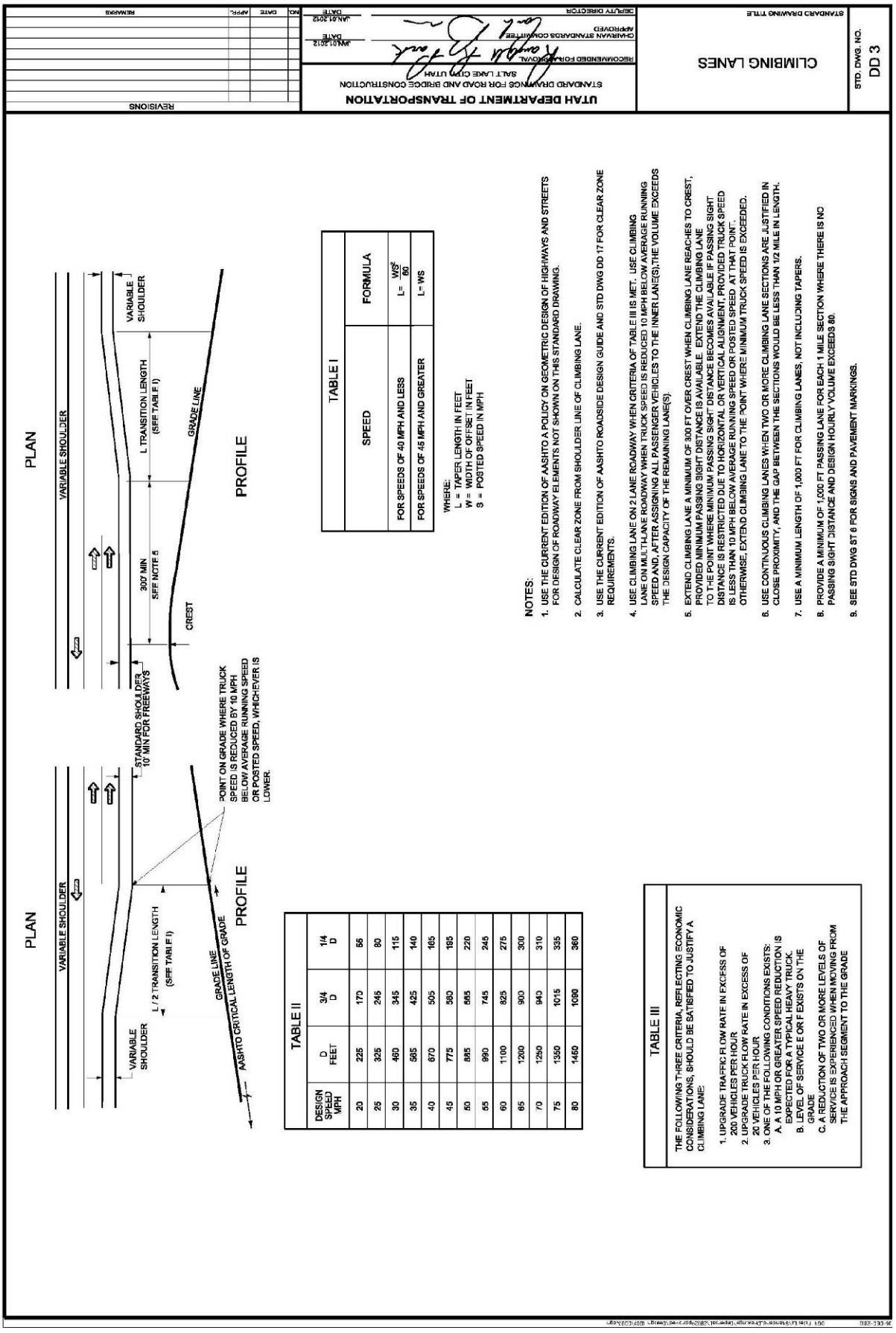


TABLE I

SPEED	FORMULA
FOR SPEEDS OF 40 MPH AND LESS	$L = \frac{WS^2}{60}$
FOR SPEEDS OF 45 MPH AND GREATER	L= WS

WHERE:
L = TAPER LENGTH IN FEET
W = WIDTH OF OFFSET IN FEET
S = POSTED SPEED IN MPH

TABLE II

DESIGN SPEED MPH	D FEET	3/4 D	1/4 D
20	225	170	55
25	325	245	80
30	460	345	115
35	595	425	140
40	670	505	165
45	775	580	195
50	885	665	220
55	990	745	245
60	1100	825	275
65	1200	900	300
70	1250	940	310
75	1350	1015	335
80	1460	1080	360

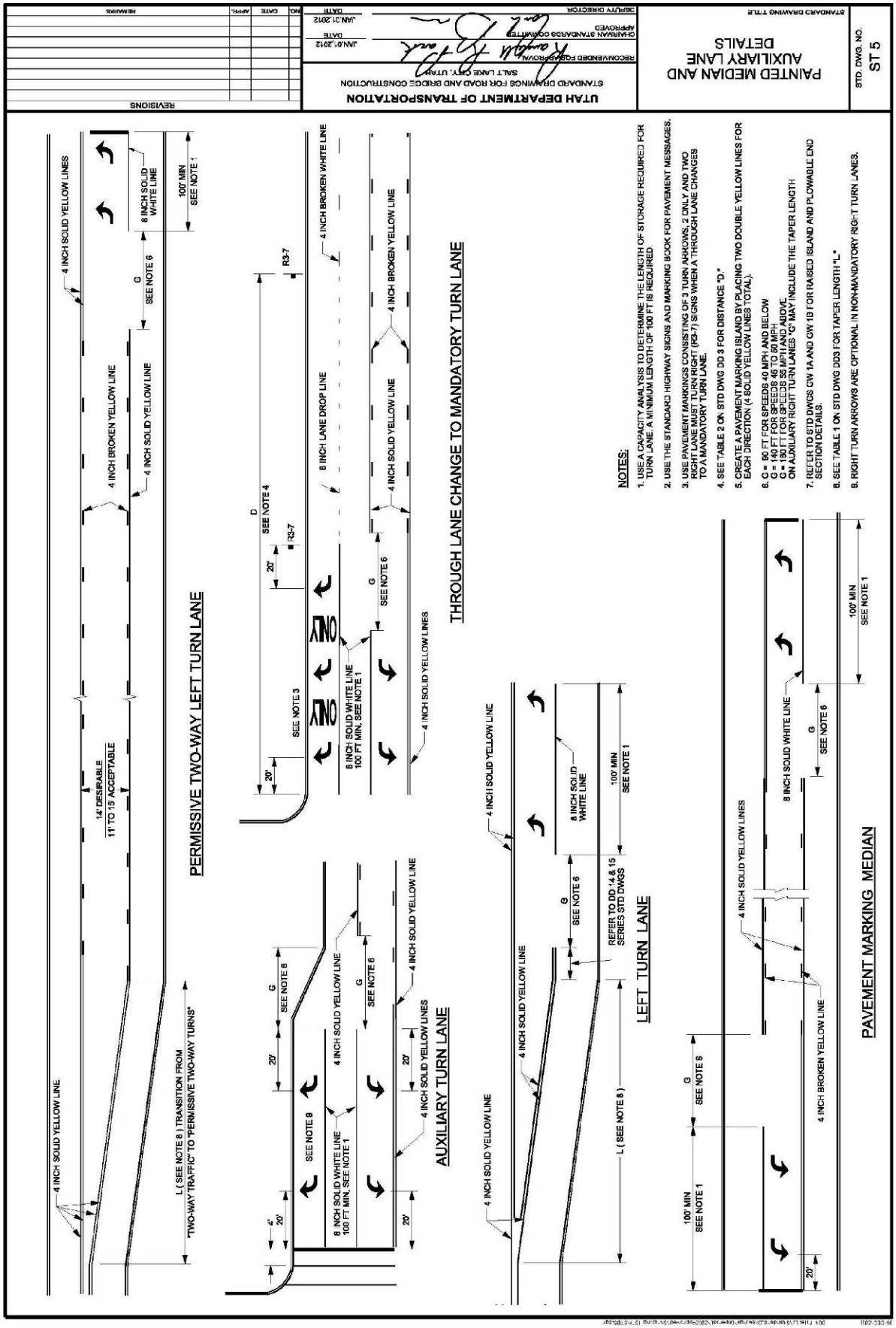
TABLE III

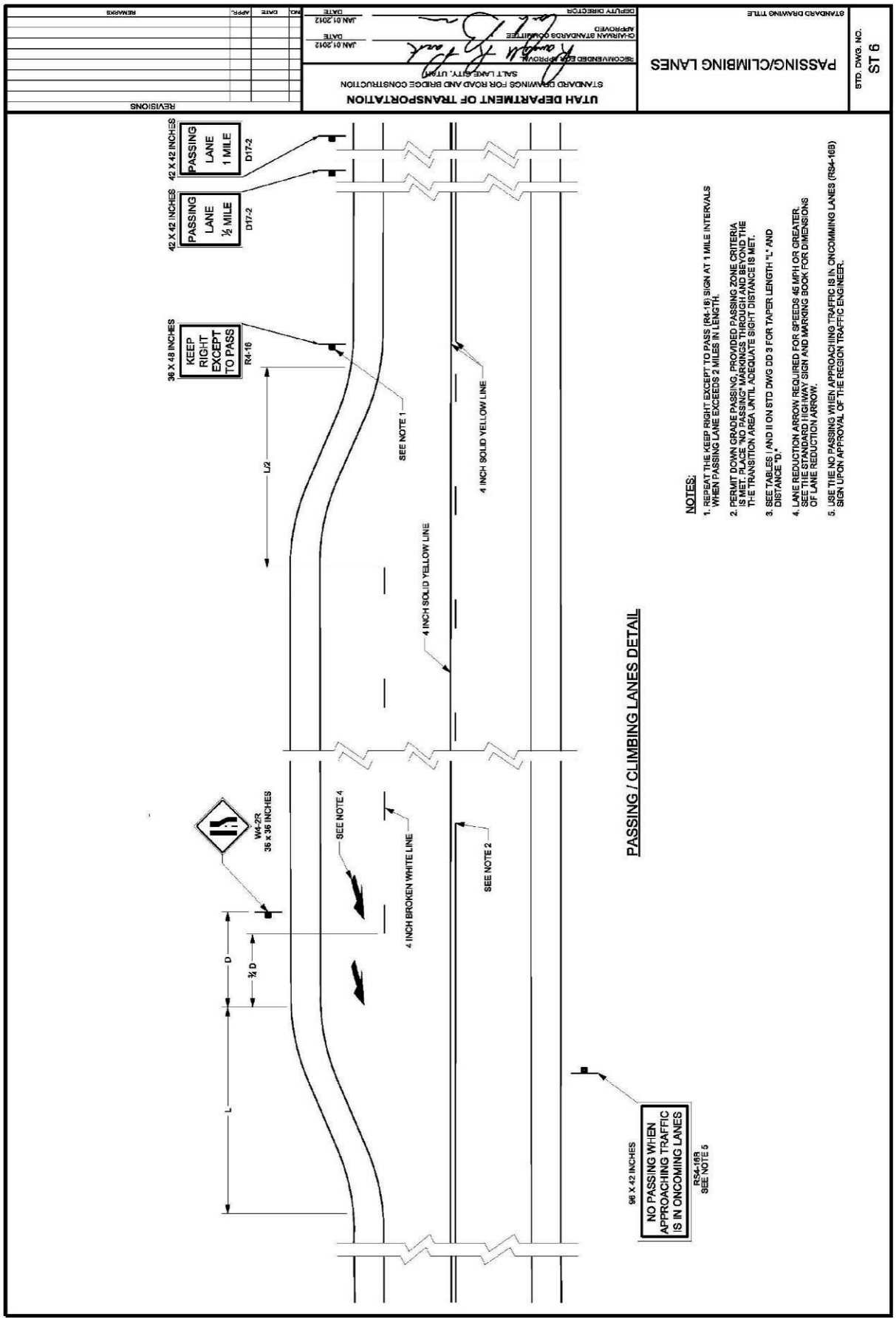
THE FOLLOWING THREE CRITERIA, REFLECTING ECONOMIC CONSIDERATIONS, SHOULD BE SATISFIED TO JUSTIFY A CLIMBING LANE:

1. UPGRADE TRAFFIC FLOW RATE IN EXCESS OF 200 VEHICLES PER HOUR
2. UPGRADE TRUCK FLOW RATE IN EXCESS OF 20 VEHICLES PER HOUR
3. ONE OF THE FOLLOWING CONDITIONS EXISTS:
   A. A 10 MPH OR GREATER SPEED REDUCTION IS EXPECTED FOR A TYPICAL HEAVY TRUCK.
   B. LEVEL OF SERVICE E OR F EXISTS ON THE GRADE
   C. A REDUCTION OF TWO OR MORE LEVELS OF SERVICE IS EXPERIENCED WHEN MOVING FROM THE APPROACH SEGMENT TO THE GRADE

NOTES:

1. USE THE CURRENT EDITION OF AASHTO A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS FOR DESIGN OF ROADWAY ELEMENTS NOT SHOWN ON THIS STANDARD DRAWING.
2. CALCULATE CLEAR ZONE FROM SHOULDER LINE OF CLIMBING LANE.
3. USE THE CURRENT EDITION OF AASHTO ROADSIDE DESIGN GUIDE AND STD DWG DD 17 FOR CLEAR ZONE REQUIREMENTS.
4. USE CLIMBING LANE ON 2 LANE ROADWAY WHEN CRITERIA OF TABLE III IS MET. USE CLIMBING LANE ON MULTILANE ROADWAY WHEN TRUCK SPEED IS REDUCED 10 MPH BELOW AVERAGE RUNNING SPEED AND, AFTER ASSIGNING ALL PASSENGER VEHICLES TO THE INNER LANE(S), THE VOLUME EXCEEDS THE DESIGN CAPACITY OF THE REMAINING LANE(S).
5. EXTEND CLIMBING LANE A MINIMUM OF 300 FT OVER CREST WHEN CLIMBING LANE REACHES TO CREST, PROVIDED MINIMUM PASSING SIGHT DISTANCE IS AVAILABLE. EXTEND THE CLIMBING LANE TO THE POINT WHERE MINIMUM PASSING SIGHT DISTANCE BECOMES AVAILABLE IF PASSING SIGHT DISTANCE IS RESTRICTED DUE TO HORIZONTAL OR VERTICAL ALIGNMENT, PROVIDED TRUCK SPEED IS LESS THAN 10 MPH BELOW AVERAGE RUNNING SPEED OR POSTED SPEED AT THAT POINT. OTHERWISE, EXTEND CLIMBING LANE TO THE POINT WHERE MINIMUM TRUCK SPEED IS EXCEEDED.
6. USE CONTINUOUS CLIMBING LANES WHEN TWO OR MORE CLIMBING LANE SECTIONS ARE JUSTIFIED IN CLOSE PROXIMITY, AND THE GAP BETWEEN THE SECTIONS WOULD BE LESS THAN 1/2 MILE IN LENGTH.
7. USE A MINIMUM LENGTH OF 1,000 FT FOR CLIMBING LANES, NOT INCLUDING TAPERS.
8. PROVIDE A MINIMUM OF 1,000 FT PASSING LANE FOR EACH 1 MILE SECTION WHERE THERE IS NO PASSING SIGHT DISTANCE AND DESIGN HOURLY VOLUME EXCEED3 60.
9. SEE STD DWG ST 6 FOR SIGNS AND PAVEMENT MARKINGS.


UTAH DEPARTMENT OF TRANSPORTATION
STANDARD DRAWINGS FOR ROAD AND BRIDGE CONSTRUCTION
SALT LAKE CITY, UTAH
RECOMMENDED FOR APPROVAL
CHAIRMAN STANDARDS COMMITTEE
APPROVED
JAN.0.,2012
DATE
JAN 31 2012
DATE
PAINTED MEDIAN AND AUXILIARY LANE DETAILS
STD. DWG. NO.
ST 5
REVISIONS
NO.
DATE
APPR.
REMARKS
PERMISSIVE TWO-WAY LEFT TURN LANE
THROUGH LANE CHANGE TO MANDATORY TURN LANE
AUXILIARY TURN LANE
LEFT TURN LANE
PAVEMENT MARKING MEDIAN
4 INCH SOLID YELLOW LINES
4 INCH BROKEN YELLOW LINE
4 INCH SOLID YELLOW LINE
8 INCH SOLID WHITE LINE
100' MIN SEE NOTE 1
14' DESIRABLE 11' TO 15' ACCEPTABLE
L (SEE NOTE 8) TRANSITION FROM "TWO-WAY TRAFFIC" TO "PERMISSIVE TWO-WAY TURNS"
SEE NOTE 6
SEE NOTE 8
8 INCH SOLID WHITE LINE 100 FT MIN, SEE NOTE 1
4 INCH SOLID YELLOW LINES
SEE NOTE 3
SEE NOTE 4
R3-7
8 INCH LANE DROP LINE
4 INCH BROKEN WHITE LINE
ONLY
REFER TO DD 14 & 15 SERIES STD DWGS
NOTES:
1. USE A CAPACITY ANALYSIS TO DETERMINE THE LENGTH OF STORAGE REQUIRED FOR TURN LANE. A MINIMUM LENGTH OF 100 FT IS REQUIRED.
2. USE THE STANDARD HIGHWAY SIGNS AND MARKING BOOK FOR PAVEMENT MESSAGES.
3. USE PAVEMENT MARKINGS CONSISTING OF 3 TURN ARROWS, 2 ONLY AND TWO RIGHT LANE MUST TURN RIGHT (R3-7) SIGNS WHEN A THROUGH LANE CHANGES TO A MANDATORY TURN LANE.
4. SEE TABLE 2 ON STD DWG DD 3 FOR DISTANCE "D."
5. CREATE A PAVEMENT MARKING ISLAND BY PLACING TWO DOUBLE YELLOW LINES FOR EACH DIRECTION (4 SOLID YELLOW LINES TOTAL).
6. G = 60 FT FOR SPEEDS 40 MPH AND BELOW
G = 140 FT FOR SPEEDS 45 TO 50 MPH
G = 180 FT FOR SPEEDS 55 MPH AND ABOVE
ON AUXILIARY RIGHT TURN LANES "G" MAY INCLUDE THE TAPER LENGTH
7. REFER TO STD DWGS GW 1A AND GW 1B FOR RAISED ISLAND AND PLOWABLE END SECTION DETAILS.
8. SEE TABLE 1 ON STD DWG DD3 FOR TAPER LENGTH "L."
9. RIGHT TURN ARROWS ARE OPTIONAL IN NON-MANDATORY RIGHT TURN LANES.


UTAH DEPARTMENT OF TRANSPORTATION
STANDARD DRAWINGS FOR ROAD AND BRIDGE CONSTRUCTION
SALT LAKE CITY, UTAH
PASSING/CLIMBING LANES
STD. DWG. NO. ST 6
REVISIONS
PASSING / CLIMBING LANES DETAIL
42 X 42 INCHES PASSING LANE 1 MILE D17-2
42 X 42 INCHES PASSING LANE ½ MILE D17-2
36 X 48 INCHES KEEP RIGHT EXCEPT TO PASS R4-16
W4-2R 36 x 36 INCHES
96 X 42 INCHES NO PASSING WHEN APPROACHING TRAFFIC IS IN ONCOMMING LANES R5-4-16R SEE NOTE 5
SEE NOTE 1
SEE NOTE 2
SEE NOTE 4
4 INCH SOLID YELLOW LINE
4 INCH BROKEN WHITE LINE
L/2
D
½ D
L
NOTES:
1. REPEAT THE KEEP RIGHT EXCEPT TO PASS (R4-16) SIGN AT 1 MILE INTERVALS WHEN PASSING LANE EXCEEDS 2 MILES IN LENGTH.
2. PERMIT DOWN GRADE PASSING, PROVIDED PASSING ZONE CRITERIA IS MET. PLACE "NO PASSING" MARKINGS THROUGH AND BEYOND THE TI-E TRANSITION AREA UNTIL ADEQUATE SIGHT DISTANCE IS MET.
3. SEE TABLES I AND II ON STD DWG DD 3 FOR TAPER LENGTH "L" AND DISTANCE "D."
4. LANE REDUCTION ARROW REQUIRED FOR SPEEDS 45 MPH OR GREATER. SEE THE STANDARD HIGHWAY SIGN AND MARKING BOOK FOR DIMENSIONS OF LANE REDUCTION ARROW.
5. USE THIE NO PASSING WHEN APPROACHING TRAFFIC IS IN ONCOMMING LANES (R54-16B) SIGN UPON APPROVAL OF THE REGION TRAFFIC ENGINEER.

Map Label	Beg MP	End MP	Length	 1 or 2 mi Advance Sign		 1/2 mi Advance Sign		500 ft Adv Sign (Old standard)		 Keep Right Except to Pass Sign	 Intermediate Keep Right Signs (qty)	 Lane Merge Sign	Next Passing Lane Sign
				Present?	Color (G/W)	Present?	Color (G/W)	Present?	Color (G/W)				
SB 1	300.6	299.7	0.9	Y (1 mi)	W	N		Y	W	N	N	N	N
SB 2	260	258.7	1.3	N		N		N		N	N	Y	N
SB 3	104.5	104.1	0.4	Y (1 mi)	W	Y	W	Y	W	Y	N	Y	N
SB 4	78.8	77.9	0.9	N		N		Y	W	Y	N	Y	N
SB 5	76.9	76.7	0.2	N		N		Y	W	Y	N	Y	N
SB 6	53.9	53.5	0.4	Y (1 mi)	W	Y	W	Y	W	Y	N	Y	N
SB 7	45.3	44.9	0.4	N		N		Y	W	N	N	Y	N
SB 8	18.7	18.3	0.4	N		N		N		Y	N	Y	N
SB 9	0.4	0.1	0.3	N		N		N		N	N	Y	N
NB 1	258.8	259.8	1.0	N		N		N		Y	N	Y	N
NB 2	102.4	103.4	1.0	N		N		Y	W	Y	N	Y	N
NB 3	94.2	96.7	2.5	Y (1 mi)	W	N		Y	W	N	1	Y	N
NB 4	87.6	89.1	1.5	Y (1 mi)	W	Y	W	Y	W	Y	1	Y	N
NB 5	74.9	75.2	0.3	N		N		Y	W	Y	N	Y	N
NB 6	73.9	74.4	0.5	N		N		N		Y	N	Y	N
NB 7	71.8	73	1.2	N		N		Y	W	Y	N	Y	N
NB 8	70.5	71.1	0.6	N		N		Y	W	Y	N	Y	N
NB 9	28.5	30.8	2.3	N		N		Y	W	Y	2	Y	N
NB 10	24.3	25	0.7	N		N		Y	W	Y	N	Y	N
NB 11	7.5	9.4	1.9	Y (1 mi)	W	Y	W	Y	W	Y	1	Y	N
NB 12	2.6	2.9	0.3	N		N		Y	W	Y	N	Y	N

G = Green, W = White

Passing Lane Prioritization Criteria

AADT Score

Min AADT	Score
0	3
2,501	6
5,001	9
7,501	12
10,001	15
12,501	18
15,001	21
17,501	24
20,001	27
22,501	30

Truck AADT Score

Min Truck AADT	Score
0	2
501	4
1,001	6
1,501	8
2,001	10
3,001	12
4,001	14
5,001	16
6,001	18
7,001	20

Freight Corridor Score

Classification	Score
Energy Route	15
Interstate	5
Major Route	20
None	0

Crash History Score

Safety Index	Score
Value	Value x 3

Passing Lane Interval Score

Min Interval (mi)	Score
0	0
5	5
10	10
15	15
20	20